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THE CENTRAL RAILWAY AND ENGINEERING CLUB

OF CANADA

OFFICIAL PROCEEDINGS FOR JANUARY, 1909

C. A. JEFFERIS,
President.

C. L. WORTH,
Sec-Treas.

.. THE CENTRAL ..
Railway and Engineering
.... Club ....
OF CANADA

OFFICIAL PROCEEDINGS

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PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA MEETING.

ROSSIN HOUSE, TORONTO, January 19th, 1909.

The President, Mr. Jefferis, occupied the chair.

Chairman,—

As you have all been supplied with a copy of the minutes of previous meeting, I would ask that someone move the adoption of same.

Moved by Mr. Baldwin and seconded by Mr. Ellis, that the minutes be taken as read.

Chairman,—

I see the next on the list is remarks of the President. This is entirely out of my line. When I first learned that I had been elected President for this year, I was surprised, disappointed and sorry. I was surprised because I had sent word to the Nominating Committee that for several reasons I did not wish to hold any office this year, least of all the President's Chair. I was disappointed because I felt that Mr. Burrows should have been elected. Mr. Burrows has been one of the fathers of the Club, and as you all know, is a splendid speaker, and would make an ideal chairman as well as a good President. I am sorry because speech making is entirely out of my line. My life has been spent in trying to plan, organize and execute; therefore, I am entirely out of place. However, you have done it, and you will have to put up with the punishment which will surely be meted out to you. But after all, he would be an ungrateful man indeed if he did not appreciate such an honor as this. When a man is elected to such a position as this, in a social organization, I generally take it that it is because he is a good speaker or a jolly good fellow, and, of course, I am neither of these. But when an honor such as you have conferred upon me comes from those in similar walks of life as myself, either directly or indirectly, there is something deeper in it, and I do appreciate it most sincerely.

I see by the list we have a splendid Executive this year—the same as last year—and that is a good thing, because after all it is the Executive Committee that governs the Club, and if I do not keep on the right track, they will very quickly apply the brakes. However, gentlemen, I trust the same success and prosperity, which we have had in the past, will continue in the future, and that we shall spend many pleasant evenings together.

As I have said before, speech making is entirely out of my line, but you have done it, and I thank you very much. I should like to say a few words about Mr. McRae, our worthy past President, but I shall call upon a gentleman who is better fitted to pass sentence upon Mr. McRae than I am, therefore, I will ask Mr. Burrows to please step forward.

Mr. Acton Burrows,—

Mr. President, I always thought until to-night that you had some regard for the truth, but when you started out to-night by saying that I am a good speaker, I became convinced to the contrary. My forte is at the desk, and I can do much better there than standing up before an audience.

I am very glad to have the opportunity of saying a few words about Mr. McRae. However, before doing so, I wish to say that I trust Mr. Jefferis will have a very successful year in the chair. He is following two very good men, and I think the Club is fortunate in selecting such officers. I trust this will be the Club's banner year.

Mr. McRae has not been a figure-head, but has taken a very active interest in the Club. He attended the early meetings at the King Edward when we had much fewer members than we have now. He has not only been a good chairman, but has taken an active part in the discussions. Perhaps I know Mr. McRae's abilities better than many of those present. I know that the efficiency of the Toronto Street Railway service in its mechanical department, the great improvement in the mechanism of the cars and their successful operation is greatly due to Mr. McRae. I know from the position I hold in the Street Railway Association, how highly Mr. McRae is thought of, not only by the mechanical men, but by the manager of the member's Company. They all look upon him as one of the best mechanical men in the street railway service in America. At the last half-yearly meeting of the Canadian Street Railway Association held at Ottawa, Mr. McRae read a paper on the overhauling of electric railway rolling stock, which was really a text book, and I am sure that this paper will be referred to for years to come, and will be a standard, not only for large systems like the Toronto Railway, but for smaller ones.

When the members of the Club elected Mr. McRae for their President, they honored him, but honored themselves more. In the past it has been the habit that after a man has served as President that he drop out of office altogether, but this has very properly changed now, and we are pleased to have Mr. McRae upon our Executive Committee.

A very nice practice was started with Mr. McRae's predecessor, and at the request of the President, and upon behalf of the Club, I wish to present to Mr. McRae this small momento (a gold watch charm), and to wish him long life and continued good health and prosperity.

Mr. McRae,—

Mr. Chairman, Mr. Burrows and Gentlemen,—I am unable at the present moment to find words with which to express to you my appreciation for the very great honor, which I have received at your hands to-night.

In accepting this beautiful token which you have presented to me, I feel that on my part it is a fitting climax to the year of pleasure which I have enjoyed, as the chief Executive Officer of our Club.

I also desire to thank Mr. Burrows for the very kind words which he has just spoken regarding myself. Perhaps to those of you who do not know Mr. Burrows as well as I do, it might be in order for me to say, that Mr. Burrows has an enviable reputation as an able and talented after dinner speaker. With this explanation I will leave it to yourselves to draw your own conclusions.

