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CEMENT AND CONCRETE FENCE POSTS

BY

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MATERIALS USED IN CONSTRUCTING CEMENT AND CONCRETE FENCE POSTS*

By H. M. BAINER and H. B. BONEBRIGHT

PART I.

GENERAL STATEMENTS

Cement.—In cement fence post construction, it is desirable that the post be made as light and as strong as possible, and thus it is practical to use nothing but the best grade of Portland cement.

Sand.—Clean, sharp sand with grains varying in size from small to large makes the best mixture. Sharp sand is composed of sharp, angular grains of all sizes and makes a better mixture than that which is smooth and round, or "river-worn."

A sand composed of fine and coarse grains mixed, is to be preferred, because less cement will be required to fill the voids than either used by itself.

Leaves, sticks, stones or gravel should be removed by screening.

Gravel.— The same general rules used in the selection of a good grade of sand will apply to gravel. It should be composed of clean, sharp pebbles of all sizes. For post construction, the pebbles must not be too large, as they will interfere with the proper placement of reinforcement.

Broken Stone.—Broken stone used for post construction must contain no large pieces as they will interfere with the placement of the reinforcement. It is necessary to use some sand with the stone to fill voids and thus save cement. It is not desirable to use soft sandstone, soft limestone, slates, or shales. Granites, hard limestones, and coarse gravel, which has been crushed, is considered best.

Water.—The water used in making a cement or concrete mixture should be clean and free from alkali or acids.

Proportions.—On account of the difference in the total open space or voids in sands or gravel composed of different sized particles and also that more cement is required in some conditions than in others, it is often necessary to make a rough determination of the percentage of voids to the total aggregate. Where maximum strength is required about 10 per cent. more cement should be used than the total voids.

The determination may be made as follows: Secure a water-tight box or pail of known capacity, fill it with the aggregate to be used so that when it has been well shaken it will smooth off even

* This bulletin is an abbreviated edition of Bulletin No. 148 of June, 1909. A large part of the details of the tests have been omitted, but all the important results are summed up in the tables here presented.

at the top. Pour water of known amount into this until full. The volume of water used in proportion to the total volume of the receptacle determines the total voids.

The proportions used in the constructions of the fence posts in this bulletin varied from 1 part cement and 3 parts of sand to 1 part of cement and 5 parts sand. In others, gravel was used in the proportion of 1 part cement, 3 parts sand, and 3 parts gravel. It is a difficult matter to use broken stone or gravel in large quantity and place the reinforcement properly.

Measure all materials in correct proportions. This may be done with a shovel, a pail, wheelbarrow, or barrel. It will usually be advantageous to measure the water, especially where small quantities are mixed or where the same amount of mixture is made several times.

Mixing.—Where the mixing is done by hand, a flat, water-tight platform, or shallow box is convenient. Measure the sand and place it in a uniform layer and over this spread the proper amount of cement. Mix this thoroughly before adding water until it shows a uniform color. The rule is to shovel it over at least three times. Now spread out the mixture, making a sort of basin in the middle into which the greater part of the water may be poured. Work in the dry edges until the water disappears, then add enough more water in small amounts to make the mixture of the desired consistency. Do not mix more material than can be used in twenty minutes.

Poured Posts.—There are two general classes of mixtures which may be used in the construction of posts; the poured and the tamped. In the poured mixture, enough water is used in mixing to make it thin enough to pour from a pail or scoop almost like water. The mixture is poured into a mold and allowed to remain in it until it has set, which is from one to five days, depending upon the time of year and the weather. In drying summer weather, from one to two days is usually sufficient. In cool or damp weather, they must be left in the molds much longer.

In order to make several posts of the poured type at once, it is necessary to have several molds ready for use. With 6 molds only 6 posts could be made at once, and it would be necessary to wait until the cement was set before 6 more could be made.

It was found that to make a good poured post, the mixture should be stirred or shaken immediately after placing in the mold. This should be done carefully to prevent displacement of reinforcement wires. This helps to remove the air from the mixture and makes a post of smooth finish.

The experiment showed that a poured post of a certain mixture was stronger than a tamped post of the same mixture. It is enough stronger to justify anyone in constructing it in preference to the tamped one at the necessary additional expense for molds. The poured post is smoother, more nearly impervious to water, not so hard to cure, stronger, somewhat more expensive, and can be better recommended than the tamped one.

Tamped Posts.—The tamped post is one in which the mixture contains very much less water than the poured one. It contains just enough water to make it hold together well when tamped. In the manufacturing of this type of post, only one mold is necessary. The mixture is tamped into it, and the sides of the mold can be removed immediately, the post remaining on the bottom piece until the cement has set. Thus the same mold can be continuously used for making as many posts as are desired. The necessity for but one mold makes this type of post less expensive than the poured one. The results of the test made, show that the tamped post is inferior to the poured one and cannot be placed in an equal class with it.

