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THE CANADIAN PORTLAND CEMENT CO., LIMITED

DESERONTO, ONTARIO, CANADA

WORKS AT MARLBANK AND STRATHCONA, ONTARIO

East Wall, Inner Harbor, Port Colborne, Ont.
Hogan & Macdonell Contractors

CAPACITY

500,000 Barrels per Annum

ADDRESS ALL ORDERS AND INQUIRIES TO

THE RATHBUN COMPANY

GENERAL SALES AGENTS FOR CENTRAL AND WESTERN ONTARIO, Nos. 310-312 FRONT STREET WEST, TORONTO, CANADA.

ST. LAWRENCE PORTLAND CEMENT CO., General Sales Agents for Eastern and Western Canada, Rooms Nos. 101-102 BOARD OF TRADE BUILDING, MONTREAL, CANADA

Vol

WE take pleasure in putting into the hands of those who are in any way interested in building operations, the third number of our booklets upon high grade Portland cement.

In its preparation we are indebted to The Municipal Engineering Co. of Indianapolis, for permission to quote from their copyrighted work, "Hand Book for Cement Users."

While, of course, our primary object in the distribution of this booklet has been to make our cement more widely known, if that be possible, and to extend its use, we have endeavored so far as space permits to make it an edition of valuable information regarding the nature and uses of the material dealt with. We trust our efforts in this secondary purpose have been successful, and that the views shown, each of which is of work done either exclusively or largely with "Rathbun's Star," will be found of additional interest.

THE CEMENT AGE

Walks in St. George, Ont.
The Silica Barytic Stone Co.

THE remarkable growth in Canada during recent years in the use of Portland cement, and its displacement of stone and other building materials, have kept easy pace with the ever increasing variety of uses to which iron and steel have been applied.

The Canadian manufacture of Portland cement has attained to such high standards of excellence, and has become an industry of such large proportions as to merit the encouragement of every consumer of this product. Its production, too, has brought its use at a most reasonable cost, to the ground of every building operation where strength and permanency are at all desirable.

To-day thousands of barrels of this product are being freely consumed, where but recently its use was confined to such special cases as were surrounded by the most exacting conditions, and the variety of its applications is being rapidly extended from year to year.

Its displacement of masonry, necessitating as it does, the employment of entirely unskilled labor with a resulting reduction in cost, its ready moulding to any form, accompanied as it is by greater rapidity in work and its increased permanency, is, perhaps, the most striking change of recent years in building methods.

Portland cement concrete has indisputably established itself, not only as the cheapest and readiest, but as the most permanent and satisfactory foundation for structural work of every nature. Masonry foundations, especially in the best class of work, are now the exception rather than the rule and are only laid where economy is not a consideration.

In many localities superstructures as well as foundations consist at a greatly reduced cost altogether of Portland cement concrete.

Street subway and railway tunnel linings, as well as bridge arching and piers, need no longer consist of either expensive masonry nor of decaying timber. Concrete is rapidly displacing both with progressive engineers, not only for the purpose of strength and economy in first cost, but for the purpose also of escaping later maintenance outlay.

Its advantages in this class of work are so apparent to those who have made use of it that no other form of construction for such purposes is entertained.

Progressive cities, towns and villages no longer dissipate their revenues upon antiquated and unsanitary plank walks, which at best are but temporary. The small initial cost of properly laid Portland cement or Granolithic pavements, their permanency and elimination of repairs, have been to such corporations the irresistible arguments for their adoption. No public improvement presents so much the appearance of enterprise nor enhances so rapidly individual property value, as does Granolithic walk frontage.

Grange Street, Stratford Ont.
Guelph Pavement Co.

The development of Portland cement concrete construction in other directions is limitless. The exercise of intelligence and ingenuity are constantly finding for it innumerable uses in the displacement of stone, wood and iron. Its supremacy over every other building material is already established.

The Importance of Fine Grinding

(Canadian Architect and Builder, July, 1901)

The importance of the test for fineness has at times been questioned, but while it may not give any proof of the strength or weakness of cement, says "Cement and Slate," its economic value is shown by the fact that a finely ground cement will carry a larger quantity of sand than one of ~~an~~ equal grade but more coarsely ground, and will therefore make a cheaper concrete. It has been determined by numerous tests that the impalpable powder is the only really valuable part of the cement, while the coarser particles are present only as inert material and act like so much sand, decreasing thereby the sand carrying power besides being themselves inactive.

Prof. LeChatelier in making his microscopic examination of cement mortar found that, after setting, no trace of the grain of cement is left in the finer particles, while in the case of the larger, the central part of the grain remained unchanged. It has been affirmed that the part of the cement powder that will not pass a No. 100 sieve does no work as a binding material in the mortar or concrete that is made from it.

It is also a settled fact that coarse grinding increases the tendency of free lime and magnesia to expand and crack, causing disintegration, when possibly if more finely ground it would be unaffected.

King Edward Hotel, Toronto, Ont.
Illsley & Horne, Ltd., General Contractors

In burning cement the clinker obtained is generally very hard and is consequently not easy to grind. In coarse grinding this is the part that usually escapes pulverizing, and, because it is thoroughly burned it is the most valuable, so that by imperfect grinding we are apt to leave the most useful part of the cement in an inert condition.

The rate of setting of a cement increases rapidly as the fineness to which it is ground increases. This is caused by the fact that the necessary chemical reactions take place more readily between fine particles than between those that are coarser.

The hardening of finely ground cement is affected in a peculiar manner by fine grinding. When mixed neat it hardens more rapidly than coarse ground, but attains less final tensile strength. As cement, however, is seldom used neat but is generally mixed with sand, the effect of fine grinding on the strength of the mortar is of more importance than the neat test.

It is found that when finely ground cement is mixed with sand it will attain its ultimate strength sooner, and will show greater initial and final strength than would a coarser cement, under the same conditions. This effect of fine grinding is the more pronounced, the greater the proportion of sand that is used.

While it is true that some good cements, although coarse and granular, are able to pass all tests satisfactorily, it is also true that some poor cements have been vastly improved by fine grinding. The test of fineness, standing by itself, would never be sufficient to determine the quality of a cement; but other things being equal, the cheapest and best cement is the one that has the greatest percentage of impalpable powder. While itself not conclusive, this test, combined with others, gives an idea of the value of the cement tested which could not be gained without its use.

Cote des Neiges Cemetery Vault
O. Martineau & Fils, Contractors
Montreal.

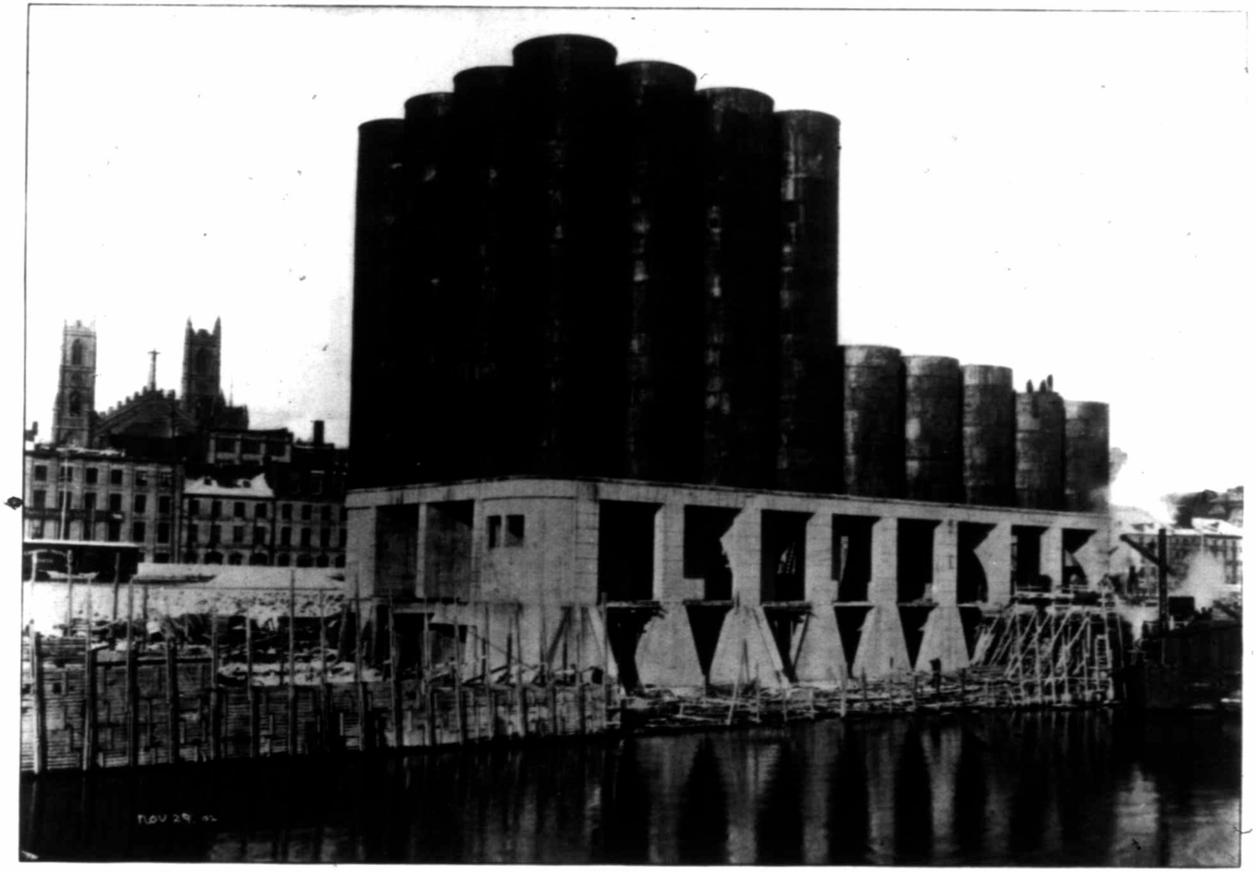
Some suggestions as to the manner in which this test should be made are here given. The amount usually taken is 100 grams. This amount should be well dried at a temperature approximating 100 degrees C. to drive off all hydroscopic moisture. The sieves should be from six to eight inches in diameter, and should be jarred or shaken until no more passes through.

A Common Injustice

A common practice, amongst some workmen in the testing of Portland cement, is to mix a small quantity with some proportion of sand upon a dry board or other absorbent surface, which is set aside frequently exposed to the rays of the sun or to a very dry hot atmosphere. The mixture is frequently made also with altogether too little water. The board, or other porous surface, upon which the mixture may have been made and the atmosphere very quickly absorb the moisture from the small body of the mortar, so that only partial setting is possible. The cement, which may be first-class, but slow setting, is pronounced worthless. A cement that may be worthless, but quick setting, or sufficiently rapid in action to use the water before it can be taken up by the board or other absorbent material and the atmosphere, is pronounced satisfactory. The only method of arriving at the value of a cement, ensuring safety and accuracy for the user and justice to the manufacturer, is to have it technically tested in a well equipped testing laboratory, where proper conditions are scrupulously observed.

The Canada Paper Co's Mills
Windsor Mills, Que.

Each view shown in this booklet is of work done most satisfactorily and either exclusively or largely with Rathbun's "Star."



Montreal Harbor Grain Elevator

The Continental Engineering & Contracting Co., Contractors

THE MAKING OF PORTLAND CEMENT CONCRETE

Walk, G. B. Ryan's residence Guelph
Guelph Pavement Co., Contractors

RESULTS in the making of Portland cement concrete will depend not only upon the quality of the materials used, but quite as much, if not more, upon the workmanship in its preparation and laying.

THE CEMENT must be sound and finely ground. The virtue of fine grinding of cements can only be appreciated when those possessing this quality are brought into competitive tests with the more coarsely ground grades. Fineness permits such addition of sand as will more than offset the mere difference in price of the coarser cements. The soundness or unsoundness of a cement depends upon the absence or presence of free lime as a constituent. Its presence is the most dangerous and deceptive weakness of many of the lower grades of quick-setting cements, and when water is added an unnecessary degree of heat is generated, with a consequent rapidity of setting and drying, which should be looked upon with suspicion, but which more often is taken as an indication of excellence of the material. Its presence will be followed later by a very serious disintegration of the work into which it enters through its gradual contact with air and moisture. For permanency and safety, slow setting cements are the better. Care should be taken to keep cement, when in store, perfectly dry. Cement in damp places must, from its very nature, at least partially set, with a consequent deterioration in value.

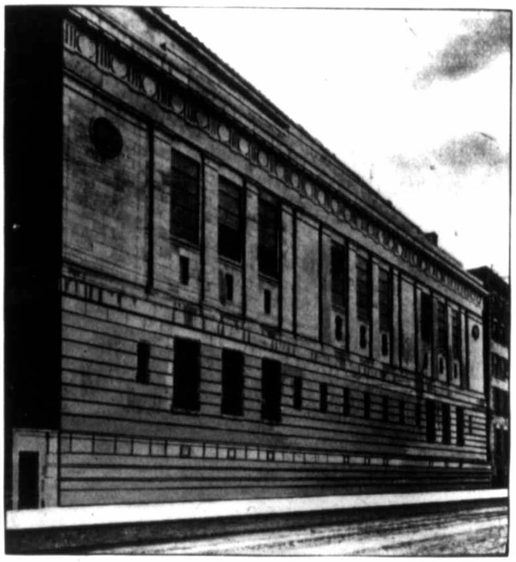
THE SAND must be clean and sharp, free from loam, clay or mica. The presence of any one of these often proves fatal in cement work. If possible the sand should be river washed. Cement mixed with very fine sand cannot properly envelop all the particles, a very necessary condition to the best results. The quality of sand recommended in Portland cement mixtures will give from two to four times greater strength than can possibly be obtained in mixtures of this material under exactly similiar conditions with the ordinary soft red bank sand. The importance attaching to the quality of the sand used in Portland cement mortar and concrete has in some quarters resulted in the use of the tensile 3 to 1 sand test, as a test of the sand itself rather than, or as well as a test, of the cement. Taking the tensile strength of the neat cement as a standard, a sand reducing in mixture with that cement, the tensile strain of the cement beyond a given percentage, should be rejected as unfit. A ready means of determining the quality of a sand for use with Portland cement is to place in a common drinking glass an inch or two of the sand to be tested with the addition of say, one inch greater depth of pure water, stirring the two vigorously and allowing the contents then to settle quietly until the water is quite clear. An appreciable deposit of loam or clay upon the settled sand should condemn it as unfit for the use intended, while a sand showing an absence of such foreign substances, is of the necessary quality, provided always it is hard and sharp and fairly coarse.

Balmoral Street, Winnipeg, Man.

THE WATER, STONE, CINDERS OR GRAVEL also must be clean and free from loam, clay, vegetable or any other foreign matter. Water taken from stagnant pools is very detrimental to Portland cement concrete.

The Continental Engineering & Contracting Co., Contractors

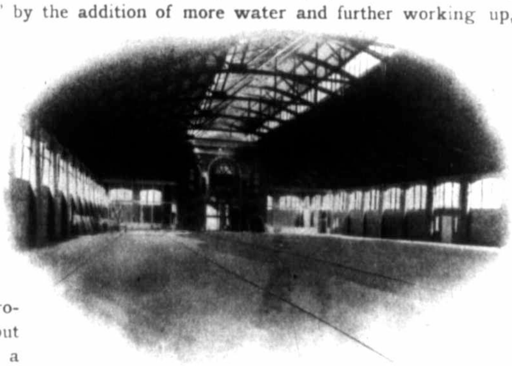
Montreal Harbor Grain Elevator



The New Bank of Montreal, Montreal
The Norcross Brothers Co., Contractors

THE MIXING. The sand should be evenly spread over the mixing board. It should then be covered with the cement, after which the two should be turned over dry at least three times. A very serious error in mixing cement mortar is that of adding water to either the sand or the cement before a thorough, dry mixing of the latter two materials. The addition of water to either, alone, throws the cement into a paste, resulting in a mixture made of separate bodies of cement and sand. All sticks, scraps of paper, etc., should be removed from the sand and cement. When the dry mixing is completed, water should be added in sufficient quantity only to make a stiff paste. Excess of water drowns the cement, each particle setting more or less independently of its neighbor, resulting in a body weakened by lack of close contact amongst the cement particles instead of a strongly bonded mass. An excess of water gives a mortar, very lightly and easily handled, but is only used by those regardless of strength and permanency of work. After the addition of the water to the sand and cement, add the stone, gravel or cinders, turning the whole mass over at least three times. If broken stone is used, it should first be thoroughly washed down. The thorough washing of this material not only removes all particles of clay, loam or dirt, all of which are very injurious to cement work, but provides them with moisture, which otherwise would be quickly drawn from the mortar itself, leaving insufficient water therein to provide for the complete chemical change which the full process of setting requires.

