CONCRETE STONE MANUFACTURE

BY

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Preface

The development of factory-made concrete units has not kept pace with the development of field-made concrete in mass. Factory conditions are obviously more easily controlled than field conditions and standardization of factory methods and of factory products should therefore be the more readily attained. There is little disposition in any quarter seriously to question the commercial and economic value of properly made concrete building units, and the failure of concrete stone manufacture, as an industry, to develop gigantic proportions can be attributed to nothing else than to the fact that too many individual enterprises have had inadequate managerial and mechanical equipment.

Failures are a necessary part of success. The failures in the field of concrete products manufacture have at least justified the assertion, that, simple as the industry's processes have seemed, they are of a nature demanding skill, judgment and thoroughgoing workmanship. To have discovered even so little as this is to have made a beginning in the way of success.

Many have gone forward much further; some have turned failure into success and there are very few who have not learned through bitter experience. Those who have paid the most dearly for their knowledge are the most generous in giving it away. They have appreciated that ultimate success is built upon public confidence and that public confidence is won for a product when its percentage of failure is low. They have seen that they cannot, in a broad sense, succeed in any way more surely than through the success of others. They are themselves but units in the structure of an industry.

It is this modern spirit of co-operation that makes this book possible. I am indebted to hundreds of manufacturers of concrete products whose letters to *Concrete-Cement Age* have helped to standardize methods in th

field of concrete stone manufacture. They have written frank inquiries and acknowledgments of failure and as frank responses to inquiry and detailed explanations of successful practice. I am especially indebted to those leaders in the industry who have contributed valuable articles and discussions to CONCRERE-CEMENT AGE which have been drawn upon for much material, as acknowledged in the various chapters; and to the numerous manufacturers who have made me welcome in their factories. I am particularly grateful for and make special acknowledgment of the valued service of J. H. Libberton, Principal Assistant Engineer of the Information Bureau of the Universal Portland Cement Co., Chicago; P. E. McAllister, Manager of the O. C. Barber Concrete Co., Barberton, Ohio; Henry P. Warner, President and Manager of the Onondaga Litholite Co., Syracuse, N. Y., and members of the staff of CONCRETE-CEMENT AGE generally. Each of these read a great deal of this book in proof and made valuable suggestions. Of particular value have been the suggestions by Mr. Libberton on Surfaces, by Mr. McAllister on Plant Equipment and by Mr Warner on Sand Cast Stone manufacture.

This book comes from the field. It has been my pleasure to make it, so to speak, a report of progress. It is to be hoped that its influence may in some degree discourage efforts in concrete stone manufacture by those incompetent to add something to the sum of progress in that industry, and that it will be the means of putting many others in the possession of such information, developed in successful work, as will lend impetus and direction to important industrial growth.

HARVEY WHIPPLE.

January 5, 1915.

Chapters

FIG. 1—CONCRETE BLOCK WALLED RESIDENCE, KANSAS CITY, MO.

CHAPTER 1—THE DEVELOPMENT OF CONCRETE BUILDING UNITS

The manufacture of concrete building units is old enough to be the father of the automobile industry, and there are walls of concrete block which were well on in years when the first reinforced concrete building was erected. Examine the record of the progress of the automobile and of reinforced concrete. Examine a similar record of the pre-cast concrete building unit. The development of the automobile and that of the reinforced concrete building have required the closest application, study and investigation on the part of trained men. At the outset, these men have been trained in the sense only that they appreciated the fundamental things involved. Their application, study and investigation constituted the training. The important element in any such development lies in an initial comprehension of the fact that *skill*—the product of application, study, investigation—is an essential in the undertaking.

The "Block Business" has been handicapped in its development by the apparent simplicity of the operations and the problems involved. A gravel bank, a block machine and a shovel—with a little cement—scarcely form an array to tempt either capital or skill. Yet there was some block machine to meet the limitations revealed by any purse and to reveal its own limitations only in the course in which time tells everything. There was also the allurement of "easy money" to be made in an industry for which any man's woodshed afforded ample space and facilities.

Of the thousands who "went into the block business" on these easy terms there are many remaining. The aspect of their route to achievement by assured simplicity and directness has materially changed for most of them. Those for whom this cheerful aspect of the industry *has not* changed remain to be swept aside by *popular disapproval*. Hundreds of men of the bette

FIG. 2—CONCRETE WINDOW TRACERY, MEMORIAL CHURCH, FALL RIVER, MASS.—EMERSON & NORRIS CO.

fibre, promptly disillusioned as to what they might accomplish, discarded this and that machine; tried one method, rejected it and tried another; tested, investigated, studied and kept at it. Other men were eventually drawn to the industry because they came to see in it, not any man's backyard occupation, but an enterprise worthy of the investment of their capital, their skill and their mettle, because they saw the possibilities and the rewards of real achievements.

The manufacture of concrete building units, considered as an industry, is coming into a position of dignity and importance through the opportunity which it affords alike to capital and to competency. The incompetent putterer has been a drag on the industry. Between his works and those of his able, discriminating and thorough competitor, the public has not yet completely learned [illegible] se. The pasty looking, porous "cement block"

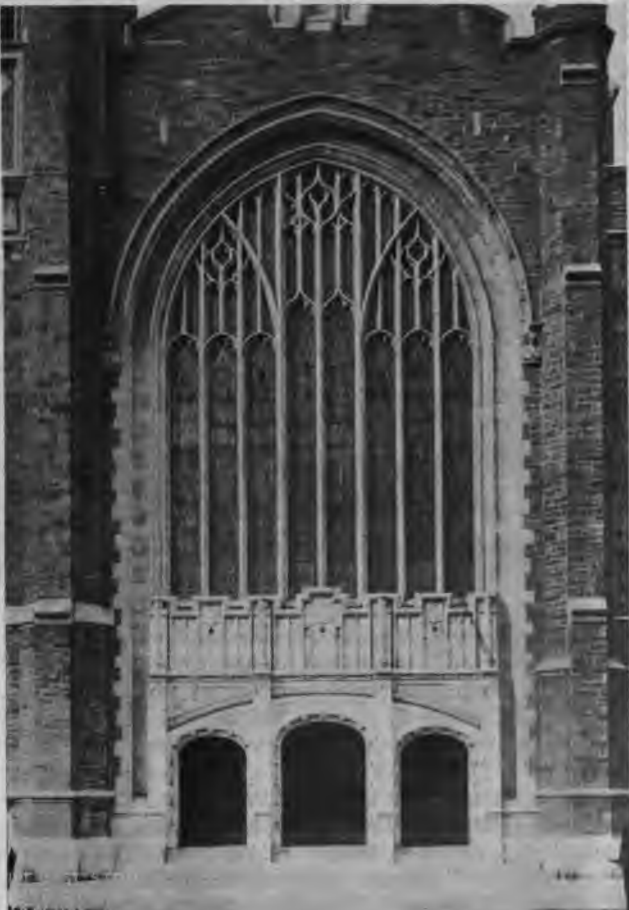


FIG. 3—ENTRANCE AND WINDOW TRIM OF CONCRETE STONE, BROADWAY PRESBYTERIAN CHURCH, NEW YORK CITY—ONONDAGA LITHOLITE CO.

has been in the majority. Because of it, the real concrete unit, structurally sound and architecturally beautiful, *made but sorry progress.* Yet the factory-made concrete *block of quality* has made its impression—has been seen

FIG. 4—ELEVATOR FOYER, BASEMENT, HOLLENDEN HOTEL, CLEVELAND—GEORGE RACKLE & SONS CO.

and used and appreciated at somewhere near its best. Its progress has been slow. It has had to make its way against the prejudices created by unworthy products. It has had to combat that conservatism which requires of a new material proof of quality far beyond that which is expected in the materials with which builders are already acquainted. The concrete block has suffered in being acclaimed a cheap material. It has suffered through the ignorance of human nature which caused it to be urged as a substitute and an imitation, rather than as a material having its own distinctive and superior qualities, its own individual and characteristic charm to commend it to the serious and appreciative consideration of people of sufficient judgment to recognize and value these things.

But there have been pioneers and stalwarts in the industry, men who have come up with it from the beginning and grown with it, and others whose investments of money and skill and study have been drawn into the industry by its show of most promising development along

IG. 5—TWO-FAMILY CONCRETE BLOCK COTTAGE AT DUNBARTON, SCOTLAND.

ines which made it worthy of their best efforts. To all of these will be due the future of the factory-made concrete unit, the synthetic stone, to which Nature has contributed a wealth of beautiful and durable raw materials for man to combine in a beautiful and durable finished roduct.

And while we shall consider more in detail the various u.es in which this *manufactured stone* is to be developed, n order that it may serve at a maximum of usefulness, it seems important here in these introductory considerations to dwell upon the fact that there is propriety in products of different qualities suited to the fulfillment of different purposes.

The best of concrete stone cannot be made to sell at he lowest price. What is true of practically every product is true also of concrete. The fact doubtless marks the limitations—at least the present limitations—in the development of equipment for use in concrete stone manufacture. Improvements are sure to come. It will doubtless develop that the best of concrete stone, structurally, can be made at a price as low as that of some relatively poor products of today. It is certain to come, because proof of it is already evident, that even the cheapest commercial products of concrete are to be of much better quality from an architectural standpoint. Yet the *concrete building* unit is a product so far superior, even *at something less* than its best, to the materials which

FIG. 6—CONCRETE VENEER BLOCK IN GARAGE, NEW BEDFORD, MASS.—STURTEVANT & HOOK.

have gone into the walls of the moderate-priced houses of the past, that it must be developed for this broad field of work. While the best of concrete stone, at from one dollar to four dollars per cu. ft., will be specified in place of granite, marble and limestone, where these materials were once required, there is the other field—the largest field—requiring an attractive wall unit at from 15 cts. to 25 cts. per sq. ft. in the wall thickness ordinarily required. This field is the one in which the greatest development must come—is now coming, in providing something better from every possible viewpoint than can now be had at any price competing with concrete. Architects want this new unit; they know that it can be produced, that *it is being produced,* for walls which are structurally sound and architecturally beautiful.

A proper development in concrete stone manufacture depends upon a study of the market, upon skillful workmanship, economical operation and competent management; upon a utilization of the best available materials and equipment in preference to makeshifts and clumsy, expensive manual labor; it depends emphatically upon artistic perception, upon an appreciation of the demands of the public for materials which shall give beautiful results at a moderate cost, because economy cannot remain synonomous with ugliness; and lastly, the development of concrete stone manufacture depends upon the develop-

FIG. 7—INTERIOR OF RESIDENCE CONCRETE STONE, NEW HAVEN, CONN.—NEW ENGLAND STONE CO.

ment of salesmanship. Successful salesmanship must be backed by all the other factors of success already mentioned. It is the affair of the salesman to project, to focus upon the screen for public recognition, the *results* of the factory efficiency; and in this, his greatest asset is something to show, an example of work well done, an achievement in building for beauty and for posterity.

CHAPTER 2—LOCATION, EQUIPMENT, LAYOUT

A prospective manufacturer of concrete products should not *accept* any location for his enterprise. He should *seek* a location. It is common to look near at hand. A local *opening,* however, should not be mistaken for a local *opportunity.* Every community doubtless requires one hardware store, surely one grocery. Careful investigation will reveal a need or lack of need for a concrete products factory. The same inquiry which is to determine what opportunity there is for the development of a successful manufactory of concrete building units in a small town will serve in selecting a city location. In the latter instance the investigation will merely be more complex and the factors making for success or failure less readily discovered. The locality should, in short, have either a friendly aspect or it should reveal possibilities for being made friendly.

The choice of a general location involves two important considerations:

1. The market for the product.

2. The availability of suitable raw materials.

Many things influence the market. It may be overcrowded, either with products similar to those which it is proposed to manufacture, or with competing products. If it is the concrete products of other factories which are to be met there may be public prejudices to be overcome. If the other concrete products on the market are of high quality the prospects are much better than they would be if the other concrete products were inferior and had been used only in erecting structures which stand as poor advertisements of the material. If the prospective manufacturer sets out to compete with good materials he appropriates some of their established reputation for merit, for his own product.

If it is the competition of local stone or brick of low *price which is to* be met, there must be a full and care*ful consideration of* the way in which that competition is to be handled. Is the concrete product to be offered for structural and architectural merit and sold at a price very nearly equal to or even more than that of the other products—as is done successfully in some few cases—or is the concrete product to be offered for structural value only, with no attempt to make it with architectural qualities of pleasing color, texture and finish? In short, is the concrete product to be offered to the public for exposed walls and trim or for foundations and structural walls which are to be given a covering of stucco or some other veneer, or for the walls of such dwellings and other buildings as are believed to be without any claim upon the right to be attractive, while still economical?

If the prospective manufacturer is to set himself up in a locality where the uses of concrete products have in the past been only in those lines of work last mentioned, he has this situation to combat in his first efforts, unless it is his purpose to serve the same class of building enterprise. If his predecessors have made concrete block of poor quality and have stood sponsor, for instance, for their use in construction where the interior plastering has been applied direct on the block and dampness and dissatisfaction have followed as they frequently do—then the prospective manufacturer should at least discover the truth of the situation and be prepared to face and to answer the community's established prejudices.

To make a good unit—a sound unit—for unpretentious work, or for work where quality and economy must serve together, is a worthy enterprise. It is an enterprise which in most localities can be carried forward with no unit more successfully than with concrete block. But to make a cheap unit—with the emphasis all on that feature—is an unworthy enterprise. It is an enterprise which, in the end, must be unsuccessful, for the reason that where the prime motive is cheapness, quality cannot remain. Eventually. the "cheap unit" will be found to have been dearly bought at a paltry price.

If, then, the aspect is unfriendly, the prospective manufacturer must either look elsewhere or be prepared to lay *siege. He must* have more capital to invest in a *campaign of education,* and by slow methods, by the constant insistence of a superior building unit, he must build up his business.

The general aspects of a locality do not, however, include all of the factors which make a locality desirable. The market will be influenced by the local building regulations. If these hold difficulties, they may not be serious difficulties. The regulations may be inadequate, or they may be too severe. Consider well the possibility of securing the enforcement of building regulations which may be counted upon to discourage manufacturers of poor products and which at the same time will be fair in their recognition of good products.

The situation as to raw materials is also to be investigated thoroughly.

Are there local materials of good quality to be had at a price which will insure a profit on the character of concrete stone to be manufactured?

What are the local haulage problems? What are the facilities for the receipt of materials by rail or by team haul or by boat? Raw materials can be transported a considerable distance and profits still be insured. But the exact nature of the situation should nevertheless be known in advance. In one instance a location where delivery can be made by boat, makes possible a saving of 50% in the price of sand. An idea of possible conditions to be met in this regard will be gained from the chapter on Examples of Layout and Operation. It is usually the case that the raw materials can be transported with greater economy than the finished products.

Processes—General

In a survey of the field in which he looks to find a market for concrete building units, the prospective manufacturer will be confronted very early in his investigations by the necessity for a choice as to the general process which he is to adopt and as to the character of his product. He will have discovered the local conditions as to available raw materials. He will know something of the preferences of local architects and builders. He will have learned the cost and quality of the native building materials. There are three processes among which to choose. He may be prompted in his choice by some previous experience of his own or of others, or the initial investment required will in many cases influence him in a decision. In a general way the difference in the three processes is chiefly in the amount of water used in the mixture of materials which go to make the concrete. A little more, a little less water in the mix, and the limitation has been found for any one of the three ways of molding concrete. The consistency of the mixture determines the way in which that mixture must be manipulated. Not only is it true that a higher or a lower percentage of water in the mixture finds one of the chief points of difference among the three lines of equipment, but it is also true that a little less water than can be successfully manipulated in the equipment of the line which uses the least water is almost sure to result in a poor concrete product, and a little more water than should be used in the process requiring the most water will likewise give an unsatisfactory result. However, the matter of consistency of mixture is properly considered in connection with the materials which make up the mixture and these subjects are taken up in the succeeding chapter.

The prospective manufacturer, having decided upon a suitable location for his factory, and having at least a general idea as to what the nature of his product is to be, must consider the plan and the extent of his factory. The plan or layout will, in great measure, depend upon the process of manufacture and the type of equipment to be utilized. The whole scheme centers in the molding equipment. The choice must be among these three: The so-called "dry-tamp" machine; the pressure machine, each of which involves the use of a small number of mold boxes in which the mixture is quickly molded and quickly released to be taken away to "cure;" or the poured process, involving a relatively large number of molds in which the concrete unit must remain until the cement has set so that the unit can be handled.

Good building units, suitable for creditable construction *and showing* qualities under tests for both strength and absorption which are satisfactory under rigorous building regulations, can be made and are made with each one of the three types of equipment. Not only are products by all three processes showing structural value, but they all have architectural merit. These statements do not hold for *all* the products of all three types of equipment, nor for *all* the products of any one of the three. Nor can it be said that all the equipment offered the public in any one of these lines is equally desirable.

If the prospective manufacturer has convictions as to the desirability of a concrete mixture of a certain consistency, he should not proceed in the selection of equipment with the idea that all the equipment in one line has precisely the same limitations in the manipulation of that mixture of concrete. Wetter concrete can be used in some machines of the dry-tamp class than in others. Further, he should consider the fact that a given consistency will be obtained with more or less water, depending upon the materials used. Crushed stone usually takes more moisture for a given degree of plasticity than gravel and this is but one of the variations to be encountered in the consistency of mixture.

Eventually each products manufacturer must face the truth: that having exercised reasonable care in the selection of equipment of any general type, it is up to his ability and his integrity to produce sound concrete units.

A block machine or a machine for the production of any of the standard building units is designed to attain a few simple results. The machine must provide a box in which the product is molded, holding the concrete mass rigidly in shape while pressure is applied or blows dealt by a tamper. The machine must also attain a simple release of the product from the mold without injury when the compacting is completed. These are the two chief requirements of molding machinery.

Machines are utilized in producing units which are either tamped or pressed. Tamped products are also produced in commercially standard molds of metal or in special molds of metal, wood or plaster.

"Block machines" as commonly understood are not involved in *wet* process manufacture. The wet process

makes use of molds of metal, wood, plaster, gelatin and sand.

DRY-TAMP EQUIPMENT

The dry-tamp equipment has been in most general use. That it has been abused can scarcely be too often repeated. That its use has been many times misrepresented by its salesmen cannot be denied. That its improper use is frequently due to the failure of some users to grasp and apply the first essentials of good concrete, is still evident. Its operation requires that the concrete mixture be placed in the mold box and tamped to a condition of maximum density. The tamping may be done by hand, or with pneumatic tools. or by power-driven machinery mounted above the mold box.

Hand Tamping—In hand tamping everything depends upon the operator. The point is frequently made that

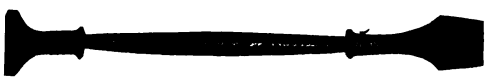


FIG. 8—COMMON TYPE OF DOUBLE-END HAND TAMP

in hand tamping the work is thoroughly done in the morning and not so thoroughly done in the afternoon. It is only natural to suppose that the operator will relax slightly as the day grows old, that his blows are less frequent, and that not only does his output decrease but its quality shows some loss. It cannot be denied, however, that a good workman forms a certain habit in his manipulation of the tamper and that the force of this habit is in the main strong enough in many cases more than to make up the difference between the morning freshness and the afternoon weariness.

A man wielding a hand tamp at maximum efficiency may do good work, and with the exercise of unusual judgment in his work, can do work as well as a machine, though considerably less of it.

Pneumatic Tamping—Pneumatic tampers are used in *products manufacture*. Their use is probably more common *in Europe* than in this country. Manufacture using them find that operators must become accustomed to their continuous jarring and vibration, which because of great rapidity of action are at first very tiring. Accustomed to their use, the operator has in a degree acquired some of the unrelaxing quality of a machine and may be expected to accomplish as much and accomplish it as well at the end as at the beginning of the day.

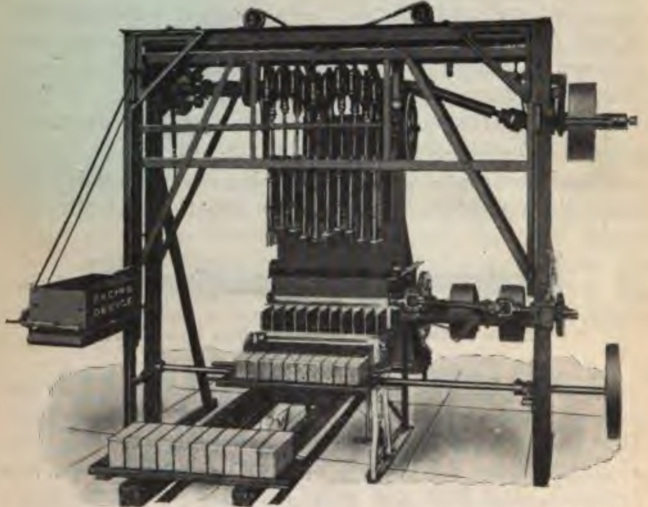


FIG. 9—POWER TAMPER OPERATING IN CONNECTION WITH BRICK MACHINE, EQUIPPED WITH DEVICE FOR HANDLING FACING MATERIAL

Machine Tamping—Machine tamping with well built equipment is the same in the afternoon as in the morning. Its work is uniform, its capacity undiminished by fatigue, and its output is rapid. Tampers have several feet at the ends of plungers so arranged as to fit the type of machine in use, striking the concrete blows of equal force and compressive value over the entire open area of the mold. The plungers are so adjusted as to be responsive to the depth of material in the mold box, the length of stroke varying as the mold box is filled.

Pressure Machines

The application of pressure in compacting concrete is accomplished in both hand and power-driven equipment. Pressure machines are made for the exertion of mechanical pressure by hand or power and other machines are hydraulic in their application of pressure.

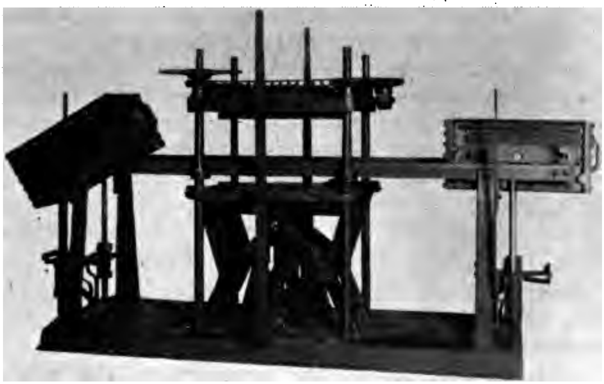


Fig. 10—Hand Operated, Double End, Pressure Block Machine

When the mold box is in position as at right, it is filled; if a faced block is to be made, the backing material is struck off to a depth of ¼" and the facing material put in and struck off. The box is then rolled to the center under the pressure head, and the pressure is applied by means of the toggles, operated by a hand lever; the levers are released, the box is rolled back to its first position, a pallet applied on top and clamped and the box turned over. It is shown turning at the left end of the machine in the illustration. It is released face downward on a pallet, and supported by the framework shown under the mold box, from which it is carried away

In their operation it is generally possible to use a wetter mixture than can be successfully manipulated under most machines which rely upon tamping in securing density. Too wet a mixture in a dry-tamp machine will be displaced by tampers rather than compacted. In pressure machines the compacting force is exerted evenly over the entire area of the mold box, and displacement *is impossible.* Opponents of pressure equipment main*tain that in applying* this pressure evenly over the entire area of the mold box, the sand, cement and aggregate are hindered in slipping into the most dense condition, by an arching action between pieces of aggregate. This claim is based chiefly upon theory and proof by satisfactory tests is lacking. The tendency in this direction would, undoubtedly, vary with the nature of the materials used, as for instance, rounded pebbles are in most cases less likely to set up an arching action than crushed stone. The consistency of the mix and the percentage of excess of mortar over voids in the aggregate would in great measure be controlling factors. The proponents of pressure machinery maintain that the tremendous mechanical or hydraulic force exerted drives the cement, sand and aggregate into a mass more dense than can ordinarily be obtained under tamping.

Wet Process

There is no denial from makers of any of the types of block machines that more water than is used in mixtures either under tamping or under pressure has a remarkable tendency to obtain density in the concrete product. Water causes the materials in the mix to flow together so that each small particle seeks out the space of smallest compass in which it can be contained. Yet too wet a mix with no means for removing the excess makes a porous concrete. The manufacturing problems, however, among which choice is to be made, place upon the side of the tamp and the pressure processes, rapidity of operation with a minimum of molds. The molded product is momentarily released and the mold is ready to repeat the operation. The molding equipment is in small area and the products are carried away from the equipment almost immediately.

The wet process involves either the use of a very large number of individual molds in which the product must remain scattered over a large casting area for from 12 hrs. to 48 hrs. or else it involves the use of molds set up in such a way that they may be conveyed to a curing [illegible] when they are filled. In the method first men- [illegible] the mixed concrete must be moved about over a relatively large shop area and in this case the manufacturer must ordinarily resort to the use of some means of keeping the wet mixture constantly agitated to prevent a separation of cement from sand or mortar from stone. It is obvious that the tendency in a very wet mixture at rest in any kind of container would be for the stone to settle, so that when poured out of the receptacle it would lack homogeneity, the stone and sand and cement in extreme cases being deposited in layers. A means for agitating the mixture, in fact a means for supplemental mixing after the concrete has been discharged from the mixer proper, is generally regarded as essential.

This is obviated only when a means is provided for conveying the molds to the mixture, filling them as the mixer is discharged, and moving the molds away again when they have been filled. It should not be lost sight of that whatever means is adopted to secure density, subsequent to combining and mixing the materials—whether by tamping or pressing or pouring into molds, no amount of tamping or pressing or care in pouring and puddling will give a dense product unless the most scrupulous care has been exercised in the choice, the grading and the mixture of materials. The most skilfully designed block machine, the most vigorous and thorough tamping, the most powerful exertion of pressure, are quite useless in the manufacture of a good product if the mixture put into the mold is lacking in those qualities (considered in the succeeding chapter) which make for density and strength. No concrete block machine has yet been devised which is fool-proof.

Types of Product

In addition to a consideration of the chief points regarding the three processes of manufacture, the prospective buyer of molding equipment will be influenced by the type and quality of products made in various machines and molds.

There are a great many machines on the market; the different principles involved and the main features o operation are comparatively few.

Where the investment involved not only in the central unit of the factory but in the consequent layout and installation of auxiliary equipment is considerable, the prospective buyer should, if possible, see various machines in actual operation, preferably in well-established

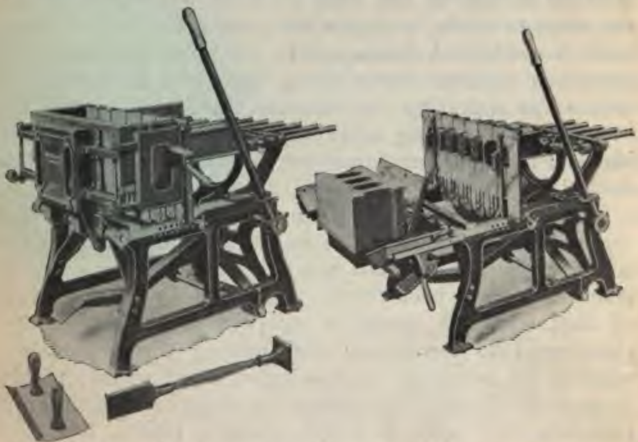


Fig. 11—Two Views of Hand Tamp Face-Down Block Machine Which May Be Operated Under Power Tamper
At the left the machine is ready to be filled; at the right the mold box is open and the block in position for removal on pallet. Cores withdraw horizontally

commercial plants. Such a procedure, of course, prevents one from being a pioneer with any new line. Pioneering should not be discouraged, but with it should go much native sense and an experience as broad as possible with other lines with which comparison can be made, so there will be something upon which judgment can properly be based.

The manufacturers of equipment and their salesmen are in most cases sincere and honest. Their circulars and other descriptive literature are for the most part based upon facts and upon truth as each manufacturer sees it. *The prospective* buyer is advised, nevertheless, to see *equipment in operation* whenever that is possible. This *not because the* manufacturers' representations are not to be believed but because it is not enough that the buyer know that a machine will do—or that it has actually done—certain things. He should know all the conditions under which the things were done. Under precisely what conditions of layout, of material supply, of mixing effi-

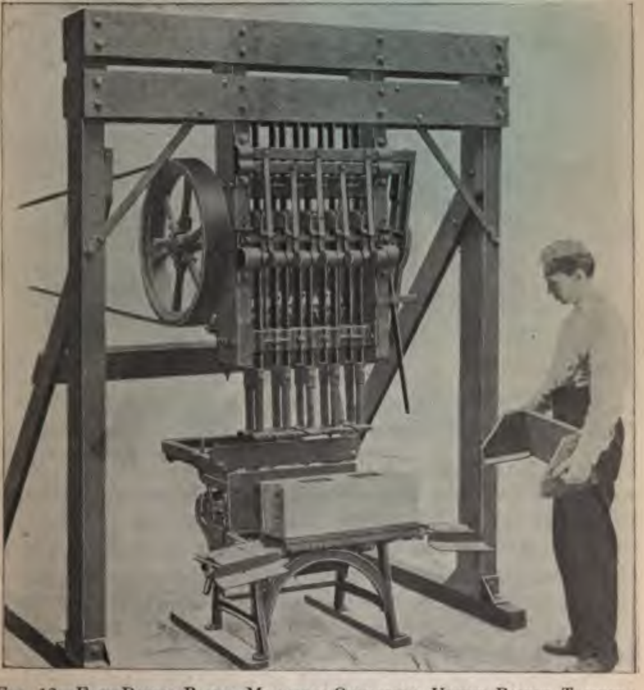


FIG. 12—FACE-DOWN BLOCK MACHINE OPERATING UNDER POWER TAMPER; MAY ALSO BE OPERATED FOR HAND TAMPING

Cores withdrawn (horizontally) and mold box open; the block is about to be removed by means of the carrier held by the operator.

ciency; under what favorable conditions as to labor and materials and curing facilities were records of production accomplished with a certain make of equipment?

Air Space—The standard concrete block which are most *generally* manufactured are from 8″ to 12″ in *thickness, 8″ to 12″* in height, and 16″ to 32″ in length.

Practically all concrete block machines are made to turn out a product which has one or more hollow spaces. The value of the hollow space lies in the fact that it econo-

FIG. 18—DOUBLE-SIDED FACE-DOWN BLOCK MACHINE
Cores are withdrawn downward after block has been turned over

mizes material, gives a product of much less weight than would be possible if made solid, and in the fact that it provides, as laid up in the wall, a series of vertical air ducts which are valuable as insulation against temperature changes and as a barrier to the passage of moisture from one side of the wall to the other. A chief point of difference among the scores of block machines on the market is in the way in which these air spaces are provided, and in general it may be said that that block is the best which comes nearest to supplying a continuous air space, yet with a reservation in this respect: that the strength of the individual unit and the stability of a wall are features of more consequence than air space and not to be sacrificed in any event.

With this idea of the value of air space, machines are on the market which produce concrete block in which each wall unit is made up of two separate pieces of concrete connected by metal ties. This type has been criticised from an engineering standpoint because it is said that the metal ties are likely to rust out and leave no bond between the two parts of the wall. As opposed to this theory, however, many buildings have been in use

FIG. 14—DETAIL VIEW OF HYDRAULIC PRESSURE MACHINE
The mold box is filled with a weighed quantity of material and this revolves under the pressure head; the view shows a block being turned over for removal on pallet after having passed out from under the pressure head.

for a sufficient number of years to give this type of block construction a reasonably good standing, and the success of this type would, undoubtedly, depend in great measure upon the tendency of the particular block manufacturer to make a block which would not absorb moisture and pass it through to the air space where it could attack the metal ties.

Going still further in the development of the idea of air space in the wall, machinery is available to produce so-called two-piece block to be laid up in a wall in such a way as to produce a maximum of air space and yet with systematic bond of concrete between the two faces of the wall. A two-lug block is made for light construction, the face of the block being but 2″ to 3″ thick, with projecting lugs giving a total wall thickness of 8″. Furring is done on the lugs. Block are also made which, when laid up in the wall, give one set of air spaces which

FIG. 15—GANG MOLD FOR 20 BLOCK, MOUNTED ON TRUCKS BEING FILLED WITH SLUSH CONCRETE DIRECT FROM MIXER CHUTE

are to be filled with a wet mix of concrete to insure stability, and another series of air spaces for insulation and as a barrier to dampness.

"Stripper" Block—If block are to be produced solely *for structural* purposes, either out of sight in basement

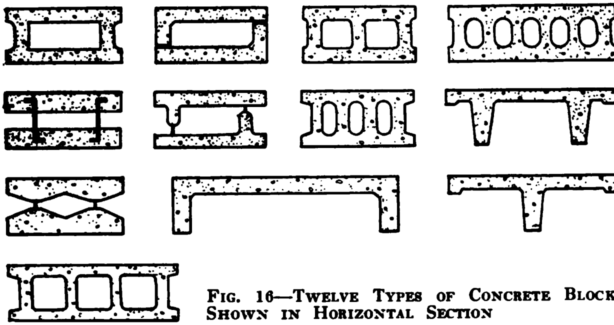


FIG. 16—TWELVE TYPES OF CONCRETE BLOCK, SHOWN IN HORIZONTAL SECTION

walls or in walls which are to have a surface either of stucco or some other veneer, probably the simplest molding operations are available in that type of machine, either hand or power operated, which produces the block upright in the mold and in the machine, introducing and removing the cores forming the hollow space in an upward and downward motion. Thus the faces of the block are always perpendicular to the bed of the machine and the block is "stripped" out of the mold with a troweling action on its sides. The use of such machinery does not admit of the easy application of facing materials or of specially molded faces.

Faced Block—When block are to be produced having exposed faces which are specially molded, a "face-down" or a "side-face" machine will be chosen. In such work, special metal or composition face plates are utilized having on their molding side a reverse of the effect sought in the concrete product.

When block are to be produced faced with a special facing mixture selected for color or texture, or both, and used only in a thin layer next to the exposed face or faces for the sake of economy, the machine chosen will be of the "face-up" or "face-down" type. It will readily be seen that where a layer of special facing material is to be backed up with a different body mixture of concrete, the molding operation will be much more simple if the facing is *placed in a layer* on the bottom or else on the top; in *either case on a* horizontal surface. Where more than one side of a block is to be faced it is, of course, a comparatively simple matter to put the facing at the side, but the operation is not so rapid as when placed on bottom or top.

Operation of Cores—The manufacture of hollow units, in which from 25% to 50% of the horizontal area of a block is air space, involves a variety of machine features in the creation of air spaces.

In most machines the cores are introduced into the mold box by a movement of a lever after a part of the mixed concrete has been deposited and compacted. The remaining space between, around and above the cores is filled and compacted and the excess material struck off, either by a movement of a hand straight-edge or by a device forming a part of the machine.

Some machines provide for the withdrawal of these cores horizontally and some equipment is so designed that after the box is filled the mold box is turned over; the core is then removed by a downward motion. The chief value of equipment which provides that the cores shall be withdrawn downward is in the fact that the walls and the cross-webs of the block stand vertically on the pallet. This reduces the tendency of the walls of the block to sag down into the hollow space or spaces. Such equipment usually permits the use of a slightly wetter mixture of concrete than can be used in a machine with similar core areas where the core is withdrawn horizontally, inasmuch as, with given materials, the tendency to sag increases (beyond a certain degree of minimum wetness) with the proportion of water in the mixture.

The sagging tendency is still further guarded against in some designs by the use of several cores of relatively small area instead of one or two cores of greater area, the walls of the block in horizontal position being put under less strain by reason of the shorter span over the hollow space. An arched core undoubtedly is a further precaution.

The cores, as the block is molded, are in a horizontal *tion and the block* in its vertical dimension is thus also in a horizontal position. (This of course is not a feature of machines designed on the so-called stripper principle—in which the cores and block are always vertical in the machine.)

Output—The number of block which can be manufactured by various methods is not to be considered except in connection with all the conditions. A block machine may make 200 block per da.; another machine 800 block and in each case there will be wide variations depending upon quality of labor and also upon auxiliary equipment.

Special Block—Machines are usually designed to provide for the introduction of division plates for use in making so-called fractional block. Provision is further made for molding block with a great variety of face designs (many of which will in time be abolished as their architectural monstrosity is more generally appreciated), by inserting special face plates in the mold box. In some machines the introduction of standard metal inserts, or special wood or even plaster inserts adapts the machine for turning out special units for copings, corners, watertables, and so on.

There is great variety in the units which can now be manufactured in the mold box of a single machine by the use of the various face plates, division plates, and standard or special inserts.

Sills and Lintels—The possibilities of any one molding equipment must, however, have limitations. So, to supplement his block or other machines and adapt his plant to the requirements of his market, the manufacturer will consider special machines for sills and lintels, large copings and watertables, and standard metal molds for colums, pedestals and caps, balusters and other architectural and ornamental units in great variety.

Structural Tile—Aside from the product commonly designated as block, the prospective manufacturer should consider still more recent developments. His market may have a big place for structural tile—light. thin-walled, hollow units which are manufactured rapidly on power equipment for exterior wall construction, where a veneer of stucco or some other unit is to be used and for interior partitions to be plastered, or for exposed walls when surface texture or design is not of consequence. This unit, in connection with the development of thin veneer block, seems to have large possibilities. It is manufactured in a small unit and in multiples of that unit up to 4. The machine involves the use of knives and plungers which cut the partially molded concrete and force out the center, thoroughly compressing the walls of the tile. Another type of machinery for the manufacture of structural tile uses a very wet mix. The tile are made vertically and the molds of the machine are steam heated, thus securing an acceleration of setting in the cement.

Brick—Brick manufacture is a line which should show strong development in any field where clay brick have to be shipped, or in *any* location, providing the manufacturer chooses to develop his product as a facing material with architectural appeal. Brick machines are of both hand and power types involving in different makes both the tamping and the pressure process, and are made also by the wet process in multiple molds.

Roof Tile—The field of roofing units will be looked into. Such equipment with shallow, tray-like molds turns out concrete roof tile and shingles by a pressing and troweling operation. These units have not had a general development but in some localities have been demonstrated to be a valuable line in products manufacture.

Special Molds—The manufacturer, however, must never feel secure against all demands of architects until he has made provision for the manufacture of building and ornamental units from molds made up especially to order. He should, if he purposes manufacturing a full line of building units, be prepared to turn out models and patterns for these special molds, which are faithful to the architect's details.

Layout

Operations to Be Considered—The chief molding equipment has been considered first because it involves *the pivotal consideration* of the whole plant. It is the *center of things*. Its choice determines the nature of the output and in some measure the quantity of the output. Of the last, nothing has been said because the quantity depends also in great measure upon the auxiliary equipment, the layout and upon the general efficiency of the whole factory.

The principal molding equipment is at the middle point of manufacturing operations. These operations are simple operations for the most part and yet their effectiveness and their economy must depend upon how well thought out is the factory plan in which they are to be carried forward. The principal operations are five in number:

1. Receiving and storing materials—cement, sand and aggregate.
2. Bringing materials together and combining them with water.
3. Depositing and molding the resulting mixture.
4. Conveying the molded product to the place where it will remain under conditions favorable for attaining strength.
5. Removal of the product to the storage yard.

There is still another operation, or perhaps a series of operations, which contributes to the beauty and effectiveness of the product. It has to do with the treatment of surfaces. Some recognition of this phase of products manufacture should and in most cases does precede even No. 1 in the enumeration of operations. Certain other conditions affecting this sixth consideration lie between operations No. 1 and No. 2; again between No. 2 and No. 3, between No. 3 and No. 4, between No. 4 and No. 5, and in some degree after No. 5. These seemingly minor operations and considerations are shown in another chapter to be of major consequence as affecting the availability and therefore the salability of the product, for architectural purposes.

All of the operations as listed are touched upon in this chapter only in so far as they must be considered in the layout of the factory.

Receiving and Storing Aggregates—Development in plant layout and operation has been toward a more general adoption of the idea of first storing the raw materials at a high level; bringing them by gravity to the mixer at a secondary level and discharging and conveying the mixed materials to the molding equipment at the first level. This arrangement has in consequence caused the elimination of much hand labor and the substitution of power conveying equipment. Man-power is costly. The elimination of two laborers will cancel an interest, depreciation and maintenance charge of 25% on about $5,000 worth of equipment.

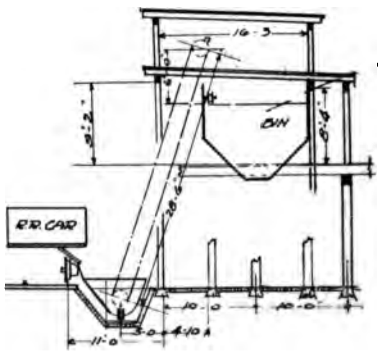


Fig. 17—Suggestion for Elevating Equipment for Sand, Gravel and Stone

The average products plant—if there is an average plant—will have one large mixing unit for body concrete and one unit, perhaps two, for facing materials. In such a plant the mixing units for facing material may be disregarded so far as they are to determine the principal arrangements for storing and conveying materials.

In a large plant with a large output in one particular line, or an average output in several different lines of products, the mixing may still be done either all in one general location, if not all in one mixer, or in different locations, treating each line of products as a plant unit by itself. If various lines are being manufactured, with necessity for a continuous supply of materials of different kinds or grades, the centralized mixing plant would lose most of the advantage which it would have under other conditions.

In one plant of this kind(see description and plan of Plant No. 4 in the chapter on Examples of Layout and Operation) the several mixers are on the second floor. Materials especially for one class of work are put into carts on the first floor, where the storage bins are, and

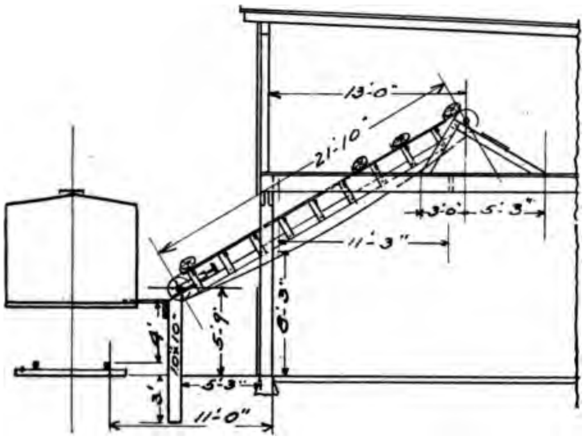


FIG. 18—SUGGESTION FOR ELEVATOR FOR CEMENT IN SACKS

are lifted in the cart on an elevator with an attendant and wheeled to the mixer taking that particular material. Better than this, under ordinary circumstances, would be an arrangement with the mixers on an intermediate level between molding floor and second floor, with the material storage bins at the higher level, and the materials conducted through chutes direct by gravity to the mixers.

Where a plant is in close proximity to the raw materials at the origin of supply (except cement) as in Plant No. 10, each mixing unit need have only a small supply bin or extra large hopper for its particular combination of materials and by means of belt or other conveyors the material can be brought in at intervals from the main supply to replenish the various bins or hoppers. In the instance referred to the main supply is from a complete gravel plant which excavates, crushes if necessary, elevates, washes and screens the gravel, depositing the various sizes in separate bins. These bins feed through gates to conveyor belts the sizes required for a particular mix.

A small plant which is fortunate in being adjacent to the source of the material in a gravel bank which is of good quality will have a more simple means of getting its supply to the mixer.

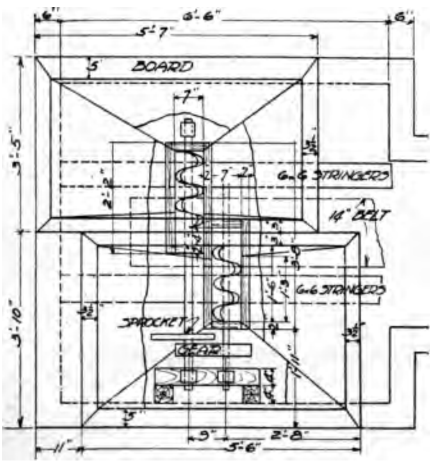


FIG. 19—PLAN, BELT CONVEYOR EQUIPMENT AT OUTSIDE HOPPER. SEE FIGS. 20, 21, 22, 23

In the great majority of factories one grade of concrete mixture will either be used for all work, except facing, or else the concrete requiring the use of materials of different size or a different mix will be so small in quantity as compared with the whole supply that no special provision will be made for conveying it.

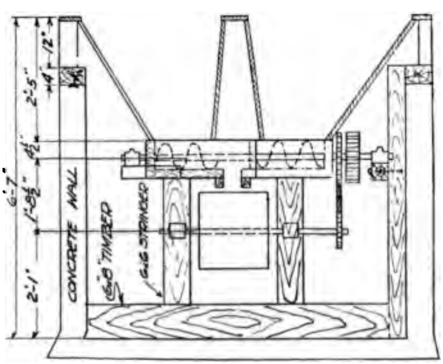


FIG. 20—END ELEVATION BELT CONVEYOR

If the plant is fortunate in having a supply of bank gravel close at hand (and such a supply not infrequently determines plant location) the arrangements are ver

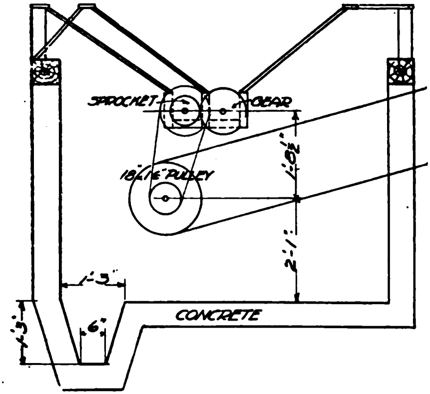


Fig. 21—Side Elevation Belt Conveyor

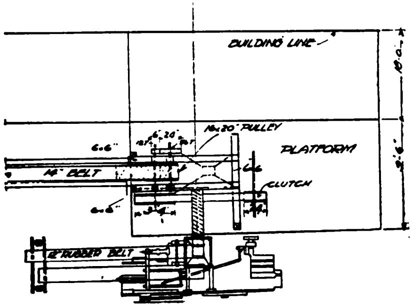


Fig. 22—Plan, Conveyor at Mixer End

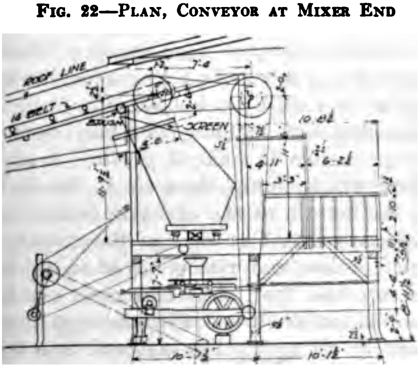


Fig. 23—Side Elevation at Mixer End

The concrete box or hopper (plan, Fig. 19) is in the yard, partitioned to receive sand on one side and crushed stone on the other. These materials are shoveled in; fed through gates to worms, controlled by adjustable gears to feed definite proportions to 14-in. belt. (See also Figs. 20 and 21). Material is conveyed to top of factory by belt (200′ long) which eliminates oversize particles. A brush under belt, returning, removes dust to protect idlers; material falls into chute and hopper to continuous proportioning mixer of special design. The mixer is on the second floor level and the tile machine to which it feeds is on the first floor. Surplus concrete rejected by machine falls on to 12-in. belt (Figs. 22 and 23) and is lifted and deposited on another return belt, which deposits it again in the hopper of the machine.

simple indeed if the supply does not have to be washed, screened and recombined.

In Plant No. 3 where such a condition exists, one man works in the gravel pit removing top soil and loading a dump car which is hauled up a track by means of cable and drum, to the level of the mixer hopper.

A discussion of mixtures and the quality of materials entering into mixtures is outside the scope of this chapter. It will suffice here to say that it is more and more generally recognized that a maximum of economy frequently is not attained in utilizing materials from the nearest or most convenient source. The additional cement necessary in a mixture of poorly graded materials, or the sacrifice in quality of product which is a result of failure to use the higher proportions of cement in a poorly graded mix, is enough to warrant the additional cost of better materials brought from a distance or else the crushing and screening, or screening and washing and recombining of materials near at hand.

In any event, it is best to store sand and gravel or crushed stone under cover, because materials which run uniformly dry are used with a uniform system of manipulation. The uniform condition makes the feed through chutes, hoppers and mixers more uniform. Materials left out to freeze and cake in cold weather require heating or else are difficult to handle, and even then are handled with less satisfactory results.

With a supply of sand and gravel or crushed stone coming in by rail or by team, it will be found economical to dump these into the boot of a bucket elevator which will take them to elevated bins. This boot may be of concrete of rather large section to make it possible to use the special gravel cars which dump their loads through a gate at one side in the bottom of the car with comparatively little work with shovels. The boot of the elevator should be so constructed that material received in other cars can be shoveled into the boot, or if materials are to come by team or motor trucks, the loads could still be handled in a short time by dumping the material into the boot of the elevator.

