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# The Canadian Engineer

*A weekly paper for Canadian civil engineers and contractors*


## HIGHWAY BRIDGES IN ONTARIO

### REVIEW OF DESIGN AND METHODS OF CONSTRUCTION OF STRUCTURES ADAPTED TO THE REQUIREMENTS OF MODERN TRAFFIC CONDITIONS


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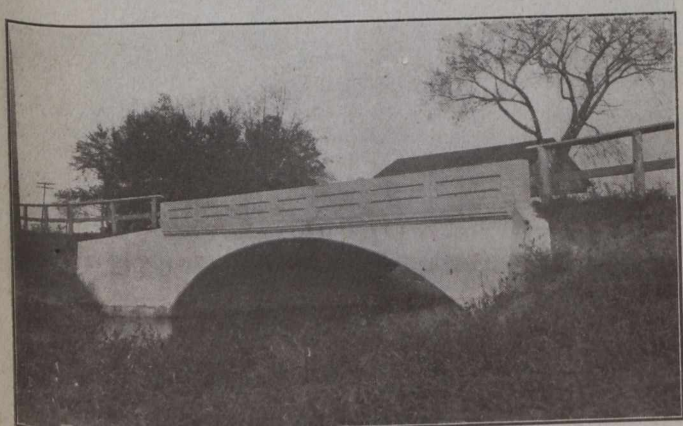
THE improvement of roads throughout the province has attracted a wide public interest for some years, and the superior type of road now built has led to a demand for better types of culverts and bridges with wide roadways, and an appearance in keeping with the improved surroundings. Among county officials there has been an increased interest in the types of construction selected. There still remains, however, a lack of uniformity in general construction, and an absence of proper appreciation of the many types of culverts which are suitable for the smaller waterways. It is, therefore, sought to present to those in charge of the highways a review of design and methods of construction



A Substantial and Attractive Concrete Arch.

which will result in securing sound and enduring structures properly adapted to the requirements of traffic in designing culverts and bridges to be built on the highways of the Province of Ontario.

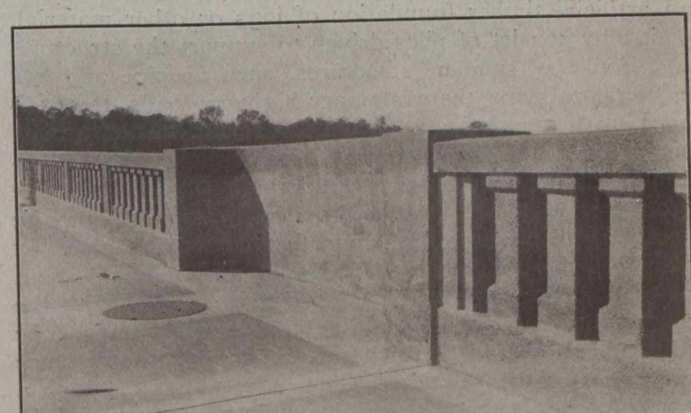
**Periodical Examination.**—It is advisable that the county or township road superintendent should periodically, at least twice a year, examine all parts of each steel bridge under his care.

**Location.**—When a permanent structure is to be erected the site should be carefully selected so that there will be the least possible exposure to the forces tending to cause destruction of the bridge. The site should also be chosen so that the cost of construction will be as low as consistent with good service to the public.

The safety of the public demands that a bridge be located so that it is parallel with the centre of the road. To place it otherwise, at an angle with the road, will give a turn at each end which is dangerous and should be avoided.

**Size of Waterways.**—In selecting the size of a waterway careful consideration should be given local conditions, including flood height and flow, size and behaviour of other openings in the vicinity carrying the same stream characteristics of the channel and of the watershed, climatic conditions, extent and character of the traffic on the highway and other circumstances affecting the safety, economical construction or maintenance of the culvert or opening.

The use of a formula to assist in determining the proper size of waterway can only be warranted when the



An Artistic Handrail.

values of the terms in the formula are known to suit local conditions. Such formulas are useful as a guide in fixing and verifying bridge or culvert sizes where only general information regarding the watershed is available. A formula should not be used where it is possible for the engineer to visit the site and by careful examination of the locality arrive at a satisfactory result.

It is advisable to place the face of the footings of abutments at least as wide apart as the banks of the river, and still further apart if other circumstances warrant. Never place the abutments of a bridge in the water. Keep the abutments on the shore with their front at the water's edge.

**Bridges.**—Many timber bridges still exist in the older parts of Ontario, and these structures are a heavy burden to the municipality in which they are situated. They require constant attention and frequent repairs to keep them in a safe condition for public travel.

In addition to the expense for maintaining such bridges they are a source of anxiety to municipal officials, as such structures frequently collapse, as the accom-

*Abstracted from pamphlet concerning the construction of highway bridges recently sent out simultaneously with and supplementary to "General Plans for Highway Bridges."

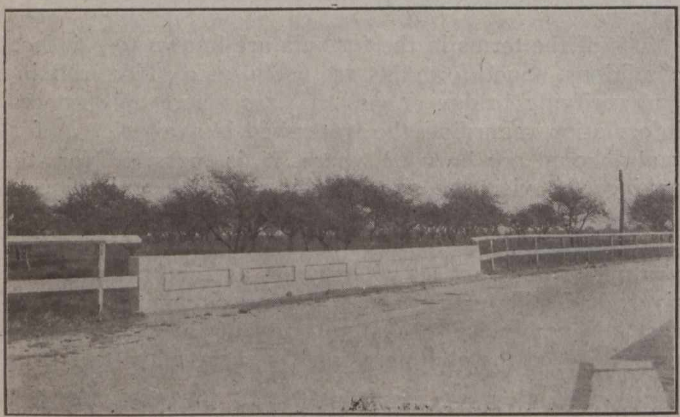
panying illustration shows. In this case the driver of the threshing engine knew before reaching the bridge that it was unsafe, but hoped to cross safely by running rapidly. The bridge fell when the full weight of the rear

A Timber Bridge after Collapse.

wheels of the engine came on the centre floor beam and the machine went down in four or five feet of mud and water.

**Foundations.**—The word "foundation" in this article means the natural bed of material upon which rest the footings of the piers or abutments. This material may be muck, silt, sand, gravel, clay, boulders, rock, an artificial timber foundation of logs or other material, or it may consist of piles driven to support the structure.

For the smaller structures, such as pipe and box culverts, carrying the customary highway loads, the ordinary earth foundation is usually sufficient, but care must be exercised to provide protection against the undermining of the foundation by running water. Where the ground is very wet and soft or in swamps it may be necessary to increase the supporting power of the soil by placing logs 10 inches to 12 inches in diameter and about two feet apart under the footing and parallel with the roadway. These logs should extend entirely under the culvert, and should be four feet longer than the distance out-to-out of the footings. The advantages of such a type of footing are that the logs distribute the weight



Handrail of Concrete Arch.

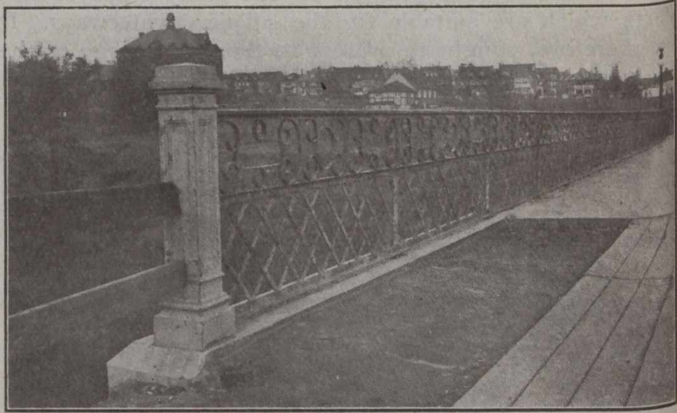
of the culvert and so prevent uneven settlement and tipping of the end and sidewalls.

**Footings.**—Footings of piers, abutments and headwalls should be carried down below the surface of the ground or the bed of the river to such a depth as to be safe from the heaving effect of frost and scour of the water. In the southern portion of Ontario the effects of frost may extend to depths of 2½ feet, while in the north it may vary from 3½ to 4 feet.

**Piers.**—Where a bridge is required of over 100 feet span it may be economical to consider using two or more short spans of about 50 feet, and support their ends by placing a pier in the river.

Whether this type of construction is economical or not depends upon the cost of the various spans, and also upon the size and cost of the pier or piers required. Where a river can be crossed by using a single span it is very often undesirable to use piers, as they furnish an obstruction to the waterway, and are liable to be damaged or destroyed by ice jams, logs, driftwood or floods. The kind of foundation available for the pier may also be a controlling factor in the design of the bridge, and should the river be very deep or have a soft, shifting bottom the use of piers may not be economical.

The size of piers is usually governed by the width of the top of the pier required to support the bearings of the bridge. This width may be from 3 to 5 or 6 or more feet. A coping having a width of about 3 inches and a height of 1 foot or more, depending on the height



Steel Lattice Handrail.

of the pier, is placed around the top of the pier, and the shaft of the pier then given a batter of from 1 in 12 to 1 in 24 from the under side of the coping to the top of the footing. The width of footing depends to some extent upon the nature of the foundation, but if it is extended for from 9 inches to 1 foot all around the pier, a satisfactory size will usually be secured.

On the upstream side of the pier a wedge-shaped cutwater or starling is usually provided to deflect the water and debris. As additional protection a steel plate or steel angle 8 inches x 8 inches x ½-inch in section may be built into the nose of the starling, and should extend from a point several feet above high water down into the footing. This steel angle should be secured to the pier by ¾-inch rag bolts, 12 inches long, having countersunk heads and spaced about two feet apart on centres.

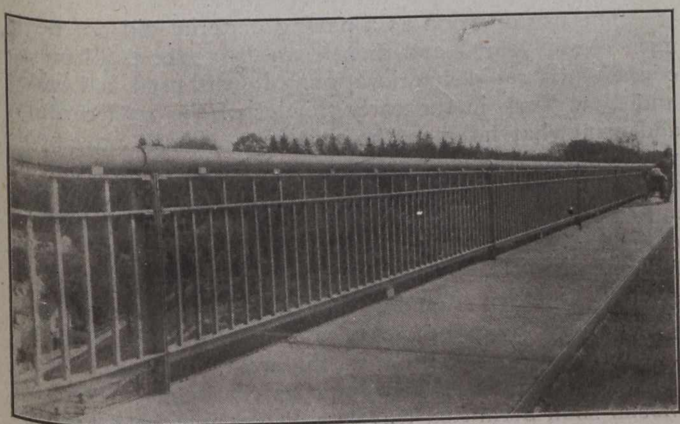
The footings of piers should be carefully constructed, and if there is any possibility of the river scouring the foundation, a quantity of stone should be placed around the outside of the footing as a protection. Where possible the footing of a pier should not be placed upon a foundation which is liable to be softened, scoured or undermined by water action or on a hard strata, when overlying softer material.

Footings of piers should be embedded in firm ground to a depth of not less than four feet, in order to make the pier secure against displacement. The entire design of a pier should be carried out so that it will have a stability factor of at least two under all possible conditions.

**Roadway Embankments.**—The embankments of the approaches to a bridge should be made in thin layers and thoroughly compacted. Each layer should be built out to the full width required, with its sides constructed to the true slope, and not widened with loose material dumped from the top. All side slopes of the embankment should be constructed to a batter of 1½ feet horizontal to 1 foot vertical.

Where washing of the embankment may be expected during times of high water, the outside slopes should be protected with a rip rap of large stones properly laid to protect the filling. Such rip rap should extend from a solid bottom up to a height of several feet above high water mark.

**Surface and Subsurface Drainage.**—Wherever possible water shall be kept off the roadbed. This may be accomplished by a properly crowned roadway surface, and by having the ditches always in proper condition to drain water away. Water should not be allowed to remain in side ditches, and to prevent such condition the



**Handrail Should be of Such Height as to Give Confidence.**

ditches should be properly graded to the natural outlet. To protect embankments built upon saturated soils a satisfactory procedure is to provide intercepting ditches or pipe drains. In cuts, the side ditches should be excavated through whatever class of material is met with. In wet cuts or in wet and soft hills or side hills a tile drain or drains should be provided. The wet spots appearing in the roadway on a hill should have a tile drain run into such wet spot, and any soft material removed and replaced with crushed stone or gravel.

Breaking and sliding away of the shoulder of a roadway is best cured by flattening the slope away from the shoulder. This should be accomplished by filling in material against the embankment. The old surface of the embankment should be ploughed before any new material is placed, so that a satisfactory bond may be secured.

Where a roadway is in a cutting and material from the sloping banks continues to slide in on to the road, the best method of securing relief is to remove the bank on each side of the road till a flatter slope is secured.

**Pipe Culverts.**—Pipe culverts are circular in cross-section, and vary from 8 to 48, and even 60 inches in diameter. The materials used in their manufacture are vitrified clay, corrugated sheet metal, cast-iron and concrete. Culverts should be permanent; should be large enough to easily pass the largest flood flow of water; should, if possible, be self-cleaning, and should be of such a size as to permit cleaning.

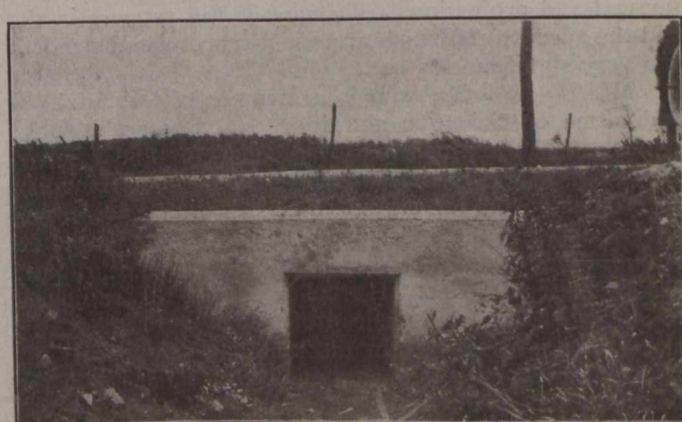
It is important that they be large enough to enable proper cleaning, and with this fact in view it is recom-

**What Happens when Good Endwalls are not Used and Pipe not Properly Located.**

mended that pipes less than 15 inches in diameter be not used, and that the opening of box culverts be not less than 2 feet square. The amount of material required for these sizes is not a very great increase over those of smaller dimensions, and the ease with which they may be maintained fully warrants their construction. Where conditions permit, culverts should be laid with a fall of about 1 foot in 20 feet, and care should be taken to see that the ditch above and below the culvert is properly graded to deliver and carry away the water.

Care should be taken to construct a substantial headwall of concrete or rubble-stone at each end of the pipe, and to see that the footings of this wall extend to a depth of not less than 3 feet. All joints in the pipe should be carefully made and thoroughly tight.