LAY the concrete as quickly as possible after completion of the mixture. Almost immediately after the addition of water to cement the process of setting commences, so that, where a batch of cement mortar or concrete is mixed and left before being put into place long enough for the setting to proceed so far that it works at all stiffly, irreparable injury is done the mixture, and any attempt at "retempering," by the addition of more water and further working up, almost completely destroys it. The strength of a cement whose even partial set has been disturbed is permanently impaired. SLOW SETTING CEMENTS ARE LESS LIKELY TO SUFFER FROM THIS CAUSE THAN THOSE OF A QUICKER SET. It is important that Portland cement mixtures be put into place as quickly as possible after preparation.



The New St. Lawrence Market, Toronto, Ont. Area 46,050 sq. ft.
A. Gardner & Co., Contractors

RAM the concrete at once thoroughly. Thorough ramming forces out of the mixture all voids and gives a density, most desirable in this class of work, obtained in no other way.

LEAVE the bed entirely free from disturbance of any nature until thoroughly hardened. The common practice of walking over or using in other ways concrete beds shortly after being put into place is most injurious. Unless concrete is in a damp place or protected from the sun, it should be frequently sprinkled very lightly with water.

All mixing of Portland cement concrete should be done on a tight plank or board platform, — never on the ground.

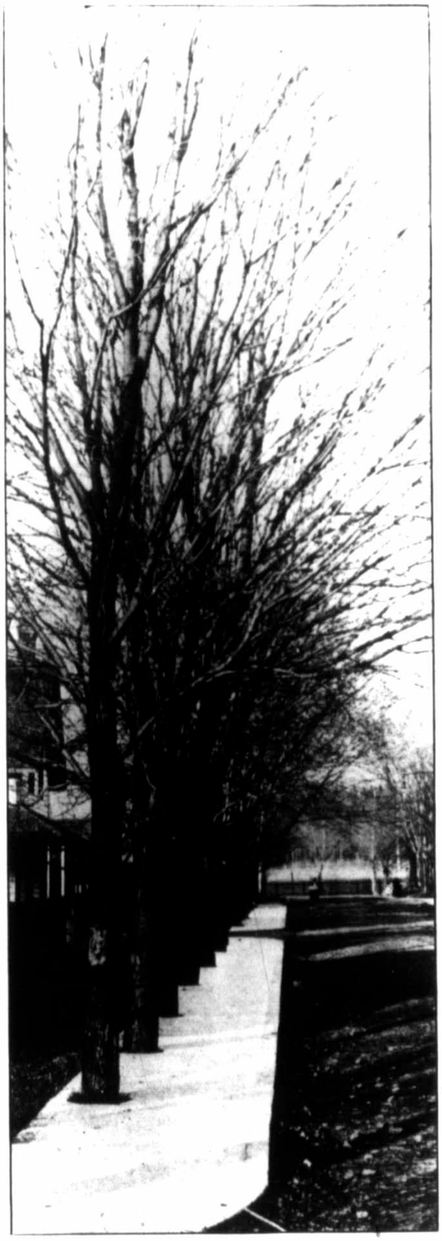
The above instructions are of course, applicable only to hand mixing. Where machine mixing is done, the process is varied according to the kind of machine used.

Preparation of Forms for Portland Cement Concrete

Mr. C. R. Neher, General Manager of The Continental Engineering & Contracting Co., Montreal, in an Engineering Paper before the Engineers' Society of Western New York, says:—

The preparation of forms calls for considerable ingenuity, and every contract requires special study, to the end that smooth surfaces be left, with unbroken corners, that the swelling of the wood does not rupture the concrete or leave distorted surfaces; and that the forms be so designed as to be used several times, and readily set up and taken down and later on devoted to other uses. As the charge for forms against the concrete can seldom be kept below 50 cents per cubic yard for heavy work, there is always an opportunity for the ingenuity of the designer, as few rules can be laid down for his guidance.

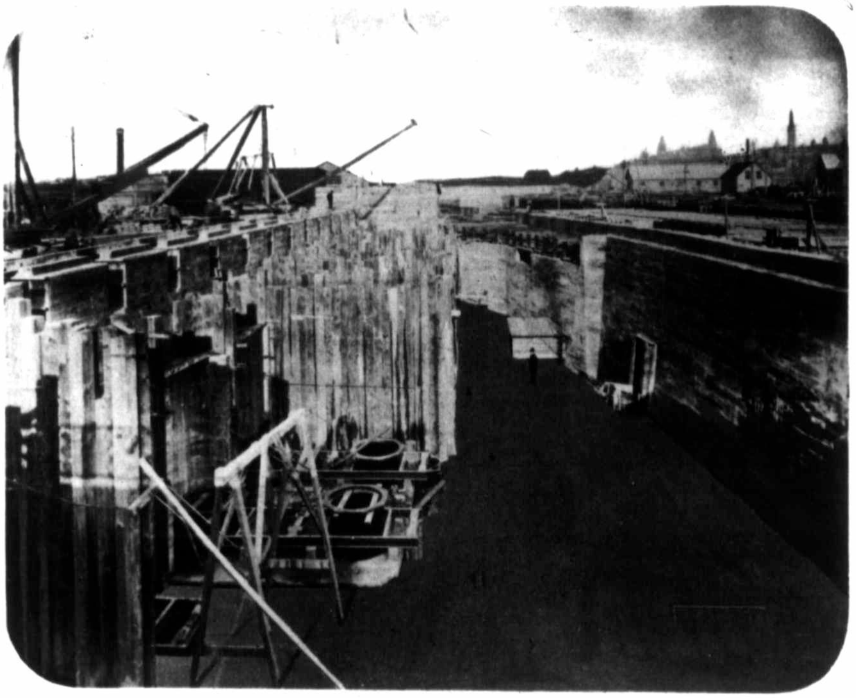
The use of matched or tongued and grooved stuff is not desirable, as concrete fills in the openings and there is no opportunity to expand from moisture. Unmatched boards dry apart and let the water in the concrete leak out, carrying with it some of the cement. Later on they swell and buckle, and if used as interior forms, burst the concrete. The best way devised so far is to bevel one edge of the boards, using narrow stuff, not exceeding six inches. The sharp edge of the bevel, lying against the square edge of the adjoining board, allows the edge to crush when swelling and closes up the joint, preventing buckling.



An Ottawa Street Walk

A coat of soft soap, before filling the forms, prevents the concrete from adhering to the forms, which should always be scraped and brushed with a steel wire brush when taken down.

Square corners should be avoided, as they readily chip off, and where used as interior forms for recesses or cellular construction, a fillet should always be placed in the corners.



Water Power. J. R. Booth, Ottawa

Concrete can often be saved by introducing cells in the mass. These are formed either by cheap hemlock boxes, which can be left in the work, or by collapsible boxes which can be withdrawn and used over again. Where weight is desirable, one-man stone can be rammed in the heart of the mass, reducing the cost very materially.

Where, for economy in handling and other reasons, it is desirable to dump the concrete from a considerable height, some precaution should be taken to avoid having the coarse aggregates separate from the rest of the mass. This can be accomplished in several ways—either by chains loosely stretched at intervals across a chute or by shelves extending part way across the chute at an incline, so as to deposit on a corresponding shelf on the opposite side, so alternating the length of the chute. Either of these methods is a direct benefit, as it more thoroughly mixes the concrete.

THE USE OF PORTLAND CEMENT DURING FROSTY WEATHER

Lower Waterloo Ave., Guelph, Ont.
Guelph Pavement Co., Contractors

WHILE it is best never to use Portland cement during frosty weather, fairly good results may be obtained by using water in which salt has been first completely dissolved, in quantities merely sufficient to prevent freezing ; but care should be taken that the salt is first thoroughly dissolved before the addition of the water to the sand and the cement, for if mixed when not thoroughly in solution, or if added dry to the mortar after that is prepared, it will crystallize in small bodies by itself, very seriously weakening the work into which it enters. One pound of salt to every twenty gallons of water, when the thermometer is at 32° F., and one additional ounce of salt for every further degree below 32, is a fairly safe guide in the use of this material.

Heated water may be used, and the materials used with the cement should also be moderately heated, and if absorbent, should be immersed in warm water for sometime previous to use.

If cement mortar or concrete can be kept from freezing until well set, and is not afterwards subjected to alternate freezing and thawing until thoroughly hardened, no injury will result from its use in frosty weather. If however, the preparation be frozen before the final set takes place, the appearance of the work will undoubtedly be destroyed, and possibly the work throughout rendered useless.

An Abuse of Portland Cement Concrete

(From "Hand Book for Cement Users.")

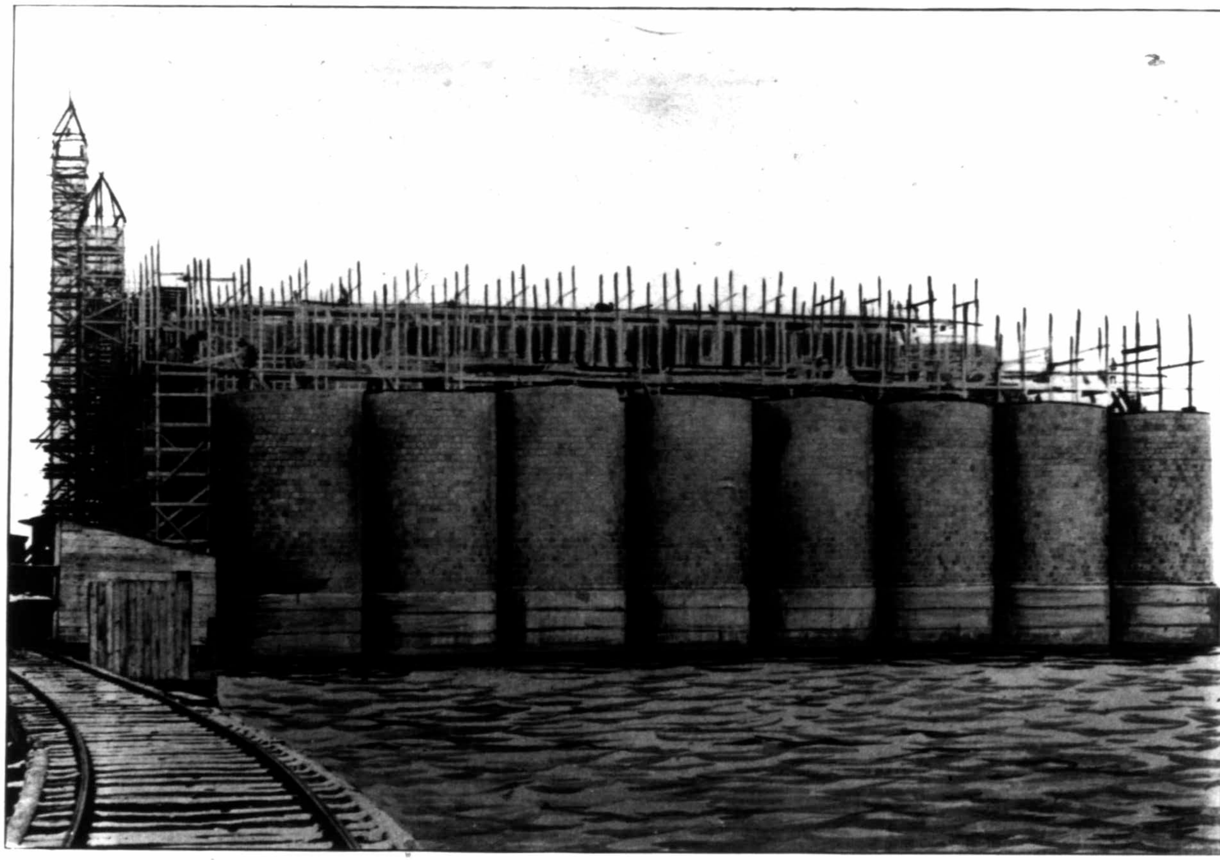
During the construction of the Holyoke dam, in Massachusetts, an experiment was made to illustrate the effect of dumping concrete into place under water. A batch of concrete was mixed, 1 part cement, 2¼ parts sand and 5 parts broken stone, as required on the work, and dropped from a height before setting into a pail of water. At the end of 12 months it was examined. About ¾ inch of nearly neat cement, hard set, was found as a top layer, then about 2½ inches of sand, with enough cement to hold it together and a few stones, then 2 to 3 inches of sand and stone nearly separate and perfectly clean, with no adhesion whatever. This indicates that separation of materials dropped into place through water is too serious to be neglected.

Walks, Paris, Ont. The Silica Barytic Stone Co.

A Successful Precaution in the Placing of Submerged Portland Cement Concrete

(From "Hand Book for Cement Users.")

On a large bridge at Ottawa, a concrete "kibble" was used for dumping concrete in the foundation under water which was found very satisfactory. It is a steel bucket, wedge shaped, and hung by six chains to the four corners, and the hinges at the middle of the short sides, which meet in a ring above the center of the bucket by which it is hung from the operating cable. The



The Canadian Northern Railway's Elevator, Port Arthur, Ont. The Barnet & Record Co., Minneapolis, Minn., Contractors box is filled with concrete and the top covered with a canvas cover securely tied, lowered to the place of deposit and the latch of the bottom tripped, when the long sides swing on the hinges mentioned, enough to let the concrete slide out. The wedge shape causes little disturbance to the water in passing through, and the batch of concrete is deposited with a minimum of unprotected movement through the water. Tests for wash were made by dropping the filled kibble 60 feet through the water at the usual speed, and again elevating it to the surface and depositing the concrete in barrels on the surface; and also by depositing it in a box 8 feet under the surface where it was obliged to drop the 3 feet of depth of the box through the water, a very severe test. The first test was satisfactory, an excellent core being obtained with a diamond drill. The second test gave no core, but the walls of the drill hole stood hard and firm.

Portland Cement Concrete's Resistance to Heat

(From "Hand Book for Cement Users.")

A floor made of steel beams, 5-inch ribbed bars of the Columbian system, spaced 2 feet apart and embedded in $8\frac{1}{4}$ inches of concrete, was recently subjected to severe tests to show the value of concrete as a fireproofing. The main body of the concrete was made in proportions of 1 part Portland cement, $2\frac{1}{2}$ parts sand and 5 parts broken stone, and its under side was veneered with 2 inches of cinder concrete. After a test loading of 1,000 pounds per square foot, the floor was subjected to a temperature of about 1,700 degrees by fire for $2\frac{1}{4}$ hours. Water was applied from a fire stream, the fire repeated for 38 minutes and water again applied. The floor was again loaded with 1,650 pounds per square foot. The result was a deflection of $1\frac{5}{8}$ inches, 15-16 inch of which was due to the fire, a few cracks in the ceiling, and the washing away of some of the cinder concrete by the fire stream, in one case to a depth of $\frac{1}{4}$ inch. The test of fireproofing and floor was highly satisfactory.

Medical Building, Toronto University.
Illsley & Horne, Ltd., General Contractors

The Effect of Portland Cement Concrete upon Iron

(From "Hand Book for Cement Users.")

The effect of concrete upon iron was shown by embedding a piece of galvanized iron in cement for six months. It was then found that the galvanizing had all disappeared but the iron was clean and bright.