If materials as received are not in condition to be used, the elevator should feed either to a washer or direct to screens. The screen separators will feed to separate bins the material in various sizes which will later be recombined in proper proportions.

In a plant making a high quality of cast stone by the poured process in sand molds, the fine and coarse material is all of one kind. Marble comes to the plant in rough blocks, most of it 6″ or 8″ in size, and is fed to a crusher and reduced to about ½″. This feeds into a bucket elevator and is taken to the top of the plant and fed to screens. Dust goes into one bin and further separation is made into various sizes up to ½″. As there is an excess of dust, much of this is used in the casting room instead of sand for making the molds. The materials for mixing come to scales through chutes, and each batch going into the mixer is made up of a definite weight of each size of material, and combined with a measured quantity of water. Inasmuch as marble in two colors is used—one blue and one white— two sets of bins are required. (See Plant No. 1.)

When the initial expense of elevating and screening apparatus is to be avoided, it is necessary to buy materials clean and suitably graded. These may be handled in carts or barrows to the mixer.

By some such arrangements as in Plant No. 2 or Plant No. 9 the gravel or stone may be stored in open pits or bins at the ends of the plant nearest the railway and by having the mixer immediately in front of these bins, the mixer can be charged by carts or wheelbarrows moved from material storage to mixer over runways placed at a level which depends upon the height of the mixer.

Such an arrangement is particularly satisfactory where all the concrete is turned out by one mixer and especially where most of the concrete molded is handled in one large piece of power equipment. In such a case if the mixer is raised just high enough so that it discharges onto the feed table from which the mixture can be scraped into the mold box by means of a short handled hoe, the handling of materials is greatly minimized.

If, however, with such an arrangement for receiving and storing materials there are several smaller pieces of molding equipment, then the cost of handling either the raw materials or the mixed concrete would undoubtedly warrant the use of elevating equipment and overhead bins. With several pieces of molding equipment distributed over rather large shop area, either several mixers must be used, placed close to the molding equipment with a consequent necessity for wheeling sand, aggregates and cement, or there must be a large mixing plant close to the supply, with the necessity for wheeling or otherwise conveying the mixed concrete to various places in the factory. Better than wheelbarrows and carts with such a layout of equipment is some arrangement of overhead trolley with bottom dump buckets which are loaded at the mixer and run to each piece of molding equipment to be dumped into a hopper or onto the feed table. In this connection, note the systems in use in Plant No. 3 and Plant No. 10. In the case of the first the block machines are in one direct line and the space for making dimension stone is on the opposite side of the trolley. In the other factory, which is on a large scale, the mixers are on a relatively high level and the trolley system operated in this instance by electricity has numerous switches and makes a wide circuit to serve a large manufacturing area. Some power-operated molding equipment can be had with auxiliary elevating machinery to pick up the concrete from a hopper at floor level and deposit it in the mold box.

These various systems should be understood as merely suggestions of certain general features which are desirable. Each plant will have its own special problem. A close study of the variety of factory layouts, shown in detail in another chapter, will make it possible to suit certain systems of storage and conveying or combinations of these various systems to the precise needs of each individual factory.

Cement—While cement is usually first named among *the raw materials it is* not first considered in factory layout. *The sand and* gravel or crushed stone supply with relation to the mixing and molding equipment is first to be thought of.

As to general considerations in the storage of cement and the effect of storage upon its setting qualities, C. W. Boynton* is quoted:

Cement stored in a dry atmosphere will remain in good condition for an indefinite length of time, although aging for any considerable period will tend to lengthen the setting time if moisture is present in the surrounding air. Cement naturally has an affinity for moisture and will absorb it at every opportunity. The result of such absorption is the lumps which are to be found where cement has not been stored properly. Screening out the lumps puts the cement in good condition.

The cement should be stored as near as possible to the level of the hopper which feeds the mixer. This may be at the second floor level, chutes being used for cement as well as aggregate, or it may be at a level between the first and the second floor determined by the level of the mixer itself. If cement is to be stored in bags on the second floor a chain or belt conveyor will give economical results. If a railway siding is on a trestle as planned for Plant No. 10; gravity conveyors, with ball bearing rollers in frames in easily portable lengths and set at a slight grade, starting at a convenient height above car level, will give a rapid means of handling, or if the cement is to be unloaded at a low level, it can still be handled on gravity equipment by the use of inclined or perpendicular elevating devices. If the mixer is set low as in Plant No. 2 or Plant No. 9 the cement may be piled where it will be convenient for placing on top of a cart load of gravel or for emptying direct into the mixer. An arrangement like that in Plant No. 7 is undesirable, as the mixer is set high so as to discharge onto a feed table and the cement must be carried up a flight of steps. In this case, the gravel is elevated to the mixer by bucket elevator, the material being shoveled from near by supply piles. The cement should also be lifted mechanically.

If the mixer is at an intermediate level cement may be unloaded and piled on a platform at that same level. One *manufacturer*, using a 3-ton, 4-wheel truck 18"

*CONCRETE-CEMENT AGE, Oct., 1914, p. 158

high, finds that he can unload 980 bags of cement from cars and pile in a location convenient to mixer in a little more than 4 hours, using but one man. Each truck load is about 30 bags. The average distance covered from car door to pile is 30′.

Cement received in bulk is as yet not fully tried out, but many manufacturers look on the idea with favor as avoiding loss of bags and lifting of bags. The lost and damaged cotton bags and freight on their return represent a considerable item in some instances. Manufacturers experience trouble in getting employees to see that bags at 10 cts. each are expensive mop cloths in wiping up water and dirt and expensive as pads under dimension stone finished or in process of finishing.

The use of mechanical bag bundlers and insistence upon every bag going to the bundler as soon as emptied should go a long way to reduce losses from this cause.

In reference to some of the general advantages in handling cement in bulk H. M. Capron says*:

The damage to bulk cement in transit by reason of a leaky car is by actual experiment shown to be 50% of the damage the same amount of water would inflict in falling on cement in cloth sacks. The reason for this is that when water comes in contact with the cotton cloth by capillary attraction it spreads to the adjacent sacks so that a leak in a car roof will frequently ruin a whole tier of sacks from top to bottom of car, and damage a large part of the cement contained in these sacks. If water falls on bulk cement it is absorbed immediately where it falls and the resulting damage consists of a crust of cement depending in size on the amount of water, while the damage is confined to the spot immediately under the leak and all the damaged cement can be lifted from the car in this cake.

Experience has shown that the handling of bulk cement does not raise so much dust as cement in cloth sacks. The cement sifts through the sacks with the many handlings so the natural cohesion between the particles is broken and the dust is blown away or falls off. The method of handling it in bulk saves all this waste. The method of handling, of course, varies with the physical conditions surrounding the work. * * * The bulk cement is moved from the car by a scraper similar to that used for unloading grain. With this the cement is scraped

*In an address at International Good Roads Convention. CONCRETE-CEMENT AGE, Oct., 1914, p. 173

from the door of the car into a chute which feeds into the bottom of the elevator leg. From the bin the cement falls by gravity through a measuring box into the mixer-hopper. Thus we see that the only labor connected with delivering the cement into the mixer is that required to unload the car with the device described above. Two men in one hour can easily unload a car containing 250 bbls. of cement in bulk.

As to the storage of cement in bulk, S. W. Hartwell says*:

Where cement is stored in bulk, with only a small surface exposed to the atmosphere, the writer has known cement to be stored for considerably longer periods than 9 mos. to 10 mos. without the setting qualities being appreciably affected in any way.

Bulk cement handling has not yet been so thoroughly tried out in concrete products factories as to warrant any further statement on the subject than to say it has been found economical where large quantities of cement can be unloaded and used at a central plant. It is therefore believed to have a future in products factories. Its possibilities should at least be thoroughly investigated.

Molding Equipment—The molding equipment should be located with relation to the supply of mixed body concrete and facing material. The latter will be in small batches from small mixers, placed convenient to the bins of special facing materials. Space should be provided back of the molding machines for racks and shelves for pallets, face plates and insert molds, in fact space for at least as many pallets, plates and parts as are to be used by machine operators in a day's run. There should be racks for reinforcing rods.

Tracks, Cars and Curing Rooms—It is only in factories of the most limited output or in wet process factories using a large casting floor that products will not be loaded onto cars to be conveyed to curing rooms. In plants of very limited output, the products may be carried on pallets to racks either in closed sheds free from sun and draughts or in steam curing rooms. The use of the rack system for storing products to cure is, however, fast disappearing because it involves too much handling of the products. There are still many products plants, however, without steam curing and in such plants

*Concrete-Cement Age, Oct., 1914, p. 158

the rack system is largely in use because a very number of cars is required to hold the products fc length of time in which products must remain undist when natural curing is depended upon.

If, however, the plant is small and cars are not used the block should be racked as near to the machi possible. The racks may be of 2 x 4's and each 16′ to 20′ long. One rack can readily be made to a modate 26 block, 8″ x 8″ x 16″. These racks c piled about 4 high. Four rows of racks will thus a modate about 400 l

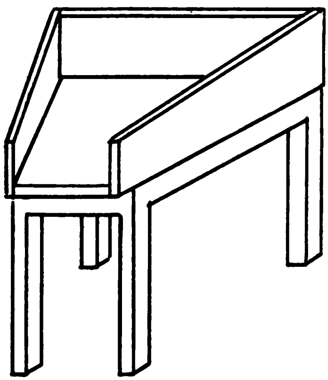


Fig. 24—Suggestion of Boxed-Top Table for Mixed Concrete to be Scraped into Mold Box of Block Machine

It will readily be that with a large o the rack system is bersome and necess a great deal of labc

With natural cı the products are us removed from the ca be put upon racks a steam curing the ucts are left on the for from 24 hrs. t hrs. Enough cars s be provided for two output so that products may remain 48 hrs. in the steam room. Transfer cars, running on tracks of much wider gauge than the block cars, obviate the installation of a number of turntables, so *that in running* the *block cars onto trans-*

Fig. 25—Partial View of Thri Block Car

fer cars to be moved at right angles it is readily seen that the transfer tracks must be at a lower level. The level will be the lowest of the floor levels; the next higher level will be the level of the rails for block cars in both factory and curing rooms. It has been found to contribute to easy and economical operation to have the level of the block car rails somewhat lower than the floor on which the block or other machines stand. So the cars at the track-ends nearest to molding equipment are in pits so that the machine operator stands 6″ to 10″ above them. This makes it possible to use cars with 4 decks instead of 3 decks without necessitating an inconvenient lift to the top deck. Cars are usually about 8′ to 10′ long and 2′ to 3′ 6″ wide. Such cars will accommodate from 36 to 48 standard block, depending upon size and type.

FIG. 26—VIEW SHOWING TRACK LEVELS; BLOCK MACHINE AND OPERATOR HIGHEST; BLOCK CAR IN THE PIT AND TRANSFER CAR AT LOWEST LEVEL IN LOWER LEFT HAND CORNER

In small plants with one, two or three hand-tamp machines, it is enough to have one track and therefore one car pit convenient to each machine. When the car is full the operator shoves it to the curing room and brings in an empty car. With mechanical tamping or power presses and consequent larger output, or with more hand-tamp machines, there should be two tracks to each machine, so that when one car has been filled the operator begins filling the lowest deck of the other car, and another man employed for the purpose moves cars to curing rooms and brings up the empties. The car decks usually will be detachable. The car on which the operator begins work will have but one deck and when that is filled the top deck from the other car will become the second deck of the first car. When the first car is full, the first deck of the second car will be available for block made until an empty is returned with all the decks.

The factory should be so laid out that the track system involving the movement of cars between machines and curing rooms and from curing rooms to storage yards does not interfere with the movement of raw materials. The factory should, so far as possible, be so laid out that material keeps going in one general direction from its entrance to the factory as cement, sand, gravel and crushed stone to its departure as completed building units.

If dimension stone is to be manufactured as is the case in most factories, in addition to standard machine made units, the dimension stone department should have the same relation to material supply and track system as does the machine department. The special stone department will have to be more spacious as its requirements ordinarily are for more men and for a great variety of building units. These will be made on bankers, which are rails. placed at a convenient height (ordinarily 24" to 29" but differing with individual requirements) from the floor supported by posts. On these rails planks are laid to support the special molds. Cars should be as accessible as possible for the smaller units which are carried on heavy pallets by a molder and his assistant. Heavy pieces should be handled either by a traveling crane or by a movable derrick or hoist. If lighting standards and similar large units are to be made, provision should be made for a large amount of extra space. Such units are ordinarily left to cure on the molding floor, covered with wet cloths. The extra space should take care of such accumulation which cannot be moved for a week or more.

Location for Surface Treatments—Surface treatments subsequent to molding or casting must be given special consideration in the factory plan.

If products are to be sprayed with water as taken from the mold, extra space should be provided between the machine or mold and the car. It should be borne in mind that the spraying results in a mussy condition of the floor and the location of this operation should be apart from other work with the floor, draining to a sump which can be frequently cleaned out. Otherwise the cement washed away in the spraying operation would in time clog an ordinary drain.

If products are to be scrubbed with water or an acid solution, or are to be dipped into acid or coloring solutions, or otherwise treated, either after partial curing or after final removal from the curing rooms, more convenient and agreeable arrangements can be made for a special room at the outlet end of the curing rooms.

If tooling or polishing, either by hand methods or with special power equipment, is required, this work should be provided for as mentioned above. In the case of the wet process, where large casting floors are used a means must be provided for removing the products from the molds and conveying to benches or machine tables.

In a large plant where sand cast work has been highly developed the machine tooling and hand rubbing are done at one end of the large casting floor, and products too heavy for easy lifting are handled by means of a traveling crane and by a derrick having a boom with a wide sweep. Low cars operating on narrow tracks in aisles between beds of casting sand may be used for lighter pieces.

Pattern Shop—The pattern shop, with woodworking machinery and with facilities for handling plaster and gelatin for special molds, should be located with reference to the special stone department, because it will serve that department.

Drafting Room—The drafting room will serve the pattern room and the plan of the factory should recognize this fact. The general office is the next in line but it should also communicate direct with the factory proper.

Power

Individual power units for each piece of power operated equipment are growing in favor. An electric motor or gasoline engine may be used when required and power supply turned on and shut off at pleasure. Power transmission ceases to be a problem and a source of danger as with numerous belts and shaftings. Steam was at first in great favor with products manufacturers because exhaust steam was utilized in curing. It has been found, however, that with large output exhaust steam is not satsifactory. If live steam is to be used, the power for machinery may be economically considered as a separate matter, with a boiler used exclusively for heating and curing.

General Features

Aside from the specific requirements of equipment and layout there are some desirable general features in a factory building.

The building should, if possible, demonstrate the materials which it manufactures. This imposes a difficulty in requiring that the building units be made before the factory is erected in which to make them. Even this is not an insurmountable difficulty. A temporary plant may be utilized. When this is not feasible the factory proper may be constructed and later an office front be constructed with concrete building units.

In addition the factory plan should include a show room where products are on exhibition. For that matter, the whole factory should be exhibited. It should be so operated that architects and builders may come and see for themselves how it is done.

Light in Workrooms—The conditions under which men work make a great difference in their efficiency. If the place is light and ventilated, with as high a ceiling or roof as possible, the influence on the men is sure to be such as to effect their output both as to quality and quantity. Walls can be painted or whitewashed where the window area cannot be increased. The expense will be small indeed as compared with the results obtained.

CHAPTER 3—MATERIALS, MIXTURES, MANIPULATION

There are but three necessary ingredients in making concrete: Portland cement, aggregate and water.

The quality of the resulting product, so far as the materials themselves are concerned, is dependent first, upon the quality of these materials; second, upon the proportions of the materials; and third, upon the way in which they are combined and mixed. Aside from these factors, results are independent of the materials themselves and involve efficiency in handling, curing and finishing.

The materials, however, are of basic importance. Good concrete products cannot be made with poor materials and infinite pains and rare judgment are not too great a price for quality in raw materials. It is a matter of clearly demonstrated economy in the manufacture of concrete products to go far and pay a seemingly high price for the raw materials of concrete upon which the concrete's quality, its commercial value and therefore the success of its manufacturer must depend. The material which is cheapest and nearest at hand will frequently prove to be the most expensive.

CEMENT

Standard brands of Portland cement can usually be depended upon to conform to the specifications of the American Society for Testing Materials, and these insure a safe and sound cement. Individual shipments may, however, be unsafe for use in products manufacture either because of exposure to dampness or because of insufficient ageing, and less frequently because of some fault in manufacture.

Tests—Concrete products manufacturers will not, ordinarily, undertake elaborate tests of cement. A simple test is for constancy of volume. Thoroughly mix a paste of cement and water of such consistency that a slight pressure will bring moisture to the surface and yet which will not stick to the fingers. Make this paste into pats which are about 3″ in diameter and ½″ thick at the center, tapering to a thin edge all around. The molding should be done on a sheet of glass and each pat should be placed on a piece of glass about 4″ square. The pats should be covered by a damp cloth which is to be supported above and not touch the pats, and kept in this moist atmosphere for 24 hrs. At the end of this period one pat should be left to cure in air for 28 das.; another should be placed in water for the same length of time. The temperature of the air and that of the water should be as near 70° F. as possible. The third pat should be given an accelerated test by being suspended in a vessel containing water (the glass on which the pat rests being supported above the water) and the water brought to a boil. The vessel should be covered loosely and the boiling continued for five hrs.

Each of these pats, tested as described, should show no warping or distortion or cracks at the edges. If distortion or cracks do appear, expansion is indicated and the cement should not be used in products manufacture. If these defects are evident in the steam test, it may be because the cement has not sufficiently aged and another test 28 das. later is likely to give satisfactory results. If, however, the repetition of the steam test shows unsoundness in the cement it should not be used. In the air and water tests slight hair cracks may develop and may usually be disregarded. In the air-cured pat even a slight curling at the edges is likely to indicate merely a carelessness in the preparation of the pat, too much water or too dry an air in which it was cured.

If there are any serious doubts as to the soundness of the cement for products work, thorough laboratory tests are recommended.

Aggregates—General

Aggregates are the materials of whatever size or nature (except of course, water) which are mixed with cement to make concrete. These include, so far as the products manufacturer is concerned, sand, pebbles and crushed stone, and to some extent slag, with perhaps undeveloped possibilities in the use of cinders in making partition block. It is common to consider the sand or the "fines" from the crushed stone as one thing and the coarser material as something quite different. In one sense this is unfortunate, because the good qualities of one are the good in the other and a bad feature in one is equally undesirable in the other. This is particularly true in the field of the concrete products manufacturer. The difference between fine aggregate and coarse aggregate is in size only and even then the dividing line is arbitrarily fixed.

Clean Materials—All aggregate, whether fine or coarse, should be clean. First it should be free from all vegetable or other organic impurities. The presence of only ½ of 1% vegetable impurity in sand used in a concrete mixture caused the collapse of a concrete building.* So far as could be judged by appearances. the sand was satisfactory. The impurities had been washed down into the sand bank from the soil above.

Second, the presence of clay or loam, though free from organic impurity, may be and usually is highly undesirable. If the materials are coated with clay or loam, such coatings are very apt to interfere with a good bond by preventing the cement from coming in contact with the materials to be bonded. Unusually thorough mixing will have a tendency to minimize the danger. It is true that tests of tensile strength have been made showing that as high as 15% of clay loam added strength to the 1:3 mortar. Its value was as a void filler, but is not a desirable void filler in concrete products. The concrete products manufacturer will not frequently use 1:3 mortars; he will use 1:2 mortars. And in the richer mixtures the admixture of clay is distinctly to be avoided because the presence of the clay does not admit of a full development of the binding value of the cement. Further it has been shown that the presence of clay does not permit so rapid a strength development as in a clean mixture.

**Taylor and Thompson* "Concrete Plain and Reinforced," pp. 154B *and 159A.*

Durable Materials—Aggregates should not only be clean in the sense of being free from all impurities tending to weaken the concrete, but they should in themselves be durable. Soft sandstones should be avoided. All stones which split in layers or break in thin pieces and have marked planes of weakness should be avoided. Limestones differ greatly in hardness and strength and only the best should be used. Stone which crushes in angular fragments is desirable. Durable concrete cannot be made with aggregates which are not of a durable nature.

Well Graded Aggregates—The aggregates should be in such sizes and the quantity of each size in such ideal proportion to the quantities of materials of other sizes that the mixture will settle together into the smallest possible space with the least amount of space between the various particles. This consideration may, under ideal conditions, be one which affects the choice of materials only. It will be found in most instances, however, that a well graded aggregate is a factory problem. It is up to the manufacturer to buy materials which are clean and durable and ***as well graded as possible*** and then proceed to secure a well graded product by ***grading*** the materials which he obtains.

Gravel or Stone—Concrete products of high quality can be made with either crushed stone or gravel.

Albert Moyer says*:

Short time tests for compression strength usually show broken stone concrete to be superior, but long time tests of from six months to a year show gravel concrete on an average to be equal if not stronger.

Crushed limestones, especially when there is a rather high percentage of fine material, will undoubtedly admit of the use of more water in a mix for a given degree of plasticity than sand and gravel. Whether or not that excess of moisture becomes available later for the cement is probably still debatable.

Fine Aggregate

Fine aggregate is commonly designated as that which *passes a ¼-in. screen.*

P ᵔhlet No. 6, Vulcanite Portland Cement Co.

Dust—It has been common to specify that the fine aggregate shall not have a percentage higher than 5 to 10 passing a 100-mesh screen. When a good quality of hard crushed stone is used, practice has shown that a higher percentage of stone dust may safely be used.

Albert Moyer writes:*

It so happens, however, that quarry tailings or screenings from the best crushed stone when made into briquettes for tensile strength tests, will show far greater tensile strength in long time periods than will the best quality of sand mixed in the same proportions. The writer has in his possession a broken briquette made of 1 part Portland cement, 2½ parts quarry tailings which contained 33% of fine dust, which briquette in two years' time broke at 1,000 lbs. per sq. in.

In actual commercial practice in the manufacture of a high quality of wet cast stone, percentages of stone dust in excess of the customarily specified quantities are used with excellent results.

In this, however, much will depend upon the thoroughness of the mixing process and upon the wetness of the mix. Where mixing is so complete as thoroughly to incorporate the dust particles throughout the mass, dust undoubtedly serves an excellent purpose in giving density, yet with insufficient water and less thorough mixing the dust will as surely prevent good bond.

Coarse Aggregate

Coarse aggregate is commonly understood to be that which is retained on a ¼-in. screen. The maximum size will depend upon the nature of the product, upon the surface treatment of the product and upon its thinnest section. No aggregate should exceed in size one-half the smallest section of the product. Whatever the maximum size, the aggregate should be well graded.

Water

The water used in mixing concrete should be clean—free from impurities. Water is not merely used to make a plastic mass of the cement and aggregate so that it is easily manipulated. Water is an essential ingredient. Portland cement does not become cementitious until well *mixed with water.* Impurities in water are dangerous.

**Pamphlet No. 6,* Vulcanite Portland Cement Co.

They may prevent a proper development of the binding qualities of the cement.

DENSITY

The most desirable quality in concrete building units is strength.

The second consideration is that they shall resist the elements.

The third consideration (when the units are to have exposed surfaces) is beauty.

To be strong, concrete must be dense; to resist the elements, concrete must be dense; to remain beautiful when exposed to the elements, concrete must be dense.

Density in concrete depends upon well graded materials, properly proportioned and well mixed.

With a supply of uniformly dry aggregates separated into various sizes, but having the same specific weight throughout, that combination of the various sizes will have the greatest density which gives the smallest volume for a given weight, or inversely the greatest weight for a given volume. Strive to obtain the greatest weight in the smallest space. That is fundamental in selecting, combining and subsequent manipulation of materials. To obtain that condition in concrete is the object of all tamping, pressing and puddling, yet these operations are utterly unavailing if the materials have not been properly selected and properly combined.

To combine materials properly the sizes and proportions of sizes of the materials must be known.

To repeat: in obtaining a good concrete mixture, the aggregates must be of a hard, durable nature. They must be free from soil and impurities. They must be free of any coating of a foreign nature which will interfere either with the setting of the cement or the contact of the cement with the whole surface of each particle of aggregate large and small. The chief value of the Portland cement is as a glue—a mineral glue which is to coat completely every particle of aggregate so that a good bond will be obtained. Its further value is found in the fact that it is so finely ground that when properly mixed in the presence of sufficient moisture the cement enters the minute interstices in the aggregate and fills the spaces between and around the particles of aggregate —spaces too small for the finest of the aggregate itself to enter.

It will at once be seen that if the aggregate is poorly graded so that the spaces are large and numerous, much more cement will be required to secure density than would be the case with a well graded aggregate.

In specifying sand, practice is growing away from an insistance upon sharp sand. It is now generally recognized that well graded sands with rounded grains give better results, because greater density is obtained.

Sand grains should run from fine to coarse because such a mixture will leave the smallest percentage of spaces to be filled by cement.

Most sands will be found to possess from 30% to 40% of voids and those voids must be filled with cement. The cement should, in fact, exceed by fully 10% the known voids in the fine aggregate, and the fine aggregate should exceed by at least 5% the known voids in the large aggregate.

S. B. Newberry says:*

The density and percentage of voids in concrete material may be determined by filling a box of one cu. ft.. capacity and weighing it. One cu. ft. of solid quartz or limestone, entirely free from voids, weighs 165 lbs., and the amount by which a cubic foot of any loose material falls short of this weight represents the proportion of voids contained in it. For example, if a cu. ft. of sand weighs 115½ lbs., the voids would be 49½-165ths of the total volume, or 30%. The following table gives the percent of voids and weight per cu. ft. of common concrete materials.

	% Voids	Wt. per cu. ft.
Sandusky Bay sand	32.8	111.7 lbs.
Same through 20-mesh screen	38.5	101.5 "
Gravel, ¼" to ⅛"	42.4	95.0 "
Broken limestone, egg-size	47.0	87.4 "
Limestone screenings, dust to ½"	26.0	122.2 "

It will be noted that screening the sand through a 20-mesh sieve, and thus taking out the coarse grains, considerably increased the voids and reduced the weight; thus injuring the sand for making concrete.

The following figures show how weight can be increased and voids reduced by mixing fine and coarse material:

*From "Concrete Building Blocks" by S. B. Newberry, published as *Bulletin No. 1 of the Assn.* of Am. Portland Cement Mfrs.

	% Voids	Wt. per cu. ft.
Pebbles, about 1"	38.7	101.2 lbs.
Sand, 30 to 40 mesh	35.9	105.8 "
Pebbles plus 38.7% sand, by vol	19.2	138.5 "

Experiments have shown that the strength of concrete increases greatly with its density; in fact, a slight increase in weight per cu. ft. adds very decidedly to the strength.

Proportions

There is a constant growth of sentiment against the use of bank-run gravel and crusher-run stone. With such materials the grading is unknown. The proportions are at best a matter of guesswork.

The Illinois Highway Commission, in proportioning bank-run gravel, requires that the volume of material passing a ¼-in. mesh screen be equal to 6/10 of the volume of material retained on a ¼-in. screen.* Such proportion may be used without modification, the cement to sand ratio being constant for a given class of concrete. Even this requires a frequent sieving of the gravel to maintain the proportions so that more stone or more sand may be added as occasion requires. The supply seldom runs in constant proportions. Unknown proportions result either in a poor product or a waste of cement. It has been demonstrated that there is actual economy in screening and recombining materials to maintain constant proportions.

The development of the concrete products industry must eventually entail a careful combination of materials. This will mean a more general adoption of methods for positive control of raw materials.

If sand and gravel or crushed stone are shipped in, these materials will be elevated, screened and deposited in bins to be recombined in exact proportions. Further progress will be in a more general use of crushers in products factories. Spalls from the quarry will be reduced in the crushers of the products manufacturer. This will contribute especially to facing possibilities in the development of local materials. The crushed stone will be elevated, screened and recombined.

Such methods will make for standard products, of unvarying quality, of absolutely controllable color, texture

**Engineering Record*, Feb. 3, 1912

and general characteristics—products of constant quality as to absorptiveness and strength.

Determining Proportions—A test of proportions of materials of various sizes may readily be made by means of trial mixtures. Placed in a cylindrical mold or vessel, that mixture is the best in which the greatest weight of like materials is contained in the smallest space.

Proper proportions may also be arrived at by a mechanical analysis of the aggregate passed through screens of various sizes.

Robert F. Havlik accompanies a discussion* of this method with a table of sizes and qualities.

From Mr. Havlik's paper:

For any given amount of cement, the strongest concrete is produced from that combination of aggregates the mechanical analysis of which, when plotted to a curve by the coordinate method, forms a parabola, passing through the zero ordinates and the intersection of the diameter representing the largest stone with the 100 per cent ordinate. This method was discovered by William B. Fuller in 1901, and is discussed in detail by him in a special chapter in Taylor and Thompson's *Concrete Plain and Reinforced.*. The percentage by weight of the aggregate smaller than given size can be easily calculated by the formula for the parabola, $d = \frac{P^2D}{10,000}$ or $P = 100 \sqrt{\frac{d}{D}}$ in which P = percentage of mixture smaller than any given diameter; d = any given diameter; D = largest diameter of stone used.

Table I gives the percentages by weight that are required of any size aggregate to form an ideal mixture.

Too much emphasis can scarcely be put upon the proper grading and proportioning of materials to attain the prime object density—and to *attain that object with the greatest economy.*

Much is said to urge the use of coarse sand, but the fine aggregate or the coarse aggregate should not be uniformly coarse. A coarse sand without a very high proportion of cement will give a product of high permeability. The permeability of a concrete product is the rate at which water will pass through it. It is increased by large openings. A uniformly fine sand with-

*Paper before National Assn. of Cement Users (Am. Concrete Institute) in *Concrete*, June, 1912.

TABLE I.

This table shows the percentages by weight of any size aggregate required for an ideal mixture, the largest aggregate of which corresponds with one of the sizes given below. For example, if the largest stone is 1" in diameter, the per cent of each of the other sizes is found in Columi 3. The material smaller than .015" includes the cement. These data are figured by the formula $P = 100\sqrt{\frac{d}{D}}$ as explained above.

1 Diameter of Stone in Inches.	2 % Smaller Than Diameter to Left.	3 % Between Dia. to Left and Next Larger Dia.	4 % Smaller Than Diameter to Left.	5 % Between Dia. to Left and Next Larger Dia.	6 % Smaller Than Diameter to Left.	7 % Between Dia. to Left and Next Larger Dia.	8 % Smaller Than Diameter to Left.	9 % Between Dia. to Left and Next Larger Dia.	10 % Smaller Than Diameter to Left.	11 % Between Dia. to Left and Next Larger Dia.	12 % Smaller Than Diameter to Left.	13 % Between Dia. to Left and Next Larger Dia.	14 % Smaller Than Diameter to Left.	15 % Between Dia. to Left and Next Larger Dia.	16 % Smaller Than Diameter to Left.	17 % Between Dia. to Left and Next Larger Dia.
1.00	100.0	0.0														
.75	86.5	13.5	100.0													
.50	70.6	15.9	81.6	18.4	100.0											
.30	54.7	15.9	63.3	18.3	77.5	22.5	100.0									
.25	49.9	4.8	57.7	5.6	70.6	6.9	91.4	8.6	100.0							
.20	44.7	5.2	51.6	6.1	63.3	7.3	81.6	9.8	89.5	10.5	100.0					
.15	38.7	6.0	44.7	6.9	54.8	8.5	70.6	11.0	77.4	12.1	86.5	13.5	100.0			
.10	31.6	7.1	36.5	8.2	44.7	10.1	57.7	12.9	63.2	14.2	70.6	15.9	81.6	18.4	100.0	
.05	22.3	9.3	25.8	10.7	31.6	13.1	40.8	16.9	44.7	18.5	50.0	20.6	57.8	23.9	70.6	29.4
.02	14.1	8.2	16.4	9.4	20.0	11.6	25.8	15.0	28.3	16.4	31.6	18.4	36.5	21.2	45.7	24.9
.015	12.2	1.9	14.2	2.2	17.6	2.4	22.3	3.5	24.5	3.8	27.4	4.2	31.6	4.9	38.7	7.0
Smaller than .015		12.2		14.2		17.6		22.3		24.5		27.4		31.6		38.7
Total..		100.0		100.0		100.0		100.0		100.0		100.0		100.0		100.0

out a large proportion of cement will give a highly absorptive product. Having a large number of small openings, it will be very porous and take up a great deal of water by capillary action.

The ideal sand is one in which the particles are graded in size. With such a sand a minimum of cement may be used.

To say definitely what mixture of cement to aggregate is to be used is to minimize the importance of what has already been said, to the effect that every manufacturer should thoroughly study his materials. The mixture in products manufacture should, ordinarily, be between 1:4 and 1:6, with a still richer mixture when the aggregate is all comparatively fine. The mixture of cement with fine aggregate should rarely be leaner than 1:2. Cement should always be proportioned with the fine aggregate. The proportion of larger aggregate will depend upon the aggregate itself. There is no arbitrary rule of proportion. Every set of conditions demands its own solution. The larger aggregate should not be in so high a proportion to cement and sand that the sand will not be sufficient to exceed the voids in the large aggregate by at least 5%.

In further emphasis of what has already been pointed out: In any concrete work requiring as rich a mixture as in factory-made concrete products, where all the aggregates are small as compared with those employed in large field construction work, there is full justification, in safety and in economy, for screening aggregates and recombining them in proper proportions.

Measuring Materials

In measuring materials, general practice is divided between determination by weight and by volume. Concrete stone of the best quality obtainable is made in factories where measurement is by volume, although the prevailing opinion in theory, at least, is that quantities should be weighed.

If cement is used in bags, the unit of measurement is already provided in weight, equal to approximately one cu. ft. If cement is used in bulk, discretion is on the side of weighing a quantity for each batch, because cement measured loose falls far short of cement when packed.

The principal argument in favor of weighing the aggregate is that a given volume of aggregate of uniform size will weigh far less than aggregate well graded. Supposing an aggregate were used in which the particles were of uniform size, the resulting product would not be improved by a greater volume of poorly graded material (enough to make the necessary weight) because the product would be more porous with more aggregate than with less, as an increase of volume would increase the total voids. It is to be taken for granted that the matter of grading has been taken care of previous to measuring out the material for a batch of concrete. If the materials are well graded, measurement by volume should give an accurate result. If they are not well graded, weighing will not grade them. Another argument in favor of weighing is that the volume will vary with the moisture content, because moisture will force the sand grains apart. It must also follow that weight will also vary with the amount of water in sand. The products manufacturer should keep his sand dry.

Weighing is valuable as a check upon the way the materials are running. If the weight of a cubic foot of material of any size used in a mixture is predetermined for the ideal condition of that material, weighing will check with the volume measurement and a trial weight will indicate whether or not that material is running true to form. If it is not, new proportions are the indicated remedy.

Quantity of Water

The amount of water to be used in a mixture to obtain a given consistency will vary with the nature of the material. Most crushed stone will take more water than gravel to produce a given consistency. The consistency itself must vary with the nature of the molding equipment. In the use of machines and other molds from which the product is to be removed almost immediately, *the mixture should be just as wet as possible consistent with the limitations of this process of manufacture.*

The greatest fault found with the so-called "dry-tamp" method of manufacture is this limitation which is placed upon the quantity of water used in the mixture. This fault is not necessarily so serious as the products manufacturers themselves have made it. The block machine operator prefers a dry mix. It is more easily manipulated and when molded slips away from the face plates more easily. If made too wet the molded product will not stand up. Yet much more water *can be* used than *is* used in most cases without a sagging in the product. It is a matter deserving of the closest watchfulness and supervision until operators can be made to use a wetter mixture, even at some sacrifice of quantity of output. As for the sticking of the facing to the plate, it has been found that while a mixture of a certain degree of wetness is more apt to stick than a mixture a little more dry—*it has also been found that a little more water instead of less will give the same result.*

Mixing

There has been great progress in mixing efficiency. Mixers have been designed to meet practically all requirements of concrete work of every nature. The concrete products manufacturer's mixing plant is stationary. He has no problems of getting about here and there with his mixer. He has wide latitude in making a selection. It is assumed that hand mixing is out of the question. At best, it is far from being as thorough as is probably possible with the poorest mixing machine. The mixer will be chosen for capacity and continuous service and reliability. To suggest what particular type of mixer should be used is unwarranted, as there are no data upon which to make sweeping decisions.

A few years ago there was quite a general disapproval of the continuous type of mixer for use in products maufacture. The disapproval was based upon dissatisfaction with the machines in maintaining correct proportions. The batch mixer was considered the only safe type of mixer to use. Yet when cement, sand and stone *are carelessly measured* in shovels and wheelbarrows, it *is not to be expected* that even a batch mixer will be positive in its proportions. Both batch and continuous mixers are used with satisfaction. Whichever type is used the manufacturer should be assured that proportions of materials are correct.

If a continous mixer is used, he should be assured that the materials feed properly. This will depend in many instances upon the auxiliary equipment—upon the continuity and equality of flow of materials to the mixer. With dry materials stored under cover the feed is more readily controlled. Alternate damp and dry materials have repeatedly given trouble in continuous mixers. Hoppers feeding to the mixers should be kept filled to an even height, as change of pressure will influence the feed.

With batch mixers the problem of constant proportions is less a mechanical problem. It is, nevertheless, of equal importance that the materials go into the mixer in constantly equal quantities.

Uniformity of product is dependent upon uniformity of materials as to kind and quantity.

Agitating a Wet Mix—In wet process (poured) work, it is possible to use too much water. A wetter mixture can be used in sand casting than in water-tight molds, because the excess water is taken up by the sand. A mixture should not be so wet as to cause a rapid separation of materials. To obviate that separation in the mixture, it is general practice to agitate the mixture after it comes from the mixer. This may be in a motor-driven agitator carried by an overhead crane, from which the mixture flows only a few feet into the molds. In some plants the agitator is driven by a crank operating paddles within a cask which is moved about on trucks over rails. The mixture is taken off in pails through a spigot and poured immediately into the molds. To some extent —and more notably in one very large eastern factory— there is no agitation of the mixture except by puddling with sticks after the mixture is deposited in wood molds.

e mixed concrete—of a consistency to pour—is con-*d in 12-qt. pails,* four at a time in wheelbarrows.

Duration of Mixing

The length of time in which mixing should be continued is being considered with more and more regard for its importance.

It has been commonly specified in concrete work that mixing shall continue until the mixture is of uniform color and homogeneous throughout. This leaves a great deal to individual judgment as to what is homogeniety. The best practice now is to prolong the mixing process.

A Discussion* of the Time Required for Machine Mixed Concrete by W. M. Kinney is quoted:

It is a lamentable fact that very little attention is paid to the length of time of mixing concrete by machine, more stress being laid upon the number of cubic yards of concrete mixed and deposited during the day's run than upon the amount of mixing each batch receives. The mixing of the concrete is important in all work, and especially so in the construction of concrete roads. Recent specifications for concrete roads adopted by the National Conference on Concrete Road Building and the American Concrete Institute require that mixing by machine shall be continued for 45 sec. after all the materials have been deposited in the drum and furthermore, the speed of the drum of the mixer is confined within certain limits, depending upon the rated capacity in cu. ft. of unmixed material, as shown in the following table:

Rated Capacity cu. ft. unmixed material.	Capacity bags of cement 1:2:3 mix.	Revolutions per minute of drum Min.	Max.
7 to 11	1 ..	15	21
12 to 17	2	12	20
18 to 23	3	12	20
24 to 29	4	11	17
30 to 33	5	10	15

Within certain limits of wetness of mix, water is an undoubted aid in the process of securing a homogeneous mass. It follows that dry mixtures such as are used in "dry-tamp" work should remain in the mixer for a longer time than wet mixtures.

Two Mixings—Some manufacturers favor two mixings. One foremost in mind as this is written is in a New England factory where a stone is manufactured giving very high tests for compression and as a customary corollary, a very low absorption. The general character of the stone is such as to recommend it for trim in the best of architectural *work*. The aggregate is a mixture of

*Concrete-Cement Age, Oct., 1914, p. 162

crushed limestone and crushed granite, measured by volume. The stone contains a large amount of dust. Hydrated lime equal to 15% of the weight of the cement is added. All the materials are mixed dry in a batch mixer and deposited through a chute to a continuous mixer on the floor below. Here the mixing is continued and the water added. The consistency is such that the mixture piles up in a cone, yet when it slips down the slope of the cone it forms balls. It is a sticky mix. It is deposited in wood molds and hand-tamped—using 15-lb. tamps. The water content is high enough to produce a sloppy mix in a sand and gravel mixture, but is not sloppy in this instance because of the stone dust and the hydrated lime. (Further reference to this plant, No. 11, is to be found in Chapter 10.)

Facing Mixtures

Facing mixtures, in the manufacture of stone which is not of one mix throughout, are necessarily drier than mixtures for backing. This is particularly true in stone work which is not to have a tooled, brushed, sprayed or acid-treated surface. Wet mixtures do not give attractive texture. The surface demands treatment to give it character. Dry or semi-wet mixtures give better textures, but unless carefully proportioned, mixed and placed, are frequently highly absorptive, resulting—when the surface is smooth and composed of fine particles—in discoloration after exposure. A very rough facing of larger, colored aggregates than ordinarily used does not suffer so severely by absorption, as discoloration is less evident.

Facing mixtures are best considered in connection with surface treatments and general architectural appearance. These subjects are discussed in another chapter.

"Air Bubbles"—The tendency toward the formation of air bubbles in wet cast concrete in tight molds of wood, metal, plaster, etc., has presented a serious problem to many manufacturers. A discussion* by H. P. Warner, of the prevention of these pockets which seriously injure the surface appearance of concrete stone, brings out *these suggestions:*

*Concrete-Cement Age, Nov., 1918, p. 227

For the elimination of air bubbles in products made in wooden molds with a very wet mixture, we have a gyratory process by which the material is poured in the molds while placed on a large platform which is kept constantly in vibration. This platform has a vertical rise and fall of approximately 6 in. and is driven by a 10-h. p. motor. By this method we find very few air bubbles resulting in the finished product. If the pattern is rapped sharply with a hammer immediately upon being filled the results are very similar, on a smaller scale.

Careful "spading" has a tendency to fill these pockets by permitting the fine material to move into the air space. This may be done with a stick or rod.

Hydrated Lime—There is a growing tendency to use hydrated lime in concrete mixtures for various purposes. It should not be used to displace any part of the cement deemed necessary to give a good product. It should be *added to* the cement. The amount which it is generally considered advisable to use is limited to 10% of the weight of the cement. Some manufacturers of purely ornamental products use as high as 25% by weight of the cement. It is used in quantities as high as 15% in building stone manufacture. Until further tests and investigations have been made, discretion limits the quantity to 10%.

Hydrated lime gives a more plastic mixture. It gives a concrete of lighter color. It acts as a void filler. Its use is discussed by E. L. Conwell,* as follows:

Referring to the use of calcium hydrate in a mixture of cement and coarse torpedo sand in the manufacture of hollow wall tile, we consider this of a very great benefit. The effect of the hydrated lime will be greatly to enhance the plasticity of the material so that it will flow much more readily and fill the molds. The hydrated lime will cause the composition to flow uniformly, i. e., it will prevent settling out or segregation of the cement and sand, thereby giving a material which will attain greater strength. Owing to the well recognized ability of lime more perfectly to fill the voids in a cement mortar mixture, the finished tile should undoubtedly be more dense and also somewhat lighter in color. A further benefit will be a lower capacity for absorption.

As to the variety of calcium hydrate to be used, we would certainly recommend hydrated lime manufactured by a reliable firm. It is quite difficult to proportion either paste or

*CONCRETE-CEMENT AGE, Oct., 1914, p. 161

whitewash made from slaking lime, and in addition, either of these is likely to contain such impurities as existed in the lump lime, while properly prepared hydrated lime is freed by mechanical means from such impurities as unburned stone, clinker, cinders, etc. Unless the hydrate used is known to be manufactured under strict chemical control, we would advocate that samples of various hydrate be obtained and made into small pats, using equal parts of Portland cement and hydrated lime. These pats should be 3″ in diameter, ½″ thick at the center, tapering to a thin edge and should be made up on glass. After storing for 24 hrs., these should be placed in boiling water for 3 hrs. At the end of this time they should be observed for signs of checking, cracking, warping or disintegration. The hydrates, the pats of which show signs of any of these, we cannot endorse for such use. It, of course, goes without saying, that the cement used in making these pats should be sound itself, i. e., pats of the straight cement treated in this way should show no signs of checking, cracking, warping or distortion. This test is one that can readily be carried out and has been found quite reliable for showing up in the hydrated lime the presence of elements which may cause the destruction of any structure in which it is used.

Preventing "Sticking"—In preventing concrete from sticking to molds, practice has developed the methods suggested by P. E. McAllister and Adolph Schilling, as follows:*

Mr. McAllister says:

For wood molds we have had very good results from using paraffin dissolved in coal oil; iron molds, either coal oil or "three in one" oil; for plaster molds we use mutton tallow and coal oil; and for glue molds, "three in one" oil.

Mr. Schilling says:

For wood molds use a thin mixture of lard and lard oil, or liquid waterproofing, or dampproofing; when this coat is thoroughly hard, rub with cloth slightly moistened with mixture of lard and lard oil, before each cast is made. This same mixture can be applied to iron molds, but mixtures can be thinned with kerosene.

Prepare plaster mold with a mixture of linseed oil and yellow beeswax; let this soak well into the mold; after two days wash with kerosene; before each casting brush mold with mixture of stearic acid dissolved in kerosene. This should be very thin.

For glue or gelatin molds when glue is well hardened, prepare a coating of 3 parts alum and 1 part formaldehyde. This hardens the surface of the glue and protects it against the action of cement, so that several casts can be made. Before each cast brush freely with mixture of stearic acid and kerosene.

*Concrete-Cement Age, Aug., 1914, p. 75

Care must be taken to screen glue after remelting, to eliminate the hard, thin coating, which has become insoluble under the action of the formaldehyde.

Standard Practice

The standard practice in the manufacture of concrete architectural stone, building block and brick, of the American Concrete Institute is quoted below in so far as it treats subjects embraced in this chapter.

Cement. The cement shall meet the requirements of the Standard Specifications for Portland cement of the American Society for Testing Materials.

Aggregates. The aggregates shall be clean, hard, durable materials, and shall have no coating of clay or other substances which would in any way interfere with the bond between the cement and the aggregate.

(*a*) *Fine Aggregate.* The fine aggregate shall consist of sand or crushed stone graded from fine to coarse, all of it passing when dry, a screen having ¼-in. diameter holes; not more than 6% of it passing a sieve having 100 meshes per lin. in.

(*b*) *Coarse Aggregate.* The coarse aggregate shall consist of gravel, crushed stone or other suitable material graded in size, which is retained on a screen having ¼-in. diameter holes.

(*d*) *Water.* The water shall be clean, free from oil, acid, strong alkalies or vegetable matter.

The proportions of cement to aggregate shall be such as require at least the minimum amount of cement to produce strength and density as hereinafter specified. The proportions of the various sizes of aggregates and cement to aggregates shall preferably be made by weight. If by volume, a bag of Portland cement shall be considered 1 cu. ft.

(*a*) *Measuring Ingredients.* Methods of measurement of the proportions of the various ingredients shall be used which will secure separate and uniform measurements of cement, fine aggregate, coarse aggregate and water, at all times.

The ingredients of concrete shall be thoroughly mixed dry, sufficient water added to obtain the desired consistency, and the mixing shall continue until the cement is uniformly distributed and the mass uniform in color and homogeneous.

(*b*) *Relation of Cement and Aggregates.* Concrete shall be mixed in the proportions of 1 part Portland cement to a total of not more than 6 parts of fine and coarse aggregates measured separately. In no case shall the proportion of fine aggregate used in the concrete mixture exceed 3 parts fine aggregate to 1 part cement.

Machine Mixing. The mixing shall preferably done with a machine mixer of a type which insures the proper mixing of the materials throughout the mass.

Consistency—(a) *Wet Process.* The concrete must have at least a sufficient amount of water to make it so soft that it must be handled quickly to prevent it running off the shovel, but not so thin as to cause segregation of the materials.

(b) *Semi-wet Process*—The material shall be mixed with the maximum amount of water permissible, and must have sufficient water so that the mixture will hold its form after being compressed in the hand.

Retempering—Retempering or using mortar or concrete 40 min. after being mixed shall not be permitted.

Reinforcing—All lintels, bearing stones and other members subjected to cross bending shall be reinforced by means of rods placed about 1½" from their tension surface, and the total sectional area for the reinforcement shall not be less than 8/10 of 1% of the cross-sectional area of the concrete in the member reinforced. When any member exceeds in any dimension eight times its least dimension, it shall be reinforced to insure safety in handling.