The foundation upon which the pipe rests is very important, and a solid bottom should be secured before laying the pipe. If earth is the material upon which the pipe is laid a satisfactory foundation may be secured by trimming off the bottom of the trench to a firm and even bearing. After the pipe is placed great care should be taken to thoroughly tamp and pack the backfilling around



**Well Built and Properly Drained.**

the pipe, as otherwise unequal settlement may occur and the earth will crack or crush the pipe. Backfilling should be placed in layers 6 inches thick and well tamped. In soft or marshy soils a trench should be excavated one foot below the proposed bottom of the culvert and refilled with coarse gravel or broken stone.

**Length of Culverts.**—Culverts are frequently constructed of an insufficient length so that the fill spills over the top of the coping. For pipe and box culverts on county roads the distance between the inside edges of endwalls should not be less than 24 feet where the top of the culvert is about 1 foot below the crown of the road. For cases where a culvert is placed in a fill, the proper length of barrel is obtained by adding together the width of the roadway, three times the height of the crown of the road above the top of the culvert and twice the thickness of the coping wall.

**Handrails.**—Handrails on all structures should be at least four feet in height above the top of the floor of the structure, and should be designed to safely support a load of 60 pounds per lineal foot applied laterally at the top of the handrail. Handrails may be of steel lattice, galvanized iron pipe or concrete.

It is, therefore, not advisable to use bank run gravel in concrete. A much better practice is to screen the gravel, and after obtaining the sand and pebbles in separate piles to combine the ingredients for concrete by selecting two parts sand and four parts pebbles, or using them in any other proportion which may be desired. The resulting concrete will be of much better quality and the slight extra expense for screening will be repaid in the quality of concrete secured.

**Specifications and Inspection.**—Proper specifications should be prepared for all structures, and during construction an inspector should be employed to see that the provisions of the specifications are observed. Carelessness in proportioning a few batches of concrete or the accidental omission of the cement may cause failure of the bridge.

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## ANNUAL MEETING OF JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS.

The Joint Committee of Technical Organizations, under the chairmanship of Alfred Burton, met in the Mining Building of the Toronto University March 30th to discuss and adopt the first annual report of the organization.

Captain Matheson, who has been seventeen and one-half months in the trenches, declared that upon the mental, physical and professional efficiency of the sappers in the field the success of British arms in France was dependent to a very significant extent.

Mr. R. A. Ross, who is a member of the Advisory Committee on Scientific and Industrial Research, spoke of the assistance which had been called for and received in good measure by the French, British and Canadian Governments from the organized classes of engineers, and he was sure that the joint committee of Ontario Technical Organizations would grow in importance and rapidly assume national scope. He believed that the engineers should come out from their professional retirement and take a more active part in the political affairs of the country and exercise the same quality of efficiency in the administration of internal matters as they had displayed in their contributions to the strength of the Empire in the present struggle.

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The machine tool exports from America during the year ending June 30, 1916, are said to have exceeded $61,000,000, of which about $48,000,000 left through the port of New York. This is more than twice the amount of similar exports for the previous year.

## BEST PRACTICE IN WOOD BLOCK PAVEMENTS.*

By Ellis R. Dutton,

Assistant City Engineer, Minneapolis, Minn.

PAVEMENTS are almost as old as people. When people began to be civilized and neighborly, then began the need of a better means of communication, and, as needs increased, methods were put in force to alleviate those needs—and invention, you might say, was called upon. The rough trail was smoothed and the wet places were filled and bridged so that a better means of communication was provided. As time went on, and the methods of transportation were improved, a better road was required and a surface that would permit of communication in all kinds of weather. This was provided by the use of broken stone of larger dimension and of greater depth. The remains of the old Roman roads are seen to-day and show how well they builded, but these roads would not only be costly in these days, but they would be useless under the modern methods of transportation. Stone, however, of some form has been used in the construction of pavements from time immemorial and probably will continue to be used indefinitely in some part of the work.

The use of wood as a paving material did not begin until recent years—and then it was not successful on account of its rapid deterioration. It was used in London and New York in the early thirties of the 19th century, and somewhat later on the continent. These pavements were rough, or soon became so, and the improvements were along the lines of a smoother pavement, which resulted in the so-called "Nicholson" pavements laid quite extensively about 40 or 50 years ago. This pavement fulfilled the desired smoothness but did not last, as the wood was untreated and permitted water to enter and the blocks soon decayed. There was also tried in this country, and particularly in the west, the round cedar blocks. The triangular intestics between the round blocks soon permitted travel to also round the *top* of the block, making the surface very uneven and rough, and reminding one of the old corduroy roads. Decay also played havoc with the blocks—and in a very short time this pavement had gone the way of its predecessors and some other class of pavement had to be used.

About this time attention was turned to some examples of wood which had been treated with dead oil of coal tar and used for paving purposes. One example was in Galveston, Texas, where some creosoted pine blocks were laid in 1873. Another was in New Orleans, where similar blocks were used; also in St. Louis, in 1877. The extended use, however, of this class of pavement did not begin until about the beginning of the 20th century; and then its advocates had to overcome the prejudices that had arisen on account of the previous use of untreated wood. It was, however, recognized that if wood could be preserved from decay, it would make a better pavement in many ways than any other kind of material.

One of the earliest pavements of this material, in the middle west, was laid in Minneapolis in 1902, which has made a record as to durability and low cost of maintenance—and from present appearances it will be good for quite a number of years. There are numerous examples throughout the country of as good, if not better, record; one right here in the city of Boston, laid I think, a year or two prior to that in Minneapolis. Last year I had the

*Paper read before the American Road Builders' Association, Boston, Mass.

pleasure of inspecting with Mr. Geo. W. Tillson (the engineer who laid them) some creosoted wood block pavements in the city of Brooklyn. These were laid in 1900, and they were in excellent condition. From these beginnings the industry has come to the present time through many experiments, changes and improvements, to the present-day practice. Some things that were considered in the early days of the industry of little importance have proven to be of vital import; and other things formerly considered *the thing* have been relegated to the discard.

One of my first experiences along these lines was, when in the treatment of some blocks in 1903, the sap-wood showed a penetration of the preservative of only half an inch or so. I did not think that it was sufficient, but the "expert" said the oil would penetrate further as the block aged, and that *he* would guarantee it to be preserved. Well, the results show that the oil was insufficient; that it did not penetrate any further; that the blocks were not preserved, and that the "expert's" guarantee and the blocks were rotten. So we had to learn something ourselves and not depend on the so-called expert opinion of interested persons. Since investigating, studying and applying knowledge gained, we have had no such results, and we have learned that the oil has to be put into the wood if you wish to preserve it.

Another fallacy of the early days was the idea that you had to extract all the resins, etc., from the wood before treatment; and certain methods of steaming were resorted to, to accomplish this result. The fact of the matter is, no such results, as intended, were accomplished, but inadvertently a result was accomplished which in the later days is considered quite necessary; that is, the expansion and drying or seasoning of the blocks by steaming. This feature, the proper preparation of the blocks before the introduction of the oil, and the proper treatment of the blocks after the introduction of the oil, is now considered a matter of prime importance—and the quality of the oil is more of a secondary matter.

For a number of years the oil was the whole thing and there was a great diversity of opinion as to the best oil to be used; whether it was a heavy oil, or a light oil, or a tar oil, or a distillate oil; whether it was a coal-gas tar oil or a water-gas tar oil. It has been found that there are quite a number of oils or tars that are suitable to be used, and any one of them will preserve the wood and make a first-class paving block. The statement has been made that oils used in about 1908, when the gravity of the oil was raised from 1.08 to 1.10, would not be stable and remain in the blocks and would not preserve them. We took from the street, in the fall of 1916, some of the blocks treated in that year (1908) and extracted the oil to see what changes had occurred in the oil. From the comparison with the original oil, it shows that the residue originally above 355°, was 49 per cent.; in the extracted oil it was 52 per cent. The gravity of the original oil was 1.10, and of the extracted oil 1.116. The amount of oil per cubic foot in the original treatment was 16 pounds; and from the sample from which the oil was extracted it was about 12 pounds, showing that there had probably been some loss; but that there was plenty of oil remaining to insure its preservation for a number of years. There was no indication of any decay or anything of that kind noticeable in the pavement, so that the theory that the oil had evaporated or did not preserve the wood, was false.

Almost all of the engineers and wood-preserving experts agree in recommending a heavy oil of a gravity of 1.08 to 1.12, and the majority recommend a coal-tar oil, though they do not discourage the use of a distillate oil except as to the cost and use of a less amount of oil than 16 pounds per cubic foot.

There was a committee of the American Wood Preservers' Association which have been investigating the claim of the water-gas tar producers as to the preserving properties of their material. They cited numbers of places where wood paving blocks treated with water-gas tar had been used successfully. From the personal investigation of the committee, as shown in the report as presented to the meeting of the association held in New York in January, 1917, it would appear that "refined water-gas tar has demonstrated its value and usefulness as a preservative for wood paving block." (pp. 47, Advance Copy of Committee on Preservatives.)

There has been, however, considerable progress made as to the method of treatment which has done more toward making a better block, than along the oil lines. Under the old methods, difficulties and objections arose after the pavement was laid, on account of swelling, bleeding, etc. These objections were directly traceable to the method of impregnation. Experiments and tests were made to improve the progress, and the improved method now advocated provides that the blocks be steamed from 2 to 4 hours before the vacuum is applied. This vacuum should be at least 22 inches and held for at least one hour. The preservative oil is then run in without air being admitted, and pressure gradually applied until the required quantity has been forced into the blocks. After this, a supplemental vacuum of at least 20 inches shall be applied for not less than 30 minutes. If necessary, the vacuum may be preceded or followed by a short steaming process.

This is the specification as adopted by the various societies having to do with such matters. This treatment produces a block in which the oil has thoroughly penetrated the sap-wood and the interior of the block—and leaves the outside clean and dry so that there is almost no bleeding.

We laid a section of paving blocks treated as above, in 1915, in which a part was filled with the ordinary pitch filler and a part was filled with sand, to determine actually whether blocks so treated did bleed. We found that the part filled with sand showed almost no bleeding, only a block here and there showing oil on the surface, while the bituminous filler used on the other part caused almost all of the so-called bleeding. There have been some misstatements made as to this experiment, and attributing the bleeding to the use of a coal-tar pitch filler. Such is not the case, as any bituminous filler, either pitch or asphalt, would cause the same result. If some material could be provided which would eliminate this feature and still preserve the good qualities of the bituminous filler, it would be a great benefit to the wood block industry, and incidentally to the person introducing it.

Creosoted wood block paving, in this country at least, has been usually laid on a sand cushion of approximately one inch in thickness, spread on the top of the concrete foundation. There have been a large amount of successful pavements laid in this manner, but there has been also quite another large amount that has not been so successful. If the right quality of sand be used properly, it is all right, but under most systems of doing work, it would be better to use some other method. Probably the best practice to be followed is to make a smooth surface, true to grade and contour, on the concrete foundation, when it is laid. Immediately before the laying of the blocks, this surface is painted with a thin coating of bituminous material of the proper consistency. The blocks are then laid on this bituminous coating, to which they adhere, and the joints are filled with the usual material.

This differs from the European and Continental practice, where the concrete is made smooth, but the blocks are dipped in the bitumen and then laid on the concrete. I examined an interesting example of a pavement laid in the first method outlined above, on Dawson Road, a highway leading out from the city of St. Boniface, near Winnipeg, Canada. This work was done in 1910, using a Norway pine block 3 inches in depth and treated with 16 pounds of heavy oil. There were several brick yards that used the pavement in hauling their products to town, and also the country travel in and out. The street had no care or maintenance, and no sprinkling had been done to keep the blocks from drying. At the time of the investigation in 1916, the pavement was in good condition and showed no evidence of bleeding or swelling; the curb along the edges being true and straight as they were when placed.

In the earlier days of the industry it was considered necessary to provide expansion joints at right angles to the curb line, and to lay the blocks at right angles. These expansion joints were found to be a source of weakness to the pavement and also to be of no use, so they have been discontinued. It is still an open question as to whether the blocks be laid at right angles to the curb or on some other angle. In the experimental pavement laid in Minneapolis in 1906, there were three contiguous sections laid; one at 90°, one at 67½° and one at 45°. From the several inspections of these sections it is quite apparent that the blocks laid at 67½° and 45° show less trouble from joint wear than those at 90°. These blocks were Norway pine and would show the wear much faster than a harder pine.

There has been considerable discussion as to the effect the steaming required in the new specifications, as above outlined, would have on the crushing strength of the blocks. Experiments have been made by the Forest Service, and a paper by Mr. Clyde R. Teasdale, giving the results of such tests was presented to the American Wood Preservers' Association at its recent meeting in New York. From these experiments, there does not appear to be any weakening of the crushing strength of the blocks by such treatment. Treated green heart pieces gave average results 3.5 per cent. below the corresponding natural pieces; treated green sap pieces, about 1 per cent. higher than corresponding natural pieces; treated air-dry heart pieces, 10 per cent. higher than natural pieces; and treated air-dry sap pieces, 8.5 per cent. higher than natural pieces.

The value and usefulness of a pavement depends largely on the cost of its upkeep, and a pavement where the repairs are low is the better, all things being equal. There have been numerous inquiries as to the cost of repairs on a creosoted wood block pavement. The following is the cost in cents per square yard per year for repairs, to creosoted wood block pavements in Minneapolis for the various years, and also shows the total yardage in place on January 1st of each year:

| Year. | Total square yards. | Maintenance, cents per sq. yd. |
|---|---|---|
| 1907 | 210,464 | 0.012 |
| 1908 | 312,815 | 0.085 |
| 1909 | 457,583 | 0.052 |
| 1910 | 600,922 | 0.064 |
| 1911 | 757,472 | 0.294 |
| 1912 | 928,726 | 0.162 |
| 1913 | 1,060,688 | 0.193 |
| 1914 | 1,195,932 | 0.254 |
| 1915 | 1,381,605 | 0.239 |
| 1916 | 1,516,819 | 0.054 |

The average cost of repairs in the 10th Street paving laid in 1902, for the past 10 years has been about 1/10th of a cent per square yard per year. From these figures you can readily see that the maintenance or upkeep cost is very low and that this class of pavement fulfils the requirements of a first-class pavement as to cost of maintenance; and there is no question as to its exceeding all others as to its noiselessness and traction resistance.

There has been in times past, a great deal of controversy over various things to do with the materials and manufacture of creosoted wood blocks. It is very gratifying, indeed, to see these things being overcome, and a better feeling of unity prevailing as to the disputed points by all parties, so that now they can agree on a uniform standard specification.

This adoption of a standard specification does not mean that we have learned all there is to know about creosote or wood block pavements. There is just as large a field for investigation, experiments and improvements as ever, and we should be all the better prepared, by reason of the accumulated knowledge, to go forward and make and maintain wood blocks as the best pavement known.

## RESISTANCE OF PASSENGER TRAIN EQUIPMENT.*

By E. C. Schmidt and H. H. Dunn.