The use of concrete and steel in combination is becoming very popular, and there are numerous adaptations of the principle, some patented and some free. The combination of the two

The Canadian Northern Railway's Elevator, Port Arthur, Ont.
The Barnet & Record Co., Minneapolis, Minn., Contractors

materials was originally justified by the statement that the expansion of Portland cement is .00000143 per degree Centigrade increase in temperature, and that of iron is 0.0000145, practically the same. Cement mortar has strong adhesion to iron and protects it from oxidization.

Compressive Strength of Portland Cement Concrete

Mr. C. R. Neher, General Manager of the Continental Engineering & Contracting Co., Montreal, in a paper before the Enginers' Society of Western New York, reports tests of the compressive strength of concrete of various materials, as follows:—In proportions of 1 cubic foot of Portland cement to $2\frac{1}{4}$ cubic feet of limestone, between $\frac{1}{2}$ inch and 2 inch screens and $2\frac{1}{2}$ cubic feet of lake gravel, the ultimate compression after 7 days was 135 tons per square foot. A mixture of 1 part Portland cement with 5 parts of gravel gave 60 tons per square foot after 7 days. Copper slag in place of the limestone gave 80 tons, but with the amount of gravel reduced slightly, as the breaks showed excess of gravel in spots, the slag concrete reached an ultimate compressive strength of over 140 tons per square foot in 7 days. Where weight is desired the slag is valuabe, as it weighs 3,300 pounds per cubic yard, for run of crusher against 2,800 pounds assumed for limestone.

Waterproof Portland Cement Work

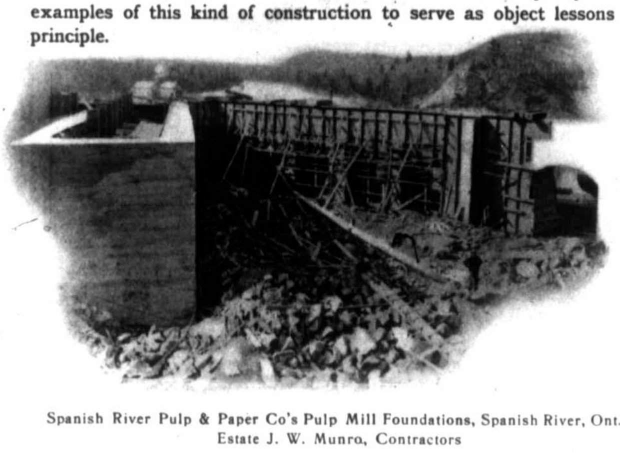
Portland cement mortar or concrete to be waterproof must contain smaller proportions of sand than that in ordinary work, and the sand must be not only sharp but absolutely free from even the smallest percentage of foreign matter of every nature. Sand of uneven grain in size is preferable. Two parts of sand are the maximum quantity that should be used for the concrete and mortar facing of water tight work. In the concrete also the proportion of stone to be added depends to a large degree upon the size to which it is broken. If broken to uneven sizes—in no case to exceed 2 inches in diameter—the quantity used can be greater than if broken to even sizes. The smaller fragments of stone broken to uneven sizes act as fillers for the larger stone, making dangerous voids less probable. The concrete should be well tamped.

Success or failure in this class of work depends altogether upon the manner in which the work is performed. Excellence of materials being of course, first essentials.

Portland Cement Concrete Bridge Pier Facings

(From "Hand Book for Cement Users.")

The success attained years ago in facing stone piers with a coating of cement mortar to preserve them from threatened disintegration should have more effect than it has heretofore. A facing that will show the marks of the forms after twenty years of exposure to weather, to the wear of water, and the shock of driftwood is certainly beyond criticism. There are several examples of this kind of construction to serve as object lessons for further application of the principle.



Spanish River Pulp & Paper Co's Pulp Mill Foundations, Spanish River, Ont. Estate J. W. Munro, Contractors

Portland Cement Concrete's Resistance to Heavy Water Action

(From "Hand Book for Cement Users.")

The use of massive concrete, either made in place or set in large blocks, for sea walls, piers, breakwaters and constructions where great weight is needed to withstand wave action and water pressure, is now so general that the superiority of this material for nearly all cases is now definitely proved.

Portland Cement Grouting for Submerged Gravel Foundations

(From "Hand Book for Cement Users.")

Within the past ten years there have been several instances of making solid foundations in gravel and sand, especially if under water, by injecting a thin cement grout by means of tubes run down to the stratum which it is desired to solidfy. Open gravel can be very successfully treated in this way. Fine sand will refuse the grout if already filled with water.

Portland Cement Concrete Sewers

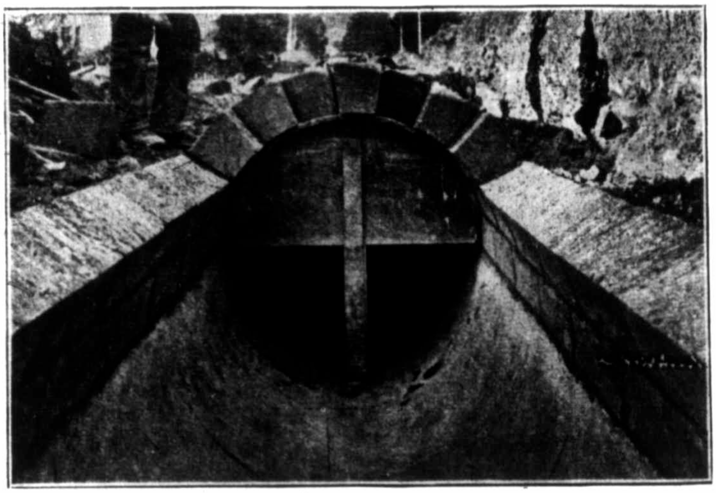
(From "Hand Book for Cement Users.")

In the construction of the tunnel of the New York Rapid Transit Railway many sewers must be reconstructed. In a number of instances they have been built of concrete moulded in place at a cost about one-third less than brick sewers. Forms were used for making the inverts consisting of strong framework and closely matched planed lagging greased with machine oil. Forms for arches were similar. They were made 12 feet long. The concrete was first put in place and brought within 1-2 inch of the grade, a template being used as a guide. The form was then accurately set in position and the remaining space filled with 1 ~~to~~ 1 Portland cement mortar. The form was then braced by struts to the sheeting of the trench and vertical planks set for the outside of the spandrel wall. Concrete was then carefully rammed in and made smooth. After 24 hours or more the form was withdrawn and a thin cement grout brushed over the surface. Concrete was in proportion of 1 : 2 : 4, Portland cement, sand and broken stone 1 inch and less. When arch centers were put in place the lagging was first plastered with 1 inch of 1 to 1 mortar, and concrete was then rammed in to a depth of 8 inches. Side forms on slope kept the side concrete in place and the crown was formed by hand. Some sewers had concrete invert and brick arch.

Portland Cement Concrete Sewer Construction

(From "Hand Book for Cement Users.")

The accompanying illustration shows the method of constructing sewers in Coldwater, the invert being a concrete monolith and the arch built of concrete blocks made in a yard at leisure and put in place in the same manner as stone blocks.



Concrete Sewer at Coldwater, Mich.

The main outlet sewer of the Chicago Transfer and Clearing Yards was built as a monolith, sewers from 36 to

48 inches diameter, having 8 inch walls, and those 84 and 90 inches in diameter, walls of 12 inches thickness. The invert was laid on a sub-grade carefully made and brought to proper surface by suitable tamping, trowelling and smoothing with templets. After the invert had set, the center for the arch was put in line. It consisted of circular ribs resting on the invert and supporting 2 x 4 inch lagging with edges planed to radial lines. Concrete was rammed on this centering and brought to proper thickness by means of templets. This would seem to be a simpler and cheaper construction for the arch than that using concrete blocks.

Portland Cement Concrete Rail Beds

(From "Hand Book for Cement Users.")

The street railway company in Minneapolis, Minn., made a novel use of concrete in reconstructing some of the lines and making the rails continuous by welding the joints. A longitudinal beam of concrete was constructed, to which the rails were spiked before the cement was set, thus making a continuous support for the rails, and a tight fastening for them. Concrete is frequently used as a foundation for the wooden ties of street railroads, but in this case the ties are displaced entirely. The usual concrete foundation for an asphalt street was laid over the street, and the pavement completed by laying the asphalt. Constructions of slightly different designs have been adopted with greater or less success in other cities, for example, Scranton, Pa., and Indianapolis, Ind.

The Liverpool & London & Globe Insurance Co's Building, Montreal
Wighton, Morrison & Co., Contractors

High Portland Cement Concrete Chimneys

(From "Hand Book for Cement Users.")

An interesting structure built with the Ransome twisted rods is a chimney at Elizabethport, N.J., which was built in sections of about five feet, a day's work, the rods being imbedded in the concrete in horizontal rings and in vertical lines. The chimney is 150 feet high.

Concrete without any reinforcement, was used as long ago as 1860 in Germany for a factory chimney about 160 feet high.

Portland Cement Concrete Reservoirs

(From "Hand Book for Cement Users.")

In a description of the construction of the Forbes Hill reservoir at Quincy, Mass., Mr. C. M. Saville states that the bottom and slopes were lined with concrete. The bottom layer of concrete was made of cement, sand and broken stone in proportions of 1 : 3 : 6. When this was finished a layer of Portland cement plaster made of 1 part Portland cement and 2 parts sand, with a finishing surface of 4 parts cement to 1 sand, was laid in strips about 4 feet wide and finished like a granolithic walk. Long strips of coarse wet burlap were used to keep this layer wet and cool, but some cracks appeared. They were thoroughly grouted, and the top layer was then put on. It was laid in alternate blocks. These blocks were 10 feet square for the bottom of the reservoir and 8 x 10 feet on the slopes. When the first set of blocks had hardened the remaining blocks were laid. These blocks were made the same as the bottom layer except that for the stone in top arch was substituted stone dust and fine broken stone, passing through a 3/8-inch screen, laid before the base of the block had set.

A GUARANTEE

EVERY BARREL OF "RATHBUN'S STAR" IS GUARANTEED to fill the following specifications for FINENESS, SOUNDNESS and STRENGTH.

FINENESS.—Not more than eight per cent. shall be retained on a standard wire sieve with 10,000 holes per square inch. Not more than twenty-five per cent. shall be retained on a standard wire sieve with 40,000 holes per square inch.

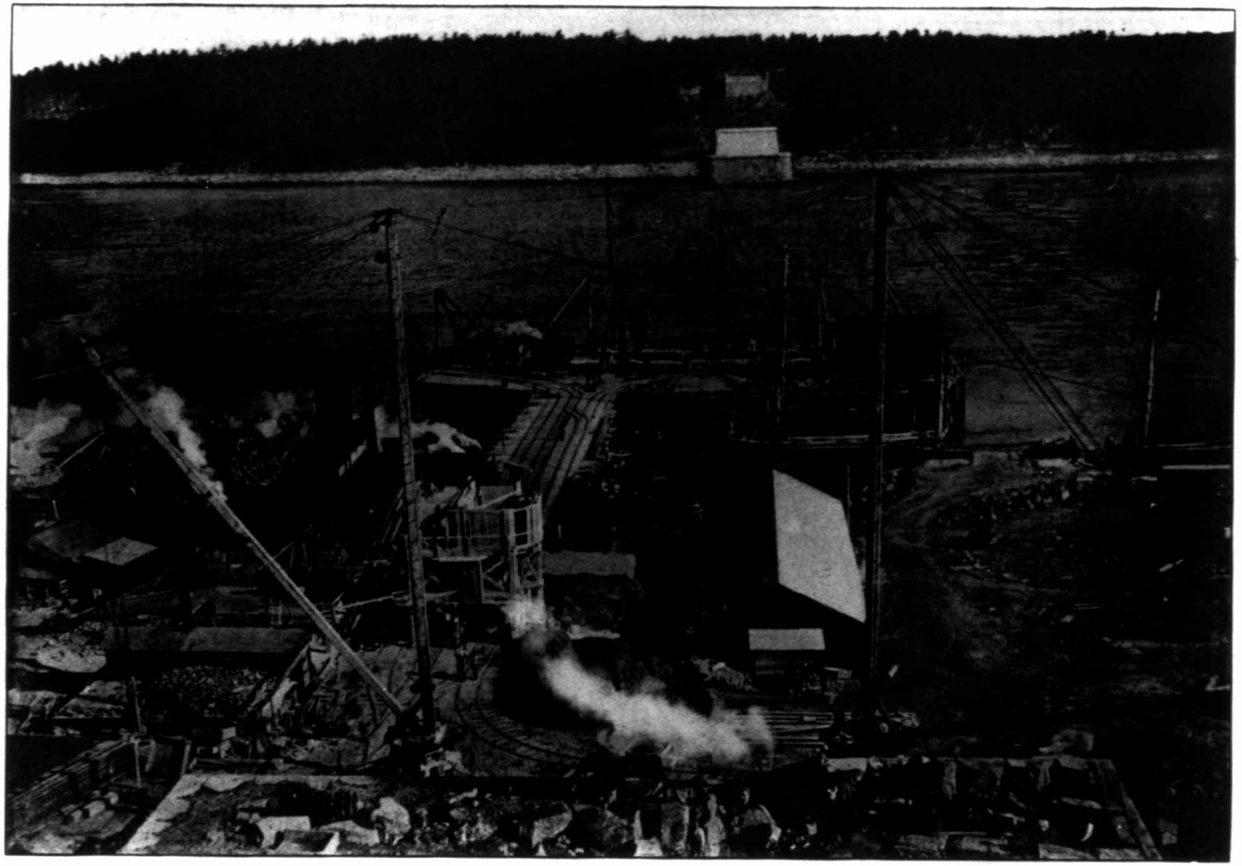
SOUNDNESS.—A thin pat of cement on glass, allowed to get hard in air, while covered with a moist cloth, and then submerged in water at 120° F. for twelve hours, must show no signs of warping, swelling or cracking.

STRENGTH.—Neat briquettes, properly guaged with eighteen per cent. by weight of water and compressed into moulds under a static pressure of at least twenty pounds per square inch, must show a tensile strength of five hundred pounds per square inch after one day in moist air and six days in water; and six hundred pounds per square inch after one day in moist air and twenty-seven days in water.

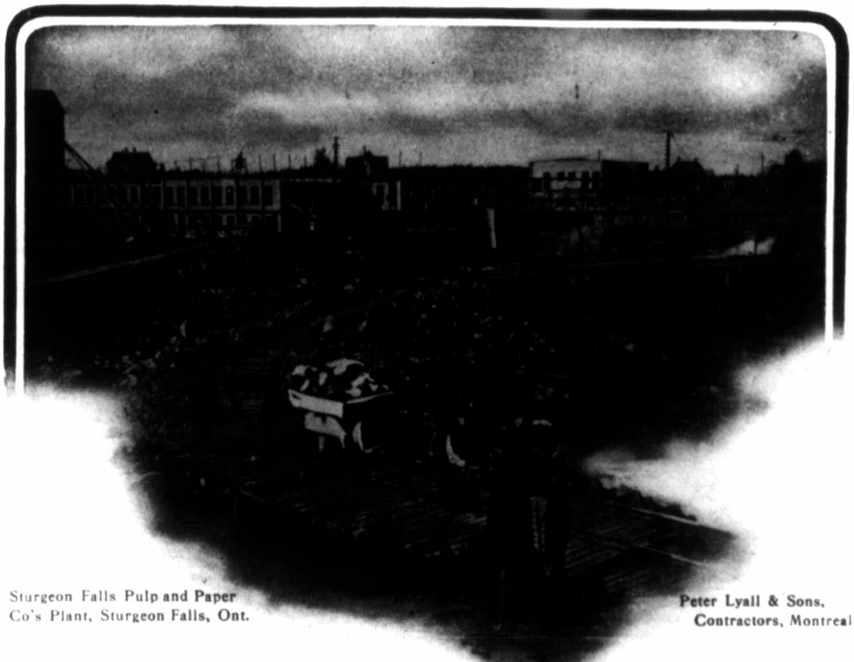
Mortar briquettes, guaged with eight per cent. by weight of water, made of three parts of standard quartz sand to one part of cement by weight, and put into the moulds under a static pressure of at least twenty pounds per square inch, must show a tensile strength of one hundred and fifty pounds per square inch after one day in moist air and six days in water; and two hundred pounds per square inch after one day in moist air and twenty-seven days in water.