The Importance of Data—In grading, proportioning and mixing and in the proper manipulation of mixtures, the manufacturer is urged to make tests and trials of everything which enters into his work.

Much good concrete stone is made without the manufacturer being able to tell just exactly what materials and methods produced the result, and without knowing what slight variations of materials and methods produce different results. Because of the same condition of apathy and lack of a spirit of investigation and progress, many manufacturers have not analyzed their methods with that close observation which reveals the elements of poor work and the causes of unsatisfactory products.

CHAPTER 4—CURING

GENERAL CONDITIONS

After water has been added to Portland cement and aggregate, the manipulation of the mixture and the subsequent handling and protection of the product should be with due regard for three considerations:

1—The time of the initial set of Portland cement places a limit upon the manipulation of the mixture.

2—The conditions for curing must be such that the product will not be rapidly dried.

3—Temperature influences the hardening of concrete. Heat quickens it; cold retards it; and freezing interrupts the hardening process for the period in which this low temperature continues.

The process of hardening may be said to have been put under way when the water was added. The time in which all manipulation of the concrete must be completed will vary somewhat with the cement. Some cement is quick setting; other cements are slow setting. The time in which the mixed material should be handled is ordinarily between 20 min. and 1 hr. In most cases concrete should be handled within 30 min. from the time it is mixed. Concrete should not be retempered—remixed with additional water. Within the half hour the mixture should be placed and the molded product, at rest and undisturbed, should be left to cure in a moist, warm atmosphere, sheltered from the sun and protected from draughts.

The number of letters of inquiry containing such questions as: "How long should concrete blocks be left to *dry out* before being used?" suggests a strong emphasis on the fact that in curing concrete products *the thing above all* NOT *to do is to permit newly made products to dry out.* The idea of "drying out" is farthest removed from proper curing methods. Keep the products moist. This is particularly true of all products made by any *other than the wet* (poured) process. Dry-tamped con-*crete or concrete* molded under pressure has no moisture gives a fine, well diffused spray. The nearer the spray approximates a floating mist, the more thoroughly it will do the work, reaching all surfaces of products stored in tiers on racks or cars.

In an eastern plant where nearly all products are made in special wood and plaster molds, with a consistency which is wet and sticky and yet so firm as to require tamping, there are interesting arrangements for sprinkling the products after removal from the molds. This is ordinarily 24 hrs. after casting in the case of large products, or but four hrs. to 5 hrs. for small products of a character not subject to easy breakage. On 10-ft. centers each way throughout the large casting floor are water outlets with 10-ft. lengths of hose and fine spray nozzles. A man is kept all night in the plant and it is his particular duty to spray all products. This spraying is done for four das. to five das.—being continued as necessary throughout the day as well as at night. Then products are carefully watched. If they lighten in color evenly over their entire surface, then all sprinkling is discontinued. Yet any product which dries or lightens in spots is subjected to further sprinkling until drying is observed to be uniform. This manufacturer puts great stress upon this feature of the work, which is in strong contrast with the haphazard way of sprinkling products when somebody happens to think about it, as in many plants.

In this part of products manufacturing, as in the selection of materials, it should never be lost sight of that uniformly good products demand uniformly thorough and efficient methods of curing.

Curing Under Water—In curing ornamental products, some manufacturers make sure of supplying sufficient moisture by submerging the products in a tank of water. This is varied in other cases by filling urns, flower boxes and similar products with water and covering them outside with wet cloths. When either of these methods is used, products are covered with wet cloths for about 24 hrs. and are then either submerged in or filled with water.

Standard practice adopted by the American Concrete Institute provides as to Natural Curing:

Natural Curing—The concrete products shall be protected from the sun and strong currents of air for a period of at least seven das. Throughout this period they shall be sprinkled at such intervals as is necessary to prevent drying, and maintained at a temperature of not less than 50° F. Such other precautions shall be taken as to enable the hardening to take place under the most favorable conditions. Products must not be removed from the yard until they are 21 das. old.

Steam Curing

Prevalent practice in steam curing is to use wet steam at a low pressure—to create a dense, warm fog, with all the moisture which can be introduced at a temperature in the curing rooms of a little above 100° F. While general opinion favors limiting the temperature of steam curing to a maximum of 130° F., there are strong arguments in favor of a much higher temperature and further argument based upon investigation tending to show that steam under pressure up to 80 lbs. can be used safely and efficiently in the development of stronger products in shorter periods than with steam at comparatively low temperatures and pressures.* As for the commercial value of relatively high pressure steam, it is doubtful that this will be apparent to many from the outcome of such limited investigations as have been made, chiefly perhaps for the reason that the gain in time in putting products through the curing rooms is not enough to warrant the large outlay which would be necessary in providing steam-tight compartments. The gain in time is by no means comparable to the time gained by using steam curing at atmospheric pressure as compared with the slow natural curing methods.

Curing Rooms—In providing steam curing rooms there are certain general features of importance. The rooms should be long, low and narrow, accommodating one, two or three car tracks.

*See Concrete-Cement Age, Aug., 1912, p. 51. The tests are fully reported in Technologic Paper No. 5, United States Bureau of Standards, entitled: "The Effect of High Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete." Further references: *Cement Age*, Mar., 1912; Concrete, Apr., 1911, in paper by *R. F. Havlik.*

They should be long and narrow for convenience in subjecting one lot of products to the treatment by means of simple pipe lines without leaving a great deal of space open for the introduction of other products from time to time. In other words, the three-day output which the rooms should accommodate, in order to provide for winter conditions, is best divided if possible into half-day outputs. This arrangement is best so that the steam treatment may be begun without too much delay

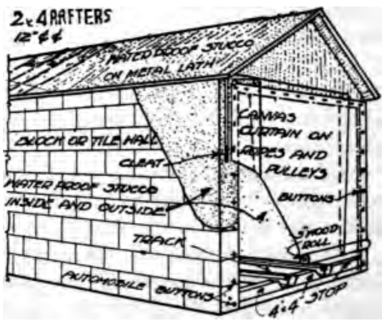


Fig. 27—Sketch Showing Construction for Use of Rolling Canvas Curtains at Inner End of Steam Room

and when under way need not suffer in efficiency from too frequent interruptions by opening doors.

The curing rooms are built low so that heat and moisture will not be wasted. The warm fog should be kept low in the room so as to envelop the products.

The ceilings should be so built as to shed water to the sides. The condensation will be great and if the condensed moisture drips on freshly made products they are likely to be damaged. The arch form of roof is most generally favored and is readily constructed on metal fabric, covered heavily on both sides with Portland cement plaster. The walls themselves may be of concrete block, or of concrete poured in place.

Curing Room Doors—The curing rooms should open *both ends so that* products may be placed in the rooms from one end as convenient as possible to the molding room, and taken out at the other end for removal either to storage yard or to finishing room. The ends should be closed by means of doors so hung as to be out of the way when oper They may be hinged at the top or slide upwards, balanced by counterweights. These doors should be so built as to withstand the conditions of moist

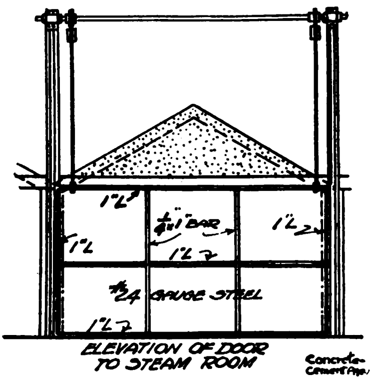


FIG. 28—SKETCH OF LIGHT METAL DOOR FOR STEAM ROOM

air on one side and relatively dry, much cooler air on the other side. Specially treated canvas curtains may be used, made to roll up and down and to fasten by carriage buttons at the edges. In making such curtains allowance should be made for shrinkage.. Curtains are frequently used at the entrance end of curing rooms. Galvanized sheet metal lightly framed with wood or iron has given satisfaction in door construction. Other manufucturers favor matched lumber, kept well painted. Suggestions as to the treatment of canvas curtains are as follows:

By A. E. Cline*:

I have had experience with but three methods of using canvas curtains, viz., plain canvas and treatments of boiled linseed oil and a patent waterproofing especially made for canvas.

The boiled oil was the most successful of the three, the plain canvas next and the waterproofing last. With the last named

*CONCRETE-CEMENT AGE, March, 1914, p. 131

preparation the canvas rotted in one-third the time that it did when untreated. With the boiled oil, the canvas curtains remained flexible and lasted for about four mos., when they had to be renewed. Steam seems to be very hard on canvas; it will not last very long in any case, but the curtains are handy, not expensive, and generally preferable to doors for the inside ends of the steam rooms.

By C. W. Boynton:*

We understand that the Techno-Chemical Recipe Book by Grant and Wahl, page 386, describes a material for waterproofing sail cloth which we believe might be used to advantage in this case. The preparation is as follows:

Seventy-two parts boiled linseed oil, six parts iron sulphate, four parts zinc sulphate. Heat these materials together and boil for several hours. (Possibly to dissolve the iron and zinc sulphate, although on this we are not positive). When cool mix with 60 parts oil of turpentine and apply as a paint.

By S. H. Wightman†:

The best preparation to waterproof canvas roll doors and at the same time not stiffen the canvas, which would interfere with the rolling and cause cutting at points where the cords came in contact with it, undoubtedly is Preservo. This can be obtained in colors (brown is best) at about $1.25 per single gal., $1.00 in 5-gal. lots, 55 cts. in bbl. lots. Ship chandlers usually carry this material.

The roll type of door is often the most suitable. Never oil canvas, as this tends to rot it. Paraffining canvas takes the life out of it, and it shrinks more when put to service. A double or triple filled canvas, No. 10, which is about a 12-oz. cloth, will give the best service. It can be obtained in any width up to 10′ for about 4½ cts. per sq. ft.

A 3-in. wood roll should be used at the bottom, to prevent puckering. A 4-in. x 4-in. timber can be placed at the floor line between rails to form a stop. On the sides, automobile curtain buttons can be used after shrinkage has taken place.

Supply of Steam—Steam should be introduced into the curing rooms in such a way as to be well diffused. It should envelop all the products.

Exhaust steam is commonly used, but in large plants such a supply is likely to be insufficient if the rooms are long or numerous. Exhaust steam, ordinarily, is not available continuously for 24 hrs. and the best practice demands a constant supply of steam. This is absolutely necessary in cold weather if good products, rapidly cured, are to be made possible. The difficulty may be overcome by the use of exhaust steam throughout the day and a

*Concrete-Cement Age, Mar., 1914, p. 181
†Concrete-Cement Age, May, 1914, p. 244

direct boiler connection at night. The increasing use of individual power units in electric motors or gasoline engines is solving the matter of steam supply; the steam not being required for power, a boiler is used solely for heating and curing.

If the curing rooms are not wide the steam supply will ordinarily be from a pipe through the center of each curing room from end to end. If the room is wide, two pipes may be necessary, one at each side, or possibly three pipes, with one at the center. Safe practice is in the introduction of the steam from perforations in the supply pipe or pipes, through water, except when the steam used is introduced at low pressure. The supply pipes may be in a trough of water just below floor level and open at the top, or the steam outlets may be in wells, sunk at intervals throughout the length of each curing room. Steam supply in each room should be controlled so that steam may be supplied to each room separately.

Size and Number of Curing Rooms—The size and number of the curing rooms will depend upon factory output—not only upon quantity but upon variety of output. The length of each curing room must be considered in connection with steam supply and pressure. With perforated pipes and low pressure steam, it will be difficult to get enough steam through a small pipe so that there will be any steam left to escape from the perforations at the farther end of a very long curing room. A length of 60′ to 90′ is general. For a small output of standard products a one-track room is most convenient. There is economy of outlay for construction, however, with two or possibly three tracks to a room. There should be at least one room wide enough to take cars on a center track bearing large units which must be quickly cured.

Under the head of "Steam Curing" the American Concrete Institute recommends the following practice:

Steam Curing—The products shall be removed from the molds as soon as conditions will permit and shall be placed in a steam-curing chamber containing an atmosphere of steam saturated with moisture for a period of at least 48 hrs. The curing chamber shall be maintained at a temperature between 100°

and 130° F. The products shall then be removed and stored for at least eight das. (This does not apply to high pressure steam curing).

Proper Use of Steam in Curing Concrete Products—The following discussion by W. M. Kinney was submitted to the *Information and Consultation Department* of CONCRETE-CEMENT AGE in response to an inquiry as to best practice in the use of steam:

Mr. Kinney says:

The principal object in curing concrete products with steam is to accelerate the hardening by means of heat without endangering the concrete through loss of moisture by evaporation. Saturated steam will provide not only heat but sufficient moisture to insure against injury from drying.

In the early history of concrete products manufacture it was customary to use exhaust steam for heating the curing chamber, but as a sufficient quantity was not always to be procured, the natural resort was to use steam direct from the boiler. The records show that in many cases large quantities of good concrete came to grief due to its drying action, which was not at that time explained.

Especially difficult is the maintenance of a sufficient quantity of steam in a boiler at low pressure to heat sufficiently any number of curing rooms. Coupled with this difficulty is the danger of the pressure rising considerably above that necessary for proper curing. With this in view we have been recommending steam under pressure, that is, around 30 lbs. to 45 lbs., provided it be admitted through water.

The most satisfactory way of admitting steam in this manner is through a perforated pipe embedded in a trough of water running through the center or along the sides of the curing chamber. The floor should be so sloped that any water or condensation on the products or on the walls of the curing chamber will be returned to the trough for re-evaporation. In this manner the trough is automatically kept full of water and we have yet to record a case of trouble when this method of curing was employed. All of the heat which the steam contains on being emitted is taken up immediately by the water and the result shown by evaporation. The temperature of the water is at the boiling point due to the fact that steam is continually being forced through it and what heat is taken up by the water is used in evaporating the water. This water evaporated at 212° F. is just as useful in warming the room as is the steam at the same temperature.

To explain the drying action of steam under pressure when admitted to the curing chamber, let us assume that we are taking steam from a boiler operating at 30-lb. gauge pressure. The temperature of the steam in the boiler is 252° atmospheric pressure. It is, of course, understood that steam under atmospheric pressure and having a temperature of 252° is in an abnormal condition which we technically call super-heated. This steam is in a similar condition to that which would be obtained if water vapor at 212° were heated up to 252° away from contact with water. Naturally the first thing that steam in this condition does is to avail itself of the first opportunity to reach normal conditions and the most ready way is to absorb water from anything in its vicinity which is so possessed. The result is a drying out of the concrete products which happen to be stored in the vicinity.

Construction and Layout of Steam Rooms in Products Manufacture—The following question* developed the following several excellent discussions* as to the construction of steam rooms:

The question:

What is the ideal construction for a curing system in a plant where the products to be manufactured include drain tile, building block, fence posts and ornamental work? By the kind of system we mean: 1, How large should the kilns be built? 2, Is it better to have them two-track kilns or one-track? 3, What is the best construction for walls and roof? 4, What is the best system for piping the supply of steam. 5. What is the best door construction?

A discussion by Charles E. Sims:

In building a new plant I would favor kiln room sufficient to accommodate three days' production of tile of any size. Each manufacturer must determine for himself the room required, because he will get a production larger or smaller than another manufacturer according to the ability displayed in operating the plant. In ordinary use we find cars 36″ or 40″ wide and 8′ long. One hundred cars will suffice in some plants, where 150 are required in others. The curing rooms should be of tunnel shape to accommodate one track each and 10 cars in a tunnel. One track is preferred to two or more because cars can be run in and out without exposing the tile on any other track to cold or drying winds before they are ready to be taken out of the kiln.

Concrete block make a durable wall for a kiln and are the best construction for the money. Such a wall can be made wind- and steam-tight. I would make the outside walls of the kilns of concrete block with an air space throughout the wall, and the inside or partition walls of half the thickness—say 4″. The roof can be made by casting semi-circular slabs of reinforced concrete and putting them on the walls so as to form an arched roof or, better still, can be made using a ribbed expanded metal, plastered with cement mortar on both sides of

*Concrete-Cement Age, Mar., 1914, p. 182

the reinforcement so as to form either an "A" roof or an arched roof. A flat roof is not desirable because the condensation which takes place on the under side of the roof should be made to run off to the side walls rather than allowed to drip at random from the flat roof and spoil freshly made products.

In putting on the "A" type or the arch type roof, attention must be given to tying the walls together with tie-rods every 6′ or 8′ in the length of the kilns. A wooden roof is cheaper than the reinforced concrete but does not keep in the heat so well. We should aim to maintain a uniform temperature in our kilns at all times when curing the products and this requires attention to the construction of the kilns as well as to the supply of heat. If the roof were made double, with an air space of a few inches between, it would be better still, but I would not use wood for this, for it rots too rapidly to make it pay.

Two systems are in use for delivering steam to the kilns. One pipes the steam from the engine exhaust, or from the boiler direct, or both, to wells in the floors of the kilns. These wells may be built by setting 20-in. or 24-in. tile in the center line of the kiln so as to have one under the track at every other car; the bottom is cemented and the sides washed with cement and water to make them cistern-tight. The steam is piped to the outlet near the bottom of each well with a valve to regulate the flow, and the wells are kept full of water. By this means an even distribution of very moist steam is obtained and sprinkling of the products is rendered unnecessary.

The other system is to use a boiler with open pipe to each kiln, the steam passing freely from boiler to kilns as generated. The only objection to this system is that the steam is not so moist as with the first method, and requires more attention from the fireman. It is good practice under either of the above systems to run the steam in until a temperature of 80° to 110° is obtained. I think we ought to maintain the temperature as nearly as possible at, say, 80° or 90° day and night, though I know many factories obtain good results without a night fireman. We use here in the summer a large boiler which gives off steam all night long, but in winter we employ a night engineer.

The best door construction, to my mind, is the wooden door hinged at the side. A trial of canvas doors has proven unsatisfactory from the standpoint of durability. Matched flooring makes a good door and such a door can be fitted tightly enough if some attention is given it after it has become thoroughly wet from the steam.

The kilns should be large enough to let in the loaded cars and allow sufficient width so that men can work around them. The head room should be no more than is deemed necessary to clear the products on the cars, as we want to hold the heat down.

to the curing products and do not want to waste it by having too much space to heat up.

It is necessary to have a transfer track at both ends of the curing rooms. These tracks should be housed so that the products being moved may not be exposed to the weather when first made and so that drafts of air will not enter the kilns. It is well to tack cloth to the bottom of each kiln door still further to exclude drafts.

A discussion by C. W. Boynton follows:

1—The word "kiln" (so frequently used) suggests a room for drying, accordingly, it is better to substitute "steam curing chambers" for this word. The size of the chambers will, of course, depend directly upon the size of the manufacturing plant and the daily output. The entire steam curing capacity should be large enough to accommodate two days' manufacture. If the plant is run continuously there should be two steam curing chambers to hold succeeding days' outputs. This is necessary because specifications state that 48 hrs. of steam curing is advisable. With two chambers, handling a day's output will not interrupt the continuous curing of that of the previous day, This assumes that the curing is carried on night and day.

In a plant where several varieties of concrete products are produced on a large scale, in general a saving of labor and a consequent plant economy should result from a separate handling and curing of the several varieties. However, in small plants where the time of the factory operatives is divided in the making of a small number of several different kinds of products, it would undoubtedly be more advisable to cure each day's output of all the products in one chamber, as this would reduce the cost of the steam curing structure by reducing the number of walls, doors, pipes, etc.

2—Whether to have two-track or one-track curing chambers depends primarily upon the size of the plant. If the capacity is large enough a two-track room will be more economical than two one-track rooms in the saving of partition wall and also as a saving in floor space would result from decreasing the distance between the outside walls by the use of a two-track chamber instead of two adjoining one-track chambers with a partition between.

3—The selection of the material for the construction of a steam curing chamber should be based upon the idea of producing a permanent and air-tight building. Wood is liable to rot from constant contact with hot, wet atmosphere or if the steam curing chamber immediately adjoins the plant proper the whole structure, in case wood is used, is liable to destruction by fire at any time. If this occurs in the rush season it will result in a loss not only of the factory itself but also a further one due to the necessity of discontinuing factory operations until another structure can be built. Concrete construction, either monolithic or block, is advisable for steam curing chambers, as the various requirements of fireproofness, airtightness and permanency are all met by this material. Concrete block construction in the past has been very popular for such use.

As to the shape of the roof, the concrete "A" roof, set upon concrete block walls, tied across the top, has been recommended in the past. An arched roof made by concreting over metal lath bent to the required shape has been proven very desirable. The object in the selection of either shape is to produce a roof which will not permit water, resulting from the condensation of steam, to drip back upon the product which is being cured and thus damage it, but a roof which will drain the water to the edge whence it will run down the walls and across the sloping floors back to the water trough.

4—A good system of piping the supply of steam is to set a perforated steam pipe into a trough of water running throughout the length of the curing chamber. This device will necessitate a flow of the steam through water before coming in contact with the products and thus obviate any possibility of the latter being dried out.

5—Any type of door construction which insures air-tightness and which facilitates opening and closing can be used. Oiled canvas attached to a roller at the bottom, so that it may be raised or lowered when desired, instead of opening out, supplies the requirements for a suitable door for the steam room.

A. E. Cline in a discussion of the same question says:

Without fully knowing the local conditions of a plant, its situation and the relative proportions of each product to be manufactured, one can write in general terms only and leave it to the interested parties to apply the suggestions, as each plant has its own peculiar problems.

Each kiln for steam curing should be large enough to take care of one day's run; whether that would mean a kiln for each product, for two products or for all products made in one day, depends entirely on local conditions—size of plant and its output.

As concrete products should remain in the kilns at least two days, this means three kilns for each, or for all products as is necessary.

In length 80′ to 90′ is enough for a kiln, as it is difficult to force low-pressure steam much further. Have the curing chambers as low as possible, though high enough to cover the highest load that will enter them—usually 7′ in the clear will do it, and 10′ or 12′ wide, which will in most cases provide for three tracks. This I like better than one track, as with a system of several kilns the empty cars can be returned through the kilns, and so one does not need an extra storage track.

There is nothing better than concrete for walls and roof—ht hollow block or tile for walls and a curved roof (to avoid drip) over each kiln, using some good expanded metal bent into shape and covered with a good cement stucco.

I have made good kilns with two thicknesses of ½-in. lumber and a layer of cold-storage insulating paper between them, but of course this has not the lasting qualities of concrete.

For steam supply, the simplest way is to have a main pipe over the top of the kiln doors; then lead from this a separate 1½-in. pipe to each kiln; run this along one of the walls close to the floor, but with slant enough to drain to the farther end. Join each length with a T, having the third hole of the T reduced to ⅛″, and turn this at right angles to the wall. The 1½-in. pipe can be reduced to 1-in. at half length of kiln; this is on the supposition that the kiln is 80′ long.

If using steam for power, have this main pipe connected with the exhaust during the day, and with the boiler at night. If the boiler pressure at night is greater than 10 lbs., it is best to have a reducing valve in the main line as a high pressure is not wanted—just steam.

The construction of the doors is not a very important item as I do not believe in having the kiln too tight; some air admitted helps condensation and prevents too great a heat. Two thicknesses of matched boards or even shiplap with insulating paper between, and fitted with ordinary refrigerator fastenings answer very well for the outside. For the inside, curtains that can be fastened on the sides with board strips and then rolled up when kiln is being filled, make a good arrangement and are handy.

Painting Cars

The moisture of the steam room demands that cars be well painted to prevent rusting. One plant is using special galvanized metal cars for white dimension stone and other special work.

Cleaning Iron Pallets and Keeping Them Clean

If iron pallets are neglected they become coated with rust and concrete so as to be useless. Suggestions* for removing the coating and keeping the pallets clean are as follows:

By H. N. Hanchett:

There is probably no way of cleaning cast iron pallets that have become coated with concrete and rust except to grind the coating off on an emery wheel. The conditions should never be permitted to exist. If these pallets are kept coated with paraffin oil, the concrete can easily be wiped or brushed off at the end of each day's work. This is a practice which should be *followed with every* concrete block machine.

*Concrete-Cement Age, Oct., 1914, p. 164

By A. E. Cline:

I suggest heating the pallats in an open fire or in the fire box of a boiler until the concrete can be knocked off with a hammer.

By L. E. Burridge:

Pallets can be cleaned quickly and economically by using a wire brush such as is used in foundries and machine shops for cleaning castings free from molding sand and other accumulations. These wire brushes will cut the cement off from the pallets and after they have been cleaned they should be dipped in a solution of 1 part lard oil and 1 part kerosene, which prevents the concrete sticking to them and also keeps the pallets from rusting.

The further suggestion is made by P. E. McAllister that he is using a sand blast with success and with economy. By other methods he found cleaning pallets cost from 8 cts. to 10 cts. each and by sand blast only 1 ct. to 2 cts. each.

Wood Pallets

Difficulties from the swelling of wood pallets on which molded products are handled from machines in which the pallets must fit accurately have prompted many experiments. Suggestions for obviating the difficulty are as follows:

By A. E. Cline:*

In the first place wooden pallets to be used in steam rooms should, if possible, be made in strips not over 4″ wide and with open joints to allow for some expansion. Before they are used either dip or thoroughly paint them with hot linseed oil. If one could have them given the creosote treatment, such as is given to railroad ties, it might be better, but would, undoubtedly, be more expensive. Where I have used the oil we could tell the difference between the treated and untreated pallets by the weight even after a year's use.

By C. W. Eberling:*

It is advisable to make the pallets of good, straight-grained wood, such as maple or beech. They should be treated by placing in a tank from which the air is drawn out, and then steeped in carbolineum from two hrs. to three hrs. at a temperature not to exceed 110° nor under 90°. This treatment will kill the fungus and prevent decay, and the swelling will be practically overcome.

By R. F. Havlik:*

In my opinion it is impossible to prevent the swelling of wood *pallets except possibly* by creosoting them. We use several

*Concrete-Cement Age, Oct., 1914, p. 163

thousand wood pallets for rough block and dip them in paraffin oil every second or third time they are used. This prevents the swelling to some extent, but not entirely. Our pallets do not fit the machine tightly, so slight swelling does not prevent their use. Wood pallets should not be used for fine work. Use iron pallets for faced block, as they make truer block.

By S. H. Wightman:*

We have done a great deal of experimenting to prevent wood pallets from swelling, due to the action of steam and also to protect them against warping and drying out, but without complete success. Carbolineum applied after the wood has been through a dry kiln gives fine results, but the treatment involved is expensive.

We have tried soaking pallets in hot paraffin for different lengths of time, from 5 min. to 2 wks., and in paraffin oil in the same way, but found it did not stop the swelling. We have since been informed that a very heavy paraffin oil should be used. We have about 4,400 pallets in use daily, and have adopted the following method:

Make the pallet body of No. 2 common, sound knot white pine, the rider strips of hard wood. Predetermine the amount of swelling that takes place (the fourth day's use should determine this), and make the pallets undersize so that they will swell to the required size. If at any time they have been idle for some time before use, or after the pallets are made and before used, soak ½ hr. in the heavy paraffin oil, heated with a steam coil, to about 200°. Oil the pallets yearly.

Further interesting references as to curing practice, with detail drawings, will be found in Chapter 10.

*Concrete-Cement Age, Nov., 1914, p. 211

Chapter 5—Special Molds and Patterns

General

Wide as is the range of standard molds which the market affords, the concrete products manufacturer should not, as has previously been suggested, be entirely dependent upon them. The manufacturers of molds have done a great deal toward providing variety in special architectural units and purely ornamental pieces. True, they have produced many things which are absurd, which would make a travesty of architecture—designs not worked out by artists. Yet they have produced many molds which are good, architecturally correct and pleasing in every respect. These have been and will be extensively used.

Yet it must be repeated that the products manufacturer who expects to have his work specified by architects for important buildings should not be dependent upon stock molds alone. The manufacturer must accept the verdict of the architect. The architect is the customer. It is his privilege to be pleased. Deny him this privilege and he will fall back upon his very certain right—to refuse to buy. The producer must please the consumer.

Let us take the view of the architect. The product from the stock mold is satisfactory *if* it is suitable for the particular work in hand. The work in hand, if you please, is apt to be *particular*. The architect is apt to be

Fig. 29—*Flower Box of* Tamped Concrete from Plaster Mold—*Philadelphia School of* Industrial Art

prejudiced against a stock mold—*because it is a stock mold.* If he can possibly induce his client to pay for it, the architect wants originality—and who does not?

A special ornamental concrete casting may cost but $3.00 so far as material and labor in molding and finishing are concerned, yet the original model and the special mold may have cost $50 to $100 to produce. Thus does originality command a price. The manufacturer will not overlook the possibility of profit in such work.

To be equipped to handle special work the manufacturer will step entirely outside the field of the so-called cement worker. His materials will include metal, wood, plaster, clay, gelatin and sand and he will require the services of woodworkers, pattern makers, plaster workers and modelers. To guide these trades there will be need for draftsmen and designers. While it is possible to engage the services of men whose skill combines a knowledge of and a familiarity with the general work of pattern making and molding, the great majority of concrete products manufacturers will find that they must

FIG. 30—FLOWER BOX AND GARDEN BENCH FROM GELATIN MOLDS—J. P. MOLLENKOF

grow into the special lines gradually. If the factory is near a large city, the services of men skilled in these special lines may be had entirely outside the facory, or they may be engaged to come into the factory to do special work. This applies particularly to modeling. Woodworkers and woodworking machinery, and at least one man with a good knowledge of plaster work, are indispensable in any factory from which it is planned to supply any products other than those from stock molds.

Products manufacturers have frequently experienced this difficulty: A man skilled in making wood patterns and molds is constantly prejudiced in favor of his own special material. The plaster worker wants to use plaster for all work, and so on. Yet economical operation requires that all materials for mold-making be used—each where it will give the best results at the least cost. It is frequently desirable to make the greater portion of a mold of wood and to put in some inserts of plaster.

FIG. 31—GROTESQUE MODELED IN PLACE—ADOLPH SCHILLING

Usually when there is deep and more or less intricate undercut in the design of the model, it is desirable to make the mold of gelatin or glue so that it will pull away from the concrete casting without injury either to the fine lines of the concrete or to the mold itself. Yet when the undercut is simple and the design not too complex it is better to make the mold of plaster, so divided into separate sections as to draw out of the undercut. This is particularly true in making castings which are to have considerable duplication. Gelatin molds can be used a few times only—sometimes four or five—sometimes, with special care, for a greater number of castings, yet the wet concrete attacks the glue and leaves it ragged and when robbed of its fine lines the mold has to be melted and re-cast around the original model. For this reason it frequently happens, when a considerable number of like pieces is to be made, that there is economy in going to great pains in making a plaster mold, so divided and subdivided as to draw out of the undercut. With reasonable care, a plaster mold is permanent and can be kept indefinitely, while a glue mold deteriorates with age and can seldom be used on later work. Experience alone will teach the mold-maker how to get the most economical results in reproducing in concrete each new model or design which comes to him. The desirability of this faculty for choosing among the available materials in making molds, with a knowledge of the economy of each material for special purposes, makes it of advantage to the manufacturer to develop men in the art of making molds,—men who have or will acquire full appreciation of the requirements of this branch of concrete work. Such men will prove of far greater value than men specialized in one craft to such a degree as to fail to see the limitations of the material of that particular craft.

FIG. 82—STOCK MOLD OF IRON FOR BALUSTER

There is still another feature of mold-making in concrete products manufacture which demands a broad understanding of all phases of the work.

FIG. 83—GENERAL VIEW OF WOOD PATTERN SHOP IN FACTORY MAKING ORNAMENTAL AND TRIM STONE EXCLUSIVELY

FIG. 34—VIEW OF PLASTER DEPARTMENT OF FACTORY ILLUSTRATED IN FIG. 33

If a model or design is very intricate or detailed, and but few pieces are to be cast, the cost of producing a *model or a mold,* or both, which will faithfully carry out the design, may be so great as to make it more economical merely to block out the detail and leave the fine lines of the design to be worked out by stone-cutters.

Molds should be true to surface and form; wood used should be of the best and all mold parts should be carefully shellacked and oiled before using.

Simple Forms and Molds

Straight work, such as sills and lintels, belt courses and cornices, which is simple, yet perhaps outside the scope of standard sill and lintel machines, can be cast on a flat surface with straight side forms and end pieces with such inserts of wood or plaster as may be required to give necessary drips, bevels and simple cuts and for straight molded lines.

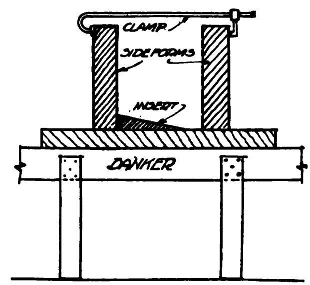


Fig. 35—Simple Wood Mold—Section View

In dry-tamp work one set of the necessary pieces for a mold will be enough for a large amount of duplication. In tamped work in which products are to be removed almost immediately from the molds the usual practice is to face the exposed surfaces with a special mixture rather than use one mixture throughout. The mold pieces are set up—well clamped and braced—on a large pallet, ordinarily made of 2-in. planks—and resting on the rails of the bankers. Such work is handled face down, getting the greatest area of faced surface at the bottom, where the facing mixture is more easily placed and tamped. If a side or end or even two sides and two ends require facing, the facing mixture must be built up two inches or three inches at a time and then backed up with the body concrete. When the mold has been filled to the top, tamped and struck off, a quantity of fine bedding sand is placed over the top and worked down to an even, *smooth layer about* ½″ thick. A pallet is then placed on top of the mold, resting on the sand, and the pallet "see-sawed" to give an even bearing. It is then clamped to the mold and the mold turned over so that the product rests on the sand, which in turn is supported by the newly placed pallet. This sand bedding between the product and the pallet is not always necessary in small units which will rest with an even bearing directly on the pallet, but the likelihood of even a slight uneveness in the pallet makes the sand necessary when the product molded is long. Otherwise, an uneven bearing would break the green product. When turned over the pallet which was on the bottom is removed from the top, the side clamps are released and the side and the end pieces of the mold are removed, carefully so as not to disturb the product, and insert pieces of wood or plaster are then withdrawn, unless they come under and support an overhang. The mold pieces are then cleaned, oiled and reassembled on another pallet as before. The product first made is either removed to a curing room or left in place either to be sprayed, for surface effect, immediately, or thoroughly wet down at intervals after becoming hard, to insure proper curing.

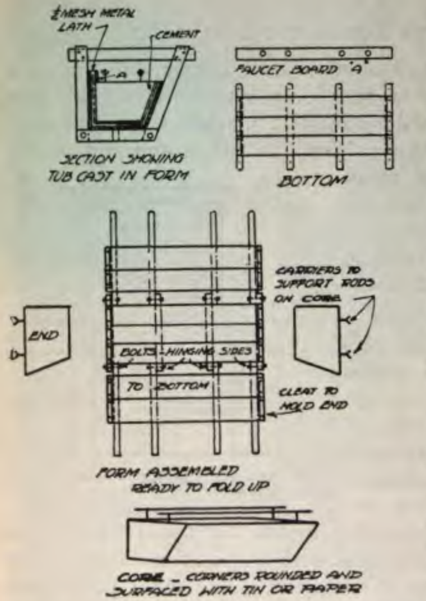


FIG. 36—DETAILS OF HOME-MADE MOLD FOR LAUNDRY TRAY—SHOWN AS AN EXAMPLE OF WOOD MOLD IN WHICH SIDES ARE HINGED TO BOTTOM BY MEANS OF BOLTS

FIG. 37—VIEW OF MOLDING ROOM OF TRIM STONE FACTORY—NOTE MOLD BEING FILLED AND CONCRETE TAMPED AT LEFT

In wet cast work, from which the molds cannot be removed immediately, straight work will either be cast in boxes in which the bottom is a part of the mold or else on a smooth floor or a table on which side rails are set up and braced, clamped or anchored in place. In casting belt courses and similar work, where a large amount of concrete stone is to be made with one cross-section and the units differing in length only, long side forms and insert pieces may be used with dividing partitions to produce the units in the necessary lengths. The casting surface may be a smooth, absolutely true and perfect floor area of concrete. It may be a large bench or a table with a concrete slab top. This will be more convenient as to height for the operators. The necessary molded lines of the concrete stone may be produced with wood moldings or plaster moldings, the latter made in long strips by means of a template to give the required section. Whether of wood or plaster, the insert molding may be sawed in lengths required for the units to be cast.

Where long side rails are necessary, channel irons of proper widths can be used to advantage. Properly cleaned and oiled, they will give long service and the chief point to recommend them is the fact that they do not warp as wood does, unless the grain is very carefully filled and the surface shellacked and oiled, nor do they spring out of line from the weight of the concrete. In long pieces of concrete stone even a slight wind due to the springing of the form prevents the subsequent use

FIG. 38—DIMENSION STONE ON PLANK PALLETS SUPPORTED ON BANKERS. NOTE WIDE "RETURN" OF WHITE FACING

of the piece with the best results. When wood form pieces and special molds are used, they must be well strengthened by cleats and firmly held by clamps to hold them in proper shape.

MORE COMPLICATED MOLDS

The more the designs to be followed deviate from straight work, where the section of the unit is uniform, and the more the design makes use of curves and arch forms, the more the manufacturer will be dependent upon plaster molds, and if the design calls for deep cut detail, gelatin will be in demand.

Plaster Molds—The necessary molds may be produced in plaster by several methods, depending upon the nature of the work. Plaster of Paris sets quickly; however, not all of it has the same time of set and grades may be used which are quick setting or not, as work demands. A good quality of smooth working plaster should be used.

The plaster worker should have large, smooth-topped tables on which to work. Where many so-called straight *moldings are* required, a table with a top slab of smooth concrete may be used, bound at the edges with angle iron which will serve as a straight-edge.

Straight moldings require a template cut out of sheet metal to give the required section. The soft plaster is poured out on the oiled surface of the table in a long stream at a proper distance from the edge. The template, guided by the straight-edge, is moved down the table, pushing aside the soft plaster except within the desired section cut from the template. As the first plaster poured out stiffens and sets, more is poured out on top of it and again the template is pushed down the length of the table. The operations are repeated until the plaster has been formed to the full height and section of the desired molding. This work must be done rapidly as the plaster hardens quickly.

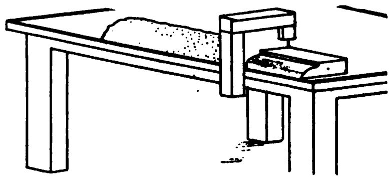


FIG. 39—SKETCH TO INDICATE USE OF TEMPLATE IN "RUNNING" PLASTER MOLDINGS

Curved work is handled by mounting the template at the end of a pivoted arm of such a length as to describe the required arc, and the template then has a circular movement. Such methods are used in making mold pieces for window tracery.

When entire molds are to be made of plaster, the model must be oiled, and covered with plaster, the work being so stopped off as to make the plaster mold in sections for easy removal, not only from the model but later from the molded concrete.

Plaster is readily cut with suitable knives and this makes it possible to handle some detail by carving the plaster to produce either a model from which a plaster mold or a glue mold is to be made or to finish the mold itself.

The details of making plaster molds are best described in *connection with* a definite piece of work and the descriptions which follow are of such radically d work as to give an idea of the possibilities of a practical information on the use of this material, uable to the maker of molds in concrete products facture.

FIG. 40—SMALL CONCRETE PANEL, PART OF CHURCH ALTAR, MADE IN PLASTER MOLD

Prelimin the consid of descript definite us plaster in molds, a discussi Joseph Ei should hel prospective of plaster to apprecia fact that ence and th knowled plaster of are necessa good work. Eilbacher s

It requires ough knowl the workings ter of Paris plaster mol cessfully, and without this will waste c able costly in the attemp it for this p

The plaster cannot be re-tempered or softened after which will take place in from 5 min. to 10 min., acco the temperature of the shop.

Then it requires skill to apply the plaster to the n avoid air-holes, which cost as much time to fill up as th itself, to get satisfactory casts.

*CONCRETE-CEMENT AGE, April, 1913, p. 180

After a man has once mastered the peculiarities of plaster of Paris, it is necessary to figure out the strength of the mold with reinforcements where mostly needed, and this varies with every design and article to be cast from it.

After the mold is really complete, made in as many sections as will be required properly to draw the concrete casting, it must be coated with the very best of shellac, but only after it has become absolutely dry.

Proper dowels and sockets must be provided in the mold to keep it in alignment while the wet concrete is being agitated.

An additional casting or jacket must be cast around the base of the mold to keep it in a positive position while making the casting. The mold must be well greased even after it has been shellacked to prevent the concrete cast from adhering to it.

There are so many details to watch that anyone not accustomed to the use of plaster would make a failure in the attempt. The above is a frank statement and is sincere, for the writer has had some bitter experience with men in his shop who pretended to know, but who could not produce results.

The first description* refers particularly to such ornamental work as flower urns and vases, producing which makes up part of the work of the students of the modeling department of the School of Industrial Art, Philadelphia, under the direction of Charles T. Scott. The practical essentials, however, are applicable to a wide range of plaster work, although in this case the unusual feature is the production of concrete urns and vases, without the use of a core within the mold.

Plaster Molds For Small Ornamental Work

Although the making of plaster molds requires in some of its more elaborate applications the experience of at least part of a lifetime, there are certain simple models that can easily be understood and molds made from them by the beginner.

Materials—The material should be purchased under the name of "Fine Casting Plaster," and for large work should be bought by the barrel. Other materials needed are orange shellac in wood alcohol, a pound or so of stearine or some good candles (not paraffin), ½ pint lard oil, some loose woven burlap and a quantity of good moist modeling clay.

Tools—Tools should include a long, narrow-bladed knife, scissors, pair of pliers and a flat steel scraper such as cabinet makers use. A large bowl or dish-pan will do to mix the plaster in. Plaster sets rapidly so care must be taken to judge pretty

**From an article by* Charles T. Scott, Concrete-Cement Age, July, *1914, p. 18* accurately the amount to be mixed for a certain job or a portion of it.

Flat Panels—All flat panels in moderate relief without undercutting can be cast in draw-molds. Such panels as are of clay or plaster should be given a couple of coats of shellac to prevent the absorption of the grease.

If the panel is regular in outline, a wood frame 1½" high may be used to control the plaster; if not, roll out some flat strips of clay 1" thick and trim to the desired width, placing these on edge around the mold instead of the frame. Grease these sides or fences with lard oil.

Heat some kerosene and dissolve some stearine or candles in it, about two-thirds kerosene to one-third grease. Use the stearine for all models and faces of molds, as it dries as an even coating and does not creep on the mold and collect in the hollows. The lard oil is used for all edges of molds, clay, wood frames, etc., whether shellacked or not. A rubbing with a greasy brush is usually all that is necessary for any molds or models.

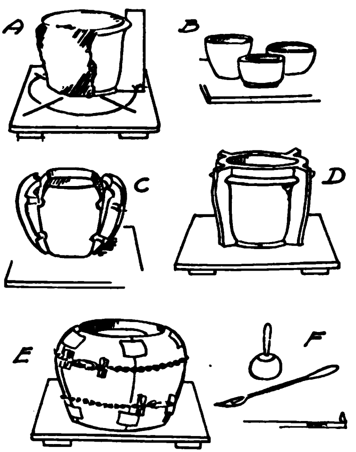


Fig. 41—Sketches Illustrating Mr. Scott's Description of Making Plaster Molds

Having estimated the quantity of plaster you will need to make this flat mold, fill your bowl or pan a trifle over half full of water. Sift the plaster slowly through the fingers until it can be felt about an inch under the surface of the water; then stir it thoroughly. It should be about as thick as rich cream.

Pour enough plaster into the enclosure surrounding the model to cover the surface of the model. Shake and jar it so as to drive all the air out of the deep places. Now fill up level with the fences.

For reinforcement cut a piece of burlap smaller than the *panel, dip in plaster* and rub it smoothly on the back, pushing it *well into the plaster.* In an hour or so the mold can be separated from the model and with a frame of wood around it, can be used to cast concrete panels. Always remember to shellac and grease the mold before casting.

MAKING A VASE MOLD

Having experienced the making of the flat draw-mold, the beginner can better understand the construction of a clay model for a simple vase form as at B in the sketch, and the making of a four-piece plaster mold from it. Level a smooth platform and draw a circle on it the size of the bottom of the vase, then draw a larger circle on the same center (at A).

Cut a ½-in. board template conforming to the outline of the vase and holding it against the circle representing the bottom of the vase, make a mark on it where it crosses the large circle (at A). The template is moved around on this circle to control the outline of the vase.

Now build a core of old bricks laid in soft clay, keeping about an inch back from the template; coat it with clay and finish by revolving the template around on the circle.

At D are shown strips of clay 3″ wide and ¾″ thick placed so as to divide the mold, exposing two full quarters on opposite sides of the vase. A strip is also shown running around the top to form the thickness of the mold at that point.

Grease the model and fences slightly with lard oil and mix plaster as before. Have burlap ready as this mix will be in two parts and the burlap will be placed between them. For the first coat set the bowl close and slop the plaster over the model by the handful, working from the top down until the model is coated over. Add plaster to one-half the depth of the fences and then put on the burlap. The last coat can be mixed somewhat thicker and will be put on over the burlap till filled even with the fences. Now make the piece on the opposite side of the vase.

When the plaster in these two pieces has set, take down the fences except the one around the top, and clean the model carefully.

Cut a couple of round notches as at C to form keys on the sides of the sections. Shellac all exposed edges of the pieces and oil them. Now fill in between as before and the mold is completed.

When hard, pry off the mold, wash it and give it a thin coat of shellac, cut away roughnesses and undercuts and shellac again.

Assemble the parts on a platform or stone slab and draw it together with a couple of light chains and turn-buckles adjusted as at E. When tight dip pieces of burlap in liquid plaster and paste them firmly over the joints as at E. This makes the mold more secure.

Take a small flexible steel scraper as shown at F, and scrape the joints level on the inside, touch up bare spots with shellac and with the aid of a spatula (at F) fill all cracks with plaster, wiping clean with a soft sponge. Shellac bare spots again when dry. If properly managed the mold will now appear as one continuous shell. With a sponge fill the crack between the bottom of the mold and the slab, with plaster; shellac the whole mold again.

MOLDING THE VASE

These molds are adapted to any process of casting in concrete but the simplest process, because it requires no core, is the tamping of a semi-wet mixture.

Cut a template of ½-in. board drawn from the outline of the model allowing an inch or more for the thickness of the vase and have it several inches higher than the top of the mold when the template is held in place.

Lay a light stick across the top of the mold. Hold the template in position inside of the vase, mark its intersection with the horizontal stick and nail the two together. When the vase is finished this template is to be revolved around on the inside to give the proper thickness to the concrete. Grease the mold carefully with stearine. Make a thorough dry mix of 3 parts of sharp sand to 1 of cement, and moisten very gradually by sprinkling. When properly wet and mixed a quantity of the concrete grasped firmly in the hand should retain the shape of the inside of the hand when released. If too dry the vase will crumble, if too wet it cannot properly be tamped. Dump about three inches of the mixture into the bottom of the mold and tamp hard with a mallet (at F); do not pack clear up to the sides, but leave three inches all around unpacked. Put in several small shovelfuls more and with the hand protected by a glove pack the sides 3″ thick, testing thickness with a piece of wire, till the walls are up to the top of the mold. As you build up the sides keep the top of the layers square and loose so that subsequent layers will rest upon them and adhere to them.

When full the cement should show 2″ of extra material opposite every part of the mold to allow for compression.

Now tamp gently with the mallet, going over the entire surface again and again, till all the concrete has been forced into the mold. Scrape out excess material till the template fits and finish with the small oval scraper.

Cover all with wet cloths and oilcloth and allow to stand till the following day. Soak the vase with water twice on the second day and keep covered as before. On the morning of the third day the molds should be removed and the vase immersed in a tub of water for several days.

This soaking is important as the cement has had only its *initial set and if allowed* to dry out at this time the vase would *be soft and crumble* easily.

FIG. 42—BUILDING FRAMEWORK FOR CLAY MODEL 16′ HIGH FOR CONCRETE STATUES, USING PANTOGRAPH IN CONNECTION WITH ¼-SIZE MODEL

PRODUCING STATUES IN CONCRETE FROM PLASTER MOLDS*

The statues described surmount the concrete stone cornice of the Boston City Hall Annex, designed by E. T. P. Graham. The original clay models were the work of Roger Noble Burnham. After the original sketches, he made models 7″ high. These were accepted and working from these he made quarter-size models.

Each of these four statues is more than 16′ high, semi-circular at the base and cut on a vertical plane up to the shoulders. That part from the shoulders down sets close to the limestone ashlar, while in each case the head pitches forward.

Preparations were made for the work of reproduction of the models in concrete, three months before the time for delivery.

As each completed figure weighs approximately 8 tons, four small concrete floors, 8″ thick, were put in 4′ below the ordinary floor level in order to bring the statues down to a more

*Abstract of article by D. B. Adams, CONCRETE-CEMENT AGE, May, 1914, p. 222

convenient position to work on. Special arrangements were made for heating and lighting. Platforms for the quarter-size figures were placed so as to bring the models into a correct position relative to the arm of a pantograph which was used in reproducing them in full size.