CONTINUING the work on train resistance which it has been carrying on since 1907, the department of railway engineering of the University of Illinois has recently completed a series of tests undertaken to determine the tractive resistance of moderately heavy passenger trains. The tests were begun in May, 1916, and finished in August. Through the courtesy of W. L. Park, vice-president of the Illinois Central, they were made on the lines of that company between Champaign, Ill., and Centralia, on trains in regular through passenger service, and by means of a dynamometer car. The results of the tests prove that in passenger trains, as in freight trains, the specific resistance is materially affected by the weight of the cars composing the train, and that it decreases as the average weight of the cars increases.

**The Trains Tested.**—The trains experimented upon —18 in number—were all passenger trains, which varied in total weight from 535 to 727 tons. The number of cars varied from eight to twelve. The train make-up was not uniform and is shown for each train in the table. The average gross weight per car in the various trains ranged from 48.7 to 71.1 tons. In 13 of the 18 trains the dynamometer car was coupled with its measuring drawbar toward the rear, and in these cases its own resistance is excluded from the test car records; its weight is consequently likewise excluded from the train weights listed in the table. In the five remaining trains, on the other hand, the resistance of the dynamometer car itself is included in the records and its weight is therefore included in the train weight. Since the test car weighs only 29 tons, the normal average car weight is somewhat lowered in these five instances. All but 32 of the 187 cars included in the 18 trains had six-wheeled trucks. Other data defining the train make-up are given in the table.

*Abstract from Railway Age Gazette of a paper published in Bulletin 194 of the American Railway Engineering Association.

All the northbound trains were "No. 2 Through Mail," whose schedule for the 124.5 miles is 3 hours and 5 minutes—a schedule speed of 40.4 miles per hour. The running time of a typical northbound train is 2 hours and

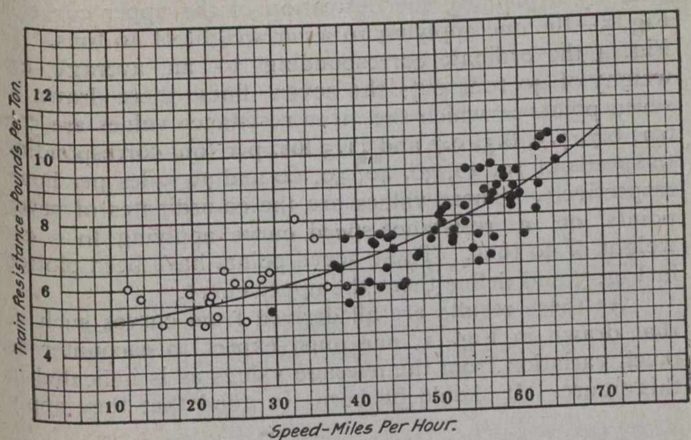


**Fig. 1.—Relation Between Resistance and Speed for Test 44B.**

37 minutes, which is equivalent to a running speed of 47.5 miles per hour. The southbound trains, "No. 5 Fast Mail," have a schedule of 3 hours and 35 minutes, or a schedule speed of 34.8 miles per hour. A typical running time for this train is 2 hours and 51 minutes, which gives an average running speed of 43.7 miles per hour.

**Track and the Weather Conditions.**—The roadbed on which the tests were made was in good condition and the drainage, in general, was excellent. The track was especially surveyed for the purposes of these tests. Except on a few short stretches through station grounds, where cinders and screenings are used for ballast, both tracks are ballasted with broken limestone. The cross-ties, 6 ins. by 6 ins. by 8 ft., are spaced about 20 ins. between centres and are of treated red oak, treated soft wood or untreated white oak. Sixty-one miles of the southbound track are laid with 85-lb. rail of American Society of Civil Engineers section, while the remaining 63.5 miles are laid with 90-lb. rail of American Railway Association section. Practically all of the northbound

| Test Number | Average Approximate Wind Velocity Miles Per Hr | Gross Train Wt. Tons | Cars in Train | No. of Cars Having Three Axles Per Truck | Kind of Cars: Test Car | Baggage and Express | Mail | Coaches | Pullmans | Diner | Special |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 44A | | 604.5 | 11 | 9 | | 6 | 2 | 2 | 1 | | |
| 44B | | 570.0 | 11 | 9 | | 6 | 2 | 2 | 1 | | |
| 46A | 20.0 | 615.48 | 11 | 9 | | 4 | 4 | 2 | 1 | | |
| 46B | 15.0 | 551.32 | 10 | 8 | | 3 | 4 | 2 | 1 | | |
| 47 | 10.0 | 727.0 | 11 | 10 | 1 | 1 | 1 | 3 | 4 | 1 | |
| 48A | | 538.5 | 11 | 9 | | 5 | 2 | 2 | 1 | | 1 |
| 48B | | 562.0 | 11 | 8 | | 6 | 2 | 2 | 1 | | |
| 49A | 20.0 | 588.2 | 9 | 8 | 1 | 1 | 1 | 2 | 3 | 1 | |
| 49B | 20.0 | 634.9 | 10 | 8 | 1 | 1 | 1 | 3 | 3 | 1 | |
| 50A | 25.0 | 601.6 | 12 | 9 | 1 | 6 | 2 | 2 | 1 | | |
| 50B | 25.0 | 535.2 | 11 | 8 | 1 | 5 | 2 | 2 | 1 | | |
| 51A | 20.0 | 618.01 | 9 | 8 | | 1 | 1 | 3 | 3 | 1 | |
| 51B | 20.0 | 549.02 | 8 | 7 | | 1 | 1 | 2 | 3 | 1 | |
| 52A | 20.0 | 570.1 | 11 | 9 | | 6 | 2 | 2 | 1 | | |
| 52B | 15.0 | 540.0 | 11 | 9 | | 5 | 2 | 2 | 1 | | 1 |
| 53A | 15.0 | 708.3 | 10 | 9 | | 1 | 1 | 3 | 4 | 1 | |
| 53B | 15.0 | 639.92 | 9 | 9 | | 1 | 1 | 2 | 4 | 1 | |
| 54 | 20.0 | 606.23 | 11 | 9 | | 6 | 2 | 2 | 1 | | |

**Description of Cars.**

track is laid with 85-lb. rail of American Society of Civil Engineers section. All rails are laid with broken joints supported on two ties. During eight months of the year there is employed in maintaining this portion of the road, a force of men averaging one man per mile of track. During the remaining four months this force is reduced to one man for each two miles.

The tests were all made on fair summer days, the air temperature which prevailed during the tests varying from 69 degrees to 93 degrees Fahrenheit. The wind velocity varied up to 25 miles per hour.

**Test Methods.**—The apparatus within the dynamometer car used produces continuous graphical records of the gross resistance of the train, the speed, time, brake cylinder pressure, wind direction and wind velocity. The net weights of all cars were obtained from the records of the Illinois Central and the Pullman Company. To determine the car loads, passengers were counted and allowed for at 140 lbs. each; the weights of baggage and mail were estimated by personal inspection and count of the contents of each car; the weight of express was determined by reference to the bills, supplemented by inspection and estimate. The maximum error in the gross train load itself caused by the processes described is less than 1 per cent.

All resistance values here presented have been corrected for grade and for acceleration, and they denote,

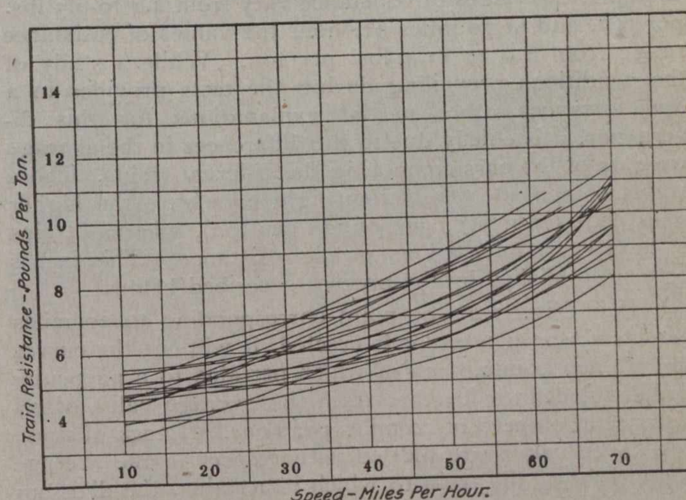


**Fig. 2.—Relation Between Resistance and Speed for the 18 Trains Tested.**

therefore, the resistance of the train when running at uniform speed on level track. The data do not permit the resistance due to wind to be differentiated and this element of resistance is consequently included in the values presented. Unless otherwise stated, these resistance values are expressed in terms of pounds per ton of gross train weight.

**Test Results.**—The immediate purpose of the tests was to define for each train the relation between net resistance and speed. On the dynamometer car records for each train there were accordingly chosen a number of points or sections corresponding to as great a variety of speeds as the data presented. At each section the net resistance was calculated and the calculated value with its corresponding speed was plotted on a diagram such as Fig. 1. The curve there drawn establishes for the train in question the average relation between resistance and speed. Fig. 1 is fairly representative of the eighteen such diagrams produced during the experiments. In this figure the black dots define average value of resistance during the passage of the train over several hundred feet of track at a uniform speed; the circles define instantaneous resistance values as the train passes a particular point on the road. In this manner there has been produced for each of the eighteen trains tested a curve, like that drawn in Fig. 1, which has been accepted as defining the relation between resistance and speed. All eighteen of these curves are brought together in Fig. 2,

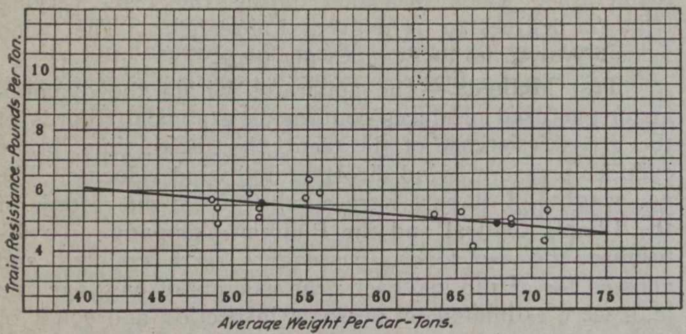


**Fig. 3.—Relation Between Resistance and Average Car Weight at a Speed of 20 Miles per Hour.**

which embodies therefore the immediate results of all the tests.

Inspection of Fig. 2 reveals a considerable divergence among the curves there drawn. At 20 miles per hour, for example, the values of resistance vary from 4.1 to 6.3 lbs. per ton, and at 70 miles per hour the values of resistance range from 8.0 to 11.4 lbs. per ton. While a study of the conditions prevailing during the tests provides in a few instances other partial explanations for this divergence, it is chiefly due to the differences in the average weights of the cars composing the different trains. Those trains composed of relatively light cars have the higher resistance (expressed in pounds per ton), whereas trains of heavy cars have a low specific resistance. This fact is better established by the process described below.

If in Fig. 2 at the point corresponding to 20 miles per hour a perpendicular is erected, it will cut the curves in eighteen points, each of which pertains to a particular train and defines for that train the average value of resistance at a speed of 20 miles per hour. If each of these resistance values are plotted with respect to the average car weight of the train to which it pertains, the diagram shown in Fig. 3 is obtained. It is obvious that as the car weight increases, the specific resistance decreases. The average rate of this decrease is shown by the straight line.

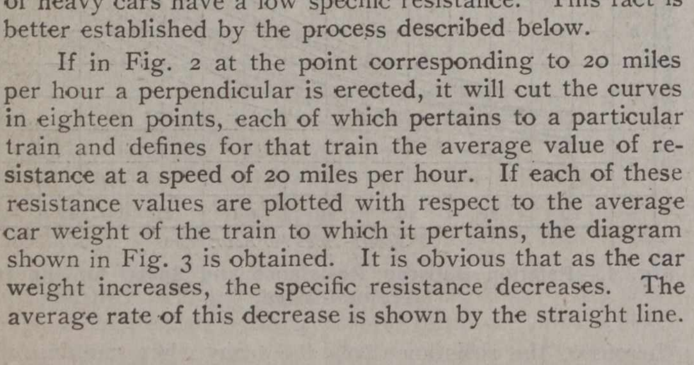


**Fig. 4.—Relation Between Resistance and Average Car Weight at Various Speeds.**

By a similar process, six other such straight lines have been determined defining this relation at speeds of 10, 30, 40, 50, 60 and 70 miles per hour. These six lines, together with those from Fig. 3, are all brought together in Fig. 4, which shows the average relation between resistance and car weight for each of seven different speeds. This figure, however, presents the relations in unusual form and Fig. 5 has been drawn from Fig. 4 to show a corresponding group of resistance-speed curves.

The relation between the two figures will be made clear by explaining the derivation of the upper curve in Fig. 5—the one applying to a car weight of 40 tons. In Fig. 4 the ordinate corresponding to an average car weight of 40 tons cuts the seven lines there drawn at seven points at which the mean resistance values are 5.5, 6.1, 6.7, 7.5, 8.5, 9.7 and 11.5 lbs. per ton, corresponding to speeds of 10, 20, 30, 40, 50, 60 and 70 miles per hour, respectively. These values are the co-ordinates of seven points on a resistance-speed curve applying to a car weight of 40 tons. These seven points have been plotted in Fig. 5 and define there the upper curve.

As these results are all derived from curves such as that drawn in Fig. 1, one must expect to encounter as much variation from the average values as is indicated in this figure. It should be borne in mind that they apply

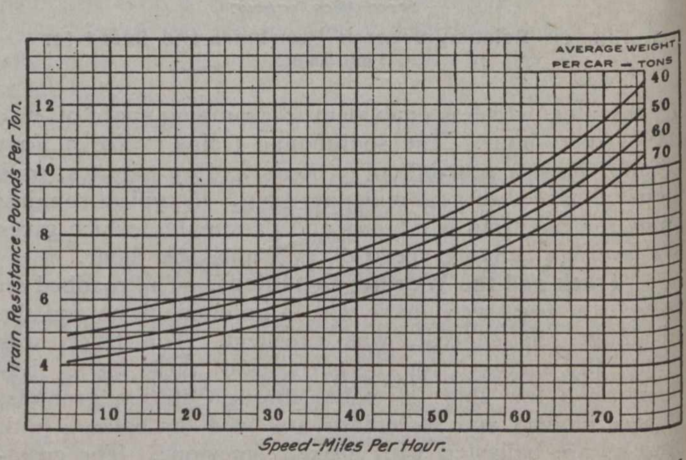


**Fig. 5.—Relation Between Resistance and Speed for Cars of Various Average Weights.**

to trains running on level track at uniform speed in warm weather, and under favorable conditions. Cold weather and high winds will both operate to increase the resistance above the amounts shown.

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## JOINT COMMITTEE OF TECHNICAL SOCIETIES, VANCOUVER BRANCH.

On the recommendation of the Joint Technical Committee of British Columbia appointed provisionally a couple of weeks ago, that body is to be recognized as a permanent committee. It will be known as the British Columbia Joint Committee of Technical Societies.

The committee was formed a couple of weeks ago, when representatives were appointed by the Canadian Mining Institute, the Vancouver Chamber of Mines, the Canadian Society of Civil Engineers, the British Columbia Architectural Society, the Chemical Society, the British Columbia University, the University Club and the Society of Electrical Engineers. Mr. R. F. Hayward, general manager and chief engineer of the Western Canada Power Co., was appointed as chairman.