I will wear this very beautiful token with a great deal of pride, and it will be a pleasure to me to exhibit it to my friends, and explain to them its origin.

Mr. President, I wish you as much pleasure during your occupancy of the chair, as I had during my tenure of office, and I assure you, sir, that I will deem it an honor at any time to be of assistance to either yourself or the Club.

I thank you most sincerely, Mr. Chairman and Gentlemen, for your kindness to me.

Chairman,—

The next order of business is the announcement of new members.

NEW MEMBERS.

Mr. R. H. Fish, Road Foreman, G. T. Ry., London.

Mr. C. G. Herring, Mechanical Draughtsman, Consumers' Gas Co., Toronto.

Mr. W. C. Philpotts, Analyst, Consumers' Gas Co., Toronto.

Mr. W. E. David, Machinist, Consumers' Gas Co., Toronto.

Mr. J. T. Fellows, Draughtsman, Consumers' Gas Co., Toronto.

Mr. E. Linstead, Machinist, Consumers' Gas Co., Toronto.

Mr. J. Dewdsbury, Machinist, G. T. Ry., Toronto.

Mr. C. A. Witherspoon, Machinist, G. T. Ry., Toronto.

Mr. N. D. Watmough, Assistant Storeman, G. T. Ry., Toronto..

Mr. H. O. R. Horwood, Leveller, Toronto.

Mr. J. E. O'Reilley, Machinist, G. T. Ry., Toronto.

MEMBERS PRESENT.

E. Blackstone.	D. Campbell.	W. E. Archer.
A. W. Durnan.	J. McWater.	N. D. Watmough.
W. E. David.	W. Poulter.	F. J. Lawlor.
T. Ward.	A. W. Shallcross.	F. R. Wickson.
T. J. Ward.	J. Griffin.	G. McIntosh.
J. R. Armer.	B. J. Markle.	C. G. Herring.
H. O. R. Horwood.	D. G. Hollawell.	J. V. Jackson.

J. M. Clement.
G. F. Milne.
G. Shand.
H. P. Ellis.
W. R. McRae.
J. Tiverdale.
H. E. Rowell.
Acton Burrows.
J. Barker.
M. Wright.
J. Kyle.
J. Dodds.
R. H. Fish.

A. G. McLellan.
E. Linstead.
H. H. Wilson.
G. Baldwin.
A. M. Wickens.
H. O. Eddrup.
W. H. Bowie.
W. J. Bird.
J. T. Fellows.
E. B. Allen.
L. S. Hyde.
W. Evans.
G. Cooper.

J. Herriot.
H. Cross.
A. J. Lewkowiez.
C. A. Jefferis.
M. N. Garland.
S. Turner, Jr.
J. Mouldey.
R. Pearson.
E. Logan.
A. E. Nurse.
C. L. Worth.
J. Duguid.

Chairman,—

Gentlemen, we have with us to-night Mr. Nourse of the Expanded Metal Company, who is going to give us a paper on Reinforced Concrete. I have a great deal of pleasure in calling upon Mr. Nourse.

REINFORCED CONCRETE CONSTRUCTION.

BY A. E. NOURSE, ASST. ENGINEER EXPANDED METAL AND FIREPROOFING CO., TORONTO.

For many years the high strength of concrete was well known, and it was made to do good service in foundation work or other structures subjected only to compression. Its low tensile value barred it from any structure where tensile stresses were likely to be introduced. Thus concrete had only a limited use. However, engineers found that by introducing sufficient steel tensile stresses could be taken care of. This gave rise to reinforced concrete which has now a practically limitless number of applications in building construction.

We are most familiar with reinforced concrete in the shape of beams or slabs.

It is well known that if a beam is simply supported at the ends and is loaded, the top fibres of the beam are in compression whereas the lower fibres are in tension. Now in the reinforced concrete beam the concrete is made to take up the compression and the steel takes care of the tension. This is the principle of the reinforced beam. Great volumes have been written on the theory of the reinforced beam, but many of them consist of higher mathematics of little interest to the technical man and absolutely useless to the man on the job.

However, from all the mathematics engineers have been able to get together enough facts to construct various formulae for the design of reinforced concrete beams. This question of formulae is rather complex and would easily take a whole evening of itself and then we would have merely begun.

The man who has to design reinforced concrete should be cautious for the mere blind employment of a formula spells disaster. There are so many variable elements entering into the theory of reinforced concrete that a mere rule of thumb method of design is absolutely useless. A formula may be perfectly safe for a concrete of a certain mix, but would be extremely unsafe with some other proportions, unless due regard is had to the safe unit compressive stress of the concrete. It is best to leave the design of reinforced concrete to the specialist.

CONSTRUCTION OF BEAMS.

However, let us pass on to construction, which perhaps, is more to the point.

The reinforcement of a beam usually consists of rods either trussed or straight. Generally both trussed and straight rods are employed. By trussed rods is meant rods bent at the ends to take care of the shear.

