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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

SOME COSTS OF SEWER WORK

SEWER WAS BUILT IN THREE SECTIONS—IN TUNNEL, IN OPEN CUT FOR CONCRETE AND BRICK, AND IN OPEN CUT FOR TILE

By **W. G. Cameron, B.Sc.,**

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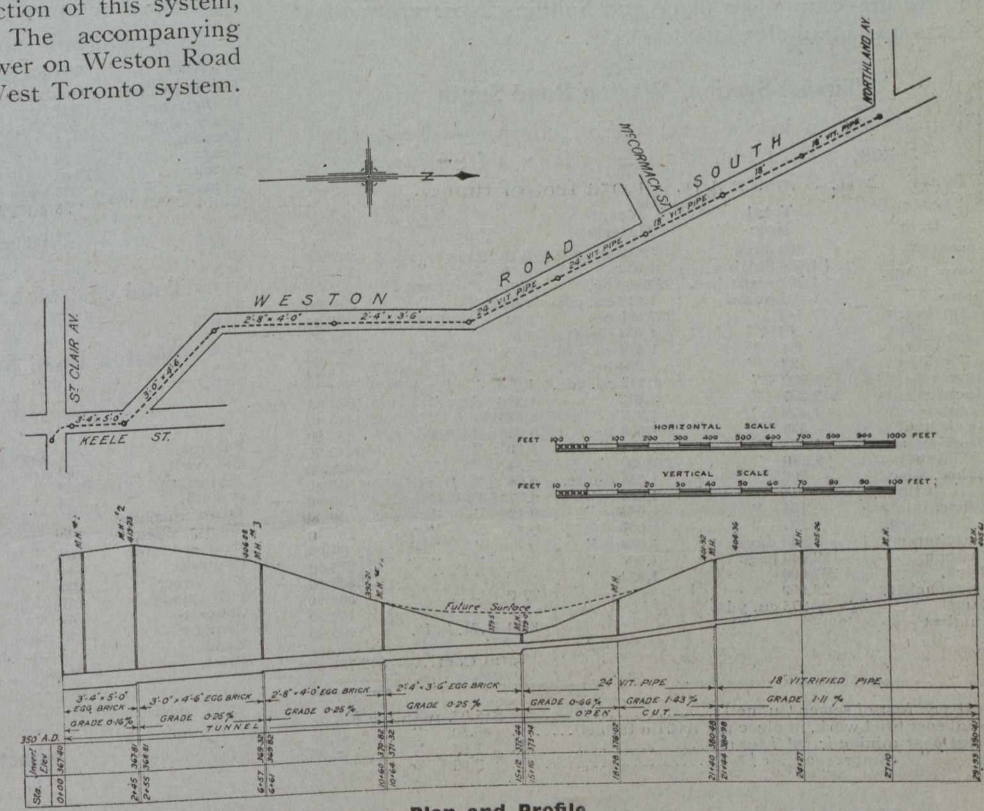
IN former issues of *The Canadian Engineer** a series of articles has appeared dealing with the "West Toronto Sewer System," lately completed at a cost of $2,000,000.

A general sketch of the system was given, a description of the outlet for storm water to the lake and a description of the stand-by tanks where this storm water is separated from the sewerage. Compressed air, which was used extensively in the construction of this system, was also discussed in this series. The accompanying plan will show the location of the sewer on Weston Road South and its connection with the West Toronto system. As will be seen, it serves a part of the abattoir district and discharges into the Woodville Avenue sewer.

This sewer on Weston Road south is interesting, not because of its costliness, nor because of any great difficulty met with in the work, but because it was constructed in three sections. Part of it was built in tunnel, part in open cut for a concrete and brick sewer, and part in open cut for tile pipe, thus requiring a different organization for each part. The accompanying section shows the reason for this division into three parts. As will be noted, the sewer was built in tunnel where it was far beneath the surface of the ground and in open cut where the street dipped down to cross a ravine, bringing the sewer near the surface of the ground. The lengths of these three sections were as follows: 1,054 feet were built in tunnel; 456 feet were built of brick and concrete in open cut; 625 feet were 24-in. and 851 feet were 18-in. tile pipe built in open cut.

The tunnelled portion of the sewer passes through ground which was found to contain water to the depth of about two feet in the bottom of the tunnel. Compressed air was accordingly resorted to in order to drive it out while the work was being done. From three to ten pounds was found sufficient to accomplish this, but owing to the loose nature of the ground, much air escaped and the necessary pressure was both difficult and costly to maintain. The contractors, Messrs. Jennings and Ross, decided to construct the tunnel from the small or head end since it was nearer to the surface. The tunnel was built in three sizes and all from one heading. A single lock was built in open cut at No. 4 manhole, where the tunnel approached nearest to the surface, and so necessitated the minimum amount of excavating. Another lock was built at No. 3 manhole—this one in tunnel. In this case, the shaft was sunk after the lock was built. Seeing that the finished sewer would be small, the inner of the three rings of brick was left out temporarily to facilitate the work. When this inner ring was later put in after the other two rings were completed, a small pipe or hole was left through it every 2½ feet along the crown. When the inner ring had set, grout was pumped in through these holes to fill up the small shrinkage crack which necessarily appeared above the inner ring.