The above specifications will be recognized by engineers, architects and contractors as ensuring a first-class cement. Any correct test of "RATHBUN'S STAR" ever made has shown strengths very much higher than those guaranted above.

In the event of any misunderstanding as to the interpretation of these specifications or of the results obtained in testing, the decision of McGill College, Montreal, or the School of Practical Science, Toronto, is to be final.



Mr. M. P. Davis' Plant, Quebec Bridge, Opposite Sillery, Quebec



Sturgeon Falls Pulp and Paper Co's Plant, Sturgeon Falls, Ont.

Peter Lyall & Sons, Contractors, Montreal

Portland Cement Used Under Water

When necessary to use Portland cement concrete or mortar, for this purpose, the mixture must be protected from any disturbance whatever by the water when being put into place, and great care should be taken that the water in which it is afterwards submerged be still. If exposed to flowing water, either before or after deposit, the cement, the sand and the stone will invariably be separated.

Pointing Walls

Whether a wall be built of brick or stone, it is most important that sufficient of the old mortar be removed from the joints to provide "keys" for the proper adhesion of the fresh mortar. The cleaned joints should then be well wetted, and the work frequently sprinkled lightly afterwards with water, until the mortar has thoroughly hardened.

Plastering

The wall should be cleaned in the same manner as prescribed for pointing, the brick or stone itself thoroughly washed and wetted, and the work afterwards kept damp, in the same manner as in pointing, and until the same results are obtained.

Specifications for Mixtures for Portland Cement Work

CONCRETE FOR FOUNDATIONS

1 part "RATHBUNS STAR." 3 parts clean, sharp sand. 5 to 6 parts clean stone or brick, broken to irregular sizes, not exceeding 2 inches in diameter.

CONCRETE FOR CELLAR FLOORS

1 part "RATHBUN'S STAR." 4 parts clean, sharp sand. 8 parts broken stone, brick or gravel.

TOP DRESSING OR FINISHING FOR WALKS OR FLOORS

1 part "RATHBUN'S STAR." 2 parts crushed limestone or sifted gravel, the fragments of neither to exceed a diameter of 1/4 inch.

CONCRETE DRAIN TILE

1 part "RATHBUN'S STAR". 3 to 4 parts clean, sharp gravel.

POINTING MORTAR

1 part "RATHBUN'S STAR". 3 parts clean, sharp sand.

PLASTERING MORTAR

1 part "RATHBUN'S STAR". 2 parts clean, sharp sand.

The proportion of sand used in mortar for plastering must be less than that for other purposes. Otherwise the mortar will be "short" making the work difficult.

BRICKWORK AND MASONRY MORTAR

For Brickwork 1 part "RATHBUN'S STAR". 3 parts clean, sharp sand.

For Masonry 1 part "RATHBUN'S STAR". 4 parts clean, sharp sand.

Very great care should be taken that the brick and stone be well wetted. Unless this is done, the moisture in the mortar necessary for the proper setting of the cement will be absorbed and the mortar itself left valueless.

GROUTING FOR PAVING BLOCKS

1 part "RATHBUN'S STAR". 3 parts clean, sharp sand.

The quantity of water to be added to the above mixture must necessarily be greater than that used in Portland cement mixtures for any other purpose, and it is therefore difficult to keep the mixture at an even consistency. After pouring, the sand settles to the bottom of the joint making a sand filling above with no binding strength whatever. To avoid this weakness, only one-half the depth of the joint should be filled at one pouring, allowing this deposit time for partial setting before the second pouring.

In this way a perfectly strong bond is formed at both the centre and upper parts of the block.

The precaution of making two or more pourings according to conditions, in grouting of any nature, should be carefully observed.

Capacity of Portland Cement in Mixture

1 bbl. of "RATHBUN'S STAR," with 1 bbl. of sand will cover about 67 sq. ft. 1 in. thick.
1 bbl. of "RATHBUN'S STAR," with 2 bbls. of sand will cover about 104 sq. ft. 1 in. thick.
1 bbl. of "RATHBUN'S STAR," with 3 bbls. of sand will cover about 140 sq. ft. 1 in. thick.

The following tables are from "Hand Book for Cement Users."

Proportions for the Making of Portland Cement Mortar

Proportions	Cement	Sand	Resulting Mortar
1 to 1	1 barrel	3.5 cubic feet	6.0 cubic feet
1 to 2	1 barrel	7.0 cubic feet	8.0 cubic feet
1 to 3	1 barrel	10.5 cubic feet	10.7 cubic feet

The volume of mortar in fractions of a cubic yard necessary to lay a cubic yard of masonry, is as follows:

For Brickwork, 1/8 inch joints	.15
For Brickwork, 1/4 inch joints	.25
For Brickwork, 1/2 inch joints	.40
For Ashlar, 20 inch courses	.06
For Squared Stone Masonry	.20
For Rubble Masonry	.25
For Concrete, broken stone	.55

Necessary Ingredients per Cubic Yard of Portland Cement Mortar and Concrete

To make one cubic yard of Portland cement mortar the following quantities of cement and sand are required for the proportions stated, the cement being given in barrels, packed, and the sand in cubic yards.

Proportions	Barrels of Portland Cement	Cubic Yards of Sand
Neat cement	7.14	0.
1 cement, 1 sand	4.16	0.67
1 cement, 2 sand	2.85	0.84
1 cement, 3 sand	2.00	0.94
1 cement, 4 sand	1.70	0.98
1 cement, 5 sand	1.25	0.99
1 cement, 6 sand	1.18	1.00

Weights and Measures of Concrete Materials

Sand weighs from 80 to 100 pounds per cubic foot dry and loose, and from 90 to 115 pounds dry and well shaken.

A Grand Trunk Railway Culvert, 20 foot opening, 205 feet long, near Port Hope, Ont.
Wm. Gibson, Ex.-M.P., Contractor

Gravel weighs from 100 to 120 pounds per cubic foot loose, and about 20 pounds more when well rammed.

Crushed limestone weighs about 90 pounds per cubic foot, varying somewhat either way with the size and amount of fine dust.

Copper slag which has been used successfully where weight is wanted in concrete, weighs 120 to 125 pounds per cubic foot.

Quicklime weighs 64 pounds per cubic foot.

Portland cement, loose, weighs 70 to 90 pounds per cubic foot; packed, about 110 pounds per cubic foot.

Approximate Weights of Portland Cement Concrete

When made with cinders	60 to 80 lbs. per cubic ft.
When made with broken brick	100 to 110 lbs. per cubic ft.
When made with crushed lime stone	125 to 135 lbs. per cubic ft.
When made with crushed granite	160 to 170 lbs. per cubic ft.

The following table of approximate quantities of materials to make 100 cubic feet of finished concrete shows the reduction in amount of cements used if the ingredients are measured in the mixing box rather than in the original package :

Proportions of Cement to aggregate	Barrels of Cement, when proportioned by barrels	Barrels of Cement, when proportioned by measurements	Yards of Aggregate
1 to 1	18.3	15.8	2.75
1 to 2	11.6	10.	3.85
1 to 3	8.7	7.5	3.95
1 to 4	6.9	5.9	4.15
1 to 5	5.6	4.7	4.30
1 to 6	5.0	4.3	4.40
1 to 7	4.4	3.7	4.45
1 to 8	3.9	3.3	4.46
1 to 9	3.4	2.9	4.47
1 to 10	3.0	2.6	4.48
1 to 11	2.8	2.4	4.50
1 to 12	2.5	2.2	4.53
1 to 13	2.4	2.0	4.55
1 to 14	2.3	1.9	4.57
1 to 15	2.2	1.8	4.59
1 to 16	2.1	1.7	4.62
1 to 17	2.0	1.6	4.63
1 to 18	1.9	1.5	4.65
1 to 19	1.8	1.4	4.68
1 to 20	1.7	1.3	4.70

The following table shows the variations in amount of ingredients necessary to make a cubic yard of concrete. The table appears in the report of a committee on the use of cement made to the Association of Railway Superintendents of Bridges and Buildings, and is made up from reports of such superintendents for various railways, giving their actual practice and observation :

PROPORTIONS			AMOUNT OF INGREDIENTS		
Portland Cement	Sand	Crushed Stone	Portland Cement	Sand	Crushed Stone
			Bbls.	Cu. Yds.	Cu. Yds.
1	1	2	3. 1.5	0.39 0.45	0.79 0.96
1	2	4	1.4 1.6	0.42	0.83
1	2	5	1.0 1.2	0.35	0.95
1	3	4	0.92 1.0	0.36 0.51	1.00 0.87
1	3	5	1.1 1.2 0.96	0.5	0.9
1	3	6	1.2 1.0 1.2	0.5 0.55	1.00 1.00
1	3	6	0.82	0.37	0.72
1	3	$6\frac{2}{3}$	0.96	0.43	0.94
1	3	$7\frac{1}{2}$	0.9	0.35	0.95
1	4	$7\frac{1}{2}$	0.68	0.35	0.96

GRANOLITHIC WALKS AND FLOORS

T. I. Ry. Engine House, Gananoque, Ont. Built entirely of Concrete

AN essential preparation for the laying of walks and cellar floors, is the proper drainage of the surface to be paved. Where the bed to be paved offers no natural drainage, a sufficient depth to allow the placing of a layer of broken stone or coarse gravel, varying in depth from four to twelve inches should first be excavated. The latter quantity is used where pavements are exposed during the winter season to the action of frost. The concrete and top dressing should be divided into five feet sections, leaving a space between the blocks, generally one-half inch in width. which is filled with dry sand.

These divisions allow for the expansion and contraction of the concrete, consequent upon changes of temperature. Surface cracks seldom appear after the exercise of this precaution.

To procure the greatest possible strength in floors and walks it is necessary that the top dressing or finish be laid almost immediately after the concrete is put into place, and under no circumstances should the setting of the concrete be more than appreciably begun before the laying of the top dressing. Otherwise a perfect bond will not be assured. It is very necessary that the bond between the concrete and the top dressing should be perfect. If the finish is laid after the concrete has hardened, a space is left between the two layers, into which water will find its way in wet weather. This, during frosty weather, is the cause of the upheaval of the top layer of outside walks. Thorough drainage and a perfect union of the two layers are absolutely essential to permanency.

Too much trowelling of the top dressing results in a crumbling, or scaling surface later. The sprinkling of the surface with dry cement to absorb the surplus water is also attended frequently with poor results. It is advisable to use a smaller quantity of water. The sprinkling of the dry cement will then be quite unnecessary.

Two G. T. Ry. Culverts near Newtonville, Ont. 8 and 20 foot openings

Wm. Gibson, Ex.-M.P., Contractor

A common fault in cement work is the excessive use of water, seriously prolonging the time of set, as well as reducing the ultimate strength. In concrete the result is the presence of many voids and a proportionately weakened mass.

Walks and floors when laid in warm weather, or when exposed to heat of any nature, should be covered with canvas or coarse cotton, kept damp until the cement has thoroughly hardened. Sprinkling lightly for a few days after is most beneficial.

The following two diagrams are shown to illustrate the essential formations in Granolithic walk construction.

Figure I, illustrates a combined Granolithic walk and curb. This form of construction is generally used on such streets as are most largely used.

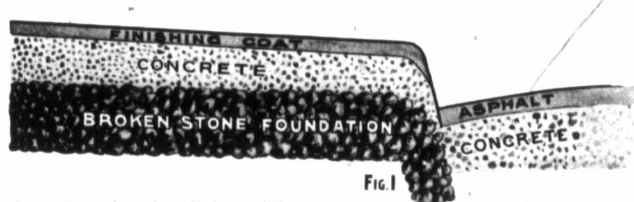


FIG. I

Walks of similiar formation reduced to 3 inches of concrete and 1 inch of top dressing have been found entirely satisfactory on residental streets.

Figure II, illustrates a combined Granolithic walk, curb and gutter, a very satisfactory form of construction for paved or unpaved streets, particularly for asphalt roadways. The asphalt if carried to the curb is seriously affected in the portion by deposits of surface drainage.

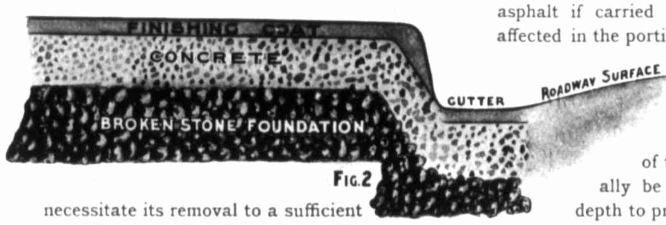


FIG. 2

When preparing walk grades, the nature of the subsoil may occasionally be found to be such as to necessitate its removal to a sufficient depth to provide for a refilling with gravel as a suitable foundation bed.

Quarter inch iron plates with curved ends firmly imbeded in the walk and well anchored are sometimes used at narrow street corners and at corners of streets carrying very heavy traffic as curb protectors.

Each view shown in this booklet is of work done most satisfactorily and either exclusively or largely with Rathbun's "Star."

SPECIFICATIONS FOR GRANOLITHIC SIDEWALKS

CORPORATION OF THE TOWN OF PRESCOTT

W. B. SMELLIE, Town Engineer.

LINE AND GRADE.

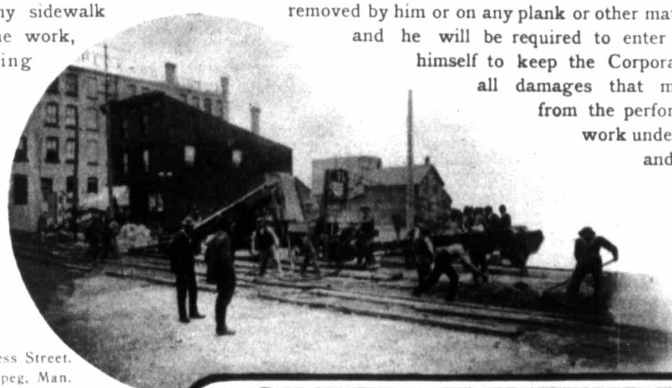
1. The sidewalks to be laid down to the lines and grades shewn upon the plans and set out by the Engineer upon the ground. The space between the Street line and Curb line shall be of such widths as may be determined by the Council.

MATERIALS, TOOLS, ETC.

2. The prices submitted in the tenders must include the providing of all materials, tools, and labor required in the performance of the work, and for the excavation of all material to the depths required from the line of Curbing to the full width of the new sidewalks, and the removal of said material to such places as the Engineer may direct, within a distance of one-half mile.

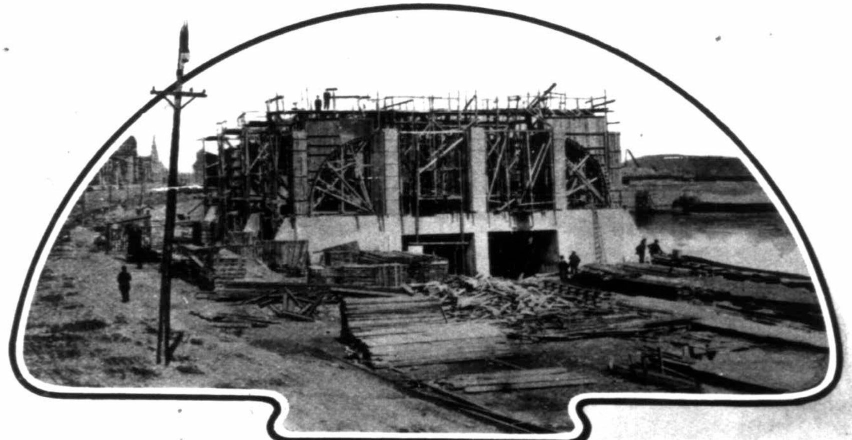
3. The present sidewalks must only be removed in sections of sufficient length to enable the work to be properly carried on, and so as to not unnecessarily interfere with the public traffic.