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The Mechanical Engineering Company, Montreal, are moving their business to Three Rivers, Que. The new factory will be of brick construction with concrete floors and columns. The plant will be modern in every way and cost approximately \$100,000. A large machine shop will be the most important feature of the plant, where new machinery will be installed. Mr. Barrie is the superintendent.

# DUST PREVENTATIVES AND BITUMINOUS BINDERS.*

By G. Cameron Parker, M.A.Sc., A.M.Can.Soc.C.E.

It is not the purpose in this paper to discuss nor promote discussion on the technical points connected with the selection and use of dust preventatives and bituminous binders but to approach the subject from the standpoint of the road builder, a person whose time is too fully occupied with other matters to permit any attention to the complicated problems involved in the production, or chemistry of these materials.

The presence of dust on a stone or gravel road is an indication of wear, and while to the property owners along the road it is a decided nuisance, to the road builder it represents dollars and cents that have been paid for crushed stone or gravel. The application, therefore, of some medium which will prevent the removal of the powdered stone in the form of dust results not only in the elimination of the dust nuisance but in the prolongation of the life of the road.

Two general methods may be followed: the frequent application of light, inexpensive materials, the effectiveness of which is only shortlived; or treatment with a heavy material containing a non-volatile base or residue which remains on the surface of the road or is incorporated in the wearing course.

For the purpose of discussion we will consider the materials under the four general headings: dust palliatives, protective mediums, carpeting mediums, and binders.

**Palliatives.**—Palliatives, as the name implies, are primarily for the purpose of retaining the dust on the road surface, rather than for the prevention of its formation. They should be quite a fluid in order that they can be applied without heating and that they may spread over the surface in a thin, even layer and hold the particles of dust together without impregnating the surface of the road. It is not necessary that they possess binding qualities nor that when applied this property be developed. We need not consider water, salt solutions, granular salts, emulsions, nor non-asphaltic oils. Frequent applications are required for effectiveness and for this reason their use is confined to part and suburban roads, their place being taken on rural highways by materials of which not more than one application per season is necessary. Asphaltic oils, when containing more than 20 or 25 per cent. of asphalt, cease to come under the category of dust preventatives and take on the nature of protective coatings.

**Protective Coatings.**—When a road is required to serve a small proportion of motor traffic it is necessary to use a material which not only retains the dust but forms a protective film over the road surface, and which resists the combined action of horse-drawn and motor traffic to a greater degree than ordinary palliatives.

Protective coating materials should be fluid at ordinary temperatures in order that they may be applied cold and that they may spread uniformly. They should contain a small amount of volatile oils which evaporate, leaving a cementitious film on the surface. A large percentage of volatile matter is objectionable, particularly if in evaporating it leaves a residue which becomes hard or brittle on exposure.

*Paper read before the 3rd Annual Conference on Road Construction, Toronto, March 27-30, 1917.

Light refined tars which are fluid at ordinary temperatures and are easily applied, as well as asphaltic oils containing from 40 to 55 per cent. of asphalt, have given satisfaction in this class of work. The amount applied should rarely exceed 1/5 of an Imperial gallon per square yard and excessive amounts are to be strictly avoided.

**Carpeting Mediums.**—When the proportion of motor traffic is so great that the protective coating is destroyed, a thin mat or carpet of bituminous material has been found effective. The tendency for the horses' shoes and the steel tires to cut up the surface is overcome by the ironing action of the rubber tires of the motor vehicles.

Carpeting mediums are applied hot, being immediately followed with a coating of stone screenings, pea gravel or coarse sand. When properly applied the result obtained should be a thin mat or carpet on the surface of the road consisting of the bituminous material and the mineral matter. At ordinary temperatures carpeting mediums should be viscous but not fluid, in order that they will spread in a comparatively thin layer and not chill and solidify in a thick mat, on striking the cold surface of the road. They may or may not contain a small percentage of volatile matter but this will depend on the nature of the material used. Shortly after application they should develop a degree of cementitiousness

From Tank Car to Pressure Distributor.

forming a strong bond between the road surface and the mineral coating.

Asphaltic oils containing from 60 to 80 per cent. of asphalt, and refined tars containing few or no constituents distilling at a temperature lower than 170° C. are effective as carpeting mediums. Although the amount of material to be applied will vary according to the condition of the surface to be treated and the nature of the material used, for the purposes of comparison from 1/3 to 1/2 of an Imperial gallon per square yard may be considered an average application.

Where the proportion of motor traffic is so great that protective and carpet coatings are ineffective it becomes necessary to incorporate the bituminous materials in the wearing surface. Two methods are used: in one the road is built as in the case of waterbound macadam construction and prior to the application of the screenings the bituminous cement is applied to the surface either by pouring or under pressure, filling the voids in the top course of the road. This is known as the penetration method. In the mixing method the stone forming the top course of the road is mixed with the bituminous cement, spread on the foundation and rolled. This method of construction, however, is beyond the scope of this paper and is only mentioned in passing. The penetration method, on account of the small outlay necessary for plant, is particularly adapted to use on rural highways.

Penetration materials are solid at ordinary temperatures and consequently must be heated before they can be manipulated. As previously stated, they are applied by gravity from pouring cans or tanks or under pressure from specially constructed distributors. As in the case of all materials which require heating, they should, consequently, be of such a nature that they will not ignite at the temperature to which they must be heated in order to render them fluid, nor should they undergo any change in characteristics due to such heating. On cooling in the road surface they should return to their original state, forming a strong bond in the surface of the road. The point of greatest importance in the selection of material for this work is the choice of one having the proper consistency when cold. This property should be specified with due consideration of the size of the stone, the proportions of the various sizes present and the character of the traffic which will be carried by the road.

Heavy asphaltic oils, oil and fluxed native asphalts and heavy refined tars are used in the penetration method, the grade used being governed by the conditions mentioned above.

For repair of bituminous surfaces there has recently been developed asphalt and tar emulsions. They consist of the ordinary bituminous material with the addition of a small amount of alkali which renders the material miscible with water. When received from the manufacturer the material is thick and contains only a small amount of water and is mixed with an excess of water on the road and added to the loose stone. The mixture is then tamped into holes and depressions and in a short time hardens, taking on the same characteristics as the surface of the road. The transforming of the bituminous material into an emulsion renders possible the patching of the road with a material corresponding in consistency to the material that was used on the construction of the road without preheating. They should not, however, be used without a thorough investigation as to their effectiveness.

A discussion on bituminous materials would be incomplete without mention of the formulating and use of specifications upder which the materials are to be supplied. As in the purchase of other manufactured materials, the use of specifications is to be strongly recommended and is to be urged for the same reasons as those which have caused the universal use of specifications in the purchase of cement, steel, and other materials of construction. The first and most important word of warning in connection with specifications for bituminous road materials is that against the attempt to formulate a specification from a number of others, picking out some clauses from this one and some from that. The properties of the materials are closely interrelated and the adoption of one clause from one specification may render those from another impossible of fulfilment. In the second place, do not assume that all specifications will cover the materials that are wanted for any particular class of work. The virtue of a specification lies in the results that are obtained from the use of materials purchased thereunder. Investigation should, therefore, be started from this point, and when successful results have been found one can be reasonably sure that, conditions being the same, the specifications under which the materials that gave the satisfactory results were purchased, are safe to use.

## SHRINKAGE IN FILLS.

The following table on shrinkage in fills is taken from the February bulletin of the American Railway Engineering Association. The association has been considering this question and in order to get what was the usual practice in this connection the following question was sent to railway officials and railway contractors: What allowance for shrinkage, both in width and height, have you found satisfactory for different heights of fill and different materials: first, on new location, and second, under traffic? The accompanying table is a summary of some of the replies sent in:—

### Shrinkage in Fills.

Atlantic Coast Line—10% for sand-clay soils.

Chicago & Alton—15% for clay or loam deposits from trestles.

Chicago, Rock Island & Pacific—10% on new and old work.

Illinois Central—10% on new location.

Illinois Central—3% in height and 10% in width under traffic.

New York, New Haven & Hartford—10% on new location.

New York, New Haven & Hartford—3% under traffic.

Seaboard Air Line—10% for height; fills 15% wider than standard.

Rock Island Lines—About 10% is general rule.

Grand Trunk—1 in 10 for ordinary earth fill.

Grand Trunk—1 in 20 in sand or gravel.

Soo Line—Embankment with cars from trestle, ½ to 1% per foot of elevation.

David W. Flickwir*—2 ft. for each 10 ft. in height.

John F. Dolan*—10% for shrinkage.

P. McManus*—On new location: Earth, up to 15 ft., 10%; up to 30 ft., 12½%; up to 50 ft., 15%.

Paterson-Moran Co.*—7 to 10% in clay.

C. W. Lane & Co.*—10% for width or height.

C. P. Bower*—Earth, about 1½ ft. higher for 25-ft. fill.

*Railway contractor.

The conclusions of the committee were as follow: In determining the allowance for shrinkage to be made in a fill, it should be remembered primarily that it is easier to add to the height of a fill that settles than to lower the track if the settlement does not amount to as much as that anticipated in the original allowance. Therefore, unless the shrinkage of a material is well-known in the conditions under which the fill is made, it is best to be well on the safe side; *i.e.*, little or no allowance should be made in height; the extra material, when possible, being deposited where it will be conveniently available for raising the track, as required. The allowance in width should be from about 5 per cent. to 20 per cent. of the height of the fill, depending on the material and conditions.

The material used for fill varies in shrinkage from sound, non-disintegrating rock, or gravel, which is least, to certain swelling clays, which give the greatest shrinkage both in compactibility and erosion at the slopes. While vegetable loam has a large percentage of actual shrinkage, it so quickly produces a protection cover of vegetation that the shrinkage due to erosion is usually small. Where frozen material must be used in making a fill, heavy settlement must be expected, and this is to be avoided where possible.

## VENTILATION OF THE CONNAUGHT TUNNEL.*

By J. G. Sullivan, C.E.
Chief Engineer, Western Lines, Canadian Pacific Railway.

WHEN the Connaught tunnel was first planned, it was generally supposed that it would be necessary to operate by electricity, but upon further studies of this subject it was found that the large cost of installing a plant for this short section and the enormous extra expense of operation would have entirely wiped out any economical saving made by the construction of the tunnel. Therefore, a study was at once commenced on other methods of operation.

As a result of the study a plan was adopted of blowing air through the tunnel by the use of fans, similar to the method adopted by an Italian engineer in the ventilation of the St. Gothard tunnel a number of years ago. However, instead of putting up an obstruction at the portal of the tunnel where the fans are situated, to prevent the air from coming out of that end, a nozzle patented by Chas. S. Churchill and the late C. C. Wentworth was adopted, plans of which are illustrated in drawings Figs. 1, 2 and 3. With this system we can with perfect safety operate this tunnel with steam locomotives.

The principle of this nozzle is as follows: Air is forced into a comparatively large chamber which terminates in a nozzle inside the tunnel. If the pressure is great enough, there is sufficient energy in the air leaving the nozzle at high velocities to overcome the resistance offered by friction, variation in barometric pressure or other resistance to the flow of air that may occur in the tunnel. In general, where tunnels are comparatively short, this ventilating plant would be located at the lower end of the tunnel, and trains reduced to a speed lower than the velocity of air in the tunnel, in this way the smoke and gases being blown ahead of the moving train. In a tunnel as long as the Connaught tunnel, this method of operation with a fan system was entirely out of the question, but as the tunnel is of a large area, it was decided to establish the ventilating plant at the higher end of the tunnel and blow fresh air against the approaching trains on the up-grade, and thus dilute the gases coming from the locomotive. The dangerous gas generated by a locomotive is carbon monoxide, and this gas is usually generated in cases of an accident where the draught to a heavy coal fire is shut off. The ordinary carbon dioxide, the usual resultant of complete combustion, is not so dangerous and a much larger percentage of the latter gas in air is permissible. As our locomotives on this section use oil for fuel, in case of a sudden stop the fire can be shut off and there is no danger of producing the deadly carbon monoxide.

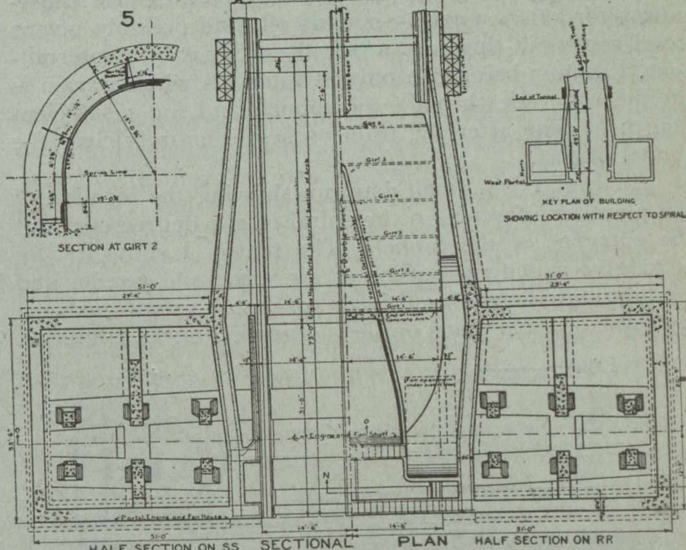



Fig. 1.

Returning again to the plans of the ventilating system, the usual method is to put the fans at the side of

*Cornell Civil Engineer, February.