Plan and Profile.

Where the street dips down to cross the ravine shown in the section above, the sewer was, as we have stated, built of brick and concrete in open cut. The ex-

*See *The Canadian Engineer* for March 2, 1916, and August 10, 1916.

cavating was done with the aid of a clam shell. Since the bottom of this trench was wet, a great deal of pumping was required. Part of the sewer in this open cut was so near the surface of the ground that an extra ring of brick was provided, and at the nearest point to the surface a 6-inch concrete covering was also provided.

For the 24-inch and 18-inch tile pipe sections of this sewer, the excavating was done in stretches of open cut and tunnel alternating; or, say, a 12-foot stretch of open cut and then 8 feet of tunnel. The space remaining above the sewer in the tunnelled stretches was packed with 1:4:9 concrete. These short stretches of tunnel saved a great deal of handling of excavation.

A fair line of costs was kept on this job, and we shall endeavor to give them as clearly as possible. Of course, they do not include overhead charges, depreciation of plant, cost of bond or wastage of tools, etc. In the costs is given separately the cost of the tunnelled section, open cut section, 24-inch tile pipe, 18-inch tile pipe, lining, building one lock, setting up compressor plant and building Nos. 1, 2 and 3 shafts and manholes.

Intersections of Weston Road South Sewer with that on St. Clair Avenue.

Tunnel Section, Weston Road South.

Ground wet in lower 2 feet only, compressed air used. Sizes, 3 ft. 4 ins. x 5 ft.; 3 ft. x 4 ft. 6 ins.; 2 ft. 8 ins. x 4 ft. 1,054 feet of tunnel.

Item	Total Time	Total Material	Unit	Cost
Foreman	200 days	1,812 cu. yds.	0.11 days /c. yd	$ 800.00
Comp. Engr.	1,626 day hrs.	1,812 "	0.90 hrs. "	1351 70
	1,600 night hrs.	237,000 br.	6.71 " /1 000	
Pump "	1.895 hours	1,812 cu. yds.	1.046 " "	758 00
Team Brick	145 "	237,000 br.	0.61 " /1,000	98.10
" Plant	201 "	1,054 lin ft.	0.9 " / ft.	135.97
" Surplus	464 "	1.812 cu yds.	0.26 " /c. yd.	309 35
" Misc.	22 "	1,054 lin. ft.	" / ft.	14.65
Miners	1,929 "	1,812 cu. yds.	1.065 " / yd.	964.50
Muckers	2,297 "	1.812 "	1.270 " "	803 95
Tagman	1,478 "	1,812 "	0.816 " "	443.40
Brick haul	533 "	237,000 br.	0,290 " /1000	159 90
Bricklayers	1,374 "	237,000 "	5.80 " "	1442.70
" labor	6,556 "	237,000 "	27.64 " "	2,094.60
Labor, Misc.	708 "	1,054 lin. ft.	0.66 " /1. ft.	212.40
" Cl'n'g Sewer	811 "	1,054 "	0.77 " "	243.30
Labor, Pumps	136 "	1,054 "	0.13 " "	40 80
" Plant	337 "	1,054 "	0.32 " "	101 10
Watchman	43 days	1,054 "	" "	86 00
Cement	2,449 bags	1,054 "	" "	979.60
Brick	237,000	1,054 "	" "	2,607.00
Brickpackers	28,000		27 0	308 00
Sand	275 cu. yds.			412.50
Lumber			8.00 B.M. /l. ft.	400 00
			Total Cost.....	$12,767 52

Cost per foot of sewer (tunnel)	$15.02,	with air $15.02
Total cost brickwork, in place per 1000 (in tunnel)	40.50,	" " 42.00
Total cost mining /c. yd. / tunnel	1 63,	" " 3.05
" " compressed air / l. ft.	3.00	

Weston Road South—Shaft and Manhole No. 1.

Sand; 39 ft. deep, 8 ft. x 10 ft.

Item	Time, etc.	Volume	Unit	Cost
Foreman	13 days	112 cu. yds.	0.12 days /c.y.	$52.00
Engineer	69 hours	112 "	0.610 hrs. / "	27.60
Team	60 "	112 "	0.536 " "	39 80
Excavation	251 "	112 "	2.241 " "	75.30
Timber	77 "	112 "	0.689 " "	23.10
Backfill	92 "	72 "	1.278 " "	27 60
Moving Plant	156 "	112 "	1-393 " "	46.80
Bricklayer	49 "	11,000	4.455 " /1,000	36.75
" labor	210 "	11,000	19.091 " "	63.00
Brick	11,000	117 bags cement		121.00
Cement	117 bags	112 cu. yds.		46.80
Sand	13 cu. yds.	112 "		19.50
Lumber				30.00
				$609.25

Total cost of brick in place, $28.82 per thousand.

Lining.

The third or inner ring of the 2 ft. 8 ins. x 4 ft. was left out and built after the tunnelling was completed.

