VOL. 4. NO. 5.

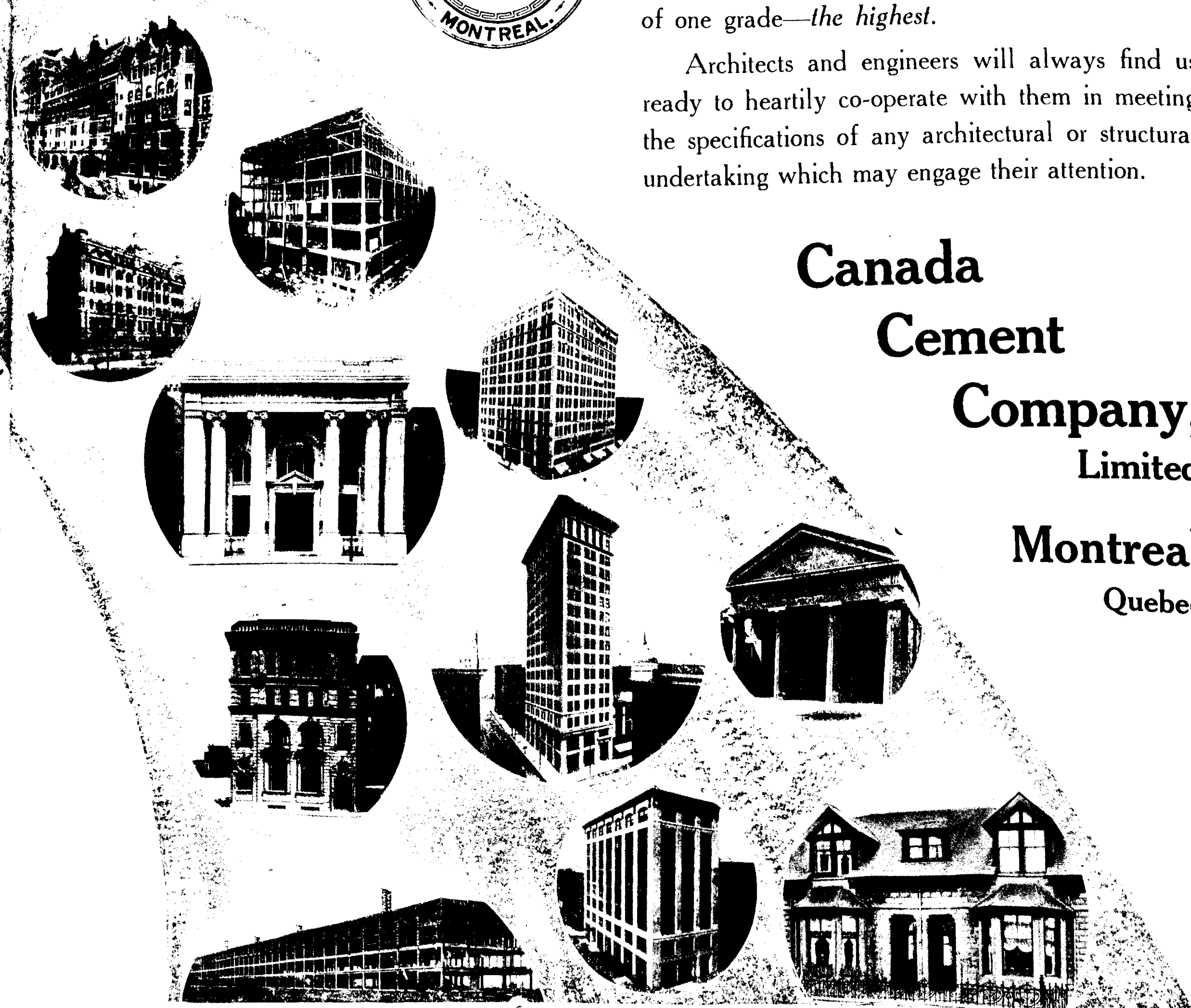
APRIL, 1911

$3.00 per Year
35c. per Copy

CONSTRUCTION

A · JOURNAL · FOR · THE · ARCHITECTURAL ENGINEERING · AND · CONTRACTING INTERESTS · OF · CANADA

OFFICE OF PUBLICATION
· TORONTO ·
BRANCH OFFICES
MONTREAL - LONDON · ENG.



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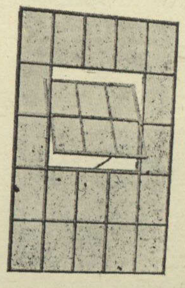

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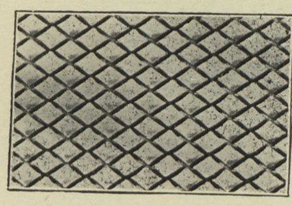

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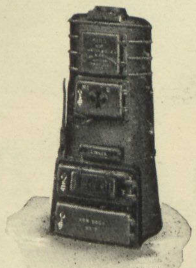

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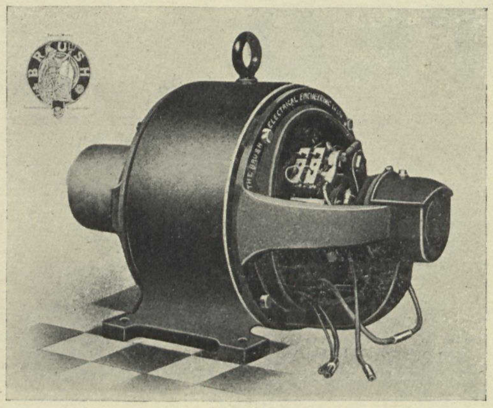

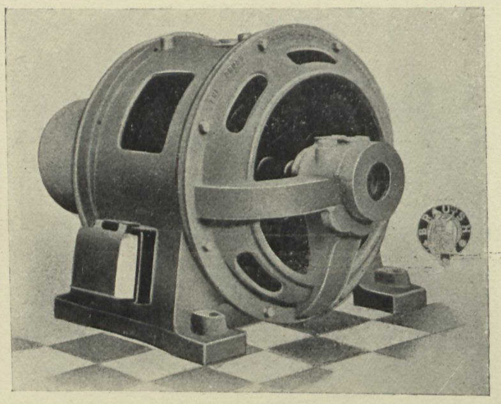

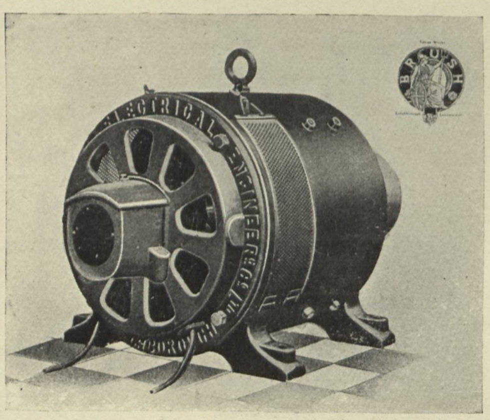

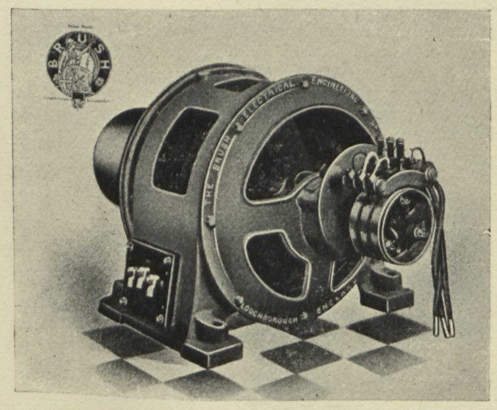

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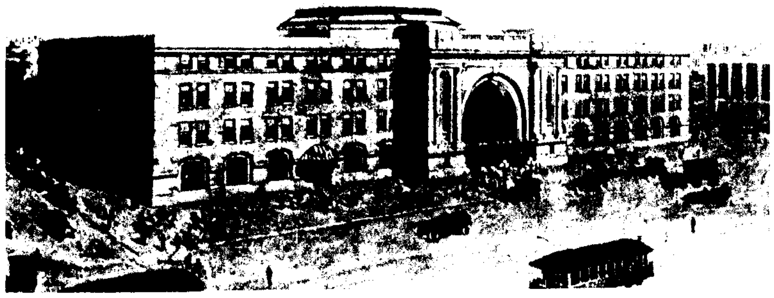

Facade of the New Fort Garry Union Station, Winnipeg, Man.

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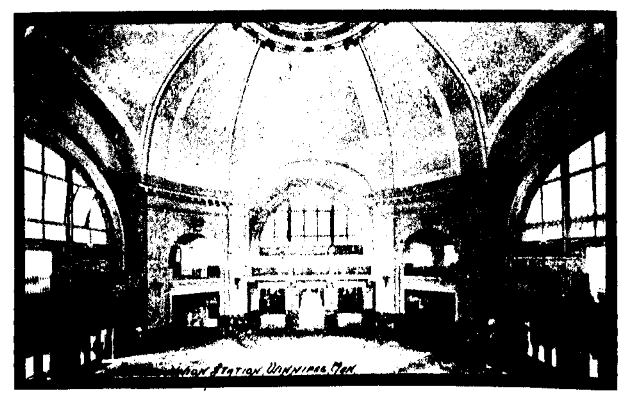
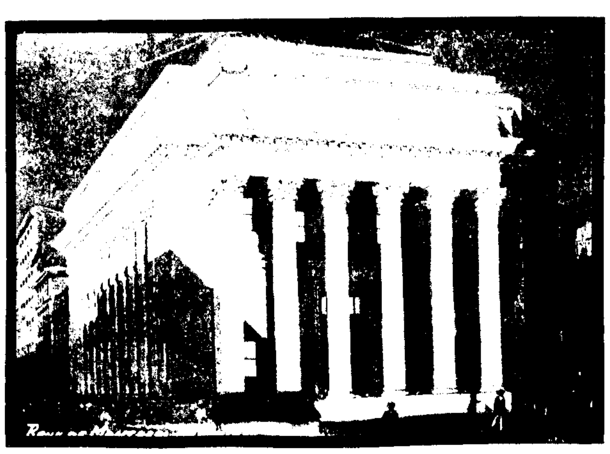
Heating Contractors: James Ballantyne & Co., Winnipeg, Man.



Rotunda, New Fort Garry Union Station, Winnipeg, Man.



The New Bank of Montreal Building, Winnipeg, Man.

8000 square feet of Safford will be installed in this splendid new banking building. Total cost of building about $1,250,000.

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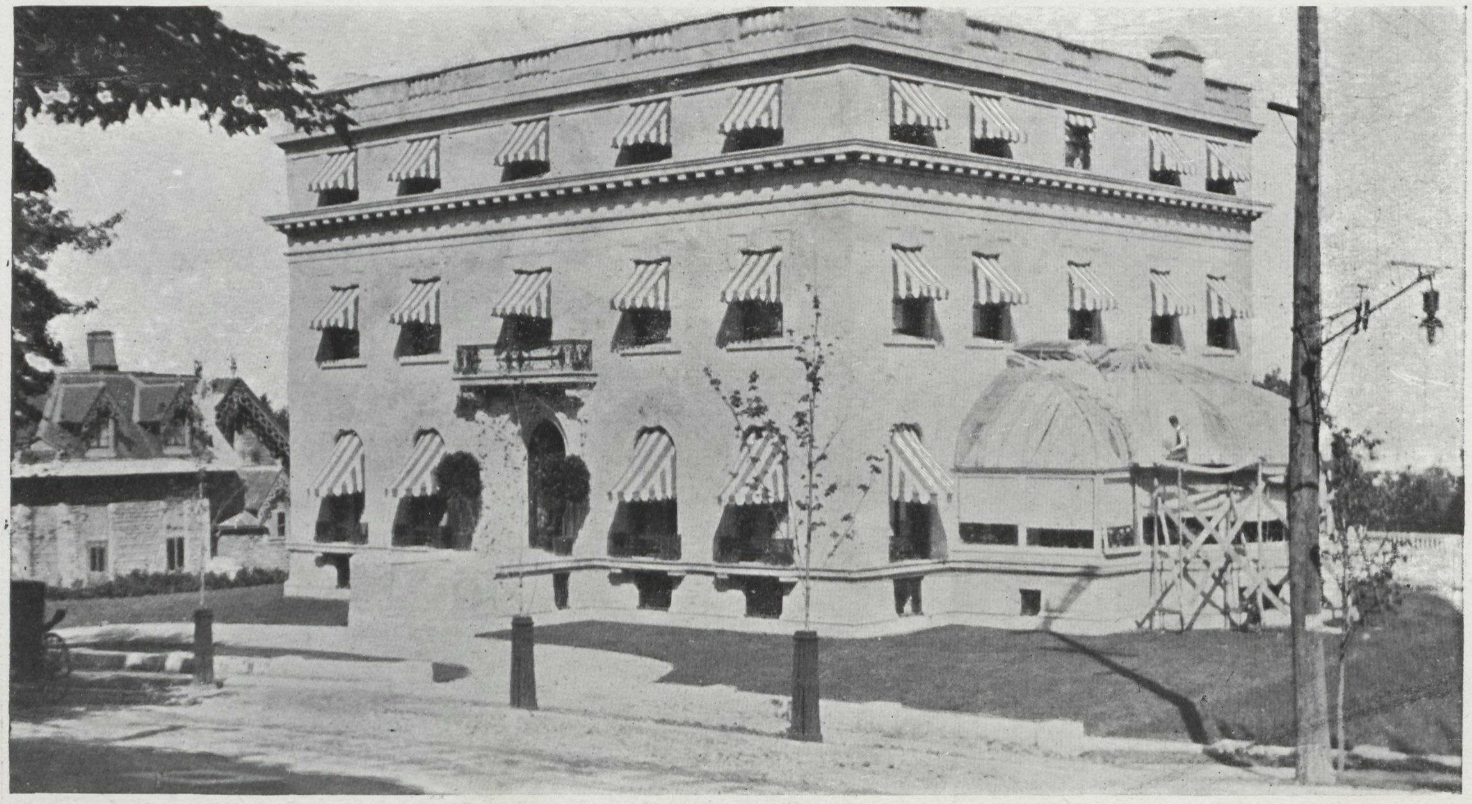

Residence of M. B. Davis, Montreal. Equipped with "Standard Ideal Ware." Robert Findlay, Architect. W. J. McGuire & Co., Plumbers.

Jacobs Building, Montreal. Equipped with "Standard Ideal Ware." Mitchell & Creighton, Architect. W. J. McGuire, Plumber.

Bennett's Theatre, Montreal. Equipped with "Standard Ideal Ware."

Shea's Theatre, Toronto. Equipped with "Standard Ideal Ware." Chas. J. Read, Architect.

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TERMS OF SUBSCRIPTION

Canada and Great Britain $3.00 per annum, single copies 35 cents. United States, the Continent and all Postal Union Countries, $4.00 per annum in advance. Entered as Second-Class Matter in the Post Office at Toronto, Canada.

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Saturday Night Building

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MONTREAL—Board of Trade Building. LONDON, ENG.—Byron House, 85 Fleet St. E.C.

THE LATE JOHN·M·CARRÈRE

The late John M. Carrere—Pioneer Worker in modern school of American Architectural design, and highly esteemed by both confreres and public.

NO MORE WIDESPREAD regret has been felt in architectural circles in recent years than that occasioned by the death of the late John M. Carrere, which occurred in New York recently under most distressing circumstances. As a man highly esteemed and honored by his confreres, respected by the public and recognized as one of the foremost, if not the foremost designer on this continent, the deceased held a position in the architectural profession which falls to the lot of but few men in this particular calling of life.

John M. Carrere was one of the pioneers who undertook to establish an American style of architecture. He, together with his partner, Thomas Hastings, and the members of the firm of McKim, Mead & White, were responsible for the introduction of the *beaux art* influence with its spirit of Italian and French Renaissance. The work of Mr. Carrere, along with his co-adherents, has been the chief factor in bringing about the present American architectural revival.

Mr. Carrere was the son of John Mervin Carrere and Anna Louisa Maxwell. He was born in Rio de Janeiro on Nov. 9, 1858. He received his education in Europe, graduating from the Ecole des Beaux Arts in 1882. He achieved great success with Thomas Hastings in designing many notable buildings. The firm known as Carrere and Hastings were architects for the New York Public Library, the new National Academy of Design, the New Theatre, the Cathedral of St. John the Divine, and the Alcazar and Ponce de Leon Hotels at St. Augustine, Fla. The artistic merits of these structures reflect much of Mr. Carrere's personal talent. In 1886 Mr. Carrere married Marion Dell of Jacksonville, Fla. His wife and two daughters, Anna M. and Dell, survive him. He is also survived by his mother, Mrs. A. L. M. Carrere, and his brothers, J. Maxwell and Henri Valente Carrere.

Mr. Carrere was a member of the New York Chapter of the American Institute of Architects and was twice its president. He was also the founder and twice president of the Beaux Arts Society of New York city. He was delegate to the Fine Arts Federation and a member of the Architectural League of New York. He was also a member of many prominent clubs, including the Century, Players, Baltusrol Golf, City and the Richmond County Country Clubs.

Building Returns for March—Substantial improvement noted over preceding month—Twenty-three cities register average gain of 37 per cent.

FEWER LOSSES than were noted in the previous month, and a substantial improvement as compared with the corresponding period of last year, is the summary of CONSTRUCTION'S report in brief for building operations carried out in twenty-three representative Canadian cities during the month of February. In reviewing the situation, the same accelerating tendency is observed as that which obtained at the beginning of last year, and this in itself is a pretty reliable indication that the volume of work ahead is to assume greater proportions than has ever been attained in a like period before. Permits issued in the twenty-three centres referred to amounted to $4,015,958, as against $3,000,127 in the same month of last year, which represents an average of gain of 34 per cent.—a most satisfactory showing to say the least, especially so, when one takes into account the heavy operations which were carried on right up to the close of the fall season.

Ontario, as in the previous month, experienced the hardest rub, five of the seven losses noted falling in this province. Ottawa dropped behind to the extent of 33 per cent., and Fort William and London registered respective decreases of 21 and 35 per cent. The losses noted in the case of Stratford and St. Thomas, while indicating a large decrease per cent., are really unimportant. On the other hand, Toronto has a total of $969,590, which is 18 per cent. better than her corresponding amount; Hamilton doubled her previous figures by undertaking work aggregating in cost $75,450; and Windsor and Brantford succeeded in surpassing their former mark to the extent of 614 per cent. and 180 per cent. in order named.

In the West, a marked onward movement was in evidence on practically all sides. Lethbridge's setback (20 per cent.) alone is the only thing which prevented the centres reporting from having a perfect score. Vancouver not only surpassed the million mark, but again has the highest total for the month registered in the Dominion. Everything seems to indicate that Vancouver is just entering what is to be a period of growth that will be much more marvellous and rapid in every way than even the high state of development through which it has already passed. While less pronounced from an investment standpoint, Victoria's total of $182,940, representing a gain of 20 per cent., shows excellent progress, and as much can be said regarding the total of Calgary ($333,660), and the amount of Winnipeg ($432,-500), both of which reflect a most satisfactory and wholesome condition. Edmonton, also, with a gain of 187 per cent., notes a substantial upturn; Regina is ahead by 104 per cent.; and Moose Jaw tacks on a gain of 27 per cent., although in the latter case the corresponding amounts are quite small.

Without the figures of Montreal, the Eastern section would be rather slimly represented, although it is known that a large number of places in both Quebec and the Maritime Provinces are undertaking considerable construction work. Halifax and Sydney put in a somewhat quiet month and St. John failed to report. Montreal, however, issued permits amounting to $642,428, as compared with $274,030 in February of last year, and has the third largest total in the list. Advices to hand state that Montreal has a big building year in prospect. In fact, reports from practically all sections predict big things, and unless industrial disturbances interfere with conditions, the record for each and every month from now on should double that registered in the year just passed.

	Permits for February, 1911.	Permits for February, 1910.	Increase, per cent.	Decrease, per cent.
Berlin, Ont.	$ 8,600	....	.....	.....
Brantford, Ont.	6,600	$ 2,350	180.85	.....
Calgary, Alta.	333,660	169,800	96.50	.....
Edmonton, Alta.	83,825	29,130	187.74	.....
Fort William, Ont.	25,775	32,725	.....	21.24
Halifax, N.S.	6,000	14,525	.....	58.70
Hamilton, Ont.	75,450	37,650	100.40	.....
Lethbridge, Alta.	30,000	37,570	.....	20.15
London, Ont.	13,195	20,322	.....	35.08
Montreal, Que.	642,428	274,030	134.44	.....
Moose Jaw, Sask.	10,200	8,000	27.50	....
Ottawa, Ont.	64,500	97,200	....	33 65
Peterboro', Ont.	5,550	.....	.....	.....
Port Arthur, Ont.	4,200	....	....	....
Regina, Sask.	67,975	28,255	140.57	....
Stratford, Ont.	700	8,000	....	91 25
St. Thomas, Ont.	1,300	4,700	....	72 34
Sydney, N.S.	2,030	1,775	14.36	....
Toronto, Ont.	969,590	860,440	12.68	.....
Vancouver, B.C.	1,047,790	880,795	18.95	....
Victoria, B.C.	182,940	151,760	20.54	....
Windsor, Ont.	37,150	5,200	614.42	....
Winnipeg, Man.	432,500	335,900	28.75	....
	$4,051,958	$3,000,127	34.44	....

Cement Show of C.C.C.A. a Success—Next show for Montreal—Its President responsible for its present existence—Co-operation of interests necessary.

THE CANADIAN CEMENT and Concrete Association conducted, during the month of March, the most successful cement show that has as yet been held in Canada. This association encountered many difficulties in its early history, and had it not been for the persistent and energetic labors of its president, Mr. Peter Gillespie, who is himself in no way financially interested in any branch of the industry, the association would have been no more.

While the cement interests, to some extent, have taken interest in the success of the organizaion and the work that it is doing, they have not lent the co-operation that they should, to effect an organization which was created solely for the purpose of disseminating scientific information relative to the proper and improper use of cement. However, at this time it appears that the Canadian Cement and Concrete Association is past the period of infancy, and although it has not as yet been officially announced, it is generally understood that the next convention will be held in Montreal, where it is to be hoped the association will receive a greater degree of courtesy from the local authorities than was accorded them in Toronto. The show, if taken to Montreal, we feel safe in stating, will be by far the largest and most important ever held by the association.

Ernest Flagg, Architect of Singer Building, in discussing the future of American architectural style, believes that materials should express their utilitarian function.

THE FUTURE OF AMERICAN architectural style, or the style of architecture that shall be adopted in the New World, has been one of the most interesting subjects for discussion in architectural circles in both Canada and the United States during the past decade.

In discussing the future American style, Mr. Ernest Flagg, the architect of the Singer Building of New York, recently made the following comments, which fairly represent the views of the profession on this continent:

Nothing can hinder the advancement of invention and progress of architecture if we meet the problem squarely and bring to its solution common sense, reason, and good taste.

The great hindrance to all advancement in art is the habit of copying. When invention ceases and servile imitation takes its place, progress stops. The blighting effects of this sort of thing, even when well done, can be seen in French architecture after the Revolution. For centuries the beautiful styles called after the French kings had followed each other in orderly sequence, when suddenly it became the fashion to affect the antique—invention stopped, progress ceased, and French art received a blow from which it has hardly yet recovered.

Style in architecture is in the nature of an evolution; it is a thing that is constantly changing. The changes are gradual; so slow indeed as to be imperceptible from year to year, but clearly discernible at longer intervals of time. Like changes of fashion in dress, no one knows who is responsible, because no one person is responsible; but the changes appear as the result of the labors of all those working in that field.

To produce an architectural style it is necessary that all those engaged in the work should proceed along a common way. Here in America we have not yet reached the starting point. Like a bird which rises and circles about before taking its direct flight, we are veering about, making ready to set our course. English influences, French influences, Italian influences, and other influences have been at work, and we have made a sort of salad of them all. Soon some one force will prove itself dominant—at the present time it looks as if that force would be French. As Italian influences dominated in France at the time of the Renaissance, so French influences will perhaps dominate here in what may be our naissance of art, and just as Italian styles became French when transplanted to French soil, so French styles will, if we have the true art instinct, be transformed after taking root on American soil.

The time has almost gone when one stops to consider what style, ancient or modern, he shall adopt for a building; and the time has almost come when one will think only of how, using the style of the time, he can do his share in the onward march of invention and progress. When this movement fairly gathers headway, neither England, France, nor Italy will set our fashions for us; we will evolve them for ourselves.

What our future styles will be no one can predict; neither can one tell what forms our building will take. As in the last twenty years, the elevator and the steel frame have wrought wonderful changes, so future inventions may cause no less important ones.

The role of the architect should be to accept these new conditions frankly and bring to the solution of the problems that present themselves these methods which the architects of the thirteenth century used with such wonderful results in dealing with the new methods of construction of their time. That is to say, the spirit of daring adventure, the spirit of invention, guided by good taste, which transformed every structural feature and engineering expedient into a thing of beauty; the spirit of truthfulness in the use of materials and methods, so that things appeared to be what they were, not, as too often happens nowadays, what they are not.

Let us cast aside shams and makeshifts; let sheet metal no longer masquerade as stone. Let us be more sparing in the use of columns and other architectural features in places where they have no use or meaning, but let us try to give to every material the forms and uses suited to it, and let the exteriors of our buildings tell the story of the plans.

A new generation of architects is now taking the field. These men have had advantages of education which few of their predecessors possessed. They can apply to their work those sound principles of good sense and correct taste which, though coming to us from France, are not French, but universal, for they are the fundamental principles of true art of all times.

From these young men, then, we may expect great things, and, unless all signs fail, we shall in due time have an American style of architecture of which we shall not be ashamed.

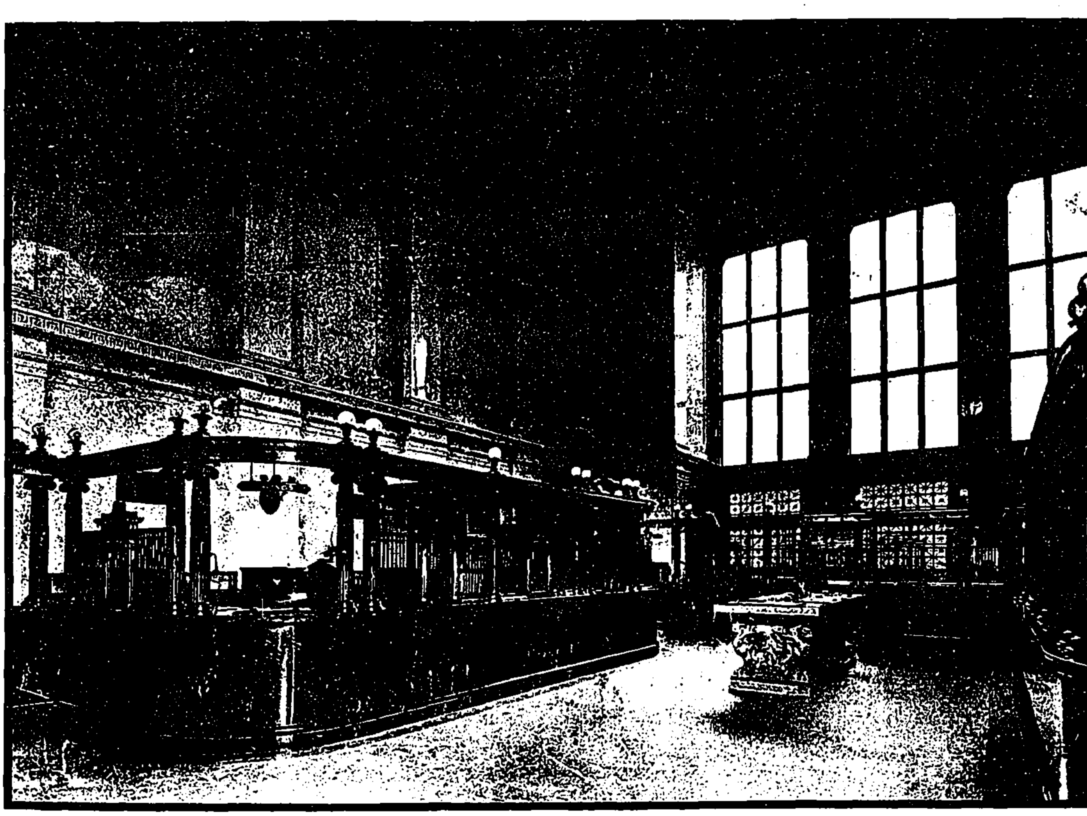
¶ *Lord Kitchener believes there should be women architects—Draughtswomen may be possible, but the profession of architecture cannot be successfully practised by women.*

THE EMINENT GENERAL, Lord Kitchener, who knows much about architecture and building construction, has expressed himself in favor of the idea that there should be women architects. In view of the fact that women of to-day have found their way into almost every profession and business, it seems on the face of it that Lord Kitchener is right. But when we remember the atmosphere of the draughting office we cannot but think that architecture is a profession for which women are not well suited. There is no question but what a lady architect would remember the clothes closets, arrangement of pantry, and other details in modern residences that are very often overlooked by the draughtsman, but could she be an architect in the real sense of the word? The true architect, as his title implies, is a master builder who superintends the construction of the building he designs. He must be able to direct the actual work of constructing his building as well as write the specifications for the work. He must be a competent buyer; he must know the comparative value of materials and the relative abilities of contractors. We believe that if draughtswomen could live in, and not object to the usual atmosphere of the draughting office, she would be valuable as a draughtswoman, but she will never make an architect. Lord Kitchener can hardly be taken seriously. He is, evidently on this point, more chivalrous than sincere.

