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Volume 21. Toronto, September 21, 1911 Contents of this issue on page 345

The Canadian Engineer

An Engineering Weekly.

FIELD WORK IN CONCRETE AT UNIVERSITY OF WISCONSIN.*

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Concrete floors in masonry buildings offer many advantages as compared to the best timber construction, aside from resistance to fire.

Steel and tile floors commonly used in the so-called standard fire proof construction are too expensive for ordinary work such as dwellings and other small buildings. The comparative merits of each as a fire resistant has not been given the thorough tests that time will afford, but it may be they are about equal. For buildings not more than five storeys in height brick walls and concrete floors appear to be the most economical and to unite the advantages of the old and the most modern systems of construction. Such buildings can be erected with the same thickness of walls as good construction demands and the sole difference in cost as between ordinary and fire proof construction is the excess cost of concrete floors and fire proof partitions over those of timber.

One of the chief expenses in reinforced concrete work is the false framing upon which the concrete is poured. About fifty per cent. of the lumber used in making false work is usually destroyed on taking down. Any system by which the major part of this can be saved results naturally in a decrease in the total cost of the building. In applying concrete construction to small work the scale of parts involves expensive and intricate preparation of false work so that the cost of this part sometimes exceeds the value of the concrete poured upon it.

Small buildings, meaning those not over five storeys high, have been built since civilization began and their elements have been so especialized particularly in modern times as to meet in an excellent way all the various requirements of strength, convenience and good appearance. Provision for modern improvements have been practically standardized and become a habit with the carpenter, the plumber and other workmen. If these buildings were not subject to the danger of fire there would be no good reason for making radical changes in building methods.

The invention of steel and tile construction introduced quite different members into floors and brought a good number of difficulties, some of which have not yet been satisfactorily met. Among these are the fastening of wood floors, the placing of pipes in accessible places and the like. With the advent of concrete the faults of steel and tile construction were mainly conserved and others added. All of this was done with apparent unconsciousness and probably without knowledge. The problem of construction was taken over by the engineers, who from training and practice are better acquainted with questions of strains than details of convenience and architectural appearance.

The first concrete buildings were designed as economy of strength and expense would suggest. The wide spacing of beams, together with their large size, produced a result at once simple and scientific. The application of accessories such as plumbing, heating, lighting, finish and decoration to these buildings was attended with some credit but not entire success. It was very soon dicovered that the loss of continuous spaces in the structure of the floor and the recurrence of impervious beams at intervals having no relation to the division of rooms was no small inconvenience.

Very soon systems of construction securing flat ceilings were developed and the fact was emphasized by the designers while advertising other merits. The practice of imbedding pipes and wires in the concrete seems to meet the approval, however, of every one but the owners of the buildings. Experience with this practice shows its disadvantage. In concrete construction there cannot be permitted the usual "tearing up" of floors to repair electrical and plumbing work, etc., as in wooden floors. It is no easy matter to cut out concrete that has hardened for some time, and besides, as reinforced beams are designed, it is extremely hazardous to break into them at random. Whatever, therefore, is cast into the work is there "for all time," and there is a serious embarrassment whenever the owner wishes to remodel his building.

There is room for trouble also in constructions where a certain beam supports a considerable area. Such a beam is usually calculated to do the work intended, with a good margin of safety, but suppose the casting of the beam proves to be faulty, or in some manner the beam suffers slight damage. At once the entire area is threatened. This suggests the arrangement of many beams of small size, each supporting a small floor space. To this there arises the objection of increased cost. Beams of long span and narrow width suggest cross bracing, and again the comparison with wood construction suffers as regards expense. The good elements of wood construction are, however, precisely those of advantage in concrete. Wood beams are of long span, slight dimensions, and are set closely together. Each beam is braced to its neighbor by cross bridging. Under the beams all sorts of pipings are extended, and a flat ceiling is placed beneath. Upon the beams the floor is laid. What could be more reasonable and convenient? Should a pipe fail it requires only the removal of the ceiling for its repair. Should it be necessary to change the dimensions of rooms the necessary readjustments are readily made. Should a beam be slightly defective, or suffer injury, the beams adjacent will support the load, or if necessary, a section can be replaced without removing a large area of the floor. None of these advantages are to be had in the "mill type" of floor construction.

To retain the advantages of the ordinary form of construction and at the same time to effect a decrease in the cost of construction work would seem to be worth while. In order to bring this about a decided improvement in the false work must be made and the false work must be preserved for future use. At the same time methods of placing steel must be simplified and standardized so that it can be safely done without the assistance of a skilled engineer. The steel must be made secure while the concrete is poured upon it.

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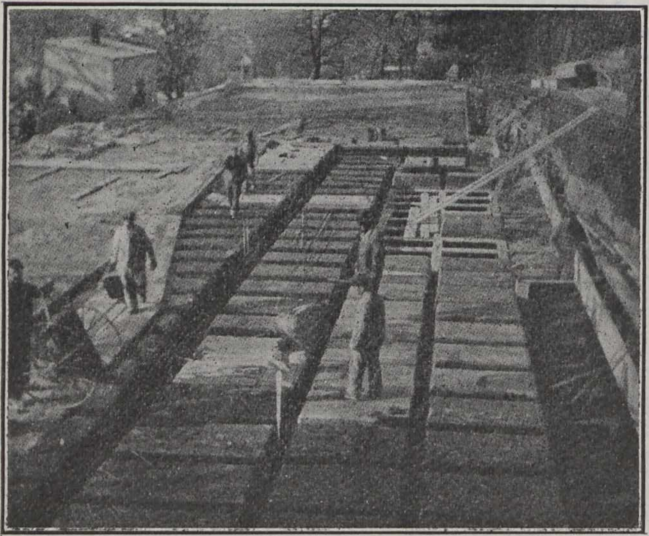
*A paper given before the Wisconsin Society of Engineers.

Field methods must take the place of laboratory methods, without serious loss of quality in results. The system employed at the University of Wisconsin has been found practical, economical and effective, and for buildings intended for ordinary use more satisfactory than the "mill type" of construction. In competition it has been found less expensive where the requirements of the specification for the steel and other elements forming a ncessary part of good construction have been conserved. This has been put to proof by obtaining alternate propositions on the same work, imposing only the requirement that the steel shall be strained not to exceed a certain amount, that spaces shall be provided for pipes, etc., and that the ceilings shall be flat.



Pouring a concrete floor on the movable forms. At the left the joists and girders are completed, ready for the floor sheet. In the center the steel shows in the girder. At the right a space is still to be covered with the forms.

Other systems approach the practical values of this one in some degree, as for instance that one where hollow tiles are used in place of the wood cells. Where but one building is to be constructed the cost of the cells might excel the cost of the tile. Where the building is of several storeys, or in buildings of large enough area so that one part can be constructed before another, thus permitting the repeated use of a reasonable number of cells, the cost of the tile would probably exceed the proportionate cost of wood cells. The tiles serve no useful purpose except as forms between which the beams are cast, and their weight adds to the dead load of the floor construction. In either case a floor sheet must be placed on top, and the ceiling must be furred to receive piping and other accessories. Of course, such pipes may be buried in the floor sheet, but there is serious objection to this. It is done in most fire proof buildings, but the expense of repairing damage in case of leakage of water, gas or electrical current is made very heavy on account of it. Changes also are very expensive and difficult, and it is safe to say that every building will be changed over a number of times before it becomes obsolete.

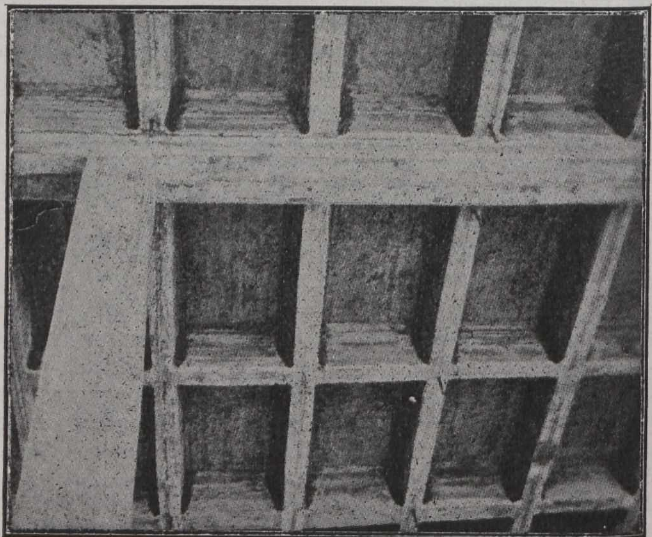
The system or design of the floor construction in use at the University of Wisconsin consists of an arrangement of narrow beams spaced at about three feet centers and braced by cross beams at six and one-half feet centers. The beams are formed by employing a series of wooden boxes, with slightly flaring sides and ends, laid face down upon a system of supporting planks upheld by shores. The intervals between the boxes or cells being filled with concrete constitute the beams and cross braces of the floor. The concrete is reinforced with steel after calculations made by the Dean of the Engineering Department of the University.

Upon the beams a floor sheet is poured, reinforced with steel wire fabric and finished with a wearing surface of cement and granite "fine stuff."

The reinforcing steel consists of round rods enclosed in loose stirrups. In the girders the rods are bent according to the best practice. Straight rods are used in the joists with counter flexure rods over the girders. In the cross braces small single rods are placed. The stirrups are of the U form, but to secure correct spacing and holding, several stirrups are bent from a single rod forming a unit series. These have been found very convenient on account of stability and resistance to drifting, falling and other annoying peculiarities of single stirrups. Mild steel has been employed in all work. High tensions have been prohibited, as well as calculated tension in concrete. This may be conservatism, but is no doubt wise. The effort of the architect has been to simplify and reduce the cost of work and to retain the good elements of old-fashioned constructive systems; to provide reasonable means of access to parts for repair and changes and to bring back the forms of surfaces on the interior of buildings which long custom has found most suitable and agreeable.

In detail of work it has been found that two rods in each beam are more convenient than one, although theoretically very narrow beams closely spaced and containing each a single rod would be ideal.

The rough way in which concrete is now mixed and cast, the danger of imperfect castings and the liability of damage to concrete in stripping forbid the use of very slender parts at present. For private house work the concrete floors of to-day are probably excessive in strength. Refinement in the false work and casting will come in time, however, and it is to be expected that future constructions will be very much lighter and less expensive.



Ceiling of shop and storehouse building showing concrete joists and cross-bracing, and one main girder. The bolts extending out of the joists are for attaching line shafts.

By the system described spans from twelve to twenty-six feet have been successfully cast at the University during the past two years. It is proposed to cast beams of twenty-eight feet span this year. These will require joists eight inches wide on the bottom, fourteen inches deep, and ten inches wide on top. With a spacing of 3 feet 4 inches from center to center of joists the amount of concrete employed does not seem excessive. The cross braces in the floor, due to the intervals between the lengths of cells, have not been considered in the estimated strength of the floor. Their value in holding the joist against lateral strain is unquestionable and they serve also to distribute the load upon the floor. The increased width of the beams at the top, due to the flaring sides of the moulds gives increased resistance to crushing, while the narrower bottom, enclosing the steel, is sufficient and economical.

The calculated strength of the floor is entirely in the beams. That is to say, the floor sheet is not expected to increase the compressive strength of the joists as in the T beam. The floor, reinforced with a woven wire fabric simply applies the load to the beams.

In casting this work the supporting columns are poured first and are left over night to shrink. The girders and beams follow, being also allowed to shrink, after which the floor sheet, almost a separate item, is cast and finished with cement and granite.

This method of working has been followed upon finding that heavy members need time in order to avoid cracking at the junction with the thin floor sheet. It has been found that the floor sheet may be cast at any convenient time, care being taken to clean the upper surfaces of the beams to secure good contact with the floor. In fact with a sufficient number of boxes or cells an entire building may be constructed, casting the posts, girders and joists, but leaving the floor sheet to be placed after the building has been enclosed. Where mosaic floors are required it may prove economical to lay them at once on the wire fabric without going to the expense of the preliminary floor sheet. This, however, has not been verified. For attaching the ordinary ceilings to this construction small strips of wood are cast into the bottom of each joist and secured by bent nails, thus affording a ready means of applying the furring strips for the ceiling. These in turn give the needed spaces for pipes, etc. Upon the furring strips wire lath or plaster board is nailed and plastering is applied.

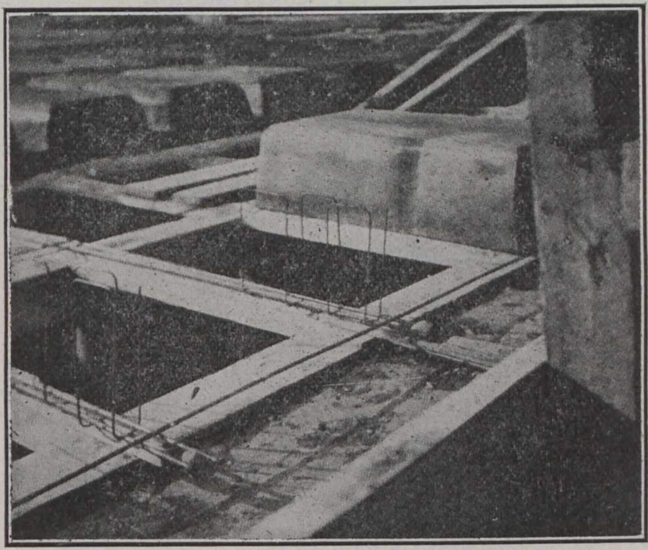
The false work for posts and girders is composed of dressed planks put together in the ordinary way. These parts suffer the least injury in removal and may be set up a good number of times. The cells rest upon the girder boxing where adjacent, forming the false work for the upper part of the girders. In other locations they are supported by the plank scaffolds above described or upon the inside edge of the walls. In all places they are carefully levelled so that the concrete cannot penetrate between the scaffold planks and the cells. A few nails from below hold the cells securely to the plank.

The spaces between ends of cells may vary somewhat, where convenient. Nice adjustments do not give great results where labor is expensive Making the joists narrower on one side of a girder than on the other, on account of a slightly shorter span does not bring final economy at times. It is simpler to make the "lay out" regular and strong enough for the longer span.

Posts and girders are incidental to all floor construction of large areas. Concrete posts are the least desirable element of concrete work because of the necessarily large size as compared to their length. Their elimination by increasing the spans of the floor seems to be the present solution of this problem.

With the completion of the false work the floor is ready for placing steel and casting concrete. The supporting columns are poured first and while the concrete is settling the steel is placed in the girder and joist channels. The "unit stirrups" are set in the ends of the girders and joists, being held up from the bottom of the forms by the small wooden strips to which the ceiling furrings are to be nailed later. The stirrups confine the tension rods of the beams. The steel is laid in the girders and joists of the entire floor before any part is covered with concrete. It may be inspected all together, corrections made, and the pouring is then begun. As fast as the joists are filled with concrete the counter flexure rods of the joists are floated in the concrete, extending over the girders and the work is ready for the floor sheet. At the end of the day's work the concrete of the joists and girders is dammed off at the center of the spans and the work is resumed the next day.

The second day's work usually begins with pouring the floor sheet on the area completed the day before. The woven steel fabric is unrolled over the surface and the concrete poured upon it. When sufficiently hard the surface finish is applied and the floor is completed. The pouring of the remaining joists follows the part of the sheet, using a half day on the sheet and the other half day on the joists and girders so that no part of the unfinished floor is more than one day old.

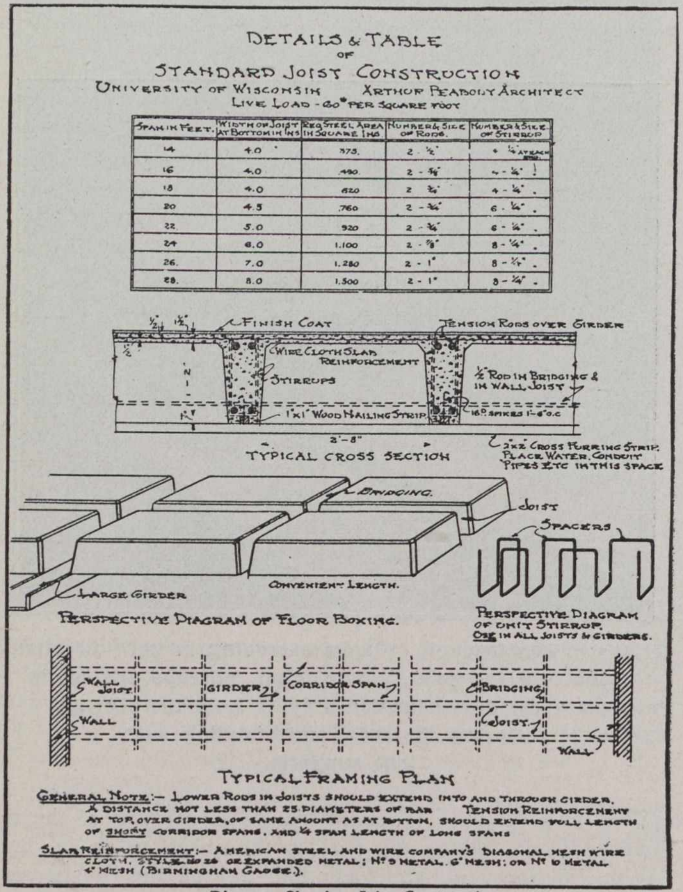


Details of construction. Planks extending in both directions, supporting the cells. The steel stirrups are set in place for demonstration only. Note the stirrups enclosing the rods, and standing without supports.

Practice has shown that the floor sheet is not separable from the joists even when poured after the joists have been set for several days. The finishing of the surface of the floor must be done of course soon after the sheet is poured. The entire work is allowed to set for three or four days before the mason work of the walls is allowed to proceed, but no stripping is done until after fourteen days. The girders and posts are then stripped and the cells are drawn out from underneath. For this work a chain about the interior framing of the cell is looped over a stout lever and one end of the box is started, whereupon it falls out, ready to be used over again. Small shores are then placed under the joists and left for a short time.

The cells first made at the University were built of pine sheathed with yellow pine flooring quite smooth and carefully put together. These cells were successfully drawn and were used fifteen times without a great percentage of loss. Their cost was approximately two dollars and fifty cents each. Each cell presented twenty-eight square feet of surface making a first cost of eight and nine-tenths cents per square foot. After fifteen casts the cost per square foot remained at about nine-fifteenths cents per square foot, assuming that the cells were then worthless. The contractor then covered them with sheet iron, at a cost of one dollar and forty cents each and expects to use them probably fifteen times more. This iron covering is well greased before using.

At this time a good number of new cells were constructed, also covered with iron. These were well built but without the same care in smoothing the surface on account of the iron covering. These cells slip out of the concrete so easily as to show a great advantage in the use of a metal covering which presents a smooth unbroken surface to the concrete. It obviates also the swelling of the wood covering, from dampness which made the drawing of the first cells rather hard at times and destructive to the cell. The life of a cell depends of course on the treatment it receives. Some were wrecked the first time they were used. Many of them were in apparent good order except as to the lower edges after fifteen casts. Their weight occasioned some damage, especially if allowed to fall to the ground on being drawn. The most convenient size of cells appears to be two feet, eight inches wide by six and one-half feet long. Beyond this size they cannot be so easily handled. Some cells were made seven feet long and a few five feet. At times it is necessary to build special cells to finish out a span.



SPAN IN FEET.	WIDTH OF JOIST AT BOTTOM IN INS	REQ. STEEL AREA IN SQUARE INS.	NUMBER & SIZE OF RODS.	NUMBER & SIZE OF STIRRUP
14	4.0	.375.	2 - ½"	4 - ¼" AT EACH END.
16	4.0	.490	2 - ⅝"	4 - ¼" "
18	4.0	.620	2 - ¾"	4 - ¼" "
20	4.5	.760	2 - ¾"	6 - ¼" "
22	5.0	.920	2 - ¾"	6 - ¼" "
24	6.0	1.100	2 - ⅞"	8 - ¼" "
26.	7.0	1.280	2 - 1"	8 - ¼" "
28.	8.0	1.500	2 - 1"	8 - ¼" "

GENERAL NOTE:— LOWER RODS IN JOISTS SHOULD EXTEND INTO AND THROUGH GIRDER. A DISTANCE NOT LESS THAN 25 DIAMETERS OF BAR. TENSION REINFORCEMENT AT TOP, OVER GIRDER, OF SAME AMOUNT AS AT BOTTOM, SHOULD EXTEND FULL LENGTH OF SHORT CORRIDOR SPANS, AND ¼ SPAN LENGTH OF LONG SPANS

SLAB REINFORCEMENT:— AMERICAN STEEL AND WIRE COMPANY'S DIAGONAL MESH WIRE CLOTH, STYLE NO 26 OR EXPANDED METAL; NO. 9 METAL, 6" MESH; OR NO. 10 METAL 4" MESH (BIRMINGHAM GAUGE).