Item	Time, etc.	Volume	Unit	Cost
Foreman	10 days	27,100	0.37 hrs. /1,000	40.00
Bricklayer	335 hrs.	27,100	13.36 " "	117.25
" labor	579 "	27,100	58.26 " "	552.65
Cleaning	46 "	27,100	1.70 " "	16.10
Team	26 "	27,100	0 96 " "	9.10
Brick	27,100	325	83 /bag	298.00
Cement	325 bags	27,100		130.00
Sand	36 cu. yds.			54.00
	Total brick -	27,100		$1,217.10

Total cost of brick lining in place, $44.91 per 1,000.

Weston Road South—Shaft and Manhole No. 3.

Sand; 31 ft. deep, 10 ft. x 14 ft.

			Unit	Total Cost
Foreman	11 days	160 cu. yds.	0.07 days/ c y.	$ 44 00
Excavation	480 hrs.	160 "	3.00 hrs. "	144.00
Timbering	128 "	160 "	0.80 " "	38.40
Backfill	36 "	80 "	0 35 " "	10.80
Team Surplus / Moving Plant	83 "	80 "	1.04 " "	55.35
Moving Plant	180 "	160 "	1.14 " "	54.00
Engineer	64 "	160 "	0.40 " "	25.60
Bricklayer	60½ "	7,050 "	8 64 " "	45.35
" labor	187½ "	7,050 "	26.80 " "	56.25
Concrete	67 "	5 "	13 40 " "	20.10
Cement	96 bags			38.40
Sand	11 cu. yds.			16.50
Brick	7.047			77.00
				$625 75

Shaft and Manhole No. 2.

39 ft. deep.

			Unit	Total Cost
Foreman	16 days	324 cu. yds.	0.05 days/ c.y.	$ 64.00
Engineer	249 hrs	" "	0.77 hrs. "	99.60
Fireman	185 "	" "	0.57 " "	64.75
Pumps (labor)	34 "	" "	0.105 " "	11.90
Team (D.R.)	195 "	224 "	0 87 " "	130 00
Excavation	1,127 "	324 "	3 48 " "	450.80
Timbering	170 "	324 "	0.525 " "	+0.00
Backfill	341 "	100 "	3.41 " "	119.35
Concrete	47 "	5 "	9 40 " "	16.45
Bricklayer	174½ "	16,400	10 64 " /1000	130.70
" labor	531 "	16.400	32.40 " /1000	185 85
Miscellaneous	34 "	324 "	0.105 " /c.y.	11.90
Brick	16,400			181.00
Sand	22 cu. yds.			33 00
Cement	193 bags			77.20
			Total Cost..........	$1,644.50

Total cost of brickwork in this shaft, $35.53 per thousand, in place.

Weston Road South—Building Locks and Setting Up Compressor Plant.

Foreman—Locks	10 days	@ $4.00	$ 40.00	
Comp.	11 days	"		$44.00
Engineer—Locks	55 hrs.	@ .40	22.00	
Comp.	80 "	"		32.00
Fireman—Locks	60 "	@ .35	21.00	
Comp.	30 "	"		10.50
Carpenter—Locks	54 "	@ .40	21.60	
Comp.	10 "			4.00
Team—Locks	39 "	@ .66⅔	26.00	
Comp.	39 "	"		26.00
Excavation—Locks	178 "	@ .30	53.40	
Timbering— "	30 "	@ .30	9.00	
Backfill— "	200 "	@ .30	60.00	
Engineer—Pump	102 "	@ .40	40.80	
Watchman—	8 dys.	@ 2.00	16.00	
Labor Pump	30 hrs.	@ .30	9.00	
Labor—Concr., Locks	226 "	@ .30	67.80	
Moving—Comp.	981 "	@ .30		294.30
Cement—Locks	162 bags	@ .40	64.80	
Sand— "	13 cu. yds.	@ 1.50	27.00	
Stone— "	30 "	@ 2.00	60.00	
Cement—Comp.	82 bags	@ .40		32.80
Sand—	9 cu yds.	@ 1.50		13.50
Stone— "	15 "	@ 2.00		30.00
Single Lock			$538.40	$503.10

Open Cut—Weston Road South.

Sandy Loam; Length, 456 ft.; Depth, 13.4 ft; Width 6 ft.

Unit	Total Time	Total Volume	Unit	Total Cost
Foreman	61 days	1,390 c. yds.	0.045 days /c. yds.	$ 244.00
Watchman	61 "	1,390 "	0.045 hrs. "	122.00
Engineer—hoist	425 hrs.	1,390 "	0.315 " "	170.00
" —pump	614 "	1,390 "	0.455	245.60
—moving Plant	50 "	1,390 "	0.040 " "	20.00
Fireman	270 "	1,390 "	0.200 " "	94.50
Labor, Pump	80 "	1,390 "	0.060 " "	24.00
Excavating	2.967 "	1,390 "	2.200 " "	890.10
Timbering	276 "	1,390 "	0.205 " "	82.80
Backfill	998 "	742 "	1.345 " "	299.40
Surplus	391 "	608 "	0.643 " "	117.30
Concrete	1,028 "	129 "	8,000 " "	308.40
Team D	157 "	608 "	0,260 " "	106.05
Team Moving Q	20 "	456 c. ft.	0.044 " / c. ft.	13 35
Labor "	40 "	456 "	0.088 " "	12.00
Bricklayer	333 "	45,000 br.	7.400 " / 1,000	249.75
" labor	683 "	45,000 "	15.180 " "	204.90
Cement Concr.	685 bags	456 lin. ft.		274.00
Brick	525 "	45,000 "		157.50
Stone	127 c. yds.			254.00
Sand	76 "			114.00
Brick	45,000			495 00
Forms				50 00
Lumber				300.00
				$4,848.65