On account of less water being used in the mixture for a tamped post than in the mixture for a poured one, the tamped post requires more water and attention in curing. It is of more open texture, less impervious to water, not as strong, and not as desirable as the post of the poured type.

Molds For Tamped Posts.—In this class of molds we find mostly the heavy cast-iron forms which are built of strong and heavy material. The most of these molds are designed to be laid upon pallettes or upon a smooth floor. The mixture is first tamped into the mold to a depth of about one inch. The reinforcement is then placed and the mold is next filled, and the mixture tamped, so that only about one inch of material remains to be filled in. The second set of reinforcement wires is put in place next and the mold is tamped full to overflowing. The last step consists in smoothing off the top of the post with a trowel and removing the mold. This is done by unfastening some form of hook or clasp, slipping the sides of the mold a little distance away from the post, and then removing the molds to the position chosen for the next post.

The principal advantage of these molds lies in the fact that they being made of heavy iron need no center stays. This gives greater speed in operation, due to the fact that there are no cross pieces to interfere with the placing of the reinforcement, the tamping of the mixture, and the smoothing off of the top of the post at the finish.

Molds For Poured Posts.—The more common forms are made of sheet iron, either galvanized or plain. For posts having a continual taper from top to bottom, sheet iron molds prove very satisfactory, providing sufficiently heavy material is used in their construction.

The advantages of the sheet iron mold are many. They are light to handle and easy to keep clean. If properly made they are nearly water tight. This insures the user against the possible loss of cement by leakage. Another marked advantage of the sheet-iron mold is that the surface being smooth, imparts a very smooth,

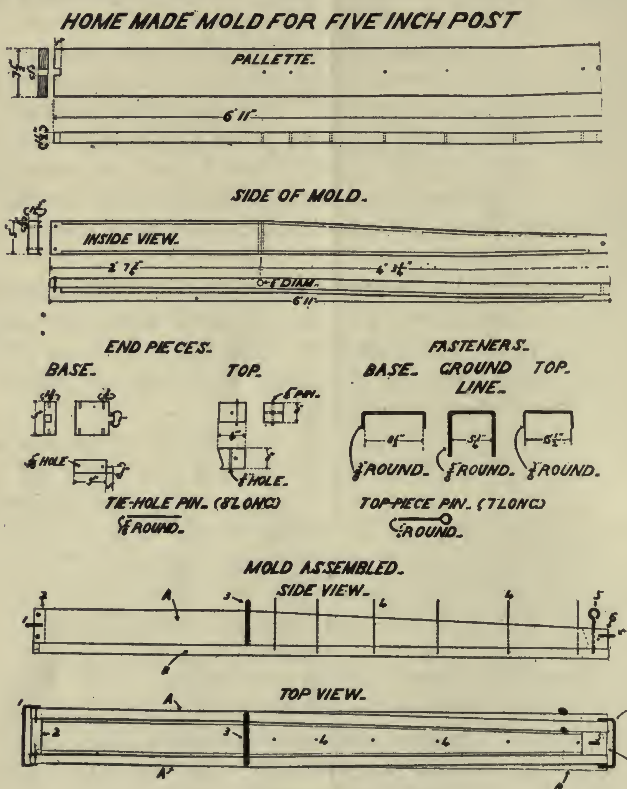

Figure I.

A Home Made Mold Giving the Proper Shape to the Post.—1. Base fastener. 2. Base end piece. 3. Ground line fastener. 4. 4, etc. Tie hole pins. 5. Top piece pin. 6. Top end piece. 7. Top fastener. A. Side of mold. B. Pallette.

glossy finish to the surface of the post. This not only adds beauty to the post, but aids in keeping out water, which might otherwise enter the cured post.

As the sheet-iron molds are made in one piece, no pallette is necessary. In hot weather the post may be removed after 48 hours, but in cold weather a much longer time is required.

In making poured posts in these molds exactly the same process is followed as with tamped posts in molds of the first class just described; with the exception that the mixture is not tamped and greater care must be exercised in preventing the reinforcement from being misplaced.

Some forms of wood molds are made and used for the purpose of making poured posts only. Any desired form may be given to the post by properly shaping the mold. This point, in favor of the wood mold, is an extremely important one, as it permits the post to be made of uniform size from the bottom to the ground line, but with a rapid taper from this point to the top. Then too, the sides of the mold may be removed after 24 hours and used again in connection with other pallettes; while the post which has not yet become sufficiently strong to be removed from the pallette lies unmolested in its original place until it is ready to move.

Molds which may be used for making either the tamped or the poured posts are much the same as the wooden molds for poured posts, except that they are stronger. The heavy, cast-iron molds could be used in making the poured posts as well as the tamped ones, but their original cost make them impracticable. The wooden molds serve the purpose equally well and are much cheaper.

Selecting the Mold.—The most important point to be considered in selecting the mold is the *shape and size* of it. Next to the shape and size we should look for ease of operation. The simple mold almost always proves to be the best, providing it has sufficient strength.