For purposes of weather and fireproofing the specifications usually state that the reinforcement is to be protected by 1½ inch of concrete. This is done by placing a layer of concrete about 2 inches thick in the bottom of the form and then laying in the steel.

The rods should be spaced so as not to be closer together than 1½ times the diameter of the larger rod. Rods larger than 1 5-16 inches are *not* recommended for ordinary beam work. The concrete should be rather wet and should be well tamped around the rods. The English method is to use a dry mix and do a large amount of tamping, but the American and cheaper way is to employ the wet mix. Practically all reinforced work is now done with a wet concrete. However, about every three or four months some one writes an article for an engineering paper, discussing the merits and faults of both systems.

Sometimes instead of using rods for beam reinforcement, steel structural shapes are employed. In fact buildings have been constructed where a light skeleton steel work has been assembled, strong enough only to stand by itself. This has then been centred and encased in concrete forming a reinforced concrete building. This is distinct from fireproofing where the steel is given only a certain thickness of concrete to protect the steel, but not to add to its strength.

Other methods of reinforcing concrete beams have been devised, some using cable and even chain.

In designing a beam it is always necessary to see that sufficient bearing is allowed on the supporting wall or column.

The reinforced concrete slab is simply a very broad beam. The steel is usually protected by 1½ inches of concrete on the under side. There are probably hundreds of varieties of slab reinforcement—plain rods, deforemd bars, wire, expanded metal, even chain and cable.

Some of these reinforcements come in sheets and possess a distinct advantage over bars for the reason that there is no chance to make a mistake in the spacing of the metal. They require less handling which in these days of high paid labor means something. However, in selecting reinforcement, the designer must be guided by experience supplemented by common sense.

In building a reinforced concrete slab it is very necessary to provide proper bearing at the points of support and just as necessary to run the metal well into the bearing region. The neglect of this precaution has been the cause of many failures.

Some firms in their catalogues give tables of safe loads for various spans and thicknesses of slabs for a certain reinforcement. If these tables are used it should be with care because there is a vast difference between a uniform load of say 10 tons and a concentrated load of 10 tons. That is to say, if a slab is designed for a safe live load of 10 tons uniformly distributed, don't expect the same slabs to be equally safe if it is subjected to a moving load of 10 tons. As a matter of fact a slab which will safely support 10 tons uniformly distributed will only support 5 tons with same factor of safety if the load is concentrated in the centre. Hence be careful and decide whether the load is uniform or moving.

COLUMNS.

Reinforced concrete columns are now largely employed where fireproof construction is desired. The theory of the column is indeed complicated, in fact more so, than the beam. Especially is this true of long columns. However, let us not stir up trouble.

There are two methods of reinforcing concrete columns. In one method the steel is all placed longitudinally and the rods are tied together at intervals by bands. In the other method called the hoop method, hoops are provided and only sufficient longitudinal steel is supplied to hold up the loops. French engineers have found that the steel is 2.4 times as efficient when in loop form as when in the longitudinal form.

When the longitudinal method is adopted it is usual to space the bands at a distance from each other equal to the least diameter of the column. The rule for the diameter of the column is usually that the diameter in inches is equal to the height in feet of unsupported length.

The steel of the column must be so placed that sufficient concrete covers the reinforcement to provide its being fireproof. This is usually stated as 2inches.

When one column is to be built on top of another the steel of the upper column must be placed on top of the steel in the lower column and held there by metal sleeves. They should not be wired side by side.

Footings for walls and columns are very economically constructed of reinforced concrete.

Reinforced concrete walls are quite popular, especially in the United States. By reinforcing a wall we may decrease its thickness to a very great extent, thus cheapening construction. Many curtain walls are now constructed of reinforced concrete. Usually a mesh reinforcement is employed for this purpose.

Mention has been made repeatedly to the fireproof qualities of reinforced concrete, but perhaps a few words on this subject might be of interest.

A great many experimental tests have been made showing the value of concrete as a fire resisting material. However, one of the best tests is when a fire occurs in a reinforced concrete building. The Baltimore fire gave some striking instances of the power of concrete to withstand high temperatures.

In a report to the Chief of Engineers, United States, Capt. Sewell says that the damage to one building which was subjected to extreme heat could have been repaired, for 20 or 25 per cent. of the initial cost. He found the concrete calcined to a depth of ¼ inch, but no tendency to spalling except at corners.

Reinforced concrete is better than terra cotta for fireproofing as found in the Baltimore fire. Authority for this statement is found in Report No. XIII. of the Insurance Engineer's experiment station at Boston, Mass.

The reason for the high fire resisting properties of reinforced concrete seems to be that, the heat calcines out a small portion of the concrete which is a poor conductor of heat. Thus it takes very prolonged heat to continue the action.

CONCERNING BOND.