Total cost of brick in place, per thousand, $26.54.

The manholes are built 2 ft. 6 ins. x 4 ft. (inside measurement). Manholes Nos. 1 and 2 are built of 18-in. brickwork throughout the bottom 9 ft., while the middle 20 ft. are of 14-in. brickwork and the remainder of 9-in. or two rings.

Weston Road South—24-in. Pipe.

851 ft. South of Northland Street to 635 ft. Further South. Dry Sand and Clay Loam; (Macadam). Length, 635 ft.; Width, 4 ft.; Average Depth, 13.7 ft.

Item	Total Time	Total Material	Unit	Cost in Hours Labor
Foreman	45 days	635 ft. of sewer		
Excavation	3,286 hours	1,275 cu. yds.	hrs. /c. yd.	2.58
Surplus	321 "	152 "	" "	2.13
Timbering	690 "	635 ft. sewer	" /lin. ft.	1.09
Backfill	690 "	1,123 cu. yds.	" /c. yd.	0.614
Concrete (hand mixed)	524 "	75 "	" "	7.00
Team	139 "	152 "	" "	0.91
Pipelaying	214 "	625 feet	" /lin. ft.	0.34
Concrete M.H.	23 "	2 cu. yds.	" /c. yd.	11.50
Bricklayer	23 "	3,500	" /1,000	6.57
Helper	39 "	3 500	" /1,000	11.14
Cement { Joints		83		
Cement { Pipe		300		
Cement { M. H.		49		
Brick		3,500		
Stone		60 yds.		
Sand		45 "		
Pipe				
Junctions				

Concrete, hand-mixed; surplus earth moved at different times, some having to be picked and scraped off road.

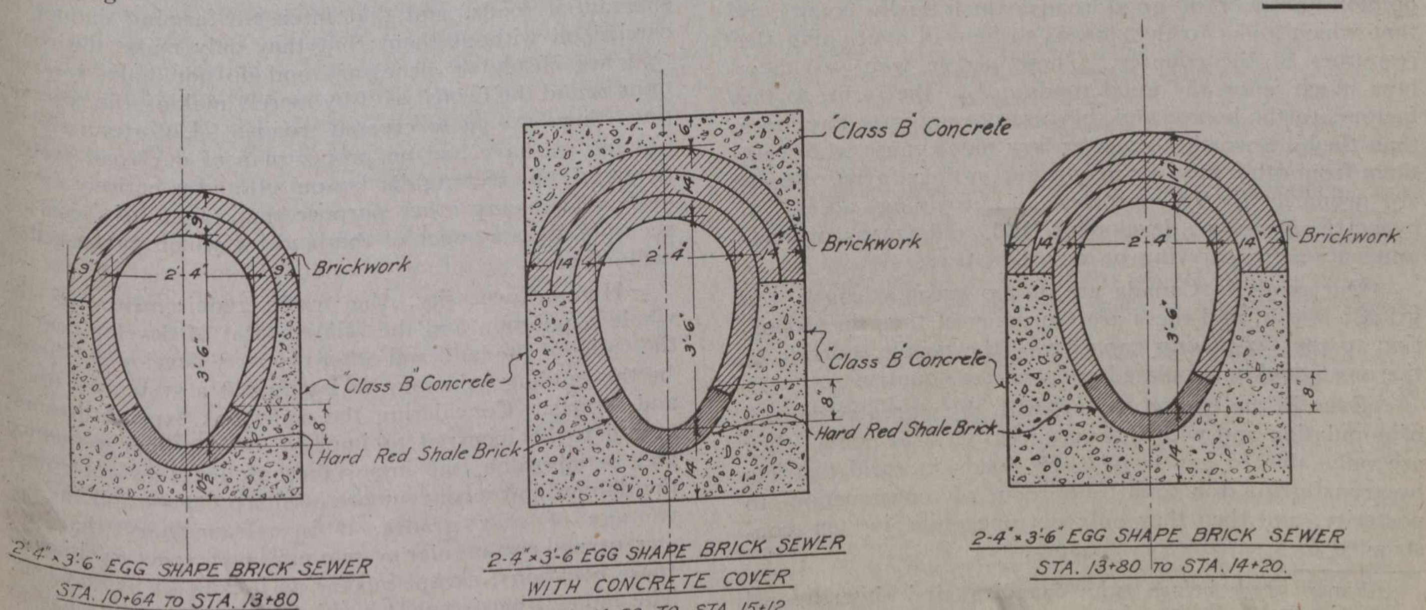
Weston Road South—Northland Street to 851 ft. South. 18-in. Pipe.