Modeling in Clay—As soon as it arrived, the first model was placed on its platform, and by means of the pantograph the outline of the large model was determined from the small model, the pantograph working at a ratio of 1:4. As points on the large figure were approximately located, carpenters and modelers started the actual work, building a skeleton framework of 2-in. x 4-in. stock, strapping and laths. An attempt was made to keep this framework within an inch or so of the finished surface, and this was done fairly well except in the draperies. As it was, the clay used in each one weighed between 2 tons and 3 tons. The preparatory work was slow and very expensive. Once finished, it was a comparatively easy job to throw on a rough covering of clay before handing the roughly outlined figure over to the sculptor. Mr. Burnham and his assistant then completed the clay figure, using their hands, and the modeling tool with a wire loop and a flat point, to bring out all the fine detail work.

Precautions were taken to keep the temperature of the shed as near 50° F. as possible and to keep the clay moist. On very cold nights, because it was almost impossible to keep up a full head of steam, there was great danger of the clay ladies being frost-bitten. As a matter of fact, Jack Frost did perform several amputations on fingers and other exposed portions. The clay was kept moist by a wet cloth covering at night. As soon as a clay figure was completed the Boston Art Commission came to inspect it.

Making Plaster Molds—The plaster men started their work as the model was approved, while the clay was still in good condition, and to prevent any possibility of the clay freezing. The best grade F. F. F. plaster was used in this work, being mixed quite wet in large dish-pans, and then applied directly to the clay. The men began at the bottom and worked up, making a reverse mold with a minimum thickness of 6″. As the plaster was applied, strips of burlap were embedded in the plaster for reinforcement. It was first planned to make each statue in four pieces, but at the request of those in charge of the work it was decided to build the body in one piece, and the head separately. As each body was about 13′ high, a supporting cradle was necessary, one that would take all of the stress incurred in moving the mold to its horizontal position for casting. The cradle was built of 2-in. x 4 -in. and 4-in. x 4-in. spruce, strongly braced to resist torsion and thoroughly attached to the plaster mold by several ties extending from the framework into the plaster shell itself.

FIG. 43—FINISHING CLAY MODEL 16′ HIGH FOR CONCRETE STATUE

The mold dried in two days and then the clay and framework, no longer of use, were ready to be removed. In this case, as the figures were built against a back wall, a small portion of this outside wall was torn out and the frame and clay were passed out from the inside, leaving the plaster mold undisturbed. The head was taken off at a specially prepared joint running from shoulder to shoulder where the draperies would help hide any traces of it. The projecting feet were also removed at the bottom of the draperies.

It had been the intention in the first place to allow the plaster mold to remain in an upright position, build the core in sections,

FIG. 44—COVERING CLAY MODEL WITH PLASTER, WORKING FROM BOTTOM UP—MOLD STANDS IN PIT AND FULL HEIGHT IS NOT EVIDENT

and pour the concrete from the top, but considerations of placing and supporting the reinforcing, the extra labor of pouring because of the height and lack of room, and some difficulty which was anticipated in getting the huge blocks out of their concrete well, decided the question in favor of laying the first plaster mold in a horizontal position. This was so satisfactory that the three others were handled in the same way. These plaster molds were extremely heavy and cumbersome, and the grave danger of breaking when they were being tipped over added to the difficulty. No matter how strongly they were braced there was always a certain amount of give to the wooden

FIG. 45—TURNING CRADLE CONTAINING PLASTER MOLD FROM VERTICAL TO HORIZONTAL POSITION FOR FILLING WITH CONCRETE

supports and plaster, of course, is extremely brittle. Only one of them did break and this one sprung a vertical crack which caused several days' work. Jacks were utilized to push the sides together, the crack was carefully plastered and the cradle practically rebuilt. In each case the feet of the figure projected 1′ or so, and had they been left attached they would have been completely smashed when the mold tipped forward.

Placing Steel and Concrete—When the mold had been placed in its horizontal position the inside was given two coats of orange shellac; meanwhile, the steel men worked on the ⅝-in. and ¾-*in. reinforcing*, and ⅜-in. rods, bent to conform to the

FIG. 46—FILLING PLASTER MOLD WITH CONCRETE. NOTE CORE TO MAKE STATUE HOLLOW

draperies of the figure, were placed at 8-in. intervals, while through each vertical fold a ¾-in. bar was laid. At the back of the shoulders a heavy horizontal bar was put in, with its ends slipped into the looped ends of vertical rods on each side. This made a convenient form. Seven of the horizontal reinforcing rods were carried across the back to aid in resisting any force which might cause a vertical crack. This was important, as each concrete figure was turned completely over so as to bring the front side uppermost, and a break would have caused a very serious loss.

After the steel was laid, a wooden core was suspended from bars on the top of the mold and the core was firmly braced. Cores were carefully made so as to conform as nearly as possible to the shape of the mold, and at the same time allow a minimum thickness of 6″. There were, of course, many projecting parts where the concrete was more than 1′ 6″ thick.

The casting of each figure took about 15 hrs. of continuous work. The mix was dumped into the mold as fast as two tampers could thoroughly work it into all the holes and crevices. *The rough casting* surface of the mold made this job a very

FIG. 47—STATUE FINISHED EXCEPT FOR HEAD AND PROJECTING PORTIONS OF FEET, SEPARATELY CAST

slow one, as it was desired to produce a finished cast without any air-holes on the surface. The two tampers could work from inside the core and the mix was well placed. As soon as the mix began to stiffen the slightest bit, as much as possible of a coarse 1:7 mix was put in for backing. This was placed next to the core, as soon as it was certain that none of the coarser material would sink through to the face.

After casting, the whole thing was left alone for two weeks. At the end of this time the mold with its concrete load was turned right side up onto skids which ran out of the building, and laborers went to work with axes chopping off the plaster. This was a simple enough job, requiring only a little attention and care. When the concrete was stripped it was of a dark olive color, this effect being produced by the wet cement on the surface and the water still present. For another week the figure was sprayed twice a day, allowing the water to stand in the hollows wherever it would. In this way the danger of surface cracks, as far as they result from green concrete stone, was obviated. At the end of this period, three men went to work with hand stone-cutting tools and two automatic tools. These men worked under the direction of the sculptor, carving out effects in the concrete, as they would have done in limestone, for this special concrete stone cut like limestone in every way. This tooling removed all the neat cement surface and made the stone safe against any cracking and subsequent discoloration on the surface. The final effect was that of high-grade cut limestone, and the finished product was in every way entirely satisfactory to so critical a body of experts as the Boston Art Commission.

Being on skids it was a simple matter to haul the huge 8-ton piece of stone onto a truck and to deliver it under a derrick at the Boston City Hall. Once there, a very few minutes sufficed to unload a figure and to swing it 100′ or more up to its lofty perch.

Concrete Jar Made Without a Mold

While not dealing with the subject of plaster molds nor with molds at all, the following description,* by Charles T. Scott, of the use of templates in producing ar ornamental concrete jar without the use of a mold, ha a definite place in this chapter. Whether or not thi method of modeling concrete is commercially practicable this use of templates is applicable to plaster work or cla modeling and should convey valuable suggestions, fo the products manufacturer.

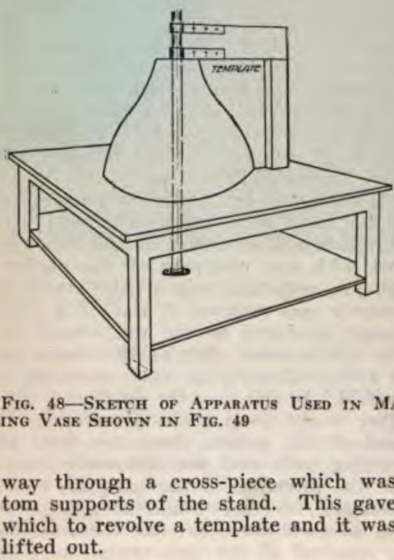


Fig. 48—Sketch of Apparatus Used in Making Vase Shown in Fig. 49

Owing to the shap of the jar it wa made in two pieces which were subse quently jointed wit rich mortar on th line of the jar' greatest circumfer ence, the joint bein hidden by a belt o mosaic.

The jar was mad on a low, stron stand with a smootl heavy top. A piec of ½-in. pipe wa dropped through 9/16-in. hole in th center of the top o the stand and sun into a hole of th same size bored par way through a cross-piece which was nailed across the bot tom supports of the stand. This gave a steady center rod o which to revolve a template and it was at the same time easil lifted out.

A full size drawing of the vase was made and a line trace within the outline to mark the thickness of the vase. Thi inner line was used as a pattern to cut the wooden templat to form a clay core for the inside of the vase. The vase bein in two pieces, the template was divided and but half the wor done at a time. This template had a cross-piece halved an screwed across the top to reach the center rod. A couple o sheet iron loops were bent around the ends of this cross-piec

*Concrete-Cement Age, April, 1914, p. 173

so as to enclose the rod and form a bearing when the template was revolved. These bearings were fastened on with stove bolts. Notched into the bottom of the template was a short piece of ⅞-in. wood beveled up at the ends. This raised the bottom of the template about ¼″ and acted as a runner to make it revolve smoothly.

FIG. 49—CONCRETE VASE, MODELED DIRECTLY IN CONCRETE BY MEANS OF TEMPLATES

A bunch of damp newspapers was tied around the rod and soft clay was piled around them, the template being revolved as needed to form the round core. The clay was allowed to dry until tough, the surface roughened, and then given a couple of coats of shellac.

The template, readjusted so as to describe the outer rather than the inner outline of the work, was then furnished with a zinc facing cut exactly to the final outline of the vase. This was tacked on so as to extend ¼″ over the inside edge of the wood, which was beveled away from the zinc on the back. The template was put in place and the clay core given a rubbing with a greasy brush.

A stiff cement mortar composed of 1 part cement to 2 parts of sand was then plastered on the core until coated all over. When this had hardened enough to be slightly absorbent the coating was built out and shaped by the template. When finished, the template was removed by taking out the stove bolts and releasing it from the rod.

The work was covered with oilcloth and, after several hours, sprinkled with water. This was kept up for three or four days.

Then the center rod was pulled out and the whole form inverted and placed on the floor. The paper was pulled out and the still moist clay pulled away from the inside of the jar.

The two parts of the jar were made in the same way. A projection on the bottom of the template made a depression around each part of the jar in which the band was set. The stones were set in soft mortar after the vase was dry. A bottom was plastered in and the vase was completed.

Concrete is handled to some extent commercially in factory work, in a way which involves methods similar to those described by Mr. Scott in molding a concrete jar. This is in the use of a mandrel on which hollow concrete columns are turned. Over a core, metal fabric is placed on which concrete is built up to the desired thickness by gradual application of a plastic mixture. Templates give the column a perfect outline as the core is revolved. The core is so constructed as to collapse for withdrawal to release the product.

Similar apparatus is employed in turning plaster models or patterns from which molds are to be made for casting in the usual way.

Gelatin Molds

In making gelatin molds which are not stiff enough to support the concrete poured into them, it is necessary to make the glue mold within a supporting shell, ordinarily of plaster. The shell is made first. The model is greased

Fig. 50—Making Hollow Reinforced Concrete Column by Means of Mandrel

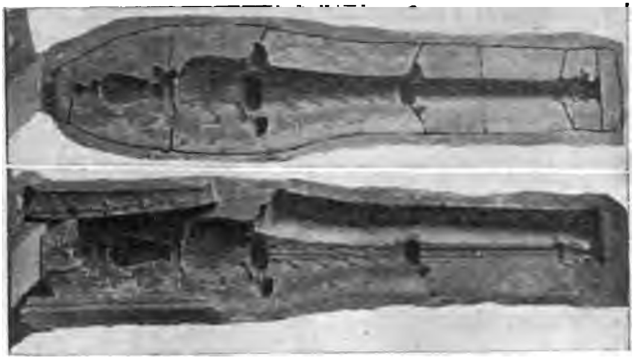


FIG. 51—TWO VIEWS OF PLASTER MOLD, IN MANY PIECES (TO AVOID UNDERCUT) HELD IN PLACE BY OUTER SHELL OF PLASTER

and covered with modeling clay to whatever thickness is decided upon for the thickness of the glue mold. The clay covering is then greased and plaster applied after the methods already described—in one piece for a flat panel or in such sections as are made necessary by the

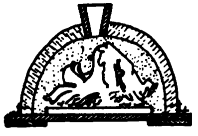


FIG. 52—SECTION VIEW TO SHOW THE USE OF A PLASTER SHELL, TO BE PLACED OVER MODEL AND FILLED AROUND MODEL WITH GELATIN FOR MOLD

model to be reproduced. Then the plaster shell is removed, the clay covering removed from the model, which must be cleaned and oiled, and the plaster shell assembled again around or over the model. The space between the shell and the model is then filled with the gelatin through a hole in the shell. When firm the gelatin is divided to conform to the sections of shell, for easy removal from the concrete.

Gelatin should be melted in a double receptacle. Very little water is used in the vessel with the gelatin. This vessel should be supported in a larger vessel in which the water is heated.

Following is a discussion* by Julius C. Loester, of proper procedure in the treatment of the gelatin an the completed mold.

For a gelatin mold for concrete casts, there should be a good grade of gelatin, boiled somewhat thicker than for

FIG. 53—PLASTER MODEL AND SHELL TO COVER IT WHILE SPACE BET IS FILLED WITH GELATIN

of plaster casting and of a uniform thickness of about all over the model. When the mold is taken off from the m it must be dusted out with French chalk or talcum powde remove all grease; then a saturated solution of alum is ap with a brush all over to harden the surface of the gelatin. A the alum is dry, varnish the mold all over with a high-g

*NCRETE-CEMENT AGE, March, 1913, p. 126

spar varnish. The best is none too good, considering that the mold is filled up with the liquid concrete, each cast requiring under the most favorable conditions 24 hrs., and is filled up again as soon as one cast is taken out. When varnished (and the work must be done carefully so that the varnish will not fill up all the deep places), the varnish must be allowed to become perfectly dry or it will stick to the cast. Before making the cast, grease the mold with *raw* linseed oil, to which a small quantity of machine oil may be added. It is very essential to prepare the mold carefully or the surface will become defective and necessitate making a new mold. Cheap grade or old gelatin is not elastic enough and loses its clean surface quickly.

Coating Molds to Prevent Sticking

Under the heading : Preventing "Sticking," in Chapter 3, are suggestions which should be considered in connection with the various molds described in this chapter.

Sand Molds

The use of sand molds in making concrete casts is covered by patent. The use of sand in which are certain other definitely named ingredients having a tendency, it is claimed, to prevent a rapid absorption of the excess moisture of the concrete mixture, is also controlled by patent. The prospective manufacturer will do well to make inquiry of the Patent Office, Washington, D. C., as to the precise features of such work which are privately controlled, and to make corresponding arrangements with the patent owners for the use of the process in the period before the patent expires. Sand is used in which there is mixed a certain percentage of loam, and successful work is being done using stone dust in place of sand.

For ordinary work the sand is used in large beds throughout the casting floor of the factory and is packed around models which are drawn to make the molds.

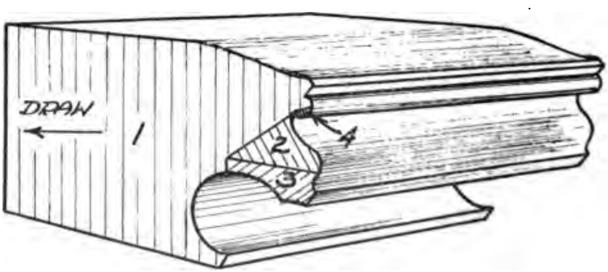
Balusters, capitals and similar pieces having no large flat surface which may be left upward as the pattern is placed in the sand and toward which the pattern can be drawn are made by the flask method, in which a box for each of two or more portions of the pattern supports the sand for a section of the mold. The boxes are assembled to complete the mold. Both of these methods will be given further mention.

Patterns—When sand molds are used the problem of the manufacturer is to make a pattern or model of the stone to be cast. The pattern must be so made as to be withdrawn from the sand without breaking down the mold.

This is best shown in an illustration. Take for instance the piece of stone shown in Fig. 54. Beside this stone is the sheet metal guide of the exact section of this particular trim. The metal was marked out from full-size drawing. It served in the pattern shop when the pattern was made, and as shown in the illustration has been brought to the finishing department to serve as a guide in tooling the casting.

FIG. 54—SEE TEXT—SAND MOLDS

In Fig. 55 is a sketch of the pattern with the parts clearly indicated. It will be seen that the pattern is in four parts. The molded side is placed downward in the sand and when the sand has been tamped into place the pattern is drawn in the direction indicated by the arrow It is obvious that any side projection in the pattern must be a separate piece and separately withdrawn. If drawn



55—SKETCH OF SPLIT PATTERN FOR STONE SHOWN IN FIG. 54

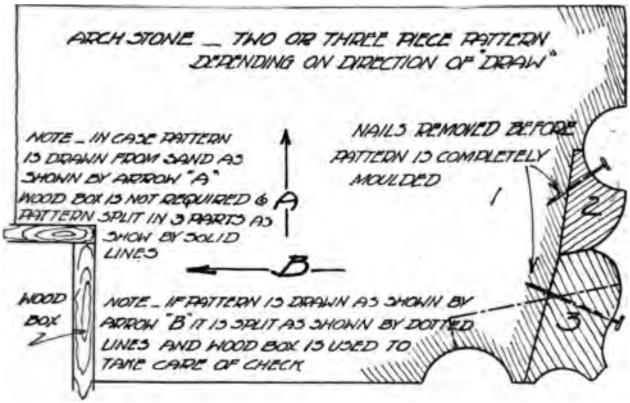
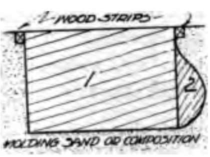


FIG. 56—SHOWS TWO WAYS OF SPLITTING PATTERN FOR SAND MOLD

all at once the projections would break the sand mold. If there were but few such pieces to be cast it would be more economical—by saving time in making the pattern and in making the sand mold—to eliminate the small pattern part numbered 4, by filling in so that the pattern would draw on that line. The additional detail would then be cut in by stone-cutters. Further illustration of splitting patterns is shown in Fig. 56.

It will be noted in the illustration that the parts of the pattern are held by nails which are withdrawn before the sand mold is complete.

In Fig. 57, there are two parts. This serves to illustrate the use of wood strips around the top of a sand mold to give firm edges which are not disturbed by workmen when the surface is smoothed off with a trowel after



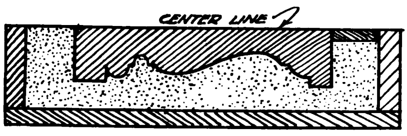


FIG. 57—SEE TEXT—SAND MOLDS

FIG. 58—SECTION VIEW OF SIMPLE FLASK. SEE TEXT—SAND MOLDS

FIG. 59—CONCRETE CAPITAL FROM SAND MOLD, PARTIALLY CUT BY STONE CARVER

the concrete has been in place for a few minutes in which it has stiffened slightly by loss of moisture in the sand.

The flask method is indicated by Fig. 58. This is a comparatively simple flask, involving the use of but two sections. It is common practice to mix the sand with plaster in such work, because, when the sectional molds have been made in the boxes the boxes must be fitted together and stood on end. The parts are made to fit precisely by the use of dowels in the sections of the flask or the box or by cleats which engage at the corners. The flask, as completed, is filled through an opening in the top as made by wood insert shown.

FIG. 60—SAND CAST STONE WITH DETAIL ONLY ROUGHLY BLOCKED OUT, TO BE FINISHED BY STONE CUTTER

In making an elaborate capital like that shown in Fig. 59, it would be more economical to use a gelatin mold providing a full-size model were available. In this way all the detail and undercutting could be fully brought out. If one section of the hexagonal figure like that at the left in the illustration were available, it would be enough from which to produce a sand mold by the flask method, but the numerous sections of the flask and the resulting joints frequently give trouble. The use of two sections of the figure would be desirable so that a mold could be in but three sections. In this case much of the undercutting would be filled in on the pattern sections and the reverse molds would be made of a mixture of sand and plaster. The three sections, each being a reverse mold of two sections, could be placed together to make the mold. The three sections of mold when placed together would be backed up with sand to hold them securely.

Placing the concrete mixture in a sand mold should be done with great care. The mixture should be *smooth* and this depends upon care in the selection of materials and care in proportioning them and it depends further upon agitating the mixture up to the time it is poured. Equipment for this purpose has already been described. When the mixture is deposited the spout or pipe from which it issues should be held close to the mold (a pipe can uusally be lowered into the mold) so that the force of the impact will not disturb the sand. The pipe should have a short, trough-like piece of sheet metal at the end to break the force of the flow. If the mixture is not poured through a pipe direct from an agitator, the man in charge of the casting should use a short board or piece of sheet metal held in his hand, and the mixture should be poured against it.

Chapter 6—Surfaces

The one, great, outstanding objection to the concrete block, as it is most generally known, is its looks. There is no wisdom in any attempt to evade this fact. The sooner manufacturers accept it as a fact, the more quickly will they invite real progress.

It has been rightly called a *cement block*. It has looked the part. It is *cementy* in appearance. Its color is lifeless, its texture nil. It is conservative to say that 75% of all concrete block manufactured has deserved no better use than that to which most of it has been put —covered up, out of sight, in basement walls.

The development of beauty in concrete building units is actually more deserving of serious consideration and painstaking effort than the development of strength. Strength is of first importance but at the present time strengths are in a measure standardized while the aesthetic qualities have been but poorly developed. It does not seem possible that structural qualities could reach such a high percentage of failure as have those qualities of attractiveness which make for architectural desirability.

There is a place for the manufacturer who is frankly and honestly making no pretense of doing anything more than to produce a good unit for basement walls, for partitions which are out of sight, for the plainer purposes of factory construction and for the structural part of such other walls as are to be veneered for the sake of appearance with stucco, or some other facing material. In proportion as he *does* make a good unit is he entitled to respect and consideration. There will always be a demand for his products. This chapter is not for him. It is for the manufacturer whose intention is to make a building unit to serve architectural purposes.

The very worst has already been stated. Concrete *building units* have wonderful architectural possibilities. *This is not a theory.* It is a fact. It has been demonstrated. The possibilities are realities. What has been done at a profit in many places, by different men, with different methods of manufacture and by a variety of architectural treatments, can be done by the many more, until the attractive concrete buildiing unit will be the rule, not the exception, when it will be widely accepted rather than being a purely local triumph.

What is the Matter With the Concrete Block?

The common variety of concrete block placed in a wall:

1—Are of lifeless color.

2—Are of monotonous, uninteresting texture.

3—Commonly are of poor architectural design.

4—Show moisture disagreeably after a rain (due chiefly to color and texture and in some cases to a greater extent because of porosity).

5—Very frequently are poorly set and show ragged arrises.

Color and Texture—The fault in color is not necessarily a fault in itself. Even a gray, cement-colored block may not be objectionable if it is not smooth. Many manufacturers put forth a great deal of effort to make smooth, *slick* looking block. Of course, if a block has the appearance of being intended to have a smooth surface, and possesses flaws, it is objectionable. The "cementy" appearance is heightened by a very fine facing material. If the surface were rough, with coarser material, the texture would, in a measure, relieve the color defect. Even the ordinary limestone has a grain and a suggestion of sparkle, while a smooth cement surface is pasty and dull. The eye demands relief from sameness. When the color is a lifeless gray and the texture lacking to break up the color into specks of light and shadow, the result is monotony. In short, common gray Portland cement is objectionable as a surface coating; it is a lusterless gray and when it *is* used as a surface material the color should be toned in lights and shadows by a rough texture.

Face Design—Rock Face—The less done with face design in concrete building units, the better the units are ordinarily apt to be from an architectural standpoint. The rock-face block, as commonly known, has been responsible for more prejudice against concrete block from an architectural standpoint than any other feature, with the possible exception of the disagreeable wetness of appearance after a rain. This chapter could not contain the full rock-face controversy. Briefly, it is this: The original idea in concrete block was to make something that looked like natural stone. The new material was so easily molded, and many of those commercially advocating it suffered from such limited imaginations, that the easy course to follow was in imitating something else. The beautiful possibilities of concrete as concrete—as a composite of chosen aggregates of unlimited range—were not understood. The rock-face block was intended to look like pitched-face stone. Considerable criticism has been raised against the product for the simple reason that it was an imitation, yet many of the foremost architects specify cast stone, surface finished just as natural stone is finished, and they use "birch-mahogany" doors in place of real mahogany for good and sufficient reasons. It is a fine, ethical point scarcely worth discussion, that the rock-face block is or is not objectionable for the reason that it has a molded face of a character similar to that considered attractive when obtained by other means on natural stone. This is a matter which others may decide. If the rock-face concrete block made a beautiful wall, there is no doubt that architects would specify it. Its origin in design would scarcely be questioned. The fact that rock-face block very rarely make possible the informality, variety and charm frequently possessed by walls of pitched-face natural stone is one good argument against this type of block. Natural pitched stone *has* variety. It has variety without effort. Every stone is separately cut. The cutter supplies the cleavage force; the stone actually breaks according to its grain. Rock-face block are molded on face plates and even with the most diligent effort, duplication is impossible to avoid. Therefore, *the rock-face block* is not free, easy and charming, but

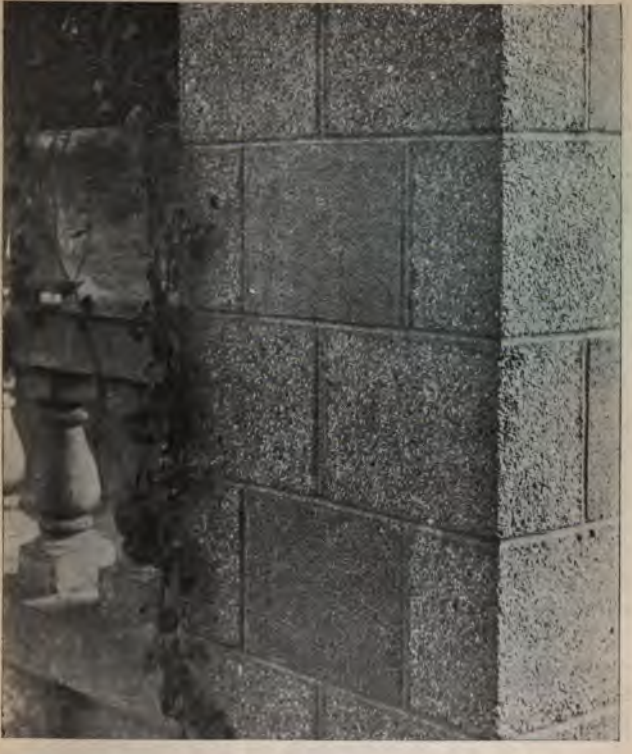


FIG. 61—DETAIL OF CONCRETE BLOCK HOUSE WITH TWO GRADES OF FACING, BRUSHED WHILE GREEN—R. H. BUSHNELL

stiff, unnatural and ugly—not because it is an imitation, but because it fails to imitate.

The most attractive work done with rock-face block has been with broken ashlar. The variety in size of units breaks up the wall so that recurrent block faces are less obvious, yet this is still far from being a realization of the best in concrete surfaces.

Wet, Clouded Surface After Rain—The objectionable feature of many concrete block in "soaking up a rain" is more an objection because of the appearance of the wall than anything else. A wall built of concrete block which tests at 10% for absorption looks wetter after a hard rain than a wall built of brick which have an absorption of from 15% to 20%. A wall built of block of uniform absorptiveness will not look so wet as one in which the units are unequal as to porosity. The difference in appearance between the block wall and the

FIG. 62—GOOD DESIGN AND INTERESTING TEXTURE; DRY-TAMP CONCRETE IN PLASTER MOLD—PHILADELPHIA SCHOOL OF INDUSTRIAL ART

brick wall is due chiefly to difference in color and texture. The looks of such walls after rains have done much to establish a prejudice against the material. Some people have plastered direct on the inside surface of concrete block walls, where the air space was not continuous. They would never think of doing so on a wall of common brick. Such uninsulated walls frequently result in condensation of interior moisture on the walls. This feature should be considered in connection with absorptiveness because both conditions affect architectural desirability, but they should not be confused. The concrete wall which is the most porous and most absorp-

FIG. 63—DECORATIONS IN COLORED TILES—TILES SPLIT, WITH ROUGH SIDE OUT—PHILADELPHIA SCHOOL OF INDUSTRIAL ART

tive is the *best* insulated wall. The very best concrete wall, so far as density is concerned, is the most apt to give interior condensation. Therefore, where the air space is not continuous in the wall, the insulation should in most climates be provided by furring and lathing for interior plaster.

While architects have been vigorous in their condemnation of the so-called spongy characteristics of concrete block, this criticism is chiefly due to a matter of looks. A concrete block with an absorption of 8% to 9% looks very wet after a rain, unless its color and texture are such as to make the moisture less obvious, yet it is not considered unsafe to use Indiana limestone on an almost equal absorptive basis. It has been charged that such block are structurally weak, not being sufficiently dense. It is not within the scope of this chapter to take up tests for absorption and for compression and such a basis of criticism as has been mentioned is important here as indicating that a very great deal depends upon appearance.

Sharp Edges—Good Setting—As to the setting: *Concrete units should* be treated as stone. A brick layer

FIG. 64. SIMPLE FLOWER POT DESIGN IN CONCRETE. FROM PLASTER MOLD AND CLAY MODEL—PHILADELPHIA SCHOOL OF INDUSTRIAL ART

frequently handles block as he does brick. A slight unevenness in laying brick is not always offensive. An unevenness in setting block is as unsightly as a similar careless treatment of natural stone units. But previous to setting the manufacturer must produce units with strong, sharp edges. The broken down edges so commonly seen are due to poor mixtures, poor curing and careless handling.

Better Looking Units

The great problem of the manufacturer is to produce *better looking* building units. This is not in the line of least resistance, because the common, architecturally objectionable concrete units can be sold without great effort for foundations, factory walls, and in cheap real estate development for houses. The more concrete block of the common variety are used in such work, the greater must be the effort to introduce the new concrete block to architects and to a discriminating public. Every unsightly piece of concrete block work is condemning concrete block. Its own awful example is doing more to retard the progress of the industry than the most stringent of building regulations. From 1 ct. to 5 cts. in additional manufacturing cost with the object of making block which have architectural merit — block of good color and surface texture which will advertise themselves

Fig. 65—Common Variety of White Rock-Face Block

Fig. 66—Concrete Block Made With Plain Face and Given a Rock-Face Just as Natural Stone is Treated—By a Stone Cutter with Mallet and Chisel. Not a Commercial Success, but Shown Here by Way of Comparison with Fig. 65

—will open up entirely new markets, will develop a new and an intelligent interest and will put the concrete products industry in the way of a general success as remarkable as the individual successes which have rewarded the individual efforts in this direction. Such successes are to be found in many parts of the country.

The attractiveness of concrete building units depends mainly upon the development of texture or color, or, better still, upon a pleasing combination of both texture *and color. In any* event, the flat, cementy surface either must not exist in the product as molded, or it must be removed or changed in appearance after it has been molded.

Providing for Color and Texture

Surface colors and textures are otained in several ways and from all the possibilities the manufacturer must choose the method suited not only to the precise results desired but adapted to his methods of manufacture as governed by the process and equipment which he is using. In fact, the manufacturer who has not fully decided upon his equipment should be influenced by the architectural possibilities with that equipment.

The surface of wet-cast stone as it comes from the molds is usually unsightly and is more cementy in appearance than products made with drier mixtures. This is not true where a special means is provided for a dry facing and a poured backing as will be further described. Wet-cast stone is usually made, however, with one mixture throughout. The result is not satisfactory without some treatment of the surface which removes the "skin" of cement and exposes the aggregate in its natural color and texture. In practically all tamped work and in compacting by the application of pressure, facing mixtures are used, with a backing which requires no special selection or combination other than for structural value.

Facings

The faci gs most commonly used consist in mixtures of 1:2, 1:2½ or 1:3 of cement, either common gray or white Portland cement, and sands, either white, buff, yellow or red, or of cement, sand and crushed granite or fine marble screenings or cement and graded crushed granite (usually under ⅛" in size) or fine crushed marble. For more pronounced colors or for special tones, ordinarily in combination with white cement, coloring matter is mixed with the cement.

Mineral Colors—Great care should be exercised in the selection of colors—first, because of a tendency to retard the set of the cement and to weaken its binding quali-ˀs, *and second*, because of the instability of many colors when mixed with cement or when exposed to the weather and to the light. Only mineral color, of the best quality, should be used. Colors, chemically produced by artificial means or colors of vegetable origin, should not be used, not only because of the probable lack of permanency of color but because of the danger of weakening the product or causing its disintegration. Even when the best colors are used with Portland cement the quantity should not be in excess of 5% of the weight of the cement. While much higher percentages *have* been used without evident damage to the product, the results are uncertain and until careful investigations have demonstrated the further possibilities in the use of certain colors in excess of the commonly specified 5%, the stone manufacturer should be cautious. Many others recommend the use of considerably higher percentages. The following discussion* by a producer of colors, J. H. Jackson, bears out the recommendations of those who have had experience in the use of colors. Mr. Jackson says:

Mineral colors of the highest degree of purity are the only kind to use in coloring cement. The permanency of shade of color obtained depends upon the elimination by the manufacturer from the color of anything that the cement itself will destroy, for otherwise the ultimate result would be cement discolored, which is worse than cement not colored, and this is one very sound reason why the contractor should exercise as much care in selecting color as he would in selecting cement, for no concrete walls or floors look so poor and cheap as when colored with colors that are fugitive and are as unsightly as an unpainted, old board fence.

Few contractors realize that the more intense and brilliant are the colors, the more quickly they fade, and in more instances than one help to disintegrate the concrete, for none of the mineral colors useful in cement is found naturally brilliant or intense, and the addition of chemically prepared colors or the treatment of the native mineral colors chemically, to give intensity, is a positive detriment under all conditions.

Mineral colors, as before stated, occur in a native state, but never pure, being alloyed with other minerals; for instance, iron is found alloyed with nickel; in meteoric forax with arsenic, sulphur, chromium, magnesium, aluminum, etc.; in oxides, silicates, carbonate, etc.; and the most valuable of these are the oxides and silicates, and the color chemist produces

*CONCRETE-CEMENT AGE, Nov., 1914, p. 208

therefrom such colors and shades of the colors as red, yellow, brown, black and dull green, and, from other metals and combinations, are also obtained bright greens, blues, purples, reds and blacks.

Do not use color that necessitates more than 8% to 10% in the mix, based on the weight of cement. Usually 6% is enough, because an excess of coloring matter positively displaces the sand and grit and reduces the bonding power of the cement.

Avoid colors which, when shaken well in a tube or glass of water, permanently discolor the water, for such colors will fade, run and streak; also eliminate chrome green and chrome yellow and similar brilliant paint store colors for they (many of them) will fade almost before the concrete has set.

Free sulphur or an excess of combined sulphur in reds, browns, etc., are evidenced by the colored concrete turning darker and having a muddy or soiled appearance.

Do not blame the building material dealer for selling colors like the foregoing if you have insisted upon buying for price and not for quality. Insist upon obtaining samples of better colors to try out, and if they cost more, they will (and this seems paradoxical) in the end, cost less, for you will use a smaller quantity and obtain richer, more lasting effects. The results will be mild or soft tones that are more natural and your concrete will be more like native stone, in natural shades, blending with the surroundings and enhancing the architectural effect. What is more unnatural or objectionable than an intense red, blue or yellow in a wall?

The use of white sand is of course necessary when you want a color to be more prominent and is really essential in using green for decorative work in walls, so that the green is effective; and in floors when green is used for the field, with a milder green, red or other color in the border.

All true cement colors will withstand acid treatment (1 part of acid to 5 parts to 6 parts of water) scrubbing and troweling, but in polishing after being set, and trowel polishing before being set, special care should be taken when yellow, green and similar colors are used, for the metallic polishing is likely to darken the color. Never give a smooth finish to outside concrete walls when color is used.

The contractor should obtain samples of the best colors, consulting his cement and material dealer, or any cement manufacturer, and make as many stucco pieces, concrete block, brick, floor squares, etc., as his ideas of shades to be obtained suggest, making them in duplicate, keeping one of each in water, the other protected from direct sunlight for 28 das., and then give all as long an exposure test as he can before again using cement color, to satisfy himself by actual practical trials what colors are apparently stable and what shades are soft, yet effective, and base his color schemes thereon and he will not make any errors.

In combining two or more colors to obtain a desired shade try to use colors of the same specific weight in order that in the mix they do not separate or show a lack of uniformity of the shades to be developed.

Many contractors do not make a thorough mix; by this we mean they do not mix the color well into the mass and when it sets and dries out to a lighter shade they think it has faded and blame the color when their own carelessness is the cause.

The standard proportions for colors generally used are 6 lbs. to 6½ lbs. of color to every 100 lbs. of cement. The amount of color can be increased if a deeper shade is desired, always bearing in mind that you should not use more than 10 lbs. of color to every 100 lbs. of cement, for an excess of color reduces the binding power of cement. The color, if thoroughly mixed with the other ingredients dry, and water then added, will form a homogeneous mixture in the mass, thereby always producing uniform and durable results.

Very strong colors must be used to obtain even soft tones, because of the small quantity of color as compared with the cement with which the color is mixed. A table of color quantities by L. C. Sabin* indicates the approximate results to be obtained.

Practice varies as to the proper way of mixing colors. Some put the color into the water to be used in the mix. Others thoroughly mix the color, cement and aggregate dry before adding water. The preferred practice, however, appears to be in first thoroughly mixing the cement and color. This mixing should continue until the color is uniform throughout the mixture. Take a little of the mixed cement and color and press out under a piece of clear glass or on a piece of white paper and examine the mixture carefully. If the color is in specks, the mixing should be continued.

Colored Aggregates—Special sands and pebbles and crushed granites, marbles, trap rocks, limestones, with their natural colors exposed are much to be preferred to coloring matter. Scarcely more than a beginning has been made so far as commercial production is concerned in utilizing the materials which nature has

**Cement and Concrete,* by L. C. Sabin

Colored Mortars

Colors given to Portland Cement Mortars Containing 2 Parts River Sand to 1 Cement.

Dry Material Used	Weight of Dry Coloring Matter to 100 lbs. Cement			
	½ Lb.	1 Lb.	2 Lbs.	4 Lbs.
Lamp Black	Light Slate	Light Gray	Blue Gray	Dark Blue Slate
Prussian Blue	Light Green Slate	Light Blue Slate	Blue Slate	Bright Blue Slate
Yellow Ochre	Light Green	....	....	Light Buff
Ultramarine Blue	....	Light Blue Slate	Blue Slate	Bright Blue Slate
Burnt Umber	Light Pinkish Slate	Pinkish Slate	Dull Lavender Pink	Chocolate
Venetian Red	Slate, Pink Tinge	Bright Pinkish Slate	Light Dull Pink	Dull Pink
Chatt. Iron Ore	Light Pinkish Slate	Dull Pink	Light Terra Cotta	Light Brick Red.
Red Iron Ore	Pinkish Slate	Dull Pink	Terra Cotta	Light Brick Red.

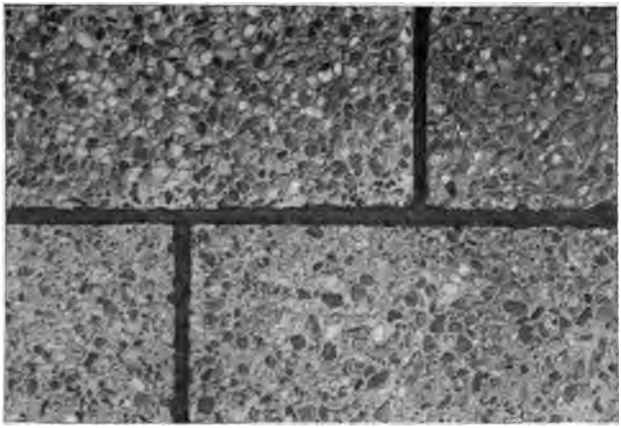


FIG. 67—WET PROCESS, BRUSHED CONCRETE BLOCKS, GRAVEL AGGREGATE—WORK UNDER DIRECTION OF GROSVENOR [illegible]

provided in making beautiful concrete. Materials which are waste in the quarry are the very things needed to make real architectural units. While many of these materials are on the market, the manufacturer will, in many cases, when suitable materials are locally available, do well to install a crusher and develop many facing materials for himself.

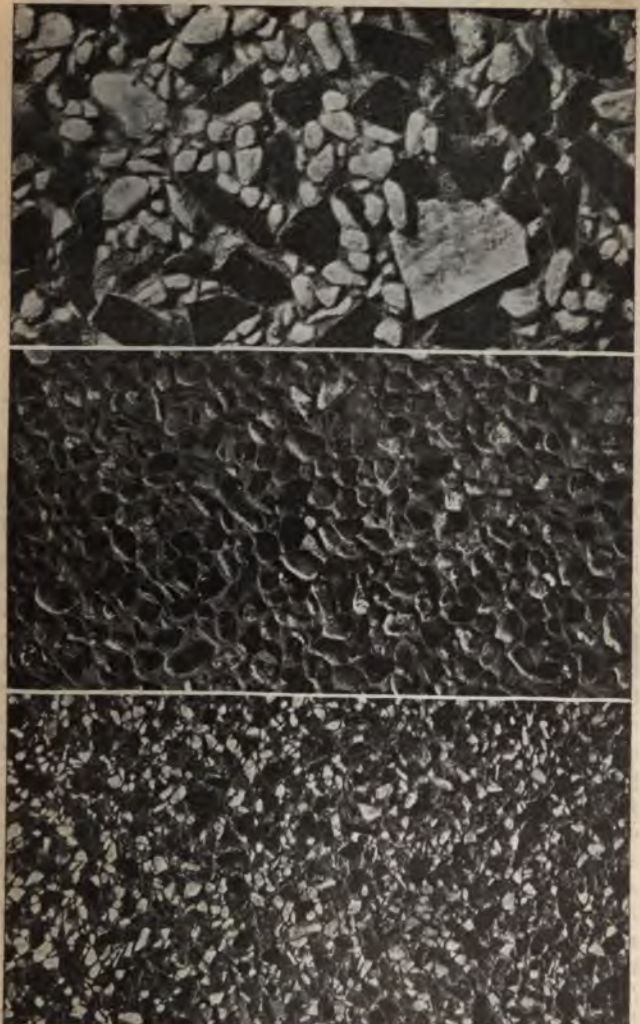
Unfortunately the accompanying illustrations show only the texture and tone values and leave the beautiful color qualities to the imagination. A commonly used facing is mica feld spar for granite effects. In fact, many manufacturers seem to feel that it is the only thing open to them, offering a facing with life and sparkle, and with a grainy, rough texture. The material is used in various sizes up to about ¼″ but trial facings will develop the variety and charm which are possible in the use not only of entirely different facing materials but in different gradings, using coarse and fine; fine of one color and coarse of another, and so on. The combinations are almost limitless, and the results will amply repay investigation and experiment. It is neither necessary nor

FIG. 68—BLOCK SPRAYED WHEN FIRST MADE AND BRUSHED A FEW HOURS LATER—FACING OF MICA SPAR CRYSTALS—R. F. HAVLIK

always desirable that the selected aggregates be so graded as completely to cover the face of the work, and it will, in many cases, lend additional charm to permit the matrix of cement and sand, which holds the special aggregates, to become a considerable part of the surface.

It is far from the spirit in which an investigation of architectural qualities should be undertaken to proceed by definite rule or to adopt any choice arbitrarily. It is the purpose of this chapter to emphasize the importance of work along this line and to outline the methods by which results can be obtained. It is for the individual manufacturer to add something to the general knowledge by individual and original effort. He will be surprised to find out how from 1 ct. to 3 cts. per sq. ft. added to the cost of the units will open up entirely new possibilities. With proper care and judgment at the outset, followed by consistent good workmanship, the concrete block becomes a new material—not in competition with common brick, but offering beautiful architectural results. It becomes a true facing unit—not to be veneered with something else nor to be put out of sight in foundations, but to be used in preference to other attractive facing units now on the market.

Silica sands of many rich colors—red, purple, yellow, orange and brown—are obtainable, and to a limited extent have been marketed in bags, reground and ready mixed with Portland cement for use in stucco and facing *tures.*



FIGS. 69, 70, 71—BRUSHED AND WASHED FACINGS
Top, *of coarse black and white marble; center, screened torpedo sand; at bottom, fine black and white marble and red granite—illustrations, courtesy* Universal Portland Cement Co.

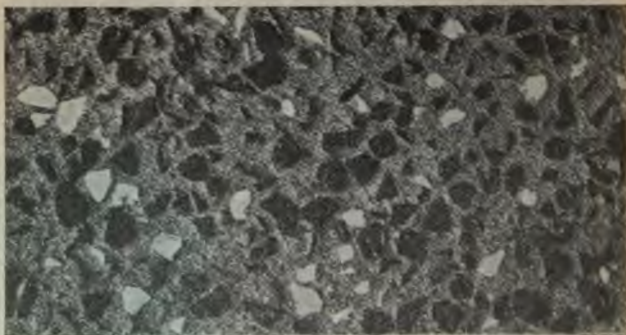


FIG. 72—SCRUBBED FACING OF 1 PART ¾-IN. WHITE MARBLE CHIPS, 4 PARTS ¾-IN. GREEN MARBLE CHIPS, 2½ PARTS SAND, 1 PART CEMENT—VULCANITE PORTLAND CEMENT CO.

Placing the Facings—While relatively dry, lean facing mixtures may be used without covering the entire surface which is to be exposed with a film of cement, it is the usual practice to insure a firm matrix for the exposed particles by using a good mortar with them. If the facing mixtures are spread over the bottom of the mold in a lean, dry mix, the concrete used for backing should be wetter and well tamped into the facing to be sure of good bond. If the facing mixture is to be used on vertical walls of molds it can be placed by means of a division plate. This will consist of thin sheet metal, preferably made to fit the side of the mold where the facing is to be placed. The facing mixture will be placed on one side and the backing on the other side. The two sides of the metal plate are to be filled in gradually and the backing thoroughly tamped as the plate is gradually raised, allowing the two mixtures to come together and bond. In other work the mixture must be worked up the sides of the mold and tamped into place 2″ or 3″ at a time, and must be of such a consistency, neither too dry nor too wet, as to stick together and keep in position. If a rough texture of stone particles is desired it is necessary to use but very little sand in the facing mixture. In such work the backing must be well

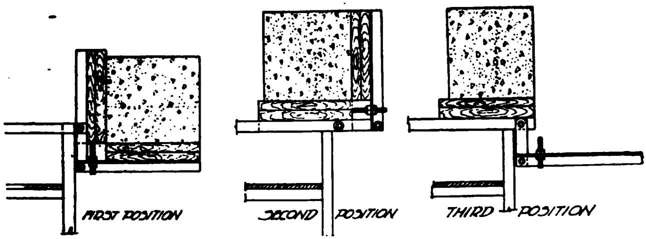


FIG. 78—THREE VIEWS OF TURNING STAND FOR HANDLING GREEN CONCRETE BLOCK TO BE BRUSHED ON THEIR FACE SIDES

This is for handling products which are delivered on pallets face down. A block on pallet is placed on stand as in the 1st position. The shelf is turned over, so that the block rests on its side as in the second position. The shelf which first supported the block is then turned down leaving the face exposed for brushing or other treatment.

bonded with the facing and where facing is to be applied on top of the work, the body concrete must first be compacted and then struck off $\frac{1}{4}''$ to $\frac{1}{2}''$ below the surface of the finished work by means of a straight-edge which fits into the mold box, and rides at the sides on the box, projecting just far enough into the mold box to give the required depth of facing. Such facings may be pressed into the backing by means of a trowel. Tamping will not give a smooth finished surface without unusual care and the application of pressure is the ideal way of making sure of good bond. Pressure machines which exert an even pressure by means of a plate over the entire area of the mold box give excellent results in such work.

Exposing Facings—Concrete stone facings may be brightened and the aggregates exposed by several different means: spraying with a very fine mist used with considerable force immediately after removal from the mold; brushing with fibre or fine wire brushes and washing after a period of from 6 hrs. to 24 hrs., depending upon the curing conditions; by etching with a solution of commercial muriatic acid after the product has cured for several days; or after the stone is hard, by rubbing, using concrete bricks of fine material, or stone, or one of the commercial abrasive materials; or by tooling, polishing or planing, each of the three last named treatments requiring power equipment for the most economical results.

FIG. 74—SMALL DETAIL OF GRANITE CONCRETE MAUSOLEUM, RUBBED FINISH —CHARLES EILBACHER

Sand blasting has been used with success on large areas poured in place but has not been developed for factory purposes.