Bond is the interlock of the reinforcing with concrete. It is this property which allows the reinforcement to transmit its stress to the concrete. For reinforcement there are plain bars and deformed bars. The plain bars are prevented from slipping through the concrete by the gripping of the concrete on the surface of the bar. The deformed bars rely on the anchorage afforded by the deformations. These two systems have been argued by engineers for many years. Undoubtedly each has its place and it is absurd to claim perfection for one to the exclusion of all the rest.

So many things depend on the conditions that it is hard to give judgment.

Plain bars and rods are more easily secured than deformed and are vastly cheaper.

In Europe where reinforced concrete has reached a high state of perfection the plain bar is mostly used.

Although the bond between concrete may run as high as 600 lbs. per sq. inch of surface, a designer may run as high as such a value since the safe shearing value of concrete is only 50 lbs. per sq. inch.

In designing a beam it is very important that the reinforcement should have sufficient surface to develop the bond required by the stress on the steel. This is the argument for reinforcement of small size.

The following is an extract from the City of Toronto Building By-Law govering reinforced concrete:

Proportion of Concrete.

The concrete shall be mixed in the proportions of not less than one part of cement, two parts of sand and four parts of clean stone or gravel, or in such other proportions as may be necessary to make the resistance of the mixture to crushing not less than two thousand pounds per sq. inch after hardening for 28 days.

Mixing Concrete.

The concrete used in reinforced concrete construction, must be what is usually known as a "wet" mixture, and all concrete shall be thoroughly mixed by machine to an even uniform consistency.

When a section or panel of reinforced concrete or any trussed concrete member is started, it must be finished in its entirety before shutting down for any purpose, which will make a necessary delay of more than thirty minutes duration, and any patch or remnant of concrete which has been allowed to stand until it begins to set must be at once removed and shall not be mixed and used in any portion of the work.

Putting Concrete in place.

All concrete must be placed in the forms in its final position as quickly as possible after being properly mixed, and particular attention must be given to the thorough puddling of concrete around all reinforcement, and under the lower flanges of all beams so as to make the entire mass a monololithic body entirely free from voids or unfilled portions.

Quality of Cement.

Only high grade Portland cement shall be used in reinforced concrete construction. Such cement when tested neat shall after one day in air develop a tensile strength of at least 200 pounds per sq. inch. and after one day in air and six days in water shall develop a tensile strength of at least five hundred pounds per sqaure inch, and after one day in air and twenty seven days in water shall develop a tensile strength of at least six hundred pounds per square inch. Other tests as to fineness, constancy of volume, etc., made in accordance with the method described in recognized "Standard Specifications for Cement," shall be furnished when deemed necessary by the City Architect.

Sand.

The sand to be used must be clean, sharp and coarse, perfectly free from loam or dirt.

Crushed Stone or Gravel.

The stone used in the concrete shall be clean, crushed stone or gravel of a size that will pass through a three-quarter inch ring. The stone shall be fresh broken and screened, free from dust, and if gravel is used it shall be thoroughly washed.

Thickness of Concrete Between Reinforcement Rods.

The steel in lintels, beams, or girders shall be disposed so that there shall not be less than one and a half times the thickness of the steel in concrete between the different pieces of steel of which the reinforcement is composed.

Stresses.

Reinforced concrete shall be so designed that the stresses in the concrete and the steel shall not exceed the following limits:—

Extreme fibre stress on concrete in compression	500	lbs. per sq. in.
Concrete in direct compression	350	" " "
Shearing stress in concrete	50	" " "
Tensile stress in steel	16000	" " "
Compression in steel	12000	" " "
Shearing stress in steel	10000	" " "

Adhesion of Concrete to Steel.

The adhesion of concrete to steel shall be assumed to be not greater than the shearing strength of the concrete.

Moduli of Elasticity.

The ratio of the moduli of elasticity of concrete and steel shall be taken as 1 to 12.

It will be noticed that the City of Toronto has a very complete set of rules regarding reinforced concrete work.

FORM WORK.

As the erection of reinforced concrete work is similar to the making of a casting, it is very necessary that the form work should be very carefully done. For this purpose dressed lumber should be used and all joints made as nearly water tight as possible. In column and beam forms a small beading is usually placed in the corners to give a chamfer to the finished product. Since the form work must contain the plastic concrete, it is very necessary that sufficient bracing should be employed. In the case of columns, wooden clamps are made to surround the form. These clamps are tightened by wooden wedges. The lower part of the column requires more clamps than the upper part.

It usually pays to have a first-class carpenter in charge of the form work, as he can accomplish more work than half a dozen handy men.

The importance of thoroughly bracing and securing forms cannot be emphasized too much, as a burst beam or column means a large loss of money.

In placing heavy beam forms it is usual to allow a slight camber—say three-quarters of an inch in twenty feet. This will give a perfectly horizontal beam when the forms are struck.

The time which should elapse before pulling the centreing depends on the mass and also the weather. Concrete sets quickly in summer but slower in cold weather.

Just here it might be well to say that the setting of concrete is not a drying out process but a chemical combination.