Diagram Showing Joist Construction.

Variation in strength of floors was made in spacing the cells farther apart, making the concrete joists wider for the heavier floor. The percentage of steel was then increased according to rule. The joists were sometimes left exposed over laboratories, and made a very presentable appearance. This gave opportunity for the convenient support of shafts, etc. Electric conduits were there left exposed, following the direction of the joists and cross bridgings. In other buildings plastered ceilings were attached in the ordinary manner. Steam coils were suspended from hangers secured by drilling the joists at the neutral axis. For line shafts bolts were cast in the concrete at regular intervals, to which timbers carrying the shaft hangers were bolted.

The floor sheet, two and one-half inches thick including the sand finish, seems fragile. In walking over the floors the resonance of the parts between joists suggests the same thought. Experience, however, shows that, except for the mechanical difficulty of casting the floor could be thinner. Floors have been broken during construction, but by blows which would break other floors considered amply strong. On one instance a scaffold plank fell about sixteen feet, striking on end. At another time a piece of sandstone three feet long, weighing about four hundred and fifty pounds, fell the same distance upon the floor. Each of these accidents made a break about a foot square, leaving the steel fabric but little damaged, and the repair of the floor very easy. Drilling through the floor for extending steam risers or setting anchor bolts shows the strength to be ample if not excessive.

All floors thus far constructed have been covered with a finishing coat of cement and granite, following the usual method in sidewalk work. This coat must be put on to the sheet at the time of pouring, and is a source of trouble and anxiety, especially in winter. The mixture is probably too rich, resulting in some contraction and cracking. The recent practice of tamping the rough concrete and floating smooth may be a decided improvement. There is no great need for a granite finish in floors. The surface must be covered anyway with some material less hard and unyielding than stone. Linoleum and cork carpet have proved very successful and are pleasant under foot.

Where concrete floors are exposed the surface wears off a disagreeable dust that is untidy in appearance, and injurious to everything. This may be ground off and the hard concrete exposed, or the floor may be coated with special paint which resists wear and closes the pores of the concrete, preventing the absorption of water.

An example of the use of the system, with resulting costs is shown in a floor constructed in the Mining Laboratory of the University of Wisconsin. The floor area was approximately 4,500 square feet. The superimposed load was taken at 200 pounds per square foot. This work being done by the University forces gave an opportunity to know exact costs, as follows:

		Per square foot.
Crushed limestone, sand and Portland cement	$474.00 or	10.54 cents
Lumber for girder and post forms, etc.	252.00 or	6.60 cents
Cost of placing false work and cells	250.00 or	5.55 cents
Cost of steel reinforcement	354.00 or	7.86 cents
Labor of placing steel and pouring concrete	200.00 or	4.44 cents
Labor of removing false work	50.00 or	1.11 cents
Use of 200 cells at 1/15 original cost	33.00 or	.73 cents
Total cost	$1,613.00 or	35.83 cents

The cost of lumber for girder and post forms is, of course, too high, no allowance being made for the value of the material after removal. This lumber was not greatly damaged, but the exact value is hard to set down, as no subsequent floors of good area have been constructed by the University where it could be used. If the material could be taken to be as durable as the cells the proportionate lumber cost would be brought down to $16.70 instead of $252, and the total cost to $1,387.70 or 30.84 cents per square foot.

In applying this system it is to be noted that except in the items of concrete and steel a light floor will cost as much as a heavy one. It can be cast with the same cells, planks, shores, etc., and with approximately the same amount of labor. The increase on the heavy floor would, of course, be in the labor of pouring the larger amount of concrete. In the use of this laboratory the floor calculated to carry 200 pounds per square foot has been greatly overloaded, with no bad results, however, which indicates that the actual strength of concrete construction is probably far in excess of that calculated.

This suggests lower factors of safety or diminished sections, but chiefly, in building work, longer spans. The economies in materials are not great, as between a strong and a weak floor. The elimination of posts is of much greater interest. If spans up to forty feet could be safely employed the interiors of many buildings might be quite clear and the parts arranged in the most convenient way, unhampered by lines of supporting columns. With the present depth of fourteen inches for the cells there is, of course, an economical limit to spans. Deeper cells would bring a new set of calculated values, however, so that there may be no reason why long spans should not be made use of.

Along with the description of constructive systems the real values of concrete floors are no less proper to consider. Aside from the first quality of resistance to fire, the elimination of unseasoned lumber with the consequent shrinking and sagging is of itself an important item. Concrete floors are practically immovable and not at all responsive to footfalls. For this reason they are more nearly noiseless than wooden floors. When covered with a soft material they are very quiet indeed. Another excellence is the intimate and continuous contact between the floors and walls which cuts off the passage of air, fumes, odors, etc., and the easy access from story to story of insects and vermin, the common nuisances incident to timber construction.

The use of tile partitions is possible in connection with concrete floors of the usual strength. This completes the exclusion of wood from the structure of the building. Whatever may be the resisting qualities of concrete the omission of wood from constructive parts both in floors and partitions removes such a large quantity of fuel that the possibility of serious fires is materially reduced.

These qualities have been met with only in "regular" fireproof buildings and in the ancient vaulted floors of European buildings, until the advent of concrete construction. Concrete buildings are warmer in winter and cooler in summer than those of ordinary construction. They are quiet. The ordinary sounds from overhead or underneath do not penetrate through the storeys. An exception to this must probably be made as to musical sounds. A "resonance" travels some distance in certain cases. The claim that concrete floors are cold is probably wrong. In buildings heated by steam the entire building is warm. Concrete being a good conductor takes the same temperature as the room and should not feel cold to the foot. The probability is that wooden floors are really colder than concrete, on account of the draughts of air admitted into the spaces between the joists. Their quality as nonconductors may not carry the temperature so readily to the person, but all things considered concrete floors are probably warmer than wooden floors.

The less agreeable qualities of concrete are not so quickly discovered, but are none the less present. One of the first of them to be noticed is resonance. An uncovered floor in a large room produces a surprising echo or ringing which can be overcome only by applying a fibrous or sound-absorbing cover to the floor. This has been met at the University by linoleum, and cork carpet. Both of these substances have given good results. Both, however, have the tendency to wrinkle in the summer and shrink in winter, that obtains in all such materials. Some use has been made of very hard asphalted felt, and the results have been rather gratifying.

OPERATING COSTS OF GAS POWER PLANTS.

The following information with regard to the operating costs of various gas power plants has been extracted from the Report of the Plant Operations Committee of the American Society of Mechanical Engineers. This committee has been actively engaged during the past year in soliciting these costs from various plants, their report appearing in the September journal of the society.

The plants upon which the commitee is able to make a report are described in some detail in the following pages and, following each description is a summation of their operating costs. In some instances, these cost records cover a few months and, in one instance, a considerably longer period of operation.

For the purpose of identification, but without disclosing the name or location, the plants are designated by letters.

It should be distinctly understood that the cost figures are presented as they are furnished by the operators. The committee has not been in a position to verify or question any of the operating costs which are herein presented.

PLANT A.

Details of Plant.

Producers.—There are two 250-h.p. pressure producers, 7 ft. 0 in. inside diameter, with water seal bottoms and 9 in. fire-brick linings, also two wet scrubbers, 7 ft. 6 in. in diameter by 18 ft. 0 in. high, filled with wooden lattice work. There are two dry scrubbers, 7 ft. 0 in. square by 3 ft. 6 in. high, filled with coarse shavings.

Gas Engines.—There is one 500-h.p. horizontal, double-acting, 4-stroke-cycle engine with two cylinders, 23½ in by 33 in., arranged tandem. The engine has three bearings rigidly in line. It runs at 150 r.p.m. and is direct connected to an electric generator. It is started by compressed air at 100 lb. pressure and has an electric ignition of the make-and-break type, the source of supply being a 110-volt direct-current lighting circuit and a motor generator set.

Auxiliaries.

There are two tar extractors and one blower.

Details of Operation.—The data received covered two complete months. The plant is run 24 hours per day from 6 a.m. Monday until 12 p.m. Saturday night, and the current generated is utilized for light and power. During the two months, a total of 308,410 kw-hr. was generated and 35,190 kw.hr. was used in the plant, leaving a net output of 273,220 kw-hr. The fuel used is bituminous coal. The cooling water from the engine is utilized for other purposes and is not, therefore, charged to the plant. The cooling and cleaning water for the scrubbers is not given.

Cost of Operation.

Fuel		$0.2576 per net kw-hr.
Water		0.0000 per net kw-hr.
Supplies, oil	$0.0141	
waste, etc	0.0024	
Total		0.0165 per net kw-hr.
Superintendence		0.0000 per net kw-hr.
Labor, producer room	0.1585	
engine room	0.0555	
electrical	0.0000	
Total		0.2140 per net kw-hr.
Repairs, producer	0.0127	
engines	0.0040	
electrical	0.0000	
Total		0.0167 per net kw-hr.
Total cost		0.5048 per net kw-hr

PLANT B.

Details of Plant.

Producers.—There is one set of producers of the Loomis-Pettibone type.

Gas Engines.—There is one 500-h.p. horizontal, double-acting, 4-stroke-cycle engine with two cylinders, 23½ in. by 33 in., arranged tandem. The engine has two bearings rigidly in line. It runs at 150 r.p.m. and is direct connected to an electric generator. It is started by compressed air at 240 lb. pressure, and has an electric ignition of the make-and-break type, the source of supply being a 110-volt lighting circuit.

Details of Operation.

The data received are for fifteen complete months. The plant is run ten hours per day.

Cost of Operation.

Fuel		$0.4460 per net kw-hr.
Water		0.0879 per net kw-hr.
Supplies, oil	$0.0465	
waste, etc.	0.0335	
Total		0.0800 per net kw-hr.
Superintendence		0.0000 per net kw-hr.
Labor, producer room	0.1603	
engine room	0.2050	
electrical	0.0000	
Total		0.3653 per net kw-hr.
Repairs, producer	0.0243	
engines	0.2375	
electrical	0.0000	
Total		0.2618 per net kw-hr.
Total cost		1.2410 per net kw-hr.

PLANT C.

Details of Plant.

Producers.—There are two sets of producers of the Loomis-Pettibone type and 2000-h.p. capacity each.

Gas Engines.—There are two 1500-h.p. horizontal, double-acting, 4-stroke-cycle engines each with four cylinders, 32 in. by 42 in., arranged twin tandem. Each engine has two bearings rigidly in line. They run at 107 r.p.m. and are direct connected to electric generators. They are started by compressed air and have an electric ignition of the make-and-break type, the source of supply being a motor generator set supplying current at 60 volts.

The information following is taken from the plant's own forms, as due to the supervision of a State Commission they could not use our forms without duplicating the work.

Cost of Operation.

For the Year 1908.

Fuel		$0.566 per kw-hr.
Water		0.000 per kw-hr.
Supplies, oil and waste	$0.044	
miscellaneous	0.013	
Total		0.057 per kw-hr.
Superintendence		0.031 per kw-hr.
Labor, producer room and engine room	0.173	
electrical	0.000	
Total		0.173 per kw-hr.
Repairs, producer	0.006	
engine	0.000	
electrical	0.004	
Total		0.010 per kw-hr.
Total cost		0.837 per kw-hr.

For the Year 1909.

Fuel		$0.439 per kw-hr.
Water		0.000 per kw-hr.
Supplies, oil and waste	$0.029	
miscellaneous	0.016	
Total		0.045 per kw-hr.
Superintendence		0.023 per kw-hr.
Labor, producer room	0.109	
engine room	0.066	
electrical	0.000	
Total		0.175 per kw-hr.
Repairs, producer	0.020	
engine	0.006	
electrical	0.002	
Total		0.028 per kw-hr.
Total cost		0.710 per kw-hr.

For the Year 1910.

Fuel		$0.422 per kw-hr.
Water		0.003 per kw-hr.
Supplies, oil and waste	$0.024	
miscellaneous	0.015	
Total		0.039 per kw-hr.
Superintendence		0.026 per kw-hr.
Labor, producer room	0.102	
engine room	0.063	
electrical	0.000	
Total		0.165 per kw-hr.
Repairs, producer	0.024	
engine	0.004	
electrical	0.005	
Total		0.033 per kw-hr.
Total cost		0.688 per kw-hr.

PLANT D.

Details of Plant.

Producers.—There are two 400-h.p. pressure producers, 8 ft. 0 in. inside diameter with water seal bottoms and with 9 in. fire-brick linings, and two wet scrubbers, 8 ft. 0 in. in diameter by 20 ft. 0 in. high, filled with coke. There are two dry scrubbers, 6 ft. 0 in. square by 3 ft. 6 in. high.

Gas Engines.—There are three 250-h.p. vertical, single-acting, 4-stroke-cycle engines each with three cylinders, 20 in. by 19 in. arranged side by side. Each engine has five bearings rigidly in line. They run at 230 r.p.m. and are direct connected to electric generators. They are started by compressed air at 200 lb. pressure and have an electric ignition of the make-and-break type, two sources of supply being a primary battery and a direct-driven magneto.

Details of Operation.

The data received are for three complete months. The plant was in operation 1,439 hr. during the three months and generated a total of 309,300 kw-hr. The fuel used was No. 1 anthracite buckwheat.

Cost of Operation.

Fuel		$0.2828	per net kw-hr.
Water		0.0000	per net kw-hr.
Supplies, oil, waste, etc.		0.0572	per net kw-hr.
Superintendence		0.0000	per net kw-hr.
Labor, producer room	0.1135		
engine room	0.2640		
electrical	0.0000		
Total		0.3775	per net kw-hr.
Repairs, producer	0.0249		
Repairs, engines, electrical		0.1745	per net kw-hr.
Total cost		0.8920	per net kw-hr.

The cost of coal at the plant given was $2.55 per ton at Plant A; $4.53 per ton at Plant B; unknown at Plant C; and $2.33 per ton at Plant D. Reducing the cost of coal at Plant B to $2.50 per ton, the costs of operation compare as follows:

Plant A	$0.505 per kw-hr.
Plant B	1.041 per kw-hr.
Plant C	0.745 per kw-hr.
Plant D	0.892 per kw-hr.
Average	$0.796 per kw-hr.

TOWN PLANNING SUGGESTIONS FOR CANADIAN MUNICIPALITIES.*

By J. P. HYNES.

Municipal government throughout this continent has long been a reproach upon the ability of a democratic people for self government. Canadian municipalities may not have experienced organized graft to the same degree as their neighbors in the republic to the south, but the congratulation is purely a negative one, for the possibilities of municipal development have not been availed of in Canada any more than they have been in the United Sates. These years of wasted opportunity have been contemporaneous with the virtual re-construction of Paris, Vienna and Berlin, which have respectively lead the cities of their nations in an active rejuvenation.

Perhaps the causes for this state of affairs are too numerous and varied to all be traced, but a few from which perhaps all the others grow may be here stated.

First, the lack of a proper civic sentiment. While the most extravagant bragging is done by the citizens of every municipality on the continent, the single purposed personal service necessary to procure capable and efficient civic government is a duty that they have not yet begun to discharge. Second, the lack of a proper civic ideal. Big is the one civic ideal constantly heard of by business, no matter what degradation follows it, big buildings no matter how humanity suffers for light and air, big population no matter how inadequately housed. In fact in civic matters it is only in regard to the big tax rate that this ideal fails to hold good. Third, the lack of a proper civic foresight. Individuals are permitted to lay out property in city lots for a speculative game and the city accepts them, provided the streets are 66 ft. wide, but the lack of foresight has lost the opportunity to plan the best possible for the growing municipality. Corporations obtain franchises without being forced to co-operate with each other and discharge their duties without disfiguring the city with a constant breaking and repairing of street pavements and the planting of poles and poles and poles, not to mention their accompanying wires.

Municipal councils use false economy and show a lack of faith in their own town by making temporary instead of permanent improvements, and last but not least fail to recognize the financial value of beauty despite the fact that it is one of the chief revenue producing assets of European cities.

The basic unit considered in city planning is the family and it is the aim of civic improvement to provide every facility in its power for that unit's best development. The success of civic improvement may be judged by the measure in which it provides such facilities to the units with means to procure them for themselves. After providing water and sewers, the most pressing requirement is transportation, both freight and passenger, and it is here that city planning plays a large part, for this requirement is more a matter of plan than equipment.

The next important measure is for the municipality to procure for itself, as far as possible, the increased value of property and franchise created by its growth. This is largely done in Europe by the municipality being a large landlord and by having the powers of excess condemnation.

The wave of agitation for civic improvement which has swept the continent since the Chicago World's Fair has had two developments, first for an economic and artistic physical development of cities on the one hand, and second, a more responsible executive administration on the other.

The first is exemplified to a greater or less degree in innumerable places, but most notably in Harrisburg, Des Moines, Philadelphia and Cleveland, while more than a hundred American cities have adopted commission government and St. John, N.B., in our own country, in an endeavor to procure more efficient civic administration.

In conclusion may I recommend to your association the advisability of urging upon this province of Ontario to take a leaf from our sister province of Saskatchewan and establish a municipal department that will act as a clearing house for the diffusion of the tried and proven ideas in civic improvement, both in physical development and executive administration, as a town planning commission. To insist on private property being developed to the best advantage of the municipality as a whole and on public service corporations performing their services without temporarily or permanently disfiguring the city they are chartered to serve.

In England this work is now largely done by the local government board, and it is for such bodies as yours to urge our provincial government to do its duty in regard to municipalities. The manner in which the government now promotes good roads is an evidence of what it could accomplish on behalf of municipalities.

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*Delivered to meeting of Ontario Municipal Association Aug. 31, 1911.

NEW ENGINES.

New developments with regard to the employment of oil engines for marine work in Great Britain are now proceeding apace, and the next six or twelve months may possibly open out a new era in marine propulsion. The admiralty has ordered a 6,000 horse-power Diesel engine, which is to be placed in existing twin-screw cruisers in substitution for one-set steam engines.

GERMAN ACCIDENT STATISTICS.

The German Street and Interurban Railway Association (Verein Deutscher Strassenbahn-und-Kleinbahn-Verwaltungen) has prepared an interesting summary of electric railway accidents in Germany during the years 1905 to 1909, inclusive, for exhibit at the International Exposition of Hygiene, which is being held in Dresden. The following is an abstract of the data presented, together with a selection of the most striking charts, the originals of which were prepared in color. The report states that the total route length of the street railways in Germany amounts to 4,000 km (2,480 miles), of which 3,875 km (2,403 miles) are electrically operated. The members of the association operate 3,772 km (2,339 miles). The accident statistics cover the operations of lines having a route length of 3,658 km (2,278 miles), equivalent to 95 per cent. of all the electric street railway mileage in Germany.

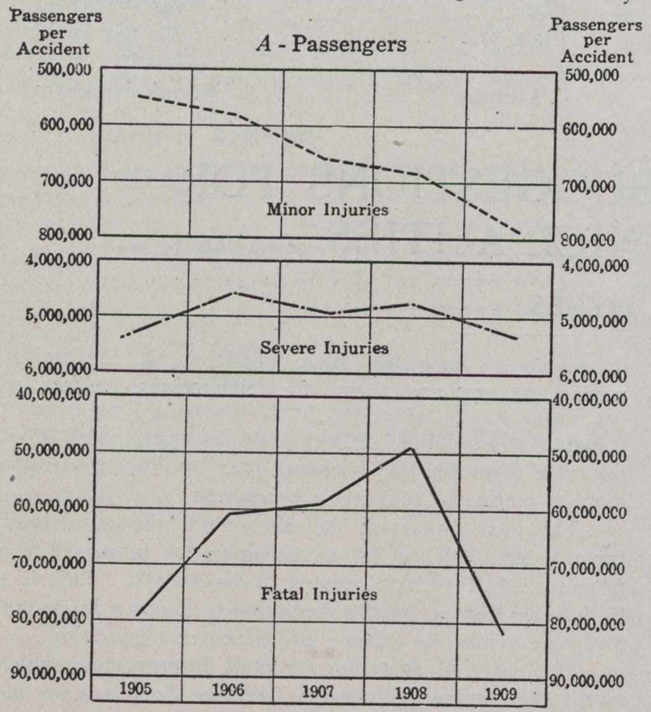

Fig 1. —Accidents per Passenger from 1905 to 1909.