Following are excerpts from a discussion of color possibilities by W. M. Kinney.

Mr. Kinney says*:

There is little difference between results secured by using artificial coloring matter in cast stone where the mixture is uniform throughout and the facing of tamped concrete, such as is ordinarily used in block, brick and other products except that in using a wet mixture, the manufacturer will be deceived as to the identity of the color. What appears to be quite a dark shade in wet concrete will be a much lighter one when *the product has* thoroughly dried.

*ONCRETE-CEMENT AGE, NOV., 1914, p. 207

FIG. 75—SAND-CAST CONCRETE, HAND-TOOLED—EMERSON & NORRIS CO.

Several companies now manufacture all of the colors that may safely be used in concrete work. Mineral coloring matter only should be used. The proportions should not exceed 8% of the weight of cement, as greater amounts may seriously weaken the concrete. Coloring matter should be thoroughly mixed with the dry sand before either cement or water is added. Various shades of red, yellow, blue and black may be produced, but brilliant effects are impossible, and tests have shown that *all artificial colors fade* in time.

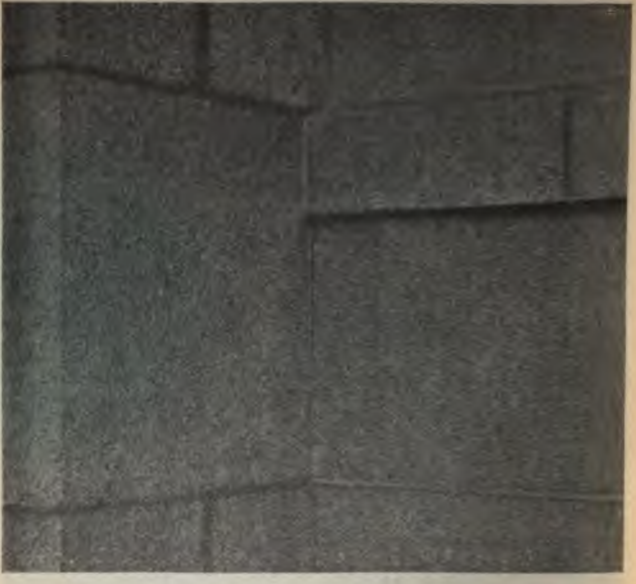


FIG. 76—NATURAL GRANITE AT LEFT OF CENTER; MANUFACTURED GRANITE AT RIGHT—DETAIL OF GORE HALL, HARVARD UNIVERSITY, WARREN AND SMITH, ARCHITECTS—EMERSON & NORRIS CO.

Recent experiments indicate that the intensity of color or tint produced by artificial colors may be somewhat augmented by increasing the time and thoroughness of mixing considerably beyond that usually given a batch of ordinary concrete.

The most satisfactory way of obtaining desired color and texture in concrete surfaces is to use an aggregate of proper size and color and treat the surface of the work so as to expose the aggregate. A surface so produced will not deteriorate, scale, fade or require renewing. The exposed film of cement which coats the aggregate is removed from the surface by brushing while still green with a steel brush or one having stiff palmetto or other fibe bristles or a good brush for this purpose may be made by clamping together enough small pieces of wire cloth to make a brush about 4″ wide. After brushing, the work should be washed with a solution consisting of 1 part of commercial muriatic acid and 3 parts of water. *After the use of* acid solution the work should be washed *immediately and* thoroughly with clean water, as any acid remain-

FIG. 77—HAND TOOLED CONCRETE—EMERSON & NORRIS CO.

on the face of the work will ultimately cause streaks iscoloration.

following materials are recommended as suitable aggre- for the production of desirable brushed surfaces, using cases a mixture of 1 sack of Portland cement to 2½ cu. aggregate.

FIG. 78—MACHINE-TOOLED CONCRETE WITH PARALLEL GROOVES—EMERSON & NORRIS CO.

Yellow marble screenings up to ¾″; red granite screenings up to ¼″; black marble graded from ⅛″ to ½″; white marble graded from ⅛″ to ½″; river or lake gravel graded from ¼″ to ½″. For economy, limestone may be substituted for white marble and either black granite or trap rock may be substituted for black marble.

One of the chief advantages of finishing surfaces by brushing is the adaptability of this process to every class of concrete product. Concrete block and ornamental products, such as park benches, lawn vases, lamp posts and statuary of all kinds, may be finished very attractively by this process.

Coloring by Absorption—Some unusual methods in producing interesting color effects in concrete ornamental work have been developed by Adolph Schilling. These he describes as follows*:

The absorptive qualities of concrete during its stage of curing and seasoning offer opportunities for coloring concrete products by capillary action. By this method, the color is deposited in the pores of the surface, amalgamating with the concrete in a permanent unit. The possibilities of this treatment

*From paper read before National Assn. Cement Users, (Am. Concrete Institute); CONCRETE-CEMENT AGE, Jan., 1913, p. 6. Further reference, May, 1914, p. 216

are unlimited, but individual knowledge of coloring values and judgment, so as not to impair the strength requirements of concrete, are essential for success.

Coloring solution can be made to penetrate the surface of concrete 6″ or more, if the object is placed in the solution in a very green state. It is rarely necessary to penetrate more than 1/32″ to 1/8″; this thoroughly fills all pores, gives the desired color effects, and is less expensive.

Every atom of coloring matter absorbed by the concrete reduces the strength of the solution; and as some of the coloring matter used is quite expensive, good judgment in allowing only the necessary absorption of coloring matter is advisable from an economic standpoint.

Aniline colors and the sulphates of copper and iron are the most suitable to make solutions in which to color concrete by the capillary method.

The concrete to be colored can be treated after it is several days old. Concrete products with strength requirement should not be subjected to the coloring bath until the concrete has attained its required strength, as the filling of the pores in the concrete stops the action of its curing by the usual methods.

Coloring by absorption is effective on surfaces of concrete after it comes out of the mold, or after being treated with acid or tools. Surfaces that have been colored by absorbing mineral or metallic colors become waterprooof, and the action of the weather on the metallic colors is the same as on real metals, increasing the beauty of coloring by the usual oxidation noticed on bronze and copper. Surfaces of concrete treated by this method become so hard and dense that they will take a uniform dull or high gloss polish. I have treated such surfaces in the same manner as marble, granite and metal, under polishing or buffing machines.

Products made by these methods, such as flower pots, vases and boxes, will hold water after the second day of casting, and become so hard that when struck with a hammer they ring like a metal bell. I do not think that waterproofing compounds are essential in obtaining this result, but consider the proper amount of water and thorough grading of the aggregates as all important.

I have made extensive tests in the last three years with waterproof paints, and have obtained excellent results. Ordinary concrete can be made very attractive by one coat or two coats, and if applied in stipple fashion it will not impair the grain or texture, avoiding the undesirable effect of painted stone.

This method is especially to be recommended for dry or semi-dry process concrete work, as the porous surface readily absorbs the waterproof liquid, and allows the pigment particles to fill the pores.

nozzle attached to a length of ½-in. hose is all the extra equipment needed and the spraying is a very simple operation which, with a little practice, can be done effectively by any intelligent laborer. The object and the effect of the spraying are as follows: It is well known that one of the greatest objections to the ordinary cement block has been, and is, its dull, lifeless appearance. No matter what kind or color of sand or crushed stone is used for facing, a certain amount of cement adheres to each grain, hiding the natural color and giving to the block the color of the cement used. White sand will give a lighter effect than dark sand, but in either case the entire surface is one color, dull and for many uses, unattractive.

The spraying is to give a mottled effect, exactly the same as in fine, high-grade granite, where you see the black mica set off by the white or light gray of the quartz crystal in which it is embedded. The originator of the process described had for years the idea of spraying a green concrete block to wash the cement from the particles of sand, before it had had an opportunity to set, thereby accomplishing three things in one simple operation. First, to expose the color of the sand; second, to give to a semi-dry facing mixture the water needed to aid in the proper crystallization of the cement before the initial set had taken place; third, to remove mold marks and to give to the surface a roughened effect, equal to fine bush-hammering. * * *

The facing mixture should not be made too wet. The reason for this is that it is not desirable to lose the cement from the face of the block, which, if the facing were too wet, would stick to the mold.

In spraying, where the facing has been properly mixed, watch closely and give all the water it will take without sagging. For the regular line of block, nothing more need be done except to cure in the usual way, either by steam or by sprinkling. For special and ornamental work, it is best to spray again, one hour or two hours after, and as soon as the cement has set so that there is no danger of its washing, give it all the water it will take.

The spraying is much more quickly done than described. In actual practice in a plant with power machinery which carries two molds, one at a time revolving under a pressure head to be compacted, the machine delivers a block vertically with the faced surface on one side. The faced block are removed on the pallet and set down to be sprayed. The spraying for each block requires less time than the molding of a block. The extra labor involved is done by the men handling the spray *nozzle, and* a man who lifts the block, when sprayed, to the car. With a machine in which block are made face up, the block may be sprayed before being removed from the mold. J. M. Gifford suggests* spraying products face up as follows:

In the treatment of the surface of concrete stone with spray, it is found that when using granite facing the best results are secured when the surface to be treated is turned up so that the surface lies in a horizontal plane instead of vertical. In this way we have found that water from the spray, after taking away the film of cement from the surface, runs down into the block carrying the cement to the base of the facing aggregate, giving a much stronger bond. We find that this also gives additional density in the face, resulting in a more nearly waterproof product. If this spraying is done with the face vertical, the water runs off, carrying the cement with it, leaving the face streaked, or at least washing the face deeper at the top than at the bottom where some of the surplus cement is deposited on the way down.

Brushing and Acid Washing—Brushing and acid washing in producing the desired surface are discussed by W. M. Kinney, J. K. Harridge and R. F. Havlik.

Mr. Kinney says†:

Where the desired surface finish of concrete necessitates the removal of the cement film, the surface should be brushed while green with a brush of palmetto or other stiff fiber bristles. Care must be taken that the brushing is not started too soon, as small particles of aggregate will be removed, resulting in a pitted and unsightly surface. On the other hand, the longer the surface stands before being brushed the more difficult it will be to remove the film of mortar that has flushed to the surface. The free application of water during the brushing will materially assist in the work. The brushing should be started just as soon as it is possible to do so without removing particles of aggregate. The time required for sufficient hardening can only be determined by experimenting with the particular surface.

For surfaces that have been allowed to become partially hardened, a brush about 4″ wide, made by clamping together a sufficient number of sheets of wire cloth, has been found to be more effective than the wire brush commonly used for this purpose.

After the entire surface has been brushed the appearance of the work can be improved by washing with diluted muriatic acid applied with a brush. While wet with acid, the surface should be quickly worked over with an ordinary scrubbing

*Concrete-Cement Age, Apr., 1913, p. 188
†Concrete-Cement Age, Nov., 1914, p. 209

brush and the acid immediately removed with clear water applied through a hose. It is important that the surface be thoroughly washed after the acid treatment as otherwise it will have a mottled, streaky appearance. This final acid treatment thoroughly cleans the aggregate, thereby intensifying the color, and assists in giving the surface a uniform appearance, especially on large surfaces where different sections have been brushed at different times. A solution of 1 part commercial muriatic acid to three parts clean water should be used.

As to the use of acid Mr. Harridge says:

I believe that the most practical and generally desirable way to use acid for the removal of the cement film from aggregate in the face of concrete block is with a scrubbing brush. The block are set with the face up, the acid applied, allowed to stand a few minutes and then scrubbed with stiff fibre or wire brush until the face shows the desired results. As soon as possible the acid should be washed off with a liberal application of clean water. In some cases it is necessary to make several applications of acid before the face shows as well as desired. If the block are handled while the faces are still somewhat green, scrubbing with a fibre brush and water not only gives more economical results, but makes it possible to get a much larger range of textures than would be practical with the acid treatment. Acid is likely to cause stain of either the cement or the aggregate if it is not handled *just so.*

The granite block are made the same way as the rough block except that a thin layer of granite mixture is placed on top of each block. As soon as the block is pressed its face is sprayed with a fine spray to wash the surface coating of cement from the granite. A pallet is then placed on top of the granite face and when the block is removed from the machine the face rests on this pallet. This prevents the facing from hardening as rapidly as the balance of the block. The granite block are removed from the steam rooms the following morning and the faces scrubbed slightly with water and a stiff scrub brush. This is done merely to brighten up the block and takes but a few seconds for each block, as the spraying removes nearly all of the surface cement.

After the block have been thus scrubbed they are put back on the same cars and again set in the steam rooms to cure.

The concrete lamp posts erected in Chicago by the Lincoln Park Board have been the object of much favorable comment because of their interesting color and texture. A description† of the manufacture of these posts by P. *Zinner, master* mechanic of the Board, includes

†*Concrete, June, 1911, p. 48*

the proportions and quantities for the facing mixture for each post, which are: 16 qts. torpedo sand, 24 qts. crushed red granite, 5 lbs. ground black mica, 16 qts. white cement. After several days' curing the surface is scrubbed with full strength muriatic acid and then thoroughly scrubbed with pure water to remove all traces of acid.

The American Concrete Institute standard practice specifies as to color, sharp edges and care of product to prevent injury, as follows:

Coloring Matter—Where color is required, only the most permanent and durable mineral colors shall be used and shall be considered as aggregate.

All surfaces and arrises of stone must be true and without imperfections.

All concrete products of full standard size shall be marked for purpose of identification, showing name of manufacturer, brand, date (day, month and year) made.

All concrete products shall be handled with utmost care. When transported and subjected to rough handling they shall be crated and packed in non-staining material in such a way as to insure no damage from chipping or abrasion. All large and heavy stone shall be provided with hooks for lifting. When necessary, stone shall be provided with metal bonds for the purpose of tying to the masonry backing.

Removing "Air Bubbles"

When a wet mixture is used it must be deposited with care so that the tendency to form air pockets will be reduced. This is considered in Chapter 3 in so far as "spading" the mixture and tapping or vibrating the molds are concerned. When these pockets are formed in spite of such precautions, it is common to use a creamy grout of cement and water applied to the product with a brush and rubbed in with a small wood block. When hard, the stone is then rubbed,polished or tooled to remove the effect of a painted surface.

Crazing

Crazing, or the formation of hair cracks on the surface of concrete stone is encountered more in wet-cast than in dry-tamp work. Two discussions of this problem are presented, one by H. P. Warner, who writes from the viewpoint of a manufacturer of wet-cast work, and one by P. E. McAllister from experience more especially with drier mixtures.

Mr. Warner says:*

Surface cracks or crazing in concrete are matters which have long vexed manufacturers of concrete stone and I believe I am safe in saying, with our present knowledge and methods of manufacture, they are a feature which can never be absolutely eliminated. With proper care and surface treatment, however, I believe that crazing, while it can never be absolutely eradicated as long as the concrete is exposed to the elements, can be overcome to such an extent as to render it practically unnoticeable.

Crazing is apparently caused by changes in temperature, resulting in uneven expansion and contraction on the surface as compared with those portions nearer the center. In making concrete stone a thin skin of cement mortar is formed on the surface which is much richer in cement than that forming the body of the concrete.

These two materials have different coefficients of expansion, and because of this fact, varying changes in temperature cause "hair cracks" to appear. These are particularly marked on a surface which has been troweled to any extent, thereby bringing an excess of cement and finer materials to the top. On a surface treated in this manner, the crazing appears more rapidly and to a much greater extent.

Structurally these cracks are practically harmless, since they seldom extend into the stone more than 1/32"; but when they become full of dirt, as they invariably do, they result in a very unsightly appearance.

Crazing, when it has once occurred, is most difficult to rectify by anything short of removing the entire surface. The writer has completely removed all crazing from concrete stone with wire brushes, only to have the same cracks appear in the same place in two days' or three days' time. I have also applied a fine mixture of beeswax, paraffin and benzine to the surfaces when they are absolutely dry. This mixture does not discolor the stone and penetrates to the depth of about ½". This treatment, however, is at best only temporary and but postpones the evil day when the crazing appears.

I have also found that crazing varies inversely with the size of aggregates and that, in general, the finer the ingredients used in the concrete, the more decided is the crazing. It is also true, so far as concrete stone is concerned, that crazing is to a certain extent governed by the finish used. For instance, a rubbed surface will show the crazing much more than a tooled or fine-axed finish; and with a coarse crandaled or point finish it *virtually disappears* so far as is apparent to the eye.

*CONCRETE-CEMENT AGE, Sept., 1914, p. 123

The only permanent remedy, which while it does not entirely eliminate crazing, reduces it to such an extent as to render it unobjectionable, I have found, is to remove completely the thin skin of cement from all exposed surfaces. This may be done in various ways and either while the concrete is still green or after it becomes hard. While the concrete is still green it may be washed with a thin solution of hydrochloric acid and then rinsed off with clear water, or the surface may be cut down with hand scrapers or wire brushes. These methods, however, have been found to disturb the aggregates and the final result is not so pleasing as may be secured if this thin skin is removed after the stone becomes hard. There are various methods in vogue for re-cutting this surface, the most practical of which I have found are either by means of sand blast, carborundum machines, or pneumatic tools. These two latter methods entirely remove the surface skin and expose the aggregate, thus greatly improving the appearance of the stone.

Mr. McAllister says:*

Hair cracks or crazing might be due to any of the four following reasons, that is, if the concrete is made by the tamping process:

1. Troweling the surface after removing the mold.
2. Too rich a mix.
3. A breeze striking the freshly made product.
4. Placing the product in the weather before properly cured.

Albert Moyer experimented with oil-mixed concrete as a means of eliminating hair cracks. Mr. Moyer is quoted in part:†

Mineral oils added to wet mixed concrete and the concrete immediately remixed have the effect of emulsifying the oils. The proportion of oil used should be 10% to 15% of oil to the weight of the cement. Oil weighs from 7½ lbs. to 8 lbs. per gal. This oil-mixed concrete, when hard, appears to be non-evaporative, indicating that the emulsifying oils hold all the excess water in the mortar or concrete, keeping the cement particles moist until the water had been taken up in crystallization and ultimate strength reached. Thus similar conditions are supplied as apply to concrete set under water.

Another method which is given here merely as a suggestion and subject to further experiments, is the use of double fluorsilicide of magnesium and zinc. This is a salt readily soluble in water, which is easily painted over a concrete surface.

From experiments made by our chemical director, he is satisfied that its action on concrete is due to the alkali and alkaline earth salt in the concrete reacting with the fluorsilicide which

*Concrete-Cement Age, Oct., 1914, p. 160
†"*Hair Cracks or Crazing* on Concrete Surfaces," by Albert Moyer

has been carried into the pores of the concrete. This reaction produces a gelatinous binding material consisting largely of silicic acid.

These salts in solution applied one coat at a time, three coats to five coats being necessary, according to the porosity of the surface of the concrete, undoubtedly harden the surface to a great extent, and might prove valuable in painting cast stone or other ornamental concrete work, which may not only have the effect of preventing hair cracks and crazing, but will probably assist very largely in protecting the arrises. We might also use a thin solution of sodium silicate, which will soak into the pores of the concrete, which also gives a reaction and causes a deposit of silicic acid in the pores of the concrete.

EFFLORESCENCE

A surface disfiguration which is not uncommon in concrete products is due to efflorescence. Its prevention is discussed* by C. W. Boynton as follows:

Efflorescence is a disfiguration common to brick or concrete when either is of a porous nature; but is one which, with sufficient precautions, can easily be overcome in concrete. Efflorescence occurs in practically every case as a direct result of porosity in the material on which it appears. An impervious substance is never subject to efflorescence because it is impossible for water to penetrate.

This white substance occurring on the surface of block or brick is principally lime carbonate, which is dissolved by any water which penetrates the interior. A concrete product which soaks water "like a sponge" after a rain, subsequently dries out, generally from exposure to the sun. In drying out, any salt solution is brought to the surface and, on the evaporation of the water, deposited. The average concrete block, not having been manufactured with sufficient water to make it impervious, is generally subject to efflorescence—more so in the yard than when placed in the building because of the exposure of two surfaces in place of one, which permits greater absorption. Concrete block, or other products, which are made of wet concrete properly proportioned, rarely give cause for complaint on this score. Such block require more care in manufacture but are of a superior quality of concrete.

Efflorescence can usually be removed with a water solution of muriatic acid. This treatment must not be with too strong a solution nor must the action of the acid continue too long because it will attack the concrete. The acid must be thoroughly washed away with water. Further recurrance of the efflorscence may be prevented

*CONCRETE-CEMENT AGE, Aug., 1914, p. 77

by the use of any preparation for filling the pores of the concrete. Such treatments may not be permanent and

FIG. 79—USING PNEUMATIC TOO[illegible]N FINISHING CONCRETE

may have to be repeated. There are commercial preparations for the purpose, or a soap solution (¾ lb. soap to 1 gal. water) may be applied hot with a brush and after drying be followed by an alum solution (2 oz. to 1 gal. water) applied at ordinary temperature.

FINISHING WET CAST CONCRETE STONE

In the production of a high quality of wet-cast stone, the best results are obtained in treating the products just as natural stone is treated. This includes the use of chisels, bush-hammers, crandals, abrasives, planers, polishers and so on. To make this work possible, the texture of the concrete should be uniform with no large aggregates—at least the best results are being obtained

FIG. 80—MACHINE FOR FINISHING CONCRETE IN PARALLEL CUTS OF FROM 1/8" TO 1/4" WIDE

with aggregates passing a 1/2-in. screen. Crushed limestone, marble, granite and trap rock are being used with excellent results. Facings are not used and the finished products depend for their beauty upon the beauty of the aggregates, whether all of one kind or a combination of several different materials.

Exception to the general rule of a uniform mixture throughout the work is in the use of molds to the face plates of which a coating of glue makes it possible to apply a facing of fine crushed granite or other material. When the glue has set, the face plates are put in the molds, which are filled with the wet mixture of the backing.

It should not be understood that tooling cannot be done on any concrete except that which is wet-cast nor on any concrete which is faced with one mixture and backed up with another. However, the nature of the finishing puts the concrete to a test which will frequently shatter it or at least dislodge many particles of aggregate unless the concrete is of excellent quality.

For fine detail cutting, expert stone-cutters must be employed. In finishing straight work with conventional styles of tooling, power equipment effects great saving.

Stone cast in sand molds frequently has rough spots where sand or a mixture of cement and sand has adhered. Laborers can be employed in plain, rough finishing, using rasps, concrete brick and commercial abrasives.

When a grooved tooling in close parallel lines is required, as in much natural stone work, the stone may be cast on a mold surface having the necessary shallow grooves. Afterward these may be cut deeper and considerable life given to the product by using thin sections of carborundum or some other good abrasive bound together in such a way as to fit and cut in from four to six of the parallel grooves.

A better way of accomplishing the same result is with a power machine similar to that shown in the illustration. The essential part of this equipment is a group of thin carborundum wheels, revolving together and employed in producing vertically or horizontally tooled surfaces.

Some manufacturers merely rub their product enough to remove the surface skin of cement, while more elaborate treatments are employed in obtaining the interesting textures and surfaces shown in the accompanying illustrations. Large planers are now used in the production of finished concrete stone. Polishing machines, electrically driven, are coming into quite general use. These may be had in large units for large areas, or with small grinding surfaces operated by a flexible shaft for fine detail. The degree of polish possible depends upon the surface area of hard aggregate. Cement will not take a polish. Pneumatic tools are also being used for crandaling and similar work and are a great economy over hand work. An instance of this is in the fact that one man operating a pneumatic tool could cover 70 sq. ft. in a 9-hr. day as compared with 30 sq. ft. by hand.

Cast stone, finished by the various methods mentioned,

FIG. 81—DETAIL OVER ENTRANCE—SAND-CAST CONCRETE, CARVED AFTER SETTING—ONONDAGA LITHOLITE CO.

has reached a high plane of development in several factories, more especially in the East. The product is sold for from 90 cts. to $4.00 or more per cu. ft., depending upon the amount of detail and the extent of the duplication of individual pieces. On straight work it is made for very little less than Indiana limestone, but on work where natural stone would require a great deal of cutting, and where many like pieces are required, the concrete stone is much cheaper. Not only that, but it is preferred by many architects because it weathers better, due to lower absorption, and shows less discoloration.

ORNAMENTAL WORK

In the production of ornamental work—urns, vases, garden benches, flower boxes, sun-dials—and in similar work, good design and a thorough feeling of the material in which the design is to be expressed, are essential to pleasing results. Concrete is at its best in bold treatments. It is not a fine-grained, pasty material like clay, nor is it metallic, like iron or bronze, and while these commonplace observations seem scarcely necessary, there is enough concrete ornamentation being attempted which is of the iron dog variety to warrant some emphasis upon the importance of a study of the qualities of concrete. Accompanying illustrations, several of them showing work done by the Pennsylvania School of Industrial Art, convey some idea of ornamental treatments in concrete which are far above the average commercial product in an appreciation of the possibilities and the limitations of concrete and the proper utilization of these possibilities in working out pleasing designs. In this work there has been no surface finishing. The mixtures have been of the dry-tamp consistency and in manufacturing the urns and vases they have been made by pressing the mixture into plaster molds, made from clay models, without the use of cores. Absorptiveness has not been considered undesirable and many of these ornamental pieces which have been standing in the school garden for several years have taken on a weathered green, mossy appearance. The manufacturer of ornamental work will find that the requirements are not the same as for structural units. He will also appreciate that in highly finished work in white cement and white marble, for instance. the weathering and ageing and blending with the surroundings in a rustic result are undesirable. The same discoloration would constitute a defect. The manufacturer must control his material—in every object made appreciate the importance of a definite result.

Chapter 7—Shop Records and Cost Keeping

The importance of a knowledge of costs in every part of the program in factory operation is so obvious as scarcely to demand emphasis, yet the value of cost information sufficiently detailed to give the manufacturer a constant index of the weak spots in his organization or in general operation and equipment is frequently overlooked, with the result that a remedy cannot be applied. A system of shop records, too elaborate, tends only to add a big item of overhead expense. Data too detailed demand much time for compilation. The effort should be to arrive at a knowledge of costs by as simple a system of records as can be made to cover various departments and various different kinds of labor performed and materials handled.

As an instance: Nearly all factories have several employees broadly designated as yard men. Such men are usually employed at a cost about the same as or perhaps a trifle more than the wage of common laborers.

These men are employed the greater part of the time in the yard—removing cars from curing rooms, piling block, loading trucks and freight cars and in unloading raw materials. All their work as mentioned, except the last item, is properly chargeable to yard work, but unloading raw materials adds to the raw material cost and if that additional cost is not definitely known, it is impossible to arrive at a basis upon the strength of which an important saving might be made by adopting some different method or installing equipment to cut down these costs.

One man adds 25 cts. per ton to the cost of his crushed stone by his method of putting it into his bins. As an actual instance: he has the contents of a car shoveled into wheelbarrows; run on to a freight elevator and lifted to the second floor and dumped into bins. Another man who has used wheelbarrows under slightly different conditions now uses a belt conveyor to cover the greater part of the distance and cuts his cost in half. Economical operation is uncertain and entirely a matter of chance unless it is based upon a knowledge of other methods which are less economical, and which are, therefore, uneconomical, unless the change would require an investment the interest and depreciation on which would more than offset the difference in methods of handling.

Another instance of economy based upon a definite knowledge of results is frequently encountered in connection with steam curing, which makes possible the use of less cement for a given result in quality. The cement should not, of course, be cut down to a proportion which makes it insufficient in quantity properly to fill up the voids, yet it is undeniable that cement in excess of what is actually required for good concrete must frequently be used to compensate for improper curing methods. It naturally follows that this excess cement may be eliminated by provision for proper curing. This may appear to affect costs only remotely, and have to do with quality of product only, yet where quality is to be maintained at whatever cost, the absence of records to show how that cost could be decreased, with no sacrifice of quality, prevents a substantial increase of profits. By precisely the same careful procedure there must be records of the quality of the raw materials. One manufacturer of structural tile tried two different supplies of slag, four of crushed stone and several of gravel, with various mixtures and combinations, keeping careful account of costs and results before reaching a conclusion as to the most economical material—a mixture of sand and washed stone screenings—for a given quality of products. This same manufacturer, after tests as to strengths obtained when products were submitted to a long period of curing in an atmosphere of hot, moist air, supplemental to the usual 24-hr. to 48-hr. period, decided that it was actual economy, in a saving of cement, to erect a large building to contain more than a month's output in separate rooms and to continue the moist, warm air treatment for a period of three weeks.

Again, in connection with the operation of various *'ing machines*: In operating but one machine, or frequently with two machines, with hand-tamping, a machine operator will undoubtedly shove the filled cars to curing rooms. Yet when the number of machines is increased, or when power equipment is used, records will usually show an economy in keeping the machine operators at their special work and having cars taken away by men employed for that purpose.

It is advisable to establish certain standards of output, particularly with machine products, where dimensions and conditions remain about the same. As organization is perfected, it will also be found that the production of special stone of the more common types and dimensions should be constant as to number. It will be found that the molding cost of sills and lintels and other regular units varies only slightly over a considerable variation in the sectional dimensions. The big variations in cost are discovered in irregular units and in the number of exposed surfaces which are faced or surface finished.

It will be noted in the description of the operation of Plant No. 2 (Chapter 10) that with an hydraulic pressure machine (mold boxes revolving under the pressure head) four men do the work—one at mixer, one filling mold boxes, one operating machine and cleaning face plates and the fourth man placing the molded block on cars. This arrangement gives an output of 650 block per da. In Plant No. 7, with two presses of like manufacture, as in Plant No. 2, 17 men are employed at the machines and bearing away 1,700 block per da. to racks. Block are larger than those made in Plant No. 2 and nearly all of them are sprayed on exposed faces as carried away. The operation of the two machines should show economy at the mixer, yet the rack system with natural curing defeats economy. At Plant No. 7 the manufacturer is considering putting in cars enough to handle block to curing sheds instead of carrying the block to racks, yet when block should be sheltered for seven das. to 10 das., the number of cars necessary represents a large outlay, an outlay out of all proportion to the cost *of installing and* maintaining steam curing. It will be noted that in Plant No. 3, making 8-in. x 8-in. x 16-in. block, on face-down hand-tamp machines, with side removal of core, one man *can* make 300 plain block to 350 plain block per da., or 200 faced block. For these five machines there is but one man helping operators lift block to cars and helping each operator in turn to shove a car to curing rooms. It is obvious that one helper cannot serve all the operators, so part of the time the operators work alone in lifting block to cars. The figures given are undoubtedly of high speed production, or else all five operators were not continuously employed, because in 53 working days, the production of block of all kinds was only 33,000. With five operators, each producing 200 faced block per da. (the lowest production given) the total for 53 das. would be 53,000.

These rather general observations serve in directing attention to the great value—quite obvious to many and yet not so obvious as to be observed in general practice—of records of every phase of operation. It is poor business to take anything for granted as having been solved, to complete satisfaction. Even those elements of manufacturing procedure which are most fundamental, simple and apparently under closest observation, frequently escape the careful analytical observation which would reveal a leakage. The best product at the lowest price demands records and careful analysis of those records. Such records need not, in most cases, be continuous so as to burden "the overhead" but they should be made as a basis upon which operation is to proceed.

Having established a condition of economical operation a much more simple system of records will keep things in proper balance.

Quantities of Materials

The figures in the accompanying table showing sand and cement required for 100 block in various sizes were compiled by R. F. Havlik.* They show quantities in *1:4 and 1:5 mix*tures and will be of some value as indicat-

*Concrete, Apr., 1911, p. 46

antities of materials used, probable output per
:r da. by hand-tamp methods.

D AND CEMENT REQUIRED FOR 100 BLOCK IN SIZES SHOWN

Block	——1 : 4——		——1 : 5——			
›w	Yds. sand	Bbls. backing cement	Yds. sand	Bbls. backing cement	Bbls. facing cement	Output per da. per man by hand labor
.6" S.	1.05	1.78	1.10	1.56	.875	185
.6" H.	.81	1.37	.85	1.21	.375	172
.6" H.	1.11	1.88	1.17	1.66	.375	125
.6" H.	1.41	2.38	1.49	2.12	.875	100
.6" H.	1.90	3.21	2.00	2.84	.375	74
.6" H.	2.27	3.84	2.38	3.38	.375	61
:4" S.	1.58	2.67	1.66	2.35	.562	89
:4" H.	1.10	1.86	1.16	1.64	.562	128
:4" H.	1.84	3.12	1.94	2.75	.562	78
:4" H.	2.19	3.70	2.31	3.28	.562	60
:4" H.	2.78	4.62	2.88	4.09	.562	48
:4" H.	3.27	5.53	3.45	4.90	.562	41

DETAIL DRAWINGS

ortant work is usually detailed to a considerable by architects and the manufacturer will have ele- showing each stone to be set in the wall. Many ıcturers have found, however, that architects, when 'ing standard block, and not being entirely famil- h them, leave the preparation of detail as to units sed to the manufacturer. Particularly is this true less important work. The manufacturer should pped to handle all this detail in his drafting room. er or not the setting drawings in detail elevations ›plied, the drafting department of the factory will for the shop a card detailing each different piece ıe. When standard block are required the draw- ınnecessary but the slightest deviation from stand- ıits requires a drawing giving explicit descrip- ıcluding all dimensions.

CARD RECORDS

›mpanying illustrations show two types of cards or this purpose. If the stone requires a mold to cifically made, the card, after being filled in with number, stone number (as shown on setting plan) scription of facing or finish, reinforcing, together e *number of* such pieces required, goes first to the

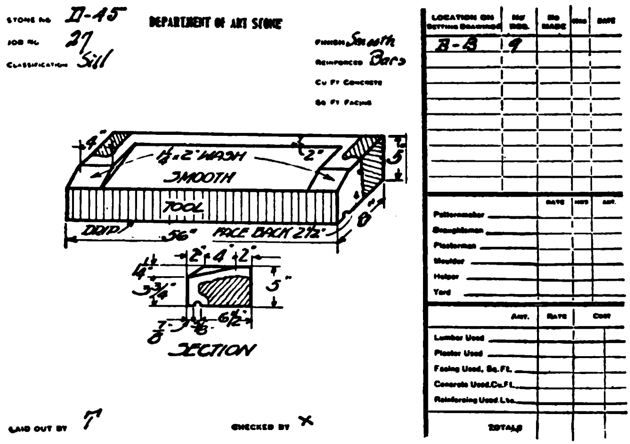


FIG. 82—CARD AS FILLED IN BY DRAUGHTING DEPARTMENT DETAILING DIMENSION STONE AND PROVIDING FOR COST RECORDS

pattern shop. If the work is intricate, with considerable detail, a full-size drawing may be sent with the card. When the mold is made it is properly marked and sent to the dimension stone department with the card. If the card used requires filling out as to each item of cost, it is filled in as the particular cost system requires. The usual items are shown in the card here reproduced. Such cards are usually kept by the foreman who assigns the work and records time and materials. When the work is finished the card is checked and returned to the office or to the drafting room, depending upon where the complete record is kept for material required on each job.

If the block or stone to be made does not require a special mold but can be made on standard machines with special stock inserts, the card goes direct to the foreman of the proper department.

With the use of the cards calling for the cost information, it is soon possible to arrive at a reasonably accu-

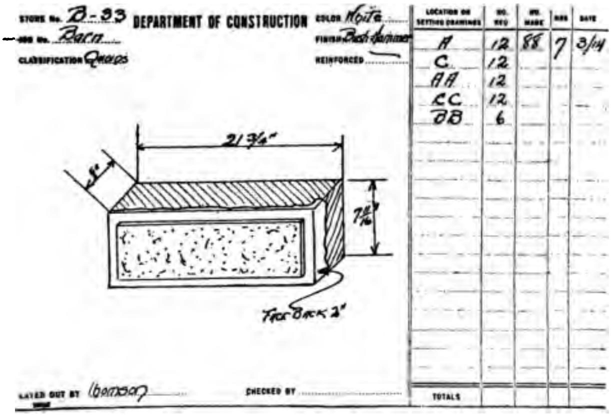


FIG. 83—CARD SIMILAR TO THAT IN FIG. 82 BUT MAKING NO PROVISION FOR COST RECORDS

rate knowledge of unit costs, from which close estimates can be made.

Without close estimates, the manufacturer will either put his prices too low and experience disaster, or he will put his prices too high and lose business. Consistent error either way generally gives the same ultimate result.

A manufacturer of cast stone, using sand molds, with somewhat different conditions involved, uses a system of shop records outlined as follows:

Each particular stone is first drawn up on a card (shown in Fig. 84), red cards being used for rush jobs and white cards for other work. The necessary information is filled in on the card in the drafting room. On leaving the drafting room the card is entered up on a bill-of-material sheet (Fig. 86) and forwarded to the pattern department. The card contains sufficient information, together with template or full sized detail if either is required, to enable the pattern shop to get out the pattern. The card is then turned over to the finishing department for future use. The pattern foreman makes out molding tickets (Fig. 87). These are

DETAIL SKETCH JOB NO.

STONE .... STONE COLOR IS ....
MOULD IN .... STONE FINISH IS ....
IS TEMPLATE FURNISHED SHOP .... REINFORCED WITH ....
IS F. S. DETAIL FURNISHED SHOP .... STRIP AND TROWEL ....
ARE LIFTING HOOKS REQ .... YARD WORK ....
ARE SETTING HOOKS REQ ....
ARE WALL TIES REQ ....

(Space for Detail Drawing)

DRAWN BY .... CHECKED BY ....

CARD O. K. FOR SHOP .... SUPT.

FIG. 84—CARD USED IN SAND CAST STONE FACTORY. SEE REVERSE SIDE IN FIG. 85

sent to the molding department, together with the pattern, one ticket for each style of stone. These tickets are made in various colors, signifying to the men who pour the stone the particular mixture or color. These are stuck in the sand and when the stone is poured are inserted in the wet concrete by means of wires. These tickets give to the molding room all the information required in regard to reinforcement, setting hooks, etc. They also give the molder's name and make it possible to check up any inferior work and place the blame on the proper man. The day after the stone is poured, the casts are gone over and casting report (Fig. 88) is made out and at the same time the job number, pattern letter, and stone number are marked on the stone with black paint. These casting reports are turned into the

CARD ENTERED
..........19

SHOP CARD STONE DEPARTMENT

CONTRACT No.......... NAME..........

PATTERN	STONE	REQUIRED	DESCRIPTION	CUBIC CONTENTS

PATTERN COST

DATE	NAME	HOURS	RATE	COST	DATE	NAME	HOURS	RATE	COST

PATTERN LUMBER USED	B. FT.	KIND

RECASTS	REQ.		
DATE	NO.	BY WHOM	CAUSE

TOTAL

PATTERN CHECKED BY..........
DATE..........

RECAST CHECKED BY..........
DATE..........

PATTERN O. K.
.... FOREMAN

FIG. 85—REVERSE SIDE OF CARD SHOWN IN FIG. 84

office daily and the information contained on them is transferred to the bill-of-material sheet, previously referred to. Three das. or four das. before shipment is required on any particular job, a list is furnished the finishing department containing the letter and number together with the cubic contents of the stones which are to be included in the shipment. These stones are then finished, checked up by the foreman by means of the original card shown in Fig. 84, and loaded directly into cars. This system requires considerable detail work and co-operation on the part of everybody, but it has been found that results secured are well worth this detail.

Another manufacturer of sand-cast stone does not paint *setting numbers* on his stone after casting but uses *die-marked metal* tags with barbs or points by means

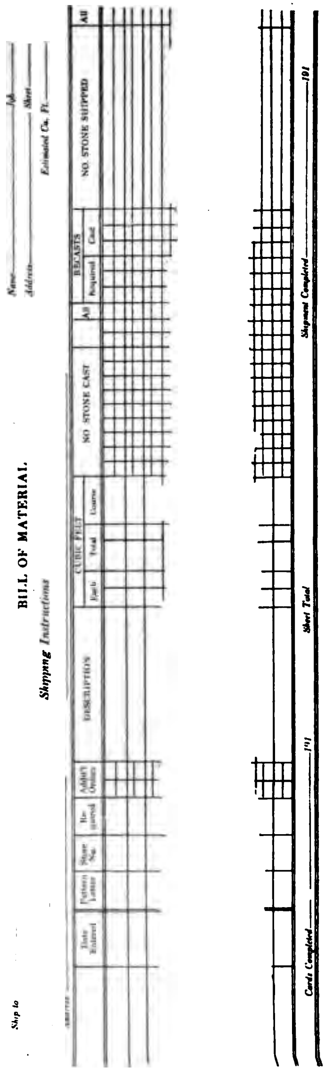
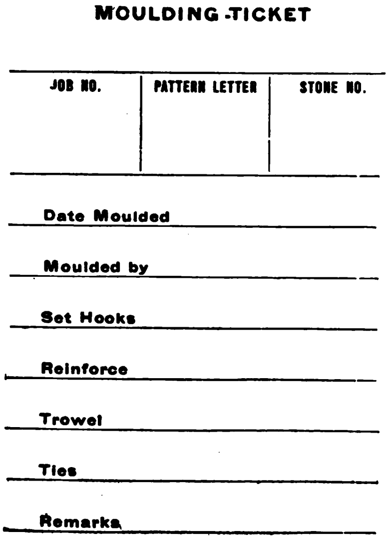


FIG. 86—BILL OF MATERIAL SHEET USED IN SAND CAST STONE FACT
'EE TEXT


MOULDING TICKET

JOB NO.	PATTERN LETTER	STONE NO.

Date Moulded
Moulded by
Set Hooks
Reinforce
Trowel
Ties
Remarks

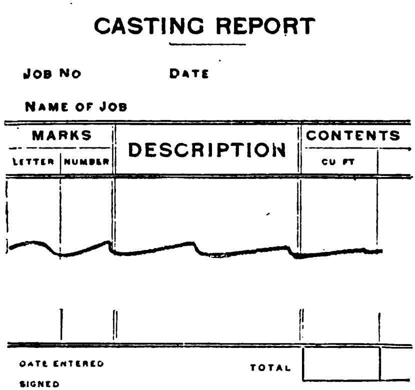
FIG. 87—MOLDING TICKET. SEE TEXT

of which a tag is made to stick in the sand inside the mold; other barbs project in the opposite direction and are cast in the stone. These are, of course, so placed in the mold as to be cast on an unexposed surface of the stone.

STOCK RECORDS

In a factory with a considerable output of standard units, as is usually the case where machine molding is done, stock may be recorded by a yard foreman in an inventory which is always kept up to date by means of a card, as shown in Fig. 89.

It would be unsatisfactory and misleading, in view of the widely different types of equipment used, the different layouts of factories and the different factors of labor


CASTING REPORT

JOB NO DATE

NAME OF JOB

MARKS		DESCRIPTION	CONTENTS	
LETTER	NUMBER		CU FT	

DATE ENTERED TOTAL

SIGNED

FIG. 88—CASTING REPORT. SEE TEXT

STOCK CARD

Size 8x8x20 Formula A4

Description White R.F.

Date	Rec'd	Delv'd	Balance	Date	Rec'd	Delv'd	Bal.
10/1	1000	—	1000				
10/4		300	700				
10/5	225	—	925				
10/6	214	600	539				

FIG. 89—STOCK CARD. SEE TEXT

and material, to attempt to state actual costs of production unless they are given in connection with a somewhat detailed description of all the conditions. Some records of production are shown in Chapter 10 in connection with descriptions of specific operations.

DETERMINING ALL COSTS

The products manufacturer should, at the outset, make detailed records of every line of work to arrive at certain standards and to determine what general conditions of equipment or layout may be changed to effect a saving. He should know exactly what all raw materials cost *delivered* in the storage space provided for them. He should know what labor costs for a given set of operations or a definite time of work. Men exclusively employed in one line of work are easily chargeable to that work but the wages of men handling materials, of the mixer man, the yard men, the foreman (if but one) and so on, should be charged to block production, dimension stone production or to whatever lines are served by them, in proportion, as nearly as can be determined, to the service given to each department. These costs become a part of the production cost of each department. Overhead expense—interest on investment, depreciation, frequently figured at from 15% to 25% on machinery, superintendence, sales cost, light, heat and so on, should be fully covered and apportioned on the various lines of production. Scrupulous attention to these essential details frequently stands between failure and *success.*

Chapter 8—Building Regulations—Tests —Specifications

Local building regulations, so far as they restrict the use of a given material, are, in a broad way, a reflection of the popular or at least the predominating degree of confidence in that material. This confidence is, to some extent, a product of a community's experience with the material in question, or its observation of it, or of a reflected experience from some other community which has taken the initiative in regulating the use of a similar material. A natural conservatism favors established standards and tried materials, and a natural skepticism judges a material by its poorest samples, discounts its numerous successes by its fewer failures and establishes standards for defense against the worst which may be expected. In individual cases a material might suffer from discrimination due to the legislative influence of established commercial interests which would be called upon to compete with a newer product.

Looking squarely at this situation it is obviously the part of wisdom for manufacturers of concrete products to restore public confidence where it has been lost and to build up confidence where it has never been gained. It is true that many conscientious and competent manufacturers are working against odds in correcting public misconceptions and removing prejudices which have become established through the work of unscrupulous and incompetent manufacturers. This, however, does not alter the facts of the situation in the least and does not in the smallest degree affect the necessity of a rehabilitation of an industry and a re-establishment of its products by the strictest adherence to good practice in every manufacturing operation.

Manufacturers should be cautious about their efforts to lower the standard specified in building regulations. Such efforts are apt to arouse suspicions of an *inability to manufacture* concrete units of high quality. The wise course would seem to be to aid the authorities in enforcing regulations and in so doing eliminate the poor product, either by raising the standards of manufacture or by eliminating the manufacturer who persists in low standards.

It is not paying any tribute to the qualities of properly made concrete products to require that their strength in compression shall be no more than 1,000 lbs. per sq. in. of net cross-sectional area. This means that an ordinary standard block with a core or hollow area of $33\frac{1}{3}\%$ shall withstand a compression of only $666\frac{2}{3}$ lbs. per sq. in. of gross area. Yet in actual building practice there should be recognition of the fact that with this comparatively low strength, there is an ample factor of safety in the construction of ordinary dwellings, even with 8-in. block only.

Yet it is unfair to the manufacturer of concrete units which withstand a compression of 2,000 lbs. per sq. in. of net area and vastly more unfair where products test as high as 6,000 lbs. per sq. in. to class all concrete units together in a regulation which fixes the standard by the value of the product with the lowest strength.

Manufacturers whose processes have been highly developed and whose factory efficiency has been built up to the exactions of high standards should go very slowly in any organized effort to lower the standards of building requirements so that there is no recognition of high quality products.

While it is unquestionable that the highest standards of quality cannot be attained with equipment designed and utilized for the most rapid production for the lowest investment, it is also unquestionable that, even with machinery in its present state of development, products *can* be made of vastly higher quality than the average product now made with such equipment.

Again, while it is true that with the available equipment for the most rapid production the products can *not attain the highest quality which is possible in commercial practice*, using other methods, it does not follow that all products which fall below the standards of the best commercial products (commercial at higher cost) should be regulated out of existence.

The public does not undertake to put all natural stone used for building purposes upon a basis of granite and marble, using these as a standard. If an architect wants granite—knowing the price—he can specify it, but if he wants Indiana limestone, little, if any, better in the matter of absorption than commercial concrete units, there is no effort to discourage him. If a man wants concrete stone with a compressive value of 4,000 lbs. to 6,000 lbs. per sq. in. and absorption of only 3% or 4%, he should have it, but if he is going to build a $2,000 cottage, a story and a half high, it would certainly be limiting concrete as a boon to the public if building regulations stood in the way of his using concrete block made by the much criticized dry-tamp method with a compressive value of 1,000 lbs. per sq. in. and an absorptive value even as high as 10%, especially when he could buy such block at 15 cts. each.

Concrete block which will test at 1,000 lbs. per sq. in. in compression and show as high as 10% of absorption are good units—good for certain uses. In taking this stand there should be a full consideration of the present development of building construction with all materials available and generally recognized in the building material market. Concrete block of this comparatively low quality, when properly used in construction, unquestionably insure better buildings at lower cost than is possible in the average locality with other materials. Such products should, however, be properly used; they should not be used in construction which requires concrete products of better quality, either for structural or for aesthetic reasons.

All the conditions—all the limitations and the triumphs of concrete units of various qualities, all the conditions of manufacturing possibilities and building requirements, point to the conclusion that there should be recognition of concrete of various qualities for various uses. The *public should be* protected, yet it should not be denied the right to use concrete units, not of the best, when such a denial would necessitate the use of other materials of no better quality, frequently of much lower quality, and as frequently at a higher cost. In short, the progressive concrete products manufacturers should first apply organized effort to the task of eliminating poor products, of which there are many, and in this way secure a more respectful recognition of their products. Second, they should try to secure building regulations which will secure to the public the fullest benefits from good, economical concrete building units, according to accepted building standards which prevail with respect to competing materials. This will undoubtedly be accomplished in a set of regulations which recognizes a scale of quality to meet the variations in the demands of building construction.