It might be said that very cold weather is not the very best for reinforced concrete work. There is always the danger of the concrete being frozen and ruined. If it is necessary to do concrete work in the winter try to get the work protected by using heat or covering with cement bags or manure. The least that can be done is to heat the sand and cement before mixing.

Cinder concrete was, up to a short time ago, in high favor but its use is not recommended for the best class of work. It does not possess the high crushing value of stone concrete, and is relatively heavy for its capacity. No cinder concrete work is allowed in Toronto except as a fill between wooden sleepers laid on the supporting floor. For this purpose it is valuable. Never use cinders in foundation work.

WELDING OF REINFORCING BARS.

We sometimes hear of welding two rods together when a single rod of the required length has not been at hand. At the best this is dangerous and is not recommended. If the rods are lapped forty times their diameter the bond will deveopl the strength of the single rod.

In the construction of the test syphons for New York city's new water supply at Peekskill, N.Y., the 1 in. x 1 in. twisted steel rods were welded by the Thermit process. This weld developed the full strength of the rod or 70,000 pounds per sq. inch. However, it is well to avoid welding reinforcement.

RUST.

Quite often reinforcement comes with a slight rust. This is not injurious and is completely arrested when embedded in concrete. Sometimes specifications are written which state that any steel beams to be covered with concrete must first be given three coats of paint. This is supposed to prevent rust. As a matter of fact any moisture that was on the steel at the time of being painted, stays there and sets up rusting. The lime of the concrete is prevented from reaching the rust, and consequently it is only a matter of time until the beam is unsafe. The paint destroys the bond between the steel and concrete and is worse than useless.

As to the permanency of reinforced concrete, it may be said that it will last forever. If conscientious work is done there is no reason why the structure should not last an indefinite period; of this we feel certain, from observations on floors in certain buildings which have been pulled down to make room for larger. In every case the reinforcement has been found bright and clean after many years in the building.

EFFLORESCENCE.

It sometimes happens that a white powder called efflorescence, appears on concrete work. This gives a very unsightly appearance

A wash which has been used to get rid of efflorescence is composed of one part hydrochloric acid and 5 parts water. Apply with scrubbing brushes and wash off with clean water.

INSPECTION OF CONCRETE WORK.

It is the rule nowadays to appoint an inspector on any engineering undertaking to look after the interests of the owner and see that specifications are lived up to. A good inspector can do much to keep everything working smoothly, but he need never be idle. Concrete work will stand an endless amount of inspection. The mix must be closely watched, to see that gauging is properly done. The beam sizes must be checked as also the reinforcement. The inspector must see that all columns are true and plumb, beams not shifted or forced. He must see that sufficient fireproofing is allowed, and must check column sizes. In fact, i tis absolutely essential to have thorough inspection to obtain best results.

CULVERTS.

Reinforced concrete culverts are now quite common and every railway has its own standard sizes for branch and main line work. When properly constructed the reinforced concrete culvert should last forever. Usually they are built for plain concrete work and then reinforced for luck. On the other hand some people have supposed that reinforced concrete would do the impossible and their work has been made too slim, only to fail.

A favorite reinforcement with railways is the ordinary T-rail. This makes a splendid reinforcement, many designers using this entirely.

The arch culvert can be made thinner than the box culvert, but the selection depends on the nature of the ground. Sometimes it is necessary to reinforce the floor of the culvert to form an inverted slab, giving it strength for bearing.

In flat top culverts it will be found that the thickness may be diminished as the depth of fill increases.

Wing walls are frequently built of reinforced concrete. They must then be figured as retaining walls.

Retaining walls of reinforced concrete are quite popular on American roads. The method used in reinforced concrete is to practically make the earth retain itself by shoving a toe into the bank, thus getting a lever action for the retaining wall.

The foregoing is but a few uses of reinforced concrete. Other uses are light houses, bridges, sewers, hot wells, water tanks, septic tanks, wharf floors, bridge floors, coal pockets, round houses, and also dams.

CEMENT.

The question has sometimes been asked, What is cement?

In answer to this we may say that there are two kinds of cements, viz., Natural and Portland. Natural cement is obtained by burning an argilaceous limestone. Portland cement is an artificial mixture of lime and clay burned to a clinker at a temperature of insipient fusion and finely ground.

Portland cement is made of marl and clay. Sometimes a certain limestone is used instead of marl. The necessary ingredients of a Portland cement are:

$Ca\,O$, 61% to 65%.
$Si\,O_2$, 21% to 24%.
$Al_2\,O_3$, 6% to 8%.

Other substances are present in a more or less degree, but are not essential.

Certain tests are applied to cement to determine whether or not it is suitable for a certain piece of work.

The physical tests usually applied are:

(1) Soundness or constancy of volume.
(2) Fineness.
(3) Tensile strength.
  (*a*) neat.
  (*b*) motar (3 to 1).
(4) Specific gravity.
(5) Setting.

In the soundness test we discover whether or not any free lime exists. Free lime is injurious as it swells and cracks.