The statistics, as gathered by the association, show that injuries are more frequent to passengers than to pedestrians and other non-passengers, but that a greater proportion of the non-passenger accidents are fatal. Thus the percentage of slight injuries was practically equal for both classes, but 6 per cent. of non-passengers' injuries resulted in death as compared with 1 per cent. of passengers' injuries.

Fig. 1 shows the fluctuations and the number of passengers carried per accident during the five years from 1905 to 1909, inclusive. It will be noted that there has been a great reduction in the number of minor injuries. On the other hand, the severe accidents and fatalities have increased. A set of similar curves (not reproduced) shows that there have been no important changes in the number and classes of accidents to non-passengers on the basis of mileage operated.

Fig. 2 is a chart which shows by differently sectioned areas the division of responsibility for accidents, the proportion of each class of accident and the results to the person injured. In the case of passengers an overwhelming percentage of accidents was due to negligence in boarding and leaving the cars, although some were also caused by leaning beyond the clearance lines of the windows and platforms. Most of the accidents to non-passengers resulted from either negligence in crossing the track of from side-wipes on devil strips, etc. Of every 100 fatal accidents to passengers ninety-four were due to carelessness of the passenger, four to the railway and two to causes beyond the control of both parties. In the case of non-passengers the responsibility for fatal accidents averages as follows: Non-passengers, 94.8 per cent.; railway, 4.5 per cent., and other parties, 0.7 per cent.

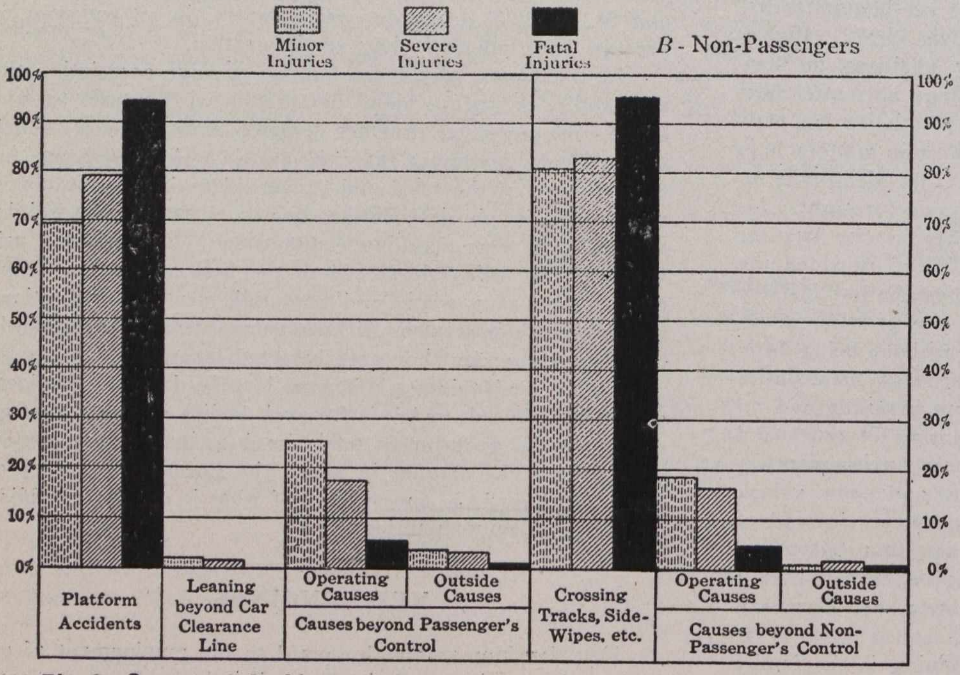

Fig 2—Causes of Accidents to Passengers and Non-Passeng ers.

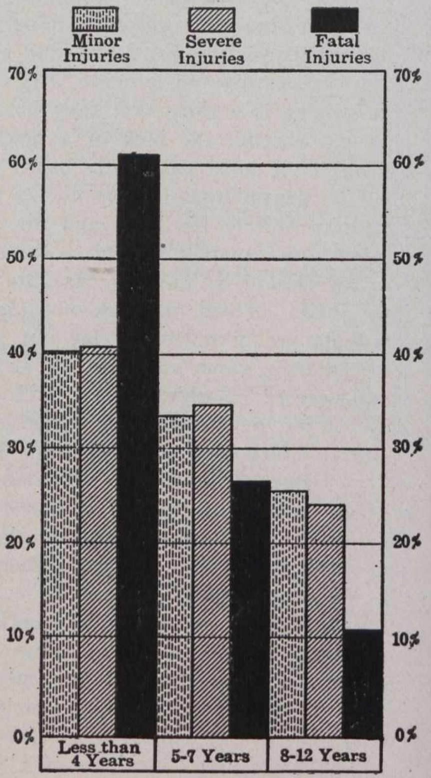

Fig. 3—Accidents to Children.

Fig. 3 is an analysis of accidents to children caused by trespassing on the tracks. This chart indicates that by far the greater percentage of fatal accidents occurs to children of less than four years of age. In fact, the deaths in this classification of accidents exceed either the minor or severe injuries by 20 per cent. or more. These tragic figures are cited to prove the need of giving children some safer playgrounds than the public highways. Similar curves (not reproduced) show that the greatest proportion of platform accidents to adults and of accidents to adult non-passengers occur to people between the ages of twenty-six and forty.

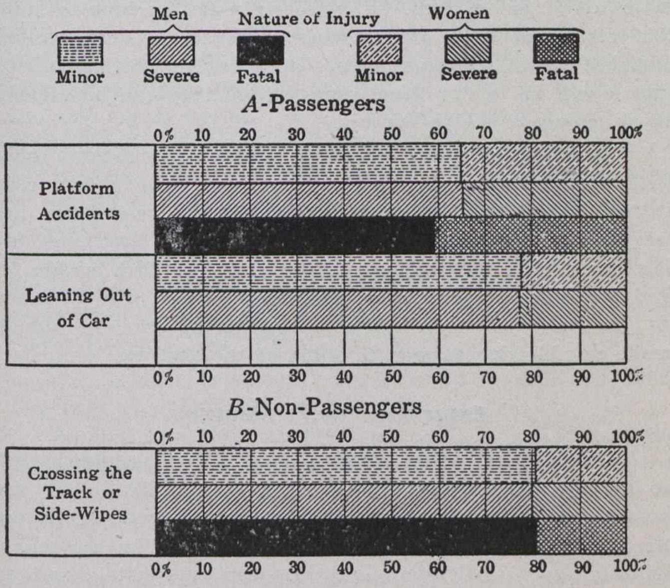

Fig. 4—Accidents to Adults.

Fig. 4 shows a division of accidents to adult passengers and adult non-passengers arranged according to sex. The comparatively large proportion of boarding and alighting accidents to women may be explained perhaps by the circumstances that in Germany a limited number of street railway passengers may stand on the platforms, but no one is allowed to stand inside the car. Consequently there is a temptation for a platform passenger, who is standing near the step, to alight before the car stops, and in this women are well known to be less expert than men. In general, however, women are far more cautious than men in avoiding accidents, as is shown by the general comparisons in Fig. 4.

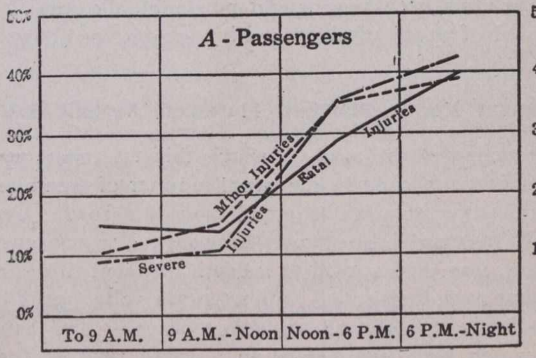

Fig. 5—Time of Accidents to Passengers.

With respect to the distribution of accidents to passengers and non-passengers according to the time of the year, it is a remarkable fact that in both cases the smallest number of accidents occur during the dangerous winter months of December to February. This leads to the conclusion that the presence of ice and snow makes the necessity for caution so apparent to passengers that the number of accidents is actually less than in months with more favorable weather. So far as the non-passengers are concerned the reduction in accidents during the winter months can be ascribed largely to less travel on the streets. The heavy passenger death rate from September to November is accounted for by fog and rain which causes people to lose their footing in getting on or off the cars.

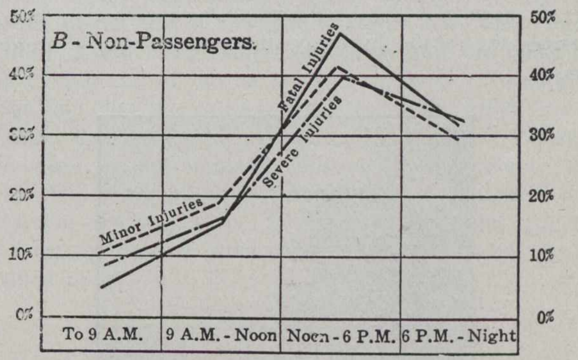

Fig. 6—Time of Accidents to Non-Passengers.

Figs. 5 and 6 show the proportions of accidents to passengers and non-passengers respectively for different hours of the day. In both classes most of the accidents occur in the afternoon and evening. It is not clear why this should be so in the case of passengers, but so far as non-passengers are concerned it may result from the greater crowding on the streets in the late hours of the day.

In addition to these accident charts others were presented detailing the nature and percentage of each kind of injuries. The charts were accompanied by a description of the efforts made by the street railways of Germany to equip their cars with safety apparatus and to train their employees in accident prevention. It was stated that on an average not more than one-fourth of the accidents to non-passengers could have been avoided or ameliorated by the use of fenders or wheelguards. The report concludes with an appeal to the public to co-operate in the reduction of accidents by the exercise of greater care in boarding and in leaving cars and also in crossing street railway tracks.

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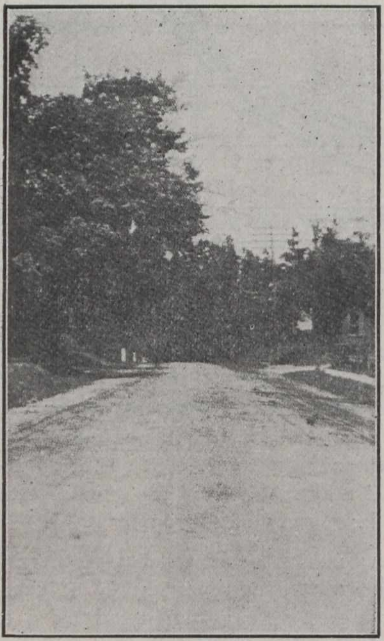
A STANDARD PORTLAND CEMENT SPECIFICATION.

A standard Portland cement specification for all United States government work is being looked into by a special committee of government engineers, which has been meeting during the past summer. This committee was appointed to draw up a tentative specification by a conference of government engineers, that first met in Washington, D.C., on June 17, 1911. The draft of this specification was submitted later to the conference and proved acceptable in most particulars. The committee was then instructed to consult with the American Society of Civil Engineers, the American Society for Testing Materials and other similar bodies as to the practicability of developing a uniform specification that might become a generally accepted standard throughout the United States. Such consultation is now in progress. The committee is composed of A. P. Davis, Chief Engineer, U.S. Reclamation Service; J. C. Plant, Supervising Architect's Office; Captain W. R. Rose, Corps of Engineers, U.S.A.; Lieut. C. A. Carlson, Corps of Civil Engineers, U.S.A.; S. S. Voorhees, Bureau of Standards; A. E. Phillips, Superintendent of Sewers, District of Columbia, and R. J. Wig, Bureau of Standards.

THE OHIO STATE EXPERIMENTAL ROAD.*

The State of Ohio has been exceptionally progressive in the matter of investigating new and improved methods of road construction, as well as in constructing by means of the "state aid" plan. Such roads are conceded to be equal to any to be found in the United States. Intelligent, honest effort to ascertain the best forms of construction has characterized the state highway department for a number of years.



Section I. Glutrin.
Ohio State Experimental Road.

In accordance with this principle of investigation it was decided in 1909 to construct an experimental road, upon which were to be laid sections of the various kinds of preparations for preventing dust and binding sections of macadam roads. This work was undertaken through the efforts of James C. Wonders, at that time highway commissioner, and an appropriation was made by the legislature to carry on the work. A section of old macadam road was chosen for the experiment.

In preparing for the work, letters were addressed to the different firms advertising road-building materials, and they were advised of the intention to build this experimental road and of its scope and purpose, and the hope was expressed that all manufacturers would show their confidence in their product by participating in the work. With few exceptions the firms addressed complied with the request and applied their materials on the road. The highway department paid for all labor and materials required in the work, but stipulated that each firm should furnish an expert to superintend its particular section, in order that the work should be constructed exactly according to the manufacturer's ideas. In addition to the above-mentioned work, a few sections were constructed using Portland cement as a binder.

The surface of the road was carefully leveled, and it will be possible to ascertain the amount of wear by releveling at various times.

In 1910 an official inspection of the road was made and photographs were taken to show the progress of wear on the different sections. Since that time no inspections have been made by the highway department, though D. W. Seitz, who has been connected with the experimental work since its start, states that an inspection will be made this fall and at succeeding intervals until the results are fully determined.

At the present time the road shows a marked differentiation between the classes of treatments used, though the distinction between the different kinds of the same class of materials is not evident. It is possible at this time to state that certain sections are showing evidences of deterioration and that others are "holding up" to a degree which indicates that it will be two or three years before they can be divided so as to say which is the best.

There are seventeen sections in this experimental road, each section being of sufficient length to give a fair trial. In the description and comment that follow, the sections are taken up in the order in which they occur, the first three being north of a little village, the fourth and fifth within it, and the other twelve being south and in the open country. A nine-ton road roller which passed during the inspection made notable depressions in some of the sections.

Experiment No. 1—Glutrin.

This material was applied on a well-constructed, two-course macadam road that had been thoroughly rolled and bonded. Glutrin is prepared from materials produced during the manufacture of cellulose. It is described by the manufacturers as a "calcium-magnesium-ligno-sulfonate, and at the specific gravity of 1.26 at which it is sold, contains probably about 18.00 per cent. of glucosides." It is a viscous liquid, soluble in water, and in addition to its binding qualities, it is said to form a chemical action upon the road material that increases the flow of the binder, which results from the action of water upon the road metal.

The surface of the macadam was sprinkled with water, and while it was still damp, glutrin was applied by sprinkling with an ordinary road sprinkler. Two applications were made, a day elapsing between the first and second applications. The road was ready for travel in four hours after each application.

Except for a somewhat dusty condition the road is compact and solid and has much the appearance of water-bound macadam, though it is brownish in appearance. The application of glutrin each year would no doubt alleviate the one objectionable feature of dust. Photograph 1 shows this section.

Experiment No. 2—Standard Macadam Asphalt Binder.

The section of the road on which this treatment was applied was first prepared in the usual manner of treatment for the lower course of a water-bound macadam road. Crushed limestone, ranging in size from three inches to one and one-half inches, was then spread to a depth of about three inches. This course was then rolled with a ten-ton roller until it presented a fairly smooth and uniform surface. The asphaltic binder, which had been heated in a small tank at the side of the road, was then applied by means of hand sprinkling cans. About one and one-half gallons of the binder was used for each square yard of surface treated. Screenings varying in size from one-half to three-fourths of an inch were then spread upon the road and the roller again brought into use. Additional screenings were added where the binder appeared on the surface, and this work of rolling and adding screenings continued until no more binder appeared on the surface. On a portion of this section a second coat of the

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*From Municipal Engineering.

binder, consisting of from one-fourth to one-half of a gallon per square yard was applied, followed by another coat of screenings and more rolling.

Experiment No. 3—Pioneer Asphalt Cement.

The material used as a binder in this experiment is refined rock asphalt mined in Utah. In the construction the foundation course was finished as a water-bound macadam road, thoroughly rolled and bonded. The second layer was composed of stone ranging in size from one and one-half to two and one-half inches. This was rolled to a finished depth of about two inches, no water being used. One-half to three-fourths inch screenings were broomed into the surface in a quantity sufficient to reduce the voids about 50 per cent. The asphaltic cement was then poured at a temperature between 390 deg. and 410 deg. F., until all of the stone was thoroughly coated. When the coating had cooled, a thin dressing of screenings was sprinkled over the surface. These screenings were sprinkled but a short distance ahead of the roller, which followed immediately after the screenings were placed. The screenings were sprinkled at first in a thin layer, and as the rolling proceeded more screenings were added, until the coating had absorbed all the screenings which it was possible to absorb. The quantity of the binder used was one and one-fourth gallons per square yard.

The surface is smooth, dustless and in excellent condition with no excess of binder.

Asphalt has been forced to the surface to a degree that it has flowed to the side of the road. The temperature at the time of inspection was only about 85 degrees and yet the imprint of the horses' hoofs was plainly visible at points on the surface where the asphalt had exuded to a great extent. Excepting for these points the surface is hard and dustless. Photograph 2 shows this section.

Experiment No. 4—Tarvia "X"

In the preparation of Tarvia X, ordinary coal tar is heated to drive off the water and ammonia. The road was prepared for this treatment in a manner similar to section No. 3, except that the stones in the top course were from 1½ to 3 inches in size. No screenings were used. When this course was thoroughly dry, the refined tar, under pressure, at a temperature of from 250 deg. to 300 deg. F., was spread over the surface by means of a hose attached to a tank wagon. The tank was hauled by a steam roller to avoid the displacement of the stone that would be caused by horses' feet. By the use of the tank wagon the tar was kept heated and under pressure, and this method of applying the tar greatly facilitated the work. The time required for one pouring over the entire section was about one-half hour.

This section shows evidences of dust, due, doubtless, to the fact that a number of cross-streets in the village contributed a portion of their surface. The larger stones are in places exposed and worn, but were held firmly in place. Photograph 4 shows this section.

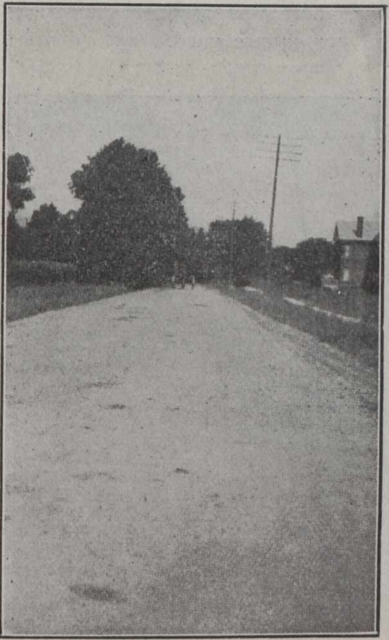
Experiment 5—Tarvia "B."

This material is a tar preparation that may be applied without heating. In this instance it was placed on a macadam road that had been filled and rolled, but had not been watered, and had been under travel for about two weeks. In making the application, all of the dust and dirt was carefully swept to the sides of the macadam, and on the clean surface the binding material, which had been heated for this work, was applied by means of the same tank wagon that was used for Tarvia "X." Two-thirds of a gallon was used per square yard. As soon as the Tarvia had been applied the dust that had been removed from the road was swept back over this surface.

This section is in excellent condition—superior, in fact, to the section just mentioned. It is hard, perfectly smooth and dustless.

Experiment No. 6—Liquid Asphalt.

The material used in this section is the Indian Refining Company's heavy asphalt binder, said to contain 90 per cent. asphalt. It was shipped in barrels and was heated for use on the road in a large heating tank. The barrels were rolled on skids to the top of the heating tank, and when in place one head of the barrel was knocked in and the material allowed to flow out of the barrel thus opened. Notwithstanding the fact that the weather was very warm while this work was being done, the material was so heavy that it flowed very slowly, and several minutes were required to empty a barrel in this manner. The material was heated to a temperature of about 200 deg. F. and applied to the road under conditions similar to those used for the "Pioneer asphalt," described above.