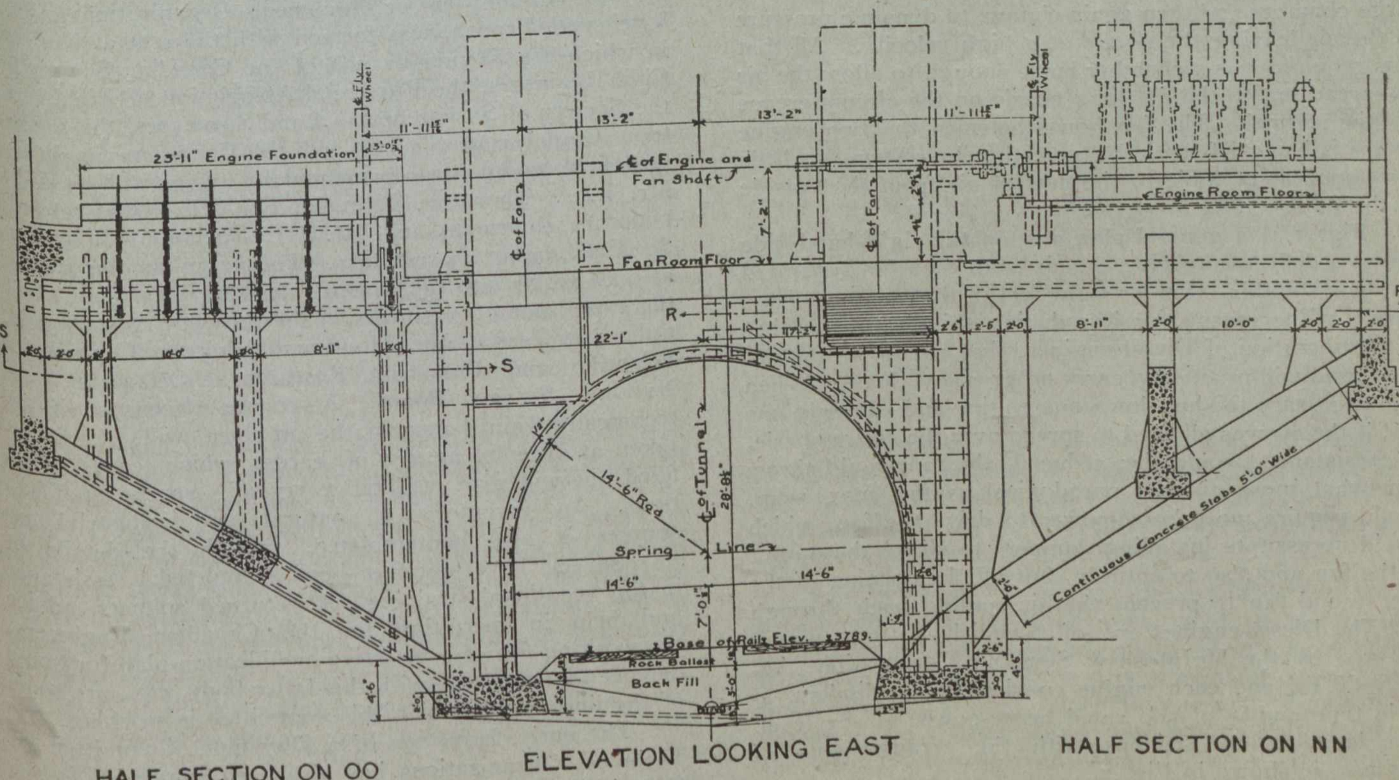
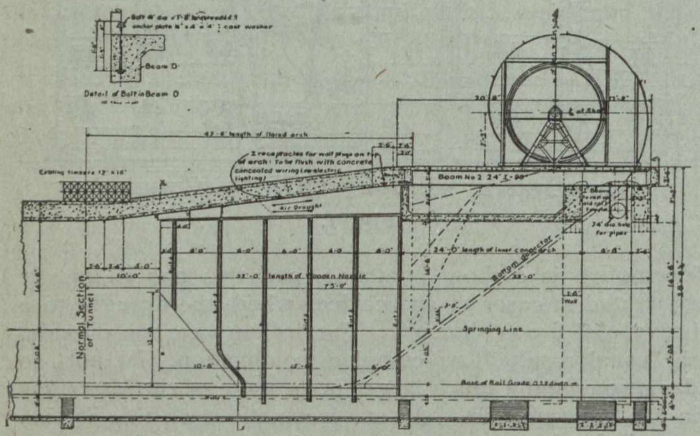



Fig. 2.

the track a little above the elevation of the base of rail. In this case, however, since the portal of the tunnel is in a very deep cut, it was decided to put the fans over the portal. Instead of running these fans by engines driven by steam, it was further decided to use Diesel engines. These engines will only consume 0.4 to 0.5 pounds oil per horse-power hour of work, while the best we could hope to get from a boiler would be one horse-power for every 2 or 2.5 pounds oil, and possibly not as good results in this case where the work is only intermittent, the fans being run only at intervals when a train is on the up-grade through the tunnel, and for a sufficient length of time after the train passes to entirely clear the tunnel of gas.

In Fig. 1 is a small diagram showing the location of the plant in reference to the spiral of a 4 degree curve at the entrance of the tunnel. The reason I show it here is to give a general outline of air space and nozzle, and I might state here, that this air space was greatly reduced from the original plans on the suggestion of the engineers




LONGITUDINAL SECTION
**Fig. 3.**

of the company supplying the fans; the idea being, that there was nothing to be gained by changing from dynamic pressure as the air left the fans, to a static pressure in a large chamber and then again change to dynamic pressure in the air leaving the nozzle at a high velocity. All that was required was a chamber large enough to allow the air to spread out to the flat long nozzle on the circumference of the tunnel. The fan house between the two engine rooms is being left entirely open, thereby offering as little resistance as possible to the flow of air from the outside to the fans.

Fig. 1 is a general plan and on the right-hand side shows a deflector keeping the air from each fan separated to a point within seven or eight feet of the opening of the nozzle. The reason for introducing this feature is that in the operation of Diesel engines, they run at a constant speed and will practically carry no great overload. When it is necessary to shut down one engine and run only one fan, if the air was allowed to spread over the entire nozzle, the resistance would be reduced, the fan would throw somewhat more air and paradoxical as this may seem, would require more horse-power to drive the fan, which would necessitate installing dampers to choke the output of the fan and also to entirely shut off the opening of the idle second fan to prevent the air coming back through it. The Diesel engines are of Swedish pattern, manufactured by the McIntosh & Seymour Corporation, Auburn, N.Y., and each engine consists of 4 cylinders, 4-cycle type and is of 500 rated horse-power at sea level. The elevations and sections with the arrangements of engines are shown in Fig. 2.

A change was made in the original plans by building the inside arch from the portal proper as far back as the engine house extended, of concrete, and in this way eliminating entirely a great number of rods that were in the air chamber holding the wooden arch in place.

Another innovation was the use of rails as arch ribs for the nozzle lining. This only required one stay to be put through the air space for each rib instead of having stays every three or four feet which would offer obstruction to the free passage of the air. These features are shown in Figs. 1, 2 and 3. The bottom of the nozzle is cut away to enlarge the opening of the nozzle at grade line which is a development of the opening of the nozzle to keep the centre of gravity of the moving air approximately at the centre of the section of the tunnel.

The installation of this ventilating plant is not yet entirely complete. The tunnel was opened for operation December 9th, 1916, when one fan was installed and which has been capable of properly ventilating the tunnel up to the present time. No annoyance or trouble of any kind from gases or smoke has been experienced in this tunnel.

The work was laid out and commenced under Mr. F. F. Busteed, M.Can.Soc.C.E., engineer in charge of double tracking. It has recently been under the supervision of Mr. W. A. James, M.Can.Soc.C.E., engineer of construction, Western Lines, with Mr. H. G. Barber as assistant engineer, Mr. T. Martin, resident engineer at the west and Mr. J. R. C. Macredie, M.Can.Soc.C.E., resident engineer at the east end. The contractors are Messrs. Foley Bros., Welch & Stewart. The construction work was supervised for the contractors by Mr. A. C. Dennis, M.Can.Soc.C.E.

## SASKATCHEWAN BRANCH, JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS.

Following the example set in the province of Ontario, a Joint Committee of Technical Organizations, Saskatchewan Branch, was formed with the seat at Regina, in which the Regina Branch of the Canadian Society of Civil Engineers, the Provincial Association of Architects, the Society of Saskatchewan Land Surveyors, the Saskatoon Engineering Society and the Canadian Engineers (3rd field troop) are represented by two members each. Mr. L. A. Thornton, Mem.Can.Soc.C.E., was elected honorary chairman, and Mr. J. N. deStein, Mem.Can.Soc.C.E., honorary secretary. The committee has started at once to go into the work of devising means by which the experience of engineers in the province could best be utilized to assist the Honorary Advisory Council for Scientific and Industrial Research at Ottawa and the National Service Board. A complete census of all technically trained men in the province will be undertaken at once by means of cards, which cards when filled out will give in detail everyone's special qualifications. An inventory of natural and industrial resources is also contemplated, though the details of this survey have not yet been completed. Assistance in the vocational training of returned soldiers, advice and help in recruiting for the Canadian Engineers, the working out of a tentative mobilization plan for home defence in connection with this latter body, etc., are some of the lines along which this committee is working.

The early formation of a Dominion Committee of Technical Organizations has also been suggested to the Ontario Branch.

## CULVERTS.*

**By Arthur Sedgwick,**
Department of Public Highways, Ontario.

A CULVERT, being much smaller and simpler than even an ordinary bridge, its cost will be proportionately less, but the number of culverts required per mile of road makes the total cost thereof as high or higher than the cost of our bridges. To reduce the cost and improve the methods of construction requires the constant, careful attention of the municipal official responsible for their construction and maintenance.

I believe it is customary for the county and municipal officials to go over the roads in the spring of each year, to examine the bridges and larger culverts and order the immediate reconstruction of such of them as they find in an unsafe condition. This procedure is almost imperative since a collapse of one of these structures would probably entail very serious consequences.

It would be better if the same practice were adopted for the smaller culverts, but unfortunately these are generally left untouched in each case until somebody reports that they have been washed out or the top has broken in. When this occurs it is, of course, necessary that a new culvert be built immediately. Since it is important that the road be not blocked any longer than is absolutely necessary, it frequently happens that the culvert is hastily built without regard to cost or for what is required to make a durable and satisfactory job.

It must be conceded that the expected additional life of such of our old wooden culverts still existent cannot be appreciable and therefore little or nothing is gained by allowing them to remain until actual failure takes place. Besides, there is always the risk of accidents to be considered.

Where these precautions are not taken, and the culverts are left until failure takes place, there is a natural temptation to save time by putting in a large pipe where the size of opening and natural conditions would otherwise suggest a concrete box type of construction being used.

Concrete or vitrified clay pipe should not be used for culverts where there is a danger of water standing in them and freezing. Neither should they be used unless an earth fill at least two feet in thickness can be provided over them. Otherwise they will become cracked with the frost and ice and become displaced by the weight and impact of the traffic on the road. Corrugated iron pipe, especially the larger sizes, should also have plenty of fill over them, or they will bend and become distorted under the loads passing over them.

The chief precaution to be taken in using any kind of pipe culvert is to thoroughly compact the earth around it, especially around the lower half. To this end the trench should be dug wide enough to permit an iron ram to be used to compact the filling underneath. If this is not done the pipe may break or bend from the pressure above, or the water may find its way underneath and by freezing, force the pipe out of position or may eventually cause a "washout."

To prevent the water from undermining the ends of the culvert and working a passage through on the outside, end walls, preferably built of concrete, should be provided; or, where corrugated iron pipe is used, end walls of the same material may be used. It should be remembered, though, that these iron culverts cannot be expected to last indefinitely.

Pipes over three feet in diameter should preferably not be used. They are clumsy to handle and are apt to crack or bend sooner or later, no matter what precautions are taken. Square box masonry culverts will give better satisfaction, even though the first cost be greater.

Where one is sure the ditch or watercourse will not require deepening, such box culverts, where they are not over five feet square, can be built with a reinforced concrete floor and a considerable saving of material result. Otherwise, the sides must be carried down to footings reaching below the frost line. The floor sides and top can be built of concrete about one foot thick and reinforced. For such sizes of culverts, wire mesh or expanded metal make a convenient form of reinforcement. Such a type of culvert will give permanent results at a very reasonable cost.

Square-built culverts give a larger waterway than a circular one of the same width. With a circular section, the water has to rise to some height before there is any appreciable volume of discharge. This is an important factor in flat drainage areas where it is most desirable to keep the level of the water in the drains as low as possible. Again, during abnormal flood conditions the natural watercourses expand in width and thus provide for themselves an unusually large area of waterway. A circular culvert reduces in width very rapidly above the centre line. It will be seen, therefore, that under such flood conditions there is a tendency for such a culvert to restrict the flow of water and cause it to rise still higher.

Culverts less than fifteen inches in diameter should not be used as they are apt to become blocked with sediment, ice, or coarse debris from the road-side.

Moderate-sized culverts are not readily discernable to motor vehicle drivers, and they should therefore be built the full width of the road grade. The required safety thus ensured is well worth the moderate additional cost entailed.

Culverts that are not built the full width of road-grade should be provided with strong guard-rails of such size and type that they may be readily seen by the travelling public under unfavorable conditions. The guard-rail is the only warning a stranger using the road has of his approach to the culvert. The use of gas pipe for railings should be discouraged as much as possible, as it is difficult to see them, especially at night. Concrete spindle railings are strong, easily seen and when carefully built present a very attractive appearance. They must, of course, have well-bonded and reinforced posts, top railing and curbs.

Municipalities which have not the necessary experience and facilities for constructing the above type, may use a solid reinforced concrete railing as they may advantageously use reinforced concrete posts with three or more iron pipe rails built into them.

In conclusion, let me urge the desirability of putting a better finish on our bridges and culverts than has been the prevailing custom in too many of our local municipalities in the past. These structures which in most cases are expected to last indefinitely, should have the appearance and substantiality which will conform to that of the magnificent system of roads which we may expect to have in the not distant future.

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*Paper read before the 3rd Annual Conference on Road Construction, Toronto, March 27th to 30th, 1917.

## CANADIAN WOODS FOR STRUCTURAL TIMBERS*

CANADA'S present supply of commercial timber has been estimated at from 500 to 800 billion feet, board measure, covering an area of approximately 250,000,000 acres. This estimate, which is about one-half the forested area of the Dominion, refers only to saw-timber; material suitable for pulpwood, firewood, poles, etc., not being included. Russia is believed to have the largest timber resources of any country in the world; the United States is second, and Canada is third on the list.

**Principal Structural Woods.**—The heavy structural species of Canada named in order of merit and resources are: Douglas fir, western hemlock, eastern hemlock, western yellow pine, western larch, red pine, and eastern larch.

It is a general rule that the heavier a wood is the stronger and harder it will be. This is not only the case in comparing one species with another but also where timbers of the same species are examined. The effect of knots and other defects is taken up in detail in the section on grading, but some of the more general results may be stated here.

The density or absolutely dry weight of wood is usually a direct measure of its strength. Wood with a considerable development of summer-wood is generally heavier and stronger than wood with a smaller proportion of summer-wood.

Checks and shakes in beams reduce the area which resists horizontal shear and are most harmful when they are in the centre half of the height of the beam.

Very rapid or very slow growth in conifers usually produces a wood lacking in density and of inferior strength.

The strength of posts or columns containing knots decreases as the knots increase in size.

Sound knots do not weaken wood subjected to compression perpendicular to the grain.

Large specimens tested in compression perpendicular to the grain show but little increase in strength due to seasoning.

If structural timbers are seasoned slowly, in order to avoid checking, there should be an increase in strength, but it is not safe to base working stresses on results secured from any but green material.

**Discussion of the Most Important Coniferous Woods of Canada.**—In 1913 there was more Douglas fir timber cut in Canada than any other single species. Only the spruces, collectively, produced more timber than did Douglas fir, while in 1914 the spruces and white pines both produced more. Although in 1915 the cut of Douglas fir decreased, it may be expected to increase rapidly hereafter in yearly production, as it is the only timber in North America of which great areas, accessible to easy development, remain untouched. British Columbia cut practically all of the 601,643,000 feet, board measure, of Douglas fir, worth $6,810,000 at an average value of $11.32 per thousand feet, which were cut in 1914. In 1915 the production was 453,534,000 feet, board measure, with an average value of $11.76 per thousand.