The fineness test is important for several reasons, among them being (*a*) the finer the cement, the greater will be the covering power; (*b*) the less likely to blow; (*c*) fine grinding hastens setting.

From tensile test we have a method of comparing the sample with other good cements and have a method of arriving at the compressive value.

The relation between tensile and compressive strengths of mortar 3 to 1 is $\frac{\text{Comp strength.}}{\text{Tensile strength.}} = 8.64 + 1.8 \log A.$

A is the age in months.

A high specific gravity shows overburning, whereas if low it shows adulteration. Fresh cement has higher S. G. than old cement.

From the setting test we obtain the times of initial and final set.

CANADIAN STANDARD CEMENT TESTS.

1. Fineness.
   Not a residue 10% on a 100^2 sieve.
   " " 1% on a 50^2 sieve.
2. Specific Gravity.
   3.09—3.25 for fresh cement.
3. Setting Test—Gilmore's needles.
   $\frac{1}{4}$ lb. 1-12 inch diameter for initial test.
   1 lb. 1-24 inch diameter for final test.
4. Hot or Blowing Test.

Pats shall be made covered with a damp cloth and allowed to obtain a final set; they shall then be immersed in vapor of water at temperature of 130° for 6 hours, including the time of setting in air. The pats shall then be immersed in the water for 18 hours. The pats should cling to the plate and there shall be no turning up of edges.

5. Tension tests.
   (*a*) Neat cement with about 22% water.
   1 day in air— 2 days in water, 250 lbs.
   1 " " 6 " " 400 lbs.
   1 " " 27 " " 500 lbs.
   (*b*) Mortar 1 : 3.
   1 day in air— 6 days in water, 125 lbs.
   1 " " 27 " " 200 lbs.

The method of obtaining the correct proportion of cement to sand and stone has not been dealt with in this paper. It is however very simple, although usually some standard mix as 1 : 2 : 4 or 1 : 2 : 5 is employed.

Altogether it might be said that reinforced concrete is not a mystery and should not be looked at with bated breath as something fearful and wonderful. It is merely the application of common sense and although we would not advise everyone to try the design of reinforced concrete, still it is within the reach of any one who is well grounded in the first principles of statics.

Reinforced concrete is not without its faults, however, for durability, fireproof qualities and low maintenance it surpasses all other building materials of the present day.

Chairman,—

I think, perhaps, before opening up the discussion, we had better have ten minutes recess in order to get acquainted with the new members, and it will also give those gentlemen who wish to pay up their dues, a chance. Also it will afford you an opportunity to have a smoke.

Chairman,—

Has anyone got any question they wish to ask Mr. Nourse, as I know he will be very pleased to answer any questions, and we would like someone to start up the discussion.

Mr. Lewkowiez,—

There are one or two questions which I would like to ask. One is, speaking of the bond value of being equal to the shearing of 50 lbs. to the square inch. Is that figured on the total circumference of the rod for its full length?

Mr. Nourse,—

It is from the centre of the beam to the end of it. That is 50 lbs. per square inch of surface.

Mr. Lewkowiez,—

I notice that columns from the ground to the top are of the same size. Do they make the top one strong enough to support the full load at the bottom.

Mr. Nourse,—

According to the City by-law it is not right. They are also wasting steel.

Mr. Lewkowiez,—

Is there no wind bracing on concrete buildings. I noticed none on those I have seen.

Mr. Nourse,—

They usually project from the column into the beam and that takes care of it.

Mr. Lewkowiez,—

These are the only points that I thought of during the reading of the paper. I would like to hear from some of the other members.

Mr. Wickson,—

Speaking of the dry and wet mix, or American and English, what do you mean by the dry mix?

Mr. Nourse,—

A dry mix is where you have to pound it to bring the moisture to the surface. When you have pounded it and brought it up to the surface it is a sort of a jelly.

Mr. Wickson,—

Regarding stopping work over night on a column, I did not understand what you mentioned about that.

Mr. Nourse,—

They never stop work on a column; they must finish that. They stop over it, or bring the concrete over the centre of the column. They never stop when the column is half full.

Mr. Wickson,—

Speaking of centering beams just before they camber, I should like to know something about this.

Mr. Nourse,—

The act of putting forms into place is centering.

Mr. Lewkowiez,—

That leads to one more question. In stopping on a beam over night, do you stop in the centre horizontally, or vertically. Do you build half way up to the centre and then build the other half later on?

Mr. Nourse,—

In pouring beams it is considered best practice to stop over its point of support. No horizontal break must be made. It must be a vertical break. They never stop pouring until the beam is complete. In starting next day the stopping board is removed and work proceeded with.

Mr. Herring,—

There is one thing I would like to ask, Mr. Chairman. In any future extensions which are required to a floor or wall, the stopping board which you place there, cannot be postponed to an indefinite period.