Dry Sand and Clay Loam; (Macadam.) Length, 851 ft.; Width, 3.5 ft.; Average Depth, 19.2 ft.

Classification	Total Time	Total Material	Unit	Cost in Hours Labor
Foreman	34 days	851 ft. of sewer		
Excavation	4,776 hrs.	2,118 c. yds.	hrs. /c. yd	2.26
Backfill	1.558 "	1,997 "	" "	0.78
Timbering	1,100 "	851 lin. ft.	" / in. ft.	1.29
Surplus	587 "	150 c. yds.	" /c. yd.	3.91
Team	59 "	150 "	"	0,393
Pipelaying	315 "	830 feet	" /lin. ft.	0.38
Concrete	.725 "	83 c. yds.	" /c. yd.	8.74
Bricklayer	79 "	11,200 br.	" /1000	7.0
Helper	208 "	" "	" "	17.70
Cement { Joints		97 bags		
Cement { Manholes		118 "		
Cement { Concrete		374 "		
Brick		11.200 br.		
Stone		71 c. yds		
Sand		54 c. yds.		
Pipe				
Junctions				

Summary of Costs.

Tunnel Section	$12.767.52
Open Cut "	4,848.65
Building Locks	538.40
Setting up Compressors	503.10
Shaft and Manhole No. 3	625.75
" " No. 2	1,644.50
" " No. 1	609.25
Lining 2′ 8″ x 4′ sewer	1,217.10
Compressed Air	3 663.56
24″ Pipe	3.295.50
18″ Pipe	4,873.40
Lumber, Oil, and other Incidentals	1,336.89
Total	$35.323.62



Sewer Sections.

GOOD ROADS AND LAND DEVELOPMENT.*

By Thomas Adams,
Town Planning Adviser, Commission of Conservation, Ottawa.

ECONOMIC and other practical questions in connection with good roads are not confined to matters relating to construction. While a great deal of money can be lost by extravagance in paving, by using the wrong materials and by want of employing engineering advice in making roads, yet although the fact is not quite appreciated, the direct and indirect loss due to bad planning of roads can be, and probably is, much greater than that which may be due to unscientific construction. Bad planning of a highway system has the effect of increasing costs due to haulage up steep grades and over greater length than is necessary; it causes roads to be laid over hills and across muskegs, creating difficulties in connection with land development and drainage of the worst kind; it has the effect of scattering the population, so that the amount of road surface to be made is entirely out of proportion to that which can be paid for out of any reasonable tax on the people or on the land served by the roads. For the latter reason it causes local authorities to leave roads unmade or to accept the most primitive forms of construction.

Roads should be designed by engineers to save waste in road space as well as in road construction. Above all else our highway policy should be designed to secure the principle of the maximum of convenience at the minimum of expenditure.

When road questions are discussed it is too frequently assumed that it only requires courage and willingness on the part of public administrators to secure a good roads system. As a matter of fact, there is scarcely anything in regard to which more courage and willingness are shown, and the real trouble is not the want of public spirit but simply the want of the available cash to construct roads according to our expensive and wasteful system of planning them. As a matter of fact we do not plan them; we fit them in somehow into a system of rectangular subdivision—either along the concession lines or on a five per cent. basis, which is little better. We should learn to plan our roads for a purpose. There are a few people in favor of good roads because they want to enjoy motoring in the country and a few others who do so because they want to sell road materials or machinery; but the public opinion in favor of good roads which really counts, is that which looks to that means to help in developing the resources of the country. These people want to know how much value the good roads are to the farm, to the factory, to the home; and they are not going to pay more than they are worth no matter how much those who want them from other motives may argue in their favor. Roads are primarily for the purposes of providing access to property, means of developing land, and means of communication for carrying on our industries.

Our roads in Canada are of too great a length, too great a width, and there are too many of them in proportion to the tax-paying capacity of the people, outside of the most thickly populated parts of the country.

Even in the United States, with their greater density of population and with their progressive road policy, they are only able to get satisfactory roads in rural districts by transferring too great a burden of construction to posterity, and then they only get one mile in ten constructed in a satisfactory manner.

*Paper read before 4th Canadian and International Roads Congress, Friday, April 13th, 1917.

According to Mr. Nelson P. Lewis, engineer of the Board of Estimate and Apportionment of New York City, "The State of New York, by the vote of its people, has authorized the expenditure of $100,000,000 for the improvement of the state highways, and this enormous sum is raised by the issue of 50-year bonds. While a portion of the work to be done is undoubtedly of a permanent character, such as the widening and straightening of the roads, the improvement of grades and provision for drainage by substantial structure of masonry or steel, a very large proportion of the expenditure is for road surfaces, many of which can scarcely be expected to last for more than ten years. Borrowing money for fifty years to pay for ten-year roads is obviously unwise."