It is obviously an unfair discrimination to require that a concrete unit shall absorb no more than 5% of its weight of moisture in 48 hrs. immersion, because a like degree of density is not required of other materials. With common clay brick showing an absorption of 10% to 25% and testing in compression at 500 lbs. to 3,000 lbs. per sq. in., it is hardly economic wisdom to require absorption as low as 5% and value in compression as high as 1,500 lbs. to 2,000 lbs. in concrete units in ordinary construction. There should, however, be a careful investigation of the relation which exists between porosity and strength.

The other side of the argument, of importance to the future of concrete building units, is that manufacturers should not settle themselves in the idea that concrete units are merely for "ordinary construction." When the manufacturer fully appreciates the possibilities of concrete for facing units of superior quality and beauty, his methods of manufacture will take him entirely out of the controversy between *common clay brick* and *common concrete block*. He will then adopt new standards and will have no quarrel with building regulations which otherwise seem unnecessarily restrictive.

Qualities of Concrete Block

Strength—S. B. Newberry, in discussing the strength of concrete block, says*:

In the use of concrete block for the walls of buildings, the stress to which they are subjected is amost entirely one of compression. In compressive strength well made concrete does not differ greatly from ordinary building stone. It is difficult to find reliable records of tests of sand and gravel concrete, 1:4 and 1:5, such as are used in making block; the following figures show strength of concrete of approximately this richness, also the average of several samples each of well-known building stones, as stated by the authorities named.

Limestone, Bedford, Ind. (Ind. Geo. Survey)	7,792 lbs.
Limestone, Marblehead, Ohio (Q. A. Gillmore)	7,898 lbs.
Sandstone, N. Amherst, Ohio	5,981 lbs.
Gravel Concrete, 1:1.6:2.8 at 1 yr. (Candlot)	5,500 lbs.
Gravel Concrete, 1:1.6:3.7 at 1 yr. (Candlot)	5,050 lbs.
Stone Concrete, 1:2:4 at 1 yr. (Boston El. R. R.)	8,904 lbs.

Actual tests of compression strength of hollow concrete block are difficult to make, because it is almost impossible to apply the load uniformly over the whole surface, and also because a block 16″ long and 8″ wide will bear a load of 150,000 lbs. to 200,000 lbs., or more than the capacity of any but the largest testing machines. Three one-quarter block, 8″ long, 8″ wide and 9″ high, with hollow space equal to one-third of the surface, tested at the Case School of Science, showed strengths of 1,805 lbs. 2,000 lbs. and 1,530 lbs. per sq. in. respectively, when 10 wks. old.

Two block, 6″ x 8″ x 9″, 22 mos. old, showed crushing strength of 2,530 lbs. and 2,610 lbs. per sq. in.

These block were made of cement 1¼, lime ½, sand and gravel 6, and were tamped from damp mixture.

It is probably safe to assume that the minimum crushing strength of well made block, 1:5, is 1,000 lbs. per sq. in. at 1 mo., and 2,000 lbs. at 1 yr.

Now a block 12″ wide and 24″ long has a total surface of 288 sq. in., or deducting 1/3 for openings, a net area of 192 sq. in. Such a block, 9″ high, weighs 130 lbs. Assuming a strength of 1,000 lbs. and a factor of safety of 5, the safe load would be 200 lbs. per sq. in., or $200 \times 192 = 38{,}400$ lbs. for the whole surface of the block. Dividing this by the weight of the block, 130 lbs., we find that 295 such block could be placed one upon another, making a total height of 222, and still the pressure on the lowest block would be less than 1/5 of what it would actually bear.

**Bulletin No. 1, Concrete Building Block*, Assn. Am. Portland Cement *Mfrs.*

Tests were made at Columbia University, by J. S. MacGregor of cement stone made from crushed Gouverneur marble and cast in sand molds by the Onondaga Litholite Co., Syracuse. Five samples were tested and showed an average strength in compression of 4,953 lbs. per sq. in. and absorption in 24 hrs. of 6.2%. Further tests were made as follows*:

In making freezing tests, five specimens of full-size block were subjected to the test. For the major part of the test two freezings were taken every 24 hrs. except when a Sunday intervened. The duration of each freezing ran from 9 hrs. to 40 hrs. The specimens were previously soaked in water for 1 wk. and were then removed and placed in the dry freezing atmosphere of a refrigerating room with an average temperature of 13° F. Twice a day they were taken out and thawed in water varying in temperature from 150° to 200° F. This thawing required 45 min. After being thoroughly thawed they were again placed in the freezing room, and this was repeated 20 times.

The block were weighed before the test began and after the last freezing and the loss in weight was calculated in per cent, and amounted to an average for the five block of 0.69. All the block were in good condition after the freezing except for being slightly scored on their corners and edges.

In making the fire tests, three half-block of brick shape were placed in a gas furnace, so arranged that while the flames could play about the stones, the sharp jets of blue flame could not strike them. The furnace was cold at the start, and the heat was gradually raised in 35 min. to a total of 1,785°. When a bright red heat was attained one of the specimens was removed and immediately plunged in water, and the other allowed to cool in air.

Specimen No. 1, which was removed at the end of 35 min., was immediately plunged under a stream of cold water, and showed no surface cracks. Its edges and corners were sharp. Under light hammer blows, the specimen gave a good ring.

Specimen No. 2, which was removed from the furnace at the end of the test and plunged under a stream of cold water, showed a few hair cracks on one edge. The edges and corners were not affected by the application of water, and the specimen broke under several sharp hammer blows.

Specimen No. 3, which was cooled in the air, showed several hair cracks, but its edges and corners were sharp and could not be broken by hand pressure. It also broke under several *sharp hammer* blows.

*CONCRETE-CEMENT AGE, Feb., 1918, p. 61

As a result of the tests the product is admitted on an equal basis with natural stone in New York City.

Cleveland Tests of Concrete Block

Interesting tests have recently been made in Cleveland by the Department of Buildings of concrete block manufactured in that city. A summary of the investigation is made by V. D. Allen, Insp. of Bldgs., as follows*:

In the early part of 1913, the Department of Buildings of the City of Cleveland gave considerable attention to concrete building block in order to determine whether or not these products were being kept up in their quality to the requirements demanded by the Building Code of the city.

As a result of this investigation the following information was obtained:

There are in and about the city of Cleveland approximately 30 plants where concrete building products are manufactured of which at the time these investigations were made about 20 were in active operation, with varying capacities from 100 block to 1,000 block per da.

All block are made of Portland cement concrete, the mixture varying from 1:3½ to 1:5, the sand being river, lake or bank sand.

In some of the plants the block were tamped with machine tampers and cured in steam, but the greater portion of the block were hand-tamped and air-cured under shelter.

In order to secure test block which would be representative of the ordinary product of the plant the inspector from the Departments of Buildings visited the various plants unannounced and observed their methods of manufacture, quality of materials, etc., and marked from three block to five block, giving directions that the manufacturer was to have absorption and compression tests made when the marked block had obtained the age of 28 days.

In cases where the plant was not in actual operation at the time of the inspector's visit he marked block from stock then on the curing racks.

All the tests were made in the testing laboratory of the Case School of Applied Science, Cleveland. Three block from each maker were submitted. The tests were conducted as follows:

The block were allowed to stand in a warm room until dry. They were then carefully measured and weighed, the absorption test consisting of first placing them face down in ½″ of water for 30 min., after which they were weighed and then immersed in water for four hrs., weighed again, and immersed

*Concrete-Cement Age, July, 1913, p. 26.

for 48 hrs. The percentage of weight in each case was computed from the dry weight of the block. After the absorption test was completed, the block were faced with plaster of Paris, when necessary, and broken in compression while still wet. The absorption test showed very little gain in weight after four hours' immersion and in a few cases, an actual loss of weight after 4 hrs., due, no doubt, to some disintegration on the face's of the block.

The machine-tamped block showed a mean absorption in 48 hrs. of 5.57%, and a strength of 1,046 lbs. per sq. in. Hand-tamped block, an absorption of 8.04% and strength of 815 lbs. per sq. in

There were about three times as many hand-tamped as machine-tamped block.

The steam-cured block showed an average absorption of 6.83% and a strength of 867 lbs. per sq. in., while the air-cured block showed an absorption of 7.52% and 794 lbs. strength per sq. in., there being about twice as many air- as steam-cured block.

Four sets of block made with river sand showed 8.17% absorption, and a strength of 692 lbs. per sq. in.

Three sets of block made with lake sand had an average absorption of 10.97% and a strength of 648 lbs. per sq. in.

Twelve sets of block made of bank sand showed a mean absorption of 6.27% and a strength of 1,034 lbs. per sq. in. The bank sand was evidently better graded than the lake and the river sand and produced denser block, as shown by the lesser percentage of water absorbed and higher crushing strength attained.

The lake sand in this locality is of uniform size grains and very fine and should not be used where a strong and durable concrete product is desired.

The advantages of a well graded sand are also evidenced in the unit weights of the concrete in the block. Block made of bank sand gave an average weight of concrete of 130 lbs. per cu. ft., the highest being 137; the lowest 122.

Lake sand, an average of 112 lbs. per cu. ft.; the highest being 119 lbs. and lowest 106 lbs. per cu. ft.

River sand showed an average of 120 lbs. per cu. ft.; the highest being 127 lbs. and the lowest 116 lbs. per cu. ft.

The block of greatest weight were machine-tamped.

The evidence gained by the inspection and tests seems to show clearly that block made of graded bank sand, machine-tamped and steam-cured, are the best. However, the advantages of this combination cannot be definitely claimed until more exhaustive tests have been made.

New York Specifications for Cast Stone

"Specifications for Cast Concrete Stone as used by The State of New York for the Construction of State Fair Buildings," approved by F. B. Ware, state archt., N. Y. C., and Green & Wicks, designing and supervising archts., Buffalo. These specifications* in part are as follows:

All cast stone shall be made of Portland cement, such as will pass the standard specifications of the American Society for Testing Materials, and of a brand satisfactory to the architects, mixed with an aggregate, of uniform color and texture, and free from iron and other foreign material liable to discoloration. Aggregates shall be crushed *granite,* or *hard marble.*

The cement and aggregates shall be thoroughly mixed in a proportion of 1 part of cement to not over 6 or less than 4 parts of aggregate. The aggregate shall be made by crushing selected pieces of stone to insure uniform color and texture and shall be screened into at least three sizes, the largest of which shall not exceed that which passes a ring ½" in diameter, and there shall be at least 50% of such a size of aggregate that will not pass a ring ⅛" in diameter. The various sizes shall be used in proportions to give maximum density and all measured by weight.

The concrete for making the cast stone shall be mixed with not less than 15% *of water* by weight and shall be mixed by a machine, preferably of the rotary type. If cast in a semi-liquid condition, it shall be constantly agitated, and *continuously* deposited in the mold.

All casts shall be properly seasoned by being kept moist and away from the sun's rays and draughts for at least 10 das. after being made.

After having been seasoned for at least 10 das., all exposed plain surfaces of the stone shall be tooled with a drove finish of four cuts or six cuts to the inch, or such other finish, as the architects shall specify. The tooling shall preferably be done by grinding the grooves by the use of an abrasive material so that the larger aggregates will not be disturbed or in any way shattered.

All surfaces of cast stone to be true and without hollows and other than plain surfaces to be recut as necessary to make perfect. Models of all ornament to be furnished for architect's approval, and all stone to be finished true to such models.

All cast stone shall be of such quality that it will pass a test at the *age of 28* das. of at least 1,500 lbs. compression *per sq. in., and shall* not have an absorption to exceed 5% of

*Concrete-Cement Age, Feb., 1918, p. 61

weight when thoroughly dried and immersed in water for 48 hrs.

All lintels, bearing stones, and others subjected to cross-bending shall be reinforced by means of steel rods placed about 2 in. from their tension surface and the total sectional area of the steel shall be equal to ½ of 1% of the cross-sectional area of the concrete in the member reinforced. When any cast exceeds in any dimension eight times its least dimension, it shall be reinforced to insure safety in handling.

Samples of cast stone on which bids are based shall be submitted for approval. Said samples to be *retained* by the architect. Preference shall be given to stone cast in an *established* factory, and contractor must be able to show work of a similar character that he has erected, and same must meet the approval of the architects. All casts shall be provided with steel bonds for the purpose of tying into the masonry backing and with hooks for handling and lifting which shall be placed in the stone when cast.

Cast stone need *not* be plastered on back with La Farge cement, nor need it be painted as specified for Indiana limestone.

Absorptiveness of Concrete and Clay Brick

A comparison of the absorptiveness of concrete and clay brick appears in a report* of tests made by the Plymouth Cordage Co., as follows:

The extensive use of cement brick by the Plymouth Cordage Co., Plymouth, Mass., has demonstrated several valuable facts. For the construction of its new mill, having an aggregate wall length of nearly one-fifth of a mile, almost 2,500,000 concrete brick were made upon the ground.

The mixture used in the major part of the work was 3 parts sand to 1 part cement. A few brick were made of 4 parts sand to 1 cement, for lightly loaded walls.

Table 1—Absorption of Brick

Brick	Dry lbs. oz.	Saturated lbs. oz.	Absorption oz.	%
Face	5 8½	5 10	1½	1.7
Common inside	5 8	5 11	3	3.4
†Facing material	5 9½	5 10	½	.6
Hard burned body clay brick	4 11	5 7	12	16.

*Concrete-Engineering, Oct., 1909

†Brick made entirely of the material used for facing outside brick

Fireproof Qualities

A discussion* by W. M. Kinney of the fireproof qualities of concrete block is as follows:

The fire-resisting qualities of concrete have been so well established by the practical lessons of conflagration that it is well known not only as a non-combustible material but as a non-conductor of heat. There can be no stronger recommendation for the fire resistance of concrete than the prevalent practice of fireproofing structural steel by enclosing it in a coating of this material. If anyone is in doubt as to the fire resisting qualities of concrete he should read any or all of the following:

Annual address by the president, Richard L. Humphrey, before the National Association of Cement Users, printed in the Proceedings for 1911; also his report to the U. S. Government on the San Francisco earthquake and fire, published in series "R" of Structural Materials Bulletin No. 324.

A report on the conflagration at Baltimore, published by the Engineering Experiment Station, a copy of which may be obtained by addressing the director, 31 Milk St., Boston, Mass.

Report on fire in a glue factory, published in *Cement Age,* for Aug., Aug., 1909.

Report on fire in first class dwelling, published in *Concrete* for Apr., 1910.

In addition to possessing the fire resistance of all concrete construction, the concrete block has the additional advantage of a hollow wall, providing a non-conducting air chamber, which prevents the passage of heat in case of fire in an adjoining building. A concrete block building at Estherville, Ia., went through a severe fire and it is reliably reported that while the fiercest flames from a large adjoining building were attacking the outside, the merchant who went in to remove his goods found it unnecessary because the inner side of the block was so slightly heated that the hand could be held against it, and his goods were undamaged.

A very remarkable instance of the efficiency of concrete block under fire happened at Nashville, Tenn., in Apr., 1907. A portion of a four-story building filled with furniture was gutted by fire so intense that the walls were at white heat. On the following day the building inspector of Nashville made an examination and found the walls in perfect condition except a slight chipping of window sills and a few block adjacent to openings. The walls were 16" thick, 50% hollow, except in the upper story where the walls were 12" thick, 40% hollow. A brick building formerly stood upon the site but it was demolished by fire and replaced by the concrete block building above referred to.

In *Engineering Record* for Mar. 7, 1908, an account is given of a concrete block fire test of an exceptional nature afforded by a fire which took place in a three-story building at Anderson,

*Concrete-Cement Age, Aug., 1914, p. 72

Ind., Dec. 9, 1907. The interior of the building was completely destroyed, the only thing left standing being a steel beam supported by a steel post. The concrete block, however, were not injured and there was no necessity of rebuilding any portion of the structure in which they were used.

In *Concrete* for Sept., 1906, we find the following:

An unusual and severe test of concrete block was recently carried out at Allentown, Pa., for the purpose of determining the fire-resisting qualities of concrete building block. The experiment was undertaken by the Keystone Cement Block Co., Phoenixville, Pa., to demonstrate the fact that its block will resist high temperature, long continued. A test building 6′ x 8′ x 6′ was constructed of block and a fire was built inside of this building. Twenty-four bbls. of hard wood, furniture factory waste, were used as fuel and the fire continued for four hours. There was no sign of crumbling or cracking on the part of the block, which at the end of the test were in the same condition as at the beginning. Geo. H. Hankins, who was present on behalf of the Bd. of Fire Underwriters, expressed himself as satisfied with the ability of block to withstand fire.

Unfortunately for all concerned, a certain prejudice against the introduction of any new building material has made it difficult for the concrete block and the concrete brick to obtai the rate of insurance they should enjoy. As an evidence that this condition is rapidly correcting itself in Chicago and in Cook County, the Bd. of Underwriters has given to buildings constructed of concrete block or concrete brick the same rating that is given to buildings constructed with walls of clay brick of equal thickness, providing the concrete block or concrete brick are manufactured in accordance with specifications of the Building Dept., which are in every way fair and reasonable an sent no difficulty to the intelligent and conscientious ma turer. This is an evidence of the changing spirit among n palities and insurance companies, and such examples fr larger and more progressive communities will, we are sure, speedily bring to concrete block and concrete brick the rating which is their due.

Specifications

Specifications of the American Concrete Institute for concrete Architectural Stone, Building Block and Brick are as follows:

Concrete architectural stone, building block and brick must be subjected to compression and absorption tests. The test samples must represent the ordinary commercial product of the regular size and shape used in construction.

Compression Test—(a) In the case of solid concrete stone, block and brick the ultimate compressive strength at 28 das. must average 1,500 lbs. per sq. in. of gross cross-sectional area *of the stone as used* in the wall, and must not fall below 1,050 *lbs. per sq. in. in any case.*

(b) The ultimate compressive strength of hollow and two-piece building block at 28 das. must average 1,000 lbs. per sq. in. of gross cross-sectional area of the block as used in the wall, and must not fall below 700 lbs. per sq. in. in any case.

(c) In the case of hollow building block the gross cross-sectional area shall be considered as the actual wall area including the block and air space displaced by the block.

(d) In the case of two-piece block the block shall be tested in pairs consisting of the front and the rear block as used in the wall. The compressive strength shall be regarded as the sum total sustained by the two block divided by the product of the length of the block and the width of the wall.

Absorption Test—The percentage of absorption at 28 das. (being the weight of the water absorbed divided by the weight of the dry sample) must not exceed 5% when tested as hereinafter specified.

General—(a) Laboratory. All tests required for approval shall be made in some laboratory of recognized standing.

(b) Samples. For the purpose of the tests at least nine samples or test pieces must be provided. Such samples must represent the ordinary commercial product, and shall be selected from stock. In cases where the material is made and used in special shapes or forms too large for testing in the ordinary machines, smaller size specimens shall be used as may be directed.

[illegible] Tests. Tests shall be made in series of at least three. [illegible]maining samples are kept in reserve in case duplicate or [illegible]atory tests be required. All samples must be marked [illegible]ntification and comparison.

Compression Tests—The compression tests shall be made as follows:

(a) Solid concrete stone, block and brick. When testing solid concrete stone, block and brick, the net area shall be considered as the minimum area in compression.

(b) Hollow and two-piece building blocks. Whenever possible such tests shall be made on full sized block. Whenever such tests must be made on portions of block, both pieces of the block must be tested and both must contain at least one full web section. The samples must be carefully measured, then bedded flatwise, in plaster of Paris to secure uniform bearing in the testing machine and crushed.

The net area shall be regarded as the smallest bearing area of the piece being tested. The total compressive strength shall be divided by the net area to obtain the compressive strength in lbs. per sq. in. of net area of each piece. The sum of the two results shall then be averaged to obtain the average strength in lbs. per sq. in. of the net area of the total block.

The entire block shall be carefully measured to determine the maximum air space prior to breaking the block for the compressing tests, and the net compressive strength obtained shall then be reduced to compressive strength in lbs. per sq. in. of gross area, this being figured from the actual air space of the block determined above.

Absorption Tests—The sample is first thoroughly dried to a constant weight at not to exceed 212° F. and the weight carefully recorded. When dried, the sample is to be immersed in a pan or tray of water to a depth of 2 in., resting on two strips not over 1″ in width to allow the water to have free access to face. At the end of 48 hrs. from the time it is placed in water, the samples shall be removed, the surface water wiped off, and the sample carefully weighed.

Building Code Regulations of Concrete Block in 27 Cities

City	Date of Ordinance	Height Limitations S=Stories F=Feet	Hollow space shall not exceed—%	Crushing Strength 28 das.—lbs. per sq. in. Gross or Net Area	% of Absorption	Age of block in days when used
Albany, N. Y.	'09	6S	33[2]	1,000G	..	21
Baltimore, Md.	'08	6S	45[2]	1,500	7[4]	28
Birmingham, Ala.	'12	8S	25	1,000	15[4]	21
Buffalo, N. Y.	...	8S	33 ⅓	.....	..	..
Chicago, Ill.	'14	2S[1]	..	.....	..	..
Cincinnati, Ohio	'13	note[1]	..	.....	..	..
Cleveland, Ohio	'11	3S	35	1,500	7[4]	28
Detroit, Mich.	'11	4S	note[2]	1,500N	5[4]	28
Elizabeth, N. J.	'08	6S	33[2]	1,000G	..	..
Hoboken, N. J.	'11	2S	33 ⅓	1,000G	..	..
Indianapolis, Ind.	...	2S	33 ⅓	800G[3]	..	20
Jersey City, N. J.	'07	..	88	1,000G	..	..
Los Angeles, Ca.	'14	2S[1]	..	.....	..	..
Manchester, N. H.	'11	3S	33 ⅓	1,500N	..	28
Memphis, Tenn.	'14	..	..	1,500[3]	16[4]	21
Milwaukee, Wis.	'14	60F	35	700	..	..
Newark, N. J.	'11	3S	33	1,000G	..	21
New Haven, Conn.	'12	6S	..	1,000G	..	21
New York, N. Y.	'13	8S[1]	33 ⅓	1,500N	..	28
Philadelphia, Pa.	'13	6S	88[2]	1,000G[3]	15[4]	28
Portland, Ore.	'13	3S	note[2]	note[3]	7	28
Rochester, N. Y.	'11	3S[1]	33 ⅓	450G	..	15[6]
Springfield, Mass.	'12	3S[2]	88	1,500[3]	..	..
St. Paul, Minn.	'10	3S	..	1,000G	..	21
Syracuse, N. Y.	'13	8S	33	1,000G	..	28
Waterbury, Conn.	'10	35F	33 ⅓	1,500N	..	..
Worcester, Mass.	'11	4S	33	.....	..	21

NOTES

[1]*Height*—Chicago, permissible for residences, garages, stables and apartments. Cincinnati, used where brick are permissible. Los Angeles, hollow block not permitted for exposed walls in certain districts; other districts limited to two stories. "Artificial Stone, made of Portland cement and incombustible and fireproof and waterproof, may be used as substitute for natural stone, providing no bearing members in buildings over three stories contain more than 15% of lime or limestone." New York, height also limited to 36′. Rochester, height also limited to 48′. Springfield, height also limited to 40′.

[2]*Hollow Space*—Albany, 33%, 1-story and 2-story walls; 1st story, 25% for 3-story and 4-story walls; 1st story, 20% and 2nd story and 3rd story, 25% for 5-story and 6-story walls. Baltimore, 45% for 1-story and 2-story; 1st story, 35% for 3-story and 4-story walls; 1st story, 25% and 2nd story 35% for 5-story and 6-story walls. Detroit, same as Baltimore for 1, 2, 3 and 4 stories. Elizabeth, hollow space limited to 25% for 3 lower stories of 5-story and 6-story walls. Philadelphia, 33% for 1-story and 2-story; 1st story. 25% for 3-story and 4-story walls; 1st story, 20% and 2nd story and 3rd story, 25% for 5-story and 6-story buildings. Portland, Ire., 45% in 1-story and 2-story walls; 1st story, 35% in 3-story walls.

[3]*Crushing Strength, 28 days, lbs. per sq. in.*—Indianapolis, strength at 30 das. instead of 28 das. Memphis, strength of 1,500 lbs. required at 8 das. Philadelphia, average strength 1,000 lbs. gross area, no block to fall below 700. Portland, Ore., 1,500 lbs. average, in no case below 700. Springfield, Mass., 1,500 lbs. at 30 das.

[4]*Percent of Absorption*—Baltimore, average 7, maximum 10. Birmingham, average 15, maximum 18. Cleveland, average 7, maximum 10, block immersed ½″ face down 48 hrs. Detroit, average 5, maximum 7, total immersion 48 hrs. (The most unreasonably severe restriction found in 27 cities.) Memphis, average 16, maximum 22. Philadelphia, average 15, maximum 20, ½″ immersion face down 48 hrs.

[5]Block may be used in 5 das. if cured by steam.

Marks of Identification—The marking of block to identify manufacturer is required in Birmingham, Detroit, Hoboken, Manchester, Memphis, Milwaukee, Newark, New York, Portland, Springfield, Syracuse and Worcester. Block are required marked with date of manufacture in Birmingham, Memphis and Newark, and in Birmingham the mixture used must be indicated.

Party Walls—Party walls must be solid in Albany, Birmingham, Indianapolis, Manchester, Milwaukee, New Haven, Springfield, St. Paul, Syracuse and Worcester.

Loads—In Birmingham block may be loaded 8 tons per sq. ft.; Buffalo 150 lbs. per sq. in. of net area (not including hollow space); Cleveland, 200 lbs. per sq. in.; Los Angeles requires factor of safety of 10; New York, 100 lbs. per sq. in.; Philadelphia, 8 tons per sq. ft.; Waterbury, Conn., 100 lbs. per sq. in.

Thickness of Wall—Thickness of wall is the same as required for brick in Birmingham (upper story may be 8-in. block), Buffalo, Chicago, Cincinnati (wherever brick are permissible) Detroit, Hoboken, Indianapolis, Jersey City, Manchester, Newark, New York, Philadelphia, Portland, Springfield, St. Paul, Syracuse, Waterbury, Worcester. In Cincinnati, an 8-in. block wall may be used where 9″ of brick are required. (As a matter of fact this is the customary practice in most cities.) In Cleveland the 8-in. block wall is considered 1 brick thick. In Memphis and New Haven the block wall may be 10% less in thickness than brick walls.

Thickness of Web of Hollow Block—Jersey City, Manchester, New York, Syracuse and Waterbury require that webs and walls of each block shall equal ¼ of the height.

Organization of Manufacturers

Organized effort by block manufacturers in securing not only better recognition for their products but also in securing better standards of manufacture and consequently better products, has shown great promise in several cities—notably in Detroit and in Cleveland.

Tests

The obvious conclusion of this chapter is in an emphasis of the importance of an accurate knowledge by every manufacturer as to just what quality of product he is making and just how he gets that quality. That is the first step in the standardization of methods. The standardization of products is not possible without an absolute control of manufacturing conditions.

Chapter 9—Selling the Products

A good salesman can sell a poor product once. It is almost an axiom of trade, however, that a good business must be built up on steady customers and "repeat orders," and for that reason good salesmanship is dependent upon a good product. The term "good product" in this case does not necessarily mean a product of high quality; it is relative and so far as the salesman is concerned merely implies that the product is good, in the eyes of the purchaser, for the purpose to which he puts it, and at the price he has to pay for it. The concrete industry has not had a big sales development. There are thousands of manufacturers who are doing a small business, operating only a part of the time and selling products for small work. This does not establish the limits of the industry. It merely proves the limits of the sales development. The possibilities for the use of con-

Fig. 90—Sand-Cast, Hand-Carved Concrete Screen, Hamilton College *Library*—*Onondaga* Litholite Co.

FIG. 91—CAPITALS AND CORNICE (WITH LION HEADS) OF CONCRETE STONE, BOSTON CITY HALL ANNEX—EMERSON & NORRIS CO.

Note difference in stone after a few months' weathering between concrete cornice and capitals and the natural stone in the remainder of the work. The statues partially shown at top are 16′ high of concrete and are described in Chapter 5

crete units are not narrow; in general, however, the appreciation of those possibilities by manufacturers has been narrow.

There are two channels for sales development—dependent entirely upon the manufacturing development. These two channels are: bulk sales and quality sales. The manufacturing development which has been most evident is one which should have called for bulk sales if business were to show great progress. The quality development has been carried forward by comparatively few manufacturers—in a really dominant way by perhaps no more than half a hundred in all the United States. Yet strangely enough the manufacturers who should have been doing the quantity business have not, and both quality and quantity have been developed together by the half hundred.

This fact, in itself, speaks volumes for the possibilities in concrete products manufacture.

Common red brick are made and sold in enormous *quantities.* Plain, sound, durable concrete block should

FIG. 92—WHITE CONCRETE BLOCK COTTAGE. CRESTON, IA.—MERRILL MOORE

be manufactured with the same idea in view. They should be made with a double purpose—structural integrity and economy. The manufacturer's sales campaign should not include any pretense of offering an architectural unit. The unit offered on the basis of quantity sales for foundations, unexposed walls and similar construction, should not be offered or even suggested for any work which has a claim upon beauty. The larger the output which can be disposed of at even a small margin of profit, the more economically can the product be made, and the manufacturer will constantly find himself in a better position to get the kind of business he seeks.

The architectural unit will bring a higher price, because it will compete with materials of much higher price. High quality concrete units can be made to sell at a price so much lower than any other material of so good an architectural value, that the profits on a smaller output will warrant a manufacturing enterprise of as great a magnitude as one manufacturing three times as many units merely for structural purposes.

The manufacturer who proposes offering a unit of high architectural value should not feel that his business need be small. "Quantity" business and "quality" business are terms here used to distinguish the unit suitable for facing exposed walls and for trim, from the unit—

always used in greater quantity—which is intended solely for backing, and for unexposed walls or unpretentious construction. As already mentioned, it is a fact that the men who have developed the best architectural units have built up bigger manufacturing enterprises

FIG. 93—CONCRETE STONE TRIM, TOWER, BROADWAY PRESBYTERIAN CHURCH NEW YORK CITY—ONONDAGA LITHOLITE CO.

'IG. 94—DETAIL, CONCRETE BLOCK COTTAGE, WAYFORD WOOD ESTATE, NOR-'OLK, ENGLAND

han most of those who might have been expected to do he greatest quantity of work, because they made a plain, ınarchitectural unit for construction in which economy was the chief consideration.

There seems to be no good reason why the manufac-ture of both plain and architectural units should not con-stitute two separate and distinct departments in a single enterprise.

The most important developments are likely to follow an admission that the common concrete block is not beautiful. There is some disposition, now and then, to debate the matter with architects. Granting that when two good men differ, each of them is partly right, argu-ments between buyer and seller as to qualities of beauty are *futile. The* buyer, or rather the prospective buyer, *as the upper* hand. So, entirely aside from the merits of the case, it will be a good day for the manufacturers of concrete building units when they adopt generally—as a few have individually—the slogan of certain retail

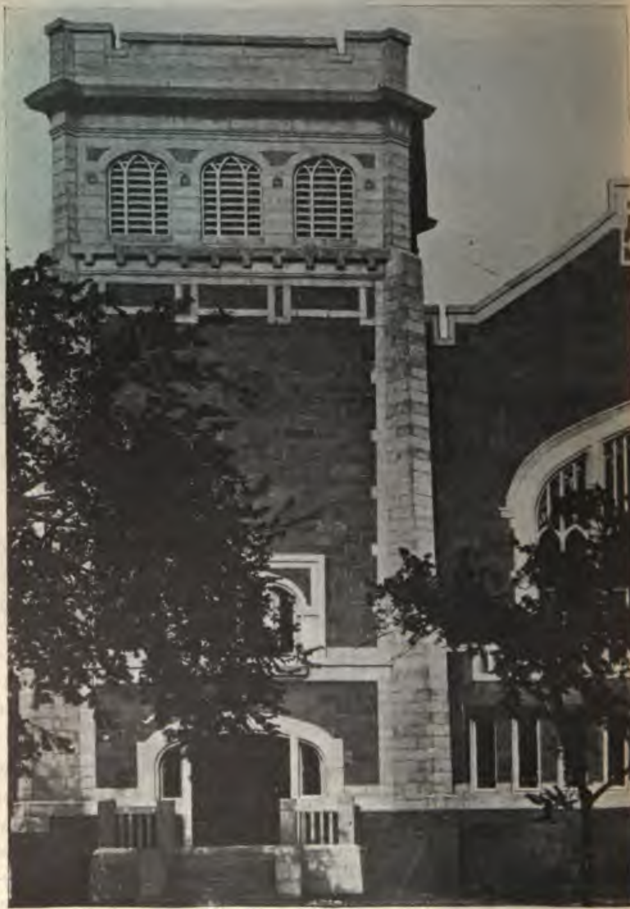


Fig. 95—Concrete Block (Gray Cement) and Concrete Stone Trim (*White Cement*), Normal Park, M. E. Church, Chicago

FIG. 96—DETAIL, CONCRETE BLOCK HOUSE, SCARBOROUGH-ON-HUDSON, N. Y.—OSSINING PRESSED STONE CO.

merchants: "The customer is always right." It is the prerogative of the architect to know—at least to say—what is beautiful.

It is obvious that the salesman should first thoroughly *know* his own product. He must know it structurally; he must test it by every conceivable standard. He must know just what strength his product has and this accurate knowledge will serve as a spur to the improvement of materials and methods in manufacture. He should *have frequent tests* made—made publicly and impartial-

FIG. 97—ONE OF A NUMBER OF SYMBOLIC FIGURES IN CONCRETE, FORMING SUPPORTS FOR RUSTIC PERGOLA, ESTATE OF ALBA B. JOHNSON, ROSEMONT, PA. —ADOLPH SCHILLING

ly. He should invite architects to select products from stock to be tested. He should court the fullest research into the qualities of his material and the constancy of his manufacturing conditions. His factory should be open to visitors. He should seek publicity—the most honest and frank publicity. Best of all, he should, as soon as possible, have something to show. He should even go so far—as some manufacturers have done—as to refuse to sell his products for work of a character which will not display them to his credit.

It is of deep concern to the sales end of the business to prevent the use of poor products. To this end, manufacturers in some cities have organized for the express purpose of putting the poor product out of the field. Such organizations can do much to raise standards and to have standards made which will be a credit to the industry. They can put organized effort behind a movement to aid a city building department in enforcing building regulations. A movement of this kind has been started in Cleveland. A similar organization in Detroit is insisting upon the maintenance of standards and is *doing advertising* in a broad way, calling to the attention of the public, in street car posters, the merits of rete block as a building unit—mentioning no make ›lock, but urging the use of all block bearing the x of the association. There is only one danger in a campaign. If the organization should relax ever ttle in its insistence upon quality up to a given stand- the resulting poor products would bring discredit ı an entire local industry. There is no doubt of the e of organized effort and it is only necessary that

FIG. 98—DETAIL, CONCRETE GARDEN SEAT—ADOLPH SCHILLING

FIG. 99—CONCRETE GARDEN ORNAMENTATION (SEE FIG. 97)—ADOLPH SCHILLING

the organization shall be efficient in maintaining its standards, to accomplish great things in such a general educational campaign.

There are three classes to be appealed to in selling concrete building units. First, the general public, in order to reach the individual builder who is the owner of property being developed, whether this happens to be a man building a house to live in or a real estate dealer erecting houses for sale; second, the contractor who is in a position to influence the choice of materials in building operations, where architects are not directly employed; third, the architects.

The three classes are named in the order suggested by the difficulty in making the appeal.

The individual home builder and the real estate man may be reached by letter, the names of the prospective home owners frequently being available from published lists of building permits granted, and from the columns of more or less local building and contracting papers publishing lists of the work of architects under way. The real estate men may also be reached by letter and names are readily obtained from newspapers and directories. Contractors may be reached with circulars, price lists and letters, names being published frequently in connection with building permits, or names may be had from directories. It will not be difficult to compile a list of architects for systematic "follow-up," but there must be great care in the method of approach. Manufacturers have found that it is a poor policy to offer an architect, as an architectural unit, a unit which has no architectural value. Either offer him a plain unit in a straightforward way for purely structural purposes (in which case you must be prepared to show substantial proof of quality by authenticated tests) or else offer him an architectural unit, *not as a cheap unit* but strictly for its attractive character. Do not urge the economy as though that were most important. Let that be incidental.

When a manufacturer has furnished material which has been used in structures of real architectural merit he will find it worth his while to invest something in fine photographs. A poor photograph is worse than none. A photographer who portrays the beauty of the work—the texture, the tone, not merely outline and flat surfaces—should be employed. Particularly is this true in getting the attention of the architect. Some manufacturers have issued quite pretentious books illustrating the use of their products in important work and in such a course of advertising it carries weight to connect the name of an architect or owner of recognized standing with the work illustrated. Not a few architects who stand high in their professions have recommended certain concrete stone in preference to natural stone. Architects, however, are conservative. Evidence of this is in the slow development of the monolithic concrete house, which requires thinking in new terms and new architectural forms and effects. Concrete units have a distinct advantage in this respect, in the fact that their use involves nothing essentially new in design. They have the added advantage of offering the *same* possibilities as natural stone with a manufacturing control which extends *those possibilities*, not only in shapes and sizes, *but in surface* color and texture. There is a strong architectural tendency toward color,—toward relief from dreary sameness. The sales end of the concrete stone business will show strong development in meeting this architectural demand.

While architects whose favorable opinions are worth heeding have expressed strong approval of concrete stone, these opinions have in most cases been based upon a specific product—upon the output of some individual factory. This is an evidence of conservatism which manufacturers will do well to consider. This should not occasion discouragement on the part of manufacturers whose products are not specifically mentioned. It should, on the contrary, be regarded as a condition to be dealt with so as to turn it to account. Numerous manufacturers have advertised their products by trade names. Thus a product of high architectural character comes to be known by the name of its manufacturer, or by some name with which an individual manufacturer is inseparably identified.

Many manufacturers have been discouraged by the refusal of architects even to consider a concrete block. This is chiefly the fault of the block. It has been demonstrated that concrete block are not opposed by architects *because they are concrete block* but because they are not good concrete block, architecturally—because they make no appeal to an eye trained to seek beauty. When a factory has produced a truly beautiful unit, it has not been difficult to impress architects. One sales representative,when he calls on an architect, takes a block with him. The block talks. It is of common observation that architects are disposed to specialize. They specialize in buildings of certain kinds and also in certain materials. Leaving out of consideration the common types of dwelling and the common types of store buildings, and considering the architectural work in almost any locality which is above the plane of mediocrity, there are certain architectural features which point to certain architects. This is the mark of the architect's specialty, *of his originality*. This fact contains suggestions for the manufacturer of concrete stone. He should not look for instant results with architects. They should not be expected, even when they are *convinced* of the quality and beauty of the new material, to use it on the next job. The sales campaign must be gradual and insistent. One handsome catalog will not bring the results. The architect should be systematically reminded of his recently acquired conviction of the value of the concrete unit.

A manufacturer of structural tile, whose entire business is to sell for bulk work, calls upon architects and writes to them and quotes comparative prices until the architects are convinced of the structural value and of the economy of the material. Then the architect is reminded regularly every two weeks by a neatly printed postcard—always carrying the same essential message but each time changed so as to convey some new message to add weight to the old.

Such a sales plan can also be used for architectural units. The printed matter must be good printed matter and there should be recognition of the fact that there are specialists in the preparation of advertising matter. No matter how well the manufacturer knows the practical side of his own business, there is almost always someone who knows the advertising business—the trick of putting appeal into pictures and type—better than the manufacturer.

Photographs showing a factory yard full of products seldom appeal to a buyer of such products. The man who is going to buy is interested in illustrations of the *use* of the products. Twenty flower urns, a dozen window boxes, garden benches and pergola columns make a motley display as photographed together. Yet a fine bit of photographic work showing one flower box in use, with vines and flowers in it and around it, will appeal to the man who is thinking in terms of a finished house—a finished architectural effect. The manufacturer is interested in the products *as factory products* but the buyer is interested in life and its accessories, in useful things which are also beautiful. He is interested in these products *as details contributing* to a general attractiveness. T is true not only with ornamental pieces but with building units. The architect, accustomed to materials in the rough, can, with the aid of an attractive unit, picture to himself the final result in a wall of such units. Yet the best aid to the salesman is the finished work. The best products of the concrete stone manufacturer are still unfinished until the architect with his lieutenant builders has assembled them, fitting each unit into place, to be lost in the attainment of finished and collective excellence which stands for all the beauty and permanence of concrete at its best. Such work, well done, the best product of manufacturing skill, utilized by competent builders under the guidance of able architects, is, after all, the best advertisement and the best salesman. It converts the conservative and the skeptic. It gives to the manufacturer the satisfaction which is the reward of everyone who adds something to the beauty of the world and something to the comfort of its people.

Chapter 10—Examples of Layout and Operation

A set of plans and specifications for a model factory cannot be prepared without noting every special consideration of process involved, equipment used, variety and quantity of output proposed and methods of curing, finishing and storing, besides material supply and labor conditions.

The manufacturer who plans a new factory, or the prospective manufacturer who is to build and equip a plant for the first time, will have individual problems. He will study the fundamentals of good concrete. These are of first importance. He will build and equip to observe those fundamentals, to secure the best and largest output at the least cost. No two plants are alike. He will pick and choose equipment and evolve a layout and a plan of operation, basing his factory scheme upon the best features of other factories.

It is with this idea that this chapter is offered, with its examples of commercially operated factories—not theoretical designs.

The first 10 descriptions—Plants Nos. 1-10 inclusive—are abstracted from material published in Concrete-Cement Age. Not one of these plants is ideal. Probably there is not one which could not have been improved upon the day it was completed. Plant No. 10 is only just beginning to operate and at the time the description of layout and equipment was prepared the plant had not been entirely completed.

Each of these descriptions, with its accompanying drawings, was selected for some valuable suggestions which it contained. The original descriptive articles have been condensed and in some instances entirely rearranged. Local and personal elements have been removed.

Plant No. 1*

This factory manufactures a high quality of concrete stone, most of the products being cast in sand molds.

Aggregate—The material for aggregate comes direct from

**Data as of 1918*

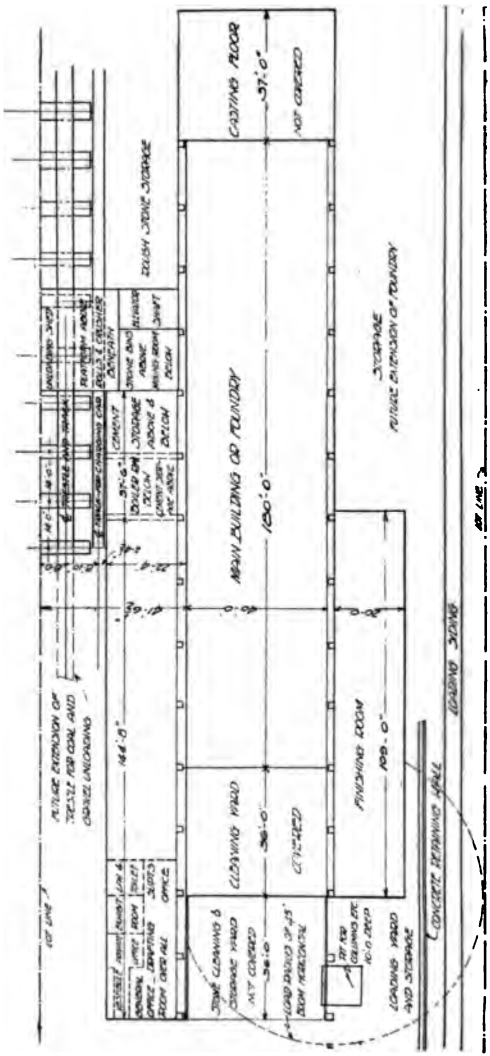


FIG. 100—PLAN AND LAYOUT OF PLANT NO. 1

a quarry in two colors of marble, white and gray-blue, and is crushed in the company's own plant. The crushers take 8-in. piece and larger spalls are broken with a sledge to be fed to the crushers. The stone is broken up to about ½-in. size and smaller. It is elevated to a tower and conveyed by gravity through ore separators where it is divided in four sixes—½-in. down to dust.

Anything which is larger than ½″ is automatically returned to the crusher to go through a second time. After being separated, it goes into four bins from which it is conveyed by chutes opening directly above the mixer hopper.

Mixing—All of the aggregate used in the concrete stone is weighed and the water used in each mix is definitely measured. The mixture is not always the same and depends upon the particular kind of stone which it is desired to produce. The mixtures come out of the mixer, which is of a slightly modified standard batch type, very wet and is conveyed, a ¾-yd. batch at a time, into an agitator, which consists of a large receptacle, holding approximately 35 cu. ft. to 40 cu. ft. of material; it has a shaft through the center, revolving six paddles which are in motion constantly from the time the mixture leaves the mixer until the last of a batch is deposited in the molds. The shaft bearing the paddles is operated by a 5-h.p. motor which is directly connected with the agitator and the entire outfit is conveyed from the mixer to any part of the shop by means of a 5-ton crane. By this method the material is constantly in motion and in process of mixing from the time it enters the mixer until it is deposited in the molds. Owing to the elevation of the agitator and the weight of the material, the mixture is deposited under sufficient pressure largely to eliminate the possibility of air pockets and to insure a uniform composition of the stone being formed.

Sand Molding—In casting in sand, wood patterns are embedded in sand and withdrawn upward. Undercut is taken care of either by split patterns or by filling in undercut in the pattern and tooling the finished stone. To protect the top edges of the sand mold (the top is usually an unexposed surface of the finished product), wooden strips are put in the sand bed around these edges. In this way is is possible for men to go along a few minutes after the casting is done and trowel off the edges without disturbing the mold. This could not be done with the edges of sand. Furthermore, if the edges were of sand clear to the top, the shrinkage by absorption would be so great as to leave the stone imperfect on the top side.

Color—In the manufacture of this cast stone, color is used on some work, but very sparingly. White is made by using the natural white marble as an aggregate with ordinary gray cement. The stone with a blue cast is made by using the blue marble to some extent in the aggregate, and a buff stone is made by using not more than 2% color. This gives a very light buff, not more pronounced than a creamy tint.

Curing—After removal from the sand molds the material is carefully cured out of direct sunlight and as much as possible away from draughts. While curing, the products remain at a temperature within the factory as nearly constant as possible and are then conveyed by cranes to the department where all faces of the work to be exposed are finished by grinding or surface cutting. It is believed that in this way practically all possibility of surface crazing is removed. When this treatment has been finished the stone is stored until ready for use. The entire time required to get out an order is usually about 30 days. All pieces of size sufficient to require it are cast with iron anchors and setting hooks in place and each piece is tagged with the day of casting and the detail number.

Reinforcing—When the length of any stone is five times its smallest cross-dimension, it is reinforced to prevent breakage in handling and when the structural design calls for added strength it is reinforced as required.

Finishing—When the stone comes out of the sand molds it is frequently very rough from sand containing some cement which has adhered to the product. About 24 hrs. after being cast, however, it is gone over with rasps, scrapers and wire brushes in the hands of common laborers. The sand adhering to the surface is removed, the rough spots are taken off and each piece of stone is brought down pretty close to a finished condition. It may be that this stone is to be turned out perfectly smooth without any tooling, but with a rubbed finish, using a good commercial abrasive or perhaps a brick made of cement and sand.

A feature of this company's work, however, lies in the fact that concrete stone once cured is handled just as natural stone is handled—given any tooled effect desired. Numerous architects prefer it to natural stone because they believe that it weathers better, is less absorptive and keeps a better color.

Plant No. 2*

Location—The factory is situated on a three-acre plot of ground, on railroad. The main building is 125′ x 120′, with four wings comprising office, power plant, material store room and a two-story stock room and pattern shop.