Mr. Nourse,—

Where it comes over the top of the column, yes. There is a sufficient bearing there already. They do not try to do that, however. The steel usually runs to the centre of the column. Of course if you have what they call a continuous beam—(you cannot use it in this city)—you would have to stop in the centre and not over the column. In the city where you figure with the simple beam, it is alright to stop right over the centre of the column, and you can postpone it indefinitely.

Mr. Herring,—

As regards the electrolysis in a beam. I should like to hear something about this.

Mr. Nourse,—

Stray currents may get into a reinforcement, but just exactly the amount of damage they are going to do, nobody knows as no test has yet been made.

Mr. Herring,—

I was thinking that the salts or acids which might get into the concrete, in combination with the current of electricity, might cause a corrosion of the beam in the reinforcement.

Mr. Nourse,—

It might. I really have not seen any discussions on this point. They know there is electrolysis in a steel building, but as far as electrolysis in reinforcements, I cannot say anything about this.

Mr. Herring,—

As regards using a reinforced tank, say, for water storage, either for underground or raised on a structure, is it necessary to apply an asphalt solution to the tank to keep it from leaking?

Mr. Nourse,—

In tank work they use a pretty rich mixture of cement. One tank I have seen up, did not leak. Whether the water that got through evaporated I do not know.

Mr. Herring,—

This calls to mind a case of some large coke hoppers in

England. The hoppers and tank weighed about 360 tons empty. The top of the storage tank was about 75 feet above the ground level. This was supplying water to the works and neighboring plants by gravity. The whole of this plant was constructed of reinforced concrete. I have never seen a better example of reinforced architecture than that was, because it took care of a large number of conveyers supplying hot coke into this tank or hopper, and the vibration of the machinery was a large factor, however, altogether it was finished up very successfully, and required a large amount of skill.

I thank you for answering my questions.

Chairman,—

Can you tell us, Mr. Nourse, how it is some of these concrete buildings sweat so much? Take, for instance, the roundhouses. They have to paint them so much due to this sweating.

Mr. Nourse,—

It does not change its temperature as quickly as the surrounding air. Galvanized iron would do about as much sweating as concrete would.

Mr. Wickson,—

A roundhouse is liable to have more moisture than any other building, and this may aid in causing it to sweat.

Mr. Nourse,—

You can always get over that by a suspended ceiling.

Mr. Lewkowiez,—

Getting back to the electrolysis question. When there is no moisture at the surface of the metal, would electrolysis do any damage to the reinforcing?

Mr. Nourse,—

I do not know whether it would start up without moisture. However, I know that moisture would certainly help it a great deal. I have not heard of any experiments along this line. Probably in reinforced concrete sewers, electrolysis would do damage as there is considerable moisture there. I know there is a discussion now going on in the engineering papers regarding the effect of alkali on concrete. In most cases they say it is injurious to concrete. It is really a chemical action taking place.

Mr. Wickens,—

Mr. Nourse spoke of a case where a beam should have been

24 x 16, but was found to be only 20 x 16. Was that concrete set, and had the 4 inches to be added? Would it make up as strong?

Mr. Nourse,—

When I found that it was 4 inches short, there had been nothing poured. If it was set we would certainly have had to put on the other four inches, but it would not be as strong as it should be. That is one of the things about which they are very strict in this city, that it must be poured together.

Mr. Bird,—

Supposing you have a lot of cement on hand, say, for two years, does it deteriorate?

Mr. Nourse,—

The best way is to test it. As cement gets older it loses a portion of its weight. They would not use old cement in first-class work, although it could be used in inferior work. It is freaky stuff, and to test it is really the only way to discern its value.

Mr. Wickens,—

Mr. Nourse spoke of proportions of cement and mentioned 1, 3 and 5. I do not know anything about making cement for buildings, but I have had considerable to do with making cement for large engine foundations. We used what we considered the best mixture for that purpose—2, 3 and 5. Of course an engine foundation is not like building a wall. We wanted the weight which would stand the shocks of the reciprocating motion of the engine so many times a minute. It is like shooting a gun, the admission of steam at each end of the stroke must be considered as an application. If the gun is heavy enough you get no kick. We found that if the foundation was not thick enough it would crack. The firm I was with was the first company to use cement for foundation work for engines. I would like to know whether it would be possible to use 1, 3 and 5 instead of 2, 3 and 5 for engine foundation work. We make the richer mixture because we wanted the work strong as well as heavy.

Mr. Nourse,—

Yes; I know it would. The only reason that you used 2, 3 and 5 was that there was a certain tensile strength in it, but if you reinforced it with steel it would take care of it with a mixture of 1, 3 and 5.

Mr. Wickens,—

I understand that reinforcing is for reducing the weight of the wall or amount of cement to be put in.

Mr. Nourse,—

You would get the same weight but with less cement.

Mr. Baldwin,—

Some four years ago I helped to install a battery of boilers in a concrete building down over the Don. I am speaking concerning what Mr. Nourse said about the Inspector having his troubles. The building was about 250 feet long. The contractor was an American, the foreman of the firm who had the work was a Frenchman, and the workmen were dagos. You can imagine the troubles of that Inspector.