Care of Molds.—Before the molds are used they should be well coated with some kind of heavy oil. Crude petroleum is perhaps the best and cheapest material for this purpose. In case the petroleum cannot be obtained, a good oily mixture may be made by stirring about two pounds of axle grease into a gallon of gasoline. This mixture is applied to the molds with a brush. The gasoline evaporates, leaving a thin coat of axle grease spread over the entire surface of the mold. This oily mixture should be applied to the outside as well as the inside of the mold, which makes it impossible for any of the material to cling to it. With the iron molds, the oil prevents rusting. In case the molds are made of wood, the oil helps to keep out the moisture, thus preventing shrinking and swelling, and also making them easier to keep clean.

As soon as the mold is removed from the post all material sticking to it should be scraped off and the inside surface covered with a thin coating of oil. Great care should be taken not to allow the molds to become bruised or dented. If the molds are not to be used for a time, they should be thoroughly scraped and oiled, inside and out, and carefully laid away.

Reinforcement.—Cement and concrete work has the property of resisting great, crushing stresses, but when subjected to tensile stress the best of it breaks very easily. For this reason it becomes necessary to put some material possessing great tensile strength into the post, in order that the full crushing strength of the cement or concrete may be utilized. Iron is the most satisfactory material from which to make reinforcement. The reinforcement should be placed in the post as near the corner as possible. This places it as far as possible from the neutral axis thus giving it the greatest advantage in strengthening the post. In order that the reinforcements may be properly held and protected by the cement, it is a good plan to place it from ⅜ to ¾ inch in from each side.

The material used for reinforcement should be strong, light and rough enough to permit the mixture to get a firm grip upon it. It should be very rigid, with little or no tendency to spring or stretch. The experiments showed that ordinary iron or steel wire was cheapest, strongest and easiest to procure. In order to provide a means by which the cement may cling firmly to the wire, it is best to twist two small wires together instead of using one large one.

Curing the Posts.—In order for the cement to become thoroughly cured or "set" water must be supplied to aid in the action. For the first thirty days the posts should be kept wet if the best results are to be expected.

The most favorable conditions for conserving the moisture consists in curing the posts in a shed where the wind does not strike them. Under these conditions neither the sun's rays nor the wind have a chance to dry out the posts too rapidly. The posts should be thoroughly sprinkled every day for at least thirty days.

Wire Fasteners.—An inventor has devised a cast-iron socket which is placed in the post. Later the wire is fastened to the post by driving a staple into the socket or staple holder. The staples pull out easily and the sockets add greatly to the cost of the post.

Another system consists of two staples which have the prongs bent to the side. The staples are placed about one-quarter inch apart, with the prongs projecting to the side. The line wire is placed between the two staples and a nail or a piece of wire is driven down through the staples, outside of the line wire. As the tips of the staple touch the reinforcement wires, direct electric connections are established between the line wire and the ground at the bottom of the post. This, it is claimed by the patentee, insures the user against loss of stock by lightning. The system is called the "Double Staple." (See Fig. 2.)

A "single staple" may also be used, but the wire is fastened to the staple by a small "cold shut link," or wire ring. The latter system is not a very strong method of fastening, owing to the ease with which the cold shut links open. (See Fig. 2.)

Perhaps the most common method of fastening wires to cement or concrete posts consists of tying in the line wire to the post by means of a piece of smaller wire called a "tie wire" (usually No. 14 or No. 15 wire). The single tie consists of wrapping one end of the tie wire three or four times around the line wire, then passing the long end through a hole in the post and bringing it around to the face of the post where it is also wrapped around the line wire. (See Fig. 2.)

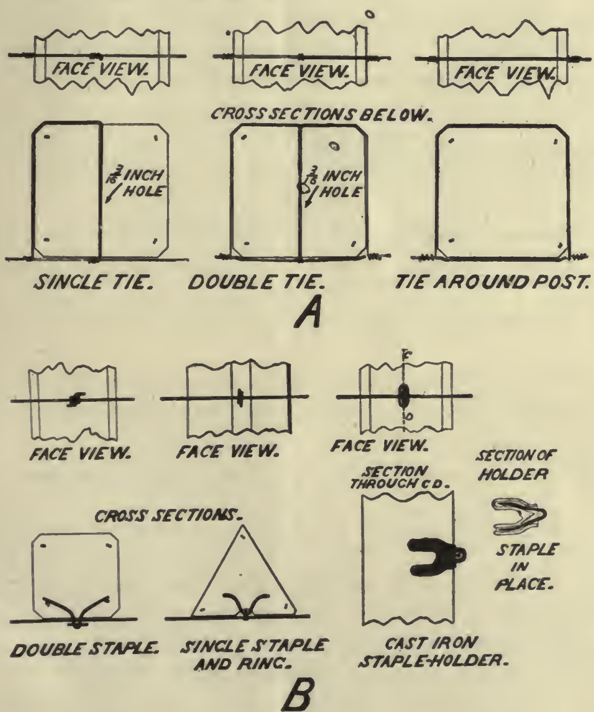

Figure II.