Douglas fir is at present one of the most important of Canadian woods, and within a few years it will probably be the most widely used and valued of Canadian timbers. It is the largest structural timber growing in Canada or the United States. In Canada it is found in British Columbia and to a limited extent in Alberta. Trees have been measured up to 380 feet high with a maximum diameter of 15 feet, the largest trees scale as high as 60,000 feet, board measure. This great size places the timber in the highest class for large timbers free from defects.

So far as structural timber in the Dominion is concerned, Douglas fir is by all means the most important, although there are several other species which produce very good structural timber. According to recent estimates of the Commission of Conservation, the total supply of merchantable Douglas fir timber is about 75 billion feet, board measure, and since the tree grows satisfactorily under reforestation there is little reason to believe the supply will be exhausted for many years. In fact, proper protection should insure a perpetual supply.

Douglas fir is manufactured into almost all forms known to the saw-mill operator and a very large amount of the wood is also utilized in the form of round or hewn timber. For bridge, trestle, and harbor work Douglas fir is superior in many ways to any other Canadian timber. It is largely used by the railways in the form of ties, piling, car, and bridge material. It has long been the most important timber for boats and ships on the Pacific Coast, being suitable for both outside and inside work, especially for decking, planking, keels, yards, ribs, and finish. Increasing amounts of Douglas fir are being used in furniture making and in this line it is particularly adapted to "mission" furniture. Tight and slack cooperage, tanks of all kinds, conduits and water pipes, paving blocks, boxes, and pulpwood may be mentioned as further illustrations of its utilization.

Although the properties of Douglas fir enable it to be employed in such a variety of ways, it is probably most widely known as a structural material. For this purpose it is inferior to no other wood, and its straight, clear trunks can supply timbers of the largest size and highest quality. Pieces 2 feet by 2 feet in section and 100 or more feet long can readily be supplied by mills in British Columbia equipped to handle such lengths. It may be said, then, that Douglas fir is not only of first value as a timber for all kinds of structural work but is also suitable for a greater variety of uses in the manufacture of various products than any other Canadian wood, with the possible exception of white pine.

**Southern (Longleaf) Pine.**—Undoubtedly the two most important American structural timbers at the present time are Douglas fir and the southern pines. It may be of interest in this connection to draw attention to certain characteristics of the two timbers as brought out by parallel tests made by the United States Forest Service and by the Forest Products Laboratories of Canada.

As far as the designing engineer is concerned and apart from considerations of durability, etc., the properties of a timber which may affect the design of a structure of this material are as follows:—

1. Timber beams: (*a*) Strength in bending; (*b*) strength in longitudinal shear; (*c*) stiffness.

2. Timber columns: Strength in compression parallel to grain.

3. Bearing areas of timber beams and sills: Strength in compression perpendicular to grain.

4. All members: Dead weight of material.

The accompanying table (Table I.) has been calculated from the sources indicated (largely United States Forest Service tests) to show the comparative properties of Douglas fir and longleaf pine in respect to the various

*Abstracted from "Canadian Woods for Structural Timbers," published by the Forestry Branch, Department of the Interior.

factors mentioned above. In all cases the strength values of Douglas fir have been expressed as percentages of the corresponding values given for longleaf pine. In cases where the strength of Douglas fir exceeds that of longleaf pine the figures are shown in bold-face type; in cases where the reverse is true the figures are shown in ordinary type. By noting the grouping of the bold-face and ordinary type the comparative strength of the two species can be readily seen.

Taking up in order the factors mentioned above as affecting the design of timber structures reference to Table I. leads to the following conclusions:—

1. Strength in Bending.—In modulus of rupture the majority of tests show Douglas fir to be weaker than longleaf pine by about 10 per cent. On the other hand, all tests with the exception of two show Douglas fir to be stronger than longleaf pine by varying amounts, say, 10 per cent. on the average, in fibre stress at elastic limit.

**Table I.—Comparative Properties of Douglas Fir and Longleaf Pine. Values for Douglas Fir as Percentages of Corresponding Values for Longleaf Pine.**

| Class of Specimen. | Static Bending. | | | Compression Parallel to grain. | | Compression Perpendicular to grain C.S. at E.L. | Longitudinal Shearing Strength. | Weight. |
|---|---|---|---|---|---|---|---|---|
| | F.S. at E.L. | M. of R. | M. of E. | C.S. at E.L. | C.S. at M.L. | | | |
| Small specimens | **105·7** | 91·3 | **103·7** | .... | 91·6 | .... | 78·6 | .... |
| " | 99·1 | 90·1 | 97·4 | .... | .... | .... | 83·5 | .... |
| " | **110·0** | 92·3 | **103·9** | .... | .... | .... | 79·4 | .... |
| " | **105·5** | 91·3 | **103·7** | .... | 91·6 | .... | .... | .... |
| " | **102·4** | 94·9 | **104·5** | **100·2** | 93·7 | **109·0** | 89·9 | 83·9 |
| " | **102·7** | 95·9 | 96·1 | .... | 94·2 | .... | 76·0 | 87·1 |
| Structural timber | **106·3** | 97·5 | **103·7** | 79·6 | 72·8 | **100·3** | .... | 80·0 |
| " | **123·8** | **110·7** | 90·8 | 94·1 | 88·7 | **111·6** | .... | 71·8 |
| " | **105·2** | 83·4 | 96·8 | 80·0 | 72·9 | **100·0** | .... | 80·6 |
| " | **126·0** | **109·8** | **111·0** | .... | .... | .... | .... | .... |
| " | **117·9** | **112·6** | **112·3** | .... | .... | .... | .... | .... |
| All sizes—Average | 98·0 | 87·4 | **111·4** | .... | .... | .... | .... | .... |

Tests of long duration on timber have shown that if a beam is loaded in excess of its elastic limit it will eventually fail. In accordance with this it appears that the elastic limit stress is the greatest stress which can be safely used in timber structures, and it would therefore be logical to base working stresses for design on the elastic limit stress and *not* on the ultimate breaking strength as determined in the testing machine. This practice is at present followed in determining suitable standard working stresses for other structural materials such as steel, and it is now being recognized that the elastic limit is the logical basis for design in the case of timber as well.

Douglas fir should, therefore, be capable of taking a greater working stress in bending than longleaf pine by the amount mentioned, for the same degree of safety. This, however, would not apply in the case of extremely short beams.

2. Strength in Longitudinal Shear.—All tests show Douglas fir to be weaker than longleaf pine by from 20 to 25 per cent. In the case of beams so short that strength in shear rather than bending strength becomes the deciding factor, longleaf pine should accordingly be allowed a working stress greater by the amount mentioned.

3. Stiffness.—Not infrequently, as in the case of ceiling joists under certain conditions, the maximum deflection of a beam becomes the deciding factor in its design rather than its strength. A stiff timber of high modulus of elasticity would in this case be desirable. Referring to the table it will be seen that in the majority of cases Douglas fir is credited with a higher modulus of elasticity than longleaf pine by from 4 to 10 per cent., although there are a few exceptions to this rule. It would look as though the safe working modulus of elasticity for Douglas fir might be taken to be about 5 per cent. greater than that for longleaf pine. In any case the same modulus could certainly be used.

4. Strength in Compression parallel to grain.—All tests, almost without exception in the case of stress at elastic limit and without any exception in the case of maximum crushing strength, show Douglas fir to be from 10 to 20 per cent. weaker than longleaf pine. A greater working stress for longleaf pine than for Douglas fir in the case of columns would, in accordance with this, be good practice.

5. Strength in Compression Perpendicular to Grain.—All tests without exception show Douglas fir to have somewhat greater strength in compression perpendicular to grain than longleaf pine, by amounts ranging up to 10 per cent., indicating that greater working stresses for Douglas fir in compression perpendicular to grain would be permissible.

6. Weight of Material.—All the tests show Douglas fir to be lighter than longleaf pine by about 20 per cent. on the average. The obvious advantages of a structural material of light weight over one of heavier weight, both having the same strength, are two-fold: (1) Less dead weight to be supported in the structure, leaving greater net strength effective for supporting live loading; (2) less weight to be handled.

In the present instance the former consideration is of little importance because of the magniture of the loads supported in proportion to the weight of the material used. The latter consideration, however, involves a very considerable difference in charges for transportation and labor of handling.

In the above comparison an effort has been made not to favor either one timber or the other, existing reliable comparative figures having been taken and analyzed without regard to their bearing on the result. It is probable that the comparison is fairly equitable, or even conservative as to the strength of Douglas fir.

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A nitrogen plant is being erected at La Grande, Wash., near the Tacoma municipal power plant, from which source power was contracted for at a rate of 1.15 mills per kilowatt-hour. The power sold is surplus which the plant does not require at present, and the municipality retains the privilege of discontinuing service at any time. The American Nitrogen Products Co. is erecting the plant, which is reported to involve a $500,000 investment.

The Bureau of Navigation at Washington, D.C., reports that there were in progress or on order in United States shipyards at the beginning of the year 682 vessels of 2,098,761 tons. Of these 403, of 1,495,601 tons gross, were steel merchant vessels; 161, of 207,623 tons gross, wooden merchant vessels; and 118, of 395,537 tons displacement, war craft. The tonnage of 61 submarines which are in progress is not included.

## WESTERN MINING ENGINEERS' MEETING.

The Western Branch of the Canadian Mining Institute has just concluded its twenty-fourth general meeting at Vancouver.

Among those who addressed the various sessions of the conference were R. R. Hedley, M.E., who read a paper on "The Iron and Steel Industry"; W. M. Garman, who spoke on "The Manufacture of Pig Iron"; Prof. J. G. Davidson, who spoke on "The Cottrell Process of Electrical Precipitation of Smelter Dust and Fumes."

Mr. R. R. Hedley, M.E., speaking on the iron and steel industry, said that it might be stated that there was practically no such industry in British Columbia, for the reason that the iron and steel plants are depending almost entirely for their supply on scrap iron.

It had been stated that coal is too costly to use in making coke and that there are no hematite ores available to mix with magnetite ores of the coast. It had been said that there was no market for iron or steel provided, even if it was produced here, but the speaker characterized these statements as rank pessimism. The market is naturally small now, because the product is not being turned out. The market could be easily increased and extended, however, provided the steel and iron industry was established in British Columbia to turn out the product.

**Steel Needed for Shipbuilding.**—The speaker contended that there is bound to be a great demand after the war for steel and iron for shipbuilding purposes. With Australia, Japan and New Zealand building steel ships, British Columbia is commencing to develop also, and Mr. Hedley expressed the opinion that there was no doubt that a profitable market could be developed in British Columbia which would absorb all the iron and steel which could be turned out. The available tonnage of ships for the first year following the war would be short, but within a year after it closes there will be plenty of vessels to handle all the material that will be demanded by countries across the Pacific. He urged British Columbia to prepare to handle this large new trade.

**Coke Outlook Promising.**—Mr. Hedley is optimistic as to the production of coal for coking purposes. He stated his belief that certain seams on Vancouver Island will produce a better coke for metallurgical work than any hitherto discovered. He then went into a technical dissertation on the cost per ton of producing this coke, which he places at about $6.

He stated that it was possible for the by-products of coke to be utilized at a saving of from $2 to $2.50 per ton, thus reducing the actual cost of the coke.

The speaker admitted that local labor conditions were adverse, but said that by introducing efficiency and judicious management this difficulty could be overcome.

With reference to iron ores the speaker said that the occurrence of sulphur in magnetite ores is not necessarily an evil. As a rule, coast ores are very high in iron and low in both sulphur and phosphorus. Mr. Hedley explained the nodulizing, briquetting and cintering methods of producing pig iron.

**Cheap Production Possible.**—Many coast ores in British Columbia carry as high as 1½ per cent. copper, which is not a detriment to the ore. He told of shipping himself from Talssoo Harbor three years ago 1,100 tons of magnetite ore which contained 62 per cent. iron, 1 8/10 per cent. copper, 3 6/10 per cent. silica, besides gold values of 40 cents per ton and 4 to 10 ounces of silver per ton. He said that similar ore can be found in large bodies in many places on the coast. As to hematite, he was pleased to state that the provincial minister of mines had stated that there is an adequate supply. Summarizing, he said that he is satisfied as to the supply of both magnetite and hematite ore, limestone of a superior quality, coal which can be converted into metallurgical coke, labor which is to be trained and fostered and a market to be found or made. As to the use of electrical furnaces as opposed to gas furnaces, he said that their installation will depend on the cheapness of power. The cheapest power known, water power, is unlimited in British Columbia. It was his opinion that it costs more to produce a ton of iron in Pittsburg than it will on the coast.

## FOURTH CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.

The fourth Canadian and International Good Roads Congress will open April 10th and continue until April 14th, 1917. In addition to the interesting and educational program of addresses and lectures that has been arranged there will be a very complete display of road materials and road-building machinery. The following is the tentative program:—

"Modern Methods of Maintaining Earth, Clay and Sand Roads," Paul D. Sargent, chief engineer, State Highway Commission of Maine.

"Drainage and Foundations," Geo. Hogarth, chief engineer, Ontario Public Highways Department.

"The Highway Laws of Ontario," W. A. McLean, Deputy Minister of Highways, Ontario.

"Bituminous Roads and Pavements," Col. Wm. D. Sohier, chairman, Massachusetts Highway Commission.

"Cement Concrete Roads and Pavements," T. Harry Jones, city engineer, Brantford.

"The Construction and Maintenance of Gravel and Macadam Roads," James H. MacDonald, ex-state highway commissioner of Connecticut.

"Highway Bridges and Culverts," W. G. Yorston, assistant road commissioner, province of Nova Scotia.

"Safety on the Public Highways," R. B. Morley, general manager, Ontario Safety League.

"Brick Roads and Pavements," D. T. Black, town engineer, Welland.

"Road Oils," Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, New York.

"Wood Block Pavements," A. F. Macallum, commissioner of works, Ottawa.

"Modern Road Machinery: Its Selection, Use and Care," Wimund Huber, assistant engineer, Ontario Public Highways Department.

"Road Organization," Geo. S. Henry, M.P.P., Ontario.

"Granite Block Pavements," W. H. Connell, chief of Department of Public Works, Philadelphia.

"Methods Employed for Making Road Material Surveys," L. Reinecke, Geological Survey, Department of Mines, Ottawa.

"The Highway in Relation to Land Development," Thos. Adams, town planning adviser, Commission of Conservation, Ottawa.

## BEST PRACTICE IN CONCRETE ROAD CONSTRUCTION.*

By H. E. Breed,
Deputy Commissioner of Highways, New York State.

THEORETICAL tests are fine. They are necessary to tell you what you should have as a final product. You proceed on the hypothesis they offer and then you have to wait until service and climatic conditions prove how far your hypothesis conforms to reality.

Tests for concrete materials have never been given their proper consideration, with the exception of cement, which has been tested with all the finesse of the art of testing. In general, little, if anything, has been done on the sands, which have been casually accepted if they looked good, or had ever been used before in a structure that would stand up. As for the stone or gravel, all kinds and conditions of both have been used with practically no tests at all.