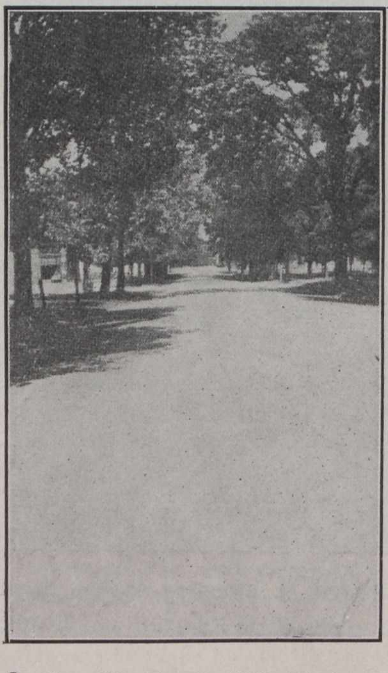
Section II. Standard Asphalt Binder.
Ohio State Experimental Road.

The larger stones are exposed in this section, but there are no signs of loosening or raveling. The surface is dustless, hard and smooth.

Experiment 7—Ugite.

The material used in this treatment is said by the manufacturers to be a true tar, made by treating water gas tar in such a manner that the hydro-carbon compounds of the paraffins in the water gas undergo a chemical change, resulting in the production of a true tar, without producing free carbon, which is commonly found in the coal gas tars; consequently, a material that does not have the deep black color of the ordinary tar. The treatment was applied in two different ways, as follows:

At the beginning of the section, extending south for a distance of 273 feet, after rolling in sufficient ¾-inch stone in the top course to bind it well, 2.05 gallons of the tar were poured on the road, at a temperature of 240 deg. The maximum air temperature during this work was 87 deg., the minimum 75 deg., and the mean 81 deg. F. The tar was heated in a small heating tank placed at the side of the road, and the average rate of application on this part of the section was about 1,200 gallons per day. After pouring the tar on the road a small quantity of ¾-inch stone was then applied, just sufficient to keep the roller from the tar compound, and the surface was well rolled. Stone chips about ½ inch in size were then spread on and well rolled in. A light coating of ¼-inch screenings and dust was put on, to protect the road surface until the compound had a chance to get set up. This was rolled until firm. On the remainder of the section, 127 feet in length, the compound was applied in two coats. On the top course of stone, which had been filled previously with ¾-inch stone, well rolled in, 1.67 gallons per square yard was poured, at a temperature of 250 deg. F. This was applied at the rate of 1,000 gallons per day. Sufficient ¾-inch stone was spread over the surface to keep the roller from sticking and was well rolled in. A surface coating of .44 gallons per square yard, at a temperature of 280 deg. F., was then put on at the rate of 3,000 gallons per day. One-half inch chips were put on and well rolled in. This was followed by a light coating of ¾-inch screenings and dust, to protect the road surface while setting up. On this section, therefore, there was applied a total of 2.11 gallons of the compound per square yard.



Section IV, Tarvia "X" Binder.
Ohio State Experimental Road.

The weather conditions during the construction of the second part of this section were slightly unfavorable, due to a shower at night, which delayed the completion of the rolling of the section.

This section seems to be in the same condition throughout, no difference being evident, due to the two methods of construction. At one point on the road, where the seepage water from an overhead railroad crossing had dripped on the road surface, the binding material has been entirely removed from about the stones, leaving them entirely exposed. This erosion may be due to the fact that the water has dropped through a distance of about 15 feet, and may not indicate that the binding material is likely to be washed away when ruts and hollows furnish an opportunity for the water to act on the road surface.

Experiment No. 8—Fairfield Asphalt Cement.

This material, which is described as a refined asphaltic cement, was applied to the top course of a two-course macadam road. This top course consisted of stone from 1½ to 3 inches in size, in a layer 4 inches thick, and it was thoroughly rolled before applying the asphalt, but without any screenings or other filler. The asphalt was heated in a small heating tank at the side of the road and applied on the road by the use of buckets. The work was done about the first of August, when the weather was extremely warm. The asphalt had been shipped in barrels, and it was so heavy and viscous that in order to remove it the barrels were cut in halves with axes, and on account of its adhering to the staves it was frequently necessary to throw them into the heating tank to save the material. After the asphalt had been applied, stone chips, varying in size from ½ to ¾ of an inch, were applied to the surface of the road to a depth of about ½ inch. This was then thoroughly rolled, the chips being forced into the voids of the macadam, and also forming a surface over the top which prevented the asphalt sticking to the roller. When this rolling was completed, the road was ready for travel.

This surface is in splendid condition, and even under the weight of the 9-ton roller mentioned, it did not show marked depressions where the calks on the wheels had pressed.

Experiment No. 9—Asphaltoilene.

In the manufacturer's description of this material it is stated that it "is made from a heavy natural oil with an asphalt base and not containing paraffin. This natural oil contains so little of the illuminating oils or valuable products that it is not worth refining for their extraction. It is, therefore, never 'cracked' or coked, but contains a high percentage of liquid asphalt with sufficient oil to act as a solvent and vehicle."

This material was applied on a macadam road prepared after the manner of experiment No. 8, excepting that the stone in the top course ranged in size from 1 to 2½ inches. The material was heated in a small heating tank placed at the side of the road and poured on the road with buckets.

After the asphaltoilene had been applied, ½-inch stone screenings and dust, in about equal parts, were spread over the surface of the road to a sufficient thickness to fill the voids and make a smooth and uniform surface, and the road was rolled until it was thoroughly consolidated and the asphaltoilene showed a tendency to stick to the wheels of the roller.

This section showed plainly the marks of the traction engine wheels, and also the prints of horses' hoofs, much after the manner of an asphalt pavement. The surface is smooth and dustless.

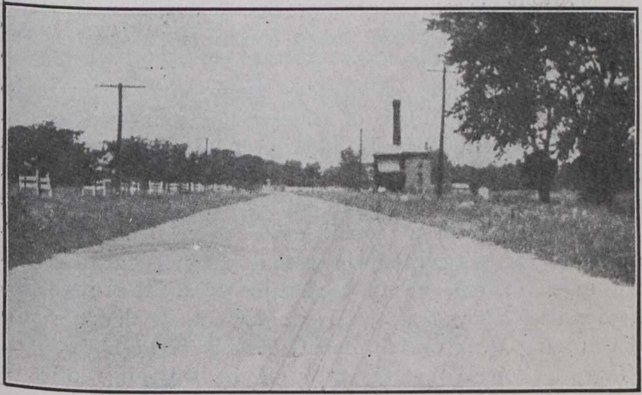
Experiment No. 10—Wadsworth Macadam.

This material is Kentucky rock asphalt, very finely ground. It was applied on the top course of a macadam road, prepared after the manner of experiment No. 9. About one inch of the asphalt was spread over the surface of the stone and evenly distributed with hand rakes, and then thoroughly rolled with a steam roller, forcing the asphalt into the spaces between the stones. This probably penetrated beneath the surface of the stone for an inch or more. After this had been thoroughly rolled, another layer of about one inch of asphalt was spread, and this was again rolled thoroughly. This material was applied in warm weather, but without artificial heat. When first completed the road tracked very readily; horses' feet and the wheels of vehicles marked it in such a manner that it seemed that it would soon be destroyed. After a few weeks of travel, however, the surface began to get firmer, and in a short time became very smooth.

It is said that for some time after the completion of this section, the surface was so soft as to be easily marked by horses' hoofs and buggy wheels. At the present time the surface is excellent. It is as smooth and dustless as an asphalt pavement, and even under the weight of the 9-ton engine it showed very little evidence of depression from the wheel calks, and absolutely no trace of any cutting of the surface.

Experiment No. 11—Carbo-Via.

This material is a refined coal tar product. It was applied on a macadam road prepared after the manner of experiment No. 9. The material was heated to a temperature of about 300 deg. F., in the same tank that was used for experiment No. 9, and was poured on the road with hand sprinkling cans. In making the first application about 1½ gallons per square yard were poured. Immediately after the pouring the surface was rolled with a steam roller, the wheels of the roller having been oiled with an emulsion of kerosene and water, to prevent the carbo-via from adhering to the roller. After this rolling, a thin layer of stone chips was swept into the voids, and the surface was again rolled. About ½ gallon of carbo-via per square yard was then applied and rolled as before and covered to a depth of about ¾ inch with stone screenings and dust.



Section XI. Carbo-Via Binder.
Ohio State Experimental Road.

This section is hard and comparatively smooth, as is shown in paragraph 11, not entirely free from dust.

Experiment No. 12—Concrete Macadam.

The construction of this section was practically the same as that of a water-bound macadam road, except that Portland cement was mixed with the screenings for the binder of the top course, with the expectation of increasing the cementing power of the stone dust. The cement was mixed with the dry screenings in the proportion of one part cement to six parts of screenings. The mixing was done by hand on board platforms placed at the side of the road, the mixture being turned until it was of a uniform color. Upon the lower course of macadam, which had been shaped, rolled and thoroughly bonded, was spread a layer of limestone varying in size from 1½ to 3 inches, to a depth of about 3 inches. After this course had been thoroughly rolled, the above described filler was applied dry, using a spreading motion of the shovel, the rolling being continued during the process of filling until all the voids were completely filled. Water was then applied and the rolling continued until a wave of grout was produced in front of the roller over the entire surface. This section was closed against travel and the surface was kept damp by repeated sprinklings for several days after the work had been completed.

This section has much the appearance of water-bound macadam; in fact, the addition of the cement seems to have added nothing to the merits of the road. An excess of dust made it necessary to treat the surface with calcium chloride.

Experiment No. 13—Taroid.

Taroid is described by the manufacturers as being "a coal tar pitch prepared in liquidized form as a binder." The lower course, or base, for this section was shaped up with rather small size stone, filled and thoroughly rolled. The stone for the top course varied in size from 3½ inches to 1½ inches. This stone was spread to a depth of about 3 inches. The method of treatment was similar to section No. 3. From 1 to 1½ gallons of hot taroid was poured on each square yard of surface. This pouring was done by hand, 4-gallon galvanized pouring cans, equipped with fan-shaped nozzles, being used. After the taroid had partly cooled the surface was well rolled. Coarse torpedo sand was then spread over the entire surface and the road was again rolled, which completed the treatment.

An excess of tar has resulted in "bleeding," both on the surface and at the sides of the roadway. The surface is not entirely smooth, by reason of the fact that the tar has not been forced to the surface uniformly, but has come out in such a way as to form small ridges or knobs on the surface.

Experiment No. 14—Petrolithic Pavement.

This process of road treatment was introduced by the Petrolithic Pavement Company, of Los Angeles, Cal., who incorporate a heavy asphaltic oil into the road material by means of various tools and devices, some of which are patented by the company. The tamping roller is an important factor in the construction of this type of roadway. It consists of a roller about 3 feet in diameter whose surface is studded with iron teeth 9 inches in length and having an end area of about 4 square inches. The action of these teeth on the road material is said to approximate that of a flock of sheep, and to produce a tamping, puddling and kneading action which compacts the lower portion first and gradually works the material into so compact a mass that the teeth or feet of the roller will finally ride on the surface without penetrating or indenting the roadway. The old macadam roadway where this section was constructed was first broken up with a rooter pulled by a steam roller and the loosening completed by turning with a common road plow pulled by horses. The loose stone was then smoothed with a heavy "A" harrow. The California liquid asphalt heated to a temperature of 200 deg. Fahrenheit was then applied by means of a Petrolithic Glover road oiler. Three applications of one gallon each per square yard were made. The mass was then mixed by means of the petrolithic road cultivator and tamped and compacted by means of the petrolithic rolling tamper. A road grader was used to crown and shape the roadway. After the work of tamping had been completed a small amount of limestone screening was applied and the surface was smoothed with a steam roller. A fourth application of the asphalt consisting of about one-half gallon per square yard was used, the surface covered with limestone screenings and again rolled.

During the summer following the construction of this road, the asphalt was forced to the surface to a degree that it became very objectionable and vehicles chose to travel at the side of the road rather than over the roadway. The highway department caused a course of screened gravel to be rolled into the road in an effort to make the road passable. At the present time, in spite of this treatment, the road is in wretched condition. It is so soft that it shows the imprint of a shoe heel when walking over the surface and the traction engine had cut in so deeply as to make even the imprint of the tires plainly marked. The road surface is spongy and deeply rutted.

Experiment No. 15—Limestone Concrete.

This section was constructed of concrete made of crushed limestone and Portland cement rolled in place with a steam roller. The foundation was prepared by grading and shaping the old macadam road to give it the cross-section desired for the surface of the finished work. It was well rolled before placing the concrete. The concrete was made in the proportion of 1 part cement, 3 parts screenings, ranging in size from ½ inch to dust, and 6 parts limestone from 1 to 3 inches in size. It was machine mixed. Water was used very sparingly on account of the impossibility of rolling wet concrete. It was difficult to secure a concrete mixer for this small amount of work, and the machine that was obtained was not of sufficient capacity to produce the quantity that would secure best results. Owing to the slowness of the work, the roller was obliged to work over such short spaces that in part of the work a wavy surface resulted. If the work had been done more rapidly a much better surface would have been secured. The concrete was uniformly 6 inches deep and had vertical joints across its width at several places.

This pavement is cracked, and is rapidly wearing at points where the batches of concrete have been joined. It is, of course, hard and dustless.

Experiment No. 16—Gravel Concrete.

This section was constructed as an experiment to demine the utility and economy of gravel concrete for construction of highways in localities where a good quality of bank gravel is found. The concrete used in this section was made from unscreened pit gravel and Portland cement in the proportion of one barrel of cement per cubic yard of concrete. The concrete, which was a wet mixture, was placed on the road 6 inches thick, and the surface was formed by dragging a template over it. This method of construction was used in order to secure a concrete at a low cost that would be uniform in quality from top to bottom, with a surface that would not be slippery. The principal objection to rich concrete for paving has been its slipperiness. This work was made without joints and is in reality a slab 6 inches thick, 16 feet wide and 400 feet long.

This section is in better condition than section 15. Where expansion cracks have formed there is no evidence of widening. It seems to possess a greater hardness than the preceding section.

Experiment No. 17—Water-bound Macadam

This section was constructed in accordance with the specifications for water-bound macadam now in use by the State Highway Department. The road is built in two courses, the methods employed on the two courses being identical. The stone ranged in size from 3 inches to 1½ inches. The stone was first rolled dry until there is no longer any waving or creeping movement, and the voids are reduced to a minimum. Dry screenings varying in size from ½ inch to dust were then applied during the finishing process of dry rolling. When the voids were completely filled water was freely applied and the rolling continued until a wave of limestone grout appeared in front of the roller as it passed over the surface. After the surface has been treated in this manner it is allowed to dry out or set before traffic is permitted to pass over it.

This section is excellent macadam and is as hard and smooth as a floor, but it possesses the one common bad feature of macadam: it is very dusty.

Although the experiment has not progressed to a point where the merits of the different treatments may be accurately determined there is a process of elimination going on which will doubtless indicate two or three of the sections as the best. At the present time it is impossible to draw an accurate conclusion. The experiment is practically ideal in the one particular that a road was chosen which, while it has only a moderately heavy traffic, carries all classes of country road traffic from the loaded farm wagon to the "joy riding" automobilist.

ONTARIO'S MINERAL OUTPUT

Returns to the Bureau of Mines show that the output of the metalliferous mines and works of Ontario for the six months ending June 30th, 1911, was as follows:—

	Quantity.	Value.
Gold, ounces	2,276	$ 42,320
Silver, ounces	15,231,969	7,644,200
Copper, tons	4,418	631,827
Nickel, tons	8,418	1,809,759
Iron ore, tons	94,803	239,114
Pig iron, tons	255,303	3,823,593
Cobalt and nickel oxides, pounds	219,584	64,876

Compared with the corresponding period of 1910, the above figures show the following increases:—

	Quantity.	Value.
Gold, ounces	2,275	$ 42,320
Silver, ounces	2,417,142	1,376,670
Iron ore, tons	55,306	126,032
Pig iron, tons	33,585	382,905

And decreases as follows:—

Copper, tons	216	$ 28,670
Nickel, tons	921	196,901
Zinc ore, tons	576	5,000

In quantity the shipments from the silver mines amounted to 12,113 tons, of which 7,733 tons were ore and 4,380 tons concentrates. In addition 1,302,699 ounces bullion were sent out. For the first six months of 1910 there was shipped of ore 12,041 tons and 2,763 tons concentrates. There is, therefore, a considerable falling off, so far as shipments are concerned, in actual weight, but a decided gain in value. Taken in connection with the increase in shipments of concentrates, this would indicate that the mines are confining their ore shipments largely to high-grade, and putting the lower qualities through the stamping mills.

Gowganda sent out 110 tons of ore and two tons concentrates, and South Lorraine 216 tons ore, the whole containing 430,540 ounces of silver.

The yield of gold is still small, production at Porcupine being delayed by the disastrous fires, which destroyed the plants at the Hollinger and Dome mines.

TIMBER USED BY MINING COMPANIES.

The Forestry branch of the Department of the Interior has been collecting statistics of the amount of timber used by mining companies. During the past year mines to the number of 136 have used considerable quantities of timber annually in their operations. Unsawn timber was used to the extent of 52,848,000 lineal feet and cost an average of $9.90 per thousand, 22,305 board feet of sawn lumber and timber were used worth $13.63 per thousand. The total quantity of timber used cost $827,000. The round timbers varied in diameter from 3 to 36 inches and were used mostly underground as mine supports to give artificial support for insecure roots and walls and to protect shafts, drills and gangways. Ordinary lumber constituted most of the sawn timber and was used above ground for building, etc. Mines use species of wood which are abundant, cheap and easily obtainable from near-by localities. Thus in each province certain species were used to the exclusion of all others. British Columbia used all the fir. Nova Scotia used all the spruce, balsam and hemlock. Alberta used all the jack pine, larch and poplar. These three provinces contain the principal coal mines and consume over 95 per cent. of Canadian mining timbers. The ore mines of Ontario, although many in number, used only 1 per cent. of the total. These mines are small, shallow and in the solid rock, so that little timber is required for supports.

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the Interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Managing Director.—James J. Salmond.
Managing Editor.—T. H. Hogg, B.A.Sc.
Advertising Manager.—A. E. Jennings.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	**$3.00**	**One Year**	**$3.50**
Three Months	**1.00**	**Six Months**	**2.00**
Six Months	**1.75**	**Three Months**	**1.25**

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone, Main 7404 and 7405, branch exchange connecting all departments.

Montreal Office: B33, Board of Trade Building. T. C. Allum, Editorial Representative, Phone M. 1001.

Winnipeg Office: Room 404, Builders' Exchange Building. Phone M. 7550. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 21. TORONTO, CANADA, SEPT. 21, 1911. No. 12

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CANADA'S APPALLING FIRE WASTE.

The fire losses in Canada for the first eight months of the current year total $15,381,825, an average of $1,922,728 per month. This is equal to a daily loss of $63,299. In other words, $2,637 worth of property has been burned every hour since the new year dawned, or $44 every minute. This is an appalling fire loss, and little is being done to check such extravagant waste of capital. The losses during 1909 and 1910 are as follow:—

Month.	1909.	1910.
January	$ 1,500,000	$ 1,275,246
February	1,263,005	756,625
March	851,690	1,076,235
April	720,650	1,717,237
May	3,358,276	2,735,535
June	1,360,275	1,500,000
July	1,075,600	6,386,674
August	2,582,915	1,667,270
September	1,615,405	894,125
October	2,208,718	2,195,781
November	935,191	1,943,708
December	1,433,813	1,444,860
Total	$18,905,538	$23,593,315

Adding to these figures the total for the first eight months of 1910, we have a fire loss in thirty-two months of $57,880,678, an average monthly loss of $1,808,771. In addition, there has to be recorded a disastrous list of fire fatalities. Last month in Canada twenty-two people met their death in fires. During the first eight months of the year 250 lives were sacrificed in the same manner. In the thirty-two months since January, 1909, no less than 728 persons lost their lives in fires, a monthly average of almost 23 persons. The following table gives the details:—

Month.	1909.	1910.	1911.
January	16	27	27
February	8	15	12
March	16	20	18
April	18	37	20
May	21	15	28
June	16	52	13
July	4	15	110
August	17	11	22
September	10	10	..
October	26	16	..
November	34	19	..
December	33	19	..
Total	219	256	250

Carelessness has been responsible for the greater part of this loss of life and property. For instance, of the 22 deaths last month, 7 were caused by stove, spirit lamp and coal oil explosions and 3 by clothes catching fire. The presumed causes responsible for fires during August and the number of fires for which they accounted were as follows: Ten, lightning; eight, incendiarism; five, defective wiring; four, bush fires; three, spontaneous combustion; three, careless with cigars and cigarettes; two, forest fires; two, careless with matches; three, oil stoves upset, and one each of the following: Defective gas plate, smoking in bed, defective drying-room, spark from threshing machine, defective auto lamp, rats and matches, asphalt boiling over, sparks from engine, film coming in contact with electric wires, gasoline explosion, hot ashes, sparks from mill, overload of current, grass fires, kerosene explosion, grease boiling over, hot box.