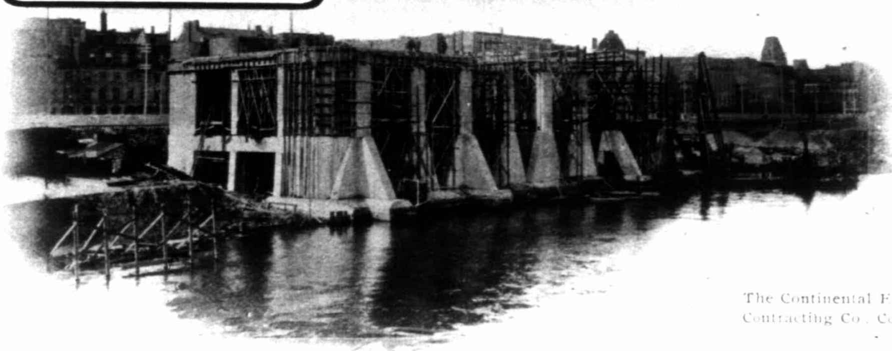
4. The Contractor in carrying on the work must so arrange as to offer the least obstruction to the public travel; and he will be held liable for all damages which may occur during the performance of his work, either from persons falling and injuring themselves on the temporary, or any sidewalk removed by him or on any plank or other material delivered on the work, and he will be required to enter into a Bond, binding himself to keep the Corporation harmless from all damages that may be caused from the performance of the work under his contract; and further must provide and attend to the lighting of all lamps required, and shall enclose at his own expense any portion of the work by barricades or employ watchmen, and also construct temporary side-walks or platforms whenever directed to do so by the Engineer or Inspector of said work. Contractor must bind himself to commence the work within a time to be agreed upon with the Corporation and to pursue the work continuously till completed.



Princess Street.
Winnipeg, Man.

Showing Mixer and Concrete Placer at Work





Montreal Harbor Elevator in
Course of Construction

The Continental Engineering &
Contracting Co., Contractors

5. The excavation or embankment shall be made to within 18 inches of the established grade line. Soft or spongy places not affording a firm foundation shall be dug out and refilled with approved material well rammed. The sub-grade when completed must conform to the required cross section.

GRADING.

6. A 3 inch agricultural tile drain to be laid on a pine plank 6 x 1 bedded in the bottom of a small trench at least 12 inches deep below subgrade, along the center line of walk. The tile to be laid on an even grade having a fall of not less than 1 in 200. The tile to be carefully surrounded and protected by the broken stone, as per cross section, and be properly connected to the nearest storm drain or catch water basin.

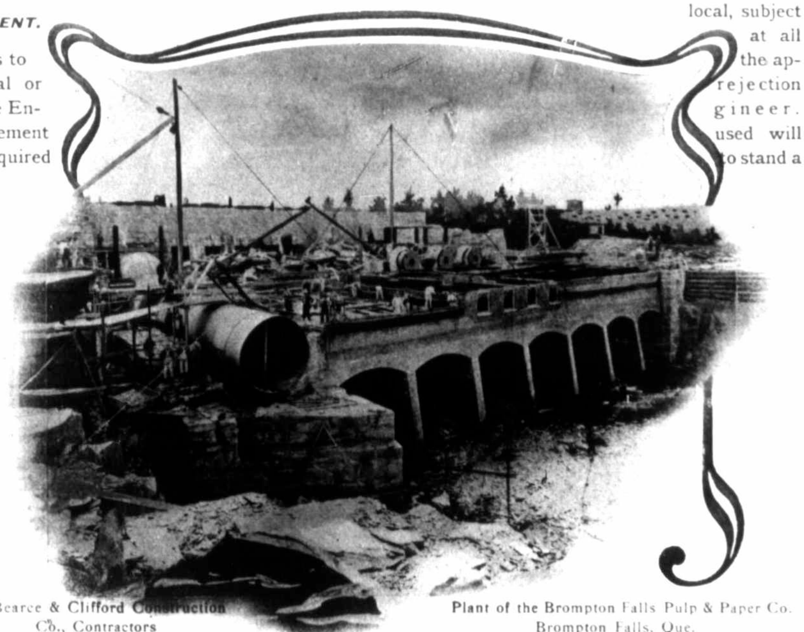
TILE DRAIN.

7. The foundation for the pavement will be of broken stone 12 inches in depth, of clean limestone or stone of the neighborhood suitable for macadam, from 2 to 6 inches through, having the openings or interstices well filled, and the whole thoroughly compacted and rammed.

FOUNDATION COURSE.

8. All the cement used must be of the very best quality, freshly made Portland, imported or local, subject at all times to the approval or rejection of the Engineer. All cement used will be required to stand a tensile strain of 300 lbs. per square inch after seven days immersion. Tenders to name brand of cement that will be used.

CEMENT.



The Bearce & Clifford Construction Co., Contractors

Plant of the Brompton Falls Pulp & Paper Co. Brompton Falls, Que.

9. All the concrete material must be mixed on boards, and on no account will it be allowed to be mixed on the surface of the ground.

10. The Curbing of sidewalks to be all of artificial stone six inches in width and two feet in depth formed of concrete, the face having a batter of 3 inches in its height. The stone for the Curb concrete must be broken so as not to exceed one inch cubes, the cement and sand being in the proportion of one to two and one-half, and of ample quantity to fill all the interstices. In forming the Curb care must be taken that the face be well filled against the face plank and rammed with iron beaters of a proper size for the purpose. The outside finish will be the same as that described for the pavement, but must have an increase thickness on the exposed angle by extending five inches down the face and three inches on the surface, as per cross section. At street corners the Curbing will be circular but no additional price will be

CURBING.

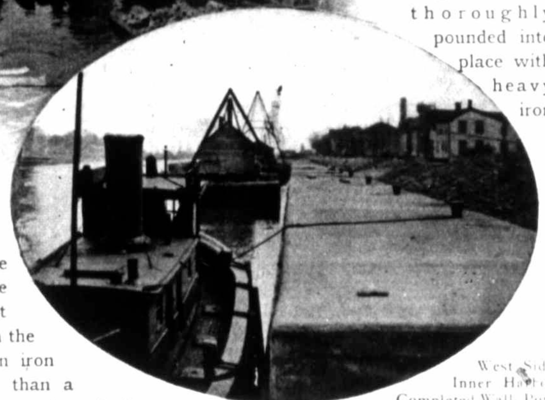
Ten Ton Concrete Blocks being placed in position upon the Crib Work

allowed therefor, beyond that stated in the tender, and must have a steel protecting band 6 inches wide and 3-16ths inches thick secured to the concrete same as in similiar situations in the sidewalks in the Town of Brockville.

CONCRETE.

11. The course of concrete overlaying the foundation to be four and one-half inches deep; to consist of approved stone, broken so as to pass through a ring one and a half inches in diameter. The proportions shall be cement, one measure; clean, sharp sand, two and one-half measures; and broken stone, five measures; to be mixed and placed as directed by the Engineer, and thoroughly pounded into place with heavy iron beaters. Should the mortar in these proportions be insufficient to thoroughly fill the interstices, additional cement and sand will be added as may be directed by the Engineer. Every six feet a cut shall be made completely through the concrete before it is set, with an iron suited for the purpose, not less than a quarter of an inch thick. The opening shall be filled with clean, dry, sharp sand. Care will be taken to make these cut edges perfectly true and straight when finished. The scantlings used for separating the blocks while laying the concrete and finishing courses to be of sufficient width to prevent bending.

Ten Ton Concrete Blocks holding Cribs in position for filling



West Side Inner Harbor Completed Wall, Port Colborne Harbor Work. Hogan & Macdonnell, Contractors

FINISH.

12. The finishing course to be one and one-half inches deep, composed of one part cement and two parts finely broken granite that has been reduced by rolls or crushed to irregular cubes which will pass through a half inch mesh, and entirely free from dust. This course to be well compacted and made to become a part of the course below. The time between the laying of the concrete course and the finishing course shall not exceed four hours. The upper or finished surface to be indented with rollers, to such pattern as may be required. When finished the sidewalk will have a fall to the Curb of a quarter of an inch to each foot in width. On completion of the walk the front boards shall be removed to a depth of at least twelve inches, on both sides of the walk, and the faces thus exposed will be neatly smoothed over with cement mortar, made from one of cement and two and a half of sand, and

after due time the earth will be neatly filled into a uniform height of six inches from the top of the Curb in front, and to the surface of the walk at back.

13. Upon sections of sidewalk being finished the Contractor must adopt measures to protect them from exposure to a hot sun, and must carefully fence or otherwise protect them from public use for a period of four days, and the Town council will hold him responsible for this being done. Where temporary crossings are absolutely necessary a ramp and plank crossing must be provided so as to guard against damage to the walk.

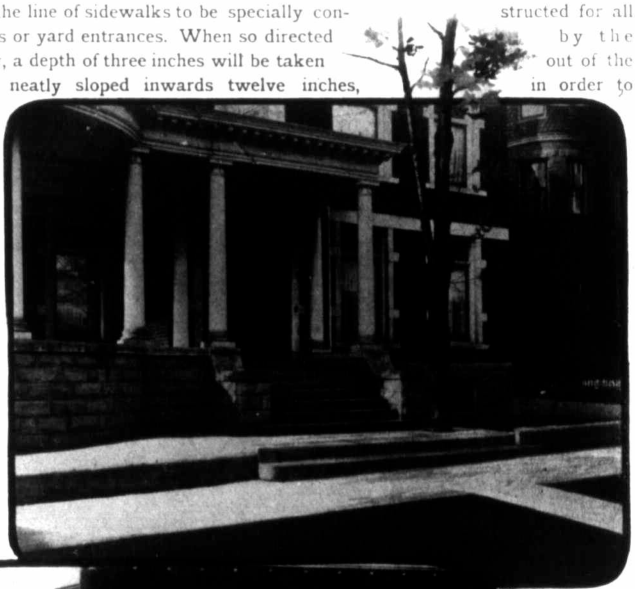
PROTECTION TO FINISHED WALK.

14. In any case where the new sidewalk is not continued inside the street line and up to the face of the buildings, a 2 x 10 inch plank dressed and set on edge will be firmly braced at the required width and height, and the pavement finished flush with the same. When the pavement is continued up to the face of the buildings, it must be of the same character and description as that herein specified.

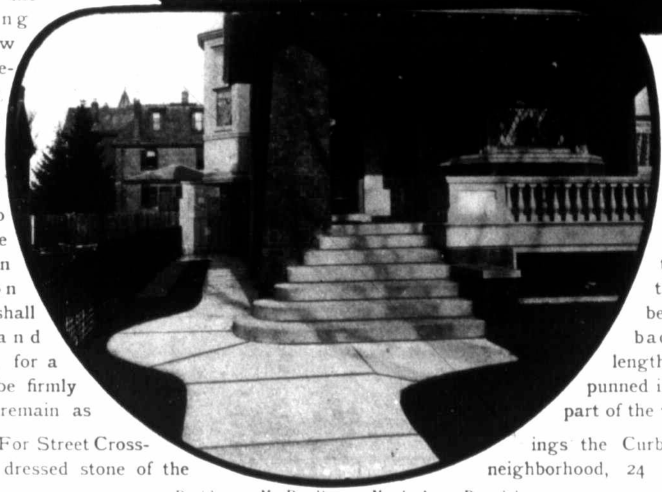
SIDEWALK INSIDE STREET LINE.

15. Driveways on the line of sidewalks to be specially constructed for all gateways or yard entrances. When so directed by the Engineer, a depth of three inches will be taken out of the edge of the Curb and neatly sloped inwards twelve inches, in order to allow vehicles to pass more freely over the edge. The sloped part to be backed with the specified depth of concrete and surface finish. Otherwise there will be no break in the edge of the sidewalk. The surface of the sidewalk at these crossings to be neatly grooved. A strip of tarred iron 7 feet long 6 inches wide by one-quarter inch thick, will be secured to the face of the Curbing below the driveway, with three three-quarter inch screw bolts, sixteen inches long having their ends turned four inches so as to secure them to the concrete. In addition to this protection the facing planks shall be again set on face and back of driveways, for a length of at least 8 feet, be firmly punned in, and allowed to remain as part of the walk.

DRIVEWAYS



Residdnce Dr. Charles Sheard, Jarvis St., Toronto. M. Heard, Architect. The Crescent Concrete Paving Co., Contractors



Residence, M. Rawlinson, Maple Ave., Rosedale
A. Frank Wickson, Architect. The Crescent Concrete Paving Co., Contractors

16. For Street Crossings the Curb required will be of dressed stone of the neighborhood, 24 inches by 6

STREET CROSSINGS.

inches and no stone to be less than four feet long, laid at such levels and distances apart as the Engineer may direct. The Curbing to be thoroughly pointed and grouted. The same preparations and excavations shall be made as for sidewalks. The foundation course to be 12 inches the concrete course, 4 inches, and the finishing course 2 inches deep. The artificial stone to be worked up close to the curbing and well grouted, the surface to be finished flat or slightly rounded as the Engineer may direct. Cuts to be made through the artificial stone as in sidewalks and the surface to be neatly grooved.

New Science Building, Toronto University

IMPERFECT WORK.

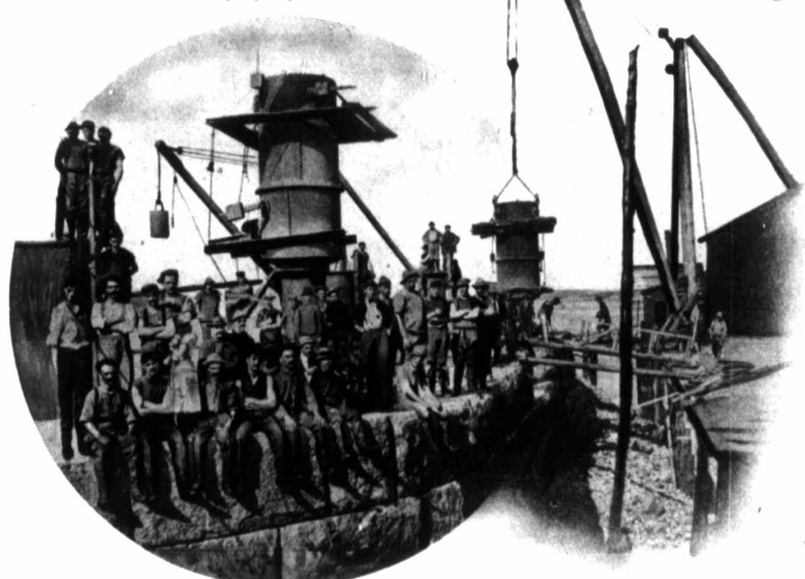
17. The Contractor on being so directed by the Engineer shall remove and make good at his own expense any work which the latter shall decide to be deficiently or improperly executed.

FIT ROUND TELEGRAPH POLES, ETC.

18. The Contractor shall carefully fit the pavement to all iron covers, stop cock boxes, lamp posts. hydrants, telegraph, telephone or electric light poles, also round projecting steps, area or window gratings, or any other openings that may be in the present walks. In measurements half grating openings will be allowed.

REPAIRS TO AREA WALLS, GRATINGS, Etc.