The only sound principle in financing road improvements is to pay for all construction over the period during which it lasts, and only to borrow money for any longer period, say, up to fifty years, in respect of such portion of the work as is permanent. This permanent portion consists of the matters which may be described as incidental to the planning of the roads, such as, improving the grades by excavation and filling, acquiring a comprehensive survey of every part of a road system before large expenditure is incurred.

Comparisons are sometimes made between the good roads of the British Isles and the poor country roads of this continent. It is only during the last one hundred years that the roads in Britain have become satisfactory, and the greater part of the cost of improvement has been borne during the last twenty-five years. In the eighteenth century the roads in England were hardly passable. We are told that the old Romans used to travel over their highways in Southern Europe at the rate of 100 miles a day, but that in 1703 it took Prince George of Denmark fourteen hours to travel forty miles from Windsor to Petworth. So conservative were the masses of people in Britain against having good roads that in the eighteenth century they resisted their construction with riot and bloodshed, and even when the roads were made and improved, country people in many districts refused to use them. To-day, it is recognized in Britain that the best means of promoting agriculture and the proper development of the land is to have good roads. But the system has to be built up on an economic basis. Those who advise the large land-owners in England consider that there is no better investment than the making of good substantial roads, and that intensive farming cannot be carried on without them; but they only make the roads that are absolutely necessary and do not make reservations round the farms, as if by merely making the reservations they *ipso facto* created roads. Unfortunately, in Canada we have had no proper plan of our road system prepared; the rectangular lay-out of land is entirely meaningless from any other purpose than that of securing accurate measurement of the land for which purpose it is well adapted.

Human necessity, the traffic requirements of the whole population and the relative cost of development to the value of the land and other property developed, should be the guiding principles in laying out a system of roads and streets. Considering the enormous expenditures required to be incurred to improve roads, their economic and social value, the importance of directness of route, the danger and inconvenience of sharp curves and the advantage of easy grades, it is extraordinary that our stereotyped rectangular system pays no respect to either of these questions, except insofar as it does so by accident. The money that is spent by highway departments has to be allocated without the engineer having any voice in the location of the roads or in their original plan. Even with all the knowledge we have on this subject we split highway administration between colonization departments and ministers of highways so that our highway departments have to finance a system which they have not designed. As a concrete instance of the saving which can be effected in planning a single piece of road the "Municipal Journal" of America draws attention to a road at Cape Cod, Mass., where the estimate of cost varied from $14,000 to $36,000. The layman, without the assistance of the engineer, guessed within 61 per cent. of the actual cost, the engineer, without special examination, guessed within 39 per cent. and after a proper study he arrived at approximately the true cost. What, however, is really more important is that he reduced the cost by 25 per cent. by planning a more economical location.

The moral in this is not only that preliminary plans of roads should be made by competent engineers in the interests of economy, but that the engineer should have the power to exercise discretion as regards location of the road.

As the County Roads Board in Australia said in their report of 1914, "Badly located and badly laid roads are a constant tax on any community." No matter what the construction, they increase the cost to maintain and determine the amount of load to be carried. We all recognize that well-planned and well-made roads would help to build up manufacturing industries, cheapen production and reduce the cost of living by bringing the farmer nearer the consumer. Incidentally it would make it easier for the motorist to get about the country, but he is only a secondary consideration. Good roads would also attract settlers to areas that must remain unsettled without them. But in order to get good roads within the paying capacity of the people we will have to be less extravagant in regard to the width of all secondary roads; and in order to be more liberal in regard to width of the main thoroughfares we will have to be less wasteful in regard to second and third-class roads and streets. We simply cannot raise the money to make our present road and street system efficient, and the 66-ft. minimum in this province is an economic absurdity. When we lay out roads we should do so on a practical basis.

Roads should be planned, designed and constructed, as a rule, to suit the particular form of land development to be served by them. They should be made with due regard to the best use to which the land can be put. Provincial aid should be confined to improving the principal lines of communication. The system of planning highways in country districts determines the street system of the city; but we do not attempt in designing the one to consider its effect on the other.

The actual cost of a street 66 ft. wide, including a 9-in. sewer, a street pavement of asphalt on concrete foundation 28 ft. wide, two cement sidewalks each 5 ft. wide and 28 ft. of boulevard in Ottawa in 1916 was $27.50 per lineal foot. Thus, for a 25-ft. lot the cost of local improvements alone amounts to $343.75. If the cost of land is added it means that $700 to $1,000 has to be paid by the working man for a properly improved lot in a city area.

Owing to their more economic method of planning, widths of streets and frontages of lots, in England, e.g., a working man can obtain a site for a home, including local improvements, on a street 36 ft. wide for $214 as against $725 in a similar location in Canada. Allowing for the difference in the value of the dollar in both countries, the cost is even then from two to three times as much in Canada.

