lbs. per square inch at the end of seven days, provided the operator understands the work of testing, for it is by no means the easy simple task it appears, to properly test a cement; it requires experience and care. It is usual and necessary that the temperature of the room and water be kept as nearly uniform as possible, say 70° F., in order that comparable results may be had. Professor Unwin, in a recent paper, questions the utility of such rigorous conditions, claiming that cement is subjected to all sorts of conditions in work and that the test ought to conform to the use to which it is to be subjected. Other able men have doubted the benefit of the hot water test. It is obvious that usually cement will not be used where hot water is flowing freely, hence the query naturally arises, why test cement with it? The answer is: that hot water accelerates the weak points in developing; that what would require several weeks or months to be learned from cold water can be had in from 24 to 36 hours by using hot water. Further, in this country it is frequently necessary to use hot water and heated sand in building during the winter months. The extraneous conditions affect small samples to a greater degree than in the large masses in works, and, after all, tests are merely for comparison, it being rightly considered that the best samples will give the best results on a large scale. Other points, such as color, etc., have really no significance. Here are two samples of the same cement and a slight difference in treatment has produced a marked difference in the color. One was immersed in a vapor bath immediately after mixing, the other was first allowed to be set in the air before being placed in the vapor bath; the first one is very light and the other quite dark.

Sand: The second ingredient of concrete is sand, and it is quite as important to use good sand as good cement; it should be clean, sharp and of varying sizes of grain, largely silicious, excluding rigorously mica, pyrities, loam or other soft friable material. Calcareous sands are seldom or never fit for concrete.

Gravel: May be clean, pit gravel, or lake shore pebbles, or better broken syenite, trap, granite or hard limestone. The principal point requiring care is to have the materials clean and that the size shall not be larger than what will pass a ring of 2½" to 3" in diameter for the largest pieces from that size down to the size of a pea or lima beam. A varying sized aggregate will give a more economical and denser concrete.

DESCRIPTION OF PROCESS IN CONCRETE MAKING.

The concrete described below is such as is advised for bridge piers, abutments, chimney foundations, engine beds, etc. Proportions to be by measure, one part Portland cement, two parts clean sharp sand and five parts broken stone or clean gravel. The modus operandi found to give successful results has been as follows. Spread evenly on a board platform or in a water tight box, two barrels of sand, on this spread one barrel of cement; mix thoroughly by turning over the sand and cement at least three or four times, do not heap it, then add water, mixing as as you do so (it is best to use a rose in putting on the water) until enough is present to make the mortar such that it will retain the impress of the hand when rolled into a ball. Spread into an even layer, then add the gravel by spreading it as even as possible. Turn the whole mass at least three times. It is not well to heap it to the centre as is usually done, the larger stones work to the outside and do not receive the proper complement of mortar. Load into barrows and sacks and place into position as quickly as possible, now ram thoroughly to place; if the concrete is too wet it will work up around the rammer and will not pack. The proper test is that after being well rammed it should jelly, better have it too dry than too wet, as it can be easily wet down. The coping course should generally be made of richer material, one part of cement to two parts of sand giving good results. Usually the coping course is from two inches to four inches thick, depending upon the whim of the engineer in charge.

During the past season the writer constructed two bridge abutments as follows: First, piles were driven, the tops being cut off four feet below low water mark. The piles were then capped with 10"×12" hemlock and rag-bolted to each pile with ¾" square by 20" long from rag bolts, running transversely with the capping, a floor of hemlock 10" was lain, the floor being fully rag bolted to the caps, curbing was then built on the floor to temporarily retain the concrete, corner piers were 4"×6" studding 2"×6", spaced 2 ft. centres, the whole being lined with 2 inch plank at the corner; 6" strips were nailed in to give a bevel corner, and at the coping a bevel piece was nailed to the sheeting so as to leave a wash edge; the abutments were 4' 6" thick by 20 ft. long by 5 ft. high to the bridge seat, a ballast wall 5 ft. high by 18 inches thick completing the abutment. Three days after the coping was laid on the abutment a heavy steel bridge was placed upon it and 10 days later it was crossed with a work train. A second sample was an old abutment which had to be renewed. It was scoured out in places three feet below the stone work. The work of repairing was, first, to carefully build a strong curb about two feet away from the abutment; an effort was made to deaden the current with puddle, bag after bag of concrete was then carefully lowered into the holes and pushed to place, the bags were slitted, and in a short time it became a homogeneous mass. A toe was then formed to the curb, and it is believed all possibility of future scouring has been checked.

A third example was as a foundation for a brick chimney—no curbing being required the sides of the excavation serving the purpose of a curb. The concrete work merely stood one day when the brickwork was immediately started. Although the completed chimney weighs some 200,000 lbs., giving a pressure of about 4,900 lbs. per square foot, and has been subjected to some very high wind at times, it has given a very satisfactory job, not a crack or appearance of settlement having occurred.

Another example of the advantage to be had from concrete is in engine beds or foundation for generators in electric power and light work, a number of which have been built under the writer's supervision. In fact wherever stone or gravel can be had concrete can be economically made. It is peculiarly adapted to trying and difficult locations, as in bridge piers, abutments, chimney caps, foundations under water for dams, docks, wharves, &c. A less section can generally be taken than is required for stone from the fact of its mono-lithic character, greater weight and strength. A principle for guidance is to so design the work as to never leave a sharp or thin corner. In conclusion, a description of a recent test made under the writer's direction will be given as a proof of its unsuitability for fireproofing. A small slab of first-class concrete 2 ft. wide, 3 ft. long and 3 in. thick was very carefully made about 10 months ago, the slab has been kept in an office since it was built and was therefore very hard and dry; for the test a small chamber was built of terra cotta blocks with three closed sides and an ordinary stove-pipe chimney. The slab was used for a cover. A slow, easy fire was kept going for about 3 hours, when the slab had grown quite warm, say about 130 F. It was then fired hard with dry pine for about 20 minutes, when three or four pails of water were thrown on the under side of the slab. The result was a great many cracks appeared in the slab. It was then carefully turned over, when it broke into a great many pieces. Upon further drenching each piece again broke up into smaller ones, which would go to show that concrete is an unsafe and unreliable material where it is liable to be heated and then drenched with water, as would be the case in any building where a fire might occur.

Within the past two years a good many buildings have been "fireproofed" with concrete, and it would seem that it is a dangerous material for such services. Further experiments on a larger scale and with the usual conditions incidental to city buildings are required before much faith should be given to concrete as a fireproof material. It merely remains to be said that the cost of concrete is much less than good stone or brickwork, requires little or no mechanical skill in the work, one expert mason for a foreman, the rest of the work being done with common labor.

The items that go to make up the cost of a cubic yard of concrete are as follows:

1¼ bbls. Portland cement, average cost in car lots $2.30 per barrel	2.87½
½ cubic yard of sand, average conditions, say	.37½
1 cubic yard of gravel or broken stone, (average conditions) say	.75
Labor, common labor $1.25 per day, foreman $3.00, 10 men in gang	1.50
Curbing, ordinary simple work as in highway or railway bridges without specially difficult foundations, etc., per cubic yard of concrete	.72
Total	$6.22

The writer has had piers and abutments erected complete in place at as low a cost as $5.00 per cubic yard and as high as $6.50, local conditions affecting the cost slightly.