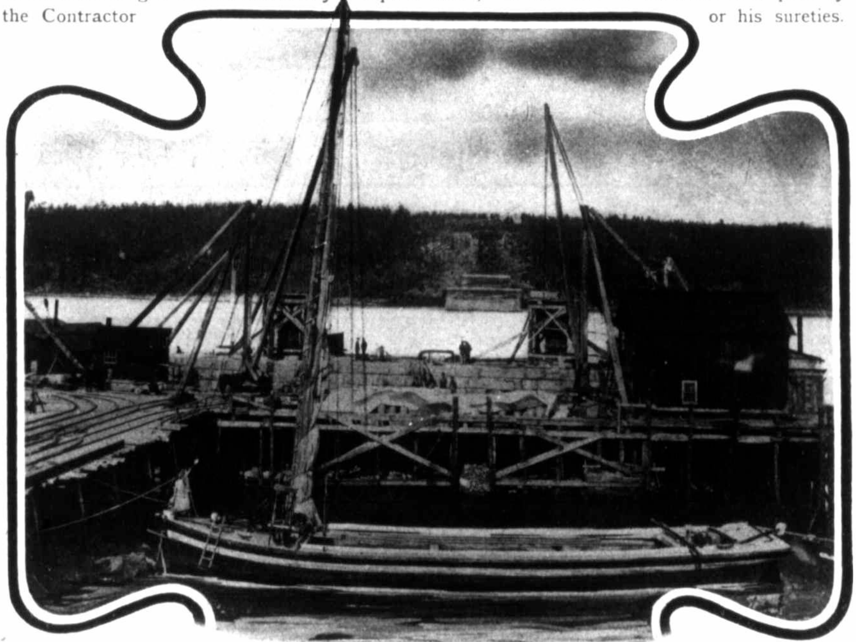
19. The Contractor shall facilitate by all means in his power, the repairing and building up of the area walls for gratings, etc., that may be required. The work to be done at the expense of the owners of property under the direction of the Town Engineer.



Main Caisson Pier Quebec
Bridge, South Side. M. P. Davis, Contractor

20. The prices submitted in tender must include the cost of the repairs and maintenance in first-class shape for a period of five years after completion of the work, and the Contractor whose tender is accepted will be required to enter into a Bond with approved sureties to the satisfaction of the Town Council to amount of ten per cent. of original contract, binding himself to keep all the pavements constructed under his contract in a sufficient and satisfactory state of repair for the said period of five years after completion, and in case of default in so doing, that power to be given to the Town Engineer for the time being to have the necessary repairs made, and the cost of the same to be paid by the Contractor or his sureties.

GUARANTEE.



A Pier of the Quebec Bridge over the St. Lawrence River

M. P. Davis, Contractor, Ottawa, Ont.

21. Payments will be made monthly as the work progresses, less twenty per cent., which will be retained until the final completion and acceptance of the work. These payments shall not relieve the Contractor and his sureties from their obligations under the guarantee clause.

PAYMENTS.

WORKMEN. 22. All the workmen employed must be residents of the Town of Prescott, except the skilled labor necessary.

23. An accepted bank cheque payable to the Corporation of the Town of Prescott for $200.00 must accompany each tender as a guarantee of good faith. The successful Contractor must enter into a contract with the town, said contract to be drawn by the Town Solicitor and satisfactory sureties shall be named. No work under this contract shall be sublet.

24. All stone used in the construction of these walks, except granite used in finishing, must be stone provided by the Corporation, which will be furnished at the following rates :

Rough foundation stone, per cord $1.75.

Crushed concrete stone, per cubic yard $1.10.

Same to be measured at pile within about one-quarter of a mile of work, and drawn to work by Contractor.

The Canadian Pacific Railway's Grain Elevator, Fort William, Ont. The Macdonald Engineering Co., Chicago, Contractors

A Few Clauses from Toronto's Specifications for Granolithic Sidewalks

EXCAVATION.

1. The street referred to in the contract (of which this specification forms a part) is to be excavated and graded to the depth and width shown on the drawing having reference thereto, and to the levels given on the ground by the Engineer, and also to such greater widths and depths as may be required to enable the curbing to be properly set, or as the Engineer may direct. The levels and cross-sections, may, however, be varied at the discretion of the Engineer to conform with the sills of buildings affected thereby, and the grades of intersecting streets.

CONSOLIDATION OF TRENCHES, Etc.

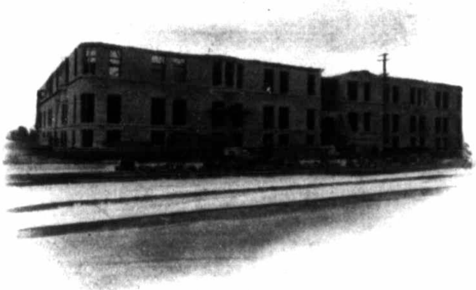
2. All trenches or excavations that have been made for, or in connection with sewers, private drains, gas or water pipes, telephone or elecric light wires, pipes or conduits, or any other lawful purpose, and which are not thoroughly settled, shall be opened out and refilled, in six inch layers of gravel, well pounded, and watered if directed or necessary, until quite solid.

DEFECTIVE PLACES.

3. Soft, boggy, spongy, or defective places encountered in excavation or elsewhere, must be wholly removed to such depth and extent as may be required by the Engineer, and all such places made good, as specified in clause 2. Where gravel filling is used under clauses 2 or 3, no extra allowance will be made the Contractor.

BOULDERS, TREES, Etc.

4. The Contractor will be required to remove, without extra remuneration, all boulders, stones, rocks, stumps, roots, trees, walls or other obstructions found upon the line of work, and fill up all areas or coal chutes for which no permits have been issued. All such filling to be of approved material, thoroughly rammed in six inch layers. The Contractor to provide proper protection to prevent the filling from spreading on private property.



Strathcona Block, Winnipeg, Man.

SURPLUS MATERIAL REQUIRED BY CITY.

5. No surplus material of any kind arising from the work or any portions thereof, shall be sold, thrown away, dumped, wasted or otherwise disposed of, without the Engineer's written sanction, and if so disposed of, the Engineer shall ascertain as nearly as he can conveniently the quantities and value, and deduct the same from the Contractor's estimate. All surplus material shall be neatly deposited and evenly spread where and as directed by the Engineer, within an average distance of one mile. The whole expense of unloading and spreading to be borne by the Contractor. Old lumber, stone flagging or other materials of value to or required by the City, are to be neatly piled in the nearest Corporation Yard, or such other place as may be directed by the Engineer, within a distance of one mile. The above mentioned surplus material must be conveyed and deposited as soon as excavated to such places as the Engineer may direct, and the Contractor will not be allowed to pile any of the excavated material upon the sides of the street, except by Engineer's written permission.

SURPLUS MATERIAL NOT REQUIRED BY CITY.

6. All surplus material not required by the City must be disposed of by the Contractor off the line of works, but in such a manner as not to cause a nuisance, injury or inconvenience to the City or to public or private parties, otherwise the Contractor will, in all cases, be held liable for, and must indemnify the City against all claims in respect thereof.

The Canadian Pacific Railway's Grain Elevator, Fort William, Ont. The Macdonald Engineering Co., Chicago, Contractors

25. Concrete curb is to be made of the best description of Portland cement concrete. It must be constructed in sections, in place, by skilled workmen only, and under the Engineer's directions. The curb will be 6 inches in thickness, and 18 inches in depth ; the body or lower part of the work will be of concrete, composed of one part of cement to five parts of approved gravel, and for the outer layer or exposed surface, (which must be at least $1\frac{1}{2}$ inches thick,) two parts of cement to three parts of approved crushed granite. All dust must be screened out of the crushed granite, and no particle shall be over $\frac{5}{8}$ inch in length or breadth. Only the very highest grade of Portland cement shall be used in the surface layer, of which the Engineer shall be the sole judge. Proper provision must be made for expansion and contraction, and any damage arising therefrom, or from any other cause at any time until the termination of the period of maintenance, must be made good by the Contractor, as and when the Engineer directs. The curb will be set on a foundation of gravel or broken stone, with a 3 inch tile drain below, as shown on the drawing.

CONCRETE CURB.

26. After the street has been graded, as above described, a foundation shall be laid, composed of clean broken brick or stone chippings, free from dust or dirt, not less than 2 inches or more than 4 inches in diameter, or coarse gravel or suitable soft coal cinders. Upon this a 3 inch layer of clinker or engine cinders, free from dust or ashes, is to be laid, and the whole thoroughly pounded and brought to an even surface. Whilst pounding, a small quantity of water may be used through a sprinkler at the direction of the Engineer.

FOUNDATION.

Clauses Nos. 28 and 31 cover the construction of wide walks on much frequented streets.

28. Upon this foundation a layer of concrete, $3\frac{1}{2}$ inches thick, shall be laid, composed of one part of Portland Cement, (of approved quality,) and one part of clean, sharp, coarse sand, and three parts screened gravel, thoroughly free from stones over 2 inches in diameter, and free from loam, clay, dirt or other impurities. Samples of the sand and gravel must be approved by the Engineer before any is brought upon the works. The sand, gravel and cement must be carefully measured and thoroughly mixed on boards whilst dry, by heaping and hoeing or raking, and water afterwards added in small quantities, each batch being completely turned over while wet at least four times. The concrete thus made shall be rammed with iron rammers into one solid mass, and until it has a straight, even surface. The whole operation of measuring and mixing must be done to the entire satisfaction of the Engineer, and as he may from time to time direct.

HEAVY CONCRETE BASE.

31. On the top of the concrete base, thus prepared, and before it has had time to set, the wearing surface of the walk shall be laid. The surface shall be $1\frac{1}{2}$ inch thick, and composed of one part of the best Portland cement, and two parts of crushed granite or quartzite. The cement must be of the highest quality of Portland suitable for such purpose, and approved by the City Engineer.

HEAVY SURFACE.

Clauses Nos. 29 and 32 cover the construction of narrow walks on residential streets.

29. Upon this foundation a layer of concrete, 3 inches thick, shall be laid, composed of one part of Portland cement, (of approved quality,) and one part of clean, sharp, coarse sand, and four parts screened gravel, thoroughly free from stones over 2 inches in diameter, and free from clay, loam, dirt or other impurities. Samples of the sand and gravel must be approved by the Engineer before any is brought on the works. The gravel and cement must be carefully measured and thoroughly mixed on boards whilst dry, by heaping and hoeing or raking, and water aftewards added in small quantities, each batch being completely turned over while wet at least four times. The concrete thus made shall be rammed with iron rammers into one solid mass, and until it has a straight and even surface. The whole operation of measuring and mixing must be done to the entire satisfaction of the Engineer, and as he may from time to time direct.

LIGHT CONCRETE BASE.

32. On the top of the concrete base, thus prepared, and before it has had time to set, the wearing surface of the walk shall be laid. This surface shall be $\frac{3}{4}$ inch thick, and composed of one part of the best Portland cement, and two parts of pea gravel. The cement must be of the highest quality of Portland suitable for such purpose, and approved by the City Engineer.

LIGHT. SURFACE.

39. Every six feet a cut shall be made completely through the concrete before it is set, with

DIVISIONS. an iron for that purpose, not less than ¼ inch in width. The opening shall then be filled in with clean, dry, sharp sand. Care must be taken to make these cuts perfectly true and straight, and the joints in the finished surface must coincide exactly with the same.

40. In order to ensure the correct proportions of cement, gravel, sand, crushed granite or

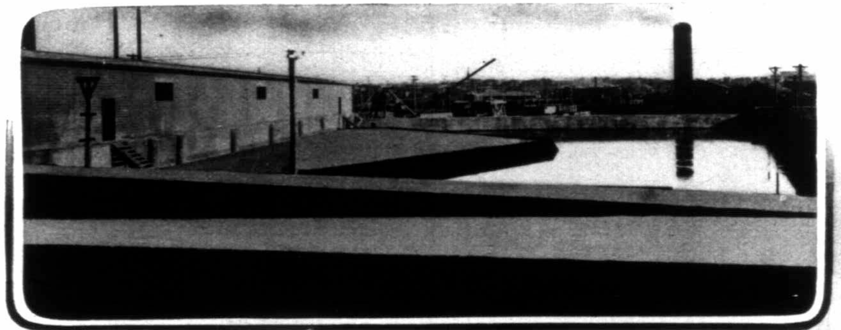
MEASUREMENT OF MATERIAL. other aggregate used in the preparation of any of the concrete mixtures required under this specification, the Contractor must provide a sufficient number of suitable, neat, planed and properly made boxes, to the approval of the Engineer, in which to measure the different materials composing the concrete, and all material used in the work must be measured in these boxes. These boxes must be made of exactly similiar dimensions and of such size as to contain exactly one measure of cement. Care must be taken whenever these boxes are used to see that they are scraped out and perfectly clean before any fresh material is placed therein. The cement, as well as the other material used, must, after being placed in the box, be struck oft true with a straight edge.

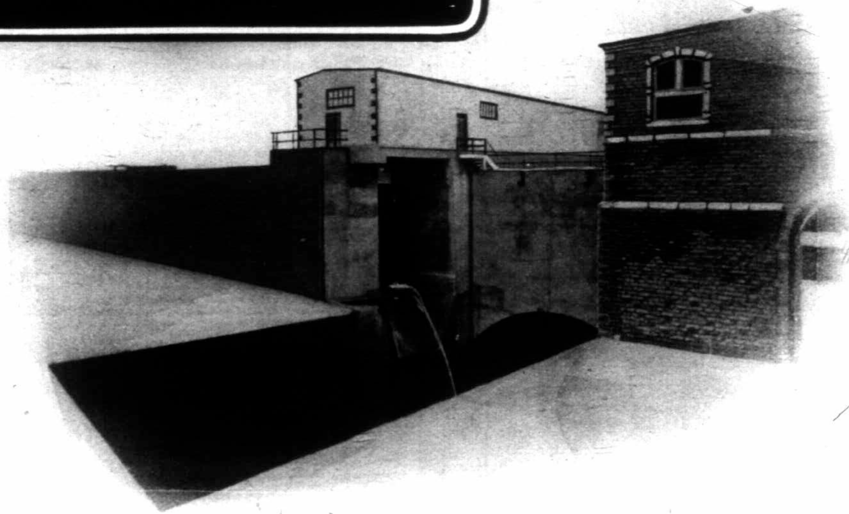
What Good Roads Mean

An Indiana Engineer has made a calculation in regard to the money saved by good roads which is receiving wide attention in connection with the movement for road improvement across the border. He estimates that the cost of moving one ton by horse-power over one mile of dry sand road is 64 cents ; over wet sand, 32 cents ; over ruts and mud, 39 cents ; over broken stone ruts, 26 cents ; over an earth road that is dry and hard, 18 cents ; over a broken stone road in good condition, 8 cents ; over a compact gravel road, 8.8 cents ; over stone paving, 5.33 cents ; over asphalt, 2.7 cents. The engineer argues that if wagon transportation at a cost of 5 cents a mile a ton could be general, many millions of dollars would be saved, and millions of tons of merchandise which cannot now be handled at a profit would be available in the markets.

The first essential for the building of good roads is a provision for thorough drainage by the laying of Portland Cement concrete drain tile.

Each view shown in this booklet is of work done most satisfactorily and either exclusively or largely with Rathbun's "Star."





Electric Power Plant, Chaudiere
Falls, Ottawa, Ont.
Ottawa & Hull Power Co.

THE PERFECT FIRE-PROOF MATERIAL

From "CEMENT," January, 1903.
With the kind permission of The Progress Publishing Co., 13-21 Park Row, New York.
(Brands of cement used in the following tests not named.)

THERE can be no subject in connection with building operations of more importance than the subject of fireproofing; either from the standpoint of safeguarding life or the preservation of property. We have witnessed tremendous calamities claiming hundreds of human beings as their victims, and the destruction of property to the amount of $150,000,000 in one year, that of 1891. Besides these losses other evil effects result from serious fires. The destruction of a manufacturing establishment means the loss of employment to men and women; and where the conflagration is extensive, as is often the case in factory, workshop and warehouse districts, the suffering inflicted is extremely severe. Besides these considerations the manufacturer and owner share in the general loss. Added to this we must include the expense of maintaining fire protection, until, finally, the figures show that the fire tax of this country in an average year is not less than $250,000,000, which sum is more than the normal expense of conducting the United States Government in all its branches, omitting interest and pensions.

The question of fireproof buildings and fireproof material, in the face of these conditions, becomes at once a matter for serious consideration and prompt settlement. We must locate the causes of these great disasters and apply a remedy. Broadly speaking, the subject can be dispensed with in a few words; use cement construction in all building operations for floors, walls, pillars, posts, stairs, roof, and, in fact, throughout. It is the one fireproof material combining great strength and durability, and permitting successful adaptations to every variety of building and conditions.