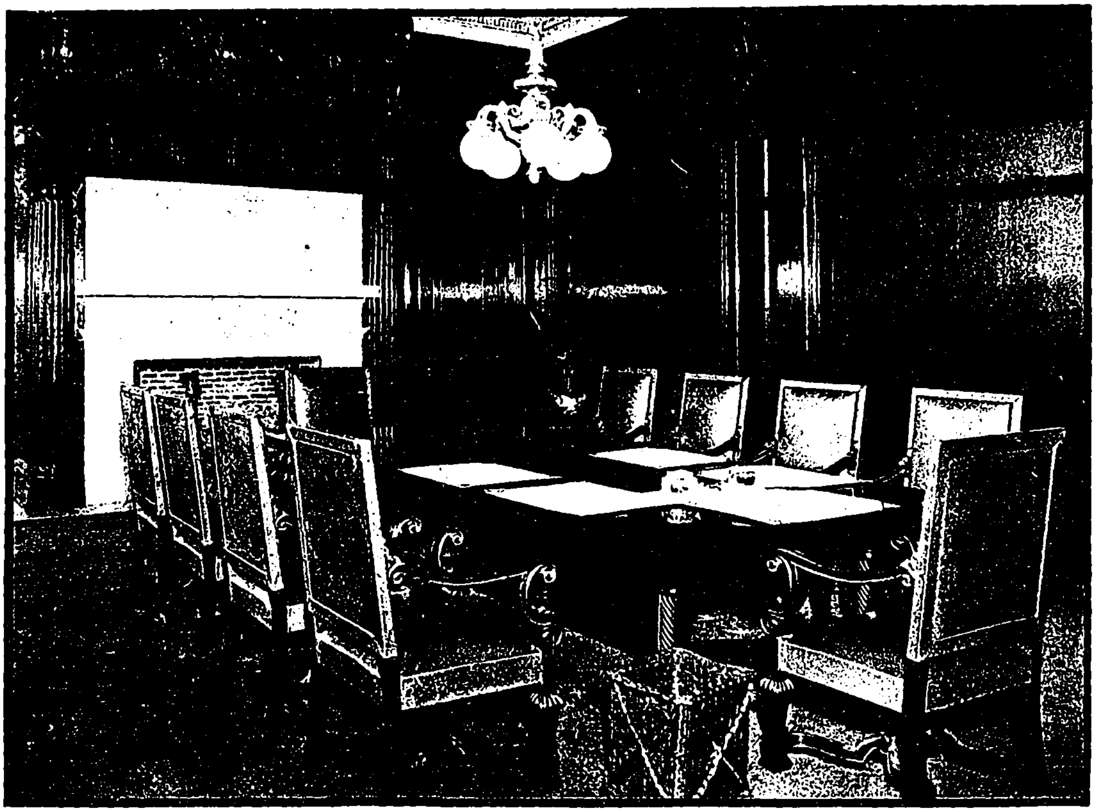
AN IMPORTANT building project reported to be in prospect is a large modern hotel, to be erected by the C.P.R. on the present site of the Murray-Kay, Limited, adjoining the block of land at the corner of King and Yonge streets on which the company will construct its new sixteen storey office structure. The new office building is to be built at once, but it will be some little time yet before the construction of the hotel will be started. The new hostelry, needless to say, will be modern in its appointments.

Head Office Building of the Royal Bank of Canada, 147 St. James Street, Montreal. H. C. Stone, Architect.

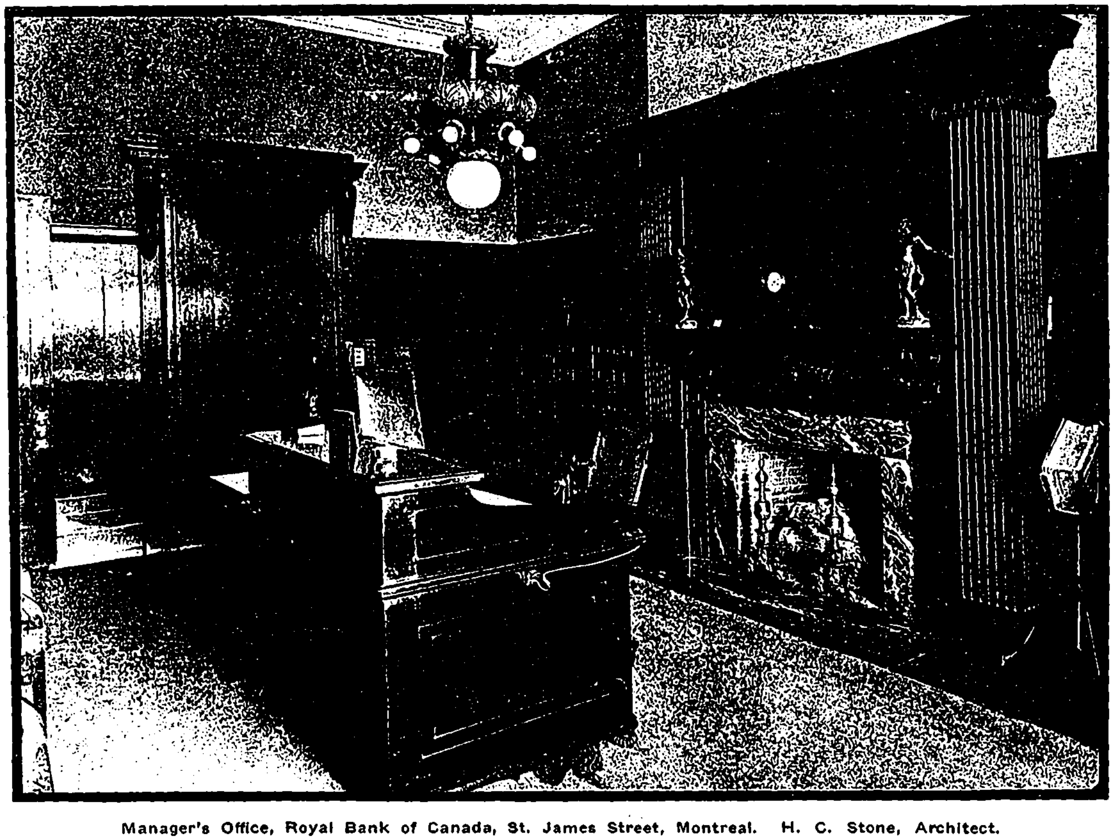
View Looking Toward Entrance from the Main Banking Room, Royal Bank of Canada, St. James Street, Montreal, Showing Detail of Doorway and Mezzanine Floor. H. C. Stone, Architect.



Main Banking Room, Royal Bank of Canada, St. James Street, Montreal, Showing the Wall Scheme and Detail of Counters and Screens. H. C. Stone, Architect.



Board Room, Royal Bank of Canada, St. James Street, Montreal. Note the Effective Wall Panelling and Treatment of Fireplace. H. C. Stone, Architect.



Manager's Office, Royal Bank of Canada, St. James Street, Montreal. H. C. Stone, Architect.

SOME FAILURES AND THE LESSONS THEY TEACH

Full text of address delivered by President Peter Gillespie before the Third Annual Convention of the Canadian Cement and Concrete Association.

IT IS A TRUISM often repeated that the public has a short memory. The lessons to be derived from great disasters are soon forgotten except by a very small number. The fatal Iroquois Theatre and Collinwood school disaster of a few years ago, so costly in child life and so much in the public mind for short intervals, showed the necessity of safeguarding the occupants of public buildings. For a time our civic authorities were active in having places of public entertainment carefully inspected. Much was heard for a season about fireproof curtains, accessible exits, fire drill and fireproof schools, but soon the public relapsed into its old ruts. Inspection became less searching and the authorities more forgetful and the public continues to run daily the same risks that the victims of these disasters ran. It sends its children to the same schools and attends itself, the same places of public worship or entertainment, and only becomes conscious as to the chances it is taking when some other horrible calamity occurs. Truly, the public has a short memory.

It is chiefly because humans are humans and not machines that we continue to take chances. A machine can be constructed to do a given thing in a specified way an endless number of times. Whether its work be punching or drilling or cutting, it does it with machine-like precision. It never tires, never grows careless and is never actuated with a spasm of over-zeal or indolence. It is never tempted to scamp its work. It is never influenced by the desire to make excessive profits and never knows the flattery of the multitude or the sting of adverse criticism. It never forgets, never flatters, never tempts, never cajoles, never bluffs and never pleads. But men are differently constituted. They possess the human traits. They are influenced by example, possess passions and emotions, cherish hatred, remember injuries and forget the lessons which great crises in their experience ought to impress on them. The attention of engineers, architects, builders and building departments has been called to the lessons which are taught by the failures of structures designed and erected by them or under their supervision. It is not that the field is a new one that this paper is devoted to so hackneyed a topic, but to emphasize once again, firstly those elements which have contributed to failures, and secondly those corrective or precautionary measures which will tend to prevent their recurrence.

Especially in the use of reinforced concrete has the general reader's attention during the past five years been called to a rather large list of failures, all of them more or less serious and not a few of them having fatal results. Reinforced concrete has been comparatively new in the building art and in its fabrication is very different from other materials with which the constructor is familiar. Unlike steel or wood, its strength increases with age. It is poured into forms, at which time it is plastic, and has to be sustained until it acquires sufficient strength to support itself. It consists of two materials, not one, and since the disposition of these, with respect to each other vitally affects the strength of the product, exercise for great care in this placing is necessary. More perhaps than of any other building material is this true—it possesses great capacity for injury in the making and placing. Following are cited a number of failures of reinforced concrete structures which during the past twelve months or so have occurred, and reference to which in the engineering press has come to the writer's notice. They represent typical cases and an examination of the list will enable us to classify the causes under a few general heads.

The comparatively recent announcement that the great dam across the Colorado River at Austin, Texas, is to be rebuilt has served to recall its failure over a decade ago. It will be remembered that that failure was announced to the world at first as a serious reflection upon the engineering profession because some hydraulic engineers of eminence had been connected with the work. Subsequently, however, when the whole history had been investigated, it was found that the authority of the engineers had been interfered with to such an extent by the city officials in control, that their responsibility had been practically nullified. Indeed, one prominent engineer had resigned rather than have his name further connected with a work over which he had no control.

On February 28, 1910, a reinforced concrete arch of three spans over the Flat Rock River at Edinburgh, Ind., collapsed during an unusually heavy flood. The design had been furnished by a well-known bridge company, but the Bridge Commissioners, in their desire to economize and with a wisdom commensurate with their experience in such matters, decided to omit the piling underneath the abutments and to carry them instead to a somewhat greater depth. And so the bridge was built. The materials supplied and the workmanship throughout seemed to be excellent, but in the season of heavy flood the piers were undermined by scouring and the structure collapsed. There does not appear to be any other cause of failure than the insufficiently supported piers, and the responsibility of course must rest on those who ordered the modification of the original plan.

A concrete dam at Fertile, Minn., was washed out by floods early in April, 1910. The trouble is attributed to the fact that the foundations were not laid sufficiently deep to prevent scouring and undermining, and failure ultimately ensued.

The partial failure of the Bayless reinforced concrete dam at Austin, Pa., in January, 1910, exemplifies a trouble of a slightly different character. The dam was completed in December, 1909, at a cost of upwards of $70,000. On completion, it was observed that there was one small crack 1-16 inch wide, extending from the top of the dam to the ground level. Subsequently others, similar in appearance, developed, and during a heavy freshet on January 23, 1910, a section of the dam between vertical cracks, under the thrust of the impinging water, slid forward some 18 inches. This movement covered a period of some 8 hours and then stopped. Investigation disclosed the information that the failure was due primarily to the fact that the dam was founded upon a bed rock, the successive strata of which were separated by layers of shale or clay. The impounded water, having worked itself under the foundations, had softened the clay, with the result that the upper stratum carrying a portion of the dam had moved forward on the lower. It was stated that the weakness of the concrete was doubtless due to the fact that much of it had been hurriedly placed, part of it in freezing weather. The anchor bolts, which had been grouted into the foundation rock, had moved outward with the rock into which they were anchored.

On April 7, 1910, the collapse of a concrete roof under construction at the new car-barn of the Shore Line Electric Road at Saybrook, Conn., took place and resulted in the death of one man and the injury of two others. The roof was a 4 inch slab of reinforced concrete on girders, about 8 inches on centres and of 37 feet span. The last work had been completed about ten days and the forms were being removed. It was believed that the premature removal of the forms and the excessive loading of the green roof slab with roofing material were the joint causes of the accident.

On July 13, 1910, one of the columns of the concrete groined arch roof to the filter chambers in course of construction at Owen Sound, Ont., collapsed while the centering beneath was being removed. Two men were quite seriously injured. The accident apparently was due primarily to the early removal of forms, combined with the fact that the 18 x 18 inch columns on two sides of the square roof of the arch were quite incapable in themselves of resisting the arch thrust. The forms were removed in only four days after pouring, notwithstanding the fact that seven days was the minimum specified time for removal.

The upper part of a reinforced concrete chimney under construction at the plant of the American Woollen Co., South Royalston, Mass., collapsed on April 9, 1910, causing the death of two men. The chimney was to have been 105 feet high with an inside diameter of 4 feet and an outside diameter of 4 feet 8 inches at the bottom, and with walls varying in thickness from 8 inches at the bottom to 4 inches at the top. The forms used in construction were in two sections, each 3½ feet deep. The procedure was to fill the upper form, then to loosen the lower and set it above the upper for filling. This took one day. Next morning, the form in the lower section was loosened and it was placed on top and filled. Thus, the concrete in any 3½ foot vertical section had less than 24 hours in which to set before its side-supporting forms were removed. The accident occurred when a height of about 70 feet had been reached, the section last uncovered, then only 20 hours old, caving in and carrying the workmen to the ground with it. It is reported that the temperature the day before the break had taken a sudden drop, but it was not at any time below freezing. The failure was undoubtedly due to loading a very green concrete before it had acquired sufficient resisting power, as the materials were good and the design and execution satisfactory.

A reinforced concrete grain elevator of typical design failed under a normal pressure of grain at Springfield, Ohio, on October 24, 1910. As has been rather common in elevator construction where a battery of cylindrical units has been constructed, the unused spaces, external to the cells, but lying within the tangent walls, had been utilized as auxiliary bins. No one saw the beginning of the collapse, so that its exact behavior cannot be stated, but from the appearance afterwards it was evident that the lower section of the wall where the pressure was greatest, was forced out under the pressure of the wheat. This portion sheared off clean at the line where the straight wall connected with the circular wall of the larger bin. The weak point in the structure was that the horizontal rods in the straight wall were not connected to those in the circular, nor were they tied back for any distance into the concrete of the circular walls. It was stated that the plans showed the rods in the straight walls securely fastened into the circular bins and that the failure to so fasten them was due to the negligence of the foreman.

On November 22, 1910, a four-storey reinforced concrete building being erected for the Henke Furniture Co., Cleveland, Ohio, suddenly collapsed, throwing one of the walls over a two-storey frame building next door and so crushing the structure as to cause the death of four of its occupants and the serious injury of seven others. It was of reinforced concrete column and girder construction with hollow tile and concrete floor system, and brick curtain walls varying in thickness from 21 inches at the basement to 13 inches at top floor. A commission of enquiry was immediately appointed, on which were representatives of the Builders' Exchange, the Cleveland

Engineering Society and the Cleveland Chapter of American Institute of Architects. This commission was empowered to take evidence, and to consult every available source of information that might explain the cause of failure. After the wreck had been carefully examined, the design checked over and the witnesses examined, the finding was announced. The failure, it stated, was due primarily to the premature removal of forms in the third storey. It fixed the responsibility on the architects, the contractor, the owner and the Department of Buildings for the city of Cleveland. The architects were adjudged responsible in that they did not give sufficient consideration to the removal of forms, in that they did not give sufficient attention to the materials, and in that they did not give adequate supervision to the work of construction. The contractor was adjudged culpable in that he employed foremen who were entirely ignorant of the intent of plans and specifications or of the nature of the materials they were handling. In consequence, the sand was inferior, the forms were removed prematurely, and that regardless of weather conditions, the green concrete was regularly overstressed, the members were not of the sizes called for in the plans, the concrete composing them was open and porous and sawdust and shavings were found in the bases of columns. In addition, it developed that less cement had been delivered to the building than would have been necessary to construct it had it been built as planned.

The owner was deemed responsible in that he had not employed a special concrete inspector on the work as required by the building regulation.

The Department of Buildings was held responsible in that it had ignored the requirements of that portion of the building code which makes it necessary that the owner employ a special reinforced concrete inspector. It thus appears that the Building Department rather than the building code was at fault.

I have chosen to classify the causes of failure in the above cited cases as follows:

(1) Interference with a suitable design by those in authority, but not possessing a knowledge of engineering practice.

(2) Defective design.

(3) Inferior materials.

(4) Ignorant or wilful disregard of specifications and plans.

The first of these is unfortunately of too common occurrence. In all human probability the Austin dam and the Edinburgh arch would be standing to-day but for the intervention of the "cock sure aggressive" individual who, when clothed with a little brief authority, becomes a paragon of wisdom on everything under high heaven. This type is found frequently in our municipal councils and it is to be regretted that engineers of wide experience and good judgment sometimes permit themselves to be dominated by them. An engineer's judgment may be in error, but is it not more likely to be productive of good results if it be corrected through consultation with other engineers of equally good standing, than if it be reversed by men entirely untrained in the problems of design and construction.

Fortunately, the day of unsafe design in reinforced concrete is becoming a thing of the past. The design of reinforced concrete, like the design in wood or steel, has been reduced or is being reducd, to a standard based on the proportion and strengths of materials which constitute it. There is, therefore, no reason to-day why the average practising engineer should not acquaint himself with concrete designing so that, at least, he can finish his plans with some such detail as he does those for his structures in steel. He may, if he prefers, leave the details to his contractor, who, like the contractor for steel, can make them according to the standards of his practice. He must exert every care in informing himself as to the character of the materials he must employ and of the foundation upon which he proposes to erect his structure. The dams at Fertile, Minn., and at Austin, Pa., furnish illustrations where disaster might have been averted by a careful examination of the underlying strata, prior to construction. The designer must recognize, too, that the safety of his design depends upon the constructor as well as upon himself, since concrete construction is not fixed as is that in steel. An editorial in the "Engineering News," speaking of this phase of a designer's responsibility, asserts that "the design cannot be sent from the drawing table with perfect confidence in its precise reproduction in the structure. It is the joint product of the man in the office and the man in the field, and any design which fails to recognize this is a poor one, no matter how nearly it may conform to accepted standards. No engineer who is not prepared to supervise the construction of a reinforced concrete structure is justified in designing that structure as closely to the safety limit as he is when the construction is to be under his eye."

The prevention of the utilization of inferior material is the work of the engineer, the architect and the inspector. No reinforced concrete work of any magnitude should be constructed without a capable, conscientious inspector. The Henke building suffered from inferior material, as it did from almost every other malady to which reinforced concrete is heir. The remedy for this is vigilant, constant inspection. Failures resulting from the premature removal of forms could invariably have been prevented by the exercise of intelligence and a little precaution. The Henke building disaster, the Own Sound filtration plant accident, the car-barn roof failure at Saybrook, Conn., and the chimney collapse at South Royalston, Mass., were all preventible if careful examination had been made before stressing the concrete, which, possibly due to temperature conditions, had not yet acquired its preliminary strength. The failure of the grain elevator at Springfield, Ohio, was due to the ignorance of a foreman. Any foreman who appreciated the proportions of the materials he was handling would not make the blunder that was made.

The remedy for these evils is the employment of the experienced, intelligent, painstaking inspector. He

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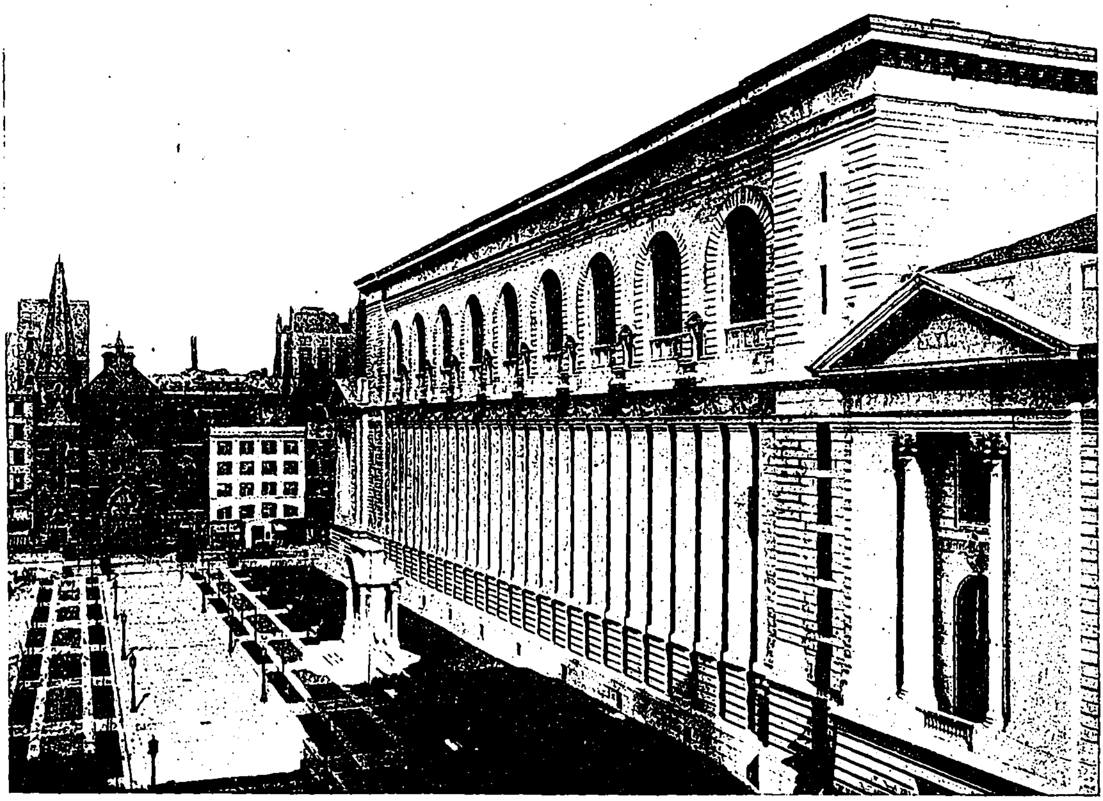
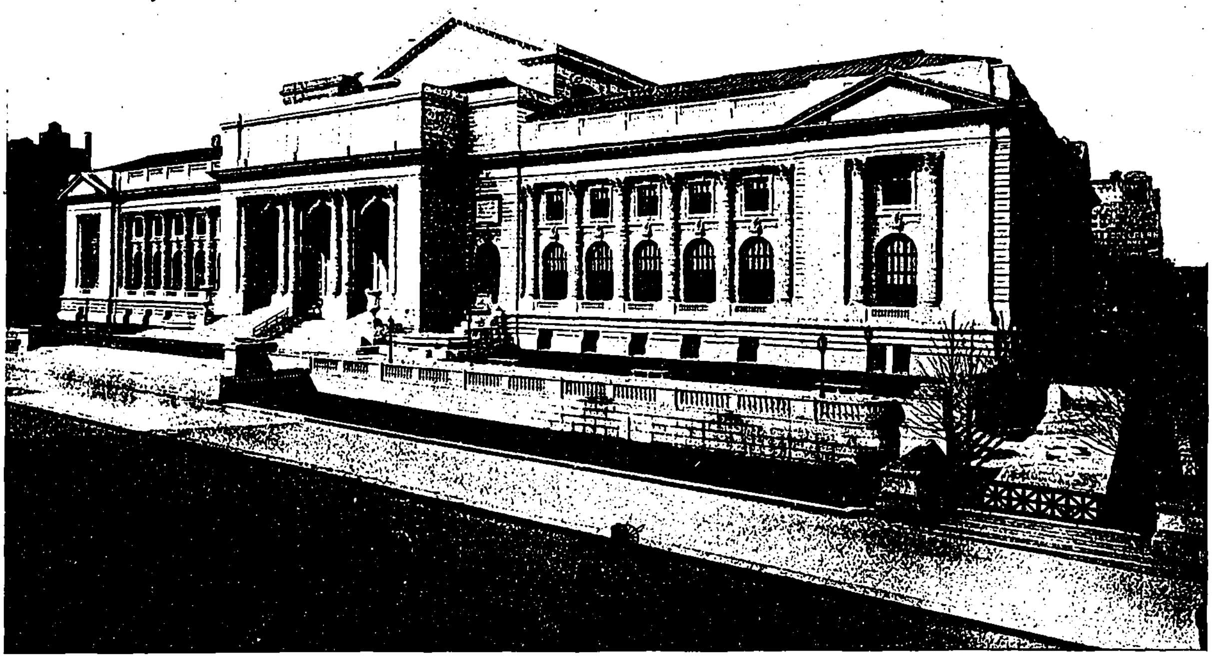
Perspective along Principal Approach, New Public Library, New York City. Carrère and Hastings, Architects.



Rear View of New Public Library, New York City, Showing the Bryant Memorial in the Foreground. Carrère and Hastings, Architects.



Main Facade of the New Public Library, Fifth Avenue and Forty-first Street New York City. Carrere and Hastings, Architects.

THE NEW PUBLIC LIBRARY NEW YORK CITY

Magnificent educational building which was recently opened for the first time to permit the public to view the remains of its designer, John M. Carrere.