I rose specially to ask one question concerning the matter of expansion. I have in mind a building of reinforced concrete, which is 150 feet long, 50 feet wide, three stories high with basement, and there is a crack right through the building. I was wondering whether it was due to the building settling or from contraction and expansion.

Mr. Nourse,—

I would not like to say, but I know this much, that expansion in concrete would not be any more than in steel. I think in this case there might be something in the settling. I do not think the crack is caused by the concrete as it will not expand any further than steel. I know rails expand and you can see them, but in buildings like you mention, there is a pretty uniform temperature, and the expansion would be practically nil.

Mr. Wickens,—

Last week I had the pleasure of attending the Clay Worker's Convention, and heard all about brick and other material for building construction. I heard all about the fire resisting qualities of brick. The lecturer has told us to-night about the fire resisting qualities of cement. The brick men claim that brick is the best fire resisting material. That led me to look up data concerning fires during the last year in America. Last year in the States there were six hundred million dollars damage done to buildings by fire. The *Insurance Review* tells us there is no country under the sun that has more fire destruction than the country to the south of us.

In some of the large buildings steel structure is used to carry the weight and brick and terra cotta used to protect it from fire. Now it is a question in my mind, is it possible to build these buildings with concrete to carry the weight. The fire-proofing of buildings to-day is the biggest problem the authorities have. We do not hear of such fires in England and Germany, simply because they build their buildings very much more fire-proof than we do. This is a very vital question in this country. While we think our buildings are of fire-proof construction, yet we must bear in mind that we are poorer in this country and cannot put as much money in our buildings and in running to cheapness, we are subject to fires. The point I would like to ask about is, will concrete stand fire as well as first class brick work or terra cotta coverings?

Mr. Nourse,—

From actual tests they show that concrete will stand a better test than terra cotta or brick. In Chicago a test was made. They built a small building of concrete and heated it up to a high temperature, and after heating for several hours they turned a stream of water on it to find out how it would be affected by it. It only went in it one-quarter inch, and they had a load on the top of it of—600 pounds per square foot. It deflected slightly in the heating but came back after cooling. In terra cotta work it stands up well under heat but as soon as you throw water on it, it cracks and no longer protects the steel work.

Mr. Wickens,—

That is not likely to occur in brick protection?

Mr. Nourse,—

Well burnt brick is pretty nearly fireproof. The idea of using terra cotta is that it is light and used where they wish structural work covered. With concrete it is poured around the beams and cannot crack away on account of the metal mesh which is used.

Mr. Herring,—

There were some splendid examples of fireproof qualities of buildings in the San Francisco fire. In one case where a large warehouse was attacked by fire, the damage was really caused by one of the reinforced beams giving way and bursting through the wall of the warehouse. The damage was not on account of the cement but through the beam falling.

Mr. Acton Burrows,—

After the liberal dose of taffy which you handed out to me at the beginning of the meeting, I am almost afraid to get up. However I am simply going to content myself in moving a hearty vote of thanks to Mr. Nourse for the paper he has given us to-night. Perhaps he will be kind enough to follow this subject up later on, especially concerning the use of concrete in railway construction, in which theme railway men are particularly interested. There is nothing which has revolutionized railway construction more than concrete. Mr. Nourse spoke of its use for culverts. I may also mention it is used extensively for abutments for bridges. I was talking to the Assistant Chief Engineer of the Canadian Pacific Railway in Montreal the other day, and he said that that Company was building a viaduct at Lethbridge which would be the longest in the world. They are using concrete piles there. Then there is the use of concrete in shop construction. As examples of this, take Battle Creek and Stratford shops of the Grand Trunk Railway, and the Intercolonial shops at Moncton. The use of concrete in railway work, with a few illustrations, and an explanation of the methods of construction would be of great value to this Club, and we trust Mr. Nourse will see his way clear to give us a paper on this at some future date.

I have very much pleasure in moving a hearty vote of thanks to Mr. Nourse.

This was seconded by Mr. Lewkowiez, and carried.

Chairman,—

I am afraid, Mr. Nourse, that you have got yourself into trouble. On behalf of the Club I extend to you our sincere thanks for giving us such an interesting paper.

A copy of the paper was sent me and on looking it over I said that the boys would not like it very much, but I am sure we are all pleased with it, and I wish you would come down and give us a paper, as Mr. Burrows said, whenever you get an opportunity.

Mr. Nourse,—

I knew very well it would be a dry paper, but it certainly has been a pleasure to me to come down here and talk about something that I like, even though it is dry. I told you to go to sleep at the beginning, and if you did not, it is your own fault.

Chairman,—

I see the next item is announcements. Our Entertainment Committee is arranging for a Smoker, but as there will be another meeting before that event, you will hear all about it later on.

Moved by Mr. Lewkowiez, seconded by Mr. Armer, that meeting be adjourned.

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