A concrete building is the acme of fireproof perfection. A few years ago the use of concrete was in its infancy, but scientific writers and investigators foretold the coming triumph with remarkable demonstrations of its strength and fireproof nature. Once its value became recognized its adoption for fireproof floors began and has continued with great activity. So great was the success of the various systems of cement fireproofing, at every public test and at every actual fire test, that all opposition to its progress was quickly swept away, and soon the acknowledgement of its superiority was given by its use in the most important building operations in the United States.

In explanation of the behavior of cement under the varying conditions of fire, we quote Professor Spencer B. Newberry, who states, "Chemistry of Concrete Steel Construction," Cement, May, 1902, as follows:—"It is well known that Portland cement is practically infusible, and that the water with which it combines in hardening is given off very slowly under the action of heat. The surprising feature of its behavior when strongly heated is that it does not crumble, crack, warp, or scale off, as most other materials do. Even after long calcination at high temperature it still shows considerable cohesion and adhesion to metal, resists the impact of powerful streams of water, and does not crack under sudden cooling. On moistening with water after ignition it again hardens. Even if this last property be found unavailable for practicable purposes, yet concrete exposed to fire and water is easily replaced, and its purpose is fulfilled if it protects from injury the steel work upon which the safety of the building depends."

"The two principal sources from which cement concrete derives its capacity to resist fire and prevent its transference to steel are its combined water and porosity. Portland takes up in hardening a variable amount of water, depending on surrounding conditions. In a dense briquette of neat cement the combined water may reach 12 per cent. A mixture of cement with three parts of sand will take up water to the amount of about 18 per cent. of the cement contained. This water is

Plate 1.—View on First Floor of Horne Store

Damage done by falling water tank. (Compare with Plate [illegible].) Steel work almost stripped of tile

chemically combined, and not given off at the boiling point. On heating, a part of the water goes off at about 500 degrees F., but the dehydration is not complete until 900 degrees F. is reached. This vaporization of water absorbs heat, and keeps the mass for a long time at comparatively low temperature. A steel beam or column embedded in concrete is thus cooled by the volatilization of water in the surrounding cement. The principle is the same as in the use of crystallized alum in the casings of fireproof safes; natural hydraulic cement is largely used in safes for the same purpose."

"The porosity of concrete also offers great resistance to the passage of heat. Air is a poor conductor, and it is well known that an air space is a most efficient protection against conduction. Porous substances, such as asbestos, mineral wool, etc., are always used as a heat insulating material. For the same reason cinder concrete, being highly porous, is a much better non-conductor than a dense concrete made of sand and gravel or stone, and has the added advantage of lightness. In a fire the outside of the concrete may reach a high temperature, but the heat only slowly and imperfectly penetrates the mass, and reaches the steel so gradually that it is carried off by the metal as fast as it is supplied."

One of the early demonstrations of the failure of porous terra cotta tile also furnished an example of the perfect fire-resisting nature of cement, occurred at Pittsburg, Pa., May 3rd, 1897, and partially or wholly destroyed a number of buildings supposed to be of fireproof construction, of the hollow tile porous terra cotta variety. The principal buildings affected by the fire included the Joseph Horne & Co's store, having fireproofing of hard clay tile; the Horne office building, with fireproofing of porous terra cotta; and the Methodist Book building, having fireproof floor composed of Portland cement concrete, the arches having a span of 16 feet and being 6 inches in thickness with a 2 inch sleeper fill.

The illustration (Plate 1) is a view of the first floor of the Horne store, and shows the wreckage caused by the fall of the water tank from the roof and it also shows the large amount of tile fallen from arch and column strewn about the floor. It was clearly demonstrated that as a protection to iron and as a fireproof floor, hard clay tile fulfilled every requirement of a complete failure.

Now that we have witnessed a notable exhibition of how porous terra cotta and hard clay tile failed under actual fire test, we note figure 2, an interior view of the Methodist Book

Building which shows the uninjured concrete floor arches of 16 foot span, of which the "Engineering News," of May 20th, 1897, says: "The floor arches were denuded of plaster leaving the concrete bare. To the structural body of the arches little damage seems to have been done, although one or two of the arches showed a slight deflection."

The general appearance of the floor arches is illustrated by the photograph, which is fairly representative of the conditions found elsewhere. Referring to the subject again, the "Engineering News," says:—"The behavior of the 16 foot span concrete floor arches in the Methodist Book Building must, we believe, be conceded by every fair-minded man to have been most excellent, and to justify the faith which many architects and engineers have shown in concrete floor constructions. It is true that the heat to which they were exposed was not as great as that in the buildings with the tile constructions; but it is also true that many of these concrete arches were in the midst of a very severe fire for a considerable time, and came through it with hardly an exception, absolutely unharmed. We believe that the Pittsburg fire adds convincing evidence to that already accumulated in engineering literature: that concrete is entitled to rank as a material of the highest value in fireproof construction." The complete triumph of concrete in this instance had much to do with advancing its use and in directing the attention of the world's builders to a material of unequalled superiority, courting the most severe tests side by side with other materials, until finally reaching the position of acknowledged excellence which it now occupies.

In comparison with the Pittsburg fire, the fire at the works of the Pacific Coast Borax Company, at Bayonne, N.J., on April 11th, 1902, offers an object lesson in the study of fireproof materials such as has never before been afforded members of architectural and engineering professions. Although there existed an abundance of testimony in regard to the practical value of concrete as a fireproof material, there has never been as perfect and complete a test, affording such thorough evidence, as exhibited at the works of the Pacific Coast Borax Company, after an intense fire had raged within the building for hours.

The building was erected four years ago, and was designed according to the Ransome System, by Mr. Ernest L. Ransome, and occupies an area of about 200x250 feet in plan. It is four stories high, excepting a small one-story addition. All floors were designed for uniformly distributed loads of 500 pounds per square foot, and consist of 4 inch concrete slabs supported on 4½ x 28 inch concrete beams 24 feet long and 8 feet apart. The columns are solid concrete,

Plate 2.—Where all other Materials but Cement Failed

Interior view in the Methodist Book Building showing the uninjured concrete floor arches of 16 foot span

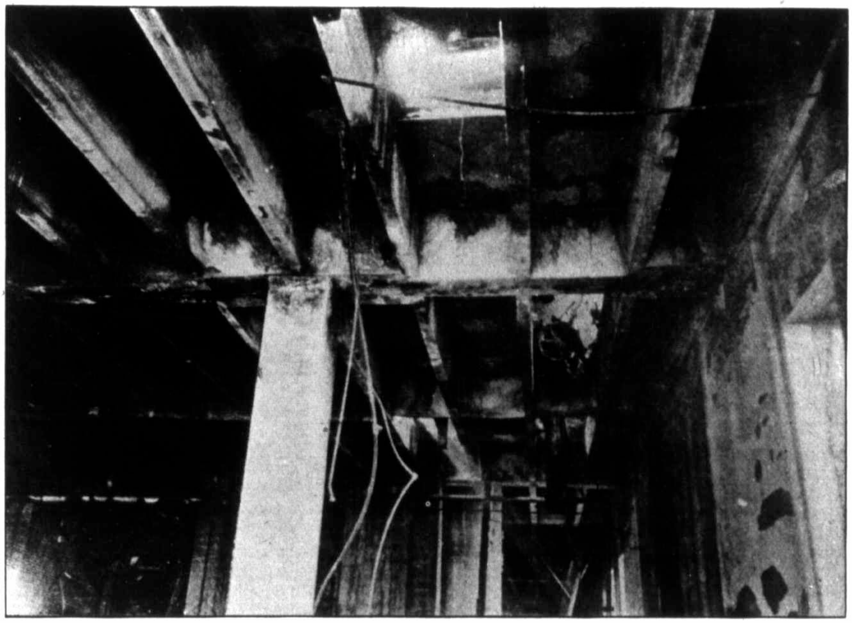


Plate 3.—Concrete after a Fire Test.

The above view shows the condition of the concrete floors, walls and columns of the third storey of the Pacific Coast Borax Company Building, where the fire was most severe and the heat sufficient to fuse copper. The entire concrete construction sustained without injury a most severe test, including intense heat and the application of cold water on its heated parts besides resisting without injury the falling bodies of many tons weight. The concrete is in perfect condition. The plaster was chipped off in a number of places, and excepting one place where 18 tons falling 14 feet slightly damaged a floor beam, no repairs will be necessary. The illustrations offer a true means of comparison between the value of tile and concrete as a fire-proof material.

17, 19 and 21 inches square in the third, second and first stories. In the first story the walls are 16 inches in extreme thickness, with 9 inch hollow spaces in the center. The upper stories have a thinner wall of the same construction. The foundations, footings, columns, walls and floors were all constructed of Portland cement concrete, reinforced by cold-twisted steel bars. In the preparation of the concrete fine unscreened rock was used. The lower chords of the floor beams were composed of 1:6 concrete, the columns 1:5, and other concrete 1:6½.

The weight of the building and contents was about as great as the carrying capacity of the salt soil on which it was supported. It was remarkably free from vibrations, notwithstanding many heavy concentrated loads contained in it, and much weighty machinery, of which a 35 horse-power grinding mill on the fourth floor was a part. Up to the time of the fire the building had stood a service test of four years without developing the slightest defect or failure in any connection. It was originally proposed to build the roof of concrete; this plan was changed, however, and a roof of lumber, beams and boards covered with tar and gravel was built, supported on light wooden columns one story high. The building contained a large number of wooden partitions, and framing for shafts, machinery, bins, stairs, etc.; also a large number of wooden boxes and barrels and other combustibles. The heat was sufficient in its intensity to fuse copper, as is shown by a number of samples in fused condition that were taken from the building.

Considerable machinery, as well as the contents of the building, was either damaged or destroyed. The upper stories suffered most, and the roof was completely destroyed. A dust chamber, weighing 45 tons, situated on the roof, and supported by wooden posts, running from the fourth floor, and extending through the roof, fell 14 feet to the floor below without injury to the floor. Three large tanks and a 6 x 6 foot concrete chamber, 50 feet long, weighing 33 tons, and a steel tank weighing 18 tons, also fell, when the roof burned, a distance of about 14 feet. The only damage done to the floor was in one place where the 18 ton tank cracked some of the floor beams upon which it fell; the damage was slight, as they were not completely broken, and can be repaired without removal. An examination of the walls, floors and columns failed to reveal the presence of cracks, deflections, distortions, or any damage whatever to any part of the concrete, except as noted in the case of the cracked floor beam.

The building cost about $100,000 and was structurally uninjured, pointing and plastering covering the principal items of repair. With the exception of the roof this building was unquestionably an ideal type of factory construction. Compare the photographic evidence exhibited by Plate 1 and Plate 3; the former unable to withstand falling bodies of slight weight, completely wrecked; what escaped fire destroying itself upon the administration of water; what a striking contrast between that method of construction and the type of cement construction shown by Plate 3. The evidence presented in favor of cement concrete construction, by this test is conclusive.

The Superintendent of Buildings for New York, desirous of obtaining a comparative record of the merits of hollow tile and the Roebling system, requested the Roebling Company to make a comparative test with a legal hollow tile arch, the test to be conducted under the supervision and control of the Department of Buildings. The object of this test was not to show the capabilities of the best forms of tile or concrete floors when the material is specially prepared for testing purposes, but to ascertain the relative efficiencies of the constructions as furnished commercially in actual buildings. The greatest care was consequently exercised by the Department of Buildings to secure as nearly as possible such materials and workmanship as would represent average construction as furnished under contract in first-class fireproof buildings in New York City.

After the test structure had been erected and the iron work set it was found impossible to purchase the necessary hollow tile blocks for this test from any of the tile manufacturers of New York City or vicinity, but a sufficient quantity was finally secured in Philadelphia where they had been delivered for the floors of a large fireproof building. The hollow tile blocks thus secured bore the imprint of one of the largest tile manufacturers of the East.

The comparative test as finally made was similar in every detail to the test as originally contemplated, except that the load on the arches was reduced to 150 pounds per square foot and the duration of the fire test increased to five hours, these modifications making this test conform to the standard conditions as adopted in the former tests of the Department.

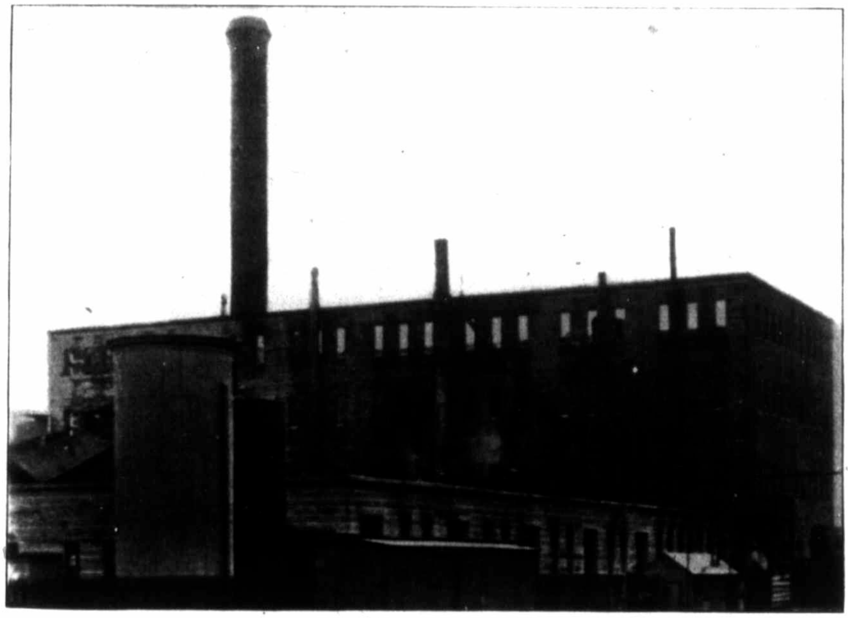


Plate 4.—Concrete Steel Factory Building of the Pacific Coast Borax Company after the Fire

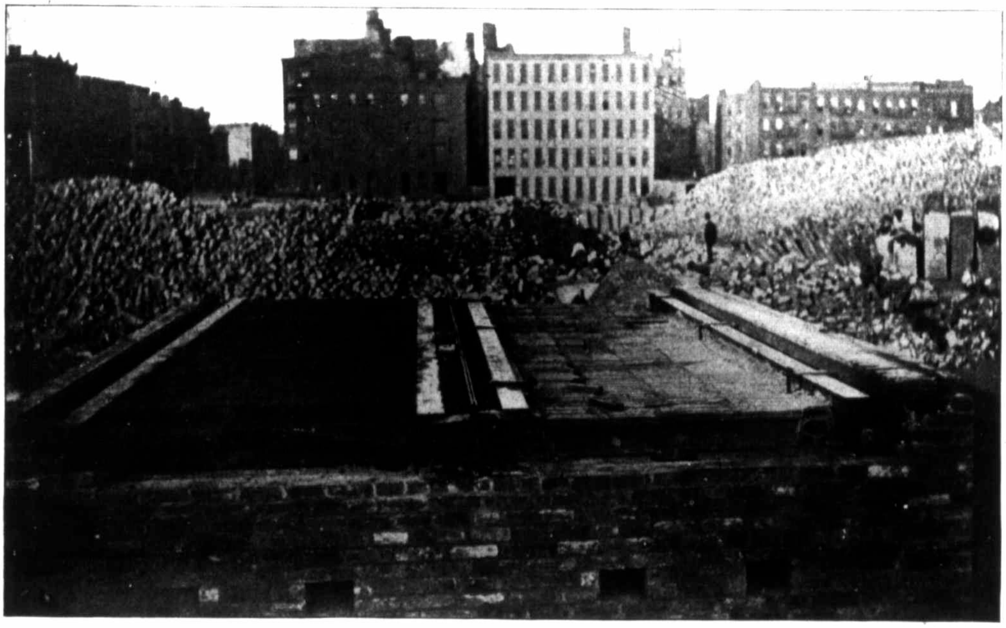


Plate 5.—Structure for Comparative Test of Tile Arch and a Roebling Concrete Arch

Plate 5 is a view of the test structure showing the Roebling concrete and the tile arch just before putting on concrete fill. No better means than this arrangement can be devised to obtain the comparative value of any material. Side by side, subjected to like conditions, the result thus obtained is alike absolutely fair and convincing. When everything was in readiness, the tile people obtained an injunction against the Building Department, carrying out the test on the grounds that the test would be injurious to them, and charging collusion between the Superintendent of Buildings and The Roebling Company. But even this last resort did not keep the arch from falling in a little over three hours after the fire was lighted. After overcoming the legal obstacle to test, Mr. Gus. C. Henning, M.E., a recognized authority on the subject of testing material, and Mr. Henry W. Hodge, C.E., Consulting Civil Engineer, kindly agreed to assume control and conduct the test as scheduled. Their report follows:

REPORT OF A COMPARATIVE TEST OF A SEMI-POROUS TILE ARCH AND THE ROEBLING CONCRETE ARCH.