Our work has shown that if we are to omit any of the tests, we might better take a chance with the cement, for of the last 455,000 barrels used only 1.4% failed to conform to the test of the American Society for Testing Materials. Fifty per cent. of these failures was due to flash set and fifty per cent. to failure on the 200-mesh sieve requirement. Had all this cement been used, that rejected for sieve requirement would have given good work, and that rejected for flash set would have been aged enough by the time it was placed in the work to give good results. There has been a far greater proportion of both sand and stone rejected for this kind of work.

Engineering skill presupposes judgment, so why not inject it into our problems? After priming ourselves with theory, let us apply it to practice. Let us make field tests that will parallel laboratory experiments; let us conduct our laboratories in such a way that their value may be significant to the man in the field, and so that their results may be checked up by him. Success of work depends upon the field man; in every case his personality helps determine the results. Put him in line with your tests, practices, etc., and his interest and co-operation will show most profitably in the work. All of our men, from the engineer in charge of the road up, are instructed in all the tests and methods of inspection and they complete them on every inspection of the work. We of New York State believe that our best results may be attributed to the *esprit de corps* engendered by this method.

**Field Tests.**—The principal tests which can be made in the field accurately enough for all practical purposes are:—

(1) Gradation tests for sand. Our field men are furnished with sand testers which have the ¼ in., the 20 and the 50 sieves. By using these they can be assured of getting a uniform product from the bank, for they would at once detect any change for the worse in the character of the material and would reject it. Each engineer is supposed to make a daily report of the gradations. A laboratory test, however, is essential to ascertain the presence of any deleterious matter in the sand.

(2) Test for loam and silt content in sand. This can be made in the field and checked up by the laboratory results.

*Abstract of paper read before the American Road Builders' Association, Boston, Mass., February 8th, 1917.
[First part of paper appeared in *The Canadian Engineer*, March 8, 1917.]

For the loam test, an excess of water is added to a given quantity of sand in a glass graduate, the whole is well agitated and allowed to stand until the loam and silt has settled on top, when their percentage may be measured.

(3) Test for set. This is made by mixing the sand with cement and forming a pat with thin edges. By breaking the edges after 24 to 48 hours it may be determined how the material sets.

(4) Tests for stone and gravel. Field determinations of these materials can be made only for voids. Visual inspection should, of course, detect soft material and dirty aggregates. Such inspection on the road and at the quarry should be made constantly to know that the material is running uniform and is equal in quality to the original samples.

When we realize that nature never has two deposits alike, the importance of these tests in securing good work will be readily appreciated.

**Laboratory Tests.**—Laboratory tests of stone are so familiar to us all that I omit discussion of them here.

For gravel, however, we found that the rattler test in general use did not give a true abrasive value. Because of the rounded structure of the rattler, the first material that was abraded off formed a protective cushion that greatly decreased the subsequent wear upon the stone. To eliminate this condition a new pot of the same size and shape as the standard pot was designed but it is slotted at intervals to prevent cushioning by allowing the worn-off material to escape. Some of the better-known gravels which have proved successful in concrete pavements are used as standards of comparison with satisfactory results. We have also had promising results in using this pot to test slag, which in the old pot used to act the same as the gravel did.

**Final Test of the Concrete.**—Concrete from a batch mix is made up on the road into six-inch cubes two in number from every 500 cu. yds. of material. They are cured for 21 days in moist sand and then shipped into the laboratory and tested at 26 days. The results of these tests are given to the engineers on the work and the rivalry to have the highest test value produces good results. It is expected that these cubes shall go over 3,000 pounds per square inch compression, and if they do not we look for trouble. Of 504 cubes tested in 1916 only 13¼% were below 3,000 pounds and the determination of the defects were as follows:—

| | 1916. | 1915. |
|---|---|---|
| Coarse aggregate coated .......... | 61.9% | 35 % |
| Fine aggregate containing an excess of loam or made up of excessively fine-grained sand .................. | 25.7% | 43.9% |
| Coarse aggregate, poor quality ...... | 6.2% | 8.2% |
| Poor manipulation in making cubes.. | 6.2% | 16.9% |

These tests also show a grand average of 3,370 pounds compression for all 1:1½:3 mix cubes stone and gravel, while the average for the stone cubes is 3,380 pounds and the average for the gravel cubes is 3,080 pounds. Thus it is demonstrated from these tests that stone concrete is 11% stronger than gravel concrete. In comparing the two, it is fair to say that all gravels with a coating that ordinary washing will not remove should be rejected; while stone that retains much of the dust of fracture is bound to make weak concrete. This is especially true of all soft limestones, and of any stone that is crushed when it is wet.

**Construction.**—An exact subgrade is necessary to save the concrete that would be wasted in evening up inequalities in the foundation. The extra time and attention spent on getting an exact subgrade will be well repaid.

The materials should be placed well in advance of the laying, so that when the mixer has once commenced operations the work may be continuous. If the road is being constructed of imported materials, the use of a stock pile to prevent shortage will materially reduce the loss from delays in operation. In order that the minimum amount of work may be done in taking materials from the subgrade and placing them in the mixer, it is advisable that the superintendent and foreman should each have a list of the amounts to be distributed for every hundred feet. A little attention to this detail will save largely in the item of labor.

**Rejection of Materials.**—Materials should be rejected before they are unloaded to come on the work. As good quality is essential in both sand and stone, both these materials should be checked up from day to day in order to secure the best results.

**Equipment.**—Attention should be given to the screed or strike board or template as it is often called. This should be heavy enough to screed the concrete properly, and it should be cut to conform to the crown of the road. It should be provided with handles and be shod with a steel angle-iron bent to the shape of the roadway. Wooden floats should be provided for doing the necessary floating, and the float to be used at a joint should be split in such a manner that it will ride over the joint smoothly and will cover an area of at least one foot on either side of the joint. Steel forms, while more costly than those of wood, are far more economical in the long run and pay for themselves in a short time.

**Measuring Barrows.**—Barrows should be of such a type that their measurement can be regulated by the bolting of boards across the rear part of the barrows to make the quantities adjustable. Forks should be provided for taking the stone from the subgrade in order to eliminate the dirt.

To insure a sufficient supply of water a pipe line should be installed, for although tank supply may amply provide for the mixer, it can scarcely take care of that and attend to sprinkling too.

The concrete road presents a good problem for the application of labor-saving devices in the handling of materials and many different installations have shown reasonable cost reductions. The industrial railroad has played a large part in this.

The forms should be placed in such a way as to give them stability and they should above all be tight. The sub-grade should be kept drenched with water immediately ahead of the laying of the concrete.

An ordinary concrete force in operation on a 16-foot road is comprised of from 32 to 35 men doing all branches of the work and it is quite often necessary to rearrange the gang so that the best results may be secured in keeping the mixer in continuous operation.

Suitable measuring tanks should be provided so that the amount of water may be such as to make the separate batches of the same consistency, the ideal consistency of concrete being where it will just settle and will not run. This is very important as the density of the resultant concrete is dependent upon it; if too wet the materials will run on the grades.

The concrete should be well spaded and kept high above the screed or strike board on the mixer side. Tamping should not be allowed. In screeding, the screed should be slowly pulled back and forth, advancing it slowly with each operation. When approaching a joint the screed should be brought up to the joint and carried back in order that the surface may be uniform. No more floating than is absolutely necessary should be resorted to as the primary object is to have the wear on the surface taken by the stone, and not by the thin mortar layer produced by floating.

Placing of joints should always be perpendicular to the surface of the pavement. If they are not, in subsequent expansion there is often riding of the slabs. In many instances it may be necessary to stiffen up the consistency of the concrete in order that the screeding on grades will not give a ridgy effect. If possible, all work on grades of over 4 per cent. should be worked up-hill. The cement factor should be taken daily and reported to the division engineer.

**Curing.**—Curing properly is as necessary as good construction, for upon this depends to a large extent the strength of the resultant concrete. Sprinkling should be commenced as soon as the surface will not pit and a cover of 2 inches, at least, of sand or loam should be spread over the surface. This cover should be kept saturated with water for ten days. Care should be taken, however, not to place cover until the concrete is sufficiently firm to withstand the impact caused by placing. Sprinkling should be done in such a manner as not to wash the cover from the surface. When the temperature gets below 50° F. in the middle of the day, sprinkling and cover may be omitted. When concrete is laid in cold weather its curing period should be lengthened, as low temperature retards its gain in strength. Work done in November should be allowed to cure from four to six weeks.

It has been our aim to designate essentials in design and specifications; to hold only such standards as have been proven practical, from our field and laboratory tests; and to employ only such methods of construction as will insure serviceable pavements at the lowest possible costs.

As you are aware, I have not attempted in this paper to cover the subject fully; limitation of time, to say nothing of other limitations, would not allow that. I have tried to suggest features which may some time lack sufficient attention, and to emphasize other features of whose importance we feel certain.

In conclusion, let me say that the ideas presented in this paper are based upon such knowledge as may be gained by inspection of concrete pavements in various parts of the country, and, more validly, on the actual construction in New York State of 201 miles of second-class concrete pavement, 1 : 2½ : 5 mix, a type which we have ceased using; and upon the actual construction of 364 miles of cement concrete pavement, 1 : 1½ : 3 mix, built in the last four seasons. There still remain 127 miles of this type of construction under contract in New York.

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"The extension of the Chicago drainage canal for two miles at Joliet to a new 24,000 h.p. hydro-electric plant on the Des Plaines River is proposed, in order to provide power for operating pumping stations of the Chicago waterworks. The sustained opposition of the city of Joliet and of private concerns proposing water-water projects has been overcome, the city being assured of ample protection against floods and overflow. It is estimated that the extension and power plant will cost about $6,600,000 and that the work can be completed in three years. It is necessary to wait, however, for the passage of a bill by the Illinois Legislature authorizing the Sanitary District of Chicago to build the extension, dam and power plant. This bill has been prepared."—U.S. Exchange.

## MAINTAINING EARTH AND CLAY ROADS.*

By A. A. Smith.

OWING to the absence in many places of rock, gravel or other hard and durable substances, with which to build good roads, and by the reason of the excessive cost of such roads, where suitable material is scarce, a large part of our public highways will of necessity remain earth and clay roads.

When one considers the number of miles of this kind of road, in any township or county in the province of Ontario and compares it with the number of miles of surfaced road, it can easily be seen that it will be many years before even one-half of them are properly surfaced with either gravel or stone. For this reason it appears most important that we should give every consideration and thought to the construction and maintenance of the common earth and clay roads.

In our effort to construct a type of road that will carry the ever-increasing motor traffic between cities, we are apt to overlook this earth road problem, where large sums of money are being spent, more often with poor results, which, if handled properly, would result in better roads and more of them, for perhaps less cost.

Before spending too much time or money on the maintenance of a road, one should bear in mind that this earth road may be the foundation for a later improved one, with a surface of gravel, stone, concrete or other hard material. It is, therefore, important to first of all be quite sure that there is no question whatever regarding the correct location.

The chief factors to bear in mind in this respect are: easy grades, proper direction, good foundation and drainage. The common error in laying out a road, is made in the endeavor to secure the shortest route between two fixed points. For this purpose the road is often made to go over hills instead of around them.

Many of our roads were originally laid out following along boundary lines of farms and concession lines, regardless of grades. Here they have been allowed to remain, where a large amount of energy and material have been wasted in trying to travel and haul loads over them and in endeavoring to improve their deplorable condition.

In locating the route, one must also bear in mind that the road for the present will be constructed out of the materials over which it passes, so it will be well to carefully study the nature of the soils and avoid, where possible, any swamps, or morasses and soils adjacent to beds of streams, not only on account of the poor nature of the road-making qualities but also on account of the difficulty of draining.

A road can never be kept hard and smooth if the water from the surrounding land drains on to it. This can often be avoided by taking a little longer route on nearby higher ground at perhaps a little greater initial cost, but certainly at a much reduced expense for maintenance.

A road should be finally located so that when constructed the length and grades will be so balanced that a minimum amount of effort will be required to go from one end to the other.

After satisfying oneself that the location of the road cannot be improved upon, the next most important feature to study is drainage. Water is, without doubt, the most destructive agent to any class of road, but much more so to an earth road, which is more susceptible to the action of water, more easily dissolved and moved by it, than any other surfaced road; for this reason, too much attention cannot be given to this problem. This is true in all climates, but more particularly in Canada, where heavy rains are prevalent during certain seasons of the year, and where the winter months are attended with severe frost and snowfalls.

Water must be kept away from the road and rain which falls on it must be made to run off as rapidly as possible.

Drainage may be divided into two sections: (1) Subdrainage; (2) surface drainage. The former will undoubtedly be required, when the road runs through wet lands, over clayey soils, or where springs exist in the soil under the road.

Various forms of underdrains are laid, some of wood and some of stone, but at the present time there is no question but that the best results are obtained by the use of tiles, either porous or glazed, the latter being preferred, even if the cost is a little more, on account of their greater resistance to frost action. These tiles should vary from 3 ins. to 5 ins. in diameter and be placed about 3 ft. below the road surface, or just below frost level. They can be placed at once side of the road, or both sides if necessary, except in places where it may be necessary to carry off water under the centre of the road where springs or spongy places appear.

The pipes should have a fall of at least 2 ins. to every 100 ft. Previous to laying the tiles the bottom of the trench should be brought to a true grade and carefully levelled, so as to avoid any humps in the pipe line. In laying the tile, care must be taken to get the ends to fit closely to each other, and cover the joints with a strip of tarred paper. When filling in the trench, tamp the first few inches of material that is being replaced above and around the tile so as to prevent any possible displacement. Some people recommend filling over the pipes with gravel or small stones, but this is only necessary in certain soils of a stiff clayey nature. The object of subdrainage is to keep the ground supporting the road dry, by carrying off all ground water before it can penetrate the subgrade, also in the spring season, when the frost comes out of the ground, any water resulting from the thaw will be quickly drawn off. Roads which were at one time impassable for wheel traffic, on account of their muddy surface, have, after being properly subdrained, become most satisfactory highways during all seasons of the year.

Surface drainage should now be considered. By this we mean that the crown of the road must be made waterproof, or in such a condition as to shed water easily to open side drains or gutters, which also must be made to carry away quickly any water to the nearest natural outlet.

In constructing an earth road, the cross fall of the surface in level country must not be less than 1 in. in 12 ins.

On hills the camber should be greater, say, 1 in. in 9 ins., so that any water falling on the road will not be allowed to run down the wheel tracks lengthwise of the road and thus create deep ruts.

In many parts of the country one will find V-shaped ditches constructed across the surface of the road. These are more often found in hilly or rolling districts, and are generally spaced about 100 ft. apart and varying in depth from 6 ins. to 12 ins. These drains are not only dangerous, but very uncomfortable to travel over; also hard on

*Paper read before the 3rd Annual Conference on Road Construction, Toronto, March 27th to 30th, 1917.

all vehicles, so should be avoided whenever possible. These can often be eliminated by giving a high crown to the road, good side ditches, and a good smooth surface. Care must be taken to keep all side ditches in such condition that water will not be allowed to remain in them. They must be kept free from weeds and rubbish and have sufficient capacity and grade to carry quickly away the water reaching them under conditions of maximum flow.