Narrow minor streets, in residential and rural areas, enable wide thoroughfares to be secured where they are wanted; they enable more air space to be given to the buildings,—although one of the reasons for making a wide minimum is for the purpose of giving the buildings air space in the street instead of from the space reserved on the lot; they enable a highway system to be developed on the only sound basis, namely, that the cost of building up the system shall not exceed the ability of the people served by it to pay for it. But there is no particular virtue in the wide street or the narrow street—the only virtue is in planning all streets to adapt them for the purpose they can best serve in connection with the development of land, and above all with due regard to the economic relationship between the value of the land and other property they serve, and the cost of the road or street. Excessively wide streets cause overcrowding—although they are designed to prevent it.

Until we have a properly planned system of highways adapted for all purposes, and economically sound, we will not be able to deal effectively with bad land development in town and country, and we will only be able to go on dealing with the improvement of roads in a sporadic and haphazard manner—good enough in its way and a satisfactory advance on the past, but far short of the ideal which we should seek to attain, and costly and wasteful in the extreme.

The want of a properly designed system of highways is one of the chief causes of the social isolation in rural districts, of lack of co-operation and of development of rural industrials. It is more correct to say that rural prosperity and increased production depend on a sound economic system of road planning than to say that those things depend on good road construction, for the simple reason that good road construction can only be widely applied if we alter our system of planning.

CANADA BUILDING STEEL AND WOODEN SHIPS.

Orders have been placed for steel ships in Canada up to the full limit of all steel plants available during the next fifteen months. The question of developing wood shipbuilding in Canada has been under investigation during the last month. It has been presented to the imperial government that substantial tonnage of suitable wooden vessels could be obtained. The Dominion government, in order to assist the development of shipbuilding in Canada, Finance Minister Sir Thomas White has offered to find credit to the extent of $10,000,000 for the Imperial Munitions Board for this purpose. This offer has been accepted and will greatly facilitate progress. Specifications and designs of the type of wooden vessels required have been under discussion between the board, representatives of the British ministry of shipping and various shipbuilding people. They are now almost complete, and will be available as the standard pattern of design. It is hoped to begin work on vessels of this type very shortly and the building of a considerable number will be arranged for in Canada, where suitable lumber is available in abundance.

Sir Thomas White stated in the House on Monday that orders have been placed by the imperial government for the construction of 22 steel vessels, with a total tonnage of 175,000, with Canadian shipyards, while orders for eight others are pending. This will keep all Canadian shipbuilding plants busy until well into 1918.

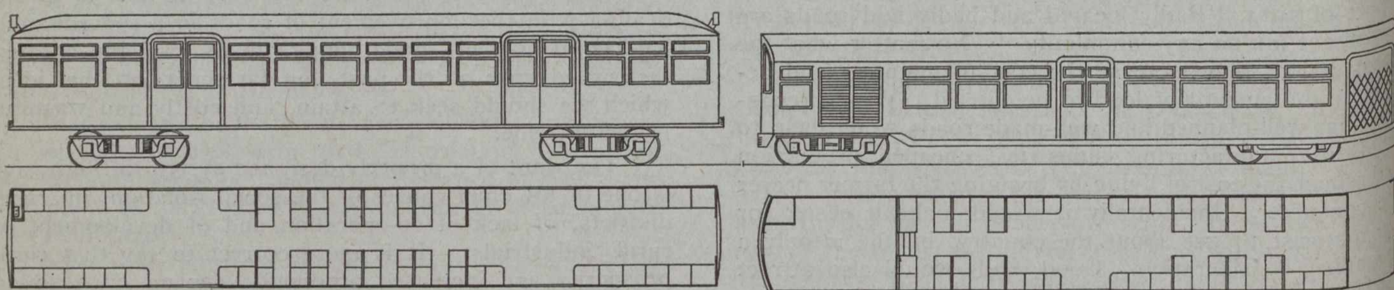
James Whalen, president of the Port Arthur Shipbuilding Company, has announced that contracts have been secured by the company for work totalling more than five million dollars. The capacity of the local plant is being doubled, and even at the work now in hand will keep it busy until well on into 1918.

RAPID TRANSIT RAILWAYS—SOME FEATURES OF CONSTRUCTION AND COST.*

By Ernest V. Pannell,
Electrical Engineer, British Aluminium Company, Toronto.

WITH the growth of population there is a stage in the development of every city where the daily travelling personnel can no longer be handled by the street railways. It is quite impossible to state any figure for population at which an urban rapid transit system must necessarily relieve the surface railways; for instance, the Boston Rapid Transit was operating its elevated lines and part of the subway when the inhabitants numbered little more than half a million, whilst in London, England, the population reached six millions before a unified electric rapid transit system was inaugurated. The width and disposition of the downtown streets, the layout and general efficiency of the street railway system, the size and speed of the cars, are all factors which, if favorable, will tend to defer the construction of rapid transit lines. Nevertheless, in matters of this kind it is necessary to plan many years into the future and preparations should be made for rapid transportation methods many years before the need for them is acutely felt. In view of the many millions of dollars now being expended on rapid transit projects it was thought interesting to summarize the principal costs of construction and equipment of rapid transit lines of various types. It is, of course, hardly necessary to mention that these costs are only intended as a rough approximation, such items as subway excavation, underpinning, etc., being different in every locality. The costs are mainly figured upon contracts placed during the last two years, but do not, of course, allow for the abnormal conditions prevailing at the present moment, particularly in reference to steel and labor.