The National Board of Fire Underwriters of the United States, continuing its plan of education on the need of better protection, issued an exhaustive classification of fire losses in 1909, showing why the insurance companies are forced to ask higher rates in America than in Europe, and why rates in America itself necessarily vary. Taking thirty of the largest cities of the United States, the per capita loss in 1909 was shown to vary from $1.36 in St. Louis to $4.55 in Kansas City. Higher per capita loss was shown in some of the smaller centres, like the city of Racine, where it ran to $24.29. The total annual fire loss is estimated at $200,000,000, and fire specialists go so far as to assert that $150,000,000 of this is waste from negligence or lack of precautions. The table of comparisons drawn up by the underwriters from consular returns in 1905, the only recent year in which statistics of the kind were gathered in Europe, showed an average loss of 61 cents per capita for thirty European cities as against $3.10 for 252 American cities. Taking the number of fires to each 1,000 of population here and in Europe, it was found to be 4.05 in the United States against .86 in Europe.

The annual average losses for six nations in Europe were compiled from records of varying years and years grouped, with this result:—

Country.	Annual fire loss.	Loss per capita. Cents.
Austria	$ 7,601,389	29
Denmark	660,924	26
France	11,699,275	30
Germany	27,655,600	49
Italy	4,112,725	12
Switzerland	999,364	30

Or an average loss per capita of 33 cents.

Estimating Canada's population last year at 7,500,000, the fire loss per capita in the Dominion was $3.14, compared with $2.70 in 1909, with an estimated population of 7,000,000.

In Berlin, where the losses amount annually to less than those of one moderately large fire in the United States, the excellent conditions are due to the attention paid to the methods of construction. Building police have authority to compel the use of iron and steel girders, fireproof stairways and roofing, heavy fireproof ceilings and all details that may diminish the risk of conflagration.

Canada cannot claim to be making untrammelled progress until its fire record has been improved considerably.

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DIVERSION OF WATER AT NIAGARA FALLS.

Much has been written on the injury being done to the Niagara Falls by the diversion of water for power purposes by the different power companies operating there. The American Civic Association have been consistently agitating increased restrictions on the water used by the companies, and to some extent the grounds of their objection have been based on the reports of the American Army engineers. On the other hand, much has appeared in the press which has no bearing on fact, but is due to the vivid imaginations of newspaper writers.

Effusions are constantly appearing in the press stating that if the power companies at present operating are allowed to develop the full amount of their franchise that the Falls will practically disappear.

There hardly seems much danger of this when we remember that with the full development only about eighteen per cent. of the average flow of Niagara River will be utilized.

It is now being agitated in the United States by the American Civic Association and others that the provisions of the Burton bill, which until last June was in operation, and which restricted the amount of power allowed to be imported to the American side, should be again put in force. For that reason the city of Niagara Falls, N.Y., have appointed a committee to arrange for the watching the result when the maximum amount of water allowed the power companies is diverted on a date named. Engineers will measure the drop in the water going over the Falls and will make an official report to the Federal Government. The members of the Senate and House Committee on Foreign Affairs and the United States engineers will be invited to witness the test.

It might be added that the power companies have invested a great deal of money at the Falls, and it is hardly fair to them that agitation developed by irresponsible people should cause heavy losses on their investment. If the diversion of this water is going to seriously affect the scenic beauty of the Falls, then the public should know it, and should take measures to prevent the destruction of the Falls. If, on the other hand, however, it is not going to seriously affect the flow, then the companies should be allowed to finish their work.

For that reason this independent test will be of great interest to both the public and the companies.

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REFORESTING WASTE LAND.

The subject of reforesting waste land is becoming one of considerable interest to Canada. The Ontario Government is carrying on considerable experimental work along this line in Norfolk county. The Norfolk Forest Station, started in 1909, at present is comprised of 1,300 acres of land. Portions of this land have been cleared for tillage and then abandoned, while the remainder contains second growth of white pine, red and white oak, and a number of less valuable species. About one hundred acres of this tract have been planted with different species of pine, oak and walnut.

It is the opinion of Mr. E. J. Zavitz, Forester for the Department of Agriculture, that if southern Ontario is to have any forest left it must be by protecting the remnants left on the non-agricultural soils and replanting where necessary.

There are hundreds of square miles of unproductive sand lands which could be obtained at low cost, and which would produce hardwoods, of which the supply is now largely coming from the United States, and of which the source there is gradually disappearing.

Near many Canadian villages, towns and cities there are areas of waste sandy and rocky land which has been cleared of timber or abandoned, worn-out for farming land. Such areas usually detract from the values of neighboring property, and their unproductivity increases the proportionate burden of taxes on the community and renders such public works as roads and bridges unduly expensive or proportionately poor in quality.

In such cases it would certainly be a great advantage to have this waste land producing valuable timber, as such land will always grow trees if the proper species be chosen.

The policy of reforesting our waste lands has many arguments in its favor. It will pay as a financial investment, assist in insuring a wood supply, protect the headwaters of streams, and provide breeding ground for wild game, as well as removing great areas of waste, sandy land and converting them into profitable forests.

STREET LINES.

We note in a recent issue of one of the local papers of Welland that complications have arisen in connection with the adjustment of street lines in that town. New surveys have been made on many of the streets, and these surveys do not check with the old lines by some four feet, necessitating a change in sidewalks and in many buildings erected.

This is the condition which practically all towns of comparatively old standing, which have come to a point of quick development, must undergo. When towns are small and property of little value, true lines and locations are not important, and as a result the original points are lost or destroyed. It is a lesson, however, that street lines should be laid down accurately and well-referenced with monuments when the towns are small, for endless trouble and complication will be saved afterwards if this is done.

We note that the councillors of Welland questions the idea of accepting the new survey, but it seems to us that in such a case as this, considering the rapid growth there, that it would be much better to lay down an accurate system of base lines for the town which would form a basis for extension in the future.

EDITORIAL COMMENT.

Hamilton has been undergoing a thorough overhauling in connection with its sanitation. Dr. Roberts, the Medical Health Officer, has had a large corps of inspectors at work since the spring on a house-to-house campaign. As a result, sanitary conditions have been greatly improved.

* * * *

Common councils and boards of aldermen sometimes make strange rulings in regard to things electrical. Not many years ago, when accidents from falling trolley wires were more common than they are now, an alderman in Brooklyn moved that the street railway companies be compelled to insulate their overhead trolley wires so as to make them harmless in case they should break and fall into the street.

* * * *

The city of Buffalo is a step ahead of Toronto in the accommodation provided to street car passengers. Beginning next Sunday, street cars for the first time will carry signs, "Wait for the next car," when a car is filled. This means that an official limit has been placed at the number of passengers that the street car may carry. The largest number of passengers that can be accommodated is eighty-three, only thirty allowed standing by city by-law. Philadelphia has reached the stage where every passenger must have a seat. Buffalo has taken a step in the right direction, and it appears as though the sentiment in Toronto was becoming such that in the near future they will follow this example.

* * * *

The central electric-power-station idea is becoming more and more important in mining from year to year. Whether or not these power plants are established to serve a number of mines of a single company with electric current, or as custom plants, selling current to independent mines, the result is the same—greater economy of operation. Electric power, owing to the ease and economy with which it can be transmitted long distances and over all conditions of surface topography, as well as underground, is especially adapted to operating mining machinery. Where electric power is available the necessity of installing a local power plant at a mine may be avoided, an important item for the small operator with limited capital.

CHICAGO TESTS OF EMSCHER TANK.

The Emscher tank formed the subject of a very complete paper read before the Boston Society of Civil Engineers by Mr. Chas. Saville—probably the most complete description which has yet been given of the tank and also of the Emscher drainage district and the work being carried on by it. This paper was discussed by a number of prominent sanitary engineers and chemists and brought out several interesting items of information concerning not only this tank but other methods of sewage treatment. Among those of special interest were a statement concerning the experiments conducted with such a tank at the sewage testing station of the sanitary district of Chicago and a description of a sludge disposal plant at Kings Park, N.Y.

The former was by Langdon Pearse, who has charge of the Chicago testing station. The experimental Emscher tank there is built of wood, approximately 7 feet 6 inches inside diameter and 16 feet 1 inch working depth. The effluent from a grit chamber containing an average of 100 to 200 parts per million of suspended matter requires at least a two-hour period for settling, with an average vertical velocity of less than 3½ feet per hour. At this rate the average removal during the month had been as high as 55 per cent. reduction of suspended matter with 152 parts per million in the influent, which had occasionally reached 65 per cent. on two-day tests with suspended matter about 200 parts per million. The average rate of accumulation of sludge has been about 2 cubic yards per million gallons, 90 per cent. of water. The capacity of this sludge chamber is estimated at one year, although it is not probable that so much storage would be required in an actual plant.

From observations with this tank Mr. Pearse was strongly of the opinion that the separate digestion of sludge in separate tanks is in itself not a solution of the sludge problem, and if carried out on any large scale such tanks would prove a great nuisance. The success of the Emscher tank, to his mind, lies in having a separate compartment for the digestion of sludge, to which the increment of freshly settled suspended matter is coming every moment. If the sludge accumulation of a reduction basin is blown out into a sludge digestion tank whenever septic action begins to develop, or even at more frequent intervals, a large mass of partially digested sludge is thoroughly stirred up each time; moreover, violent gas production will ensue in warm weather with the consequent dissemination of the settled matter through the liquid. Another objection to the separate sludge digesting tank is the difficulty of disposing of the supernatant liquid, which is so foul that it cannot be discharged without treatment, but if pumped over into the sedimentation tank would certainly tend to start septic action there.

Dr. Arthur Lederer, chemist of the Chicago sanitary district, stated that "There has never been a hydrogen sulphide odor noted in the effluent in any of the septic tanks of the sewage testing station of the sanitary district, not even during the hot season, when the evolution of gas was at its highest. The supernatant liquid of the sludge digesting chamber of the Emscher tank, while giving no hydrogen sulphide odor, gave a positive reaction for hydrogen sulphide."

A small disposal plant at Kings Park, N.Y., was referred to by Geo. W. Fuller, which has now been operating for several months. This plant treats the sewage of a population of between 3,000 and 4,000 people. The preliminary treatment consists of plain sedimentation in tanks of the Dortmund type. From the bottom of the tanks the unputrefied sludge is removed at intervals by opening a gate on the outlet pipe, through which the fresh sludge, by the weight of the superincumbent sewage, is forced to long covered sludge trenches. These trenches are about 6 feet deep and 6 feet wide, braced on the sides and top with rough lumber and covered with a foot or more of sandy soil. The sludge is distributed lengthwise in these trenches by means of a trough, so that it can be deposited at different points by adjustments made through openings which are ordinarily covered. There is an overflow pipe to take the liquid, if necessary, when the trench is filled, to the final settling basin into which the effluent from the sprinkling filters passes. Such liquid as does not percolate into the porous soil may be treated with hypochlorite of lime as it flows into the final settling basin.

The only feature suggesting modification in the preliminary treatment at the Kings Park plant is the formation of scum on the surface of the clarified sewage in the Dortmund tanks. This is largely due to the fresh and but partially screened sewage entering the Dortmund tank and probably would also appear in an Emscher tank. The sewage seems to be unusually well clarified at the Kings Park plant and is delivered to the sprinkling filters in a fresh condition. The covered sludge trenches, it is believed, will afford a disposal of the sludge without odors at a very small or moderate cost for construction and at practically no expense for operation for several years. The opening of a valve now and then is all that is required of the attendant, who need visit the plant only for a few minutes once or twice a day. Ultimately it will be necessary either to dig out the sludge from the existing trenches, or to build new ones. The writer is by no means certain that with either or both of these operations the separate covered sludge trench, or basin, is not cheaper for a plant of this size for some locations than is an Emscher tank, with its sludge beds which are supposed to need attention at such frequent intervals as to require the regular employment of a laborer.

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BRITISH STANDARD FOR REINFORCED CONCRETE CONSTRUCTION.

(Concluded.)

Jointed circular hoops as ordinarily made are apparently not quite so efficient.

Rectilinear ties are still less adapted to resist the lateral or radial expansion of a highly stressed core.

The volume of curvilinear laterals should never be less than 0.5 per cent. of the volume of hooped core.

The diameter of rectilinear laterals should not be less than three-sixteenths of an inch.

Strength.

The amount of the increase of strength in hooped pillars depends upon:

1. The form of hooping (whether curvilinear or rectilinear, etc.).
2. The spacing or distance between the hoops.
3. The quantity of hooping relative to the quantity of concrete in the core of the pillar.
4. The quality of the concrete.

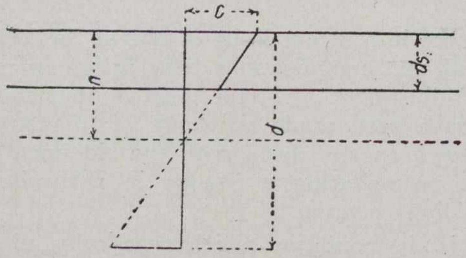

Fig. 2.

Consequently the increase of strength may be shown to be equal to the product of the four factors (u. f. s. r.)

u = the ultimate compressive stress on concrete not hooped (per unit of area).

f = a form factor or constant which will vary according to whether the hooping is curvilinear or rectilinear, etc.

s = Spacing factor or constant which will vary with the pitch of the laterals.

Vh = Volume of hooped reinforcement in cubic inches.

V = Volume of hooped core in cubic inches.

r = Vh/V = the ratio of volumes—i. e., the ratio of the volume of helical or horizontal reinforcement to the volume of hooped core.

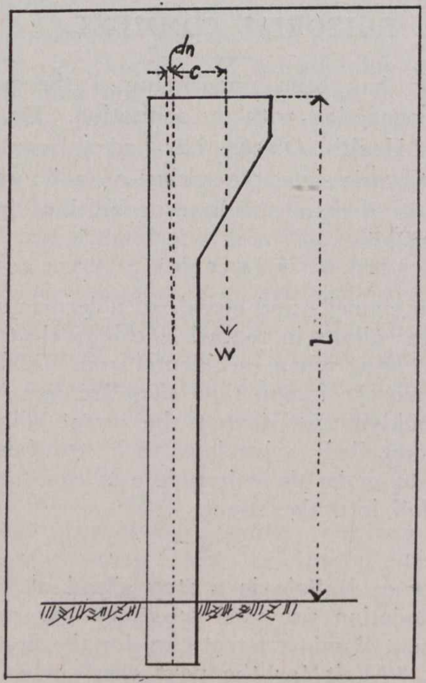

Fig. 3.

The ultimate compressive stress on concrete not hooped being = u, and the increase of strength due to hooping being

u. f. s. r.

the total resistance of the hooped material per unit of area will then be

$$= u + u.f.s.r.$$

$$= u\,[1 + f.s.r.].$$

Let cp = the working compressive stress on a prism of concrete (not hooped) = Wfu.

Wf = the working factor = cp/u.

Then the safe compressive stress on the hooped core = c, where

$$c \quad Wfu\ [1 + f.o.s.r.].$$

$$= cp\ [1 + f.s.r.].$$

The values of f, s and their product may be obtained from the following table:

Form of lateral reinforcement.	Form factor = f.	Spacing of laterals in terms of diameter of hooped core.	Spacing factor = s.	Value of f s.
Helical	1	0.2d	32	32
Helical	1	0.3d	24	24
Helical	1	0.4d	16	16
Circular hoops	0.75	0.2d	32	24
Circular hoops	0.75	3.3d	24	18
Circular hoops	0.75	0.4d	16	12
Rectilinear	0.5	0.2d	32	16
Rectilinear	0.5	0.3d	24	12
Rectilinear	0.5	0.4d	16	8
Rectilinaer	0.5	0.5d	8	4
Rectilinear	0.5	0.6d	0	0

Let p = the pitch of the laterals in inches [i. e., the axial spacing of the laterals].

d = the effective diameter of the hooped core in inches.

The spacing factor should not be taken at more than 32, even if p is less than .2d, but intermediate values of the spacing factor may be obtained from the equation,

$$s = 48 - 80\,\frac{p}{d}$$

It will be seen from the above table that the advantage of hooping disappears with an increase in the spacing of the laterals, irrespective of the volume of hooping or the value of r.

Before the safe stress on the hooped core can be obtained it will be necessary to give values to Wf and u. A table for this purpose will be found below.

The value of the working compressive stress on the concrete of the hooped core having been obtained, the maximum permissible pressure or load may be obtained from the equation:

P = c [A + (m — 1) Av], where

A = the effective area of the pillar.

$$m = \frac{Es}{Ec} = \text{modular ratio}$$

Av = Area of vertical reinforcement.

P = total safe pressure on pillar.

Working Stresses.

A safety factor of 4 at 90 days is recommended for all pillars.

The following table of working stresses is suitable if good materials are used, and is based on the assumption that test cubes have at least the strength given at the periods stated:

Table Showing the Value of u and C p for Pillars.

Proportions of concrete measured by volume.	Pounds of cement to 13½ cu. ft. of sand and 27 cu. ft. of shingles or broken stones.	Value of u at 28 days in pounds per sq. in.	Value of u at 90 days in pounds per sq. in.	Value of C p at 90 days in pounds per sq. in. (safety factor = 4) (working factor = ¼).
1 : 2 : 4	610	1,800	2,400	600
1 : 1½ : 3	810	2,100	2,800	700
1 : 1 : 2	1,220	2,700	3,600	900

It is assumed that the tests of the strength of the concrete are made on unrammed cubes and of the same consistency as the concrete used on the work.*

Limitation of Stress on Pillars.

The following limits of stress should be observed in pillars:

(a) The stress on the metal reinforcement (i. e., the value of m. c.) should not exceed 0.5 of the yield point of the metal.

(b) Whatever the percentage of lateral reinforcement the working stress on the concrete of pillars should not exceed (0.34 + 0.32 f) u where

f = form factor.

u = ultimate crushing resistance of the concrete.

Form of Laterals.	Form Factor.	Value of (0.34 + 0.42f) u.
Rectilinear	0.5	0.5 u
Independent circular hoops	0.75	0.58 u
Helical	1.00	0.66 u

If these limits are adopted, the working stress on hooped concrete will always fall within the "limit of continued endurance" for plain concrete.

Pillars Eccentrically Loaded.

If a pillar initially straight is loaded eccentrically, as when a beam rests on a bracket attached to the pillar, it may be regarded as fixed at the base and free at the loaded end. Then it must bend in the plane passing through the load, the deflection at the top being dn. Let e be the eccentricity of the load measured from the center of the pillar when straight. Then the bending moment at the base of the pillar is W (dn + e). But it is known that dn will be small compared with e, provided that W is small compared with $2EI/l^2$, and this will be the case in such conditions as are likely to occur in designing concrete pillars. Then the bending moment may be taken as We, and the extreme "fibre" stress at the edge of the base of the pillar, treating it as homogeneous, will be

$$f = W\left\{\frac{1}{A} \pm \frac{e}{S_m}\right.$$

very nearly, where A is the whole section of the pillar and Sm the section modulus relatively to an axis through the centre of gravity and at right angles to the plane of bending.

In dealing with reinforced pillars which are not homogeneous, it is convenient to substitute for the actual section of the pillar what may be termed the equivalent section, or section of concrete equivalent in resistance to the actual pillar. If A is the effective area of section of the pillar (including the area of reinforcement), and Av is the area of vertical reinforcement, then the equivalent section is

$$Ae = A + (m - 1)\ Av.$$

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*The limit of 2,400 lbs. per sq. in. given in the previous report of the committee was adopted on the assumption that the cubes would be rammed with iron rammers under laboratory conditions.

If d is the depth of the section in the plane of bending, the Inertia moment relatively to the neutral axis can be expressed in the form.

$$I = nAd^2,$$

and the section modulus in the form $Sm = 2nAd$. (See Appendix V. of the report).