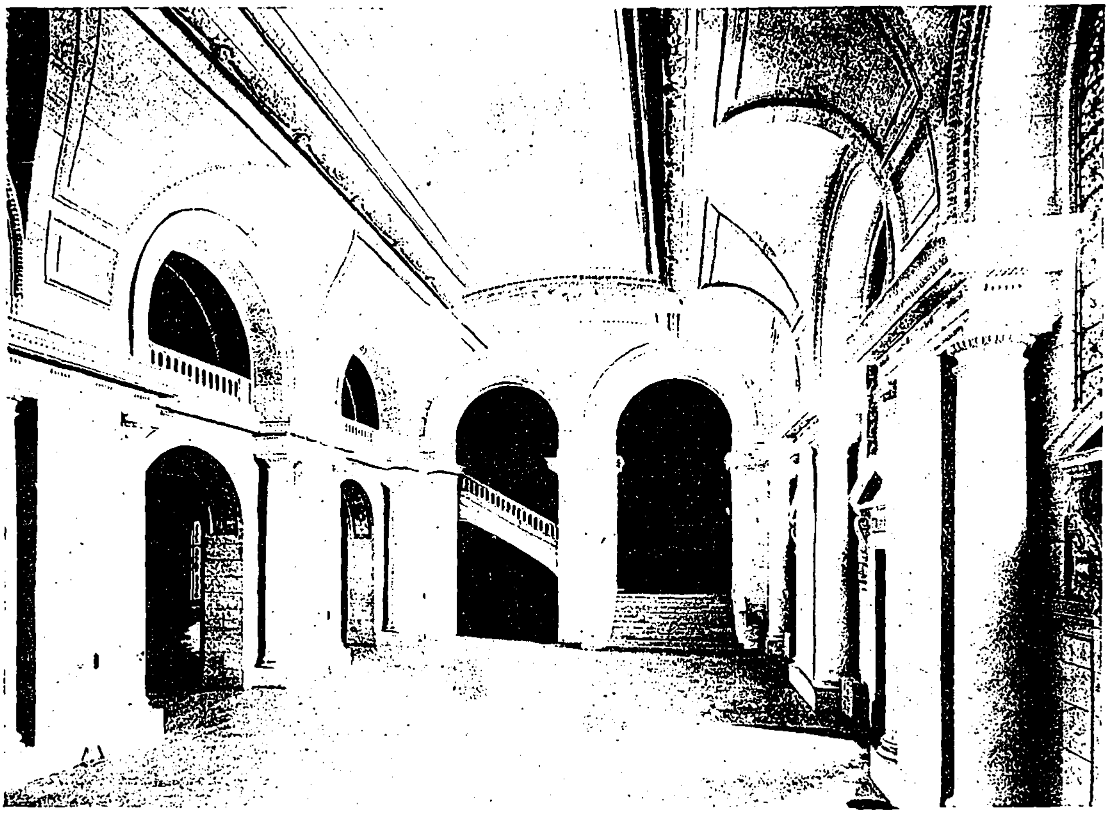
THE MOST IMPORTANT of great American educational institutions, the New York Library, was opened under rather depressing circumstances. The doors of this building were first opened to the public to view the body of its designer, the late John M. Carrere.

The New York Public Library without question is one of the most remarkable examples in the United States of the typical American aspiration in architecture. Carrere & Hastings, together with McKim, Mead & White, of New York, were the pioneers of the American Renaissance School that has dominated, to a very great extent, the architecture of the larger buildings erected in the United States within the last decade. Not only have the architects of this structure designed the building, a remarkable one, in keeping with the prevalent spirit in American architectural design, but they have also taken into consideration the utilitarian necessities in an educational structure, of such immense proportions. The old idea of the library as a secluded room in which a few scholars could browse at leisure among musty volumes, has given way to the idea that it is essentially a vehicle of popular education—one which should be in some measure supported by public funds and managed chiefly for the purpose of giving the widest possible circulation to its accumulated and accumulating store of books.

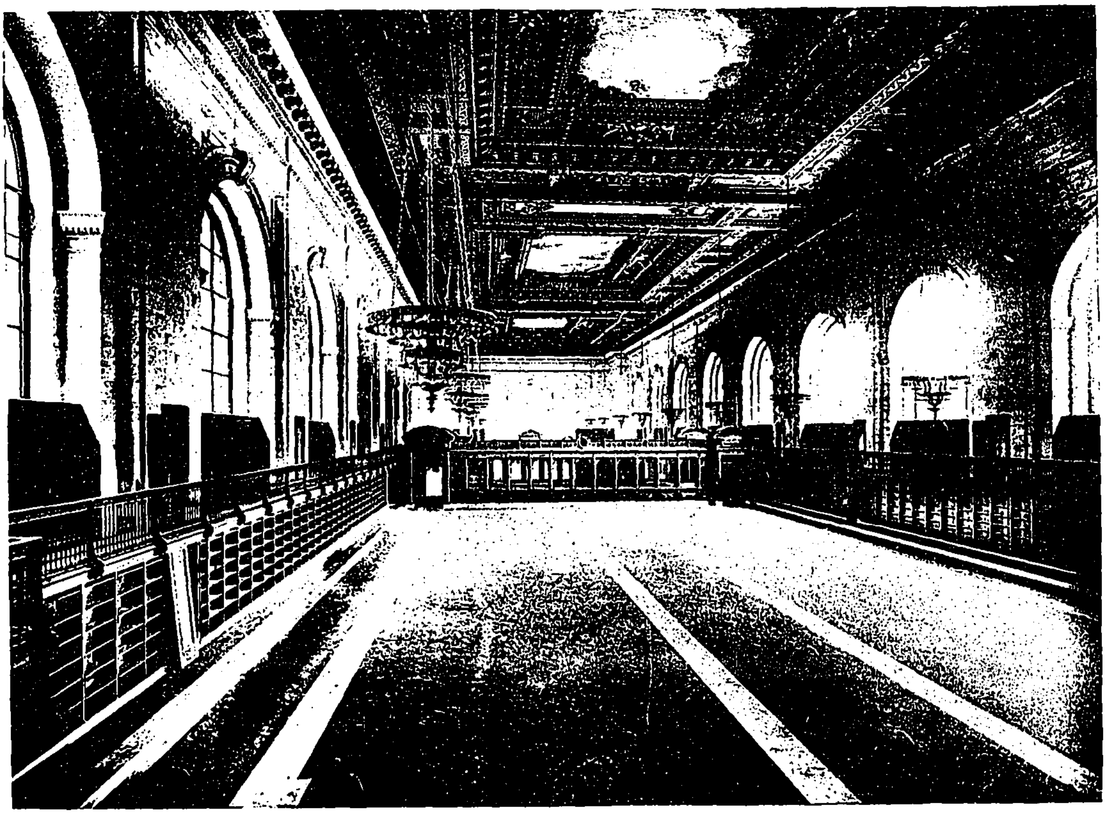
Mr. A. C. David, in describing this structure in the "Architectural Record," says:—"The American Public Library has, like all institutional buildings, usually been designed for the purpose of imposing itself upon the public. It has not attempted to solicit patronage by the suggestion of studious detachment. It has announced to the public from some colonated portico that it was a great educational institution, and that the public must for its own good, come in and get educated; and the designers have never felt it necessary to invite patronage by retaining in the building any flavor of domesticity which in Europe has always been associated with such edifices."

In his description of this masterpiece in the New American School, Mr. David describes the building further as follows:—

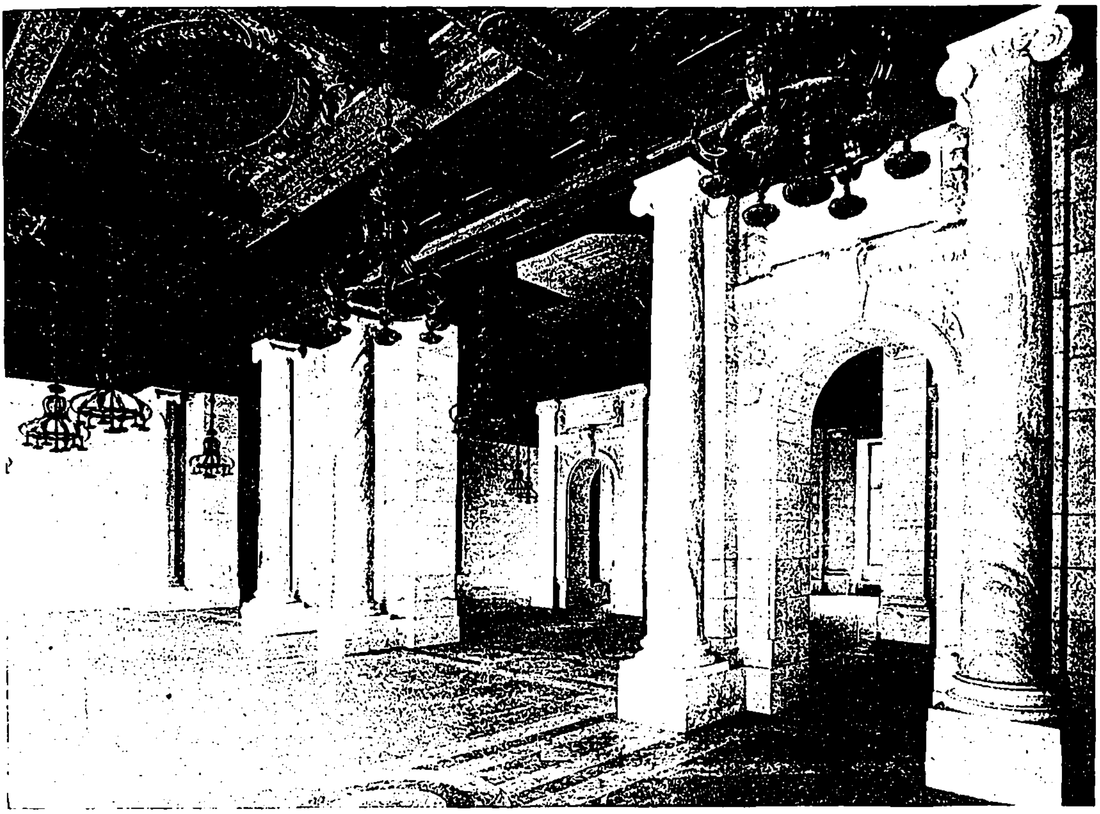
The main reading-room is one of the most spacious rooms in the world—beautifully proportioned, lighted by a series of windows on both the long sides of the room, and entirely accessible to the stacks. To have obtained a room of these dimensions, so excellently adapted to its purpose in every respect, was a great triumph for the architects. The smaller rooms, also, particularly those like the gallery, whose practical requirements are severe, are also admirably planned for their purposes. These rooms have been supplied with a good light by avoiding anything like a heavy colonnade on the facade; and while most of them (all of them except those situated on the corners) obtain light from only one



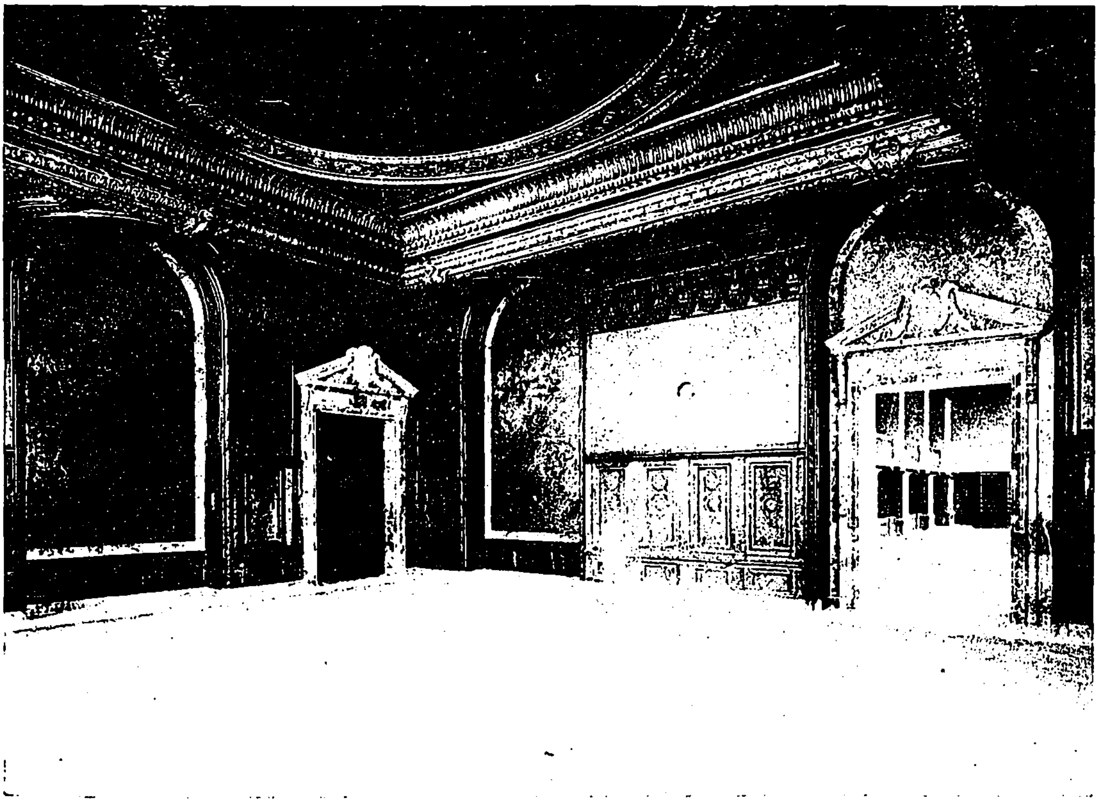
Main Rotunda, New Public Library, New York City. Carrère and Hastings, Architects.



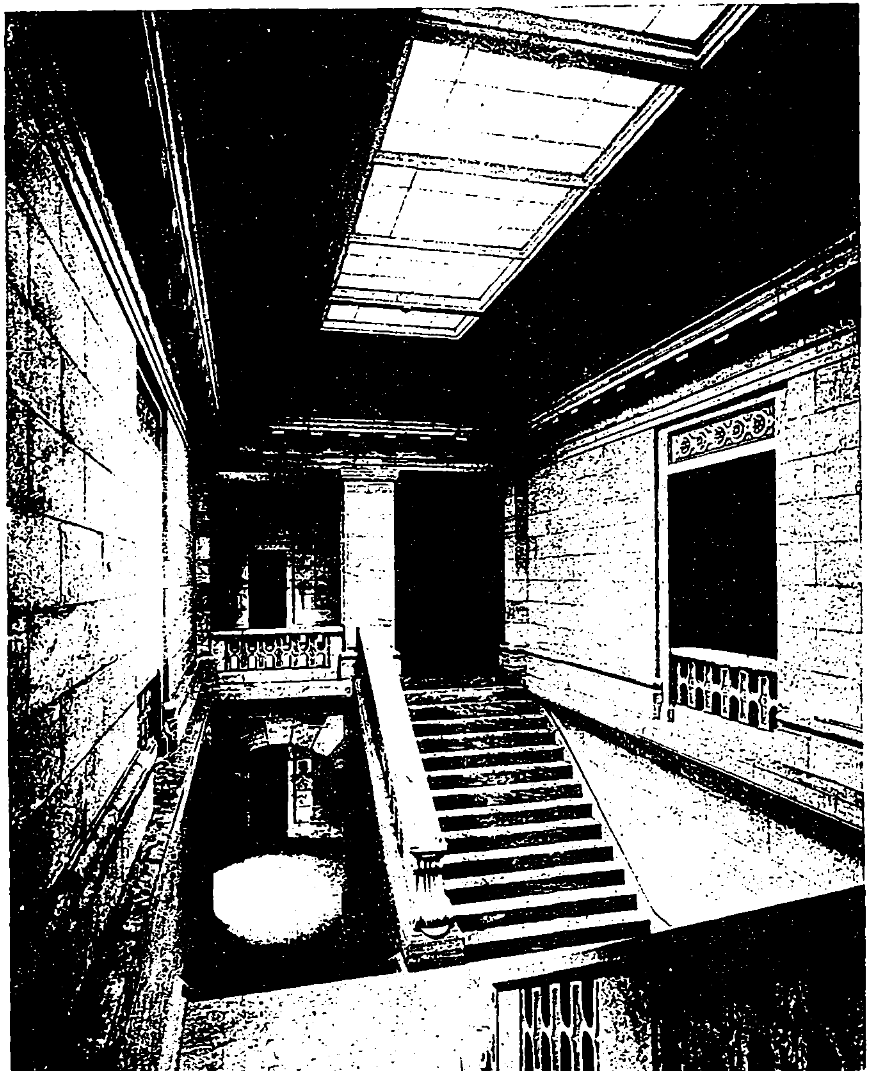
Main Reading Room, New Public Library, New York City. Carrère and Hastings, Architects.



Exhibition Room, New Public Library, New York. Carrère and Hastings, Architects.



Periodical Reading Room, New Public Library, New York City. Carrère and Hastings, Architects.

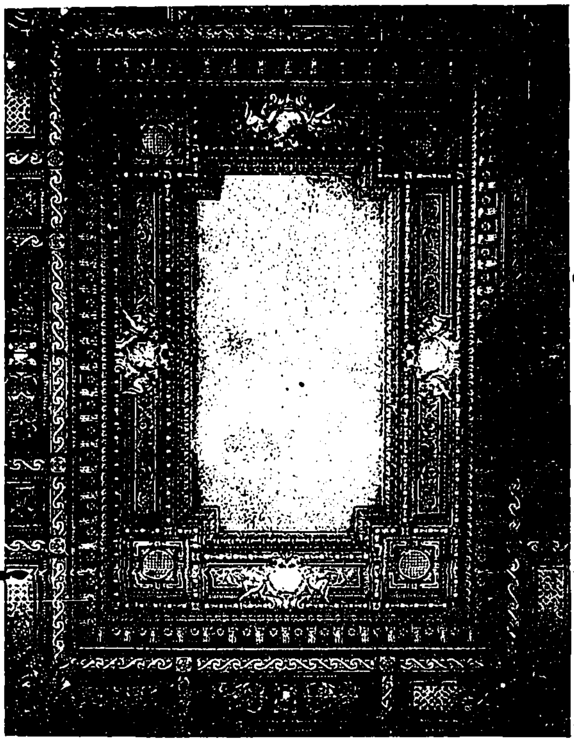


One of the Side Staircases, New Public Library, New York City. Carrère and Hastings, Architects.

Periodical Stack Room, New Public Library, New York City. Carrère and Hastings, Architects.

direction, the light is in all except a few cases, all that is needed. The corridors, which parallel to the outer lines of the building between two rows of rooms, one lighted from the street and the other from a court, have to be artificially lighted, but that is as it should be.

It is an interesting fact, however, that the superbly dimensioned reading-room—an apartment 395 feet long, over 75 feet wide, and 50 feet high—has



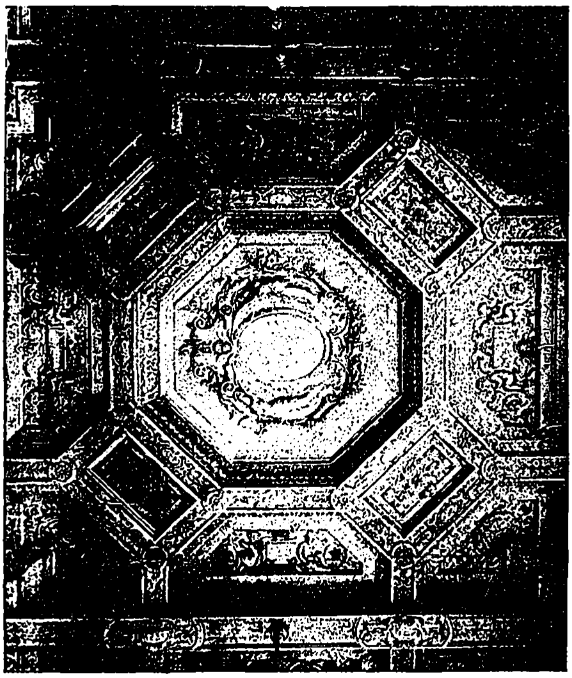
Panel of Ceiling in Main Reading Room, New Public Library, New York City. Carrère and Hastings, Architects.

practically no salient effect on the exterior of the building. It stretches along the rear of the structure, and this facade is very plainly treated, without any pretence to architectural effect. It is, indeed, designed frankly as the rear of a structure which is not meant to be looked at except on the other sides. Any attempt, consequently, at monumental treatment has been abandoned. The building is designed to be seen from Fifth Avenue and from the side streets. The rear, on Bryant Park, merely takes care of itself; and one of the largest apartments in any edifice in the United States is practically concealed, so far as any positive exterior result is concerned.

The striking fact mentioned in the preceding paragraph is a sufficient characterization of the purpose of the architects. They recognized that they could not plan a room of the required dimensions and light it properly without destroying its value as the primary motive of a monumental building; and in obedience to their settled policy of being loyal primarily to the needs of the plan, they deliberately sacrificed the monumental to the practical aspect of the edifice. What is more, they sacrificed the architectural effect of the interior of the reading-room to the convenience of the management in the handling of the books. This superb apartment is cut in two by an elaborate wooden screen, from which the books contained in the stacks are to be distributed; and it is, consequently, almost impossible to get the full architectural effect of the reading-room, except from some point a long the balcony.

The New York Public Library is not, then, intended to be a great monumental building, which would look almost as well from one point of view as another, and which would be fundamentally an example of pure architectural form. It is designed rather to face on the avenue of a city, and not to seem out of place on such a site. It is essentially and frankly an instance of street architecture; and as an instance of street architecture it is distinguished in its appearance rather than imposing. Not, indeed, that it is lacking in dignity. The facade on Fifth Avenue has poise, as well as distinction; character, as well as good manners. But still it does not insist upon its own peculiar importance, as every monumental building must do. It is content with a somewhat humbler role, but one which is probably more appropriate. It looks ingratiating rather than imposing, and that is probably one reason for its popularity. It is intended for popularity rather than for official use, and the building issues to the people an invitation to enter rather than a command.

From a strictly architectural point of view, there



Carved Wood Ceiling Panel in Exhibition Room, New Public Library, New York City. Carrère and Hastings, Architects.

are many criticisms which can be passed upon the design. The niches and fountains on either side of the entrance—the one monumental feature of the building—are a not very happy and appropriate de-

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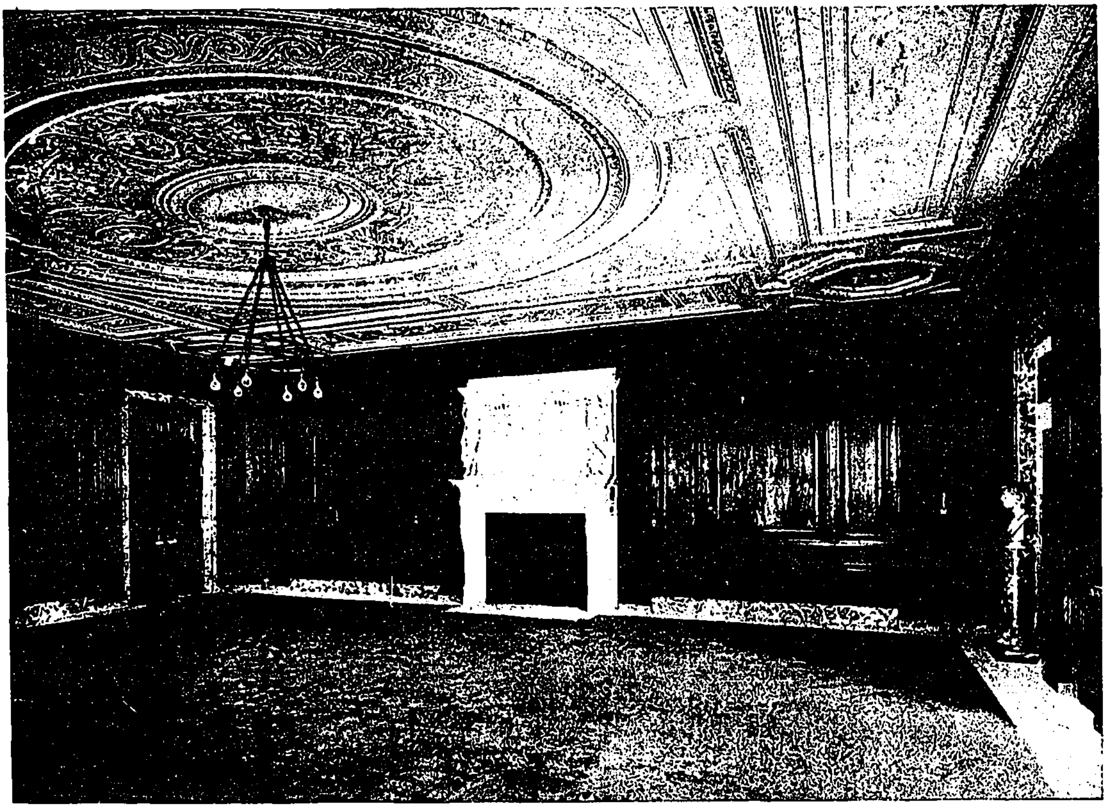
Circulating Library Room, New Public Library, New York City. Carrère and Hastings, Architects.



Trustees' Room, New Public Library, New York City. Carrère and Hastings, Architects.

A FEW POINTS ON REINFORCED CONCRETE DESIGN

Full text of paper read by C. S. L. Herzberg at the Third Annual Convention of the Canadian Cement and Concrete Ass'n.

IN DESIGNING reinforced concrete structures one is continually meeting minor problems upon which very little satisfactory information can be obtained from the numerous treatises on the subject. In the following paper I shall endeavor to enumerate a few points in design which are sometimes apparently not given the attention they deserve.

Footings have probably given more trouble to the designer, the erecting contractor and the owner than anything else in connection with reinforced concrete. Unequal settlement in footings is responsible for numerous unsightly deformities and cracks and some collapses.

The common type of reinforced concrete column footings is, of course, easily dealt with and differs from a plain concrete footing only in its being designed as a flat slab to resist bending instead of being sloped off as a pedestal. In this type of footing the centre of pressure coincides with the centre of gravity of the footing area and the required size is formed directly from the load to be carried and the resisting power per square foot of the soil. Trouble is sometimes caused by having a footing too large in comparison with the size of the other footings in the same building. This is particularly liable to happen in the design of wall column footings in the following manner:—

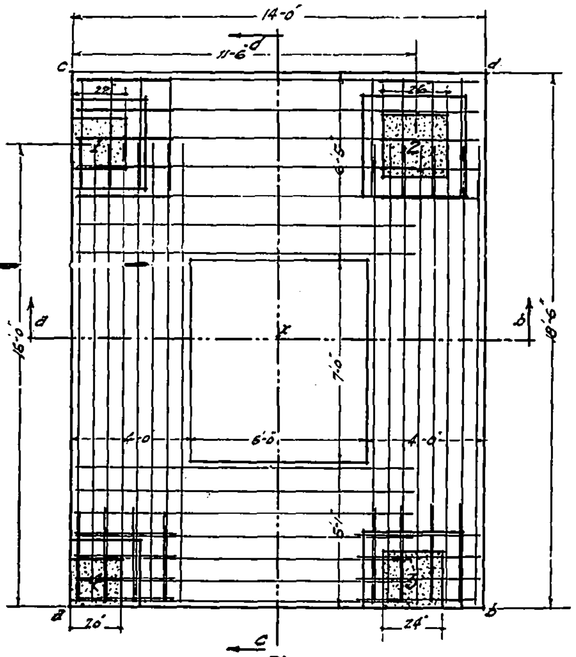
If the footings are designed to carry the total dead and live load, figuring each floor of the building fully loaded, then the interior footings will, under probable loading, not stress the soil as highly as will the wall column footings. The reason for this is, of course, that the load figured to come on the wall column footings is usually about 70 per cent. dead load (which is present under all conditions) and 30 per cent. live load (which is never all there), while that figured on the interior column footings is generally about 40 per cent. dead and 60 per cent. live. As the live load on the footings of a building of five storeys or more is never more than 50 per cent. of the total live load, it will readily be seen that the pressure per square foot is less on interior footings than on exterior ones.

As all soil is compressed under any loading, the interior footings will not settle as much as the exterior ones, and the result is sometimes the cracking of floor beams and slabs.

The difficulty is overcome, to a certain extent, by the custom of reducing the live load by about 50 per cent. in buildings of over a certain number of storeys. This, however, would appear to be insufficient, and it would seem that either a greater reduction should be figured in designing interior footings, or else no reduction at all should be allowed in figuring exterior column footings. It would also appear to be wise to even add a small percentage on corner column footings as a much larger portion of the wall coming on these is dead weight.

It very often occurs that the footings under wall columns cannot be built to extend beyond the outside line of the column. In cases of this kind some sort of combination footing should be used. This is sometimes done by carrying the column in question on a cantilever beam, pinned down at the other end by one of the other columns. Care must be taken in this type to reduce the footing under the second column in proportion to the upward thrust from the end of the cantilever beam.

A simpler method of treating the above is as follows: Consider the wall column in question and the nearest interior column as acting together on a combined footing. Figure the loads coming on both columns



Plan.

and find the position of their resultant load. Add the two loads and divide by the soil value per square foot. This will give the required footing area. Design a footing of this area and varying in width from one end to the other in such a way that the centre of gravity of the area will coincide with the point of application of the resultant from the two column loads. The thickness of the footing and the reinforcing material must now be designed, treating the footing as an inverted beam, supported at the two columns and resisting the upward pressure of the soil, which will be of an intensity per square foot equal to the soil value, minus the weight per square foot of the concrete in the footing.