Different Types of Wire Fasteners.—A. Home made fasteners. B. Commercial fasteners.

The tie around post is much the same as the single tie, except that the tie wire passes around the post instead of through the hole. (See Fig. 2.) Neither the single tie or the tie around post are very strong unless the tips of the tie wire are hooked over the body of the tie wire after the wraps have been made. This is known as the "special tie."

The strongest and perhaps the most satisfactory system of tying in the wire is the "double tie." The tie wire is bent into the form of a long staple, straddled over the line wire and both ends passed through a hole in the post. One end is brought to either side and wrapped about the line wire at the face of the post. This system insures a solid fastening and is equal in strength to any ordinary wood post fastening.

The holes in the posts are formed by No. 6 wires being placed in the post while it is soft. These wires are called "Tie Hole Pins." (See Fig. 1.) They are removed from the poured post after the cement has set for 24 hours. The pins are removed from the tamped posts immediately before the molds are removed.

The following table shows the comparative holding strength of various wire fasteners, as determined by the tests:

WIRE FASTENERS (See description of same)	KIND OF POST	No. Lbs. Required to Pull Fastener	REMARKS
Ordinary 1¾ inch staple	New Cedar	425	Average of 3 pulls. Staple was well driven into post.
Single special tie	Cement	520	Average of 2 pulls. Fence wire broke.
Double tie	Cement	510	Average of 2 pulls. Fence wire broke.
Double staple	Cement	245	Average of 3 pulls. Staples pulled.
No. 14 wire plain single tie	Cement	115	Average of 2 pulls. The wire untwisted.
No. 14 wire around post	Cement	110	Average of 3 pulls. The wire untwisted.
Cast staple holder with ordinary 1¾ inch staple driven into it	Cement	85	Ave. of 2 pulls. Staple pulled out of holder.
Cold shut-link in single staple	Cement	83	Link opened in every case. Ave. of 3 pulls.

Taper of Posts.—To obtain the maximum strength with the least amount of material, the cement post must be so shaped as to have its greatest strength at the ground line.

By making the post of uniform size from the base to the ground line, no material is wasted. The post may then be tapered from the ground line to the top. It has been found that in a 5-inch post which projects 4 feet above the ground, a taper of one inch on each side from the ground line to the top, insures almost equal strength throughout. This design gives more strength with less material than those with the continuous taper.

PART II.

THE EXPERIMENTS

These experiments were conducted for the purpose of determining the method of building the best posts at the least cost.

Apparatus.—Various commercial molds of different shapes and construction were secured. In each of these molds several posts were made in order to determine the practicability of the mold; also the best combination of mixtures and reinforcements.

The Farm Mechanics Department designed, built and used a simple home made mold which makes a post of uniform size from the base to the ground line with a rapid taper from the ground line to the top. (See Fig. 1.)

A shed which was closed on all sides with a sliding door on the east was used as the work and curing room.

Materials—The sand and gravel used was clean and sharp, with all sizes of grains varying from small to large. There was a very small percentage of mica in the sand, which was objectionable. One brand of Portland cement was used for making all posts.

A total of 238 line posts and 8 corner posts were built and tested during the experiment, the records of which are found in the following tables:

Cost of Materials.—In figuring cost of materials the following prices were used:

Sand and gravel, \$1.00 per cubic yard.
Cement, 60 cents per sack.
New reinforcement, 4 cents per pound.
Old barbed wire, 2 cents per pound.

The Test.—In making the test, the posts were placed under as near fence conditions as possible. All line posts were set and firmly tamped into the ground so that 4 feet and one inch projected above the surface. By means of a wire, a dynamometer was attached to the post exactly 4 feet from the surface of the ground. A steadily increasing force was applied to the dynamometer by means of a block and tackle, until the first visible crack appeared in the post when a reading was made. The force was then increased until the post gave away completely when the final reading was made.

In making the posts enough of the mixture was provided for the construction of three posts at once. The three were cured alike for 60 days and were tested at the same time. The tables show the average results of the test on the three posts as one.

In the reinforcement the short wires mentioned are two feet long and are placed in the post so the top extends about 12 inches above the ground line and the bottom about 12 inches below. One of these extra wires is placed in the face side of the post and the other in the back, so that they help to bear the strains on the post. In case of four extra wires, one is placed in each corner of the post with the other reinforcement wires.

TABLE NO. 1.—Poured and Tamped Posts.*

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 115 to 120 pounds. Mixture, 1 part cement and 3 parts sand by measure. Cost for cement for posts, 16.2 cents; sand, 3.7 cents. For cost of reinforcement, see table.