It is desirable in pillars that there should be no tension, and generally when the vertical load is considerable there is none. Cases in which the eccentricity is so great that there is tension must be treated by the methods applicable to beams if it is made a condition that the steel carries all the tension. In the following cases it is assumed that there is no tension.

Case I.—Pillar of Circular Section, Reinforcements Symmetrical and Equi-distant from the Neutral Axis.—Let m be the modular ratio = Es/E, A the effective cross-section of the column in square inches, Av the area of vertical reinforcement in square inches, d the diameter of the pillar, dv the distance between the vertical reinforcing bars perpendicular to the neutral axis. Then the equivalent section is

$$Ae = A + (m - 1)\,Av,$$

and the section modulus is (Appendix V. of the report).

$$Sm = \tfrac{1}{8}Ad + \tfrac{1}{2}(m - 1)Av\frac{dv^2}{d}$$

The stress at the edges of the section can then be calculated by the general equation

$$f = W\left\{\frac{1}{A} \pm \frac{e}{Sm}\right\}$$

where e is the eccentricity of the load in inches and W the weight of load in lb. The greater value of stress must not exceed the safe stress stated above.

Case II.—Rectangular Section with Reinforcement Symmetrical and Equi-distant from the Neutral Axis.—Using the same notation as in the last case, d being now the depth of the section in the plane of bending, the section modulus is (Appendix V. of the report).

$$Sm + \tfrac{1}{6}Ad + \tfrac{1}{2}(m - 1)Av\frac{dv^2}{d}$$

and the stresses are given by the same equation as in the previous case.

Case III.—Column of Circular Section with Reinforcing Bars Arranged in a Circle.—Using the same notation as in Case I., ht being the diameter of the circle of reinforcing bars, the section modulus is (Appendix V.)

$$Sm = \tfrac{1}{8}Ad + \tfrac{1}{4}(m - 1)Av\frac{dv^2}{d}$$

and the stresses are given by the same equation as in Case I.

(c) Long Pillars Axially Loaded.

For pillars more than 18 diameters in length there is risk of lateral buckling of the pillar as a whole. The strength of such pillars would be best calculated by Gordon's formula, but there are no experiments on long pillars by which to test the values of the constants for a concrete or concrete and steel pillar. There does not seem, however, to be any probability of serious error if the total load is reduced in a proportion inferred from Gordon's formula to allow for the risk of buckling.

Let, as before, A = the area of the column in inches; Av = the area of vertical reinforcement. Then $Ae = A + (m - 1)\,Av$ is the equivalent section. Let N be the numerical constant in the equation $I = NAd^2$ (Appendix V.), and d the least diameter of the pillar.

Then for a pillar fixed in direction at both ends Gordon's formula is

$$\frac{W}{Au} = \frac{1}{1 + \dfrac{l^2}{C_1Nd^2}} = \frac{1}{1 + C_2}$$

so that the pillar will carry less than a short column of the same dimensions in the ratio of $1 + C_2$ to 1, or, in other words, the column will be safe if calculated as a short column, not for the actual weight or pressure P, but for a weight or pressure $= (1 + C_2)\,W$.

The constant C_1 has not been determined experimentally for reinforced long columns. But its probable value is

$$C_1 = \frac{4\eta^2Ec}{u}$$

where u is the ultimate crushing stress. Putting Ec = 2,000,000 and u = 2,500, then $C_1 = 32{,}000$. Looking at the well-understood uncertainty of the rules for long columns, very exact calculation is useless. Some values of N for ordinary types of column are given in Appendix V. Taking these values, the following are the values of $1 + C_2$:

Values of $1 + C_2$.

	Case I.	Case II.	Case III.
$\frac{l}{d}$	N = 0.098	N = 0.075	N = 0.0646
20	1.13	1.17	1.19
25	1.20	1.26	1.30
30	1.29	1.38	1.44

The differences of $1 + C_2$ for considerable differences of N are not very great. In any case N can be found by the method in the Appendix with little trouble.

In the case of columns fixed at one end and rounded or unfixed at the other, $2C_2$ must be substituted for C_2. If the column is rounded at both ends, $4C_2$ must be substituted for C.

Key to the Notation.

The notation is built up on the principle of an index.

The significant words in any term are abbreviated down to their initial letter, and there are no exceptions.

Capital letters indicate moments, areas, volumes, total forces, total loads, ratios, and constants, etc.

Small letters indicate intensity of forces, intensity of loads, and intensity of stresses, lineal dimensions (lengths, distances, etc.), ratios, and constants, etc.

Dashed letters indicate ratios, such as a_2, c_2, n_1, etc., where the a, c, and n indicate the numerators in the respective ratios. The dash itself is mnemonic and is an abbreviation of that longer dash which indicates division or ratio.

Subscript letters are only used where one letter is insufficient; and the subscript letters themselves are the initial or distinctive letters of the qualifying words.

Greek letters indicate ratios and constants. They are sparingly used and are subject to the "initial letter" principle.

The symbols below are arranged in alphabetical order for facility of reference.

Standard Notation.

In Pillars.

A = the effective area of the pillar (see definition on page 326).

Ae = Area equivalent to some given area or area of an equivalent section or equivalent area.

As = cross-sectional area of a vertical or diagonal shear members, or group of shear members, in the length p, where p = pitch of stirrups.

At = Area of tensile reinforcement (in square inches).

Av = Area of vertical or longitudinal reinforcement in square inches.

a = arm of resting moment or lever arm (in inches).

a = Arm ratio = a'd .·. a_1d = a.

B = Bending moment of the external loads and reactions (in pound inches).

B_1B_2 = Bending moments at consecutive cross-sections.

Generally b = breadth.

In Tee Beams.

b = breadth of flange of beam (in inches).

br = breadth of rib of T beam (in inches).

$C_1C_2C_2$ = a series of constants.

In Beams.

c = compressive stress on the compressed edge of the concrete (in lb. per sq. in.).

In Pillars.

c = working compressive stress on the concrete of the hooped core.

cp = the working compressive stress on a prism of concrete (not hooped) or the working compressive stress of plain concrete.

cu = compressive stress on concrete at the underside of the slab (in tee) beams.

c, = c/t = the ratio of c to t.

In Circular Sections.

Generally d = diameter.

In Rectangular Sections.

Generally d = depth.

In Pillars.

d = the diameter of the hooped core in inches.

In Beams.

d = effective depth of the beam (in inches).

dc = depth or distance of the centre of compression from the compressed edge.

dn = deflection.

ds^1 = total depth of the slab (in inches).

In Pillars.

dv = distance between the centres of vertical bars measured perpendicular to the neutral axis.

Ec = Elastic modulus of concrete (in lb. per sq. in.).

Es = Elastic modulus of steel (in lb. per sq. in.).

e = eccentricity of the load measured from the center of the pillar (in inches).

In Beams.

f = extreme fibre stress—i. e., stress at the extreme "fibre" of any members under transverse load.

In Pillars.

f = a form factor or constant which will vary according to whether the hooping is corvilinear or rectilinear, etc.

I = Inertia moment of a member.

Ic = Inertia moment of concrete only.

Is = Inertia moment of steel only.

Ixx = Inertia moment on axis xx when necessary.

Iyy = Inertia moment on axis yy when necessary.

l = length of a pillar or effective length of span of beam or slab.

m = modular ratio = Es, Ec.

N = a numerical coefficient.

n = neutral axis depth—i.e., depth of neutral axis from the extreme compressed edge (in inches).

n, = n/d = the neutral axis ratio .·. n,d, = n.

$N_2N_3N_4$ = a series of numerical co-efficients.

P = total safe pressure.

In Pillars.

p = the pitch of the laterals in inches (i.e., the axial spacing of the laterals).

In Shear Formulae.

p = pitch of distance apart (center to center) of the shear members or groups of shear members (measured horizontally).

π = peripheral ratio or the ratio of the circumference of a circle to its diameter.

Re = Compressive Resistance moment = Resistance moment of the beam in terms of the compressive stress (in lb. in. units).

Rt = Tensile Resistance moment or Resistance moment in terms of the tensile stress (in lb. in.).

In Beams.

r = At/bd = ratio of area of tensile reinforcement to the area bd.

In Pillars.

r = Vh/V = the ratio of volumes—i.e., the ratio of the volume of helical or horizontal reinforcement to the volume of hooped core.

In Beams.

S = the total shear in lb. at a vertical section.

Sm = the section modulus.

In Pillars.

s = Spacing factor or constant which will vary with the pitch of the laterals.

In Beams.

s = intensity of the shearing stress on concrete in lb. per sq. in.

ss = shearing stress on the steel (in units of force per unit of area).

s, = ds/d = the slab depth ratio.

T = Total tension in the steel (in lb.).

T_1T_2 = Total tensile forces at consecutive cross-sections.

t = tensile stress on the steel (in lb. per. sq. in.).

U = Total ultimate breaking load on any member. [Compare W = Working load.]

u = intensity of ultimate crushing resistance of plain concrete per unit of area or ultimate compressive stress on prisms of concrete not hooped.

In Pillars.

V = Volume of hooped core in cu. in.

Vh = Volume of hooping reinforcement in cu. in.

W = total working load or weight on any member.

Wf = the working factor = cp/u = the reciprocal of the safety factor.

w = weight or load per unit of length of span.

VENEER MANUFACTURED AND USED IN CANADA, 1910.

Statistics for the amount of veneer manufactured or used in Canada during 1910, have just been compiled by the Forestry Branch of the Department of the Interior. Including natural and imported veneer 92,066,000 square feet, valued at $768,500 were produced or used. This is an average cost of $7.47 per M. square feet. Of this amount, 90.9 per cent. was native wood and consisted of 14 species; the most important of these were birch and maple, which together form over one-half of the total native woods. These were manufactured into veneer in the hardwood belt and were used chiefly for furniture, panel work and vehicles. Elm and bass-wood are next in importance, and together form about one-third of the native wood. These two species of veneer are made by smaller mills in the fruit district and are used for fruit baskets, packages and cheese boxes. Imported woods $140,687 amounted to one-tenth of the total amount of veneer used. These were more expensive than native woods, costing on the average $17.48 per M. square ft. and were used for more extensive furnishings.

TRAIN RESISTANCE.*

By W. F. Kiesel, Jr.

The bulletin on train resistance prepared by Prof. E. C. Schmidt and recently issued by the University of Illinois, describing tests with freight cars, adds much to assist in finally determining a general formula on train resistance of value to engineers, even though the author of the work has not attempted to develop a formula generally applicable to all cars. A study of this subject for the past ten years, or more, has permitted me to gradually develop a formula, the results of which agree very closely with those of the careful tests described by Prof. Schmidt.

In the April, 1897, number of the Revue Generale des Chemins de Fer, M. Barbier, of the Chemin de fer nu Nord, presented formulae for train resistance, which, in construction, have been followed by nearly all other investigators. In the Railroad Gazette of May 21, 1897, M. Barbier's formulae were discussed, compared with others, and transformed into formulae with English measurements, as follows:

For rigid axles: $R = 3.2 + 2.5V \frac{(V + 30.8)}{1000}$

For truck axles: $R = 3.2 + 2.5V \frac{(V + 6.08)}{1000}$

Attention is directed to the fact that the composition of the train, the number of cars, and the total train weight have not been considered. In June, 1899, the Pennsylvania Railroad test department made some careful tests with empty and loaded freight cars, whose weights varied from 13 tons to 75 tons. These cars were in good condition and the most careful records were taken. The results clearly demonstrated that the resistance per ton at very slow speeds decreased as the weight per car increased. The following formula expresses the results very closely:

$$R = \frac{80}{W} + 1.1$$

R = resistance in pounds per ton, and W = car weight in tons.

Comparison with tests made since indicate that the average freight cars are not in as good condition as those used in the test referred to, and that some allowance should also be made for variations in weather. Changing coefficients to conform, the formula reads:

$$R = \frac{100}{W} + 1.5 = \text{Resistance per ton.}$$

$$\text{or } R = 100 + 1.5W = \text{Resistance per car.}$$

Using M. Barbier's general formula

$$R = C + C_1V + C_2V^2$$

or as re-arranged by the Railroad Gazette in 1897,

$$R = C + C_2V\ (V + \frac{C_1}{C_2})$$

where

V = speed in miles per hour,

and substituting the value $\frac{100}{W} + 1.5$ for C,

making $C_3\ \frac{C_1}{C_2}$ and $C_4\ \frac{1}{C_2}$ the formula becomes:

$$R = \frac{100}{W} + 1\tfrac{1}{2} + \frac{V\ (V + C_3)}{C_4}$$

The values of C_3 and C_4 in the third term represent air resistance and all other resistances depended on speed and had to be empirically determined; they have been gradually modified due to a study of the tests and experiments of the past ten years. For best average results $C_3 = 16$, and $C_4 = 100$. These tests also indicate that the third or average speed term varies as the square root of W, which gives for resistance per car:

$$R = 100 + 1\tfrac{1}{2}\ W + .01\ V\ (V + 16)\ \sqrt{W}$$

The resistance per ton will be this value divided by W, or

$$R = \frac{100}{W} + 1\tfrac{1}{2} + \frac{V\ (V + 16)}{100\ \sqrt{W}}$$

If W_1 is made to represent the total weight of the train back of the tender, and N the number of cars, then:

$$R = 100N + 1\tfrac{1}{2}\ W_1 + .01\ V\ (V + 16)\ \sqrt{W_1N}$$

This formula gives good average results for solid trains, including passenger trains with open platforms. For mixed freight trains having various kinds of cars, which increase the air resistance, the denominator of the speed term should be changed from 100 to 90, or possibly 85.

For vestibuled passenger trains, presenting a rather smooth surface, the air resistance will be less, and the denominator of the speed term may be increased to 110, or, in exceptional cases, to 120. For ready comparison with

Freight Car Resistances in Pounds Per Ton on Level Tangents for Car Weights; in Tons.

Miles Per Hour.	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
5	6.735	5.710	5.025	4.535	4.166	3.879	3.648	3.460	3.302	3.163	3.054	2.954	2.867	2.790	2.722
10	7.081	6.200	5.308	4.768	4.411	4.110	3.868	3.669	3.502	3.361	3.239	3.134	3.041	2.958	2.885
15	7.540	6.430	5.682	5.143	4.735	4.415	4.158	3.945	3.767	3.615	3.484	3.370	3.270	3.181	3.101
20	8.110	6.940	6.148	5.574	5.138	4.796	4.518	4.289	4.096	3.931	3.789	3.665	3.555	3.457	3.370
25	8.792	7.550	6.705	6.099	5.621	5.250	4.950	4.700	4.490	4.310	4.154	4.017	3.896	3.789	3.692
30	9.586	8.260	7.353	6.661	6.182	5.779	5.452	5.179	4.948	4.750	4.578	4.427	4.293	4.173	4.066
35	10.491	9.070	8.092	7.375	6.847	6.383	6.024	5.725	5.471	5.222	5.062	4.894	4.746	4.613	4.493
40	11.509	9.980	8.923	8.144	7.541	7.061	6.668	6.339	6.059	5.817	5.606	5.420	5.254	5.106	4.972
45	12.638	11.590	9.845	8.998	8.340	7.814	7.382	7.019	6.711	6.438	6.210	6.003	5.819	5.654	5.505
50	13.879	12.100	10.858	9.936	9.222	8.641	8.167	7.768	7.427	7.147	6.873	6.644	6.439	6.256	6.090
55	15.231	13.310	11.963	10.959	10.174	9.543	9.022	8.584	8.208	7.882	7.596	7.209	7.116	6.912	6.727
60	16.696	14.620	13.158	12.038	11.209	10.520	9.959	9.467	9.054	8.694	8.376	8.232	7.848	7.623	7.418
65	18.273	16.030	14.445	13.243	12.324	11.571	10.946	10.405	9.964	9.569	9.222	8.913	8.636	8.388	8.161
70	19.961	17.540	15.824	14.534	13.518	12.696	12.013	11.435	10.938	10.505	10.124	9.784	9.480	9.201	8.957
75	12.761	19.150	17.293	15.896	14.790	13.898	13.152	12.517	11.978	11.504	11.086	10.714	10.380	10.080	9.805
80	23.672	20.860	18.854	17.341	16.142	15.171	14.361	13.916	13.061	12.564	12.108	11.701	11.336	11.007	10.707

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*From Railway Age Gazette.

tests and other data, a tabulation of the resistances in pounds per ton for various speeds and weights per car is given.

To permit of a ready determination of the work locomotives may perform a knowledge of the resistance of the train back of the tender is not sufficient, as the calculations must necessarily include locomotive and tender resistances. Unfortunately, results of road tests made at home and abroad are given in pounds per ton for the engine and tender combined. There seems to be no valid reason why the tender should not be considered as a car. Similarly the weight carried by engine trucks offers about the same resistance as car weight.

This statement is corroborated by data given by Prof. Goss, in his book, Locomotive Performance, page 419, where the engine truck and the tender load of the locomotive is given as 100 tons; tractive effort to overcome rolling load resistance at 366 lbs. at 10 m. p. h., and 1,033 lbs. at 50 m. p. h.; or 3.66 lbs. per ton at 10 m. p. h., and 10.33 lbs. per ton at 50 m. p. h., agreeing very closely with the resistance per ton for two cars weighing 100 tons, or 50 tons each (see table) at 10 m. p. h. This is 25 per cent. higher than the figure in the table at 50 m. p. h. Prof. Goss further bases machinery resistance on cylinder and driver dimensions. It would seem advisable to introduce additional resistance based on the number of drivers coupled together. As it is extremely difficult, and probably impossible, to definitely determine whether the use of cylinder and driver dimensions, or, on the other hand, the weight on drivers should be used as a basis for machine friction, the weight on drivers has been selected.

Prof. Goss' experiments with Schenectady locomotive No. 1 show the machine friction to vary between 142 and 742 lbs. The weight on drivers was 28 tons, hence the machine friction varied between 5 lbs. and 26 lbs. per ton of driving weight. The Pennsylvania tests at St. Louis show values between 12 lbs. and 66 lbs., with 22 lbs. a good average. In the latter tests two values were below 12 lbs., and may be considered abnormal. Assuming that the engine and tender resistance is considered equivalent to that of three cars of the same total weight as the engine and tender plus M, a value for engine friction and head end resistances, then:

$$R = 300 + 1.5W + .01\,V\,(V + 16)\,\sqrt{3\,W + M}$$

W = the total weight of engine and tender.

Formulae by various authorities have been tabulated by Mr. Lawford H. Fry in Engineering, March 26, 1909. If M is made equal to $(12 + .01V^2)\,P$, in which P = weight on drivers, the above formula will give results approximating the average results given in Engineering for four-coupled and six-coupled locomotives, but not as high as the results given for eight-coupled locomotives. The value 12P is rather too low, considered purely as the friction term. Prof. Goss' tests would point to a friction term equal to 15P or 16P, and the Pennsylvania tests at St. Louis to one equal to 22P. Without further careful road tests, it is impossible to assign values which can be definitely designed as machine friction and total head end resistances, and the value $M = (12 + .01V^2)P$ will serve the purpose as representing the difference between the actual locomotive and tender resistance, and the resistance calculated on the basis of the locomotive and tender being equivalent to three cars

The object of arranging the formula in this shape is to enable the calculator to handle the whole train weight, including that of the locomotive and tender, as a unit, not only for grades and curves, but also for resistance on straight level track. The available power of the locomotive will be the total locomotive power less M, and the total train resistance opposed to this available locomotive power may be expressed by the following formula:

$$R = 100\,N + 1.5\,W + .01\,V\,(V + 16)\,\sqrt{WN}$$

R = total resistance in pounds.
N = number of cars back of tender, plus 3.
tender.
W = weight of train in pounds, including engine and
V = speed in miles per hour.

MODERN HEATING PRACTICE.*

Konrad Meier.

There is a widespread feeling that the modern ways of heating, though more efficient, are not as healthy as the open fire-place, the Dutch tile-oven, or even the ordinary stove. Evidently, there must be some basis for this contention. We need only remember that the close, lifeless air and stuffiness too often met in buildings heated by boiler or furnace, cannot always be traced to crowded occupation. Nor can it be the failure to use the windows inasmuch as the desire to open them is rather induced, sometimes almost compelled, by these conditions. Another significant fact is that the demand for ventilation has only arisen since hot-air registers and radiators have become general. No further evidence is necessary for the general conclusion that present day methods of heating in some way spoil the air, but it is worth while to look further into the cause and effect in order to find the right means of prevention.