The above method can be used for designing combination footings for any number of columns.

Figure 1 shows a footing of this type designed to carry the four columns indicated, whose loads were (1) 267,000 lbs., (2) 347,000 lbs., (3) 284,000 lbs., and (4) 197,000 lbs. The soil value assumed was 5,000 lbs. per square foot. Column 1 was a corner column, and 2 and 3 were wall columns, and 4 was an interior column. The footings could not extend beyond the lines ab and ac. The footing was designed as follows:

Sum of column loads = 109,500 lbs.

Sum of moments about side ab = 10,272,166 foot pounds.

Therefore centre of pressure is $\frac{10,272,166}{1,095,000} = 9$ ft. 4½ in. from ab.

Taking moments about line ac, we find centre of pressure is 7 ft. 0 in. from ac.

This locates the point x, the centre of pressure.

Area of footing required = $\frac{109,500}{5,000} = 219$ sq. ft.

The lengths 1 8ft. 6 in. and 14 ft. 0 in. of the sides ac and ab are now arbitrarily assumed.

Area of rectangle abcd	259 sq. ft.	
Area of footing required	219	"
Area to be deducted	40	"
Deduct area efgh, 7x6	42	"

Let x = distance from ac to centre of gravity of area to be deducted.

Let y = distance from ab.

Then $x = \frac{259 \times 7 - 217 \times 7}{42} = 7$ ft. 0 in.

and $y = \frac{259 \times 9.25 - 217 \times 9.38}{42} = 8$ ft. 7 in.,

which locates the position of the area efgh, which will give a footing whose centre of gravity coincides with the centre of pressure.

The footing was then designed for bending by treating it as four beams between the four columns, figuring on 5,000 pounds per square foot upward pressure, minus the weight of the concrete in the footing.

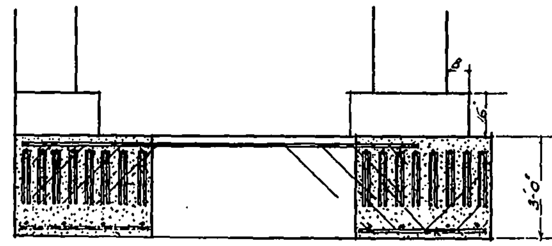
While the centre of pressure will, of course, shift under different conditions of column loading, still the variation cannot be sufficient to cause a serious settlement of any part of the footing.

In some cases it is very difficult to economically combine a wall column footing with any other footing. Where this is the case the footing is increased towards the inside of the building and along the wall. When this is done, the column must, of course, be tied in at the top and figured to resist the bending caused by the eccentric loading on the footing. This bending is generally increased by the bending moment from the eccentricity brought on the column from the floor loads.

A point in designing reinforced concrete which is often overlooked is the bending produced in wall columns carrying long span beams. This moment seldom gives trouble in the lower tiers of columns in a building of any considerable height as, in such cases, the columns are so heavily loaded that the eccentricity is not sufficient to produce actual tension in the outside of the column.

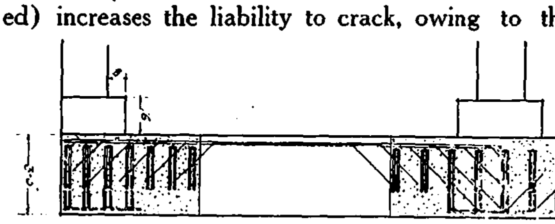
The common practice of designing wall columns 20 per cent. heavier than interior columns does not always overcome this tendency to crack from bending as the extra strength is not applied in the proper place.

Consider the roof columns of a building of considerable width in which the roof beams span from side



Section on Line A-B.

to side with no intermediate support. The usual custom is to carry the column reinforcement to within a few inches of the top of the roof slab and to bend the anchor bars of the beams down into the columns the usual depth to prevent cracking in the supper surfaces of the beams near the ends. In a building designed in this way the result is pretty sure to be cracks across the outer surfaces of the columns, immediately under the level of the bottoms of the beams, even though the roof be under no load other than the dead load of the structure itself. The reason for this is that the beam deflects under its own weight and the weight of slab carried. This deflection produces a tension in the upper surface of the beam at the end, which tension is also present at the outer surface of the column where it is altogether liable to produce large cracks. These cracks can be seen in many buildings. They should be provided against by increasing the reinforcing steel in the outer side of the column. This reinforcement should not be stopped at the roof level, but should be bent in along the upper surface of the beam. The use of plain steel rods for reinforcement in these columns (if the same are not bent over as described) increases the liability to crack, owing to the



Section on Line C-D.

fact that they must be embedded to a greater distance than deformed bars in order to develop their tensile strength. Cracks of this nature are, of course, more unsightly than they are dangerous, for beams supported in this manner are usually designed as non-continuous over the supports, and should be of the required strength whether pinned down to the columns or not. However, the bond with the column is an added strength to the beam and should be preserved.

The placing of brackets under a beam of the above description does not overcome the difficulty and is, in my mind, poor practice. The brackets tend to spread the columns by causing the beam to act as an arch whose thrust is not properly taken care of, and cracks will very likely occur on the outer surface of the columns under the brackets. This construction acts, to a great extent, like a roof truss without a tie rod.

Reverse bending should be given particular attention in the design of highway bridges where heavy moving loads have to be provided for. In short span culverts where a flat slab is used this reverse bending at the abutments, if not properly taken care of, may result in a failure which has all the appearance of a shear failure, and such it may be after a certain point, although it has probably started in tension cracks in the upper surface of the slab.

Consider a culvert, say, 12 feet clear span to be designed to carry a 15 ton road roller. The slab is designed as non-continuous and enough steel is inserted in the bottom to give a resisting moment to properly take care of the total maximum bending moment liable to come on the culvert. In all probability the concrete itself will figure to take care of all the shear at 50 pounds per square inch, and therefore no extra provision is made against failure through shear.

At first glance this culvert would appear to be properly designed to insure against failure from any cause, for, as the slab is not figured continuous over supports it does not seem necessary to put any steel in the top of the slab at the abutments. This conclusion would be safe if the slab were cast separate from the abutments, but if (as is nearly always the case) the abutments and slab are monolithic the following is liable to occur:

A heavy vibratory load comes to the centre of the span and produces considerable deflection and, as the slab is tied down to the abutment, tension is produced in the upper surface of the slab and on the outer surface of the abutments. The slab being thinner than the abutment cracks on top just inside the line of the abutment. Then as the load approaches this point the shear is increased and the cracked concrete is probably not capable of resisting this shear and collapses.

This failure might have been prevented in three ways, namely, by the use of top steel, by the use of steel shear members, or by having a complete horizontal joint between the slab and abutment.

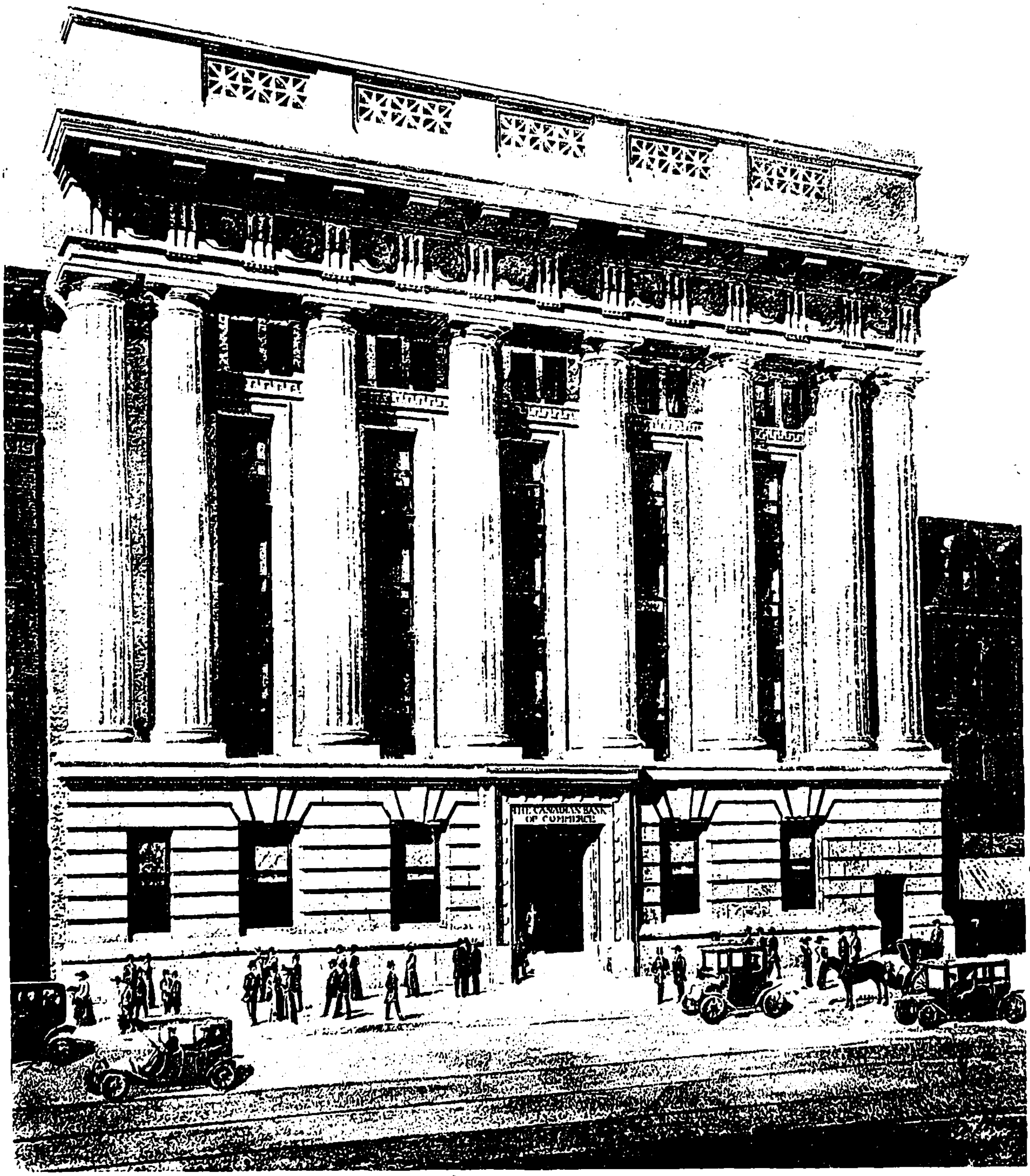
The advantages of what is known as flat ceiling construction are many, the most desirable among them being the appearance produced and the economy in floor height. The chief disadvantage in the most common types is our lack of scientific data on the subject. In a well-known type, opinions differ nearly 100 per cent. as to the bending moment to be figured in slabs under the same loading. In the Engineering Record of 24th December, 1910, there is an account of some measurements made to obtain the strain existing in different portions of a flat slab floor under working loads. From these strains the existing stresses are figured. The results of these measurements appear to indicate that some designers are oversanguine about the carrying capacities of this type of floor.

A more conservative design of flat ceilings is effected by increasing the width of the beams and decreasing their depth until the underside of the beam is flush with the underside of the slab. The slab in these cases is usually made up of small reinforced concrete joists with tile fillers in between and two or three inches of concrete over the top to aid in compressive resistance.

In this type of floor the stresses are known and the strength can be figured along the same lines as the ordinary slab and beam construction. The tile fillers are placed as much as possible below the neutral axis of the slab so as not to decrease the compressive resistance of the concrete, and, of course, they decrease the dead load of the floor. This type of floor is not as economical in steel as the usual slab and beam construction on account of the decreased arm of the resisting couple of the steel in tension and the concrete in compression.

Two-way reinforcement in a rectangular panel, designed according to the accepted theory of reductions in bending moments, effects economy in concrete only. If the bending moments each way be reduced in the usual manner of multiplying by $\frac{A4}{A4 \times B4}$ for the shorter span, and by $\frac{A4}{A4 \times B4}$ for the longer where A represents the shorter span and B the longer, the steel may be slightly reduced by placing less near the edges of the panel than near the centre. This reduction is, however, offset by the fact that, in using bar reinforcement the amount of resistance of the upper layer of steel is decreased by the decrease in the resisting arm of the forces. The saving in concrete is, of course, effected by figuring it to take its full working compression in two directions at right angles to one another.

Before closing I would like to enter a plea for the standardization of unit stresses and formulæ in reinforced concrete design throughout Canada. Some things, of course, cannot be standardized, but such points as ratio of the modulii of elasticity of steel and concrete, the allowable working compressive strength of concrete, both in bending and in direct compression, the limits of the action, etc., might be definitely settled and adhered to by all designers. If it is safe in one city to design a continuous beam uniformly loaded to resist a bending moment of one-twelfh WL., then it is equally safe to do the same in the next city, despite the fact that the second city insists on it being designed for one-eighth WL. Other points might also be strengthened out, such as whether a specification should insist on using 12 for the ratio of the modulus of elasticity of steel to that of concrete when, in another part it calls for a working stress of 350 pounds per square inch for the concrete in a column and 10,000 pounds for compressive steel embedded in the same column.



Design for the Proposed Bank of Commerce Building, Winnipeg. Darling & Pearson, Architects.

CONSTRUCTION

A · JOURNAL · FOR · THE · ARCHITECTURAL
ENGINEERING · AND · CONTRACTING
INTERESTS · OF · CANADA

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H. GAGNIER, LIMITED, PUBLISHERS
Saturday Night Building.
Toronto. - - Canada

BRANCH OFFICES
Montreal London, Eng

CORRESPONDENCE—All correspondence should be addressed to "CONSTRUCTION," Saturday Night Building, Toronto, Canada.

SUBSCRIPTIONS—Canada and Great Britain, $3.00 per annum. United States, the Continent and all Postal Union countries, $4.00 per annum, in advance. Single copies, 35c.

ADVERTISEMENTS—Changes of, or new advertisements must reach the Head Office not later than the fifth of the month preceding publication, to ensure insertion. Advertising rates on application.

CONTRIBUTIONS—The Editor will be glad to consider contributions dealing with matters of general interest to the readers of this Journal. When payment is desired, this fact should be stated. We are always glad to receive the loan of photographs and plans of interesting Canadian work. The originals will be carefully preserved and duly returned.

Vol. 4 Toronto, April, 1911 No. 5

CURRENT TOPICS

A PARTNERSHIP has been formed by Mr. Andrew Sharp, A.R.I.B.A., and Mr. J. Hodge Brown, Toronto, who have opened offices for architectural practice at 18 Wellington street east. The new firm will be known as Sharp & Brown, and will be pleased to receive catalogues, sample and price lists from manufacturers of building materials.

* * *

THE TERM "JERRY BUILT," (which applies to the product of the speculative operator on this continent), according to the suggested derivation advanced by a young Theologian connected with the Manchester, Eng.), Sunday School, comes from the walls of Jericho, which fell merely because a noise or commotion was made near them.

* * *

ANOTHER OF THE EARLY BUILDINGS of Toronto to disappear in the wake of modern business progress, is the small frame structure at 35 and 37 King street west, which was recently demolished to make way for the imposing new edifice to be erected by the Bank of Quebec. The old building was a two-storey structure, with stores below and rooms above. It was built in 1834, and while not noted for any great antiquity, it was nevertheless interesting as indicating the remarkable strides which architecture has taken in recent years.

THE CHINGFORD RESERVOIR now in course of completion on the outskirts of London, (Eng.), has a water area of 416 acres, and will store 3,000 million gallons, or enough to supplement the city's existing supply by 30 million gallons daily.

* * *

AN ANNOUNCEMENT has been received to the effect that Messrs. John M. Watt and Victor J. Blackwell, architects, London, Ont., have entered into a partnership, with offices in the Bank of Toronto Chambers in that city. The new firm will practice under the name of Watt & Blackwell, and the members report an active season's work already in prospect.

* * *

CARBORUNDUM FORMS an important constituent in a flight of concrete stairs built at Paris, France, over which 14,000,000 persons have up to the present shuffled without so much as scratching the surface. The introduction of this new aggregate, it is said, has not only produced a concrete which is eminently serviceable in every way, but one which for wearing qualities, cannot be approached by any other material used for a like purpose.

* * *

RATHER A UNIQUE BUILDING of reinforced concrete is a six-story garage built in Boston which has circular columns of the same diameter in the upper and lower storeys and has long floor spans permitting of a deep turntable well of large diameter in each story. The front wall corresponds with the brick and stone face of an adjacent building, and has a rather elaborate trimming of cornice, dentils, and carved stone, all of which, except the last, are cast integral with the body of the wall.

* * *

A BOARD OF AWARD, consisting of Dr. Douglass, city medical inspector; John D. Atchinson, a prominent local architect, and Dr. Strum, of Chicago, is now engaged in examining the thirteen designs submitted in the recent competition for the Hospital of Contagious Diseases to be built by the city of Winnipeg. The building is to cost $500,000 exclusive of furnishings. It is expected that the name of the successful architect will be announced shortlly, and that the work will be proceeded with this spring.

* * *

THE NEW HOTEL for immigrants, erected by the Argentine Government, was opened by the President of Argentina on January 24, 1911. This structure is at the Darsena Norte, where immigrants are landed in Buenos Aires, and occupies 47,840 square yards. It is practically fireproof, being built of reinforced concrete, and can accommodate 3,200. The building is fitted with all the necessary comforts and has isolation wards for contagious diseases, while the sanitary arrangements in regard to baths, lavatories, etc., are nearly perfect. The various railways will have ticket offices in the hotel, so that immigrants may purchase their tickets direct from the railways, and every facility to reach their destinations in safety will be afforded them.

IT IS ANNOUNCED that the Dominion Railway Commission will recommend to Parliament the construction of new terminal facilities at Halifax, to cost between one million and a half and two million dollars. The project advanced contemplates the removal of the present wooden wharves and their replacement by concrete structures. In carrying out the work, the plans prepared by Mr. Kennedy, Engineer of Montreal Harbor, will likely be followed, with such minor modifications as may be necessary to comply with local requirements.

* * *

A SECURE BOND between the upper or wearing surface of a concrete floor, walk or pavement and the lower or foundation layer, can be obtained, says an exchange, when laying the lower layer, by scoring its upper surface crosswise and longitudinally, to form grooved squares, with diagonals or V-shaped depressions across them. Over this surface lay a coarse-mesh woven wire, and on top of this the top layer or wearing surface. The intention of this construction is to hold the two layers together and to prevent the cracking of the top layer by excess of expansion in it over that in the lower layer.

* * *

A NOTICE OF MOTION of the intention of the Quebec Government to erect a statue in memory of King Edward VII., was recently given in the Provincial Legislature by the Hon. Mr. Taschereau, Minister of Public Works. The site selected is the historic Plains of Abraham, and as soon as the required legislation has been adopted, the Government will ask a number of prominent sculptors to submit designs for a monument that will both serve as a fitting tribute of respect to His late Majesty, and reflect credit on the province by whom it was erected. The monument will be presented to the Battlefields Commission, who will have charge of its instalation and the unveiling ceremony.

* * *

CANADIAN FIRMS intending to participate in the Third Triennial Exhibition of Electrical Engineering and Machinery, to be held at Olympia, London, from September 23 to October 21, should lose no time in securing space, as a large portion of the ground floor and galleries has already been engaged. Although promoted solely by the National Electrical Manufacturers Association, of England, this event is to be international in character, and a large number of American and Continental firms are arranging to make displays. An interesting feature in connection with the exhibition is the fact that all exhibiting firms will participate in the profits, if any, arising from the exhibition, although their liability is limited to their space rental, which is advertised not to be in excess of those of any similar exhibition. The fact that this event will take place in the coronation year, it is urged, is also strongly in its favor, as there will be a large number of colonial buyers visiting in London, who will embrace the opportunity of visiting such an important undertaking, in which many of them will be keenly interested.

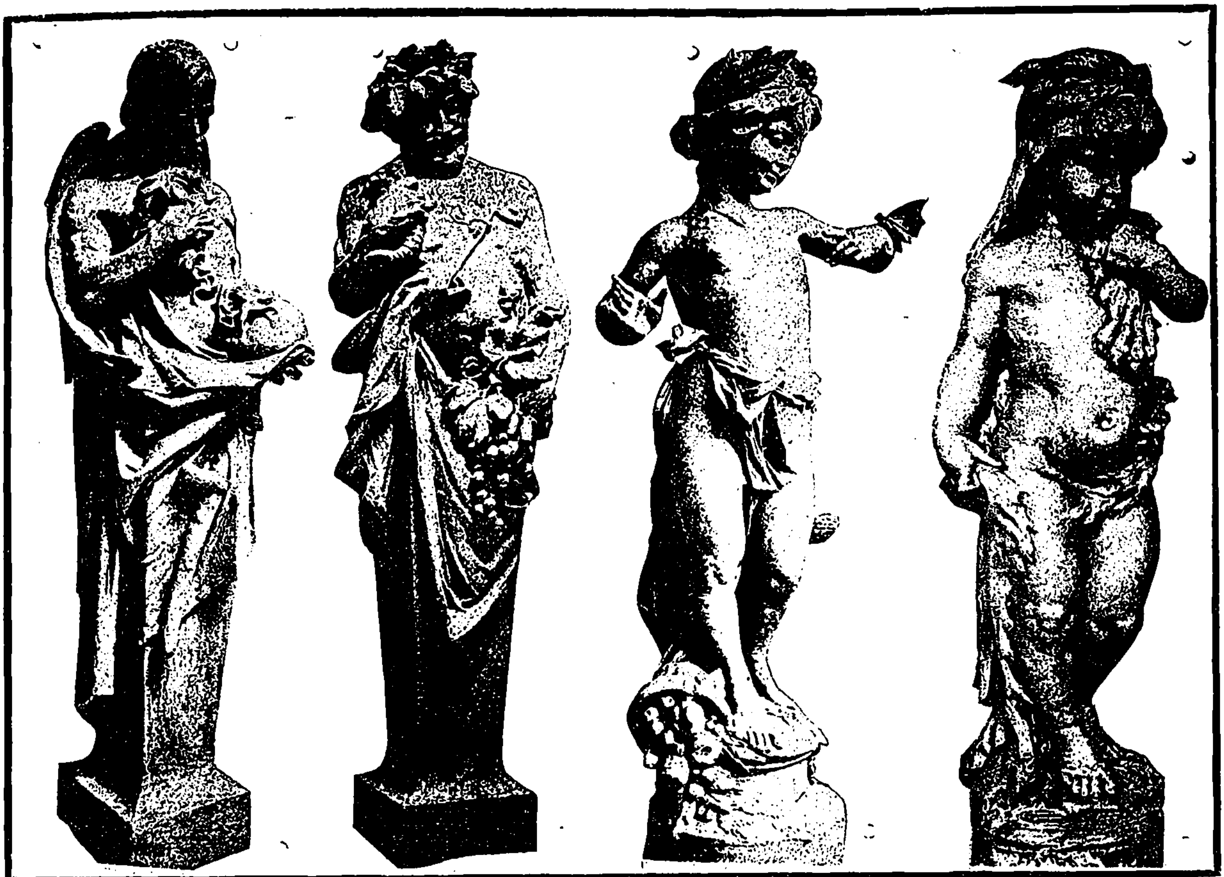
THE GREATEST POWER SCHEME yet attempted in India, is now being carried out at Lonavola, Tatas, where the Hydro-Electric Power Supply Company is damming the valleys in the Ghauts for the storage of water power convertible into electric energy. The foundation stone for this important work was laid by the Governor, Sir George Clark, on February 8th just passed. The dams will be 8,900 feet in length and from 32 to 70 feet in height, creating lakes 2,521 acres in extent, with a capacity of 3,000,000,000 cubic feet, with a fall of 1,730 feet. The estimated output, 40,000 horsepower, will be transmitted to Bombay, 43 miles away. The cotton mills will be the chief consumer.

* * *

THERE IS A PREVALENT IMPRESSION and it is not confined to those who are ignorant of history, says a writer in the *Literary Guide*, that Gothic architecture is a style essentially sacred and ecclesiastical. The term "Christian architecture" has been applied to it in text-books of authority, while in common parlance even "Church architecture" may every now and then be heard of. The idea is, however, nothing but a curious illusion, due really to the destruction of so much of the secular and preservation of so much of the sacred work of the Gothic period. During that period nobody in Western Europe ever dreamt of building in any other style, whatever the purpose he might have in hand. The art was the natural product of the time, so natural indeed that mediæval writers scarcely ever mention it. No mediæval, it is safe to say, ever thought of it as in any way either Christian or ecclesiastical. Westminster Hall is as much a Gothic building as Westminster Abbey; the great "Cloth Halls" of the Netherlands are very fine Gothic indeed; and every mediæval castle is merely an adaptation of the same style to military purposes. Domestic architecture was for the most part in wood, especially in England; but where stone was used the well-known Gothic features (less conspicuous, naturally, in wood-work) made their appearance at once. The street-fronts of Munster, for example, are "pointed" arcades; and in the wonderful mediæval survival of Rothenburg, where practically the whole town is Gothic, the illusion vanishes altogether. What the Church really did was to give the art an opportunity; to provide, in the greater cathedral and abbey churches, a field for the development, on a magnificent scale, of the marvellous possibilities locked up within it. This it did, and did right royally.

SOME FAILURES, ETC.—Cont'd from page 53

sees that the forms are cleaned before the concrete is poured, that the ingredients are correctly proportioned, that the steel is properly placed and in correct amount, that the members are of dimensions called for by the plans, and that the forms are not removed until the material has acquired sufficient strength to be self-sustaining. The capable inspector is essential to safe construction.



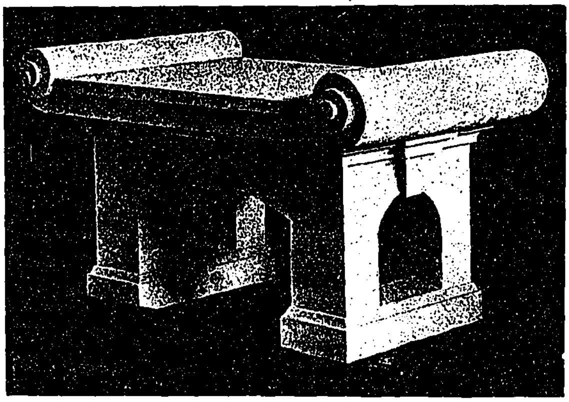
Cast Stone Statuary—Showing Four Interesting Examples of the Use of Cement in the Production of Figure Work.

THE APPLICATION OF CEMENT TO CAST FIGURE WORK

Marvellous examples of its use in modern work reveals the unlimited possibilities of the material in the field of decorative art. Specific instances of its application illustrated.

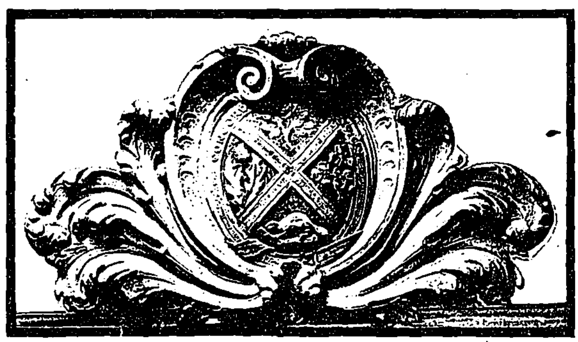
SIMULTANEOUSLY with the extending utility of cement in structural undertakings, is to be noted the remarkable use of this material for decorative work. While it is true that up to a period of fifteen years ago, the opportunities which cement offers for the reproduction of decorative detail and objects of fine art, were practically unrecognized, from that time on its possibilities in this respect have been sufficiently exploited as to admit of no doubt as to the fitness and value of this material for artistic and enduring effects. Little perhaps did Joseph Monier, the Frenchman, realize, when some forty years back he fashioned a flower pot of reinforced concrete, the broad acceptance which was to follow in the use of concrete as a medium of artistic expression. That Monier's experiment was primarily an investigation to ascertain the structural efficiency of two combining materials rather than an attempt at decorative art, seems patent from the fact that for some little time immediately following attention was particularly given to exploiting the utilitarian advantages of concrete, almost to the exclusion of what it might offer from an æsthetic standpoint. This, however, in itself is a condition which has always obtained with every new and untried product; for while concrete cannot be regarded as new and untried in the sense that its qualities were previously unknown, it must be remembered that for a considerable lapse of time its utlity was virtually classed among the sciences lost.