REINFORCEMENT			COST	FINAL BREAK			
				Poured Posts		Tamped Posts	
Kind of Wire	Weight per post	Cost per post	Cost of Material in each Post	Pounds to break	Remarks	Pounds to break	Remarks
No. 10, 4 twisted strands of 2 wires	2½	10.0c	29.9c	307	Wires broke	240	Mixture broke, wires did not break
No. 10, 8 strands crimped	2½	10.0c	29.9c	254	Wires slipped and finally broke	263	Wires slipped, did not break
No. 6, 4 long wires hooked at ends	2¾	10.6c	30.5c	232	All wires slipped	184	All wires slipped
New barbed, 4 long strands	1⅝	6.6c	26.5c	188	Wires broke (Post was 130 days old)	123	Wires broke
Old barbed, 4 long strands	1⅝	3.3c	23.2c	158	Wires broke	128	Wires broke
New barbed, 4 long and 2 short	2	8.0c	27.9c			198	Wires broke
Old barbed, 4 long and 2 short	2	4.0c	23.9c	200	Mixture broke above extra wires		
Old barbed, 4 long and 4 short	2¾	5.5c	25.4c	229	Long wires broke above extra wires		
No. 10, twisted 4 long and 2 short	3	12.0c	31.9c	290	Extra wires did no good	160	Extra wires did no good

* This table is a summary of Tables 1 and 2, Bulletin 148, Colo. Exp. Sta.

Amount of Labor Required for Making Posts.—No definite statements can be made as to the amount of time required to make a cement or concrete fence post. The amount of time will vary with conditions, handiness of materials, methods of mixing, etc. According to data obtained in the experiment, two men mixing by hand, with everything reasonably handy, can make from three to five 5-inch poured line posts per hour. Figuring labor at $2.00 per day, ten hours for each man, the cost for making a post would amount to about 10 cents each. Three men with a small home made mixer and a two horse-power gasoline engine for driving it, would be able to make at least twice as many posts as two men working by hand and the cost for making would be very much less.

The Effect of Alkali on Cement and Concrete Posts.—It has been found that some soils contain an excessive amount of alkali, which has a tendency to destroy concrete work. While no experimental work has been done to test the effect of such soils upon cement or concrete posts, it has been conclusively proven that cement drain and sewer tiles which come in contact with water which has percolated through these alkali soils are soon destroyed.

While it might be possible that the action on cement or concrete posts would be slower than in case of the tiles, it is probable that the post would eventually be destroyed.

For further information in regard to the effect of alkali on cement construction see Bulletin No. 69, of the Montana Agricultural Experiment Station, and Bulletin No. 132, Agricultural Experiment Station of the Colorado Agricultural College.

TABLE NO. 2.—Poured and Tamped Posts.*

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 115 to 120 pounds. Mixture, 1 part cement and 3 parts sand, by measure. Cost for cement per post, ~~16.2~~ cents; sand, ~~3.7~~ cents. For cost of reinforcement, see table.

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REINFORCEMENT			COST	FINAL BREAK			
				Poured Posts		Tamped Posts	
Kind of Wire	Weight per Post	Cost per post	Cost of material in each post	Pounds to break	Remarks	Pounds to break	Remarks
No. 10, 4 twisted strands of 2 wires	2½	10.0c	26.9c	222	Mixture broke, wires not well placed	192	Wires broke
No. 6, 4 long wires hooked at ends	2⅔	10.6c	27.5c	222	Wires slipped	162	Wires slipped
No. 10, twisted 4 long and 2 short	3	12.0c	28.9c	322	Mixtures and wires about equal		
Old barbed 4 long strands	1⅔	3.3c	20.2c	95	Wires broke, poorly placed	137	Wires broke
Old barbed, 4 long and 2 short	2	4.0c	20.9c	127	Poor wire. Wires broke	142	Wires broke
New barbed, 4 long and 2 short	2	8.0c	24.9c	172	Wires well placed, cement broke	170	Wires not well placed
Old barbed, 4 long and 4 short	2¾	5.5c	22.4c			196	Wires broke
New barbed, 4 long strands	1⅔	6.6c	23.5c			160	Wires broke

* This table is a summary of Tables 3 and 4, Bulletin 148, Colo. Exp. Sta.

TABLE NO. 3.—Poured and Tamped Posts.*

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 110 to 112 pounds. Mixture, 1 part cement and 5 parts sand, by measure. Cost for cement per post, 17 pounds, 10.2 cents; sand, 1 cubic foot, 3.7 cents. For cost of reinforcement, see table below.