Material Storage—Material is unloaded directly from freight cars to the sand, stone and stone dust bins at one end of the main room. In these bins 24 cars of sand, 24 cars of stone and a car of stone dust may be stored. The plant uses a car of cement every five das. This is stored in piles near the hydraulic block press (see 3. This and other reference numbers correspond with numbers on plan.) One car of white Portland cement is used each week, this being stored in th

*Data as of 1910

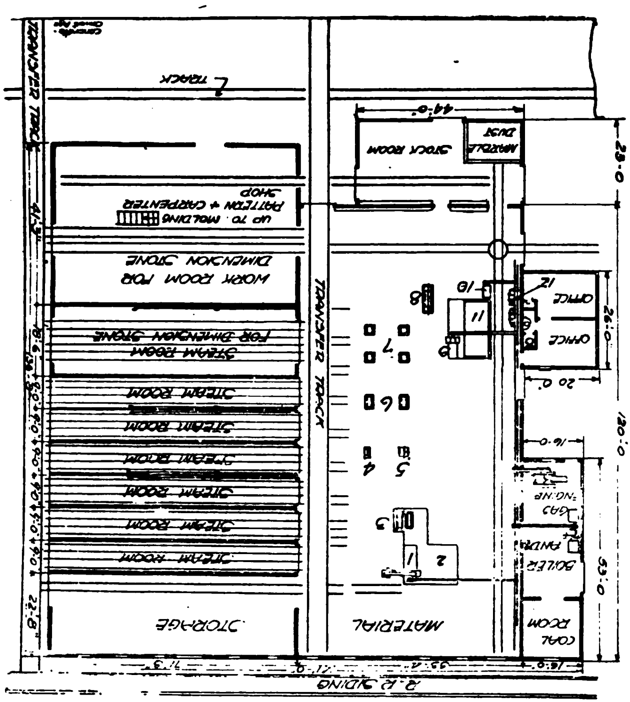


FIG. 101—PLAN AND LAYOUT OF PLANT NO. 2

small stock room at the opposite end of the main building. In this room are also stored two cars of crushed granite, white sand and dry colors. The storage capacity of this little room is increased by a pit 16′ x 20′ x 9′ deep, in which marble dust is kept. Facing sand is stored in a pit 16′ x 20′ and 6′ deep, under the mixing plant, (9)

Operation—The plant is equipped to turn out considerably more than 1,000 concrete block per day. Some of the block-making equipment is part of an old plant and some of it was purchased especially for this new factory. Most of the general purpose block are made on an hydraulic press, (3). This, and a batch mixer (1) and the material-conveying apparatus comprise a block-making unit that is the central point arou which all the other machinery is made to operate. The mixer is mounted 5′ above the floor and is operated by one man who feeds it by shoveling cement, sand and stone, in their proper proportions, into a chain cup conveyor. These charge the mixer, which in turn discharges the mixed concrete onto a table (2) which is on a level with the mold box of the block machine. A second man feeds the mixture into the machine while another operates the mold box, cleans the face plate after each operation and controls the hydraulic power. A fourth man carries away the molded block, placing them on cars which run on a track from the press to the transfer track. Thus a crew of four men operates this mixing and block-molding unit, making one block at a time, of quaky mixture, under a pressure of 60 tons. The usual daily output is 650 block. Block are made in a variety of faces, sizes and designs on this press. Steel pallets are used. The block are made face-down, the pressure on the molded block not being entirely released until the mold box has been stripped off.

The company's idea is to operate a factory that can supply all the masonry units for a building. The business has been built up along this line, and it is found necessary to keep one machine working along on a particular class of work for months at a time. This is the economical way, for changes in adjustment are infrequent and the operator is enabled to turn out a better product when his work is not changed so often. Thus, most of the concrete trim units such as jambs and cornice block are made on a hand press, (4). Block of special shape and style of face plate are all molded on this press, one man doing the work. Three other hand machines are used exclusively for foundation block, one man operating each machine. (5 and 6.) Each operator carries off the block to cars which are run onto the transfer track feeding all the steam rooms.

Roof Tile—One of the main products of the plant is roofing tile. The company has spent considerable money convincing builders, architects and home owners that concrete roofing tile, properly made, excel slate and clay tile and, of coarse, are not to be compared with the wood shingles. Two styles of tile are made, and four tile machines (7) comprise the equipment in this department, one man operating each machine. Each machine has a daily capacity of 250 tile, which lie 133 to the square, on the roof. The tile weighs 675 lbs. to 690 lbs. to the square. Slate 3/16″ thick will weigh 650 lbs. per square, and slate ¼″ thick will weigh 875 lbs.

The roofing tile machines as well as the hand power block machines and the ornamental mold department are supplied with concrete from a secondary mixing plant (12.) This consists of a batch mixer (10) for coarse mixtures and a small *facing mixer (9)*. These are located over the facing sand *storage pit (11)*.

Dimension Stone—Dimension stone up to 72″ in length are manufactured on a special machine (8) operated by two men. The machine is equipped with a variety of face plates, and is adjustable so that it turns out a product of great variety in size and shape. The company has a good trade on artificial trim for buildings that are built of brick and steel. These trimmings are of the best materials and get the most careful workmanship, making the department one of the most important in the factory. Columns, spindles, caps, bases, etc., are made in special metal molds of standard designs as are also a line of porch units and lawn pieces. Orders requiring original designs are handled in the pattern shop.

Pattern Room—The pattern room occupies the second story of the wing 65′ x 41′ 3″, with the modeling department. It is equipped with wood-working machinery enabling the pattern-maker to build wood molds for every purpose. A clay modeler models special designs in clay, from which plaster molds are made for some lines of work.

The walls of the main room of the factory are covered by racks on which are kept in order face plates, pallets and repair parts for the different machines.

One man is kept busy in this room operating the large transfer car. From the machines he pushes his loaded cars over short tracks to the transfer track and on the big car running on this track he transports the loaded rack car to a point opposite the proper curing room. The loaded car is then shunted onto the curing room track.

Curing—This battery of curing rooms is sufficient to take care of the present product of the plant and leave each batch in the room for 48 hrs. There are six steam curing rooms, each 9′ wide and 65′ long, each containing two tracks. In addition, there is a steam room, 24′ wide and 65′ long. In this there are three tracks. Most of the roofing tile, dimension stone and ornamental products are cured here.

Each track will hold 9 cars, and if all curing rooms were full at one time they would contain 135 cars. The cars are of the 3-deck type. A car will hold 24 10-in. block, or 27 8-in. block. The tracks in the factory, storage yard and one three-way dump car of 2/3-yd. capacity complete the track and car equipment.

The steam is led from the power plant into the curing rooms in 1¼-in. pipes nder a maximum pressure of 10 lbs. The feed pipe is hung on one wall of each room, 1′ below the ceiling. About 20′ from each end a vertical pipe suspends from the main pipe and extends to the floor. It is open at the bottom and the steam escapes into a well 1′ x 1′ and 1′ 6″ deep, sunk in the floor. It is the idea that in this way the steam is thus made to envelop the concrete units more perfectly than it could otherwise be made to do.

The office occupies a space 26′ x 20′, and the power plant, 16′ x 53′. The latter has a 25-h.p. gas engine. In this space are also the oil pumps which supply pressure to the power block press and the boiler supplying steam for heat and curing. The entire plant is heated to a moderate temperature throughout the winter, making concrete work safe and easy. A minimum of 60° is maintained in the main buildings.

Labor—Men employed in the factory are as follows:

Power block machine plant crew, 4; Special stone, 1; Foundation block, 3; Roofing tile, 5; Dimension stone, 2; Ornamental pieces, 2; Man on transfer car, 1; Secondary mixing plant, 1; Patternmaker and clay modeler, 1; Engineer, 1; Storage yard crew, 4; Yard foreman, 1; Night watchman, 1; Office force, 4; Total, 31.

Construction Work—Aside from the concrete products manufacturing business, the company does a general construction business, one branch of its activities working with the other. Its outside force puts up buildings of all descriptions, using concrete in every form, and takes much of the factory's output.

Plant No. 3*

The factory is 130′ 10″ long by 82′ wide, built of 8-in. concrete block and with a concrete floor, concrete block partition walls and a turret construction lengthwise of the building to give ample light and ventilation.

Materials—At one end of the plant on the railroad side are the bins and platforms where Portland cement, white Portland cement and white sand are kept, as well as waterproofing material.

The bins and platforms are on such a level that the materials are conveyed by wheelbarrow from the car along a level runway to their storage space. Ordinary Portland cement is piled up in bags. White Portland cement is kept in barrels and the white sand used chiefly for facing empties from its bin through a spout to a bucket on the floor of the mixing room.

Mixers—A special hopper has been constructed on the continuous mixer with a small platform on the side toward the storage platforms. A plank is thrown across from mixer platform to cement platform and the cement carried in bags and dumped into the hopper from which it feeds as wanted to the mixer. At right angles and extending out to the back of the plant is an inclined track on which a dump car, with a capacity of 14 cu. ft. runs from the gravel bank direct to the hopper with the aggregate. The car is hauled up the track by means of a hemp cable on a drum on the side of the mixer opposite from the bank.

From the two small batch mixers which provide the facing mixtures and from the large mixer are overhead trolley rails extending into the molding room. Suspended from these rails is an ordinary hayrack trolley system, and altogether there are 100′ of the rail. The bucket used on the trolley is home-made.

*Data as of 1911

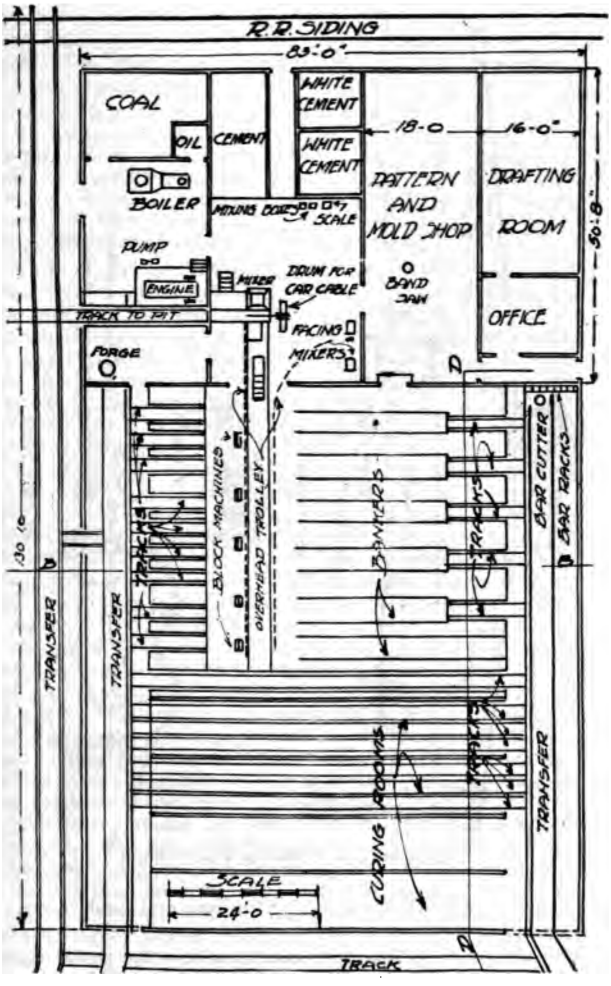


FIG. 102—PLAN AND LAYOUT OF PLANT NO. 3

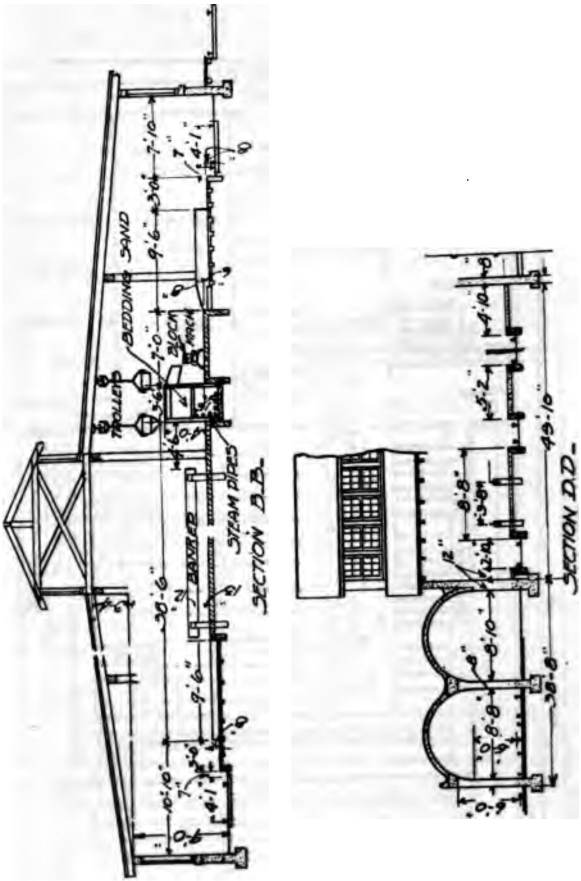


FIG. 103—SECTION VIEWS OF PLANT NO. 3

It is a drop-bottom box made of 1-in. oak and holds 5 cu. f
of concrete.

Power—Directly back of the mixer room is the power equi
ment, which consists of a 35-h.p. boiler and a 25-h.p. engi
About 300 lbs. to 350 lbs. of mine-run coal are consumed dail
a cost of about 45 cts. In one corner of the coal room to
e fuel is shoveled direct from cars on the railway track

oil room, a fireproof concrete block compartment with fire door.

Alongside the engine is a wind-mill pump, back-geared to counter-shaft. This elevates well water to a concrete tower tank holding 42 bbls. of water and when full there is a 28-ft. head. This gives good pressure for the entire factory.

Steam—Steam is conveyed by 1¼-in. pipes in an open conduit, to the curing rooms, the size of the pipes being reduced to ¾″ in the steam rooms. In winter, when heat is required in the factory, dead steam from the heating coils is used in curing and in summer exhaust steam is utilized. Above the open conduit, in which the steam pipes are laid through the molding room, is a long bin containing bedding sand which is used after filling the special molds on plank bottoms.

Molding Room—The molding room extends across the factory. About two-thirds of the space is taken up by the bankers and car pits for the specially molded work. The five block machines of face-down, hand-tamp type, are ranged in a row on the other side of the room. Ten tracks for the block cars are laid in pits so that the tops of the rails on which the cars run are 8″ below the floor of the building.

Cars—The cars used are of a special design. Instead of being built of angle iron, as is the case usually, they are made of 3-in. channel iron for additional strength and there are four decks instead of three. Because of the additional strength given by the channel iron the center posts in the deck frames are omitted. The bottom frame of the car is made of 4-in. channel iron. Each car is 9′ 6″ long and 22″ wide and with its four decks accommodates 13 block of the common type or 12 rock-face block to a deck or 52 or 48 for a car load. The plant is equipped with 66 of these cars.

Curing Rooms and Tracks—The curing rooms are entered from either end, transfer tracks being laid down one side for the special cast stone work and on the other side for the product of the block machines. These transfer tracks are extended to the yard. Cars of the product in the yard may be moved to the loading tracks and these are high enough above the level of the street alongside so that it is just about an even lift for the block from the car to the wagon.

The curing rooms are built of 8-in. concrete block as far as the arch. The arch was formed of metal fabric and plastered both sides to a total thickness of 4″. Water formed in condensation runs down the sides and does not drip on the product. The ends are covered by paraffin-treated canvas curtains, on rollers. They button down at the sides with buggy-top buttons. These canvas curtains will shrink a little and allowance for this shrinkage must be made in cutting and placing buttons.

Pattern Room—The pattern room and plaster mold shop room 18′ x 50′ and besides the requisite benches and too equipped with a band-saw which has made it possible to get along very well—even with an increasing amount of work—with one pattern-maker instead of two employed when the shop was first opened and before the band-saw was installed. Cutting out pieces which were difficult when the hand-saw had to be used was greatly simplified with the installation of a band-saw and the special molds of wood and patterns for plaster molds are now made much more quickly.

The pattern shop, which is entered from the front entry-way near the office, opens directly into the molding room, and is so convenient to the bankers on which the molds are placed for all the special work.

Labor—There are 21 men employed in the factory besides the manager. The working day has been 9½ hrs. except for the men working on the mixers, who work 10 hrs. so that batches may be ready when the other employees arrive in the morning.

The draftsman is paid $4.00 a day. He goes over all drawings which come to the factory and lays out the different pieces to be cast and he makes drawings as well for the work which originates in the factory, such as sketches for construction jobs on which the factory is bidding in competition with brick. There is a pattern-maker at $3.50 a day who is foreman of the factory and looks after all work in the absence of the manager, who may be looking after work being done outside the plant.

The man who makes the plaster molds receive $1.75 a day. (This is an unusually low wage for this work). The man on the small mixers preparing the facing concrete receives $1.75 a day and the man on the big mixer $2.00 a day.

One man looks after the supply of gravel at the bank which lies directly back of the plant, about 30′ from the door. He fills the dump car at the pit, which is hauled up the incline to the mixer. He also takes off the top soil from the gravel bank and this is being used for filling in the factory yards which are being extended in the other direction. When not so engaged he helps in shipping and loading block, receiving $1.75 a day.

The engineer, who is his own fireman, receives $3.25 a day. He was for a long time employed as a tool maker and so he puts in his spare time at a forge and anvil in one corner of the engine room, making tools for use in finishing the plaster molds and the dimension stone. There are five men on the block machines. One man receives $1.75 a day; two men, $1.90 a day each; one man $2.10 a day and one $2.50 a day.

One man at $1.60 a day is employed helping the five block machine men lifting the molded block to the car. He is called the "hook man." He does the necessary marking of block to identify them. When a car is filled the block machine man, who has filled the car, helps the "hook man" shove the car to the curing room. When a man anywhere in the plant has an injured hand—about the only accidents at all common are inju ing hands by having them jammed under block—the injured man, as soon as he is ready to work at all, goes on the hook job at his regular pay because he is able to do the work in spite of one sore hand.

One block man, when working uninterruptedly, is able to turn out from 300 to 350 plain block a day, or 200 special faced block.

There are three molders on special work at the bankers, and each molder has a helper. Two of the molders receive $2.50 a day each and one of them gets $3.00 a day. Two of the helpers are paid $1.75 a day each and one receives $1.90.

Two men are employed unloading block from curing rooms to yard and loading from yard to wagons and cars, and they also are employed when there are materials to be unloaded at the factory. They receive $1.90 a day each.

Summed up, the daily pay roll of the factory is as follows:

Draftsman	$ 4.00
Pattern maker	3.50
Plaster molder	1.75
Facing mixer	1.75
Gravel concrete mixer	2.00
Man on gravel car	1.75
Engineer and tool maker	3.25
Block molder	2.50
Block molder	2.10
2 Block molders at $1.90	3.80
Block molder	1.75
Block molders' helper	1.60
Dimension stone molder	3.00
2 dimension stone molders at $2.50	5.00
Molder's helper	1.90
2 Molders' helpers at $1.75	3.50
2 yard and kiln men at $1.90	3.80
Total	$46.95

Notes on Operation—All white cement is very carefully measured in a cube box, and waterproofing is weighed exactly for every mix.

Much of the success of the plant in making a favorable impression with its special dimension pieces is attributed to the fact that the use of stock molds has been supplemented by many original designs. Two molds for a special design of fence post were made of hard maple and served to turn out 3,400 posts. Four molds made of pine served to turn out 2,400 heavy rails used in building a concrete fence.

In 53 working days the plant turned out 33,018 concrete block and 3,861 pieces of special trim stone, besides 460 small fence posts and two water tanks.

The ordinary run of the factory is from 800 block to 1,000 block a day when the block men are working steadily at the one thing. The maximum output of block is 1,463, two men working on common block and three on white-faced block. This same da 385 pieces of dimension stone were made, most of the wo being done in 4-ft. lengths.

A molder and one helper turn out from 30 cu. ft. to 50 cu. ft. of dimension stone a day, the quantity varying, of course, with the intricacy of the mold, the reinforcing to be cut and placed and the facing requirements. Square twisted rods are used, and, after being cut to length, these are dipped in a trough of neat cement and racked for later use.

The facing mix used in all work in the factory is 1:2¼, and the body mix for the concrete block varies from 1:4½ to 1:6, depending largely upon the way the gravel is running from the bank. Cement is tested by the pat method once a week, but gravel is judged entirely by appearance. The mixture used in most of the dimension stone is 1:4.

The bankers on which dimension stone is made are 25″ above the floor on which the molder stands. These bankers are made of 2-in. x 12-in. wood rails, supported by posts as shown. The convenience of the worker and, therefore, the amount of work to be done, depends, it has been found, upon the height of these bankers.

Some inconvenience has been experienced in handling some of the large pieces, in getting them to the curing rooms. Some concrete steps recently required six men to lift them. A triplex hoist greatly facilitates handling these pieces.

In the earlier operations detailed cost data were kept on everything purchased, manufactured and laid in place. This early system was just what the work required at the start—until the manager "got his bearings" as to cost. This daily report made a big task for the bookkeeper, and, when it had served its purpose of establishing certain standards of cost, the system was abandoned.

Plant No. 4*

This factory manufactures four distinct lines: sewer pipe from 4″ to 24″ in diameter; structural tile; concrete block and dimension stone.

The factory building is 90′ x 150′ with walls 26′ high in the machine end and 16′ high over the rest of the plant with a 5-ft. lantern or turret above for light and ventilation. The boiler house at one side is 20′ x 32′. The curing rooms take up 88′ of the length of the building. There are eight of these rooms, two for tile, three for block and dimension stone and three for sewer pipe. The walls of the factory are of concrete block and hollow tile, manufactured by the company. The division walls of the curing rooms are of 8-in. concrete block. Curtains are used at one end of these and double doors at the other, outside end of each room—this for the reason that the temperature frequently goes 40° below zero in winter. The roof of the room is of reinforced concrete, designed for a heavy load inasmuch as it forms the floor for the room in which the ornamental stone is made.

*Data as of 1912

The office is in the turret with glass on all sides, so that all parts of the open building may be seen from it. Concrete floors

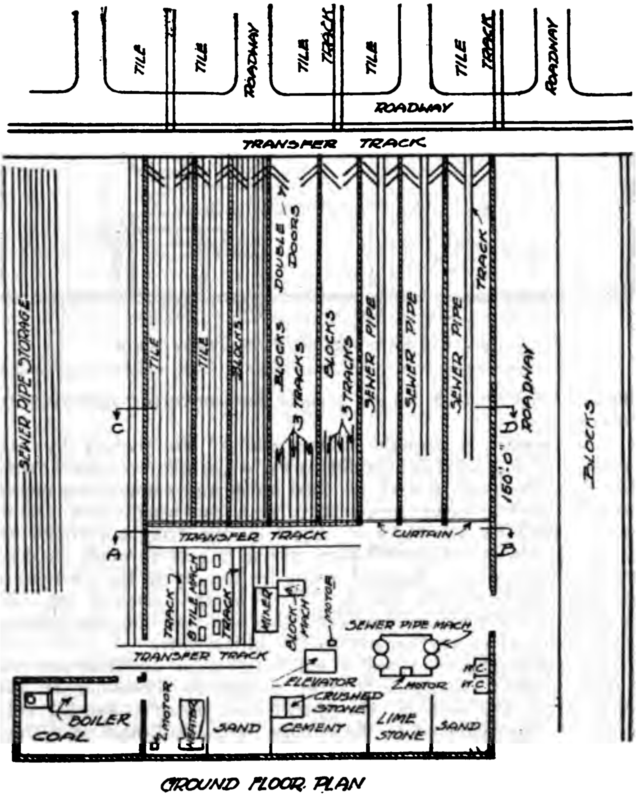


FIG. 104—FIRST FLOOR PLAN, PLANT NO. 4

are used throughout the plant. The more important items of equipment in the factory are: 1 sewer pipe machine; 1 block press; 8 structural tile machines; 4 mixers, two home-made; 1 crusher; 1 band-saw; 1 planer; 1 freight elevator; 130 three-deck cars for block and tile; 1 3-ton overhead traveling crane. for moving heavy ornamental stone; 10 electric motors, 2 1(

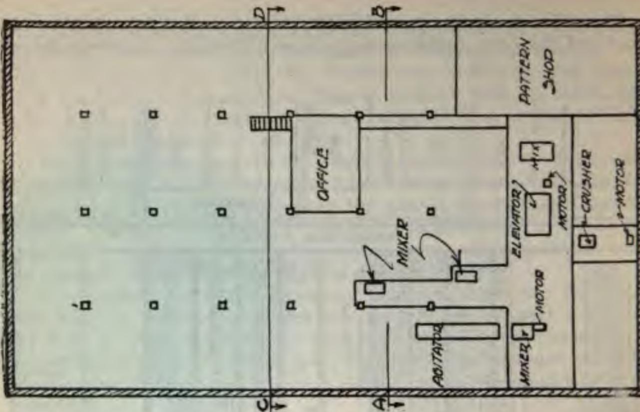


FIG. 105—SECOND FLOOR PLAN, PLANT NO. 4

h.p., 5 5-h.p., and 3 3-h.p.; 4 carts for conveying materials to mixer.

All material is brought to one end of the factory by rail where it is unloaded in wheelbarrows to the various bins. From the bins, the sand, gravel, crushed stone and cement are measured in their proper proportions in a two-wheel cart. Such a load with its attendant is raised by the freight elevator to the platform in the second story where it goes through its particular mixer and is dumped, going by gravity to the particular machine which is to use it. Then in the case of the tile and block the product goes onto the cars and into the curing rooms and after curing, out to the piling yard.

The sewer pipe are stood on end between the machine and the curing room. The space is large enough to accommodate one day's run. The next day the pipe, having attained considerable strength, are removed to the curing rooms and stacked. They remain in the curing room at least a week. All through the various lines of manufacture, the raw materials enter the factory at one end and go out finished at the other end. Nothing goes over the same ground twice.

A 60-h.p. boiler furnishes steam for the tile machines, the curing rooms and for heating (coil and fan system) and also for thawing out frozen sand in winter.

The plant has operated steadily all winter with a crew of more than 30 men and in the busy building season the force is still larger.

Curing Rooms—There are eight curing rooms, varying only in width, so that a typical one may be described as follows:

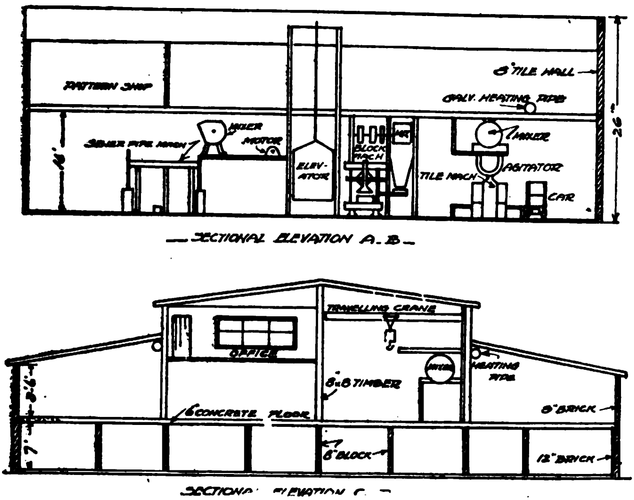


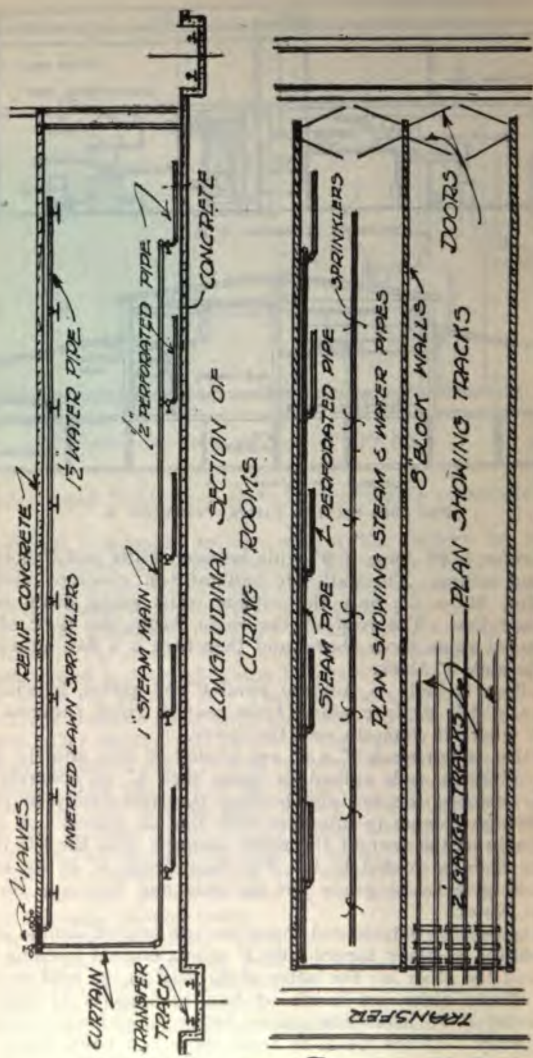
FIG. 106—SECTION VIEWS, PLANT NO. 4

The room is 88′ long, 9′ 8″ wide between walls and 7′ between floor and ceiling. The walls are built of 8-in. concrete block on a footing 24″ x 6″, only the outside walls going down below the grade line. The roof of the room forms the floor of the ornamental stone room above, and therefore is a flat reinforced concrete slab 6″ thick.

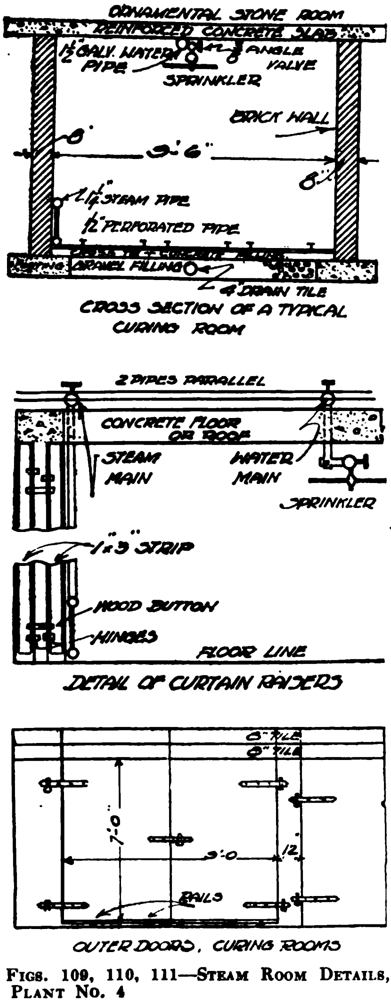
The floor is built as follows: First 6″ of gravel, in which is laid a 4-in. tile drain running from rear to front (nearest machines) where it connects with the sewer.

The ties of tamarack 3″ x 6″ are leveled on this, and the three tracks of 12-lb. rails spiked to them, then 4″ of concrete are run in, covering the ties and holding the rails firmly in place, but not high enough to interfere with the car wheels. A small catch-basin at the rear of the room connects with the tile drain and the floor is graded to it. The floor drops 4″ in its entire length to give easier grade for the cars and drainage for the surplus water.

At the rear or outside end there are two sets of double swing doors, hung on heavy hinges only 1′ apart, one set opening outward and the other in; the latter being used in the cold weather only. These doors are made of two thicknesses of ship-lap with a layer of insulating paper between, and are made to close tightly. At the inside or front there is a 10-oz. duck curtain, well oiled, and simply hung from the top and fastened to a round stick at the bottom, for weight and to roll it up on.



Figs. 107, 108—Longitudinal Section and Plan of Typical Curing Rooms, Plant No. 4



Figs. 109, 110, 111—Steam Room Details, Plant No. 4

At the sides it is held between two boards, the outer strip being hinged and held in place by a wooden button, as shown by sketch. There are transfer tracks at either end of room.

Steam is taken from a 60-h.p. boiler which is located 70′ from the nearest steam room, in a 1½-in. main pipe which runs across the top of the front end of room. From this, by a T and valve, a 1-in. pipe is taken off and goes down goes down the side wall to within 1′ of the floor, where it turns and runs nearly the full length of the room. Beginning 8′ from the front, a ½-in. pipe is taken from this every 16′. This ½-in. pipe is 8′ long and perforated with 1/32-in. holes every 6″, with a cap on the end of the pipe.

Steam pressure at the boiler is usually about 40 lbs., but a reducing valve in the main pipe lowers this to 5 lbs., which is just enough pressure to drive the steam the full length of the steam room, so that it comes from the pipe as wet steam and condenses on the block, tile or pipe. The temperature averages about 100° Fahr.

Along the front of the curing rooms, close to the main steam pipe, is a 2-in water pipe with city pressure. At the center of each steam room this connects by T and valve with 1½-in.

galvanized pipe, which runs nearly the full length of the room and is fastened to the underside of the roof by wires embedded in the concrete. Every 10′ beginning 5′ from the front, there is fastened to this by a T and ⅜-in. angle valve, a common 3-arm revolving lawn sprinkler—that is, the head and arms only are used and are put on upside down. In each arm all holes but one in the end are closed and three new holes put in on top of each arm, so that the water will be sprinkled evenly all over the room. Thus with these valves at the sprinklers, the entire room can be sprinkled at once, or only such part as is desired.

For the products, the regular 3-deck block cars are used. A room will hold 11 of these on each track or 33 in all, so that each room will hold the day's run in block.

The block are left in the steam room for two days; steam is turned on at night or as soon as the room is filled, and kept on continuously for 24 hrs. and then turned off to let the block cool before going to yard. After the first day, the block are sprinkled every 6 hrs.

The structural tile are placed in the steam rooms as fast as cars are filled, the steam being turned on as soon as the first car is put in, and these are sprinkled every 4 hrs, and steamed continuously for 3 days.

Plant No. 5*

Layout—Economy of space and in labor charge is attained in this plant, which is 80′ x 50′. There is a second story providing a space 28′ x 50′, in which the office, drafting room, pattern shop, watchman's room and gravel bin are accommodated. The gravel bank is within 20′ of the building and one man wheels the gravel to the bucket conveyor which takes it up to the top of the bin in the second story. From this bin it drops directly to the mixer. The mixer used is of the continuous type, which measures the gravel as it comes down the chute. By the arrangement of this plant, one man fulfills three duties, He is engineer, fireman and mixer man, all in one. He feeds cement (cement is kept in the corner nearest the mixer) into the hopper. The concrete falls on the concrete floors in front of the two block machines. One block machine at 3 is equipped with an automatic tamper. The other machine is used almost entirely to make fractional block, hand-tamped. There are two chimney block machines, very profitable. One machine makes a block with a flue 8″ x 12″, the other a flue 10″ x 14″. They are not operated all the time. When they are operated, two men take the gravel from the bank, mix it by hand, and make 100 chimney block per day. These block sell for 25 cts. and 28 cts. each.

Power—The power used in the plant is steam and is transmitted by belts and shafts. The boiler is on the same level as

*Data as of 1912

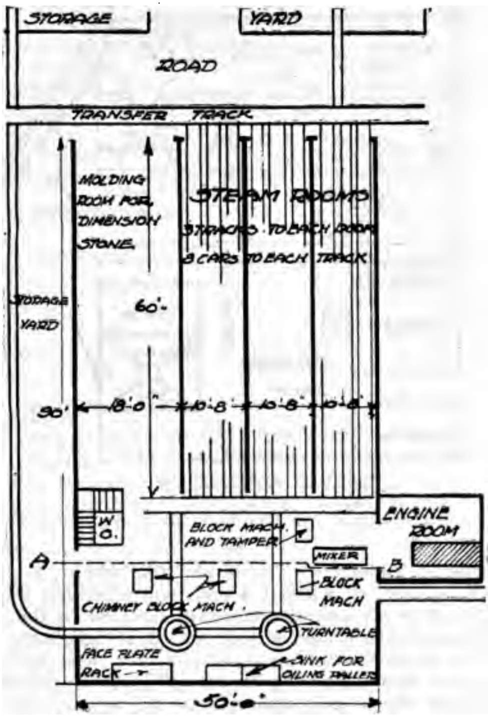


FIG. 112—FIRST FLOOR PLAN, PLANT NO. 5

the curing rooms and the main supply pipes are run overhead through a reducing valve giving a 5-lb. pressure in the steam rooms. From the main supply pipes, the pipes in the curing rooms drop at each end of the room to a trench in the center of the floor of the room. The trench is 10″ deep, so that the steam pipe can be laid with a pitch of 5″, with the same pitch for the return. It is 1½″ pipe with pet-cocks every 5′ throughout the length of the room, giving an even distribution. In the summer, the temperature runs up to about 120° F., and in the coldest weather it is not lower than from 50° to 60°.

Labor—The number of employees in the plant varies with the season and the demand. When running at full capacity, the force *is as follows:* The proprietor, who is salesman, collector, *superintendent of* outside construction and general manager

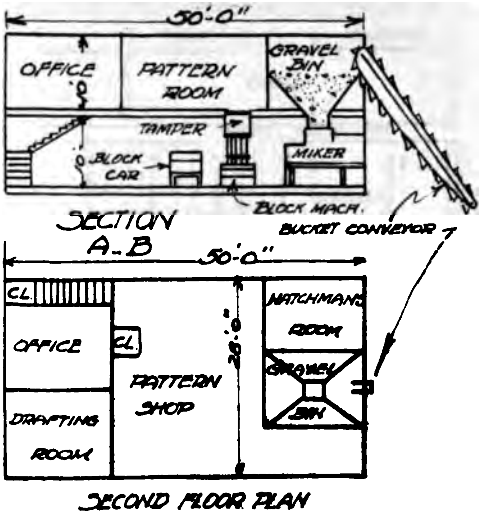


FIG. 113—SECTION AND SECOND FLOOR PLAN, PLANT NO. 5

of the plant; a bookkeeper who is also draftsman (no job, however small, is sent out without a plan and schedule; the plan is sent with the goods and the schedule retained in the shop, so that if a duplicate order is received, it is necessary only to turn to the original schedule); an engineer, who operates the mixer; a man who attends to the shipping of the product from the yard and who acts as manager in the absence of the proprietor. There are two men for each of the two block machines, and two men to make chimney block.

Men employed at the block machines are aware of a definite arrangement in the matter of output. From the block machine equipped with power tamper, two carloads of 24 block each or 48 block in all, are required per hr. Twenty block per hr. are required from the chimney block machines, and 20 block per hr. from the machine in which fractional block are made, having no power tamper. The shop is in operation 9 hrs. a day. If there is an extra demand for block the power tamper machine can turn out 450 block per day, but when the two men at each machine divide their time, which is usually the case, they are required to turn out 48 block per hr. A record has been made of turning out 28 block in 20 minutes, but the men found it impossible to keep up that pace for a full day. Two men are employed constantly in the plant making dimension stone.

Data on one day's operation selected at random show that the plant used 75 bags of cement, paid $21.50 for labor of 10 men, and had an output as follows:

49 16-in. block; 18 12-in. block; 2 11-in. block; 2 10-in. block; 49 8-in. block; 360 24-in. block; 23 16-in. block; 23 8-in. block; 1 step 7′ 6″ long; 20 posts caps 14″ x 14″; 2 post pieces 16″ x 16″; 5 steps each 5′ long.

The value of this material in the yard was figured at $112.20.

Outlay for the day was as follows:

Cement		$28.00
Labor		21.50
Expense:		
Interest on investment	$ 3.00	
Office help	6.50	
Coal	2.00	
Oil	.50	
Repairs	2.50	
Lumber	.25	
Depreciation	3.25	
		$18.00
Total		$67.50
Profits for the day		$44.70

This expense item of $18.00 is fixed and is charged up every day. It is based on the expense for a year in the various lines mentioned in the expense account.

On another day with 11 men working, the output was worth $143.75.

Cement cost	$28.80	
Labor	23.50	
Expense	18.00	
Total	$70.30	
Profit		$73.45

In winter, when there is less work, a typical day with 4 men employed shows up as follows:

Cement	$10.50	
Labor	13.67	
Expense	.18 00	
Total	$42.17	
Stock manufactured		$47.69
Profits		5.52

It might be mentioned here that nothing is charged up for aggregate, which costs nothing in this case if it is figured that the supply is inexhaustible, and that the time will not come when it will be necessary to buy a new gravel bank, or have the gravel shipped in.

Plant No. 6*

Building and Layout—The building is 40′ wide, 60′ long and two stories high. It is set about 30′ away from the side track and this space utilized for storage of sand and gravel and for a driveway. Pit-run of gravel, screened through a 1-in. screen right into a wheelbarrow, is used. It is wheeled into the building and dumped into a large hopper standing about 20″ from

*Data as of 1912

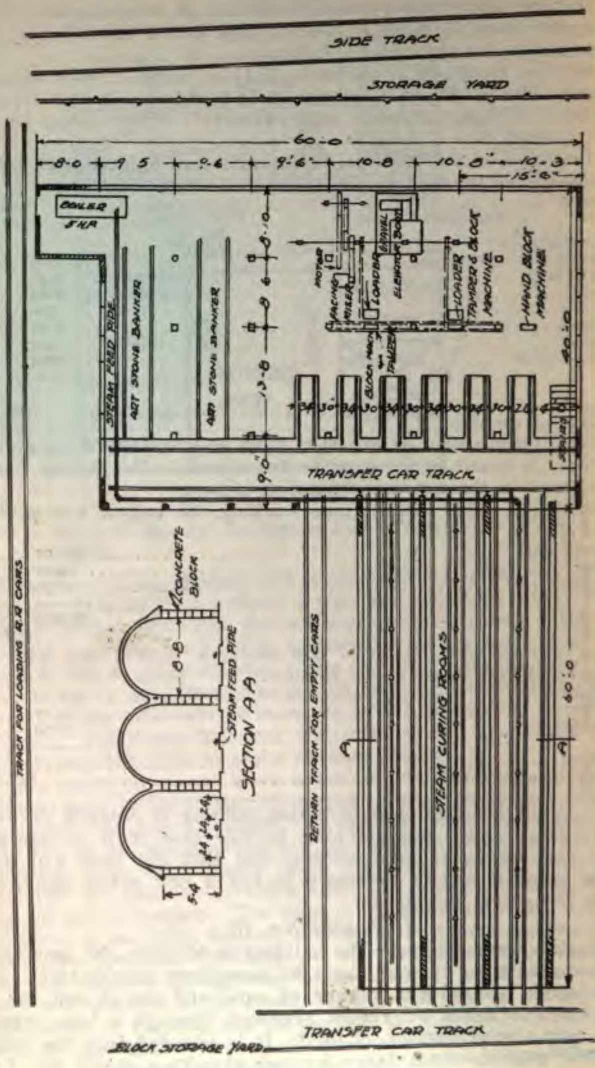


FIG. 114—FIRST FLOOR PLAN, PLANT NO. 6

the floor. From this it is conveyed by a screw conveyor into an elevator boot from which it is elevated by means of a single strand, link-belt bucket elevator into the mixer, on the second floor. The mixer has been elevated to allow a dump car to pass under the discharge end of the trough. The mixer is of the continuous proportioning type. The hoppers have been built up about 2 ft. so as to increase their capacities. The elevator is set high enough so that a rotary screen can be installed above the mixer and allow the elevator to discharge direct into this.

The concrete discharges into a dump car which is operated on a 24-in. track running the entire length of the building directly over the block machines. There are two automatic tampers located as shown in the accompanying drawings. One is for a 16-in. machine and the other a 24-in. machine or brick machine. Back of each tamper stands an automatic loader.

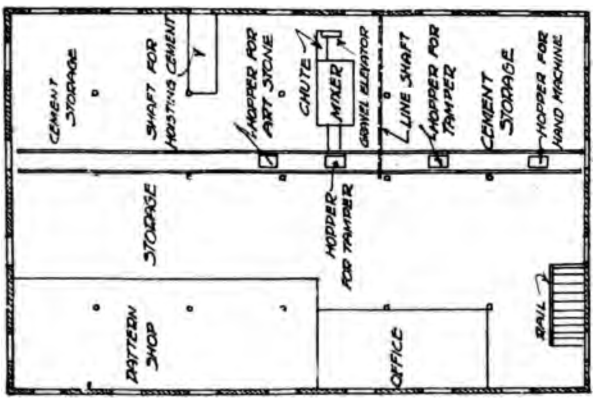


FIG. 115—SECOND FLOOR PLAN, PLANT NO. 6

The hoppers of these loaders have been built up to the floor above and the concrete goes from the dump car direct into these hoppers. From them the concrete is fed automatically as needed to the block or brick machines. The space next to the tamper has been reserved for the hand machines which are always required for special or fractional block. Each tamper has two car pits in front of it. It was the original intention to set the rails of these car pits 6″ below the floor of the factory, but on account of a mistake as to the width of the cars it w[illegible] impossible to do this.

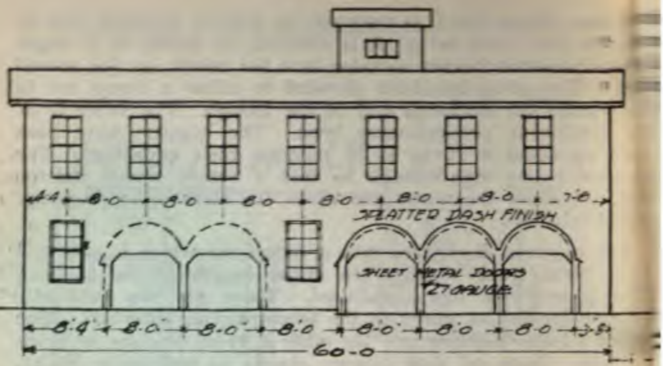


FIG. 116—ELEVATOR, PLANT NO. 6

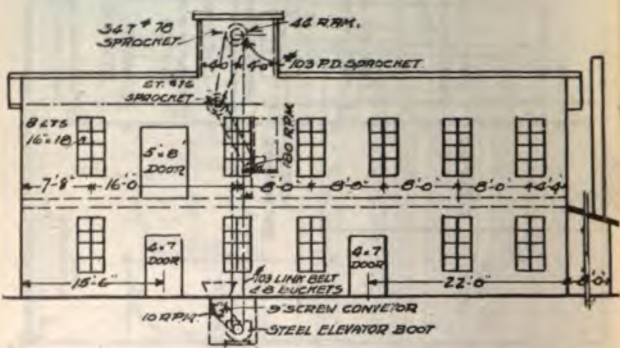
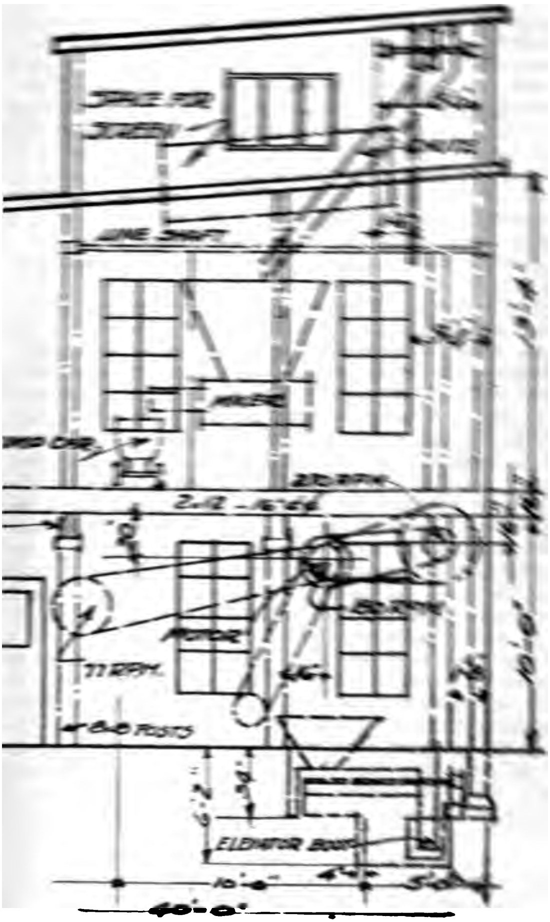


FIG. 117—ELEVATION, SHOWING ELEVATING MACHINERY, PLANT NO. 6

Three-deck cars 30″ wide with a capacity of 54 plain 8-in. x 8-in. x 16-in. block are used. These cars are suitable for both 16-in. and 24-in. block. One complete car, fully supplied with pallets, is set in one car pit and one bare car without any decks in the second car pit. The freshly made block are set on this car and pallets taken off the first car as needed. When the last car has been filled with block, the top deck of the first car is set on the second and this opera-

[illegible]



Part Elevation, Showing Elevating Machinery, Plant No. 6

pallets and places it in the empty car pit. In this way the block machine operator is not forced to wait for a car. Only one car pit is supplied for the hand machine, because the block are not turned out so rapidly as on the power machines. The space between the 24-in. tamper and the north end of the building is reserved for art stone work. There are two bankers in place and space for a third. The art stone is left on the bankers until the evening of each day or until the following morning, then loaded on a car and run into one of the steam rooms. A transfer car track is at one side of the building directly in front of the car pit and runs the full length of the building. Provision has been made for five steam curing rooms, but three are erected at the outset. These curing rooms are directly in front of the block machines but are entirely separate from the manufacturing building. Factory facilities can be increased merely by building on to the long way of the building and not in any way disturb the present plant.

Electric power is used, the boiler being used only to take care of the curing rooms.

Steam Curing—The steam curing rooms are 88″ wide in the clear and 60′ long. The roofs are of metal fabric curved to a 4-ft. radius, thus making a semi-circular arch roof. This is plastered on the top with 2½″ of concrete and on the under side with about ½″ of cement plaster. Each room accommodates 16 cars and thus has a capacity for 864 plain 8-in. x 8-in. x 16-in. block. To cure products 48 hrs. requires the use of three rooms. Each room has two sets of rails to accommodate two rows of cars. Another rail will be placed near the center of one room and used with one rail of the other two sets for a car of long art stone. The walls are of 8-in. x 8-in. x 16-in. hollow block. The doors are merely a framework of 2-in. x 4 -in. lumber covered on the steam side with No. 27 gauge galvanized iron. All the doors are swung on hinges from the top so that when they are opened up they will be out of the way.