Italy, where concrete was first adapted to practical utilitarian and practical decorative purposes,



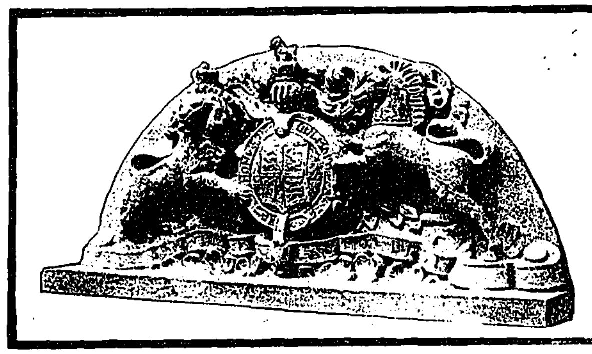
Concrete Garden Seat.

presents undoubtedly the best examples of early work. From the structural elements of aqueducts, and of domestic and civic buildings, culminating in the Pantheon at Rome, to the balustrades, the fountains, and the statues, for their enrichment, the adaptation—to quote an authority—has been perfectly made. A notable example is the celebrated fountain of the Villa Lante, at Viterbo, with its central figures and elaborate system of minor cascades and canals. For some time this was generally thought to be some other material, but is now definitely known to be of concrete, only that with time and some chemical property in the water, it has become smooth, hard and black, like the pietra nera in the mountains near by. Marvellous and interesting, however, as this early work is, it is doubtful, providing we wave our ancient prejudices aside, if it is any more alluring in its general attractiveness, or more assertive of artistic competency, than much of the modern decorative work to be seen either on this continent or in other European countries. This, indeed, more than



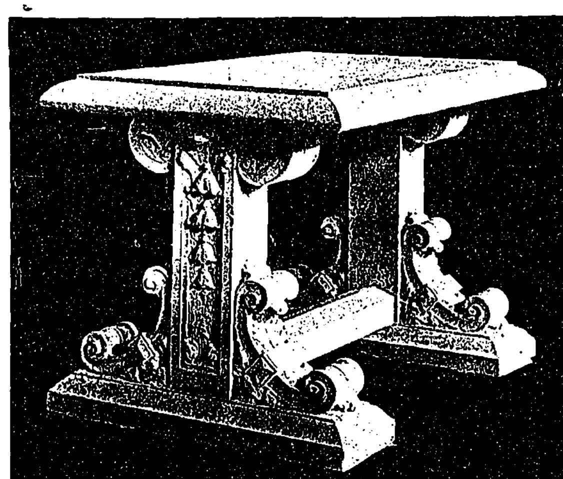
Municipal Coat-of-Arms—Executed in Concrete for the New Public Baths, Montreal.

Cement Cast Replica—Coat-of-Arms of the Bank of Montreal. Note the Workmanship and Texture of the Material.



Coat of Arms—Another Example of the Use of Cement Stone in Decorative Work.

any other time, is a period of renaissance as far as the artistic use of concrete is concerned. In the peristyles and pergolas of the formal garden, in the richly wrought detail of the stately home, in the massive entablature and carefully molded cartouche of the public, semi-public and commercial building, in the undercut tracery of the Gothic window, in the trimming and doorway of the factory, in the ornamental street lamp and the statue and band stand of the city square, the application of concrete to artistic ends unfolds itself in a manner which suggests a field of seemingly illimitable possibilities. To-day the architect specifies cement cast stone in his most important work, and the landscape artist adopts it for his finest gardens. The most expert modellers are engaged in its manufacture, in faithfully reproducing detail by its use, according to architectural or decorative requirements. And yet, by no means does its limitations end here.



Lawn Table in Concrete.

One of the most striking, as well as one of the most unique and interesting examples of the application of cement to cast figure work, is to be seen at the famous animal park of Carl Hagenback, at Stelligen, Germany, where a series of wonderful and strikingly realistic representations of the great monsters that inhabited this earth in the remote past, are reproduced in this material. These weird beasts of prehistoric days were executed by Mr. J. Pallenburg, the well-known Continental animal sculptor,

A Richly Detailed Cast Stone Garden Piece.

and are modelled with a truly remarkable life-like fidelity. They are grouped around a delightful little lake, some three acres in extent, and are depicted standing by the water's edge amid the shrubs and trees. In the lake itself are shown huge crocodiles and strange-looking creatures, half fish and half mammal. Added realism is given by representing a few of the beasts in the act of battling with specimens of their kind.

Cast Stone Group Produced by the Brommsgrove Guild, Worcestershire, England.

In order that his representations would be scientifically correct, Mr. Pallenburg spent twelve months in consulting leading naturalists and in making exten-

Ornamental Vases Cast in Cement at the Studio of the Brommsgrove Guild.

The Diplodocus—One of the Mammoth Prehistoric Animals Reproduced in Concrete for the Famous Hagenback Zoological Park at Stelligen, near Hamburg, Germany. This Huge Creature, said to be the Greatest of Terrestrial Animals in the Past, is Modelled in Life Size. It is Sixty-six feet six inches in Length, and is Remarkable as an Example, Showing the Utility and Possibilities of Cement in Cast Figure Work.

sive drawings and sketches of the most authentic specimens to be found in the leading museums of

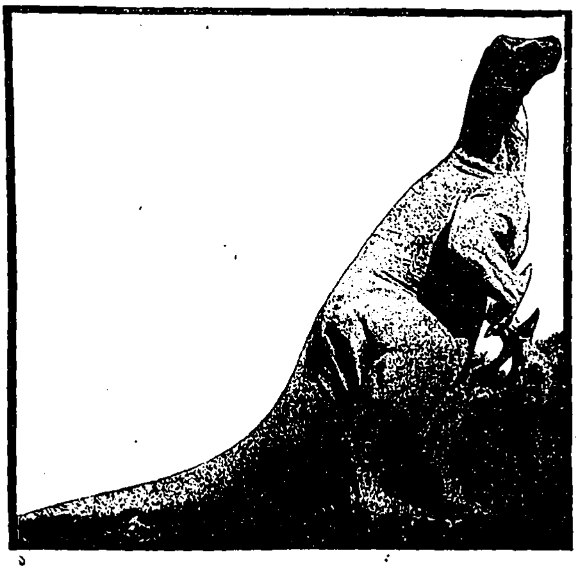
A Glimpse of the Landscape in the Hagenback Animal Park at Stelligen, Showing a Group of Cement Cast Prehistoric Beasts About the Water's Edge.

Europe. Valuable assistance was also procured from the American Museum of Natural History in New York. Preparatory to carrying out the actual work, models were built in clay, and these were passed upon by experts and re-made as often as

The Triceratops at the Hagenback Park. These Strange Amphibians Take on Quite a Natural Appearance, both Owing to Their Setting and Elephant-Gray Hue of the Concrete of which They are Composed.

required to arrive at accurate dimensions, before the molds were finally made.

The several views included in the accompanying illustrations give a comprehensive idea of this novel undertaking and how successfully the work has been accomplished. Aside from the unusual conception it represents, it has a picturesque quality and an enduring educational value that entitles it to a place of distinction among unique works in which the use



The Iguanodon—Another Huge Monster of the Past, Which is Realistically Reproduced in Concrete at the Hagenback Park.

A Carnivorous Dinosaur Cast in Cement and Forty-eight Feet long, which is also Included in the Hagenback Collection.

of cement is found. Many years hence, these huge man-made rock monsters will be standing, still defying the hand of time, a tribute to their author's skill

The Stegosaurus, an Ungainly Creature with Double Spine Plates and Spiked Tails, Whose Present Day Life-like Representation is due to the Economical Advantages which Concrete Offers for Cast Figure Work.

and an unassailable proof of the lasting and artistic qualities of a material on which the average person a few years back looked askance.

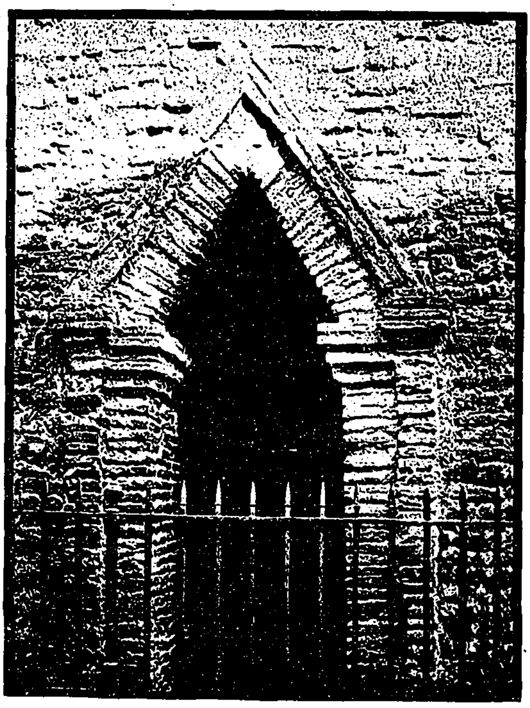
A Prehistoric Bat Modelled in Concrete.

DEVELOPMENT OF ENGLISH BRICKWORK

Complete text of interesting and instructive paper read before a recent meeting of the British Institute of Builders by H. Franklyn Murrell, A.R.I.B.A.

THE NAME BRICKWORK immediately suggests to the younger of us, perhaps, Board of Education examinations and terrifying questions of bond, to the much competing contractor prices per rod, to the sorely tried architect, "What can I get off my brickwork bill?" for a reduction estimate.

Rather than these all-important questions I would call your attention to some of the beautiful works

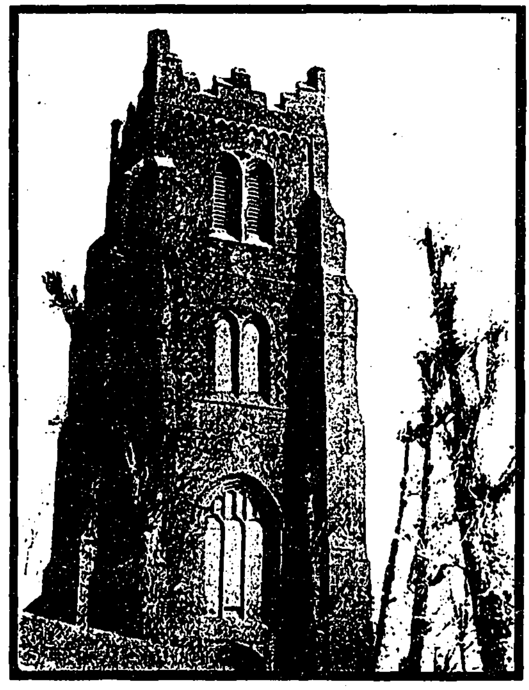


Doorway of Holy Trinity, Colchester, Showing Roman Brick Masonry of an Early Period.

which have been executed in this material in the past, as illustrating its possibilities for architectural design. It is hardly necessary to remark the very early use of bricks, both burnt and sun-dried, as building material. "And they said one to another, 'Go to, let us make bricks and burn them thoroughly.' And they had bricks for stone and slime had they for mortar." So we may claim Babel as the first big brickwork contract, and Shinar Plain as the first paying brickfield.

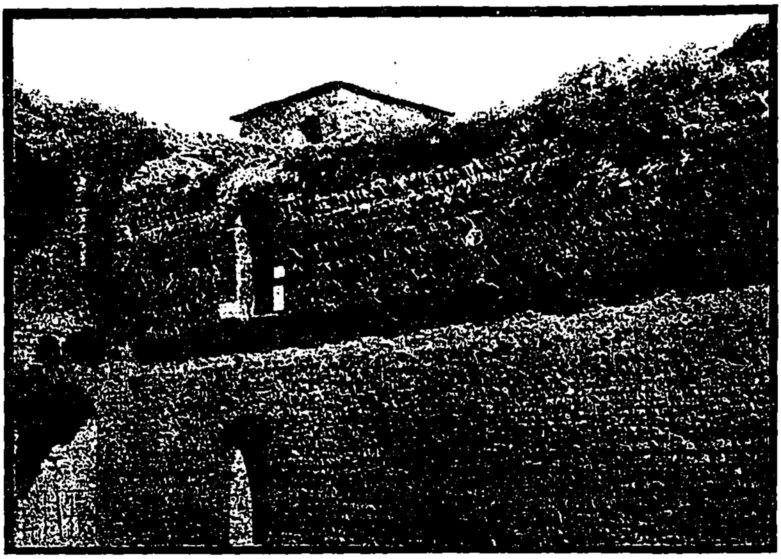
But here it must be admitted that brick for stone has been the continuing truth; men have preferably built in stone, turning to brick generally only in the absence of the finer material. Apart from Santa Sophia I can think of no great historic building of the first order faced in brick. Yet behind the scenes in the dome of the Pantheon and the cone of St. Paul's it is doing its own structural work essential to the stability of these Titans. It is evident that it is naturally suited to an arcuated rather than a trabeated style of architecture. Greek ingenuity could hardly have constructed the architrave of the Parthenon in brick; for brickwork have been reserved triumphs of a more domestic order.

In all countries the natural sequence has been that hill-dwelling peoples with quarries at their doors have built in stone; migrating to the rich clay valleys they have reserved their stone—scarce by reason of expensive transport—for their more monumental buildings, finding in brick a cheap and ready substitute to meet the needs of their growing commercialism. Stone sings the romance of the hills, brick speaks of the prose of the plain, even to the latest stone-fronted, brick-backed chapel, a compromise of God and mammon. On the other hand, brick has



Tower of St. Mary the Virgin, Ingatestone, Essex, Which is Noted for the Remarkably Fine Pattern Work of Its Walls and Its Four-light West Window with Brick Tracery.

this advantage, that harmonies and contrasts of color can be effected in yellow, red, purple and black, to mention merely the natural colors to which clay may be burnt, to rival the possibilities of marble itself.



Courtyard, Colchester Castle, Showing Interesting Herring-Bone Bond in Roman Brick Wall Built About the Year 1078.

Brickwork has proved itself particularly adapted to the lowlands of this country with their excellent brick earth, abundance of fuel for burning, and sympathetic landscape. I have attempted to show on the map that in England it is possible to draw a geographical brick line diagonally from Somerset to Northants, following the line of the oolite beds as the demarcation north and west of which stone predominates, particularly in historical and monumental architecture, south and east of which brick is the dominant material.

To many of us it is a matter for profound gratitude that London comes in the latter division. Edinburgh in spite of Princes street, Aberdeen in spite of Union street, Oxford in spite of High street, tend to show that the stone city, unless town-planned—as Paris—with spaciousness and scale, is in danger of monotony and dull uniformity. Contrast the higgledy-piggledy charm of Cheyne Walk with the sweeping lines of the Crescent at Bath, the one typical of the homeliness of brick, the other illustrating the dignity of stone.

Evidences of Roman brickwork are spread all over the country, but Essex and Kent especially can show hundreds of churches into which Roman bricks have been subsequently built. Without any question the Eastern counties, particularly Essex, are the richest in Tudor examples. The Home counties, Kent, Surrey and Hertford, can also show good work. In Renaissance and later times the Eastern and Southern counties still contain the finest brickwork, but in the west and north brick was also widely used.

Roman Brickwork.

A word first as to Roman brickwork in general. If England learnt her brickwork from Rome, Rome in turn had learnt the method from Egypt. Brick arches, elliptical, semi-circular, pointed, and even inverted arches in foundations are to be found among Egyptian remains. The Greeks also built brick, though not to the same extent, and much of their sun-dried brick has returned to clay, earth-to-earth fashion. Of Greek terra-cotta ornament much fine work is stored in museums. In Roman work brick was usually only a facing to concrete in arch and vault construction; brick ribs and borders were used to hold the concrete filling while setting, and economise wooden centering as far as possible. Brick burning and building do not appear to have been practised in this country prior to the Roman occupation, although existing remains show that the art of pottery was not unknown.

In pre-Roman times the forests of Britain formed the happy hunting-ground of a sporting people whose building needs and ideals were doubtless satisfied by wattle and daub. On the Roman advent at the end of the first century of our era systemized civilization displaced Celtic disorder. As surely as he fortified his camp and levelled his military road, so surely the Roman introduced the brick-covered construction which, thinking imperially, he had designed for universal service from the Euphrates to the Forth. Roman clay working was not confined to the typical 2-inch flat tile, but included fine terra-cotta work such as may be seen in Colchester Museum.

Great Snoring Rectory, Norfolk. An Example of Early Brick and Terra Cotta Work.

The elaboration of Roman buildings in Britain may be judged from the fact that they took the trouble to quarry Purbeck and to import Cipollino, Porphyry, and other Italian marbles. It is unlikely that they would neglect their favorite art of brick and terra-cotta work with material ready to hand.

The remains of Roman brickwork here are in no way different from those in other parts of the Empire. There are examples at most of the Southern Chesters of the two methods of employing brick construction —"Structura Cæmenticia," a mass of rubble concrete faced with stones, with bonding courses of two or three flat tile bricks, and "Opus testaceum," in which the facing and arch work of structure is brick.

In the north Roman bricks are less in evidence. The Tyne and Solway wall was entirely of stone, though bricks have been found at Inchtuthill, a Roman station in Perthshire. The most important British Roman brickwork is at Dover, in the Pharos Tower and at St. Mary-in-the-Castle. In the walls of the former are the usual bonding courses of flat tiles, some of which have ledges forming a key.

Portions of the walls and bastions at Colchester still remain. An enormous amount of brick must have been manufactured at this city. The traditional sites of Roman kilns are still visible. The withdrawal of the Roman troops abruptly terminated scientific construction in this country.

Reasonably it might have been expected that a people familiar for 300 years with Roman method, and surrounded in all likelihood with magnificent examples of its success, would have striven to continue, at least for a time, its sane traditions. To the unrest and upheaval consequent upon Roman departure and Saxon arrival may be attributed the failure of post-Roman builders to appreciate the Basilica, the Thermæ, and the villas, other than as yards of ready-made material. With an ignorant vandalism, the Saxons misused their stolen material, often building into their arches tapered Roman voussoir bricks upside down, instances such as occur at Britford, near Salisbury.

Saxon obtuseness is also noticeable at St. Pancras Church, Canterbury, where Roman triangular facing bricks are set with their points upwards. Quite remarkable is the tower of Holy Trinity, Colchester, showing throughout a consistently intelligent use of Roman bricks employed in an essentially Saxon manner. Of especial interest is the west door, with its triangular head and slight imposts.

The Norman.

Norman builders, having acquired a developed masonry with the aid of the fine French building stones, introduced into England a stone tradition for church and castle, to be maintained throughout the ages of Romantic faith. Yet in spite of this general truth there exists quite a group of buildings in which the Norman, given a box of Roman bricks, has put them together with vastly more skill and interest than had his Saxon predecessor.

To briefly examine these buildings, St. Albans Abbey, commenced about 1077, was largely constructed with Roman bricks from Verulam.

Colchester Castle, built about 1078, is largely composed of Roman bricks. The fine herring-bone bond in the courtyard shows how effectively this walling could be constructed in tile.

St. Botolph's Priory, Colchester, shows an ingenious use of Roman bricks in columns, arches and arcading.

We are hardly justified in saying that no bricks were burnt in this country from the time of the Roman evacuation in 420 till 1260, the date of Lttle Wenham Hall, Essex, but brickmaking as an industry and brick-building as an art certainly did not exist during that period. Shortage of quantity or inferiority of quality was met by Norman preference by the importation of stone from Caen. But during this period great things were being done in brick in Southern Europe.

Byzantine architecture depended almost entirely for its external effects on brickwork, treated broadly with strongly marked bands of color, whilst the Gothic architecture of Northern Italy is remarkable for the beauty of pattern and richness of color of its brickwork and terra cotta. But if the palmer from the East or the pilgrim from Rome brought back accounts of these brick glories in Asia Minor and Northern Italy, his tale fired the soul of no great brick builder in this country. It is evident that the first cause for the re-use of brick ~~was~~ the growing scarcity, not only of stone, but of timber. The constant destruction of timber buildings by fire must have been a contributory cause to the introduction of a more resisting material. This movement naturally manifested itself first in the Eastern counties and in work of a domestic character.

Little Wenham Hall, Suffolk, built about the year 1260, has long been considered the earliest remaining record of this movement. Here bricks averaging 9¾x4¾x2¼ inches, now dull in color, are mixed with stone and flint in the general walling.

The little chapel of St. Nicholas, Coggeshall, is a most important link in brick history. In plan a simple rectangle, this church must have been constructed not later than the end of the thirteenth century.

A very remarkable development took place in the neighborhood of Hull late in the fourteenth century. It is evident that this brick fashion was imported to this seaport town from the Low Countries, where many early churches are found in brick. According to Leland, in the time of Richard II. Hull seems to have been a completely brick-built town:

"And yn his Tyme the Towne was wonderfully augmented for building, and was enclosed with Diches and the Waul begon and yn continuance ended and made all of Brike, as most part of the Houses of the Towne at that Tyme was."

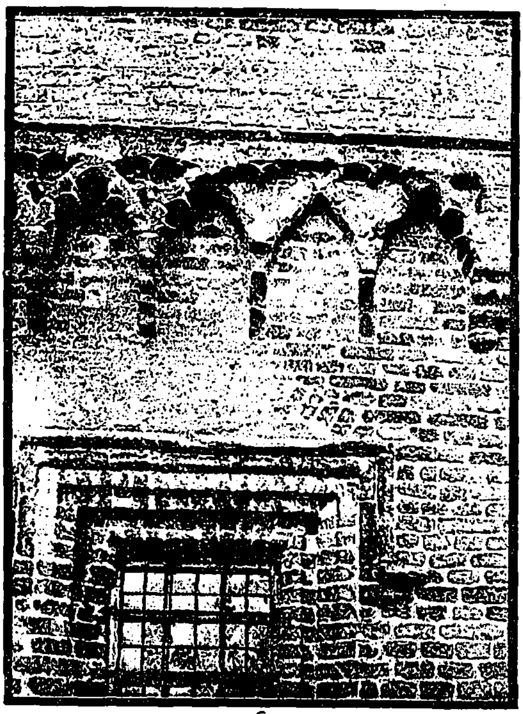
The curious fact appears to be that Bishop Lyttleton saw bricks lying in a trench, having fallen from early stone walls to which they had been applied.

In many churches in the neighborhood of Hull brick facing was used for the general walling. Brickmakers of to-day need not complain of the low price of bricks, for those used for King's Hall, Cambridge, in the reign of Edward III., cost 6s. per 1,000, while in the times of Richard II. and Henry IV. and V. they varied from 5s. 7¾d. to 6s. 8d. per 1,000. But then bricks varied greatly in size. Those used in the Priory at Ely in the reign of Edward II. were 12x6x3 inches; in many fifteenth century buildings in Norfolk and Suffolk those employed are 9x4½x1½ inches.

Church Work, 1400-1500.

Although throughout the Eastern and Southern counties churches may be found with brick walls and facings of fifteenth century date, it was in Essex and Suffolk that brick church architecture mainly developed.

In Norfolk and Suffolk churches brick was often employed as a backing to stone walls; it has been



Brick Corbelling, Rye House, Herts.

suggested that the round towers of these counties were so planned to economize stone. But even in Essex brick features are rare in sacred buildings and are limited to a few towers, porches and arcades. There appears also in England a fatal lack of confidence in this material. This is well illustrated in the porch of Bures St. Mary, Suffolk.

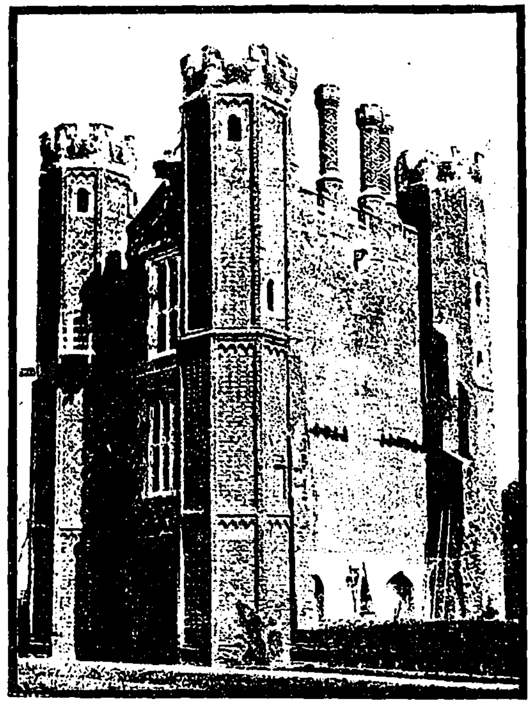
The porch at Sandon is completely brick—arches, tracery, parapet and vaulting.

Towers.

The same church possesses one of the finest brick towers in the country, with magnificent crosses in vitrified headers; over the belfry is a curious brick dome.

An equally imposing brick tower is that of St. Mary the Virgin, Ingatestone, again with fine crosses and four-light west window with brick tracery.

Very similar is the tower of the neighboring church



Little Leigh Priory, Essex, Built by the Solicitor-General of Henry VIII.

of Fryering; all have winding stairs in brick. Yet another type of tower is that of Chignal Smealey. This church carries the brick idea as far as any

Wolterton Manor House, East Barnsham, Norfolk.

village church in England. Even to the font and piscina the complete church is brick.

Ingatestone has also its brick arcade in the chancel. Great Baddow has a remarkable clerestory with elaborate tracery, brick even to the cuspings and featherings.

Tudor: General.

Although the use of brick in church building was thus fragmentary and incidental, in house work its possibilities were grasped and a style developed, the most typical of English domestic methods. In cottages and smaller houses brick was early discovered to be suitable filling for half-timber framing. This brick nogging, as abroad, developed great interest and intricacy, as in a street front at Coggeshall, Essex. Natural enrichment by diaper patterns is an essential feature of Tudor brickwork. Originating in the accidental effects of vitrified headers, its decorative value was soon appreciated. Depending necessarily upon bond, the simplest form of diaper is formed by the dark headers of English or Flemish bond.

Regularity of pattern seems less sought after than richness of effect. The diapers particularly on octagonal towers are often unsymmetrical, diagonals beginning and ending with the abruptness of forked lightning. Some remarkably fine pattern work may be seen at the Old Bishop's Palace, Hatfield. In most Tudor work door and window openings were finished in stone, but in the rarer examples with brick mullions, transoms and heads considerable constructional skill is visible.

The square-headed window and straight transom seem to have been a difficulty to be solved by the use of flat arches with radiating voussoirs, a trick to become in Georgian times the motif of a style. Of brick oriel windows few remain, though it might have been expected that its corbelling facilities would have encouraged this treatment. Rye House, Herts, has fine two-light oriels.

Brick Corbelling.

Brick corbelling is a marked feature of the style with a wide range of treatment. Suggested, doubtless, by the machicolated parapets of castellated architecture, it was effectively employed in early chitecture, it was effectively employed in early brickwork. All the great gateways have brick corbelling, as at Hadleigh, Suffolk, suitably marking its stages. It retained its Gothic flavor, well into the fifteenth century, as at Layer Marney, though finest in such early works as Rye House.

Chimneys.

The emphasis and interest given to chimneys make them the most characteristic feature of the style. The mere idea of a chimney at all was a new thought to the early Tudor architect, accustomed to let the smoke curl up and blacken the rafters of his Gothic hall. It is notable that in many completely stone buildings fireplace flues and chimneys were carried up throughout in brick, evidencing that at an early date its fire-resisting qualities were appreciated.

Early chimneys were essentially Gothic in their fantastic skyline; later their detail was elaborated with pattern and moulding. Gothic tradition was long retained in battlemented chimney caps and projecting angles on octagonal shafts reminiscent of gargoyles. With the death of Henry VIII, the elaboration of chimneys ceased. The Elizabethan chimney has a straight stalk and oversailing cap of thin bricks.