REINFORCEMENT			COST	FINAL BREAK			
				POURED POSTS		TAMPED POSTS	
Kinds of Wire	Weight per Post	Cost per Post	Cost of material in each post	Pounds to break	Remarks	Pounds to break	Remarks
No. 10,4 twisted strands of 2 wires	2½	10.0c	23.9c	235	Mixture broke (poor)	97	Mixture not strong enough
No. 10, twisted 4 long and 2 short	3	12.0c	25.9c	220	Extra wires did no good	98	Posts split. Mixture weak
Old barbed, 4 long strands	1⅔	3.3c	17.2c	113	Wires broke	117	Wires broke
Old barbed, 4 long and 2 short	2	4.0c	17.9c	137	Mixture and wires about equal	113	Mixture and wires about equal
New barbed, 4 long strands	1⅔	6.6c	20.5c	123	Mixture and wires about equal	108	Mixture and wires about equal
New barbed, 4 long and 2 short	2	8.0c	21.9c	140	Wires broke	103	Wires poorly placed
No. 14, 4 twisted strands of 3 wires each	1⅔	6.6c	20.5c	130	Wires broke		
No. 14, 4 long and 2 short, 3 twisted strands each	2	8.0c	21.9c	175	Wires and mixture about equal		

* This table is a summary of Tables 5 and 7, Bulletin 148, Colo. Exp Sta.

TABLE NO. 4.—Poured Posts.*

Size, 4x4 inches at base, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 80 pounds.

REINFORCEMENT			COST OF MATERIAL AND FINAL BREAK			
			Mixture, 1 part cement and 3 parts sand.		Mixture, 1 part cement and 4 parts sand.	
Kind of Wire	Weight per post in lbs.	Cost per Post	Cost of Material in Post	Pounds to break post	Cost of Material in Post	Pounds to break post
No. 10, 4 twisted strands of 2 wires	2½	10.0c	23.3c	183	20.6c	168
Old barbed, 4 long strands	1⅔	3.3c	16.6c	108	13.9c	65
New barbed, 4 long strands	1⅔	6.6c	19.9c	105	17.2c	88
No. 14, 4 strands of 3 twisted	1⅔	6.6c	19.9c	102	17.2c	62
No. 14, 4 long and 2 short strands of 3 twisted	2	8.0c	21.3c	185		

* This table is a summary of Tables 6 and 8, Bulletin 148, Colo. Exp. Sta.

The Three Cornered Post.—The following conclusions are drawn after testing 23 triangular posts. Size, 7 inches on each side at the bottom, tapering to 5 inches on each side at the top. Mixture, 1 part cement and 3 parts sand, by measure. Cost of material varying from 14 cents to 19 cents each.

The three cornered post which is advocated to some extent, does not have as many points in its favor as it may seem. In the first place an equal amount of reinforcement in each corner of the post cannot make a post of equal strength from two opposite directions. If a force is brought to bear against one of the flat sides of the post towards the opposite corner, the material in the corner will crush long before the wires will break on the side from which the force is exerted. On the other hand, if a force is brought to bear against one corner of the post towards the opposite flat side, the single reinforcement in the corner will break before the mixture has begun to crush on the flat side.

An extra reinforcement in the corner on which the force is exerted towards the opposite flat side will make it practically as strong as the flat side. But when the force is again applied to the flat side towards the single corner which is doubly reinforced, the mixture in the corner gives away too soon and it is no better than with but a single reinforcement.

TABLE NO. 5.—Poured Posts.

Size, 5x5 inches from base to ground line, tapering to 3x4 inches at top. Length, 6 feet 6 inches. Cured weight, 115 to 120 pounds. Mixture, 1 part cement, 3 parts sand, and 3 parts gravel, by measure. Cost of cement per post, 14 pounds, 8.4 cents; sand and gravel, 1 cubic foot, 3.7 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST		COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands of 2 wires twisted No. 10	2½	10.0c	218	Ground line Ground line 4 in. below	22.1c	Wires broke on 2 and mixture broke on one
4 long and 2 short twisted strands No.10	3	12.0c	330	4 in. above 12 in. above 4 in. below	24.1c	Wires broke
4 long strands old barbed wire	1⅔	3.3c	110	Ground line Ground line Ground line	15.4c	Wires broke
4 long and 2 short old barbed wire	2	4.0c	118	20 in. above 24 in. above 15 in. above	16.1c	Wires broke, not well placed
4 long strands new barbed wire	1⅔	6.6c	143	4 in. below Ground line Ground line	18.7c	Wires broke
4 long and 2 short new barbed wire	2	8.0c	123	Ground line 3 in. above 10 in. above	20.1c	Wires broke
4 long strands of 3 twisted wires, No. 14	1⅔	6.6c	123	Ground line 27 in. above Ground line	18.7c	Wires broke
4 long, 2 short strands of 3 twisted No. 14	2	8 0c	143	Ground line 7 in. below 4 in. below	20.1c	Mixture broke on two and wires broke on one

TABLE NO. 6.—Corner Posts.