A 25-h.p. horizontal locomotive type steam boiler is set up in one corner of the plant. The steam is fed to the curing rooms by means of a 2-in. steam pipe placed on the floor halfway between the two walls, and every 6′ is a reducing cross, reducing from 2″ to 1¼″. For the first 20′ or so these openings are plugged with reducing bushings reducing from 1¼″ to ¾″, and the remaining openings with bushings reducing to ½″. The flow can be regulated by means of these bushings. The steam pipe is placed slightly above the rails so that the steam from the crosses moves over the rail, strikes the side walls, moves upward to the ceiling and the two currents of steam meet in the center of the room and go downward again to the pipe. This gives a continuous circulation of steam throughout the room.

The openings nearest the main feed pipe are smaller than *those toward* the discharge end.

PLANT NO. 7*

Equipment—The plant has the following principal items of equipment: 2 hydraulic block presses; 1 continuous mixer; 2 double block machines; 1 single block machine; 2 small batch mixers; special block cars; 3 sill and lintel machines which were specially designed, besides special molds and smaller equipment.

Materials—Beginning at the raw material end of the plant the back part of the one-story building, as will be seen in the plan, is reserved for storage. Here the special facing materials are piled in bags. Here also is located a home-made mixer for mixing the facing material. This is a cider barrel mounted on an axis through the center and turned by hand with a crank, and with a hole in the side through which the special sand, granite, or other material is put, together with the cement, and afterward closed. Through the sides of the barrel 20-penny spikes are driven to aid in the process of mixing.

There is a driveway through the back part of the building. Over it, the gravel wagons come from the pit which is at a distance of about ¼ mi. from the plant. The gravel is dumped just to one side of this driveway and as near as possible in front of the screen through which the gravel is to be shoveled. Gravel over 2" in size is eliminated by this screen. That which falls through the screen goes to the chain bucket conveyor which lifts it to the hopper above the mixer. This back room just in front of the driveway is partially shut off by a low partition.

Facilities for gravel storage are unhandy and sometimes necessitate shutting down in bad weather. Storage bins are to be provided above this back room of the building, and to these the gravel will be elevated as it comes to the plant in wagons, in order that there may be plenty of stock on hand to carry the plant well over any period of weather in which hauling can not be done.

Operation—In the corner of the room in which the block are made, the cement is piled in sacks, as indicated on the drawing. This is carried up the steps and dumped into the hopper by hand. The concrete leaving the mixer falls onto a platform which is so constructed as to be conveniently located for the removal of the mixed concrete to weighing devices placed at the edge of the platform from which it goes direct into the molds on the presses. The concrete is approximately of a 1:5 mixture, considerably wetter than is ordinarily used in block manufacture, though not by any means so wet as to be called quaky.

Two kinds of crushed granite are generally used for the facing mixture, light gray granite and dark gray granite, mixed 1:2 with cement. Other block are faced with a specially screened sand in a 1:2 mixture. The facing mixture is brought in a wheelbarrow from the barrel mixer, which is only a tem-

Data as of 1912

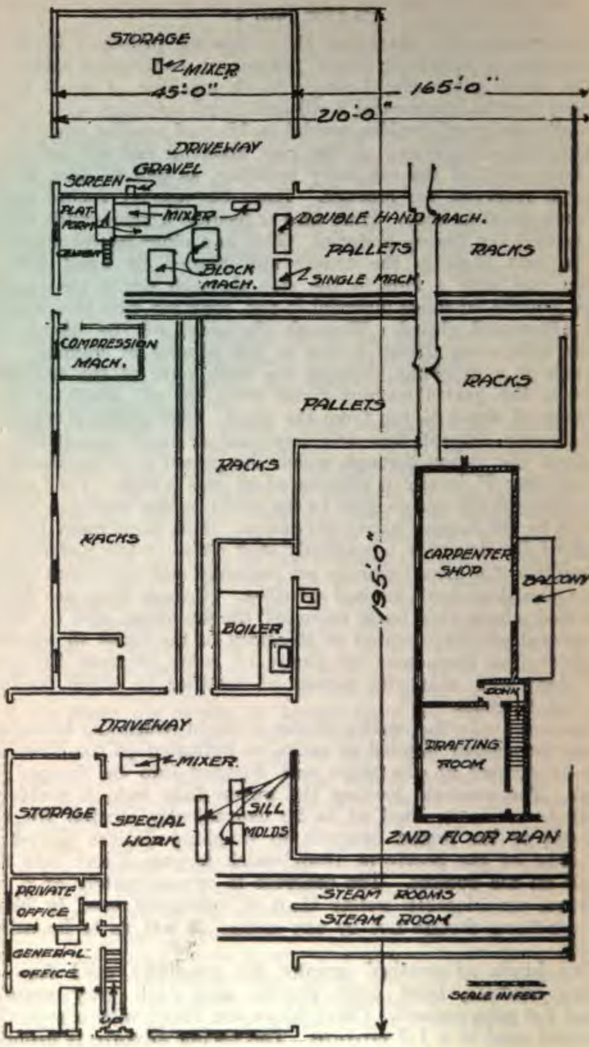


FIG. 119—PLANS, FIRST AND SECOND FLOORS, PLANT NO. 7

porary makeshift, to a box which stands beside the press. As the bed of the press revolves bringing around one of the plates, the facing mixture is put in and leveled off with a trowel, and it then goes under the press where the parts of the mold forming the side walls and core are set on, and the concrete put in by the weighers. As the block come off the press they are carried on the pallets to the car on which they are removed to the racks. Before being removed they are sprinkled, a nozzle being used to get a fine, even spray. A batch mixer is used at the location indicated on the plans when the hand power block machines are in operation. Another batch mixer is located in the room where special work is done on sills and lintels and dimension pieces.

While the plant is steam heated, electric power is used for the machines. There are three 5-h.p. motors and one is used in the operation of the presses and the continuous batch mixer. One 3-h.p. electric motor drives the batch mixer which is operated for the hand power block machines. A 2½-h. p. motor drives the mixer used for special work. About 200' of leather belting are used in power transmission. Under ordinary circumstances, 25 or 26 men are employed in the plant as follows:

2 men sifting gravel to the conveyor; 1 man feeding cement to the mixer; 2 men operating the hydraulic block presses; 1 man (who stands on the platform under the mixer to distribute the concrete for the convenience of the weighers); 2 men weighing concrete and feeding it to the presses; 4 men carrying block from the presses; 4 men racking and inspecting; 1 man spraying block as they come from the presses; 1 general utility man; 1 foreman; 3 men in the special work department; 3 men to 4 men in the yard.

Besides these there are one draftsman, one bookkeeper, one stenographer, and the proprietor, who is the sales end of the establishment.

The capacity of the two hydraulic presses is 1,800 block per day, regardless of size. The average run of the two presses is 1,700 block per day. The principal sizes made are: 8-in. x 12-in. x 24-in., 8-in. x 8-in. x 24-in. and 8-in. x 16-in. x 24-in.

These three principal sizes are manufactured in four principal styles, plain face, bevel face, rock face and dental face. Further variation is given by the fact that any one of these sizes or any one of these styles is made with any one of the following facing mixtures: sand facing, gray granite, and dark granite.

Of the men working in the plant aside from the draftsman and the foreman, three receive 30 cts. per hr., three 26 cts. and the others 28 cts. The plant operates 10 hrs. per day. The 8-in. x 12-in. x 24-in. block are sold for 22 cts. each, and the 8-in. x 8-in. x 24-in. are sold for 20 cts. each.

Curing—As to curing there are in this case unusual facilities for storing a large number of block, and racking and sprinkling have been found satisfactory for most work. The entire plant is heated with steam and in winter it is possible to leave the block inside the sheds for a full week. However, more tracks are to be installed in the storage sheds and more cars used so that the needless labor of loading and unloading will be obviated.

The plan shows two curing rooms. These are for steam treatment of special products when there is a special run of some product not held in stock, which is wanted in a hurry. In these rooms for curing the ordinary run of product which is to be held in stock, as most of the sills and lintels are held, sprinkling is used and the rooms are equipped with sprinklers very much like the sprinklers used in spraying the block as they come from the machines. Water pipes run down both side walls of these two rooms at a height sffiucient to get above any product put into the curing rooms on cars, and beginning 5′ from the front of one wall, two sprayers will be mounted on one tap at intervals of 10′. On the opposite wall the first sprayer will be placed 10′ from the front and every 10′ throughout the length so that with both walls the pairs of sprayers will alternate so as to be 5′ apart throughout the length of the room. Each pair of sprayers will be mounted on the pipe at such an angle as to fill every inch of the room with a fine mist when they are in operation.

Plant No. 8*

Gravel Hauled by Teams—Washed sand and gravel are very expensive but the plant is fortunate in securing a good screened pit-run of gravel at a near by pit. This pit is open winter and summer and the gravel can be secured all the year round. For that reason a driveway has been built going right through the plant and teams haul this material directly into the building, dumping it within a few feet of the mixer. The material is then shoveled directly into the measuring hopper of the mixer, thus saving the cost of re-handling, which would be necessary if the material were purchased in car lots. The quality of this gravel has been improving constantly as the operator has installed a rotary screen and screens out the surplus sand, which is used in sidewalk top course work.

For use in bad weather storage space has been provided for a large quantity adjacent to the block plant, so that when teams can not haul from the pit gravel is taken into the plant in wheelbarrows from the emergency supply. The material bins (so marked on the plan) are for the storage of cement, white sand, marble, stone and crushed granite.

Cement in Bulk—All cement is received in bulk and is so kept in the bins. The provisions for this are not as they should be, so are not detailed, but the results are such as to indicate satisfaction with bulk cement in products manufacture.

Block Machines—Two block machines, of a hand-operated pressure type, are used. So far as possible, one machine is

*Data as of 1914

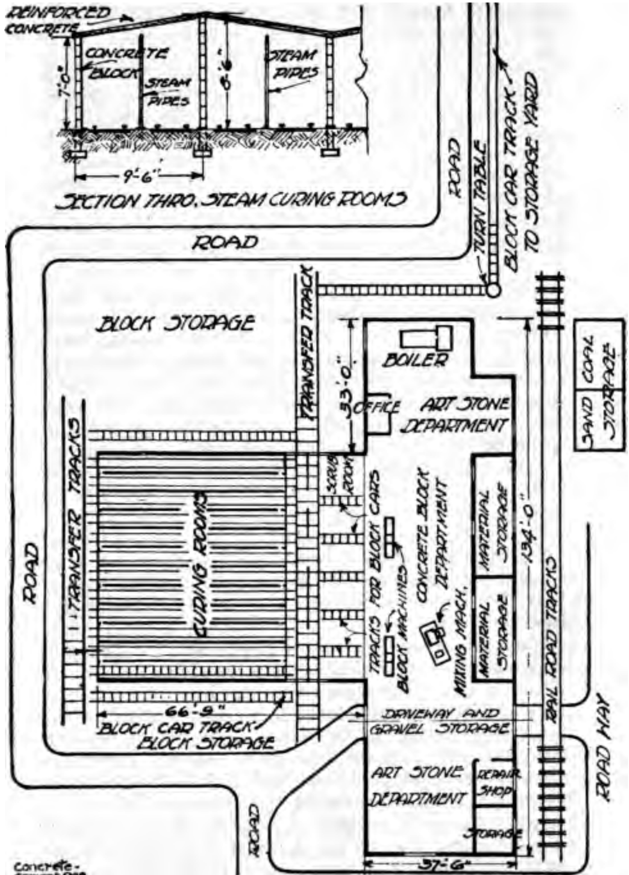


Fig. 120—Plans of Plant No. 8, with Section View of Curing Rooms

used for fractional and special block, the other for the standard type and size.

Tracks—As will be seen on the plan there are five tracks *opposite the block* machines. Two tracks for each machine *hold cars for plain block* and the center track is used for *car holding faced block* during the time they are out of *curing rooms to* be scrubbed. When one of the two car each machine is loaded and shoved into a curing room, the second car is ready for loading without any delay.

Steam Curing Rooms—Steam curing room walls are of two-lug block and the roof is of metal lath covered with about $1\frac{1}{2}''$ of concrete and plastered underneath with one thin coat of cement plaster. The roofs are pitched but slightly. This type of construction is said to answer the purpose just as well as the semi-circular roof that has been used for the same purpose and is preferred for the reason that there is not so much waste space between the top row of block and the roof. Thus it is much easier to heat up a room of this type than one of the semi-circular roof.

The manufacturer had come to the conclusion that the lower part of most steam curing rooms was not warm enough. This was verified readily in cold weather by examining the block in the first deck and those on the top deck of the cars. He declares it will be ordinarily found that the block in the lower decks will be softer than those on the top deck. To overcome this difficulty the steam is fed into the curing rooms through a three-pipe coil in the center of each room between the two rows of cars. The steam enters the top pipe and circulates through the coil and finally escapes through openings in the bottom pipe. These openings are about 5′ apart and bushed down to the required size to permit the proper control of the steam. The openings nearest to the feed end of the pipe coil are small and they increase in size toward the far end of the coil so that the flow of steam at all openings is as nearly uniform as possible.

These openings occur in crosses furnished for the purpose at predetermined points which are governed by the size of the pipes. The crosses force the steam to leave the pipes in a horizontal direction and the steam then rises vertically through the cars, passing among all the block from the bottom to the top decks. The use of the coil tends to make the temperature of the room more nearly uniform and distributes the moisture more uniformly as the coil acts as a condenser.

Costs—In order to determine accurately the cost of block and art stone, a simple and yet detailed cost system has been used with time sheets that accurately divide the time of all employees between the art stone and the concrete block departments. In addition to this the plant foreman keeps a daily record of the plant's production and a daily record of the amount of cement, sand and gravel used for both art stone and concrete block. One-third of the foreman's time is charged to the art stone department and two-thirds to the block department and 1/5 of the time of the mixer attendant is charged to the art stone and the balance to the block department.

All fractional block up to ½ block are figured as ½ bloc block larger than ½ block and less than a whole block are classed as whole block. Figuring all block on a basis of an equivalent number of whole block, the production for one month was 20,045. The average labor cost per block figured was $.0479, the average materials cost per block $.05, the average material and labor cost $0.979. These averages are average costs for block of all sizes, including both two-lug block and heavier 16-in. wall block. Assuming that the labor on granite block is twice as much as the labor for rough block the labor for rough block figures $3.83 per 100 block and the labor for granite block figures $7.66 per 100 block, but for the sake of quick comparison it is assumed that these costs are $.04 for the rough block and $.07 for the granite block. In one month the average labor and materials cost per cu. ft. of art stone was $.84. The average labor and materials cost for several succeeding months, however, was $.80 per cu. ft.

Union men only are employed, and wages are $2.75 for common labor or $.34375 per hr.; finishers or art stone workers, $4.00 per 8-hr. day, or $.50 per hr. Both wages are approximately 50% higher than are paid in most plants. About the best wages that are paid for the same class of labor elsewhere are $.275 per hr. for common labor and $.40 per hr. for art stone workers.

The approximate labor cost of rough block is $.04 apiece and that of granite block $.07. The average market price for such block is easily double these cost prices, or more. Table I gives the average labor and material cost of both rough and granite block for 8-in., 12-in. and 16-in. walls.

Cost of Laying Block—It is very difficult to determine the actual laying cost per block, as nearly all buildings require a greater or lesser number of fractional block; therefore the laying cost per block does not mean much in the ordinary sense. For estimating the number of block required for the building it is customary to take the number of sq. ft. of wall surface and from this estimate the equivalent number of whole block. It will readily be seen, however, that in actual practice the whole number of block will exceed the estimated number, for the reason that fractional block are required between all openings and so while the number of sq. ft. of wall surface remains the same the number of block will exceed the estimate. Therefore, laying costs should be based upon the number of sq. ft. of each thickness of wall. The present system is figured on this basis.

The laying cost includes the setting of artificial stone, which always costs much more than the laying of ordinary block. The first building was erected in the dead of winter with snow flying almost every day and consequently laying costs were much greater than they would have been in warm weather. Masons were unaccustomed to laying block, which also had something to do with the high cost. The first building was built of 8-in. wall block of two-lug style.

Table I—Cost of Granite and Rough Block

	Rough 12" Wall Block	Granite 12" Wall Block	Rough 16" Wall Block	Granite 16" Wall Block	Rough Double-lug Block	Granite Double-lug Block
Total Labor inc. Delivery	.040	.070	.040	.070	.040	.070
Total Cost of Materials	.040	.080	.060	.100	.050	.090
Total Overhead at 20%	.008	.016	.012	.020	.010	.018
Total Cost	.088	.166	.112	.190	.100	.178

Superintendence is included in the labor cost.

The overhead expense including fuel, light, general expense and 15% annual depreciation on the building and equipment averaged 15.6% of the pay roll but at other seasons will probably be higher so it is assumed to be 20%.

Table II—Cost of Laying Block

Bldg. No.	Sq. Ft. 12-in. Wall	Equivalent Number 12-in. Block	Sq. Ft. 16-in. Wall	Equivalent Number 16-in. Block	Sq. Ft. 2-lug Block Wall	Equivalent Number of 2-lug Block	Total Number of Block All Sizes	Total Cost of Laying Block	Average Cost of Laying Block
1	688	916	......	......	1,242	829	1,745	$ 275.08	.157
2	3,270	4,350	......	......	2,150	1,434	5,784	739.57	.128
3	840	1,119	......	......	......	......	1,119	126.06	.106
4	3,687	4,910	3,330	4,440	......	......	9,350	1,095.92	.117
5	162	216	......	......	669	446	662	65.11	.098
6	1,146	1,524	8,913	11,900	......	......	13,424	1,088.83	.081
Totals	9,793	13,035	12,243	16,340	4,061	2,709	32,084	$3,390.57	.107

Table II shows number of sq. ft. of 12-in., 16-in. and 2-lug block walls, deducting for all openings and the equivalent number of whole block. The buildings are listed in the order in which work was started on them; cost of laying the block is being reduced as the men become more experienced with the system. In building No. 5 nearly all the block used are 16-in. wall block which are 60% heavier than 12-in. wall block and yet the cost of laying these block has been lower than that of any other building. Since this table was made up block have been laid for as little as $.05 apiece. Masons are all paid the union scale of $.70 per hr. and tenders are paid $.375 per hr. In comparing these costs with what contractors have figured for the same work, it is found that they are approximately 1/3 to ½ less than what they figured it would cost them. The average cost of laying in all buildings has been $.12 and it is assumed that this is the average cost in making comparisons with other materials. In reality costs are now less than $.08 per block for 16-in. walls and about $.06 for 12-in. walls.

Plant No. 9*

This factory is entirely different from any other described in this chapter. It makes block by the wet process using a slush mixture containing an excess of water and employing dry steam heat in curing.

The gravel comes into the plant by rail, and ordinarily when the plant is in full operation it is arranged to have cars of gravel at such times as to make it necessary to handle the gravel once only. It is unloaded into the back part of the building in the space marked "Gravel Storage." Over this space from a door leading out to the railroad track is a runway for the movement of two-wheeled carts which hold approximately 6 cu. ft. of material. The cement is piled up in bags in the space to the right of the mixer and in front of the raised runway where the gravel is handled. A bag of cement is put on the top of the cart of gravel and conveyed to the loading end of the mixer, which is toward the back of the plant, two men handling all the gravel and the cement to the mixer. The mix used is 1:5½. The mixer is a batch machine, and the mixture is soupy wet. The batch is run out from the mixer through a chute into the molds which are mounted 20 on a car, which when brought in from the transfer track is shoved back under the mixer, so that the chute first fills the molds farthest from the mixer. The cars are gradually moved forward until all the molds are filled. The concrete is roughly leveled off, the car moved from the transfer track, and shoved either to the right or the left out through a wide sliding doorway into the yard. The car is then shoved over the transfer tra

*Data as of 1914

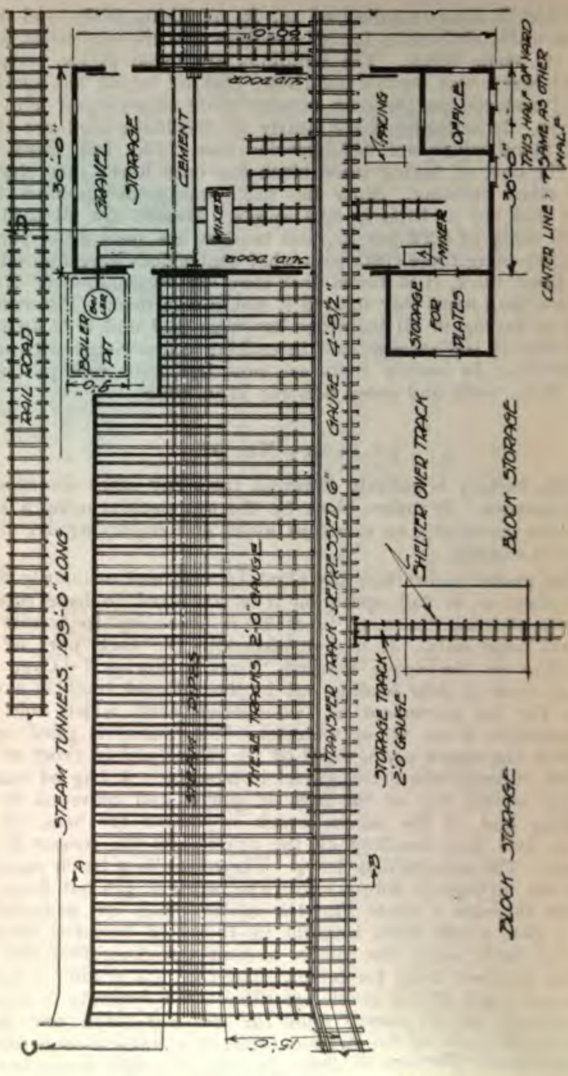


FIG. 121—PLAN OF PLANT NO. 9

to one of the tracks which extend into the low curing chambers. The cars are left exposed for about an hour, and then the block are slightly troweled off and shoved into a steam room.

Steam Tunnels—As shown in the plans, there is steam room capacity for about 2,000 block. Each tunnel accommodates two cars. On the opposite side of the plant not shown in the plan the arrangement is the same except that each steam tunnel will hold but one car. These steam tunnels are built of monolithic concrete, and under them is a bank of steam pipes (10 pipes) communicating with a 30-h.p. boiler. The intention, both summer and winter, is to keep the steam tunnels at a temperature of approximately 100° F. This is done with very little, and sometimes no steam heat in the hot summer weather. Steam supply is from a 30-h.p. boiler. There is no attempt to make the atmosphere of these tunnels moist, as is the case with curing rooms designed to take care of block made with less water.

Inasmuch as the front of each steam tunnel is built on a slant, a wooden batten is laid up against the front of each tunnel after the car has been put in and these covers are held fairly tight by means of wooden buttons.

The tunnels are all numbered, and as the output of the plant is gauged by the capacity of the tunnels, it is possible to arrange the work so that a car put in the tunnel at say 10 a. m. is removed from the tunnel at about 9 a. m. the day following.

Unloading and Resetting—The wedge pieces of metal which hold the cores in the gang mold are then removed and the cores at once collapse, and are removed; then the division plates in the molds are taken out and the block removed from car are piled in the yard. At this stage in their curing they have to be handled with reasonable care to prevent breakage. Over the storage track in the block storage yard and also over a like track on the other side of the plant, is a shelter, consisting merely of a roof and no side walls. The car is shoved under this shelter after the removal of the molds and after the block have been piled in the yard the car is brought back to this shed for cleaning, oiling and resetting the plates which form the molds. This car, now empty and ready for refilling, is shoved over the transfer track and into the factory and back over the small track to the mixer from which it started about 24 hrs. previous. Two men, with practice, can unload, clean and reset about 30 cars in a 10-hr. day.

Faced Block—A slightly different course is followed in the manufacture of granite faced and sand faced block. In the factory space, marked "Facing," the face plates are made ready for the granite-faced block. Two men do this work, one coating the plates with glue of a thick consistency, and passing them to the other operator in this department. The second man puts a plate into a frame which is mounted on axle turned by a crank and connected by means of gears with a wide, shallow box under the frame. This box is divided in the center by a partition which is directly under the axle. On one side of the box is a supply of No. 3½ crushed granite, and on the other side a supply of No. 5. The operator first sprinkles the coarser crushed granite over the glue-coated face plate and then by turning a crank, tips the surplus back into the side of the box where it belongs, the box moving under the plate to receive what falls off. He then sprinkles a quantity of fine granite onto the plate, thus covering all of the surface of the plate, and the frame is then tipped in the opposite direction, the box moving to receive the surplus which falls off. It is a very simple device, operates easily and always comes back to the center; thus the face plates are kept upright, due to the heavy weight on the axle. When the face plate has been covered with granite it is put onto a rack, which is in reality a series of shelves very close together and designed to accommodate something more than three hours' supply of plates, it being considered advisable to leave the plates for about three hours, in which time the glue is allowed to set and hold the granite firmly.

As to the facility with which this work can be handled, two men being timed (and when they knew they were being timed), applied glue and granite to four face plates per min., and on another occasion (when the men were not aware of the fact that they were timed), they turned out two and a half plates per min., so this is considered nearer their regular gait. The wetness of the concrete with which this granite facing is backed up softens the glue so that when block are removed from the steam tunnels they come away from the plates very easily, and come clean, and the resulting surface is such that it requires no cleaning.

"Setting Up" for Special Block—Opposite the space where the granite facing is applied to the plates is a track to accommodate a car while the molds in which specially faced block are to be made are set up. All the molds for these specially faced block are set up in this building rather than out in the yard, as is the case with the molds for the plain block. Two men do all this setting up for the special work. Close against the wall on the left side of this front portion of the building is a small batch mixer used for facing material. In this, cement and sand, in the proportions of 1:2, for the exposed portions of the sand-faced block, are mixed.

In the space marked "Storage for Plates," extra division plates, cores and face plates are kept, and also reinforcing material used in sills, lintels, etc.

After the glue, with the granite facing, has set for three hours and the plates are set up in the molds on the car, the men who handle this facing material throw into each mold a

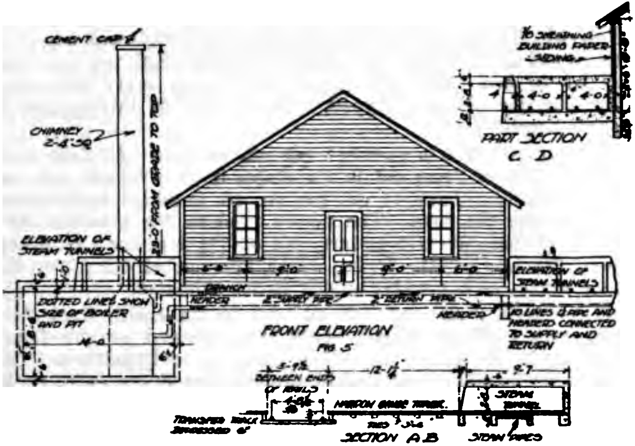


FIG. 122—ELEVATION AND SECTION VIEWS, PLANT NO. 9

small dipperful of cement and water in a creamy mixture to give all the particles of the granite facing a thorough bond with the concrete backing. This mixture, after being thrown on from a dipper, is brushed in, to be sure that it penetrates everywhere. The car with the face plates so treated is then moved forward to the transfer track and up in front of the mixer where the concrete is put in, in slushy consistency, just as for plain block.

The sand-cement facing material used for the rock-face block is put into the molds about ½″ deep, thoroughly tamped, (a rather dry mixture is used) this operation being done by the same two men who set up molds for the granite-faced work.

Labor—The 17 men in the plant are employed as follows: Two men feeding mixer and handling gravel and cement; one running the mixer and filling molds; two applying glue and granite to face plates for granite faced block; two men setting up cars and molds and handling the facing mixture for the sand-faced work, and applying neat cement on the plates, for the granite-faced block; 10 are employed in moving cars to yards and to steam tunnels, removing cars from tunnels, piling up block, oiling and resetting the molds. One of these 10 men devotes a part of his time to the boiler, which is used only to supply steam for heat, this of course including the steam tunnels. The man who runs the mixer and fills the molds at the mixer is paid $3.50 a day. All the other employees receive $2.75 a day each. This is rather more than the regular price for common labor in the district, but by adopting this scale of wages,

the plant is able to
of service. The 17
The record of the
day of 10 hrs.
ployed in the plant
granite-faced.

The gravel which is
quality, shipped from
yd. on the siding,
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nished by three
one of 3½ h.p. for
water pump, as city

Plain block, 8"x8"
block with sand
block at 25 cts. each.
largest blocks, 8"x12"
face at 31 cts., and
company has had
apiece for the granite
ture them at much
the extra cost to turn
only about 2 cts. One
faces about 150 block.

Rock-Face Block—
ing to the manufactur
the advantage of rock
block which have a
different plates are
car which goes to the
The result is that the
variety and each car of
and piled in the yard
in making a shipment
a selection from a
always the same variety
the same number of
designs being thus mixed
to the time they are
continue the variety in
result is an absence of

This factory is designed
stone; a line of large
standards, lighting posts
ordinary plain variety, and

*Data as of 1914

and roofing tile; structural tile, fence posts and curb, curb and gutter units, and concrete brick.

The Building—These departments are housed in a structure the outside dimensions of which are 289′ in length and 220′ in width. The frame of the building is reinforced concrete with roof framing of steel. The walls are of concrete block and special dimension stone built with a continuous air space. The first floor plan of the building does not include the power house, which is a building 120′x40′. The main walls are faced with a buff colored concrete stone, most of it manufactured in a temporary plant near the site of the new factory; the roof is to be covered with concrete tile made in the factory.

It will be noted on the floor plan that the main front portion of the building (facing south) describes a wide letter "U," the administration wing on the east side and the pattern room and modeling department in the other wing, each wing approximately 43′x60′.

On the first floor of the administration wing are the general offices, private office of the manager, toilet and coat rooms, and display room. On the second floor are the drafting rooms, a library, private office of the head draftsman, a blue printing department equipped with blue printing apparatus and a laboratory.

In the west wing, the lower floor contains the pattern department for turning out special molds. It is equipped with a woodworking machine. Clay modeling and plaster work are provided for on the second floor of this wing.

Back of these two wings is the main molding room of the factory. This main room is approximately 220′ wide and 93′ deep on the west side and 61′ 6″ on the east, and extends the full height of the structure. In the center of this room on the broad front side is the foreman's office, glassed in. At the second floor level, extending entirely around this portion of the building, is a balcony 4′ wide supported by steel brackets. This balcony supplies an easy means of communication between the drafting room and the modeling room at the front, and between each of these and the other parts of the factory, thus avoiding the necessity of going downstairs and up again on the opposite side.

Block Department—In the central portion of the large room are the block machines: two machines operated under automatic tamping equipment and three machines for hand-tamped fractional block, and pieces of odd dimensions; the automatic tampers operate on standard size block work only. On the other side of this central portion, space has been provided for five other machines: one chimney block machine; a brick machine; sill and lintel machine; a roofing tile machine; the other space filled as occasion demands. (This plant is not fully under operation at the time this is written.) These

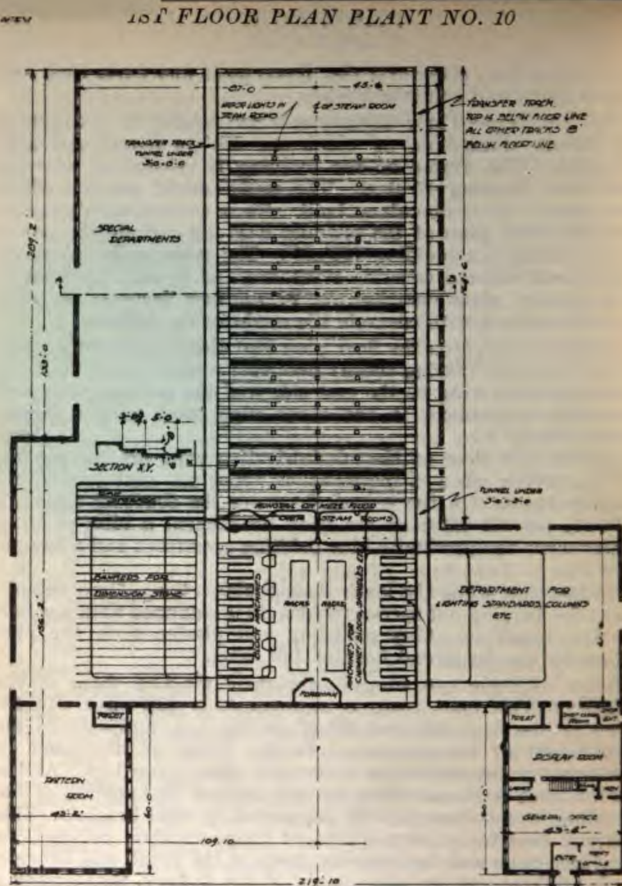


FIG. 123—FIRST FLOOR PLAN, PLANT NO. 10

two rows of five machines each (as the equipment will stand when all of it is installed) are in lines from the back to the front of the building, and between them in a space of about 35′ wide and 61′ 6″ deep are racks on which will be placed all of the pallets and special insert molds to be used on various machines in the course of a day's run. The operators of each machine will have to step back only a few feet to get everything they need in their work. Provision has been made in *the track layout* so that two 4-deck cars in a special design for

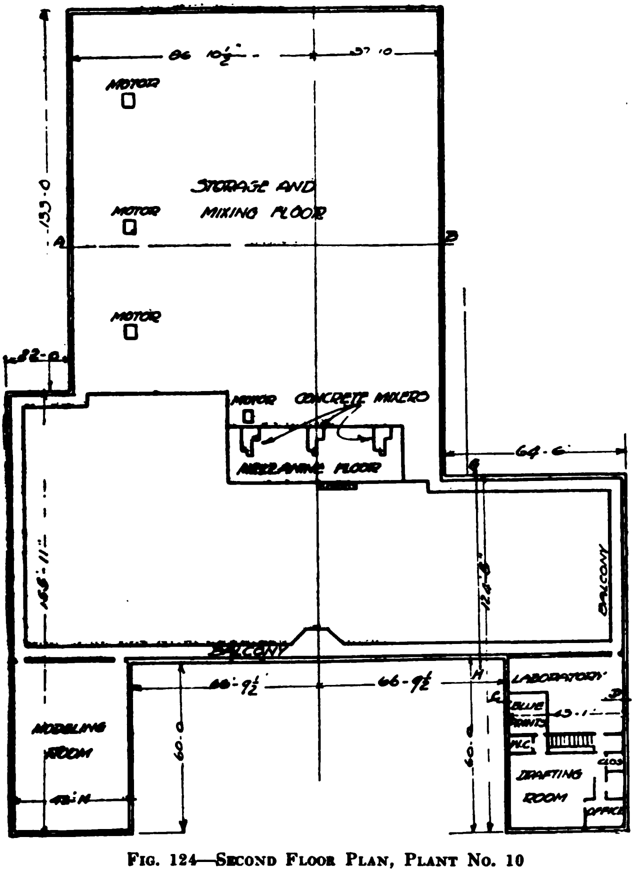


FIG. 124—SECOND FLOOR PLAN, PLANT NO. 10

extra strength will stand at each machine so that the operators will not have to wait for the return of a car to take the place of one which has been sent to the steam rooms. Cars constructed of galvanized metal are to be used in handling special stone so that it will not be in danger of damage by rust spots. The construction of the car pits and the track levels is shown in *section X-Y on the* main floor plan. The rails are flush with *the pit levels with no* projection above the concrete floor of the *pit.*

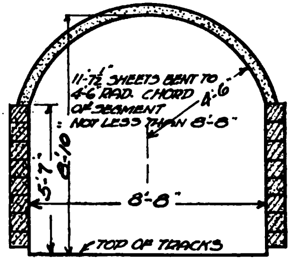
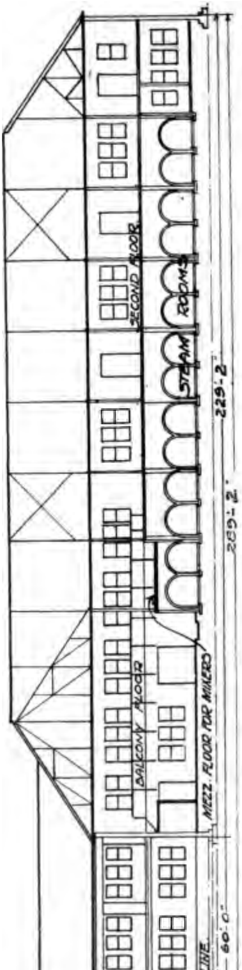


Fig. 126—Section, Steam Curing Room, Plant No. 10

Dimension Stone—On the side of the main portion of the building immediately back of the pattern room and modeling department are the bankers for special dimension stone manufacture. These bankers are supported by sections of pipe screwed into flanges embedded in the concrete floor, so that as occasion may demand, the bankers can be taken out and put in again as more or less floor or banker space is required. Pipe sections will simply be unscrewed from the flanges and taken out together with the rails which they support, leaving no obstruction on the floor. The bankers stand 26" high. This particular department is regarded as the most important and is the largest of the plant, as the demand for special stone far exceeds that for standard concrete block. The arrangement of tracks for cars is shown on the plan. For handling extra heavy pieces, a portable crane of special design will be installed for lifting anything up to five tons in weight.



. 125—Sectional Eleva-
v, Plant No. 10

On the opposite side of this main portion of the building, and occupying the same relative position as the dimension stone department, is the casting floor for columns, lighting standards and such work of considerable height, most of which is cured in place. For this work, the plant will produce its own molds from its own special designs which it will carry in stock, and in addition will be prepared to meet the most exacting demands of architects for original designs.

Mixers—Back of this main portion of the building, the structure consists of two stories, and in the central part at the front is a mezzanine floor 3′ 4″ below the level of the second floor (see longitudinal section) on which will be located the battery of 3 mixers of continuous type for mixing body concrete, and 4 small batch mixers for the facing materials.

Special Departments—At the side of the building in the rear of the dimension stone department are the special departments, and from front to back they run as follows: fence posts, occupying two bay widths; concrete brick, to occupy one bay width; concrete structural tile, and concrete curb and curb and gutter sections, using special steel molds two bay widths at the rear. The same transfer track which serves the dimension stone department and one-half of the block department also serves the special departments in the rear. The structural tile machine is served by a circular track so that cars being loaded are sent clear around the machine and back to the transfer. been struck off by the operation of the blades of the machine. This mixed concrete, while still wet and in good condition, is lifted from the pit by the conveyor and deposited in a pile convenient to the curb department, to be used up immediately in making curb stone. The curbing is cast with an edge protection of angle irons bent to a 2-in. radius with lug every 8″. A very wet mix is specified and density secured by the use of pneumatic hammers tapping against the metal molds. The molds are filled while in position on cars and after standing for 24 hrs. are shoved out into the yard, the curb being turned over lightly into stock piles and the molds removed. The curb department is equipped to turn out 600′ of curbing with protected edge, and 200′ of combination curb and gutter, per da.

Material Handling—The handling of the raw materials is almost entirely by belt conveyors, and the progress of the gravel from the time it leaves the bank is outlined as follows:

Gravel is taken out of the bank by a steam shovel, using a dipper of ¾-yd. capacity and placed on 4-yd. dump cars, of which 12 will be used. These are hauled to the receiving hopper by a locomotive of 36-in. gauge. Cars come in on a trestle to the hopper and dump to an 18-in. rubber belt which conveys the material to a bar grizzly, which rejects sizes larger than 2½″. The larger material passes through a crusher having a capacity of 25 tons per hr. From the crusher the material drops to an 18-in. rubber belt, 225′ long, meeting the material which has already passed the grizzly, and is raised to the top of the washer. Here it drops into a hopper and meets a 5-in. stream of water. The water and silt are carri away to near by swamp lands and the gravel proceeds through a series of separators and is dropped into bins in five sizes, as follows: 1" to 2½"; ½" to 1"; ¼" to ½"; ⅛" and passing ¼"; and fine sand. The capacity of the plant is 10 carloads per da.

The products plant gets its supply from the bottom of the bins, taking that portion of the contents which cannot be emptied through the chutes by which the railway cars are loaded. Under the bin is a circular roofed tunnel with four gates to each bin. The gates are controlled by hand and by their means the character of the material to be sent to the mixers is controlled. From the gates the material drops to a belt conveyor and is carried just outside the range of the bins; lifted by a bucket elevator to a height of 27′ to be deposited on a belt conveyor and taken through an enclosed passageway on a steel bridge to an opening in the roof of the products plant. Other belt conveyors pass the material along to a point above and just behind the mezzanine floor, where the mixers are located which serve the main molding room of the factory. Over each mixer is an extra large hopper to receive the material from the belt conveying equipment, the supply being regulated by the man in charge of the mixer. This belt runs across the building. Another belt operating longitudinally on the second floor of the factory takes the gravel near its entrance to the building and conveys it to three mixers on the second floor, these mixers supplying the material for the fence post, structural tile, and the curb departments.

Cement comes into the building in bags. A trestle to be built on the left side of the structure will bring the floors of the railway cars up to the level of the second floor of the building, and unloading of the bags of cement will be done by means of gravity carriers operating in several directions, governed by the requirements of the two lines of mixers and the condition of various stock piles.

Aside from the space occupied by the mixers and the conveyors on the second floor, this floor provides large storage area for a general line of building materials with which to serve the local market, and when cement is not required at any of the mixers it will be stored on the second floor as it will be rapidly placed wherever wanted by means of the portable units of the gravity carriers. So far as the mixers on the mezzanine floor are concerned, very little lifting of the cement will be required, as the hoppers come only a little way above the second floor level, and a power lift will bring the bags from the car levels to the starting place of the carriers.

Conveying Mixed Concrete—The plan calls for conveying the mixed concrete to the fence post, structural tile, curb stone and brick departments through chutes to the lower floor. The dimension stone and the block departments and all the main front portion of the building will be supplied with concrete by means of bottom dump buckets of 8 cu. ft. capacity operated and controlled by electricity on a mono-rail system by means of which the buckets will be conveyed from immediately under the spouts of the mixers out over the mezzanine floor and over the various lines of mono-rail to the different molding equipment. Each machine is provided with a hopper for about 10 cu. ft. of material. Any operator wanting concrete will bring a bucket to his hopper simply by turning an electric switch. The bucket is then to go back to the main track and to be returned around the loop to the mixers. This mono-rail system is indicated on the first floor plan by a heavy line.

Power Supply—Electric power is generated in the company's own plant. Water supply is obtained from the company's own wells, employing two 750-gal.-per-min. pumps. The gravel washing plant requires 500 gals. per min. The needs of the factory are taken care of by the rest of the supply of 250 gals. per min. furnished by one of the pumping units. The other pump is used as a relay only to avoid shutdowns in case of accident. Steam for heating and curing is supplied by a 150-h.p. boiler.

In the power building besides the equipment already mentioned, there is a machine shop occupying a space 40'x30'. This is equipped with a lathe and a shaper, with pipe cutting equipment and forge. Its equipment also includes an air compressor.

Over the machine shop, and communicating by a bridge with the second floor of the factory proper, is the tool room.

Steam and Water Pipes—Water and steam pipes from the factory are laid in concrete tunnels 3' high and 3' wide, these tunnels extending the full length of the building from back to front under the two main transfer tracks. They are readily accessible when repairs are necessary, as the tunnels are covered by concrete slabs, every fifth slab being loose so that it may be lifted by means of iron rings. In addition to the tunnels under the transfer tracks, there is also a tunnel extending across the main front of the building inside, with branches under the administration wing and under the pattern shop. Sanitary drinking fountains have been installed at intervals of about 50 ft. all around the plant walls inside.

The supply of steam for the curing rooms comes through 2-in. pipes in the tunnels across the front of the curing chambers. There are three lines of ¾-in. pipe to supply steam in each chamber. One is down in the center and one is on each side. These pipes have ⅛-in. openings every 18", so drilled that the pipes at the sides of the curing chambers shoot the steam upward and toward the center at an angle of about 45° and the one in the center sends the steam straight up.

The doors of the curing rooms are of wood made double, of matched lumber, and although they have been thoroughly painted it is feared that these doors will not give satisfaction.

being dry on one side and steam soaked on the other. The doors slide up and down, balanced by concrete counterweights.

The entire building inside is light and airy and the concrete block walls are whitewashed, using glue and linseed oil so it would not rub off. The floors, of concrete throughout the factory, have a rough float finish, the top course being made with a coarse, sharp sand.

Polishing equipment will be installed for stone requiring special finish. Part of the equipment for this work will be an electric polishing machine for flat or open surface with a small electric cove polisher for fine detail work.

The power equipment of the factory is driven by individual electric motors and a partial list, as to horse power, is as follows:

For the gravel washing plant: One of 30 h.p. for the crusher and the belt from the receiving hopper and one of 25 h.p. for the 225-ft. belt to the top of the washer. For the three continuous mixers on the second floor, one 5-h.p. motor each and for the three continuous mixers on the mezzanine floor, one 5-h.p. motor each. For the four batch mixers for facing materials on the mezzanine floor one 2-h.p. motor each. For the two power tampers over block machines, one 5-h.p. motor each. For the structural tile machine, one 5-h.p. motor, and for the belt conveyor under this machine, a 1½-h.p. motor. The woodworking machine, a 5-h.p. motor.

Plant No. 11*

This plant manufactures trim stone, using a mixture which is tamped into special molds—most of them wood. The work differs from that in all other plants described in this chapter in the fact that while making a tamped stone for trim and ornamental work, it uses but one mixture throughout the product and practically all products are tooled when hard.

The factory building is 100′ x 150′ in plan, two stories high, with considerable waste space on the second floor, although a large area is used for the storage of special wood molds.

Wood Molds—There is a large wood-working department equipped with the following power machinery: 1 circular saw; 1 band saw; 1 planer; 1 jointer; 1 variety machine, the last named being used for making moldings. With it much work is done with wood in making molds for which other plants usually use plaster. When the factory is in full operation seven men to eight men are employed in this department, while at such times the entire plant employs about 60 men in all departments.

Materials—Aggregates used consist of crushed limestone and crushed granite, the latter in two colors, gray and white, and each color in two sizes, the larger size passing a ½-in. screen and the smaller, so called "buckwheat," running from

*Data as of 1914

about ⅛″ to flour. Granite and limestone are mixed in about equal proportions for all stone, and either gray or white granite is used, depending upon the color desired. These materials are kept in bins with open fronts at the rear of the second floor. In front of the bins, which are ranged against the back wall of the building, runs a track with a car to contain the ingredients for each batch. Aggregates are measured by volume and cement by weight. To each batch is added hydrated lime to the extent of 15% of the weight of the cement. An integral waterproofing is also used equal to 1% of the weight of the cement.

Mixing—The materials are mixed dry in a mixer of the cylindrical drum type and are dumped through a chute to a continuous mixer on the first floor. Here the mixing is continued and the water added. Due to the hydrated lime and to the rather high percentage of fine material, a higher percentage of water is used in mixing than can ordinarily be handled in tamped work. The concrete is taken from the mixer in wheelbarrows and conveyed to the molds, which cover a large shop area. While the concrete is being deposited in the molds a little at a time, 15-lb. tamps are used to compact it.

Curing—Most of the work remains in the molds a day. Small pieces of such shape as to be handled on pallets without danger of breaking are removed after a few hours and remain on the floor where removed from the mold. This room is large—about 100′x125′. Products are sprinkled from a fine spray nozzle, water connection being provided on every column —10′ each way over the entire floor area. An employee is on duty all night to attend to this spraying. After thorough sprinkling for four days, products are allowed to become partially dry. They are watched carefully. If they dry out evenly all over their surface, the drying is permitted to continue, but if the drying is in spots, sprinkling is resumed.

Finishing—Nearly all products are tooled, either by hand, by stone cutters, or with pneumatic tools operated by a small compressor outfit, mounted on wheels for easy moving from one part of the factory to another. While the particular compressor equipment in use was not of large enough capacity for the work required of it, it showed a great saving over hand work, one man finishing 70 sq. ft. of work in a day as compared with 30 sq. ft. by hand tooling methods. When tooled and well cured, products are painted with a colorless waterproofing preparation. If the work is of a nature which requires unusually low absorption it is given two or three coats of a solution of silicate of soda (water glass), each application being allowed to dry before another treatment. When dry, the products is coated with the waterproofing.

The products of this company, for building purposes, sell *at 90 cts. to $1.00* per cu. ft. for plain work.

Index

An asterisk (*) indicates that the subject is treated under a special heading and in general indicates the principal reference to that subject. *Ex* indicates that the subject is treated in Chapter 10 as a part of the description of a particular factory. Chapter 10 is supplemental to all the preceding nine chapters and describes actual operation which may or may not be ideal in every particular.

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