The brick newel stairs of the period form an interesting study. They are mainly associated with the early defensive houses, before the prominence given to the upper floors in Elizabeth's time demanded a more spacious stairway. In vaulting under the winding brick treads great constructional ingenuity is shown.

Briefly let us look at some of the famous Tudor mansions in chronological order.

Eton College, partly commenced about 1440, faced in brick with diaper patterns, has very fine chimneys. Its bricks were supplied from a kiln at Slough, still a brick-making district, as shown by the record. "100,000 brike at 10*d.* the thousand, laying by Comanmet of the Erle of Suffolk." Whether the 10*d.* a thousand refers to the price of bricks or the cost of laying, it is equally a startling figure.

Nether Hall, Essex, is near Rye House, Herts, the scene of the "horrid conspiracy." In both cases only the gatehouses remain, but it is evident that in quality this work was never exceeded by the best builders of East Anglia. The construction of the great moulded brick arches at Nether Hall, spanning from turret to turret, is in fine contrast to the trefoil corbelling.

Almost with the turn of the century a new movement was manifested. With the reigns of Henry VII. and Henry VIII., characterized by great domestic building activity, the new Renaissance note, foreign in tone, was struck in all the more famous mansions. With brick architecture approaching its climax foreign influences became more felt, and a new material demanded more in harmony with the brick walling than stone. Hence a new development in English clay art, the introduction of terra-cotta, a material suited by its repetitive richness to the age of the Field of the Cloth of Gold.

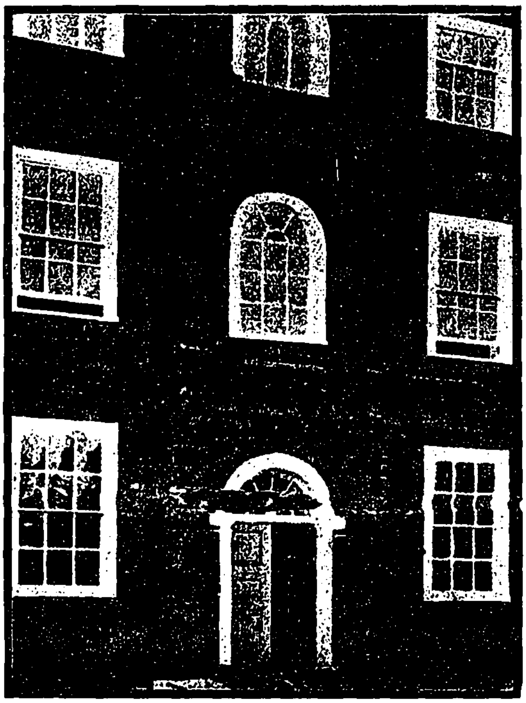
Wolterton Manor House, East Barsham, Norfolk, is in many ways the most remarkable brick house now standing. The general building is of the Henry VII. period; the gate-house appears to have been erected in that of Henry VIII. A panel here, or head there, suggests the Italian terra-cotta worker, but the general architecture is pure Tudor Gothic. Chimneys and turrets, parapets and strings blaze with brick heraldry; yet even here, with brick and terra-cotta triumphant, a suspicion, possibly as to their durability, induced the use of stone for the inner gateway and in the jambs of the gatehouse arch. The magnificent pageantry of this arch has suffered by the decay of its terra cotta, apparently burnt solid to a strong dark red.

Great Snoring Rectory, about a mile from East Barsham, is evidently the work of the same builder, but its terra cotta shows considerably more Italian influence.

Sutton Place, Guildford, one of the great houses of the Henry VIII. period, shows a similar mixture of Tudor and Italian manner in its ornament.

Hampton Court.—The Tudor portions of Hampton Court have fine brick chimneys. Stone is used for most of the architectural features. The terra cotta busts of the "Emperors" were imported from Italy.

Little Leigh's Priory, Essex, is yet another example of the home country mansion of this amazing period built by the Solicitor-General of Henry VIII. Again we have the same arrangement, the fine L-planned portion and the magnificent detached gatehouse.



Kew Palace, Sometimes Designated "The Dutch House" because of its Flemish Bond Which is One of the Early Examples of this Character of Brickwork in England.

With the advent of Elizabeth a distinct change becomes noticeable in the building fashion; brick, though used more widely than in the previous reigns, loses its interest and elaboration for a time with the advance of the Renaissance. This is evident in all the great mansions of the period in every part of the country.

Hatfield House, Hertfordshire; Bramshill, Hampshire, Burton Agnes, Yorkshire; Aston Hall, Warwickshire, and many of the Cambridge colleges are faced in bricks, with stone for all ornamental portions, the chimney alone showing an architectural use of brick.

With the development of the Jacobean style brick is again more in evidence, but showing frequently considerable Dutch influence.

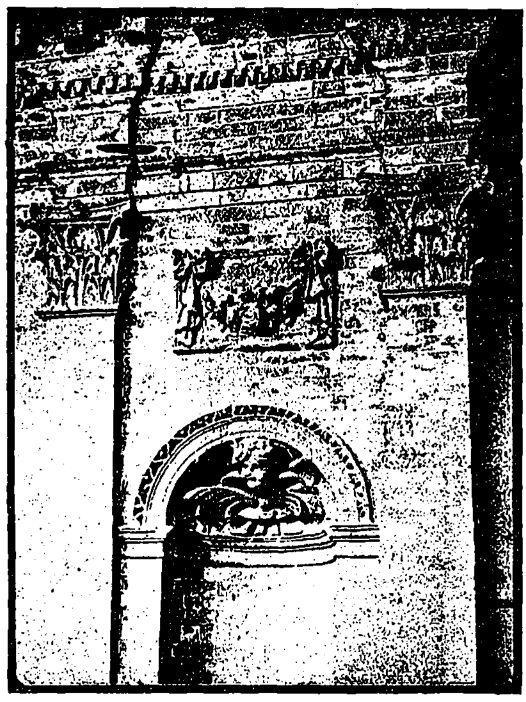
Flemish bond, a term so familiar that we have lost its alien significance, is to be seen for the first time. Kew Palace, sometimes called "The Dutch House," is a good illustration. Its window with projecting architraves of 2-inch rubbers have every third course sunk as a rustication. Some of the columns and caps of the central order are of terra-cotta; the cornices are covered with tiles—always an early indication.

The Grammar School at Rye is another good example, showing the picturesque crude Dutch manner.

All up to the East Coast this Flemish flavor may be detected, especially at such likely places as Lynn and Great Yarmouth. The free use of stepped and double-curved gables in Norfolk and Suffolk may also be traced to the Low Countries. The tumbling-in of gables is also a great feature of these counties.

Renaissance: General.

On the Continent, apart from Holland and Germany, a few Italian palaces and French chateaux, brick was not greatly in evidence during the Renaissance. Perhaps the key to Renaissance brickwork in this country was the flat rubbed brick arch. Without this, stone lintels must have been introduced for sash windows, and the architectural features of doors and windows have fallen into stone to a very much larger extent.



Detail of Brickwork, House at Enfield.

In brick, as in stone, the orders formed the great decorative resource of Renaissance architects. The small super-imposed orders of the Jameses were replaced by the one large order, in brickwork, usually Doric. Heavy Classic cornices were built up of $2\frac{1}{2}$-inch bricks, often with dentils and modillions, tiles being used in early work for the smaller fillet. Effective strings were formed of three or four courses of brick slightly projected. Architectural embellishments have their bricks rubbed to a very fine joint. Fine work, such as Ionic capitals, were made one homogeneous block by the use of a resinous substance, making the joint almost invisible. The natural diaper of vitrified headers is very noticeable, in some districts giving almost the impression of a glazed brick. To this variety of texture was added the interest of broken color. The contrast gained by employing yellow stock or purple for backgrounds. bonding with reds for windows and groins, once realized became general. Inigo Jones, as his master Palladio, was by no means averse to brick, though using it little in his more important works. In Raynham Hall, Chilham Castle and Stoke Park he used it for facing. St. Paul's, Covent Garden, was probably the first use of brick in Renaissance church building proper.

West Woodhay Manor House, an apparently authentic design of Inigo Jones, is the first instance of the typical Renaissance brick house. The old houses in Great Queen Street are of the Inigo Jones period; the combination of the window heads with the aprons of the windows above are suggestive of Pendell House, Bletchingley.

The characteristic strength and decision, the unerring sense of the fitness of things natural to Christopher Wren we find evident in his use of brick. For church work he preferred stone, using brick for constructional portions, and occasionally for economy, as at St. James's, Piccadilly, and the side portions of Bow Church. In domestic work he used it indiscriminately, now for terrace houses on Clapham Common, now for Kensington Palace. Wren's masterly use of color, with the remarkable quality of his brickwork, are the reason of his success even with such simple elements as seen in Kensington Palace and Chelsea Hospital.

Christ's Hospital, designed in 1672, retained its color in the heart of the city for more than 200 years.

The Bluecoat School, Westminster, is an almost perfect study in the proper treatment of brickwork.

The famous Banqueting Hall at Kensington Palace indicates an equally fine sympathy with brickwork, with a clear appreciation of its limitation. All carving, coping and sills are stone, while protected portions like the heads of niches are beautifully formed in brick.

At Hampton Court, Wren uses his color broadly. An ordinary dull red on the ground floor contrasts with the bright red of gauged brick above.

The brick style initiated by Inigo Jones and popularized by Wren became the vernacular for the whole of the eighteenth century. For Queen Anne and Georgian alike, brick was the medium in which were expressed the comfort and dignity of the English country house.

In town houses, as those in High Street, Hertford, the orders are more apparent; in the latter examples cornices and projections are covered in lead.

Windows are frequently framed with moulded brick architraves. There is a house in the Hight Street, Farnham, with heavy brick architraves much like a picture-frame round its windows.

The finest example of the times remaining in London are Nos. 42, 43, 44 St. Martin's Lane. In No. 43 the Roman Doric order is rendered completely in brick, from the fluted pilasters to the guttæ on the soffit of the cornice. No. 44 has a correct Ionic cornice with modillions.

The centre pediment from a house at Enfield now preserved in South Kensington Museum marks the climax of Renaissance art in brickwork. The example is eloquent, not only of the possibilities of carved brick, but also of the limitations of the material. If the gash of a joint line across love's cheek was originally healed with resin, the wound has been opened with subsequent movings.

1750 to 1800.

The climax of Renaissance brickwork was followed by a decline, hastened by the general introduction of stucco late in the eighteenth century. This militated, as always, not only against the artistic value of brickwork, but also against its constructional quality. Many of the bulging fronts and rocking party walls which cause our district surveyors sleepless nights may be attributed to the careless brickwork of the age of Nash. The introduction of Suffolk bricks served by their lack of color only to increase the architectural dulness with which the century closed.

The brilliant work of the past century in every sphere of interest is unquestionable; in architecture it was a period of brilliant revivals. To think of these, the Gothic, the Queen Anne, the Georgian, and if you will, the Byzantine, is to recall to the mind pictures mainly of brick buildings. Although a period of unequalled prosperity, it was yet a period of necessarily cheap building, hence brick; but certainly this was no hardship to the Victorian architect.

Pugin doubtless led the way by the inclusion in his "Examples" of the Tudor works at Oxborough, East Barsham, and Great Snoring, stimulating a movement which was to provide almost every parish in the country with its pseudo-Gothic church, parsonage, or schoolhouse, usually brick.

Among other leaders in this Gothic crusade were Butterfield with his pioneering work at All Saints', Margaret Street; Nesfield, with his lodges in Regent's Park; and Street with his literary research in Northern Italy and practical work in a score of churches. Apart from this introduction of native methods of brickwork in the past and present centuries, a considerable group of buildings exist in which foreign styles have been successfully naturalized in local material; Christ Church, Streatham Hill, is a fine example in yellow stocks. The Westminster Roman Catholic Cathedral, though suggesting to the lay mind a religious power station, to the architect is a successful example of a building of the first importance in brick.

In domestic work, Mr. Norman Shaw's domestic treatment of brick has induced a thousand weaker brethren to cover our town and country-side with Queen Anne and Georgian efforts. The scientific development of brickmaking, though increasing the commercial usefulness of bricks, has not equally improved their artistic quality. It has yet to be proved that pressed facings, though included in some Government specifications, will weather as perfectly as have the rubbed bricks of Wren's Banqueting Hall; the possibilities of glazed brick seem first to have been attempted by Butterfield, as in the interior of "All Saints," but in spite of many other interesting essays their architectural use must be admitted to be still in the experimental stage. In conclusion, it is evident that in the past the development of English brickwork has been advanced by alternating periods of use and disuse, of revival and decline, rather than by steady continuous progress;

That it has attained its present position of general usefulness by a ready adaptability to the complex building requirements of English civilization;

That in the future, whatever method of construction may determine the course of urban architecture, brick is likely to remain the building material most suited to express the amenities of English country life.

CONCRETE BUILDING BLOCKS

By ROBT. F. HAVLIK, M.E

A paper read before the third annual convention of the C.C.C.A., dealing with the manufacture and curing of concrete blocks and their adaptability in building construction.

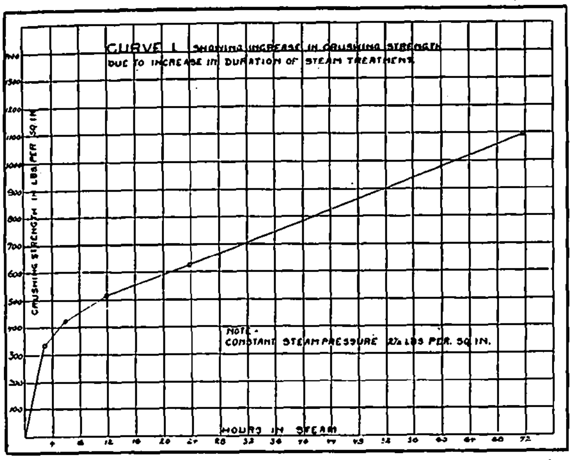
IN SPEAKING of concrete blocks I am touching upon a subject which has been hatched and re-hatched many times over, and yet in spite of all that has been said, we are learning so much more each year in the way of new methods of making concrete products that we wonder how we could begin to have been satisfied with the old methods which in the light of the present day appear so crude. I well remember the crude looking blocks exhibited at the Chicago Cement Show in Dec., of 1906. Water, when poured on same was absorbed instantly. To-day as we inspect the products exhibited at our various shows we see an entirely different material, one that is dense, hard and waterproof. Five years ago the so-called concrete blocks were used in cheap buildings only, in foundations and underground. Only cast stone was considered for work where a cut stone effect was desired. A gradual change has taken place since then, however, and the molded concrete block is now being used in some of the finest buildings. Cast stone is no longer as popular as it was then, not because it is not as good as the molded concrete block, but because the block can now be made as good as cast stone at a much lower cost, and since cost is always a prime consideration when the quality is the same, the molded concrete block is destined to play an important part in the building operations of the future. The best testimony we have of this is in the magnificent buildings of the Barber Estate, at Barberton, Ohio. These are being built of molded concrete blocks made in standard machines and special wood and gelatine molds. When such men as Mr. Barber, who want a beautiful effect regardless of price, select molded concrete blocks in place of all other materials, there must be a great value in properly made concrete blocks.

The speaker is fully aware of the fact that an immense amount of inferior work has been done in concrete blocks, but mistakes have been made in every new industry, and it is but natural that mistakes were made in the concrete block industry. But we have passed the mere experimental stage of this industry and concrete blocks are now a staple building material and if we continue to improve them in the future as we have done in the last few years, they will soon be in greater demand than any other one building material. Concrete blocks have everything in their favor. They make a house that is cool in summer and warm in winter, their strength increases with age, whereas nearly all other building materials deteriorate with age; they can be made waterproof, and last, but not least, homes built of blocks cost less in the last analysis than frame buildings, because they require no repairs. But for this fact, many a building now being put up of concrete blocks would be built of frame on account of the prohibitive cost of brick or stone. Thus the concrete block is improving the building construction of to-day both in beauty and permanency.

The concrete block is here to stay. The severe criticism to which it has been subjected in the past has resulted in the greatest possible good in that it has forced the block manufacturer to improve his product, and if we continue improving it as much in the future as in the past, we will soon place it beyond the criticisms of its present severest opponent.

We can improve this industry best by paying more attention to the selection of the materials used and the methods employed in the manufacture of the blocks and placing on the market the best product we can make. The cement should be a Portland cement that will pass standard specifications. So much has been said about the proper selection of aggregates for concrete work that I will not burden you with needless repetition any more than necessary. The most common aggregates used in concrete blocks are sand and gravel, although crushed stone is sometimes used in place of gravel, and stone screenings in place of the former. There is considerable objection to both of these, however, especially the latter, on account of the crusher dust that is always present and clings to the stone particles and prevents the cement from properly bonding with same. It has been my experience that gravel and sand produce a denser and better looking concrete. In many localities, however, sand and gravel cannot be had except at prohibitive prices, whereas crushed stone may be very plentiful. In such cases there is no recourse except to use this material. Whatever the materials, the finer, which is usually sand, should be well graded from 1/4-inch to 1-50 or 1-100-inch. The coarse material should be well graded from 1/4 to 3/4 inch, not to exceed 1 inch. The largest aggregate should never be larger than half the thickness of the thinnest wall of the block. Where a pit run of sand and gravel is used the material should range in size from 1-100 inch to ¾ inch. Both fine and coarse aggregate should be free from clay, dirt, or fine dust, as these but tend to decrease the strength of the block. The water should be free from alkalies.

The next important consideration is that of proportion. There are three principal methods in vogue for determining the proper proportions, the "void"



Diagram, Showing Increase in Crushing Strength, due to Increase in Duration of Steam Treatment.

method, proportioning by trial mixtures and proportioning by a study of the mechanical analysis of the various aggregates. The first method is universally acknowledged to be little better than a guess and has been discussed so frequently that I will pass it by without further comment.

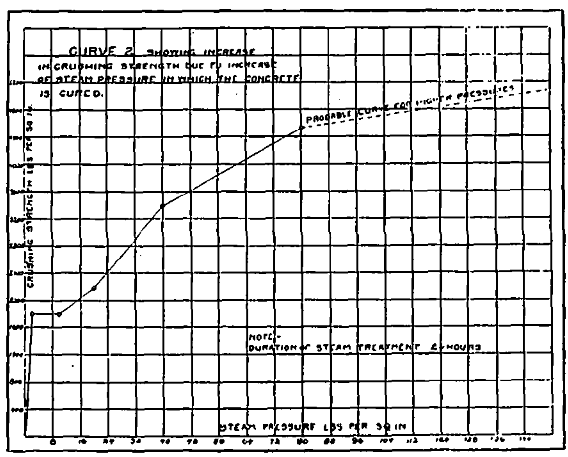
For any given materials which are to be used in their natural state, the second method of proportioning by trial mixtures will be found very satisfactory, but will not show what other changes in the sizes of the aggregate could be made. The procedure in this method is very simple. First, get a good scale and rigid cylinder, say a piece of 8-inch or 10-inch pipe, 12 inches long or so. Weigh out and mix together carefully any arbitrary amounts of the cement, sand and gravel to be used, and make the consistency the same as that of the concrete to be used in the blocks. Place this mixture in the pipe, tamping same very carefully in thin layers. When it is in place note the height of same in the pipe. Then weigh out the same amount of cement as before, and the same total weight of sand and gravel, but vary the relative amounts, and repeat the operation, using the same consistency as before. Note the height this mixture occupies in the pipe. That mixture which takes up the least space in the pipe is the best for those materials as they are.

The third method, while a little more difficult for the beginner, when once understood, proves to be the simplest of the three. It permits of the immediate determination of the best combinations of raw materials in their natural state and also how they can be improved upon by adding or screening out certain size aggregates. In 1901 Mr. W. B. Fuller made an extensive series of experiments on the comparative strengths of different proportions of concrete aggregates. All the aggregates used were screened through various sized screens after having been carefully mixed, and the percentages by weight of the materials passing screens of certain meshes were carefully recorded and plotted to curves with the distances on the vertical ordinates representing the percentage by weight passed through screens whose mesh is represented by the distances along the horizontal lines or ordinates. He found that for any given amount of cement the strongest concrete was produced from that combination of aggregates whose mechanical analysis plotted to a curve as above, formed a parabola passing through the zero ordinates and the intersection of the diameter representing the largest stone with the 100 per cent. ordinate. This is discussed in detail in a special chapter by Mr. Fuller, in Thompson & Taylor's treatise on "Concrete, Plain and Reinforced." The percentage by weight of the aggregate smaller than a given size can be easily calculated by the formula for the parabola $d=\frac{p^2D}{10000}$ or $P=100\sqrt{\frac{d}{D}}$ in which P= per cent. of mixture smaller than any given diameter.

d = any given diameter.

D = largest diameter of stone.

From this it will be seen that the per cent. of aggregate smaller than a given diameter, say ½-inch, and larger than a second diameter, say ¼-inch, is obtained by subtracting the percentage smaller than ¼-inch from the percentage smaller than ½-inch. The following table is figured out on this basis and shows the percentage of the various sizes for any given mixture up to 1 inch. Any block maker can



Diagram, Showing Increase in Crushing Strength, due to Increase of Steam Pressure in which the Concrete is Cured.

screen out a sample of his aggregate through standard screens, and carefully determine the percentages of various sized grains present and compare these with the theoretical percentages, and if he finds that he has too much coarse material he can screen out his coarse aggregate and recombine it with the fine in the proper proportions to correspond with the parabolic curve. He can do likewise if he has too much of the fine. This process is called rectifying the aggregates. I am afraid that some are of the opinion that if an aggregate is graded to the parabolic curve that it will produce the strongest concrete with say 12 per cent. cement, and no stronger if 20 per cent. cement be used. This is not true, for the strength will be increased with the increased amount of cement, but for any given amount of cement the strongest concrete will be from that aggregate whose mechanical analysis curve conforms very closely to a parabola. This probably holds true for concrete whose largest stone is ½-inch in diameter or larger. For mortar below number five mesh I think such an aggregate would have too much fine material. I have found the best result with a mixture of very coarse sand and a sand which is quite fine. (See table 1.)

The selection of the aggregates and the proper proportions properly taken care of, the next important consideration is that of properly mixing the concrete. The superiority of machine mixing over hand mixing is an accepted fact, and needs no argument. Mixers should be used by all means and none but power mixers. Hand mixers are man-killers, as anyone will testify who has used one. In choosing a mixer for concrete block work, great care should be taken that it will mix semi-wet concrete, and will handle either dry or damp materials. Every mixer will not do this, neither will every mixer that is satisfactory for a very wet concrete prove equally so for concrete used in blocks. It is an easy matter to mix concrete of the consistency commonly used in monolithic [illegible] that used in blocks, being drier, is far more difficult to mix.

Facing.

As nearly all concrete blocks are faced, considerable attention should be given this feature in their manufacture. Most blocks are sold on their appearance, so it is essential that the face be very hard and all corners and edges solid. For this reason it is necessary to use richer proportions for the facing than is used in the backing of the blocks. The usual proportions vary from 1½ to 3 parts of aggregate to 1 part of cement. When ordinary sand is used it should be graded from ⅛-inch down to No. 50 mesh, with no material smaller than No. 100 mesh. The proportions can be as low as 1 part of cement to 3 parts of sand. But in white facing, the proportions must be richer, as all available white aggregates are either all one size, as in the case of white sand, or contain too much fine material, as is the case in most crushed white marble. With some white sand and crushed white marble, I obtained very satisfactory results with 3 parts white cement, 2 parts crushed marble and 4 parts white sand.

In colored facing, none but mineral colors should be used. With proper materials and care, it is possible to use as high as 50 per cent. coloring in the proportions of 1 part cement, ½ part color and 1 part aggregate. Dark, deep shades cannot be obtained except with a large percentage of coloring. Colored blocks and brick can be brought to a high polish by grinding. This process exposes the aggregate and produces a very attractive appearance.

A recent innovation is that of the granite facing. This is becoming very popular, and is being used in large cities for public buildings for which the ordinary block would not be considered under any circumstances. The best proportions found for granite facing are 1 part of cement to 2½ parts of granite. The granite should pass a 1⅛-inch screen and be graded to about 1-32-inch. These four facings comprise the principal facings used.

Processes of Manufacture.

A few years ago a subject of considerable discussion amongst machine manufacturers was that of processes of making blocks. Each claimed that his was the only machine in which a wet block could be made and that no other was suitable for that purpose. The facts of the case are that as wet a block can be made on one machine as any other. I find that the limit is reached when the concrete is too wet to bear up its own weight. By this, I mean that beyond a certain consistency the block will settle and instead of being 7¾ inches high it may be 7¼ inches in height. This fact then determines the maximum moisture that can be used in concrete for machine-made products, and will be the same for all makes of machines. It is evident, therefore, that there are but two processes for making concrete products, the poured or cast process, and the molded, or so-called dry process.

In the poured process, the concrete is of such a consistency that it can be poured into moulds which may be of sand, iron, plaster of paris, or gelatine. . . . . In the molded process, the concrete is made as wet as is possible to still permit of molding. It is then tamped or pressed into molds and usually removed immediately. The mold is thus used over and over again. This reduces the cost of the block to a minimum, and enables the block manufacturer to compete with other building materials. Molded concrete is now being made as good as cast stone. This fact, combined with low cost, is bringing the concrete block to the front as one of the best building materials of the day. There has been considerable discussion as to the proper amount of water to use in concrete blocks. Most blocks are used when they are about 28 days old, so it is of the greatest importance to have the blocks as strong as possible at this age. Therefore, the consistency producing the strongest blocks at 28 days is the best. Actual experiments show that blocks which show the highest crushing strength at 28 days are those in which so much water has been used that it will flush to the surface when a pile of concrete is trowelled with a steel trowel or shovel 2 or 3 times. This amounts to from 8 to 10 or 11 per cent. of the total weight of the dry materials. Concrete of this consistency can be used in any block machine. When made wetter the concrete settles and is not as strong. Concrete of this consistency is being used by the largest block plants of the day.

Waterproofing.

Many claim that the block made by the wet process is more waterproof, but I have seen blocks made wet in the molded process which were so waterproof that water would stand on same for a considerable time before being absorbed. Neither process will make concrete absolutely waterproof or nearly so. There are a large number of people who claim that a block with low absorption is all that is needed for practical purposes. This is true to a certain extent, but we must not forget that the average builder who is putting up a fine residence will not consider concrete blocks unless the manufacturer thereof will guarantee them to be absolutely waterproof, or very nearly so, absorbing say not over ½ per cent. of moisture. I have done considerable experimenting, trying to produce such blocks without the use of waterproofing, but have failed to do so. I do not think that it is possible to reduce the absorption below 3 per cent. without the use of a waterproofing. By the use of a waterproofing I have reduced it to 27-100 of 1 per cent., and I think that this absorption was merely due to the surface water on the specimen so that the block itself probably absorbed no water whatever.

It is to be admitted that with proper care and graded materials, concrete blocks can be made reasonably waterproof, but I contend that they are not waterproof enough, in that they retain moisture too long. We are all familiar with the looks of the average concrete block house after a rainstorm. It usually remains dark and damp looking for two or three days, while one that is waterproof dries off in a few hours. Any man would prefer to live in a house that looked as dry a few hours after a rainstorm as before, rather than live in a building that remained a dull slate color for several days, so we should endeavor to turn out blocks that will give these results.

As long as blocks cannot be made as waterproof as this without a waterproofing, I will favor the use of a proper waterproofing. I know well enough that a great number of waterproofings do not produce waterproof concrete, but there are also a number that do.

In testing a waterproofing, full sized blocks should be made with same. Ony such will be a reliable guide. Tests on small cubes are worthless, as such specimens cannot be tamped nearly as thoroughly as a full sized block, and consequently will not be as dense and waterproof. I have often noticed that waterproofing is confused with permeability. A block may be waterproof, and yet be very permeable, and vice versa. Waterproofing refers to the per cent. of water absorbed by a dry specimen compared to the dry weight of same, whereas permeability refers to the amount of water that will pass through the same specimen in a given time, when placed under a pressure of water. It is evident that the concrete block used above grade need not be impermeable, but should be waterproof. A waterproofing may not produce an impermeable block and yet make a waterproof one. In making white face concrete blocks it is absolutely necessary to use waterproofing, as the white aggregates that are most common consist of white sand, which is very fine, and crushed marble or stone, none of which will produce waterproof concrete, the first because it is uniform in size, and the second because it has too much flour.