Size, 8x8 inches from base to ground line, tapering to 5x5 inches at top. Length, 8 feet. Cured weight, 360 pounds. Mixture, 1 part cement, 2 parts sand, and 3 parts of gravel, by measure. Cured 90 days. Cost for cement per post, 51 pounds, 30.6 cents; sand and gravel, 3 cubic feet, 11.1 cents. For cost of reinforcement, see table below. Test shows pull exerted in pounds as by each of two fences pulling at right angles.

REINFORCEMENT			TYPE	TEST			COST	REMARKS
Kind of Reinforcement	Weight Per Post Lbs.	Cost Per Post	Poured or tamped	First Crack in Lbs.	Final Break in Lbs.	Location of Break	Cost of Material per Post	All reinforcements figured at 4c pound excepting old barbed wire at 2c.
2-8 ft. and 2-5 ft pieces ½ in. rod on tension side	16	64c	poured	7200	8500	at brace	$1.057	Short wires extended from below ground line to above brace line
Same as above	16	64c	tamped	5050	5600	at brace	1.057	Short wires extended from below ground line to above brace line
14 strands old barbed wire on tension side.	8	16c	tamped	6300	7300	at brace	.577	Mixture broke
Same as above	8	16c	poured	5900	7400	at brace	.577	Mixture broke
10 twisted strands No. 10. on tension side	8	32c	tamped	5400	7300	4 in. below brace	.737	Mixture broke
Same as above	8	32c	poured	6300	6650	4 in. above brace	.737	Mixture broke

Size, 7x7 inches at base, tapering to 5x5 inches at top. Length, 8 feet. Cured weight, 250 pounds. Mixture, 1 part cement, 2 parts sand, and 3 parts gravel, by measure. Cured 90 days. Cost of cement per post, 36 pounds, 21.6 cents; sand and gravel, 2 cubic feet, 7.4 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TYPE	TEST			COST	REMARKS
Kind of Reinforcement	Weight Per Post Lbs.	Cost Per Post	Poured or tamped	First Crack in Lbs.	Final Break in Lbs.	Location of Break	Cost of Material Per Post	All reinforcements figured at 4c pound excepting old barbed wire at 2c.
8 strands old barbed wire 2 in each corner	4½	9c 2c lb.	poured	2700	3600	at braces	$0.38	Mixture broke
8 strands new barbed wire 2 in each corner	4½	18c 4c lb.	poured	3225	4050	at braces	.47	Mixture broke

HOLLOW POSTS.

It has been suggested that the cement and concrete posts should be made hollow. The hollow post would require less mixture and it would also be lighter. As the material in the center of the post does not have a good opportunity to act to the best advantage in compression, it is argued that the strength of the hollow post would be nearly as great as that of the solid post.

In case time is of little value it would probably prove more economical to build hollow posts. As the amount of reinforcement is not affected by the change from the solid to the hollow post, only the saving in cement, sand and gravel need be considered. It is an easy matter to compute the saving accomplished by the making of hollow posts, and then by knowing the cost of labor, the economy of building them may soon be calculated. With cement at 55 cents per sack and sand at $1.00 per yard, one cubic foot of 1 to 4 mixture costs 18 cents. If a 1½ inch hole were to be left in the center of a post 7 feet long about 1½ cents' worth of material would be saved. With labor at 15 cents per hour, 6 minutes might be given to the extra work of making the post with the hollow core.

In case of alkali soils the hollow center gives additional exposed surface upon which the alkali may act. In a 4-inch square post with a 1½ inch core, the extra surface amounts to about 28 per cent. of the original lateral surface.

Finally there is a serious question as to the relative strength and durability of the hollow post as compared with the solid one.

CORNER POSTS AND GATE POSTS.

In the building of a fence with cement or concrete posts, the corner and gate posts must be especially strong, so as to prevent the pull of the wires coming upon the line posts. All the pull of the wires should be borne by the corner or gate posts. With this in mind the designer should aim not only to build a very strong post, but the system of bracing should receive special attention.

As the cement posts are not as strong as wood posts, we cannot use the same bracing systems, which are so commonly in use in wood post fence construction. It has been found advisable to place the brace so that it supports the post at a point very little, if any, above the middle of the post. For the reason that the posts are strong in compression, but do not stand as much pull as wood posts, it proves advisable to place the brace against the brace post at least one foot below the ground line; thus the post distributes the pressure at the end of the brace against an area of ground equal to the surface covered on the opposite side of the post.

There should be several wires connecting the brace post and the corner or gate post together. These wires should be placed under the ground at a depth of about one foot. By having these wires tight the corner post cannot move unless the brace post moves, and as this is securely fastened to it, the whole becomes a unit, offering a rigid resistance to the pull of the fence.

In case of a corner post, the wires may be fastened by wrapping them around it, but the most satisfactory way is to cast wire staples in the post. These staples should extend into the post far enough to be wrapped around one or more of the reinforcement wires.

The hinges for gates may also be cast in the posts when it is desired to do so.

Corner and gate posts are usually reinforced in the same way as line posts. It is unnecessary, however, to place reinforcement wires on the inner sides of the corner posts, as the outer sides bear almost all of the tension.