The Vitiation of Air by Heating.

At first thought there seems to be no reason why a steam-heating apparatus, or a hot-air furnace in good condition, should alter the quality of the room air, aside from an unavoidable drying effect, not necessarily objectionable in itself. Nevertheless, on closer investigation some distinct causes of vitiation, not recordable by the ordinary methods of air testing, have been shown to exist, and found to create unwholesome conditions. We are indebted especially to two noted German hygienists, von Esmarch and Fluegge, for their investigations on this elusive subject. They have established that the stuffiness of air in heated rooms is caused by the decomposition of dust in contact with radiating surfaces at temperatures of 160 deg. F. and higher.

This process is not one of full combustion, generating carbonic acid, but a sort of dry distillation or singeing of the organic matter, which produces small quantities of the highly injurious ammonia, also traces of carbon monoxide and other gases. The presence of the former gas is explained by the quantities of animal excreta, one of the principal ingredients of ordinary street-to-house dust. It shows the little appreciated fact that dust, while comparatively harmless on furniture, will become objectionable when allowed to settle and decompose on radiators.

The gases thus generated are most noticeable after a period of interrupted heating. Under continuous service the quantities are generally too small for detection. But, in addition to this variable pollution, a constant irritation of the mucous membrane of nose and throat is kept up through the simple drying of the dust on heating surfaces, which lightens it and causes it to be picked up freely by the warm air currents. Even the dust on adjacent objects, also in ducts and air chambers, is dried and joins the procession of irritant, disease-bearing particles induced by the common forms of modern heating.

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*From "The Heating and Ventilating Magazine."

The meaning of this is plain when we remember that the dry heat is not sufficient to kill the bacteria carried by the dust, and that we inhale them in much greater numbers owing to the currents of air created by heaters, more especially those with unsanitary surfaces. It is also the presence of fine dried dust which is often responsible for complaints from dryness. The real cause is not dryness of air, but dried dust. Pure dry air has never been shown to be harmful. It has also been established that whatever little ozone may enter a room with the outer air is quickly used up in contact with organic dust, especially when heated. A small percentage of oxygen is absorbed in the same manner, but the extent and exact bearing of this fact has not yet been determined. These last points alone would account for the lifeless quality of the air as it generally issues from a register.

When these factors are considered, it will be admitted that an open grate, carrying its own vitiation up the flue, or a tile oven with clean, moderately warm surfaces, or even an iron stove kept polished, could not vitiate the room air to the same extent as will a radiator with inaccessible dusty surfaces, or a register blowing hot air from a musty source beyond inspection.

All this is not meant to advocate a return to the old-fashioned ways of heating, but only to show that the newer methods are actually at fault, and should be improved along lines suggested by the recent findings of hygienists. The result eventually will be a merging of the good features of past and present methods.

Sanitary Heating.

When planning apparatus, the first point in hygiene to be borne in mind should be to reduce contamination through dust by using the cleanest possible radiation. This means that heating surfaces should be in plain view, and accessible all around by hand, so that they will be kept clean, not by special effort, but as a matter of course in the ordinary routine of a household. Dust on concealed radiation, even if made accessible, is not seen, and, therefore, is invariably forgotten and neglected.

These facts should be sufficient, quite aside from engineering and economic reasons, to condemn all radiator screens designed for purposes of meaningless decoration. They are not the true solution of the problem and really turn direct radiation into a hot-air system without air supply. Screening is a sham, and should be vigorously opposed, not mildly tolerated. We should rather encourage neat, substantial appearance, inconspicuous finish and simplicity in arrangement of radiation. Unsightly bulk can often be reduced by judicious disposition and selection of the most advantageous style, or by deliberate reduction of the heat requirement, such as using double glass.

When direct radiation is indicated, it is possible, even in highly ornamental and formal rooms, to satisfy the artistic sense of architects without resorting to concealment. It is mainly a matter of judgment as to style and neatness in disposition, also of having the courage of one's conviction in arguing with the client. Of course, the public must yet be educated on the sanitary points, and the engineer on the ways and means to meet the situation. The present disinclination to expose radiators is mainly due to the shabby, clumsy and tasteless treatment that now prevails.

Radiating surfaces placed overhead or tight against walls are also objectionable. They are never dusted, except by an occasional air current, and then with a decided effect on the air. Fussy, round-about pipe connections behind radiators, creating dirt corners never cleaned out, are too often seen even in the better class of buildings. They always contribute to stuffiness, as do many styles of heating surface which are designed too much with a view to saving space and give too little chance for keeping them clean.

As will be pointed out later, indirect heat should be used only with certain restrictions. The casings enclosing the stacks should never be soldered up, or provided with a hand hole only. At least one full side should be hinged or made removable to invite occasional inspection and cleaning. Air filters should be used in cities to keep out the dust as much as possible. In general, dust pockets and dirt corners must be avoided. They are objectionable anywhere, as a latent menace to health, but become at once an active agent for mischief in connection with heat, which brings out the lurking germs and distributes them where they are most likely to do harm.

Temperatures of Heating Surfaces Should Be Lowered.

The second point of importance is the lowering of the temperature of heating surfaces, both with a view to preventing dry distillation, and for reducing the intensity of air currents. Hot-water heating gives the simplest and most effective means to this end. With the piping calculated and balanced accurately to secure even circulation at any flow temperature, it gives practically a full range of general control and makes it possible to carry heat strictly to suit the weather.

This means that for the greater portion of the heating season the temperature of heating surfaces need not reach the point at which decomposition is beginning to be felt. In hospitals, schools, and in other cases the surfaces might be increased within reasonable cost to keep the highest flow temperatures down to 160 deg. or 170 deg. so that a slight formation of gas could only occur under extreme conditions.

With hot-water heat applied by clean, well distributed radiation it is, therefore, quite feasible to eliminate practically all vitiation of room air currents through dust.

This is the reason for the popular feeling that this form of heat does not dry the air as much as steam. With the latter it becomes all the more important to insist on the cleanest form of surfaces, and to reduce the working pressure or temperature as much as possible. At best, steam heat will always be less desirable from the hygienic point of view. Hot-air furnaces, to be tolerable at all, should be installed of very ample sizes, giving the desired heating effect without excessively hot surfaces.

When heating by warm air, whether furnace or indirect stacks, the registers should always be in vertical position, never horizontal. Floor registers, especially, are dirt catchers in the most aggravating form, throwing up the dried dust and microbes straight into one's nose.

Overheating.

According to Fluegge, the proper attention to room temperature is hardly second in importance to the benefits of ventilation as generally accepted. He has demonstrated, that overheating is just as injurious, if not more so, than the effect of ordinary foulness of air due to lack of renewal. He explains this through heat congestion, caused by decreased emission from the human body, with a consequent disturbance of certain functions. It may be held at first thought, that summer heat would be equally, if not more injurious, but the conditions are distinctly different. Lighter clothing and freer air circulation usually allow of much greater heat emission by evaporation, except in the hottest and sultriest weather, which is known to be a tax on vitality even for short periods. In crowded, overheated though ventilated rooms, with the occupants close together, keeping each other warm by their own radiation, and wearing heavier clothing, the heat emission from the human body is very much reduced.

It is naturally difficult to determine the relative bearing of foulness and of overheating, each depending so much on the degree and also on humidity, but the fact remains that overheating has been shown to be injurious in itself and is apt to be more so when combined with foul air, humidity and with pollution through unsanitary heating apparatus. Equable, moderate temperature is, therefore, one of the primary hygienic requirements.

The logical way of meeting it is effective heat control, not only to suit the weather, but to take care of the heat from occupancy. With steam heat, which does not lend itself readily to central regulation, automatic devices for individual rooms are necessary in rooms occupied by a number of persons who are not expected to pay attention to the heating service. In other cases some form of graduated hand control of local radiation may be sufficient. Sometimes fair service can be obtained by the use of long distance devices, facilitating better control of a plant by the engineer from a central point. With hot-water heating, automatic regulation is desirable, mainly in rooms that will be crowded on occasion. On the whole, it is easiest with that system to maintain equable conditions. Still better results could be obtained by using gas for fuel in house-heating boilers, as is done for the bath heaters. The additional operating expense is no longer prohibitive in view of the saving in labor and other advantages. This combination of gas with hot-water heat should be the ideal domestic plant of the future. In this connection it is well to remember that the best heat regulation is often set at naught by some extraneous heat source, such as a hot flue, or a warm floor. All such cases should be looked out for in planning and taken care of.

Cool Air is More Wholesome to Breathe.

Aside from the desirability of avoiding excess of heat, there is still another lesson in Fluegge's findings. It is well known that a considerable portion of the heat emitted by a human body is contained in the exhaled air. Cooler air inhaled means increased emission owing to additional heat necessary to raise it to the temperature of the body. If the air is cool and sweet besides, it will be inhaled more freely and stimulate functions. Hot and dusty air makes more labor in breathing, gives less oxygen, if only for the same volume, and keeps circulation below the normal. It follows that the lowest air temperature compatible with comfort is the most rational. We all know that the indoor temperature at which one may feel comfortable varies considerably, according to the temper of the occupants, with the relative humidity and other conditions. But our sense of comfort is probably effected quite as much by the temperature of the surrounding objects, as they radiate heat or absorb it from the body. Thus we need less clothing on a sunny day than in cloudy weather, with equal air temperatures. This is so, because radiant heat will pass through the air and to its destination, without appreciably raising its temperature. Incidentally, it will be understood, that air is not spoilt by the heat rays, but by convection, or contact alone. For these reasons a room is apt to be most comfortable if the bulk of its walls is thoroughly warmed by continuous heating service, but the air be kept relatively cool by occasional opening of windows or by a constant inflow of sweet, incontaminated air not heated beyond room temperature. This idea of warming the walls, or the structure, rather than the air within, is conducive to equable conditions, and reduces the tendency to overheating, by the heat sources, as well as by the air supply, as each can be regulated effectively, and will not interfere with the other. Warmer room air, on the other hand, produces a lower percentage or relative humidity, and naturally tends more to excessive dryness and dust pollution by heating.

For the same reason it appears to be more advantageous to utilize the radiant heat of direct surfaces, rather than the heat emitted by convection. This would favor the selection of low, widely spaced, flat radiation, which is generally also more sanitary.

Cool Air and Radiant Heat vs. Hot Air.

The theory of warm walls and cool air also points towards the ideal for the solution of all heating and ventilating problems, that is, to reproduce for indoor life those atmospheric conditions which we know to be most pleasant and wholesome. A direct system with continuous service, with moderately warm, well distributed, clean surfaces giving more heat by a mild radiation than by convection, combined with a tempered air supply in some sanitary form, will certainly be the nearest approach to the mild radiant heat of the sun and cool bracing air. Any apparatus using fresh air as a heat carrier will produce the opposite effect, resembling more the enervating sirocco, or warm, cloudy weather. In any event, such apparatus necessarily gives warmer air and cooler walls since it is the air that must heat the walls. Besides, the higher the incoming air must be heated, the more it will lose of its natural sweetness. Hot air heating also tends to produce strata of warmer air overhead, and cooler air near the floor, a condition which is undesirable from the hygenic as well as the economical point of view. Again, the problem of controlling the heat without either disturbing the air supply or causing other discomforts is decidedly more complex.

There are instances, of course, where heating by air may be indicated, or permissible. The indirect method, however, should be resorted to only in such cases where the heat requirement is relatively small, so that the air supply need not be warmed to an undesirable degree which will spoil it for purposes of ventilation. The same amount of heat may, of course, be obtained with smaller volumes at higher temperatures as with large volumes at lower temperatures, but the best authorities agree that it should not be brought in to a room at more than 110 deg. F. Rietschel puts it at 104 deg. This is a severe limitation for conditions maintaining here. About 120 deg F. would seem justified. In cases where it would still result in excessive volumes it is nearly always advisable and proper to reduce the heat requirement by extra protection.

The indirect system is often installed with the idea of securing better ventilation than is expected by direct heat alone. As a matter of fact, the air renewal in either case depends largely on the natural outward leakage afforded by the structure and the draught power of any vent flues available. The inward leakage in one case comes through the register, in the other case through walls and windows. The latter air is apt to be sweeter and purer than that from the stacks. Moreover, the window ventilation can be increased without stopping the heat supply from radiators while the draught in a hot-air flue is liable to be reversed under wind action when heat is most needed. The idea of better ventilation through hot air heating is, therefore, nearly always a delusion.

(Continued next week.)

PERSONAL.

Mr. A. Parker Smith, of the Canadian P. J. Mitchell Co., Ltd., sailed from England for Canada last week.

Mr. J. B. Challies has been recently appointed to a position in the Department of the Interior at Ottawa. His position is that of Hydraulic Engineer of the Railway Lands Branch.

Mr. C. Gray Donald, chief hydrographer of the Water Branch of the Department of Lands, British Columbia, has been appointed a member of the Board of Irrigation under the Water Act.

R. C. Swan, B.A.Sc., who has been engaged on water power investigations on the Winnipeg River for a United States syndicate, has joined the engineering staff of the British Columbia Electric Railway Company, of Vancouver and Victoria.

Messrs. T. R. Roberts and A. C. Frith have opened a consulting office in Winnipeg. Mr. Roberts and Mr. Frith have been until recently in the Mechanical Department of the C.P.R., and are now about to take up a general consulting practice, dealing with the design and operation of steam heating and power plants, ventillation and economical handling of fuels, steam locomotives and marine engineering. Their offices are located in the Canada Block, Winnipeg.

Mr. John I. Conradi, a British engineer of wide experience has been appointed as general manager of the Polson Iron Works in place of Mr. John J. Main, vice-president and managing director, who has relinquished the active supervision of the company's plant. The new general manager was for fourteen years connected with the great shipbuilding firm of Thorneycroft & Company, and for the past four years with the firm of Vickers-Maxim Sons & Company.

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ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from The Canadian Engineer for small fee.

14542—August 12—Slightly amending Order 14285, of July 18th, 1911.

14543—August 11—Authorizing C.P.R. (G.B. & S. Ry.) to construct ballast pit spur across road allowance between Cons. 7 and 8, Twp. of Thorah, County of Ontario.

14544—August 12—Authorizing C.P.R. to construct a second main line track across Erwin St., town of Perth, Ontario, mileage 11.05, from S. Falls.

14545—August 14—Authorizing Esquimalt & Nanaimo Rly. to construct bridge 37.8, over Koksilah River, B.C.

14546—August 14—Directing that G.T.R. construct and complete bridge at Brooker's crossing, Twp. of Front of Escott, County of Leeds, before October 31st, 1911.

14547-48—August 11—Approving by-laws of C.N.Q. Railway and C.N.O. Railway, authorizing Geo. H. Shaw, G.T.M., to prepare and issue tariffs of tolls for all traffic.

14549—August 11—Relieving G.T.P. B.L. Co. from speed limit of 15 and 10 miles per hour over Tofield-Calgary Branch.

14550—August 12—Authorizing G.T.P. Ry. to cross and divert highway in N.E. ¼ of Sec. 27, Twp. 24, R. 10, west 2nd, at mileage 100.9, Sask.

14551—August 11—Authorizing Hull Eelctric Ry. to operate its cars over C.P.R. without being brought to a stop, city of Hull, P.Q.

14552—August 11—Authorizing C.P.R. to use temporarily, crossing at Brechin, Ont., pending completion of interlocking plant crossing James Bay Railway (C.N.R.).

14553—August 14—Authorizing Toronto & Eastern Rly. to cross 11 highways, Township of Pickering, Ontario, mileage 0.9-7.7.

14554-55—August 12—14556—August 14—Relieving C.P.R., G.T.P., and M.C.R. from further protection at crossings in Twp. of Rawdon, County Hastings, Ont.., at Ituna, in Province of Saskatchewan, and at highway east of Fargo, Ontario.

14557—August 14—Authorizing Ottawa Electric Co. to maintain wires across C.P.R. in Rideau Park, 1st road north of Stanley Ave., Ottawa.

14558—August 15—Authorizing C.P.R. (G.B. & S. Ry.) to operate trains over interlocking plant at village of Coldwater, Ont., without stopping.

14559—August 14—Slightly amending Order 13968, March 28, 1911, C.P.R. crossing.

14560—August 15—Authorizing city of Sherbrooke, P.Q., to maintain sewer under track of G.T.R. in South Ward.

14561—August 15—Authorizing city of Hamilton to lay temporary level crossing over tracks of Hamilton Radial Electric Rly. Co.

14562—August 15—Authorizing Province of Alberta to construct highway over C.P.R. in S.W. ¼ Sec. 36, Twp. 46, R. 22, west 4 M.

14563—August 16—Authorizing T.H. & B. Rly. to cross highway in 8th Con., Twp. of Pelham (Canboro Road) Ct. Welland, Ont.

14564—August 15—Authorizing G.T.R. to construct spur into premises of Colonial Wood Products, Co. Town of Thorold, Ont.

14565—August 16—Authorizing G.T.R. to use and operate Port Hope Viaduct at mileage 270.28, Eastern Division.

14566—August 15—Authorizing C.N.R. to divert spur in town of Trenton, authorized by Order 12534 of Dec. 12, 1910.

14567—August 15—Authorizing C.N.Q. Rly. to construct 90 ft. D.P.G. Bridge across St. Charles River, at mileage 4.38 from Quebec.

14568-69—August 15—Authorizing C.N.O. Rly. to cross two public roads in township of Loughborough, County Frontenac, Ontario.

14570—August 15—Authorizing C.N.O. Rly. (Hawkesbury-Montreal Div.) to construct across Riviere du Chene, County Two Mountains, P.Q.

14571—August 15—Authorizing C.P.R. Co. to construct First Street West southwesterly across main line tracks and to divert road allowance bet. Sec. 33 and 34, Tp. 19, Rge. 16, W 4 M. Townsite Southeck, Alta.

14572—August 15—Authorizing C.P.R. Co. to construct 3 industrial spurs for Canadian Tube and Iron Co., St. Patrick and Hamilton Sts., Board Ward, Montreal, P.Q.

14573—August 16—Authorizing C.P.R. Co., to construct an industrial spur for Hugh Armour & Co., Ltd., in the city of Regina, Sask.

14574—August 16—Authorizing C.P.R. to construct track across road allowances, mileage 128.16-132.39, Moose Jaw Sub-division.

14575—August 15—Authorizing C.P.R. to construct bridge No. 4.30, Angus to Mile End Quarry Road, Montreal Terminals, Eastern Division.

14576—August 15—Approving C.P.R. location Waldo Branch, Kootenay District, Province of British Columbia.

14577—August 15—Authorizing C.N.R. to cross, temporarily, for construction purposes only, the C.P.R. Co.'s Mission Branch.

14578—August 15—Authorizing C.P.R. Co., to construct industrial spur for The A. B. Cushing Lumber Company, and a sub-spur for the Pacific Cartage Company in the City of Calgary.

14579—August 16—Authorizing C.P.R. Co., to construct branch line of railway or spur into premises of A. Warren, city of Toronto.

14580—August 15—Authorizing C.P.R. Co., to construct its railway across road allowance between Lots 15 and 16, Con. 6, Tp. Ops, Ontario.

14581—August 15—Authorizing C.P.R. Co. to construct siding along Front Street, city of Vancouver.

14582—August 15—Authorizing C.P.R. Co. to construct extra track across road allowances, Moose Jaw to Caron, Swift Current Sub-division.

14583—August 15—Authorizing the S.O.P. Ry. to close portion of the Hamilton Road, replace same by highway diversion and to cross underneath with the tracks of its Guelph Junction-to-Hamilton Branch. Also close portion of present highway, mileage 14.05, of its Guelph-Junction-to-Hamilton Branch; replace same by a highway diversion and to cross underneath with its tracks at mileage 13.96.

14584—August 14—Approving C.P.R. Co.'s Class "A" station at the village of Markinch, Sask., and extending time of construction until 15th Sept., 1911.

14585—Aug. 15—Approving C.P.R. Co.'s Wilkie to Anglin Branch, mileage 21 to mileage 40.

14586—August 17—Authorizing C.N.O.R. to construct bridge over Riviere des Milles Isles at mileage 37.9 from Hawkesbury, Ont.

14587—August 17—Approving proposed "Bott Drains" to be constructed under the track of the C.P.R. Co., in the Twps. West Nissouri and North Dorchester.