Even assuming that concrete can be made waterproof with proper materials, the average man cannot get these and must make use of what he has, so it seems to me that the sooner the use of a good waterproofing becomes general, the sooner will concrete building blocks be used to a greater extent and the sooner they will overcome the objections of their present severest critics.

Curing.

When the questions of aggregates, proportions and process of manufacture and waterproofing are settled, the next important consideration is that of curing the product. This feature is oft-times neglected more than any other. The usual procedure is to sprinkle the blocks with water as soon as there is no danger of washing them away. When this is done the bocks should be kept moist constantly for a period of at least two weeks, but preferably four weeks. The temperature should register 600° F., or more, and always be kept above the freezing point. There is no danger in keeping it too high, providing the blocks are kept wet constantly. If they are allowed to dry out, the hardening process is hindered. For this reason, it is customary to keep the blocks under roof for three or four days at least, as it is much easier to keep them moistened under roof than outdoors. This method is extremely simple, so much so that it is surprising how few really apply it fully. Many are doubtless misled by the fact that blocks which are allowed to set until they show signs of drying out, seem harder than those that were sprinkled as soon as they could stand the water. This is true at first, but after a few weeks, the second block will be firmer than the first, and have clean, hard, sharp cut edges.

It is conceded by all who are familiar with the hardening of Portland cement, that it requires both heat and water to properly harden same. It is at once apparent that the ideal method of curing must, therefore, combine both of these features. The only thing that fulfils these conditions is an atmosphere of steam. We find many successful exhaust steam curing plants to-day, but in nearly all of these the temperature is kept below 150° F.

Some five years ago, together with Mr. R J. Wig, after having given this subject careful study, I felt confident that high-pressure saturated steam, which is also at a high temperature, would give the best results. If exhaust steam accelerates the hardening of the cement it is but a step further to assume that high-pressure steam will do so even more rapidly. We put this theory to a thorough test and investigated both the effect on the crushing strength of concrete of variations in the steam pressure and also the duration of the steam treatment. We found that the crushing strength was increased directly with the duration of the steam treatment and also directly with the increase in the steam pressure. Concrete blocks cured in high-pressure steam will be doubled in strength over those cured by sprinkling. This means that in order to get the same strength in the block cured in high-pressure steam, only half the cement need be used. This probably holds true up to the point where the concrete would have so little strength when green on account of lack of cement that it would crumble under its own weight. I do not know for a certainty that blocks can be made of 1 part cement to 8 parts of coarse sand, which, when cured under high-pressure steam will crush at over 2,000 lbs. per square inch or area.

An ordinary block made of 1 part cement and 4 parts sand will crush at about 1,800 lbs. at six months, whereas, the same concrete when cured in high-pressure steam will crush as high as 4,900 lbs. per square inch, thus showing over twice the strength. A 1:8 mixture, cured in high-pressure steam, crushes as high as 2,100 lbs. per square inch, practically as high as the 1:4 air-cured concrete at six months. Since nearly all blocks are used inside of 28 days, we are concerned with their strength at this age. Most building ordinances require a crushing strength of 1,500 lbs. per square inch of net

TABLE I.

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

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

TABLE II.

This table shows the effect of the duration of steam treatment on the crushing strength of concrete. Proportions of the concrete are: 1 part Portland Cement, 3 parts sand, 4½ parts gravel.

Curing Treatment.	Crushing strength in lbs. per sq. in. at 2 and 3 days.	7 days.
Not steam cured, but sprinkled for 1 week		379
Steam cured at 2½ lbs. steam pressure for 3 hrs.	334	341
" " at 2½ " " " " 6 "	427	484
" " at 2½ " " " " 12 "	517	750
" " at 2½ " " " " 24 "	627	660
" " at 2½ " " " " 72 "	1,095	1,167

TABLE III.

This table shows that the crushing strength obtained by steam curing is permanent. Proportions: 1 part Portland Cement, 3 parts sand, 4½ parts gravel.

Curing Treatment.	Crushing strength in lbs. per sq. in. at 2 and 3 days.	7 days.	28 days.	3 mos.
Not steam cured, but sprinkled for 1 week		379	1,068	1,426
Steam cured at 2½ lbs. for 24 hrs.	627	660	1,382	1,488
" " at 2½ " " 72 "	1,095	1,167	1,270	1,522

TABLE IV.

This table shows the increase in crushing strength of concrete caused by the increase of steam pressure in which same is cured. Proportions: 1 part Portland Cement to 4 parts sand.

	Steam cured at 2 lbs. for 24 hrs.	Steam cured at 10 lbs. for 24 hrs.	Steam cured at 20 lbs. for 24 hrs.
Crushing strength in lbs. per sq. in. at 2 days	1,815	1,800	2,184
	Steam cured at 40 lbs. for 24 hrs.	**Steam cured at 80 lbs. for 24 hrs.**	**Steam cured at 80 lbs. for 12 hrs.**
Crushing strength in lbs. per sq. in at 2 days	3,396	4,520	2,540

TABLE V.

Proportions: 1 part Portland Cement to 4 parts sand:
(All these specimens were made same as those given in Table IV., but were cured by sprinkling instead of steaming.)

	Age when tested, 28 days.	3 mos.	6 mos.
Crushing strength in lbs. per sq. in.	1,854	2,286	2,343

A second advantage of high-pressure steam curing is that blocks so cured are ready for the market in two days. A third advantage is that rush orders can be filled as rapidly as the blocks can be made and without danger of breaking the edges of the blocks, which happens so often in handling them when they are but a few days old and cured by sprinkling. Moreover, a very important advantage is that blocks faced with white aggregate any ordinary gray cement, when so cured, will be practically as white as white face blocks.

area of the blocks. If a 1:8 high-pressure steam cured block will crush at 2,100 lbs., it stands to reason that the block maker need not use a 1:4 mixture as he must use in the air cured blocks. He will, therefore, save about half of the cement.

The tables which follow and the curves drawn from same show the increase in strength caused by an increase in the duration of same. The tables are practically the same as those given in the July 1910 issue of the Cement Era. (See Tables 2, 3, 4 and 5, and curves 1 and 2.)

Cost of Cement Blocks.

The cost of concrete blocks is always a very important consideration, especially when it is necessary to compete with other building materials. In a general address of this character, it is impossible to cite cost data that will be applicable to all parts of the country, as the prices of cement and aggregates vary so greatly. The accompanying table, however, will be found of great value in estimating the cost of the materials and labor, but will not include any overhead expenses, such as the salaries of the officers of the company and that of a salesman for disposing of the product. It will be noticed that the data as to the output per man on different sized blocks is figured on hand labor. Wherever a plant is equipped with power tampers, mixers, etc., the output per man will almost be trebled; in fact, in many cases it has been.

Strength of Concrete Blocks.

The use of concrete blocks has been restricted to a large extent in large cities on account of the fact that many city ordinances limit the use of 8-inch blocks to buildings of but one story in height. This is probably due to the fact that the concrete block is a comparatively new building material and the average city authorities do not know much about the strength of same, and in order to properly protect their citizens against any inferior and untried building materials, they adopt measures which seem very harsh to those who are in a position to know about the strength of this splendid building material.

There is no reason why concrete blocks should not be just as strong as the concrete used in any monolithic work, and yet, we hear very little about the danger of monolithic concrete collapsing. Reinforced concrete is used to-day in sky-scrapers and all important buildings, for which purpose it has proved itself to be without a peer. The concrete building block is merely one peculiar form of this material, so in this respect it is really a tried and proven material.

In some cities where this question has been investigated, ordinances have been adopted requiring a crushing strength at 28 days of 1,000 lbs. per square inch of gross cross sectional area of the block, as it is used in the building. Assuming a factor of safety of five, which is greater than that used in steel construction, and which is an average used in other work, the allowable stress will be 200 lbs. per square inch of gross cross sectional area. The distance of outside bearing walls of an average dwelling will not be over 25 feet nor will it be greater than this in the average store building. If the distance is any greater, then supporting pillars will be found between the bearing walls.

As an example, let us suppose that the distance between outside bearing walls is 25 feet and that the total floor loads, including the live load and the weight of the floor, is 110 lbs. per square foot, and that the roof load, including the weight of the roof, snow and wind loads, is 57 lbs. per square foot. These loadings are probably higher than what is found in the average building. One 8x8x16-inch block weighs about 50 lbs., or 38 lbs. per lineal foot. Per square foot of wall the weight of the wall will run about 57 lbs., therefore the wall weight per story per lineal foot of wall will be 12x57 or 687 lbs.

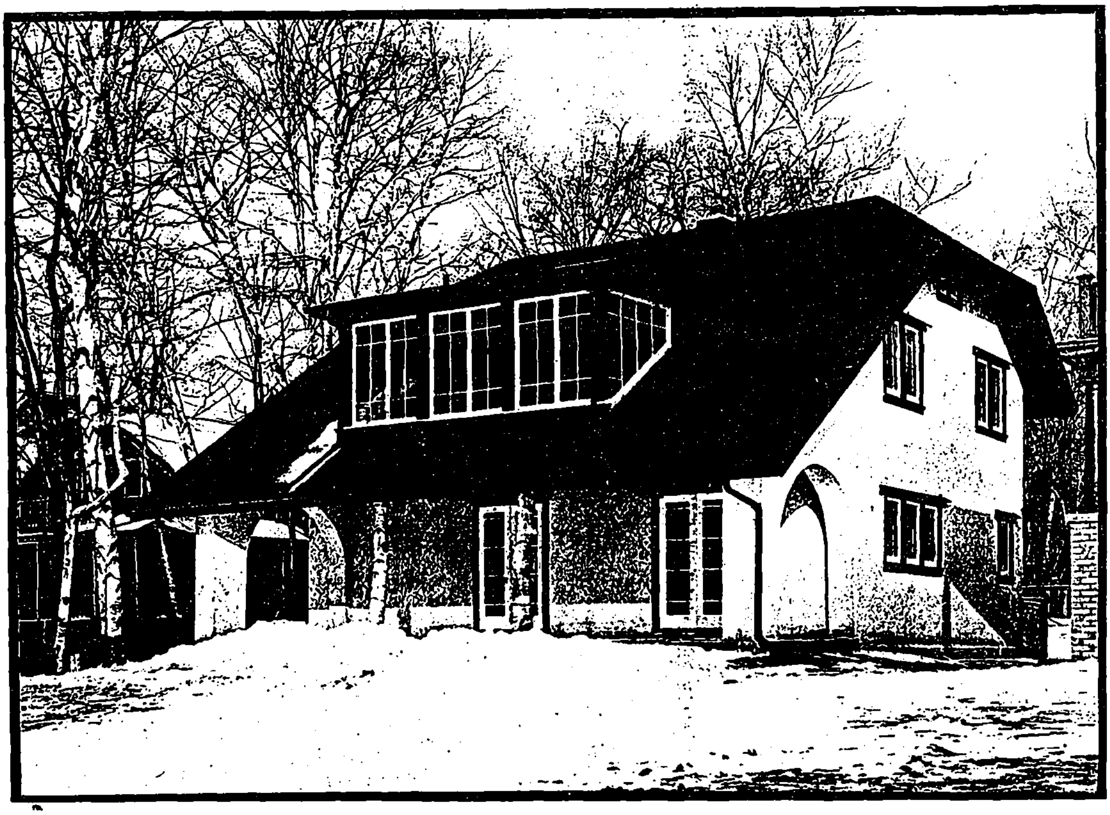
For the sake of simplicity let us consider a strip between two such bearing walls, one foot long and 25 feet wide, or an area of 25 square feet. The floor loads, etc., will be carried by one foot of each side wall. The floor load per story per lineal foot of the two side walls is 25x110 lbs., or 2,750 lbs. The floor load per story per foot of each side wall is half this amount, or 1,375 lbs. The weight of the wall per lineal foot of each side wall is 684 lbs., making a total load per foot of each side wall of 2,059 lbs. per story. An 8x8x16-inch block is 128 square inches in crass sectional area. Assuming a safe loading of 200 lbs. per square inch and a factor safety of five, the allowable load on one 8x8x16-inch block will be 25,600 lbs. Per foot of wall this amounts to 19,200 lbs. This would allow 9 1-3 twelve-foot stories to be carried by an 8-inch concrete block wall, loaded as above.

It must also be remembered that a concrete block crushing at 1,000 lbs. per square inch at 28 days will probably have a crushing strength of 1,200 lbs. per square inch at six months, so that the factor of safety at six months will be six instead of five. In view of these facts, it is hard to understand why any city authorities should limit the use of an 8-inch concrete block to one-story buildings only. They should at least be allowed in two-story buildings, and if necessary the basement wall in such buildings could be made of 10-inch blocks. On this basis the actual factor of safety would be 4x5, or 20, instead of an apparent value of 5.

It is true that some portions of a building will be loaded more heavily than I figured above on account of openings in the wall, but the openings are not likely to run over 25 per cent. to 33 per cent. of the wall area, so the actual factor of safety in any part of the building is likely to be at least 12 where it is allowable to use an 18-inch wall for two storeys. In steel work a safety factor of more than four is seldom required, so it certainly seems to me that any city authorities would be on the safe side if they allowed the use of 8-inch blocks in two-story buildings, for they can safely figure that the actual safety factor in such cases will be 12, and this will continue to increase, for the concrete will increase in strength the older it gets.

We should not feel that city authorities discriminate against the use of concrete blocks, but rather that the associations of cement users are at fault in not paying more attention to the drawing up of proper ordinances which can be presented to the various city authorities, and I heartily recommend, if this Association has not already done so, that it take steps to draw up the proper ordinances that will be fair both to the block manufacturer and user thereof, and figure the allowable thickness of walls on a basis of the crushing strength of the blocks, and also limit

Residence of C. W. Noble, Munroe Park Avenue, Toronto. A Recently Erected House which Shows an Interesting Application of Cement Stucco to Residential Work.



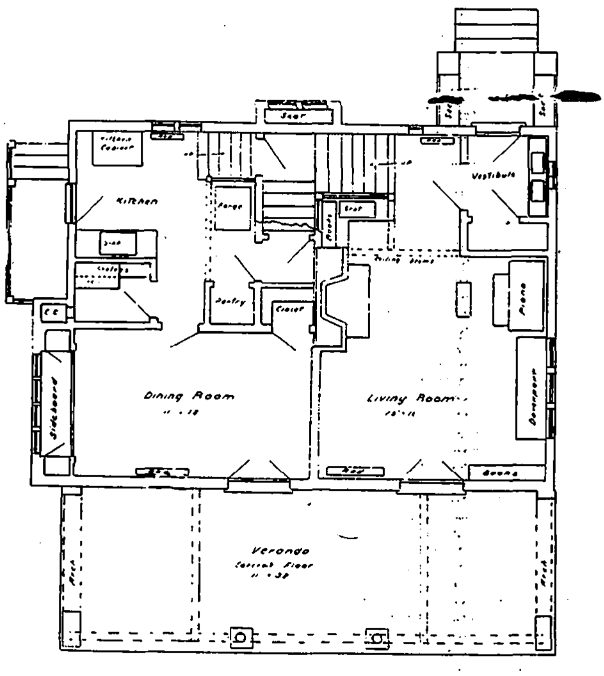
Rear View of Residence of C. W. Noble, Munro Park Ave nue, Toronto. Note how Successfully the Stucco Work has been Adapted to the Round Arch Construction, Forming the Roof Support at Either End of the Porch.

THE APPLICATION OF CEMENT STUCCO TO RESIDENTIAL WORK

Cracks and stains, their causes, and how they can be avoided. An interesting example of this type of house.

IN GENERAL, stucco houses do not differ from ordinary structures a great deal, but there are several matters which, seeming trivial, are at the same time quite essential, if one wishes to put up a structure that is going to stand the rigors of our climate. The principal problems one has to deal with are the preventing of cracks, unsightly stains, and how best to procure an outside finish which is both permanent and artistic.

There are two causes for cracks in stucco work, which might be briefly touched upon in order of their importance. One can be ascribed to poor lapping of the lath, and the other to the fact that timber expands across the grain and not in a direcion parallel to the grain, when wet. The first results from imperfect workmanship which can be charged directly to the contractor, or the poor quality of inspection given the work. It is important in the erection of a structure of this character that a grade of lath be adopted that provides for a lock-joint, as this insures a lap that is highly efficient. To obviate the second difficulty, it is necessary to guard against having sill plates between stories. In an ordinary structure, the carpenter, after laying his floor joists and his rough floor, cuts all his studs and lays them on the floor and spikes a header along the top, then up-ends the side of his building, braces it there and directs his attention to the other sides of the structure.

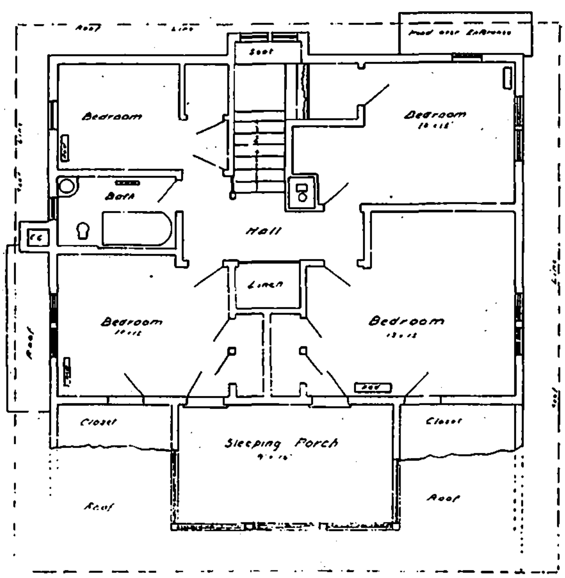


Ground Floor Plan, Residence of C. W. Noble, Munroe Park Ave., Toronto.

Now in a stucco house one must avoid having this header or bond timber, because this places the grain of the timber such wise that in wet weather it will expand and thus produce an unsightly crack between the two stories. The only way to overcome this is to run the studding the full height of the building. In the case of heads over the windows, these will be protected by the casing.

In order to prevent stains, a metal lath having the best procurable rust protective coating should be used, and in no case for exterior work should lime mortar be applied direct to the lath, but rather a good cement mortar should be used, because cement protects metal from rust, and the most rigid test for commercial lath is to imbed it in plaster of paris and to place the sample in the presence of moisture.

Corner in Living Room with Dining Room Through Arch at Left, Residence of C. W. Noble, Munroe Park Ave., Toronto.



First Floor Plan, Residence of C. W. Noble, Munroe Park Ave., Toronto.

An interesting house of the stucco type is the residence of C. W. Noble, Munroe Park avenue, Toronto, illustrated herewith. In the construction of this dwelling all of the above essentials have been thoroughly considered, with the results that a structure both permanent in character and attracive in design, has been produced at a minimum cost. Another feature of interest in connection with this dwelling is the bridging between the studs. Hair-felt deadening was placed between the studs and against the interior lath. Pieces 2x2 inches were then placed between the studs for bridging in such a manner that it would not obstruct the free passage of air, thus giving a perfect hollow wall construction running the full height of the building and not cut off between stories.

The verandah posts and verandah beam are made of birch logs. These were cut at an early stage of the work, and while green had holes bored into the heart at several places along the trunk and at the top. These holes were then plugged with Zn So, (sinc sulphate). This impregnates the wood and prevents dry rot and disintegration.

THE NEW PUBLIC LIBRARY, NEW YORK CITY.—Continued from page 59.

vice to ornament to stretches of blank wall which flank the entrance porch. The treatment of the two ends of the facade is weak. The scale of the engaged colonnade looks too contracted. The fact has not been sufficiently considered in the design that one sees the building not when one is walking west through Forty-first Street, but when one is walking up or down Fifth Avenue. But blemishes such as those mentioned are not of sufficient importance seriously to attenuate the fundamental impressiveness and attractiveness of the facade. The architects have succeeded in making the library sufficiently imposing and dignified in character to satisfy the prevailing idea that a library is a great educational institution, while, at the same time, they have awakened popular interest by making it look like a pleasant place to enter and use. And this is a great triumph, because there is a real, and sometimes an apparently irreconcilable, conflict between the monumental and practical aspects of such buildings.

The final judgment on the New York Public Library will be, consequently, that it is not a great monument, because considerations of architectural form have in several conspicuous instances been deliberately subordinated to the needs of the plan. In this respect it resembles the new Museums of Fine Arts in Boston. The building is at bottom a compromise between two groups of partly antagonistic demands, and a compromise can hardly ever become a consummate example of architectural form. But, on the other hand, Messrs. Carrere & Hastings have, as in so many other cases, made their compromise successful. Faithful as they have been to the fundamental requirement of adapting the building to its purpose as a library, they have also succeeded in making it look well: and they have succeeded in making it look well partly because the design is appropriate to its function as a building in which books are stored, read and distributed. A merely monumental library always appears somewhat forbidding and remote. The New York Public Library looks attractive, and so far as a large building can, even intimate. And in this respect it differs from the Boston Museum of Fine Arts, which, excellently planned as it may be, presents a dull and rigid architectural mask to the public.

CONCRETE BUILDING BLOCKS—Cont'd from page 83.

the maximum loading to which any part of the wall may be subjected. Such ordinances should cover the method of manufacture, as well.

It will be found that no ordinance can cover all buildings, especially factories and warehouses. In such cases, the size of the pilasters and bearing walls must be figured according to the actual load to be carried by same.

THE LATEST DEVELOPMENT IN STEEL PROTECTION

Complete text of paper presented by C. W. Noble at the Third Annual Convention of the Canadian Cement and Concrete Ass'n.

FOR THE PAST YEAR the writer has been investigating corrosion in steel and the methods of preventing it. The object of the investigation was to determine what improvement, if any, could be made in the protective coating used on metal lath. The investigation brought to light much interesting technical information.

The nature and cause of corrosion were first studied. A very exhaustive investigation of the corrosion of iron and steel exposed to the atmosphere has been recently made by Dr. A. S. Cushman of the U. S. Department of Agriculture. While his studies were confined primarily to the corrosion of fence wire the results are of general value. He states that corrosion is primarily due to the presence in the air of minute quantities of carbonic acid and sulphurous gases. These acid gases are dissolved in falling rain and thus brought into contact with the iron. Their action then depends on the condition of the metal. If it is absolutely uniform in quality the attack is exceedingly slow and impotent. If, owing to the localized presence of impurities, different portions of the metal vary in electrical potential, then the acids and the varying portions of the metal form a miniature electric battery. A current is set up and that portion of the steel which is electro positive as compared with the surrounding metal will be corroded. This explains why certain fence wires will corrode while others with the same exposure will last for many years. The local presence of impurities also explains why steam boilers will pit instead of corroding uniformly.

The action of wet plaster on metal lath depends on the nature of the plaster. Portland cement and lime plasters are strongly alkaline and will not allow the formation of acids in the presence. They therefore prevent the rusting of metal lath. The protection given by Portland Cement is a permanent one. Lime plaster, however, has a greater attraction for moisture than Portland Cement, and while lime protection may be permanent, still need is felt for further investigation before making a definite statement. Such investigation was not made as the matter is a diversion from the subject in hand.

Plaster fo Paris, which is the base of the many brands of patent and hard wall plasters, is actively corrosive. During the setting up process since acids occur in solution it has in a marked degree the tendency to start electric currents, and these currents cause the oxygen mollicules, which are momentarily freed by the chemical changes, to attack the steel. The corrosion is much more rapid than that due to atmospheric exposure. Iron rust, once started, works progressively, and the rusting in this case continues long after the chemical changes in the plaster, with their resulting electric currents, have ceased. It only requires the presence of a normal amount of atmospheric moisture to keep the action going.

The different types of protective coating which were studied fall naturally into three separate classifications, paints, electrical insulators; and galvanizing coatings. Each of these works on a different theory.

1. The painted coating is merely an attempt to shield the steel from the plaster. If well done with an undiluted

oil paint it has some value. Linseed oil is subject to attack by lime and Plaster of Paris, becoming what is known among painters, as "dead." It is then porous and will not prevent corrosion. The first attack of the plaster is however expended on the paint instead of the steel and for this reason the paint coating is of assistance. If the paint holds until the corrosive effect of Plaster of Paris has weakened it has served a useful purpose, if not, it has at least, delayed matters.

Metal lath should be coated with an exceptionally tenacious material. It is shipped in bundles and roughly handled during erection, and the coating is severely tested by scratches. In this respect even the best paint leaves much to be desired, as rust, of course, will immediately start at each scratch. If in the effort to reduce cost, the manufacturer dilutes his paint with gasoline, the resulting coating is valueless, although it can be made very cheap. Unfortunately most paint used for lath protection is thus diluted. Everything considered, the paint coating has the least to recommend it of all of the three types of protection considered.

The coating with electrical insulators proceeds on an entirely different theory. The attempt is here made to prevent the corrosive agent from reaching the lath. The cold japan coating used on metallic lath is of this class. It consists of an asphaltum varnish which is ozydized by the addition of a chemical dryer instead of by baking. It is proof against the action of all types of plaster, and is a perfect insulator as long as the coating itself is perfect. The objection to it is that it is impossible to make it proof against the wear and tear of handling. If it is sufficiently elastic to prevent chipping, then it will scratch. There seems to be no neutral territory between these two difficulties. Its cost, ⅝ of a cent per square yard, is in its favor. While rust will start at the open scratches, the attack can never, as in the case with paint, be made through a "dead" coating. It will probably be long before it will be replaced for medium priced work.

Galvanized coatings work on still a different theory. The electric currents are here allowed to circulate at will while their mischief is prevented. It has been previously stated that the currents flow only between metals which differ in electric potential and that the attack is on that metal which is most strongly electro positive. Now all zinc is more electro positive than any commercial steel, regardless of its impurities. A coating of zinc therefore will cause the currents to run between the steel and the zinc instead of between different portions of the steel, and the attack will be invariably taken by the zinc. Freedom from scratches in this method of protection is unessential. It is only detrimental when the steel is so far exposed as to disclose a localized impurity (a potential rust spot) entirely surrounded by exposed steel. In this case the rust spot would develop. So true is this that metal lath cut from galvanized sheets with all the raw edges exposed will show most excellent results.

In the search for a perfect protective coating only one type of paint, Marine Tocholith, was tried. This is not a mixture of oil and pigment and is therefore, strictly speaking, not a paint at all, but as its action is similar to paint, it will be discussed here. It is a modified Portland cement. Its advantage is due to the fact that it has the property common to all types of Portland cement, of preventing rust, and absorbing a small amount of rust already started. It grows harder with age and in time adheres very tenaciously to the steel. It was found that it would not for several weeks attain sufficient hardness to stand bundling and shipping. The manufacturers submitted a special sample designed to harden with unusual speed, but even this was not commercially feasible. It was rejected on account of its liability to scratching.

Two insulating coatings were considered, a baked and a cold japan coating. The cold japan is merely an improvement in the coating which has been used on lath for several years. It was adopted to replace the old cold japan coating, but on account of the liability to scratching, is not considered an absolutely perfect coating. The baked enamel coating is used to a certain extent in the United States. It requires considerable expense for plant, and only partially overcomes the scratching difficulty. When the lath is bent in forming cornice work the enamel is very apt to break. It is very expensive and is not regarded as sufficiently satisfactory to justify the cost.

A new metal called ingot iron was also considered. This is being used for the manufacture of lath in the United States. The impurity whih causes variation in electrical potential in steel is manganese. A very slight variation in the percentage of manganese makes a wide variation in electric potential. As it seems to be impossible to secure an absolutely uniform distribution of manganese the manufacturers of ingot iron have made a product in which this and practically all other impurities are omitted altogether. The process is a secret one, but the result seems to be well attained. Electric currents are therefore not set up in ingot iron as the result of an acid bath and corrorsion is much slower. Acid tests with ingot iron show remarkable results. Tests with plaster were not sufficient to give a satisfactory verdict.