In order to ensure a good, smooth, dry surface to the road, one will not have much difficulty after the drainage has been properly carried out. This can be done most economically and successfully by the systematic use of the log drag. It is needless here to go fully into the construction or the use of the drag, as it would be old news to you. However, as this method is the most important in the maintenance of a clay road it will, perhaps, not be out of place to impress on you a few of the most important points connected therewith.

First of all, the drag should be made of light material, preferably cedar or pine, so that it can be easily drawn by one team of horses, and frequently. Remember that the drag is not blessed with brains, and if these are not possessed by the operator one can hardly expect good results. Remember, also, that the road drag will not do the work of a grader.

Drag the surface of the road after each rain storm, not when the road is too soft, but while it is still moist. The man in charge will be the best judge as to the correct time to use it on account of his previous experience of the different characters of the soil. The material moved by the drag in planing off tops of ridges and rough places, should be smeared in a thin, even coat over the surface, fill up hollows and ruts and help to keep a good crown.

Do not attempt to move more earth than is absolutely necessary. The driver should ride, and by so doing he will be able, after a little practice, to manipulate the drag successfully by moving his position backwards or forwards.

A few hours of labor spent at the right time will often save serious destruction which may take much time and money to repair.

All railway companies adopt a strict system of maintenance to take care of their roadbed, bridges, culverts, etc., and as they have proved it good business to them, it surely will apply to the same extent or even more so in highway work.

There are several methods of operation which could be adopted to advantage, one of which I might mention. In case a township has not entered on a county road system, then the council should appoint a road superintendent who must be an experienced and responsible man who will take charge of, and be responsible for, the upkeep of all the roads. His appointment must be permanent, the same as the township clerk and treasurer.

The roads in the township should be divided off into sections of 3 to 5 miles and a man should be engaged for the season to take care of each of these sections.

Often farmers or people residing along the road will be willing to undertake this work. It will not take up the whole of a man's time and as the most efficient work on an earth road should be done just after a rainfall, which is usually a time when the farmer is less able to work to advantage on his farm and when he can often more easily spare a team which could operate the log drag, or do any necessary grading required.

These section men should be provided with rakes, shovels, axes, picks, wheelbarrows, bush scythes, and tool box, and last, but not least, a road drag.

The duties of the men will be to restore the proper shape over the grade, give the surface a good floating, so as to keep it smooth, and not allow any ruts or rough places to form. This can better be accomplished by the drag after every rainfall and when the dirt is about the consistency of putty. Besides this, he must fill up all holes with the same kind of material as the existing road surface, and not on any account with gravel or stone. The men will be expected to put in one or two days each month on the repairs to culverts, bridges, ditches and underdrainage. They must also keep down the brush and weeds, trim all trees, break through the snow in winter, erect snow fences and in general keep the road up to the required standard of the road superintendent and to his entire satisfaction.

It will be difficult to arrange a detailed set of requirements necessary for the maintenance and suitable for every section, as each one may be varied considerably by local conditions.

The road superintendent will have sole control of the section men with regard to road work. He will be expected to visit and inspect their districts periodically and thoroughly study conditions together, so that he will be in a position to advise and guide the council from time to time.

If an inexperienced man is engaged as superintendent, too much must not be expected from him for the first year, but as in all businesses, success is largely dependent on the choice of a capable man in charge.

In placing responsibility on him, he must be given full authority with regard to hiring or discharging men and teams. He must advise the council, the council will decide the work to be done, but the doing of the work will be entirely in his hands.

If statute labor is retained in the township the pathmasters will take the place of the section man previously mentioned.

The road superintendent should acquaint himself with the best methods of constructing and maintaining all classes of road and by knowing how to operate graders, crushers, rollers and all other road-building machinery, so that if at any time he is called upon to improve the earth or clay road surface he will be in a position to undertake the work.

He shall be required to keep an accurate record of all the men employed and work done, so as to be able to furnish the council whenever required with pay-sheets, accounts and vouchers, and be in such a position as to be able to show in detail the character, location and cost of each separate piece of work undertaken, whether for grading, ditching, tiling, dragging, culverts, or other work connected with the care of a road.

## NEW ZEALAND IRON AND STEEL ENTERPRISE.

A company has recently been formed in New Zealand, with a capital of £70,000 (about $340,000), with the object of producing iron and steel from magnetic and titaniferous iron sand, of which there is a large deposit on the coast at Taranaki, near New Plymouth, North Island. Works are being erected at New Plymouth. The present intention is to install a furnace capable of dealing with 70 tons of iron sand weekly, but plans have been drawn up for the installation at a later date of an additional furnace capable of dealing with 200 tons weekly. The company claims that pig iron can be produced from these iron sands at a cost not exceeding £3 ($14.60) a ton. The production of steel is also contemplated, and it is intended later to form a new company to carry out this development. Meanwhile, the company will proceed with the production of pig iron for foundry purposes.

# Editorial

## OTTAWA AND GOOD ROADS.

Federal aid is urgently needed in the building of good roads in Canada. It is appropriate, therefore, that the fourth annual meeting of the Canadian and International Good Roads Congress be held in Ottawa next week.

Not since Confederation has the Dominion of Canada contributed to the construction or maintenance of the King's highway. A bill allowing $30,000,000 for federal aid was defeated by the senate a couple of years ago on account of the senators not being able to agree as to how the money was to be appropriated. A new bill should be brought down for this amount, or even more, to be granted to the provinces *pro rata* according to population. Both the sentimental and practical value of roads, not only in peace but also in war, have been established beyond dispute. The good roads of France saved Paris.

Looking at the matter strictly from a business standpoint, it is easy to demonstrate that the expenditure of $30,000,000, or many times that amount, on good roads by the federal government would be a mighty good investment. Experience in the United States, and also upon a smaller scale in Ontario and Quebec, shows that production increases and farm properties improve in value with the construction of good roads. A few statistics taken from the last census (1911) will show just what these increases in value would mean to Canada. There were then about 703,000 farms in this country valued at approximately 4¼ billion dollars. An increase of fifty per cent. in this value—an increase attainable by an adequate system of good roads—would mean that the wealth of the nation would be enhanced by over two billion dollars.

Besides the increases in regard to improved land there is also to be considered the influence of good roads upon the farming of unimproved land. At the time of the last census the unimproved farm land in Canada was worth about $13.50 an acre compared with $51 an acre for improved land, a difference in value of $37.50 an acre. There are about 61,240,000 acres of such land in the farms of Canada. The building of good roads which would allow for the marketing of sufficient products to make it profitable to cultivate this land, would mean the addition of another 2¼ billion dollars to the wealth of our country.

These figures deal merely with direct additions to the nation's wealth caused by increases in value of farm property, and, stupendous as they are, amounting to 6½ billion dollars, they are no more important than the other benefits derived from good roads, such as the large increase in manufactured products which would result from greater facility in marketing same among the agricultural population, the improvement in the affairs of schools and churches, the greater health and pleasure of the entire community, the advertising which Canada would get among tourists from United States and other countries, and the advertising which the various sections of the Dominion would get among the tourists from the other sections.

Neither does it take into account the considerable improvement which would be made in our railway freight statistics, and in immigration. One of the causes of the present railway situation in Canada is the lack of sufficient good roads as feeders to the railways. In preparing for after-the-war problems and for attracting a fair share of American immigration, what stronger factor could there be in inducing these new people to settle on the land instead of congregating in cities, than for the Dominion Government to help in providing an adequate system of roads which would enable them to get onto the land, to market their products, and to be willing to remain in farm life contentedly, owing to easy access to towns and cities whenever desired?

## ONTARIO AND QUEBEC ROADS.

Besides the question of federal aid, there is another reason why Ottawa is the ideal city in which to hold the Canadian good roads congress this year. On the borderland of both Ontario and Quebec, forming a federal district which virtually and practically is not distinctly a part of either province but a link between them both, Ottawa is an ideal place for a congress which will exemplify work that has been done by Ontario and Quebec in the good roads movement. These two provinces have been the leaders in the movement in this country.

This is the tenth anniversary of the passing of the law which marked a new era in road building in Quebec. This law has since been amended and during the last five years far greater sums have been spent by that province than were spent in the initial half of the past decade. The first time the million-dollar mark was reached in Quebec Province road expenditures was the year 1912-13. This increased to over four million dollars the following year, and to over six million in 1914-15.

The laws relating to highways date from the founding of the French colony in Canada. Under the French regime the highways were all under the control of the Grand Voyer. After the fall of the gallant Montcalm the highways were practically neglected until 1840. Thirty years later municipalities were given sole control of the roads, and while this control has continued during the last ten years, assistance to these municipalities—even to townships and parishes—and the creation of an able provincial roads department to co-operate in the work, have helped the municipalities in building and maintaining good roads.

During the past decade over 2,000 miles of macadam and gravel roads have been constructed or improved in Quebec. The King Edward Highway, the Sherbrooke-Derby Road, the Montreal-Quebec Road, the Chambly Road and the Levis-Jackman Road have been built. Several other roads are proposed, including Montreal to Hull, Three Rivers to Grand-Mere, Levis to Nicolet, and Nicolet to Rimouski.

While Ontario as a province has been behind Quebec in road development, it has been a close second, and if total expenditures on all pavements, both streets and roads,—by all parties, both provincial and municipal,—are considered, Ontario probably leads, as over ten million dollars a year has been expended for many years past for streets and roads in Ontario.

For several years approximately a half million dollars per annum has been spent on trunk roads in New Ontario, and another half million dollars on colonization roads. During the last calendar year about $300,000 was expended in aid to counties, which would involve an outlay by the counties themselves of another $450,000. The Ontario system does not recognize any municipality smaller than a county.

The Toronto-Hamilton Highway is the only trunk road of great importance that has been built in Ontario within the past few years, but a Provincial Road from Ottawa to Windsor has been planned and will be gone ahead with as rapidly as finances permit under war conditions. In Ontario also there is an energetic highway department, which is planning far ahead, at the same time closely supervising existing roads.

Both the Ontario and Quebec governments are doing their best to eliminate toll roads and toll bridges. A considerable proportion of the federal aid could be used advantageously in the improvement of bridges. A speaker at the last road congress stated that about ten thousand wooden bridges and culverts had been replaced by steel and concrete in Quebec Province in the last ten years.

Many thousands of miles of roads in Canada require construction or reconstruction. Broadly speaking, we might almost say that Canada has no roads; the era of road building in Canada has only begun. The support that was accorded the Canadian Road Congress in Montreal in 1914 and 1916, and in Toronto in 1915, is an indication of the interest that the people of Quebec and Ontario are taking in good roads, and there is no doubt but that similar interest will be shown in the meeting at Ottawa next week.

## ANOTHER MONTREAL DRAMA.

Life must be interesting for the members of Montreal's Works Department and Board of Control. To say the least, it never becomes monotonous. Investigations, suits, scandals, charges, court trials and other incidents of municipal regime follow along with startling rapidity in our eastern metropolis. But the scenery is always the same. Different actors, various lines and new stage managers enter the limelight, but the background of alleged graft never changes.

The latest drama might be entitled, "Spending $5,000, or a Closed Specification for Flushing Equipment"—in three reels. The scenario follows:—

First Reel—Views of Montreal's streets, showing the mud for which said streets are noted in the springtime. Close-up of city engineer reaching decision to call for tenders on motor-driven flushing machines, the most modern and best method of street cleaning. Enter Chas. Hvaas, of New York City, strongly determined to have "Hvaas" superstructure equipment specified, whatever truck or chassis is purchased.

Second Reel—View of Board of Control meeting. Tenders received. Complaints of favoritism and "absolute specifications." New tenders called on revised specifications which other manufacturers allege admit only "Hvaas" equipment. Chas. Hvaas quotes Montreal truck dealers $2,500 per set of equipment, compared with $1,300 quoted for the same equipment before tenders were called. Dealers complain. Hvaas says: "It cost me a lot of hard work and $5,000 to have my specifications passed and if I give the price quoted before, who will pay me back the $5,000?" Hvaas later lowers price somewhat but is still higher than original figure.

Third Reel—Flash-back to Board of Control. Second tenders received. Demand for investigation of Hvaas' statements. Cut-in of meeting of investigators. Hvaas on stand. Admits statement, but claims the $5,000 was spent on hotel bills, salary, etc., during three months' work of persuading Montreal officials to use his specifications. Says he never gave a nickel to any city executive. Details of notes, loans and much of the private life of a controller and his former secretary, now an agent for the Hvaas Co., enliven the scene and permit a display of fine emotional acting. Return to original setting:—Board of Control calls for third tenders, manufacturers still complaining about the specifications.

The failure of this drama to secure popular applause will be its lack of new "props" and of new "location." Every up-to-date movie director knows that the public tires in time of seeing the same old background even though the story varies. Why doesn't Montreal shift the scene and play "The Open Specification, or Always Giving Everyone a Square Deal"?

## PERSONAL.

T. S. HUSBAND has been appointed waterworks engineer at Ladner, B.C.

CARLTON MILLER has been appointed town engineer of Bridgeburg, Ont., to succeed EDWIN J. JUKES, who recently resigned.

M. LEIGHTON WADE, for the past two years electrical superintendent at Duncan, B.C., has resigned, and will re-enter the plant construction field.

FRANCIS C. McMATH, president of the Canadian Bridge Co., Walkerville, Ont., was recently appointed a member of the Detroit Municipal Street Railway Commission.

A. S. CLARSON, engineer of the city of Verdun, Que., has been appointed consulting engineer to the city in connection with the proposed underground conduit system, estimated to cost $200,000.

STEWART JONES, of Welland, Ont., has been appointed inspector of power plants for the Hydro-Electric Commission of Ontario. For the last eleven years he has been with the Hydraulic Power Company of Niagara Falls, N.Y.

R. H. STARR has severed his connection with the engineering staff of the Toronto Hydro-Electric System, and has accepted a position as sales engineer with the Toronto sales office of the Moloney Electric Company of Canada, Limited.

P. W. GORDON, who has been with the Imperial Oil Co. at Calgary for eight years, has been promoted to the managership of the Saskatoon territory. Before his departure from Calgary he was presented with a watch and chain and Masonic charm by the staff.

Capt. RAYMOND TYRWHITT, of Toronto, who joined the 215th Battalion at Brantford, Ont., as a lieutenant, and was subsequently promoted to be captain, has been appointed adjutant of that unit. Capt. Tyrwhitt was a member of the School of Applied Science, class '15.

Lieut. FRANKLIN ROY MALCOLM, of Locust Hill, Ont., a student at the School of Applied Science, Toronto, has been appointed second lieutenant in the 25th Northumberland Fusiliers. He went to England with the second draft from the Overseas Training Company.

FRANK BARBER, A.M.Can.Soc.C.E., and R. O. WYNNE-ROBERTS, M.Can.Soc.C.E., consulting en-