With the tapered posts, it is desirable to construct the face sides straight; this brings all of the taper on the other two sides. Small lugs or shoulders should be cast on each brace side of the post, against which the brace is placed.

The ordinary five-inch line post proves to be strong enough to act as a brace post for an eight-inch corner post.

The following table gives a summary of breaking strength and cost of materials of some of the best poured posts, which were made and tested in this experiment.

MIXTURE	DESCRIPTION	REINFORCEMENT								
		4 Long No. 10 Twisted	4 long 2 short No. 10 twisted	4 long New Barbed Wire	4 long Old Barbed Wire	4 long 2 short new barbed	4 long 2 short old barbed	3 long No. 19⅝ in. band iron	4 long 4 short old barbed	6 long old barbed
1 to 3	Ground line 5x5 top 3x3	307 lbs. 29.9c	290 lbs. 31.9c	188 lbs. 26.5c	158 lbs. 23.2c	none none	200 lbs. 23.9c			
1 to 4	Ground line 5x5 top 3x3	222 lbs. 26.9c	322 lbs. 28.9c	none none	95 lbs. 20.2c	172 lbs. 24.9c	127 lbs. 20.9c			
1 to 5	Ground line 5x5 top 3x3	235 lbs. 23.9c	220 lbs. 25.9c	123 lbs. 20.5c	113 lbs. 17.2c	140 lbs. 21.9c	137 lbs. 17.9c			
1 to 3	Base 4x4 top 3x3	183 lbs. 23.3c	none none	105 lbs. 19.9c	108 lbs. 16.6c					
1 to 4	Base 4x4 top 3x3	168 lbs. 20.6c	none none	88 lbs. 17.2c	65 lbs. 13.9c					
1 to 3 3	Ground line 5x5 top 3x3	218 lbs. 22.1c	230 lbs. 24.1c	143 lbs. 18.7c	110 lbs. 15.4c	123 lbs. 20.1c	118 lbs. 16.1c			
1 to 3	Base 5x5 top 3x3 horse shoe shape	202 lbs. 23.3c			133 lbs. 16.6c			157 lbs. 22.3c	148 lbs. 18.8c	
1 to 3	Triangular Base 7x7 top 5x5			110 lbs. 18.0c						147 lbs. 15.9c

Strength of cement posts compared to new wood posts tested under like conditions.

KIND OF POST	SIZE OF POST	BREAKING STRENGTH	REMARKS
(1) Best cement post tested	5x5 in. at ground line tapering to 3x3 in. at top	322 lbs.	
(2) Cement	Same as above	307 lbs.	
(3) Cement	4x4 in. at base tapering to 3x3 in. at top	185 lbs.	The post was 3.6x 3.6 in. at ground
(4) Split cedar (new)	3.6x3.6 in. at ground line	613 lbs.	Same size at ground as No. 3 above
White pine (new)	4x4 in. at ground line	2000 lbs.	
Red spruce (new)	4½x4½ in. at ground line	2400 lbs.	
Red spruce (new)	5x5 in. at ground line	3350 lbs.	

CONCLUSIONS.

Poured posts are easier to make than tamped ones. They are somewhat more expensive because one mold will make but one poured post per day, while the same mold may be used for making as many tamped posts as the builder can mix and tamp in the same time.

According to the tests made poured posts are a little over 25 per cent stronger than tamped ones of the same size, mixture and reinforcement.

Poured posts are not so porous as the tamped ones and are therefore more nearly water proof, thus making them better able to withstand the action of frost and alkali.

The poured post is enough better in every respect to justify its construction and use in preference to the tamped one.

Most commercial molds make a post which tapers from the base to the top, but the most economical mold is one which casts a post as large at the ground line as at the base, tapering from the ground line to the top. For a description of this form of mold, see Fig. 4.

The best form of post is one which is equally strong from all directions. The square, or round post, fulfills this requirement. The triangular post does not meet the requirements because it cannot be economically constructed so as to be equally strong from all directions.

To be economical, the amount of reinforcement should be in proportion to the size of the post and strength of the mixture. See tables.

The material used for reinforcement should be strong, light and rough enough to permit the mixture to get a firm grip upon it. It should be very rigid, with little or no tendency to spring or stretch.

The smooth reinforcement tends to slip even if hooked at the ends.

Two or more wires twisted together make as satisfactory a reinforcement as can be obtained.

Crimped wire tends to straighten and thereby breaks pieces out of the post at the point of greatest stress.

The reinforcement should be placed in each corner of the post at a depth of from ⅜ to ¾ of an inch from the surface.

There are several commercial wire fasteners now found on the market, the most of which are either cumbersome or expensive. For a simple and satisfactory fastener, see cut of fasteners. (Fig. 5, A.)

The posts should be cured in the shade for at least 60 days, the first 30 days of which they should be sprinkled daily.