(Made at Sixty-eighth Street and Avenue A, New York City, November 19th, 1897.)

In making this test, four 10 inch beams were built above a brick furnace all as shown on the drawing submitted herewith, being in pairs each exactly five feet centre to centre, between one of which pairs the tile arch was built, and between the other pair the concrete arch was built, so that both arches were subjected to exactly the same conditions during the test.

Each arch was constructed of material bought in the open market without any special preparation for this test, and the arches were laid as nearly as possible as is the usual custom in building construction in New York City, and we consider them in all respects equally good with such work as usually built.

These arches were both laid on the afternoon of October the 20th, 1897. On November 11th, the top filling of concrete was put on each arch. On November 12th, the ceilings were plastered and allowed to dry naturally, without using any fire in the chamber. On November 18th, the arches were loaded with paving stones, each carrying a load of exactly 150 pounds per square foot in addition to the weight of the arches themselves.

The fire test was made on November 19th, commencing at 11.50 a.m. The temperatures hereinafter given being taken by a pneumatic pyrometer. The temperatures were gradually raised to about 2300 degrees, where it remained constant till the collapse of the tile arch, the temperatures being as follows:

12.45 o'clock	-	1,600 degrees F.	2.15 o'clock	-	2,250 degrees F.
1.00 "	-	2,000 "	2.30 "	-	2,300 "
1.15 "	-	2,000 "	2.45 "	-	2,300 "
1.30 "	-	2,050 "	3.00 "	-	2,300 "
1.45 "	-	2,150 "	3.06 "	-	2,300 "
2.00 "	-	2,200 "	3.06 "	-	The arch collapsed.

Plate 6 shows the under side of arches after the failure of the tile arch. The concrete arch did not suffer the slightest damage. The brown coat of plaster remained intact on the concrete arch. Patches of the white coat are shown adhering in spots.

The test of the Hennebique System, at the Paris Exposition, furnishes additional proof of the success of cement.

The advantages of this system of construction are numerous; the first being undoubtedly the fire resisting qualities of these filled-in beams and columns in armored cement concrete. Boileau, in the "Journal of Architecture," points to the numerous experiments showing how iron is excellent in case of a trifling fire or at the commencement of a conflagration but not if the fire has reached dangerous proportions. Iron beams at red heat expand, carrying with them the filling and even the walls, and become almost as active an agent in demolishing the building as the fire itself. Conclusive experiments as to cement, on the contrary, show that it can resist very considerable temperatures and effectually preserve the iron bars which it covers. Some experiments were made at the Exposition upon this feature of the system, and were reported upon to the International Congress. A small house with ground floor and one storey about 16 x 20 feet, was built on the Exposition grounds by the Hennebique Company, and tested both for the strength of the floors and resistance to fire while the floors were loaded. The first floor was loaded with

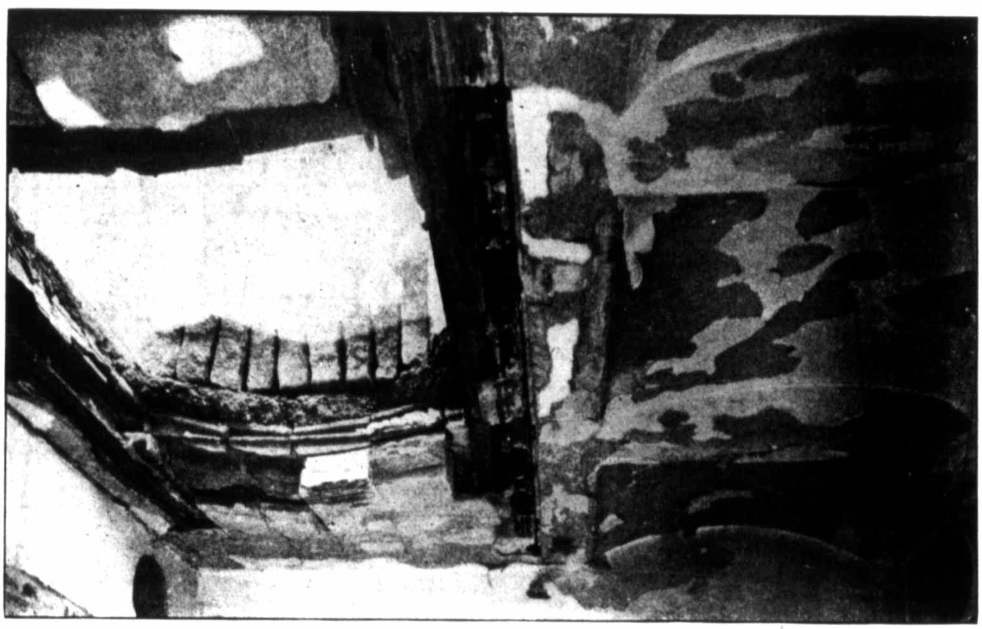


Plate 6.—Comparative Test

Under side of arches after the failure of the tile arch. Brown coat of plaster intact on concrete arch with patches of the white coating adhering in spots. Roebling Concrete arch uninjured.

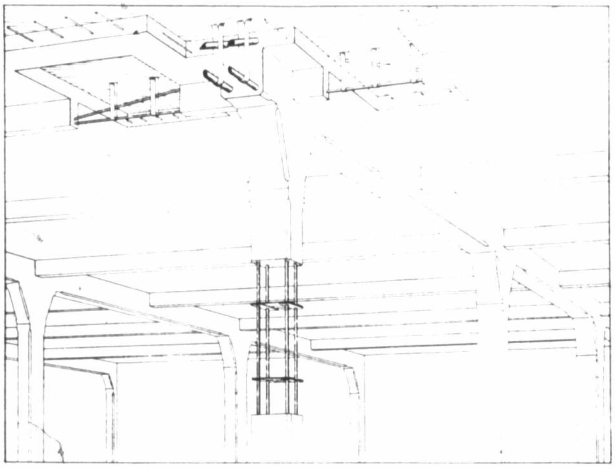


Plate 7.—Hennebique Concrete Floors, Posts and Beams

3,000 pounds per square yard, the upper floor with 2,000 pounds per square yard. The deflection of the floors was hardly one-twenty-fifth of an inch. A large fire of cord-wood and oils was built and kept at full intensity for one hour. The maximum heat developed was estimated to be 1,800 F. The temperature on the floor above the fire only increased four degrees, showing that merchandise would not be injured in such a position. The deflections were from one-fifteenth of an inch at the end of ten minutes to one-half inch at the end of the hour.

In December, 1900, the Ransome Concrete Company erected a test building at Mineola, L. I., where the Nassau County Court House and Jail were built, entirely of concrete reinforced with cold twisted steel, to demonstrate the advantages of this construction where permanent and absolutely fireproof buildings are desired.

Three of the walls were the Ransome double walls, consisting of two shells of concrete, each three inches thick, connected by vertical webs every three feet, and reinforced with twisted steel bars. The fourth wall was built of brick. The roof was constructed entirely of stone concrete, with tension bars of twisted steel placed near the bottoms of the ribs. The roof was designed for a working load of 150 pounds per square foot. All the concrete was placed in moulds at the site, making a monolith of concrete.

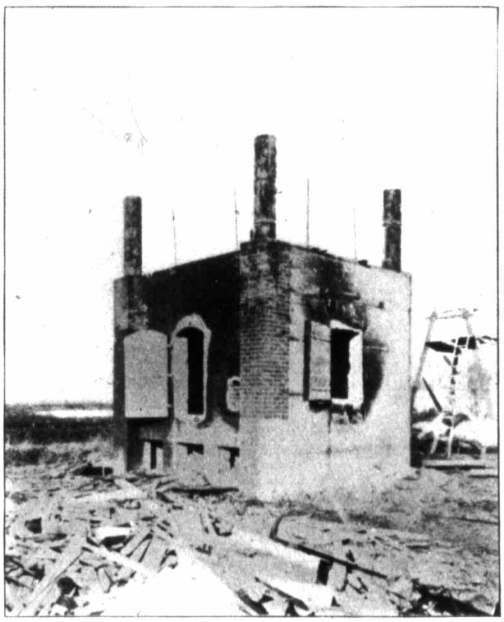


Plate 8.—Fire Test Building

Test of Ransome Concrete Floors at Mineola, L. I.

Four flues were carried up about seven feet above the roof to give forced draught. The inside dimensions of the building were ten feet six inches by fourteen feet, with a clear height of ten feet from the grate bars to the ceiling.

Preparatory to the first test, the roof was loaded to 158 pounds per square foot with bags of gravel evenly distributed. This load produced no deflection.

On November 30th, 1901, the fire test was made, the grate bars being covered with about six inches of straw, over which refuse, scaffolding and moulds, were piled to a depth of about three feet. A pyrometer, in charge of an expert furnished by Eimer & Amend, was set up to measure the temperature. The fuel was lighted at 11.40 a.m., and in ten minutes the temperature reached 842 F., and continued to rise constantly until at 3.38 p.m. it showed 1,922° F.

Refiring was done about every twenty minutes to maintain the desired temperature, and the entire test was conducted according to the requirements of the New York Building Code. At 3.40 p.m. the fire having burned for four hours, the door in the concrete wall was opened and a stream of water from 1½ inch nozzle, under registered pressure from sixty to sixty-five pounds per square inch, was directed against the opposite concrete wall for about ten seconds, and then against the ceiling for five minutes. The water was taken from two watering carts of five hundred gallons each, and delivered under the above pressure by a steam fire engine. The fire apparently did no damage to the concrete walls and roof, and which afterwards proved to be the case when the final test load was put on the roof. A few fine cracks appeared, but the walls remained absolutely true to line and at all times were so cool that the hand could be comfortably held against them at any point. The brick wall cracked from the main door to roof soon after the fire started, and finally bulged away from the roof about four inches, and the crack opened

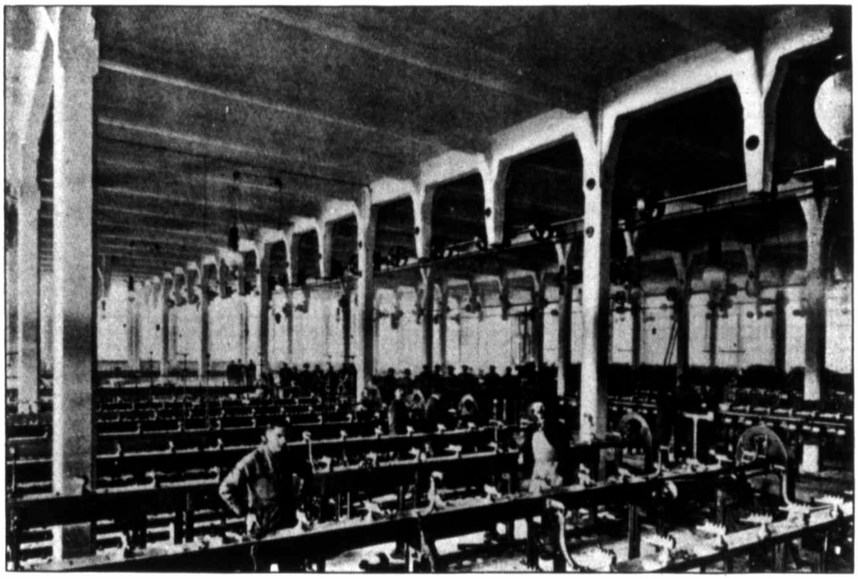


Plate 9.—Perfect Fireproof Mill Construction
Built entirely of Cement Concrete — Floors, Walls, Posts, Beams. Hennebique System, France

nearly two inches. A photograph after the fire shows this main crack; two other serious cracks occurred in the brick wall, starting at the small firing doors and running across the corners and into the concrete walls. The cracks in the concrete walls were the direct result of the strain brought upon them by the cracks in the brick wall.

The roof deflected slightly during the fire, the maximum centre deflection being 1.15 inches. The sections of a roof with a ceiling remained as cool as the walls, demonstrating that if goods were stored on a floor so constructed, they would not be in the least damaged by a fire of 1,900 degrees immediately below.

The force of the water where concentrated on the ceiling slab 1½ inches thick was sufficient to penetrate same, and three holes were thus made in the ceiling. The water also washed the concrete off in a few other places, exposing the small bars in the ceiling, but no serious damage was done, as the ceiling could be repaired and the strength of the roof was unimpaired, as proved by the subsequent test load.

The inner shell of the concrete walls contained a few fine vertical cracks, and the brick wall innumerable hair cracks running in all directions. The concrete walls were but slightly injured either by fire or water, and demonstrate that the only necessary repairs would be a new coat of plaster. The brick wall, however, was damaged beyond repair and would have to be taken down and rebuilt.

The roof had not been penetrated by either the fire or water, and the maximum deflection after the test was 1-2/10 inches for the section with the ceiling and two inches without the ceiling. The load was then removed to permit the ceiling to return to its normal condition. On December 10th a concentrated load was applied at the center of the span equivalent to a distributed load of 1,123 pounds per square foot without producing any deflection or damage. The theoretical breaking load using 80,000 pounds per square inch for the twisted steel bars was 1,048 pounds per square foot. This load remained on the building for over three weeks. The results of this test clearly demonstrate that buildings of concrete properly reinforced with steel bars are superior to all other constructions.

They are more durable, the concrete increasing in strength and hardness with age. They are absolutely fireproof, require no insurance. They are also vermin and water proof. They are monolithic and not subject to vibration.

Plate 9 shows the interior of a factory built according to the Hennebique system, and is representative of the highest type of fireproof factory and mill construction.

ERRORS We make them ; so does every one. We will cheerfully correct them if you write us. Try to write good naturedly if you can, but write to us, anyway. Do not complain to some one else first, or let the matter pass. We want the first opportunity to make right any error that we may make.

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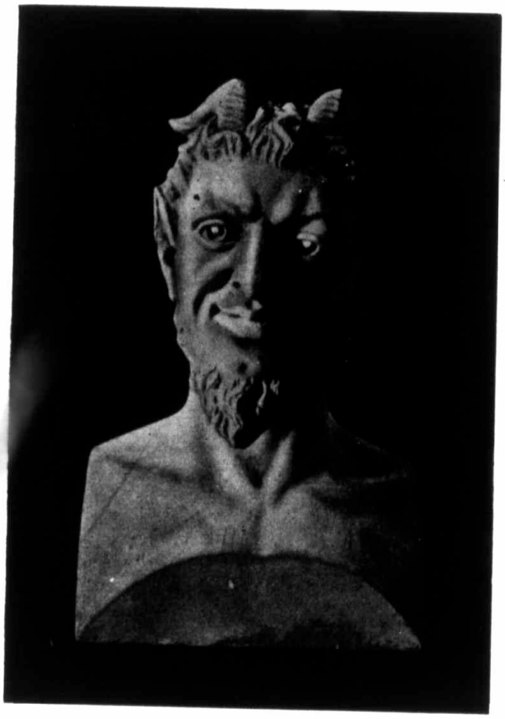
MADE IN CANADA

The workmanship and materials throughout this publication are entirely Canadian. The illustrations were produced by the Standard Photo-Engraving Co., of Montreal, and the printing and binding were done by the Perrault Printing Company of the same place.



PAN (Cement-Beton)
"Cement," May, 1901