14588—August 17—Authorizing C.P.R. to construct a switchback and industrial spur for the Sand & Supplies, Ltd., Lot 31, Con. 9, Twp. Dumfries, County of Waterloo, Province of Ontario.

14589—August 17—Approving revised location of the C.P.R. Co.'s Bassano to Irricana Branch.

14590—August 17—Approving a portion of the C.P.R. Co.'s Bassano to Irricana Branch, mileage 0, thence northwesterly for a distance of 20.2 miles.

14591—August 18—Approving Canadian Freight Ass'n Bulk Grain Bill of Lading, subject to proviso that Sec. 6 be amended.

14592—August 19—Relieving for the present the C.P.R. from providing further protection at first public highway east of Tilbury station.

14593—August 21—Relieving, for the present, the G.T.R. from providing further protection at Hensall Stn., Ont.

14594—August 21—Approving Uniform Tariff of express tolls on all cream, Schedule "B," excluding, and Schedule "C" including collection and delivery service, effective Sept. 30, 1911.

14595—August 21—Authorizing the G.T.R. to construct branch line, or siding, from Saulter St., Toronto, to and into the premises of the Hoyt Metal Co., east of Lewis St., Toronto.

14596—August 17—Approving G.T.P. Branch Lines Co.'s Biggar-Calgary Branch from the N. Line of Sec. 2, Tp. 31, Rge. 25, west of 3rd M. to 4th M. Line, District of Saskatoon, Sask.

14597—August 22—Approving location portion of C.P.R. Moose Jaw Southwesterly Branch from Main Line for a distance of 35.59 miles.

14508—August 22—Approving detail plans "A" of proposed bridge of the South Ontario Pacific Ry. Co.'s Guelph Junction to Hamilton Line, mileage 15.37 from Guelph Jct., in Lot 27, Con. 1, Tp. West Flamboro, Ont.

14599—August 18—Authorizing the C.P.R. to construct, maintain, and operate an industrial spur for the Breckenridge & Lund Coal Co., in the S.E. Quarter Sec. 26, Tp. 7, Rge. 2, West 5th M., Alberta.

14600—August 18—Authorizing the C.P.R. to construct bridges No. 80.09, 46.37, and 3.2, on its line of railway.

14601—August 17—Authorizing the Kootenay and Alberta Ry. Co. to construct its railway across fifteen highways in the province of Alberta.

14602—August 23—Approving location of the C.N. Ry. Co.'s line through Tp. 12 and Rges. 23-25, W. 2 M., Sask., mileage 0 to mileage 14.16 from the junction with the Moose Jaw Extension (Swift Current Extension).

14603—August 17—Approving revised location Algoma Central and Hudson Bay Ry. Co.'s railway where it connects with C.P.R. at Hobon.

14604—August 17—Authorizing the South Ontario Pacific Ry. to construct its Guelph Junction to Hamilton Branch across road allowance between Con. 3 and 4, in Tp. East Flamboro, Co. Wentworth, Ont.

14605—August 17—Authorizing the Calgary & Edmonton Ry. to construct its main line tracks across tracks of Edmonton, Yukon and Pacific Ry., in the Hudson Bay Reserve, North Saskatchewan River and Saskatchewan Ave., Alta., by means of a bridge.

14606—August 21—Granting application city of Brandon for transfer track between C.P.R., Brandon, Saskatchewan & Hudson Bay Rly. (G.N.R.), and C.N.R. Tariffs to be filed covering interchange charges.

14607—August 18—Authorizing C.P.R. to construct, maintain and operate industrial spur for Messrs. Holden & Service, in the N.W. ¼ Sec. 33, Tp. 17, Rge. 18, W. 2 M., near Pilot Butte Station, main line of C.P.R., Sask.

14608—August 19—Approving location C.P.R. Co.'s proposed new station at Waldeck, Sask., on S.E. ¼ Sec. 21, Tp. 16, Rge. 12, W. 3 M.

14609—Aug. 18—Authorizing the C.N.O. Ry. to construct bridge over Jock River, Tp. Nepean, Co. Carleton.

14610—August 18—Approving location C.N.R. Co.'s line through Tps. 27-26, Rges. 8-6, W. 3 M., Sask., mileage 45.54 to 62.31.

14611—August 18—Authorizing the C.N.R. Co., subject to certain terms and conditions, to construct its line across and divert Macleod Trail, to cross Thistle St., Pine St., Spruce Ave., Hungerford St., Poplar Ave., and Victoria Road, and to close and cross Lindsay and St. Joseph St., Calgary, Alta., Vegreville-Calgary Line.

14612—August 21—14613—August 31—Authorizing the C.P.R. to use and operate bridge No. 16.16, Webbwood Subdivision, Lake Superior Division, and bridge No. 45.3 on its Muskoka Subdivision.

14614—August 21—Authorizing C.P.R. to construct bridge No. 118.4 over Boundary Creek on Boundary Subdivision, B.C. Division.

14615—August 19—Amending Order No. 14342, by striking out figures "136.687" where they occur in said order, and substituting therefor the figures "135.687"; striking out words, "such highway diversions being," in the fifth and sixth lines of operative part of order; and substituting word "west" for "north" after mileage 140.385.

14616—August 18—Approving, subject to certain terms and conditions, location of C.N.R. Co.'s line through Twp. 24, Rge. 1, west of 5th Mer.—part of City of Calgary, Alta., mileage 260.03 to 261.08.

14617—August 19—Authorizing C.N.Q. Rly. to take for purpose of constructing a ditch portion of Lot No. 6, in Parish of Les Ecureuile, in County of Portneuf, in Province of Quebec, property of Elzear Barbeau.

14618—August 19—Authorizing C.N.Q. Rly. to cross with its lines and tracks the transfer track of the Montreal Terminal Railway Co., east side of La Salle Avenue, City of Montreal.

14619—August 24—Authorizing C.P.R. (G. B. & S. Rly.) to construct bridge over public road between Cons. 7 and 8, Lot No. 7, at mileage 56.4, Twp. of Eldon, Ont.

14620—August 23—Authorizing Toronto Eastern Railway Co. to cross public road, 2nd Con., Twp. of Pickering, etc., County Ontario, Ont.

14621—August 24—Authorizing G.T.P. Rly. Co. to divert highway in N.W. ¼ of Sec. 31, Twp. 21, R. 4, west 2nd. M. at mileage 62.9.

14622—August 24—Authorizing G.T.R. to reconstruct bridge No. 7 at mileage 166.91 over Thames River near Thamesville, Ont.

14623—August 24—Authorizing G.T.R. to extend its siding into premises of Anglo-Canadian Leather Co., Ltd., Bracebridge, Ont.

14624—August 24—Authorizing T. H. & B. Rly. to construct siding into lands of Schact Motor Car Co. of Canada, Ltd., Hamilton, Ont.

14625-26—August 24—Authorizing C.P.R. to construct bridge 82.7 across Kettle River in Dist. 3, Boundary Subdivision, B.C. Division and bridge at mileage 24.3 on Lots 1 and 2, Con. 6, Twp. of South Orillia, Ont. (G. B. & S Rly.).

14627—August 25—14628—August 24—Authorizing C.P.R. to cross with its Moose Jaw North-Westerly Branch 22 highways between mileage 222.20 and 242.67 and with its Lauder Westerly Extension (Tilston to Griffin) 22 highways, mileage 4.237 to 25.653.

14629—August 28—Directing G.T.R. to install within 90 days improved type of Electric Bell at crossing of Wellington Street, Drayton, Ont., 20 per cent. from Railway Grade Crossing Fund.

14630—August 29—Approving plans and specification for drain to be placed under G.T.R. by Corporation of Twp. of London.

14631—August 25—Authorizing T. H. & B. Rly. to operate spurs into premises of American Can Co., Hamilton, Ont., (2).

14632—August 28—Approving character of ditch known as "Cook Drain" to be constructed under G.T.R. by Corporation of Twp. of Logan, County of Perth, Ont.

14633—August 28—Authorizing C.N.R. to cross 6 highways in Province of Saskatchewan.

14634—August 29—Approving location of C.N.R. through Twps. 11 and 12, Ranges 25-26, west 2nd M., Sask., mileage 14.16-26.38.

14635—August 28—Authorizing C.N.O. Rly. to cross and divert the Beckwith Road in town of Smith's Falls, Ont.

14636—August 28—Authorizing C.N.R. to cross with its Prnice Albert-Battleford Line 11 highways in Province of Saskatchewan.

14637—August 29—Authorizing C.N.R. to cross 12 highways in Sask.

14638—August 28—Authorizing Algoma Central & H.B. Rly. to open for carriage of traffic portion of its Magpie Branch connecting with its Josephine Branch at mileage 17 and extending in a northerly direction for about 9½ miles.

14639—August 28—Authorizing C.P.R. to construct two additional tracks across St. Clair Avenue and Scarlett Road at West Toronto Station until subway at Scarlett Road completed.

14640—August 28—Authorizing C.P.R. to extend its spur of Calgary Brewing and Malting Co.'s spur at Bengal, Alta.

14641—August 28—Authorizing Esquimalt and Nanaimo Rly. to construct bridge No. 4.0.

14642—August 28—Authorizing Quebec Railway Light and Power Company to open for carriage of traffic the north track of its Montmorency Branch near Beauport Station to near Montmorency Falls, a distance of 3.4 miles.

14643—August 28—Authorizing G.T.P. to divert highway in N.E. ¼ of Sec. 25, Twp. 20, R. 2, west 2nd M., mileage 44.2, Sask.

14644—August 25—Authorizing G.T.R. to construct siding into premises of C. J. Miller & Son, Twp. of South Orillia, County Simcoe, Ont.

14645—August 30—Relieving G.T.R. from further protection at crossing of Brunswick Street, Stratford, Ont.

14646-47—August 30—Relieving C.P.R. from further protection at St. Jovite Laurentian Subdivision, mileage 63.28, Twp. of De Salesbury, County of Terrebonne, and at east end of Hitchcock Station on its Portal Section, Saskatchewan.

14648—August 29—Authorizing G.T.R. to construct siding into premises of Independent Glass Producers, Ltd., Toronto, Ont.

14649—August 30—Authorizing C.P.R. to divert road allowance between Cons. 7 and 8, Town Line Road between Twps. of Manvers and Cavan at mileage 87.36 (C.B. & S. Rly.).

14650-51—August 30—Authorizing C.P.R. to construct spur for Maxwell & Hood, Block 27, D.G.S. 53, St. James, Winnipeg, Man., and spur for O. Velie, at Arcola, Sask.

14652-53—August 30—Authorizing Toronto Eastern Railway Company to cross public roads (2) in 1st Con., Twp. of Pickering, County Ontario, Ont.

14654—August 30—Authorizing C.P.R. (G.B. & S. Rly.) to cross highway between Cons. 6 and 7, in Twp. of Manvers, Ont.

14655—August 31—Relieving C.P.R. from further protection at crossing at mileage 9, in Parish of St. Brigide, County Oberville, P.Q.

14656—August 29—Authorizing G.T.R. to construct spur west of Rockfield Station, Parish of Lachine, P.Q., into premises of St. Lawrence Bridge Company, Limited.

14657—August 31—Authorizing Montreal & Southern Counties Rly. to open for carriage of traffic its railway from Front Street, St. Lambert, to the Country Club, a distance of about one mile.

14658—August 31—14659-60—August 30—Authorizing C.P.R. and approving location of new station to be constructed at Luseland, Sask. At Vernon, B.C., and at Milden, Herschel, Plenty, Kerrobert, and Conquest, in Province of Saskatchewan.

14661—Aug. 21—Increasing speed limit on G.T.P., Prince Rupert easterly 100 miles to 30 miles an hour. (File 3452.23.)

14662—September 1—Extending time for filing of Dominion Express Co.'s Standard Mileage Tariffs of Maximum Tolls until Oct. 15, 1911. (File 4214—C1503).

14663—September 1—Approving plans and drawings for terrace over C.P.R. & Hull Electric Rlys. to be erected by G.T.R. at West side Chateau Laurier Hotel, Ottawa. (File 1593.2.)

14664—September 2—Authorizing G.T.R. to construct spur line into premises of Anthes Foundry, Ltd., Toronto, Ont. (F. 18203.)

14665—September 2—Authorizing G.T.R. to construct branch line at Nipissing Junction, Ont., crossing C.P.R. and connecting with T. & N.O. Interlocker to be installed. (File 17865.)

14666-67-68—Sept. 2—Approving location of C.N.O. Ry. through Twps. of Booth, Purdon, Ledger and unsurveyed territory, District of Thunder Bay, mileage 84 to 100 from Port Arthur (File 9188.58) and through unsurveyed territory Dist. of Thunder Bay, mileage 100 to 120 from Port Arthur and through same District, mileage 160 to 179 from Port Arthur (Files 9188.59 and .60).

14669—September 2—Authorizing C.N.R. to cross with its Prince Albert Battleford Line 5 highways in Saskatchewan. (Files 11462.23, .21, .22, .26, .24.)

14670—September 2—Authorizing C.N.R. to cross three highways in Saskatchewan. (Files 11929.5, 11929.6 and 11929.8.)

14671—September 2—Authorizing C.N.O. Ry. to construct station on site at St. Andrews, P.Q. (approving location) (File 3878.463).

14672—August 31—Authorizing C.N.R. to cross with its Swift Current Extension 9 highways in Saskatchewan (Files 13975.9, 13975.10, and 13975.12 to 13975.17 inclusive).

14673—September 2—Authorizing Algoma Central & H.B. Ry. to cross tracks of C.N.O.R. at mileage 80.54 on its Port Arthur to Sudbury Branch, Dist. of Algoma, Ont., Interlocker to be installed. (File 17151.1).

14674—September 2—Authorizing C.P.R. to close up highway at mileage 96.6, Twp. of Mountain, Co. Dundas, Ont. (File 18123).

14675—September 2—Authorizing C.P.R. (G.B. & S. Ry.) to close up portion of road allowance in Twp. of Eldon, Co. Victoria, Ont. (File 2100.91).

14675—August 30—Authorizing C.P.R. to cross with its Lacombe Easterly Branch 21 highways in Province of Alta. (File 618.25).

14677—September 2—Authorizing C.P.R. to construct its tracks across 6 highways with its Regina, Saskatoon & North Saskatchewan Branch from mileage 15.09 to 22.646 (File 4087.20).

14678—September 2—Approving location of C.P.R. Langdon North Branch from mileage 40.1 to 102.1 Alberta. (File 10752.8.)

14679—September 1—Authorizing Essex Terminal Railway Co. to construct an overhead crossing over tunnel tracks of M.C.R. at Windsor, Ont. (File 18187.)

14680—September 1—Approving location of Kettle Valley Ry. from mileage 0 to mileage 5, (File 11738.25.)

14681—September 1—Directing G.T.P.B.L. Co. to construct overhead crossing in N.E. ¼ of Sec. 36, Twp. 39, R. 23, west 4th M., Alta., within 90 days under penalty of $25. (File 10821.28.)

14682—September 2—Approving location of Alberta Central Railway Co. from mileage 120 to 160 east of Red Deer, Alta. (File 14097.10.)

14683—September 2—Approving detail plan for subway at Scarlett Road, Township of York, Ont. (File 16289.)

14684—September 2—Authorizing C.P.R. to construct its Swift Current to Brooks Branch across 7 highways in Sask. (File 16645.2.)

14685—August 18—Directing C.N.Q. Ry. to make certain changes in train service on its Laurentian Sub-division to connect with C.P.R. train at Three Rivers. (File 13994.)

14686—August 1—Authorizing G.T.P. B.L. Co. to cross with its Tofield-Calgary Branch to tracks of C.P.R. Langdon Branch in N.E. ¼ of Sec. 34, Twp. 27, Range 26, West 4th. (File 10821.54.)

14687—August 5—Authorizing G.T.R. to take certain lands of Mrs. J. A. Wright and Rockfield Land Co. in Parish of Lachine, P.Q., for crossing of (overhead) of Lachine Rd. (File 9437.119.)

14688—September 2—Authorizing Toronto Carpet Manufacturing Co. to construct a bridge across its siding from Company's warehouse to Axminster Bldg., King St. West, Toronto. (File 17929.)

14689—August 23—Suspending Tariff C.R.C. No. 15 of White Pass & Yukon Route to take effect Sept. 1st, 1911, until further evidence is heard at a sitting of Board to be held in Oct. (File 10556.)

14690—September 5—Authorizing South Ontario Pacific Rly. to con-
Waterdown, Ont. (File 1852.17.)

14691—September 2—Authorizing C.P.R. to construct its Bulyea South
struct its Guelph Jct. to Hamilton Line under bridge at Dundas St.,
Branch across 9 highways. (File 4806.3.)

16492—September 5—Authorizing C.N.O. Ry. to construct its line across Elmsley St., town of Smith's Falls. (File 3878.461.)

14693—September 5—Authorizing C.P.R. to construct spur for Herbert Rolling Mills Co., east of Herbert station, Sask. (File 18194.)

14694—September 5—Authorizing C.P.R. to constuct spur for Haug Bros. and Nellermoe Co., Ltd., Regina, Sask. (File 17581.)

14695—September 5—Authorizing C.P.R. to reconstruct 6 bridges on its British Columbia, Lake Superior Divisions. (Files 3416.13, 3422.13, 7693.20, 7693.21, 7706.15, and 7706.16.)

14696—September 5—Authorizing G.T.R. to construct siding into premises of Housedry & Sons, city of Peterboro, Ont. (File 18185.)

14697—September 5—Authorizing G.T.R. to maintain additional passing track across public highway east of Oshawa Station. (File 18206.)

14698—September 5—Authorizing G.T.R. to maintain siding into premises of John Heney & Son, Limited, Ottawa. (File 17949.)

14699, File 11738.36; 14700, File 11738.38; 14701, File 11738.26; 14702, File, 11738.27; 14703, File 11738.29; 14704, File 11738.35; 14705, File 11738.37—September 5—Approving Bridge Plans for crossing of Coldwater and Kettle Rivers in Province of British Columbia by the Kettle Valley Railway Co.

14707—September 6—File 2100.3. Granting certificate of correction to C.P.R. correcting error in location plan (G.B. & S. Ry.)

14706—September 6—File 3282. Approving by-law of Brandon, Sask. & H.B. Ry., authorizing H. T. Noble, G.P.A., to prepare and issue Tariffs.

14708—September 5—File 18160. Authorizing C.P.R. to construct industrial spur to C.P.R. Mill Site mileage 5, West of Ignace, Ont.

14709—September 6—File 16942. Authorizing C.P.R. to construct industrial spur for Manitoba Govt. Telephones, Winnipeg, Man.

14710—September 6—File 14097.9. Authorizing Alberta Central Railway to construct bridges over highway at mileage 20, 29, and 29.8 on its line between Red Deer and Rocky Mountain House.

14711—September 5—File 18161. Authorizing Montreal Terminal Ry. to construct spur into premises of Raymond Cement Products Co., town of Montreal East, P.Q.

COMING MEETINGS.

SOCIETY OF CHEMICAL INDUSTRY, CANADIAN BRANCH.—Sept. 21, 22, 23. Toronto. Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Oct. 3, 4, Montreal. F. S. Baker, President, Toronto; Alcide Chausse, Hon. Secrotary, 2 Beaver Hall Square, Montreal, Que.

INTERNATIONAL MUNICIPAL CONGRESS AND EXPOSITION.—Sept. 18-30. Chicago, Ill. Curb M. Treab, Secretary, Great Northern Buiding, Chicago, Ill.

FOURTH ANNUAL GOOD ROADS CONGRESS.—Sept. 18-Oct. 1. Chicago, Ill. J. A. Rountree, Secretary, Birmingham, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Sept. 26-29. Grand Rapids, Mich. A. Prescott Folwell, Secretary, 239 West Thirty-ninth Street, New York City.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENT.—Nov. 20-24. First Annual Convention, Richmond, Va. Logan Waller Page, President, United States Office of Public Roads, Washington, D.C.

AMERICAN ELECTROCHEMICAL SOCIETY.—September 21-23. Twentieth general meeting, Toronto, Ont.

AMERICAN PEAT SOCIETY.—Sept. 21-23. Fifth annual meeting, American House, Kalamazoo, Mich. Julius Bordollo, Secretary, Kingsbridge, N.Y.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain; Secretary, A. C. D. Blanchard, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

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THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

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ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang; Secretary, L. M. Gotch, Calgary, Alta.

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ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Charles Kelly, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

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CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

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CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

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SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

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WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.