The metal was rejected for an entirely different reason. Lath cut from ingot iron looks exactly like lath cut from ordinary steel sheets. An architect or contractor purchasing lath for an important contract, and paying an additional price for the best material, wants something more than the assurance of the manufacturer that he is getting the quality he is paying for. He wants the assurance of his own senses. The lack of this cannot be overcome with ingot iron.

Four types of galvanized lath were considered, hot galvanized, electro galvanized, sherardized, and lath cut from a galvanized sheet. None of these require description, except the sherardized coating.

This process was invented in England some seven years ago, by Mr. Sherard Cooper-Cole, a noted metallurgist. The metal to be treated is packed in zinc dust and baked for several hours at a temperature just below the melting point of zinc. The process and the result is very similar to case hardening. Just as the casting while being case hardened absorbs a part of the carbon in which it is packed so the metal lath while being sherardized absorbs zinc. The process differs from case hardening in the formation, also of a pure zinc coating on the outside of the steel, while no corresponding coating of carbon is formed on a casting.

As galvanizing offers a perfect solution to the difficulty regarding scratches the investigation now began to narrow down to a choice between these four types. Tests, however, which will be described later were being made at this time which showed the probability of considerable damage to the zinc by plaster. It was therefore suggested that the coating should be lead instead of zinc as the formation of lead oxide would protect the lead coating from further destruction. Mr. G. Frank Allen, a noted metallurgist, was consulted. He reported that the suggestion was of no value because lead is electro negative as compared with iron, and the iron would therefore be rusted at the expense of the lead. He proposed an alloy of lead and zinc mixed in such proportion as to be neutral toward iron. This was rejected as against opening up the difficulty regarding scratches.

The simplest manner of making galvanized lath is to cut it from a galvanized sheet. With metal lath the results are very satisfactory, although the coating is frequently cracked at the bends. Whether it would prove so in the diamond mesh type, where the bends in the metal are much more frequent, remains a question. The process was rejected on account of its commercial impracticability. To a technical man who understands how galvanizing protects, there is no difficulty apparent from the raw edges of the strands. It would, however, require considerable explanation to sell such lath to the average layman. Plato once said that a man's reputation is more injured by telling an improbable truth than a plausible lie, and the statement is as true to-day as in Plato's time. If nothing better had been found the process would have been adopted, but was finally rejected.

Hot galvanizing was rejected on account of the cost. The result is no better than that obtained by sherardizing, while the cost is about eight times as great.

Electro galvanizing was rejected on similar grounds. This process is really zinc electro-plating. In order to be efficient there must be sufficient zinc deposited to supply the wasting while the electric currents due to hardening of the plaster are in progress, and still leave an ample residue for further protection. Perfect color is obtained with a quantity of zinc entirely insufficient to provide perfect protection. It is also much cheaper to provide color than protection and unfortunately mere color satisfies the manufacturer. For this reason many American architects in specifying galvanized lath are now stating that it must not be electro galvanized. By continuing the process, any desired quantity of zinc can be deposited, but if sufficient is provided to give a coating equal to the sherardized coating the cost would be many times as great.

The sherardized coating which was finally adopted differs from other types of galvanizing by reason of the zinc iron alloy coming between the pure zinc and the steel. Immediately beneath the surface will be found a thin coating of alloy which is almost entirely of zinc. Going further the percentage of zinc decreases while the iron increases until pure iron is reached. There is, therefore, no contact between two metals of appreciable variation in electric potential. The coating can be considered as made up of a large number of layers, each varying slightly in electric potential from those immediately above and beneath it. While electric currents doubtless exist in these layers they seem to be very weak and very minute, and their effect is quite insignificant. A given quantity of zinc is far more efficient in the sherardized coating than when applied in any other manner. Prof. Burgess of the chair of metallurgy of the University of Wisconsin, reports that a given quantity of filings from the sherardizing alloy takes fifteen times as long to dissolve in acid as a like quantity of zinc filings from a hot galvanizing bath.

Another reason for choosing sherardizing is that the process cannot be scamped and is practically proof against mistakes in the shop. The zinc dust in which the lath is baked is a very poor conductor of heat. The process starts at the outside of the drums long before it starts at the centre, yet heat must be kept up until the centre is being sherardized. Conversely the process is still going on at the centre for some time after the drums are removed from the oven. The real protective is the alloy which is deposited before the pure zinc. If therefore pure zinc appears at the centre of the sheet one can be sure that the process is perfect.

In order to assist in the selection of a proper coating an attempt was made to devise an accelerated test applicable to the case in hand. The commonly used acid tests do not represent anything like working conditions. Patent plasters are not acids.

A number of specimens were coated with pure Plaster of Paris and kept for two weeks in a bath of exhaust steam. It was supposed that they would thus receive in a short time the effect of as much moisture and warmth as would ordinarily act on them in a long period of years.

The result was a disappointment. The temperature was above the melting point of asphaltum, and the cold japan coating had consequently been absorbed into the plaster. Plain uncoated lath ingot iron and cold japanned lath all looked equally rusted. All types of galvanized lath showed rust spots although the electro-galvanized was much the worst of the lot. The samples were submitted to Thomas Heyes & Sons, consulting chemists, for further examination. They reported that the only reason the galvanized coatings looked better than the bare lath is that iron oxide is red while zinc oxide is white. Actually there was more loss through oxidization of the zinc than of the iron.

They stated further that the application of steam started an entirely new set of chemical reactions and brought about conditions which never existed at normal temperatures. They reported after further consideration, that they could devise no accelerated test which would fairly represent the action of plaster through a series of years and offered as an alternative a series of very careful quantitive analyses lasting for several months.

By this time evidence obtained rom other sources had shown the superiority of the sherardized process. It remained, however, to see whether the plaster test would develop any unknown weakness. The chemists were instructed to conduct a series of tests on cold japanned and sherardized samples. These were coated with pure Plaster of Paris and carefully watched for five months. From time to time bits of the plaster were chipped off. The plaster film remaining in contact with the lath would then be scraped off and carefully analyzed. From the first these samples showed minute quantities of zinc oxide and metallic zinc dust. This is doubtless loose dust left on the coating from the manufacturing process. The first test showed 0.18 per cent. of such dust but no later tests showed as much as this. No trace of zinc sulphate or iron oxide was formed in any sample although they were watched for carefully.

The cold japanned sample showed iron oxide at the exposed edges while the edges of the sherardized sample were clear. Otherwise the results from the cold japanned sample were as good as the other.

The chemists stated that "forever" is too long a time to be considered in a careful scientific statement. Their tests showed, however, no reason to suppose that sherardized metal lath in a gypsum plaster would not last for a number of generations.

In comparing galvanizing the quantity of protecting zinc must always be considered. Prof. Burgess found that chemically pure zinc from an electro galvanized coating was two and six tenths times as efficient as zinc from a hot process bath and that the sherardized alloy was fifteen times as efficient as the hot galvanizing zinc. This was for equal quantities of metal. The excess zinc on hot galvanized material is wiped off wherever this is possible. Average tests show the commercial sherardized coating to be two to three times as efficient as a wiped hot galvanized coating but the latter requires much more zinc. Such a hot galvanized coating is also superior to the electro galvanized coating as commercially applied, yet if the same amount of zinc were used in both processes the electro galvanized coating would be much the superior.

Metal lath, when hot galvanized, cannot be wiped off, and a very heavy coating of zinc is the consequence. Our tests would indicate the probable superiority of sherardizing over even this very heavy coat although the cost is only about one-eighth as great. A conclusive test of this point was made by Mr. J. H. Burn-Murdock in England. He had one half a chain hot galvanized without wiping and the other half sherardized. Both chains were hung in sea water. When they were finally removed, the hot galvanized chain had lost all of its coating, and was so badly rusted that some of the links could be broken in the fingers. The sherardized chains had turned blue. There were occasional yellow patches which were rubbed off without showing pits or roughnes sbelow, and all the links were evidently as strong as when originally immersed.

SOME EXHIBIT FEATURES AT THE CEMENT SHOW

Comprehensive display, practically and artistically conceived, together with representative crowds, contribute to success of recently conducted event.

THE THIRD ANNUAL Cement Show held recently in Toronto, takes marked precedence over the two similar events of this character previously conducted in Canada, both as regards the scope and character of exhibits, and from a standpoint of attendance. Nothing, perhaps, more fully points out the need for a yearly affair of this kind than the growing interest which is being taken by both the building fraternity and the lay public in the production and use of cement in structural undertakings. Indeed, the lay public was strikingly in evidence throughout the entire week, paying close attention to the manufacturing features and studying the advantages which concrete offers for both utilitarian and decorative work. The display was at once comprehensive and diversified in character, covering the entire floor space of the St. Lawrence Arena and presenting much of genuine interest and value from both a practical and educational point of view. Features there were, and many of them, from the industrial exhibits, including mixers, concrete block machines, power equipment and cement working tools and appliances, to the adaptation of concrete to practical and artistic ends. Various systems of steel reinforcement and types of metal lath, together with water-proofing compounds and kindred products, were also well represented, while two particularly noteworthy attractions were the miniature cement mill and the cement gun. Manager Snaith, secretary-treasurer of the Canadian Cement and Concrete Association, is to be congratulated, both on the admirable arrangement of the exhibits and the successful manner in which the Show was conducted. Among the visitors to the Show were a large number of architects, and men prominent in public life, including the Hon. Geo. P. Graham, Minister of Railways and Canals, and Honorary President of the Association, who, with a few appropriate remarks, set the wheels in operation on the opening night. Music was furnished during the afternoons and evenings by D'Alesandro's Orchestra, and noticeable in the crowds at both periods of the day was a very representative sprinkling of the gentler sex. Viewed from any angle, the show left little to be desired, and it is an event that can well bear repeating at least once a year. This, at any rate, was the consensus of opinion among the exhibitors, who expressed appreciation of the growing usefulness of exhibitions of this kind and the interest they are awakening in the public's mind.

The exhibits were attractively set in place, and many of the booths vied one with the other for artistic distinction. The miniature cement mill was seen in operation at exhibit of the Canada Cement Company, which occupied a large space in the centre section near the entrance, and the process of converting the raw material into the manufactured product was explained during the week by an expert demonstrator to a large number of interested visitors. Another noteworthy feature in connection with this display was an artistic fireplace built of concrete, from which hot coals sent forth a warm and radiant glow. Mr. La Pierre, who looked after the company's interests, put in a strenuous time renewing old acquaintances, and Managing Director Jones and Sales Manager Ford came up from Montreal, during the week.

Immediately adjoining was Wettlaufer Brothers' extensive array of concrete mixers, including mixers for all character of work, and of any required capacity. All of these, with the exception of the small improved hand mixers, were equipped with lift hoppers and automatic dumping devices, and had steam, gasoline or electric power attachments. The company reports an increasing demand for their mixers as well as for their concrete block and cement pressed brick machines which were also demonstrated to advantage.

The Trussed Concrete Steel Company exhibit was both novel in conception and practical in purpose, being in the form of a small one-storey structure enclosed and roofed in with cement plaster on "Hy-Rib" metal lath, one of this firm's most successful products. This booth proved a big attraction during the entire show. On the interior the "Hy-Rib" was partially exposed in order to demonstrate the perfect bond which results between the lath and the mortar, and the essentially sound and rigid form of construction it effects. In addition to explaining the merits of this product, Mr. T. H. Stevens and his assistant were kept busy answering enquiries regarding the "Kahn System" of reinforcing and other well known products of this concern.

Both the utilitarian and the artistic were in evidence [redacted] booth [redacted] The laundry tubs and kitchen sinks were indeed a revelation in the use of cement for practical domestic purposes, the composition of both types of receptacles being hard, metallic, smooth and dense. The artistic was shown in an exquisitely modelled cast stone lizard and pedestral and imitation marble slabs which were strikingly true in texture to the natural product.

Eadie-Douglas, Montreal and Toronto, made a display of "Ceresit" Waterproofing and "Esco Paints" for structural and bridge work. Specimen casts of "Burmatoft" terra cotta, such as it used for the exterior facing of the Jacobs Building, the largest concrete structure in Montreal, were also introduced, together with "Keystone" gypsum blocks and "Terrano" flooring and stair treads, which are being broadly specified by architects and builders.

One of the most commendable booths at the Show was that of the Cement Products, Limited, of Toronto. This consisted of a garden wall with ornamental post caps and a background built of broken ashlar cement stone. The harmonizing variety in the face of the blocks, the texture and quality of the stone, and the artistic excellence of the display for practical demonstrative purposes won for the product of this firm many a deserved compliment.

Benjamin Moore and Company, Toronto, took advantage of the occasion to explain the merits of Moore's Cement Paints in a neatly arranged exhibit. Among the important buildings in which this paint or coating is used, is the Pennsylvania Terminal Station, New York, which was erroneously accredited in the last issue of CONSTRUCTION as the work of Architects Carrere & Hastings, instead of the firm of Messrs McKim, Mead & White. Aside from serving as a durable, impervious waterproofing protection, this coating, it is said, also enhances the appearance of the concrete. Incidentally, a large number of visitors were made acquainted with other products of this firm, including "Iron Clad" paints, Muresco, Sani-Flat, Impervo Brand Varnishes, Moormel, all of fhich are meeting with a big demand throughout the Dominion.

As on previous occasions, a conspicuous display was made at the booth of the Ideal Concrete Machinery Company, of London, Ont., and South Bend, Indiana, where a large, automatic tamping device turning out block of all sizes and varieties with wonderful facility, proved a powerful magnet. In addition to this practical and interesting feature, a display was made showing the possibilities of steam cured blocks for structural and architectural undertakings. Particularly effective was the grille work forming the lattice of an artistically carried out concrete fence, and made of adjustable units so designed as to be arranged with the openings running in either a perpendicular or horizontal direction. "Tycrete," a new product of the company, was also exhibited to advantage, and judging from the highly complimentary expressions heard, it is bound to have a very popular and lasting vogue. Mr. Pulford, Manager of the London plant, was in charge, while President Wettstien, from South Bend, was in evidence during the latter part of the week.

"Medusa" White Portland Cement and "Medusa" waterproofing compounds were demonstrated at the attractively arranged double space exhibit of the Stinson-Reeb Building Supply Company, Montreal, which was presided over by that congenial spirit—yclept, Kennedy Stinson. Space does not permit us to expatiate on the excellent merits of these products, other than to add that a beautiful placque and several specimens of decorative work executed in this cement, and a number of examples showing the practical application of "Medusa" waterproofing, commanded no little attention. A most noteworhy feature were the "Pauly" cement tiles which were used to form the wall built up around the booth. Other Stinson-Reeb products were also displayed, and these, like the above, appealed to a large number of visitors.

The Canadian Siegwart Beam Company, of Three Rivers, Que., exhibited a section of a concrete beam reinforced according to their system. Toward the end of the week this beam was subjected to a test in which it sustained a distributed load of 9,000 lbs. before showing fracture. The demonstration proved a popular feature, and brought a large number of enquiries regarding the "Siegwart" method of floor construction.

Steel and Radiation, Limited, Toronto, and Montreal, occupied a large and exceedingly well arranged booth, near the main entrance, which comprised such well known products as "Steelcrete" lath and metal reinforcement, "Klutch" bars, and "Fenestra" steel sash. This comprehensive display also included a complete line of metal lockers of which this concern makes a specialty. Adjoining the exhibit was the "cement gun," which was by far the most striking individual feature of the show, and which was demonstrated to eagerly interested throngs throughout the entire week. This "gun" is used for applying and spreading concrete mortar on wall surfaces, and has a discharging capacity of 12 bbls. of cement with the necessary proportion of aggregates, per hour. Steel and Radiation, Limited, have the Canadian rights for this unique and practical machine, and are prepared to sublet privileges for its use in various parts of Canada.

In viewing the exhibit of the Alfred Rogers, Limited, Toronto, it was somewhat of a poser at first glance to tell whether the occurring event was a cement and concrete exhibition or the annual flower display. At least nothing so prosaic as cement in its natural state entered into the scheme of this bower of beauty. On the contrary, it was a 1 : 2: 4 mix of flowers, ferns and palms, the resultant composition withstanding the most critical analysis of the artistic eye. Mr. Rogers believes that the test of cement is in the using of it, and not in a cursory examination of a mere handful of powdered material. In other words, quality tells, and judging from the number of satisfied customers who sought out this gentleman and his associates at this sequestered spot, the Rogers grade of cement is A1.

Koehring Mixers were demonstrated at the exhibit of the Canada Foundry Company, where Sales Manager Edwards and several capable assistants were in charge. The merits of three different size machines shown were quite evident to any one who called at this booth, and as many called, it is equally evident that the "Koehring" is to have a growing demand in the Canadian market. These mixers are designed to give the maximum output in the minimum time, regardless of the character of work for which they are employed. They are both modern in their attachments and power equipment, and are built to withstand the roughest kind of usage. Every part has been thoroughly considered, and in their manufacture the Canada Foundry Company has well sustained its reputation for manufacturing only high grade products.

The many advantages of "Herrringbone" lath were propounded at the booth of Clarence W. Noble, Home Life Building, Toronto, which was situated abutting the main aisle as one entered. Perhaps the best evidence as to the quality of this "lath" is to be found in the fact that within the past two years the demand for it has increased several times over. For a while the manufacturing resources of Mr. Noble's firm were sorely taxed in trying to keep up with their orders, but now that a new and much larger plant has been erected, this difficuly has been obviated, and this type of lath can be supplied in any quantity and shipped on the shortest notice.

Tech Brothers had an exhibit of cement paints and waterproofing compounds, for which E. F. Dartnell, 157 St. James street, Montreal, and Chellas & Black, Toronto, are agents.

IT IS UNDERSTOOD, says the *Westminster Gazette*, that when the time arrives to consider designs for a Shakespeare memorial national theatre, architects in all countries in the world will be invited to enter into the competition. This would be in accordance with modern practice in such matters. At the present moment, included among other competitions that are open to all, without respect to nationality, are, a monument to the Czar Alexander II. at St. Petersburg, new courts of justice at Athens, a new Presidential palace for Cuba, and the planning of the capitol of the Australian Commonwealth. International competitions of this description are apparently a modern institution, though artists and craftsmen of great ability have at all times readily found employment in foreign countries. England has used these desirable aliens as much as any people. The names of Holbein, Zucchero, Rubens, Vandyke, Roubillac, Angelica Kauffmann and numerous others may be cited as proof, while quite a legion of distinguished living artists who are closely identified with British art were not born under the Union Jack.

CEMENT SALESMEN DINE.

ON FEBRUARY 23RD, Mr. F. P. Jones, General Manager of the Canada Cement Company, gave a banquet for the salesmen of that concern, at the St. Regis, Montreal. Our photo shows Mr. Jones (at the extreme left of the picture) and his selling organization of seventeen experienced men. Mr. W. H. Ford, the Sales Manager of the institution, occupies the seat directly opposite Mr. Jones. It is interesting to note that he company have added five men to their staff of travellers during the past year. The territory has been carefully divided and even the very small towns are regularly covered. In this way the company aim to keep in the closest possible touch with the trade, as well as aiding the consumer of cement wherever he may need the advice and guidance that such trained men are able to supply.

Selling Organization of the Canada Cement Company.

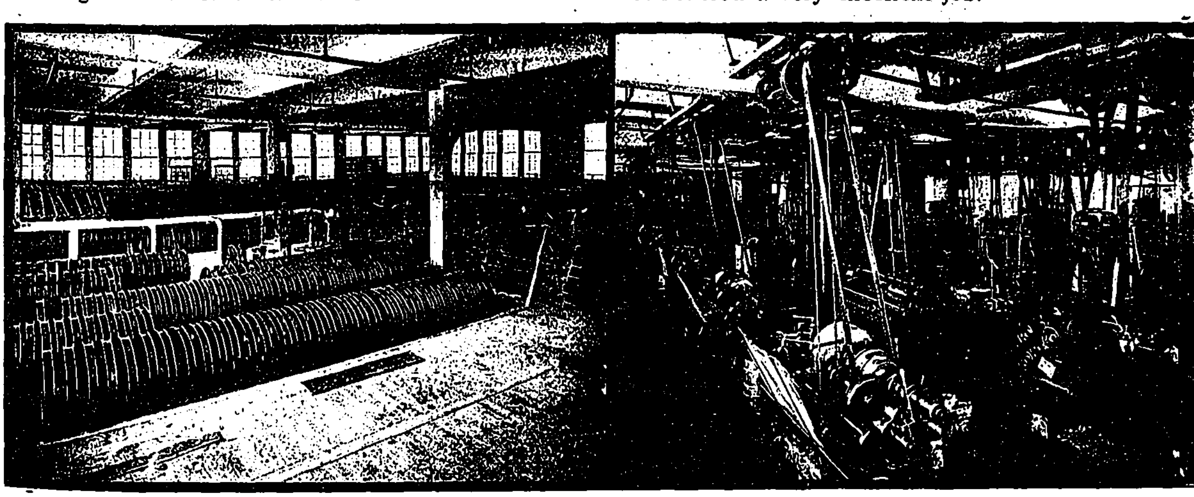
Reinforced Concrete Factory Erected for the Ford Motor Company at Windsor, Ont. Albert Kahn, Architect.

CONCRETE FACTORY OF FORD MOTOR CO.

THE FACTORY of the Ford Motor Company, illustrated in this instance, overlooks the Detroit River at Windsor, Ont., and is built of reinforced concrete construction.

This building, which was designed by Architect Albert Kahn, is a very excellent example of the type of factory construction that has become most popular recently in Canada and the United States. The frame-work is entirely of reinforced concrete, and the curtain walls are of brick. The illustration of this building represents fairly the possibilities of lighting arrangement in reinforced concrete buildings. The size of the building is 72 feet by 80 feet, three stories, and all floors were designed for a live load of 100 pounds per square foot. One of the difficulties encountered by the contractors in the erection of this building was the fact that the foundation soil was exceedingly poor at [redacted]sary, therefore, to drive piles for the foundation of the building to rest upon. Two hundred and fifty 30-foot piles were necessary. After the old buildings were removed, piles driven, and the foundation constructed, the building was erected in ten weeks. This is rather an exceptional record in concrete construction. In order that the concrete should be sufficiently dry so that wood floors could be laid without delay, wooden sleepers and concrete-fill between them were put on as soon as the concrete slab was slightly set. In usual practice it is customary to wait until forms are removed before the sleepers and concrete-fill are constructed, and the wooden floors are then laid when this has dried out. This practice, however, does not render possible the quick work done on this building, since concrete must be perfectly dry before wooden floors are laid.

Messrs. Wells & Gray, Toronto, were the contractors for this building and executed what is generally considered a very excellent job.



Views of Paint Shop and Machine Shop in Two Upper Stories, which Show the Heavy Load that the Floors are Designed to Carry. Albert Kahn, Architect.

Roman Stone

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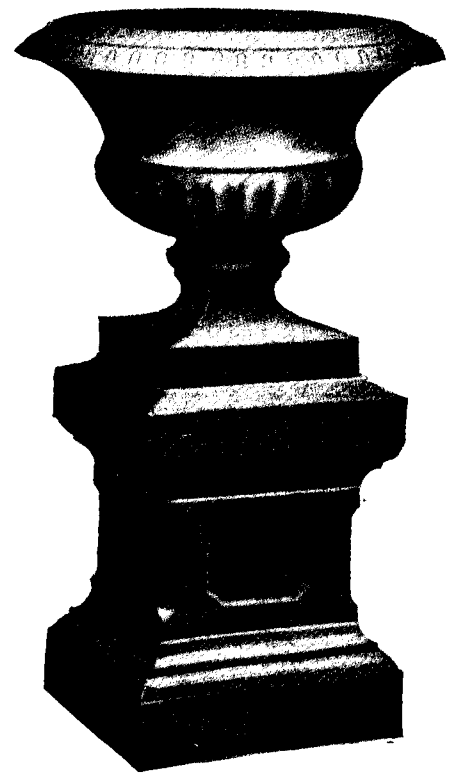
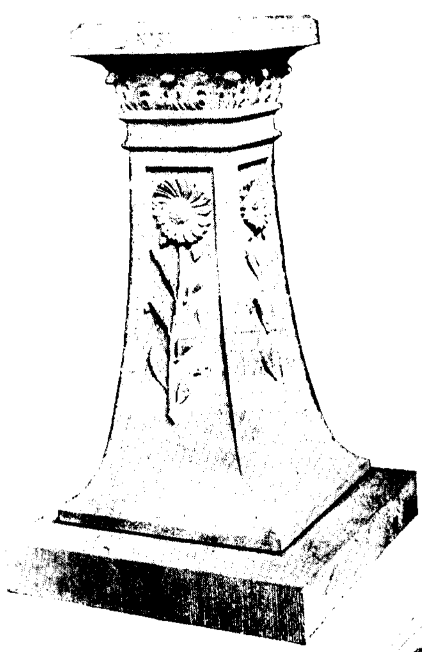


The illustrations shown herewith give some idea of the possibilities of ROMAN STONE.

It can be used as a facing for large office buildings; in small residences it can be used for columns, sills and keys; in decorative work all types of grotesque and decorative figures can be economically produced. In fact, it can be used more economically to supplant stone in any of its usual functions in building construction. It has a surface, color and texture that gives an effect that is superior to that of natural stone. In addition to tone and dignity it adds to the building, its structural strength is such that it renders it the most practicable material. ROMAN STONE has stood the test, and its superiority has been established by the properties it has demonstrated in its use in many of Canada's most important buildings.



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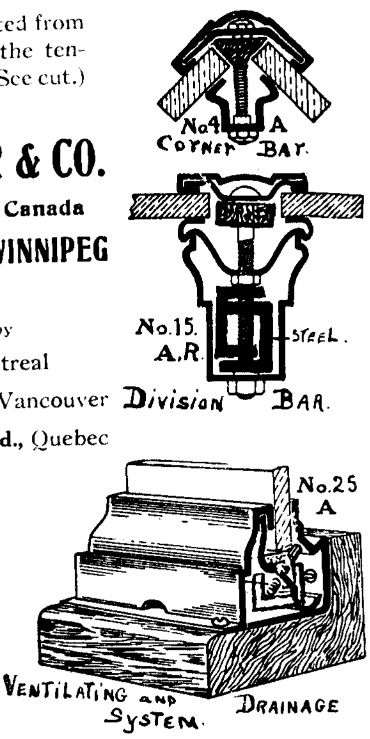

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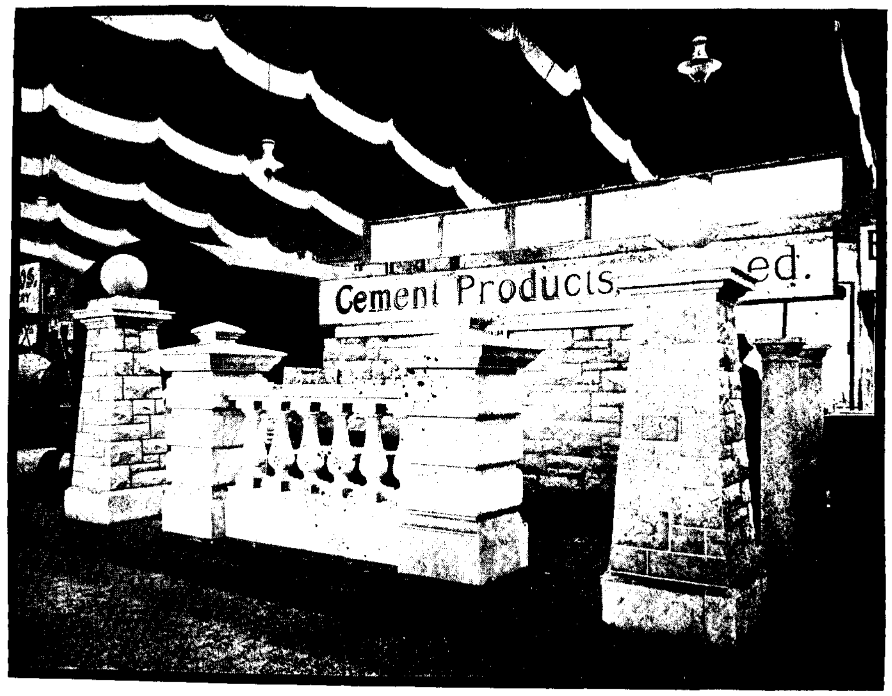

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