There are three systems of construction for rapid transit railways in cities and it will be interesting to compare these in detail. They are: (1) Elevated structures, (2) subways, and (3) tubes. The elevated railway, although less popular than the other types, provides the greatest return per dollar invested and is therefore worth very careful consideration in every locality. The earliest elevated roads in Manhattan and Chicago were objectionable from being erected in narrow streets and with an open floor. The open-floor elevated road in which it is possible to see the underside of the cars from the street beneath gives rise to a great deal of noise and discomfort due to hot brake shoe particles, water, etc., dropping into the street. It has since been demonstrated, notably in Philadelphia, that a concrete-floor elevated road with ballasted tracks is perfectly unobjectionable except in narrow and busy streets and the noise produced is less than that of the street cars below. In European cities, too, every opportunity has been taken to render the elevated railway as sightly as possible. The ground beneath is turned into a parkway and supplied with benches whilst the floor of the road, being of concrete and sheet steel, affords protection against rain to those walking beneath.



DETAILS OF MOTOR CARS AND EQUIPMENT FOR ELEVATED, SUBWAY AND TUBE SERVICE

	Elevated and Subway	Tube Motor	Tube Trailer
Length of Car	60' 0"	55' 0"	55' 0"
Width " "	8' 6"	8' 2"	8' 2"
Weight Body	45000 lb	32000	32000
" Trucks	26000	25000	12000
" Equipment	14000	18000	-
" Total	85000	75000	44000
Capacity, seated	64	50	56
" total	180	120	135
Weight loaded	111000	92000	63000
Motors per car	2 x 120 KW	2 x 200 KW	-
Rated KW per ton	4.3	4.3	-
Cars per train	5	2	3
Cost per car	16000	14000	8500
" " train	80000	53500	
" " passenger	89.00	83.00	

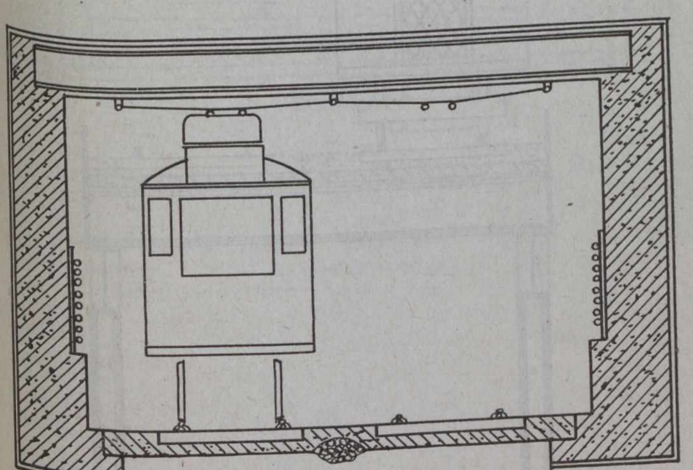
The subway next demands consideration and in comparing it with the elevated it should be remembered that each has exactly the same capacity, track for track. We shall find that the subway costs a good deal more, but in respect of handling traffic it is just as good and no better than the elevated road operating the same cars with the same headway and schedules. The extra cost of subway construction is therefore only justified where it has to be used. For example, in Lower Manhattan or Market Street, Philadelphia, the conditions do not permit of elevated structures, and subways in locations such as these are inevitable.

Subways, as at present being constructed in New York, are of steel beam construction with concrete floor and retaining walls. The excavation is through clay and

*Paper read before the Toronto Section of American Institute of Electrical Engineers, April 20, 1917.

sand with outcrops of rock according to the district. The chief difficulty met with is in excavating through quicksand which, owing to the great weight of the surrounding buildings, persists in pouring up into the subway and necessitates the retaining walls being carried to a considerable depth below the floor of the tunnel. Underpinning of building foundations is another heavy item in the cost of construction. Subways are excavated by the cut and cover method, but civic ordinances usually require the street to be timbered and made safe for the ordinary traffic to proceed during excavation. This means that hand labor only can be used and mule trains will be necessary for bringing the muck away from the heading. Appropriation of cellars and the re-location of sewers, telephone and power cables is a necessary preliminary work which must be completed before construction proper is begun.

Figs. 1 and 2 show diagrams of typical steel-beam subways in Buenos Aires and Hamburg respectively. The former is part of the new rapid transit development of Buenos Aires and runs through the heart of the city from Plaza Mayo to Plaza Once, a distance of 2½ miles, the construction being now under way for a further 2½-mile



Subway Construction, Buenos Aires.

extension to Caballito, where the subway cars come up to the surface and continue the journey along the highway to the more remote suburbs. The line now in operation involved the excavation of 527,000 cubic yards in alluvial clay or "tosca" and the use of 98,000 cubic yards of brick masonry and 13,000 tons of steel. Brick masonry is used practically to the exclusion of concrete, probably because all the cement used has to be imported whilst the brick is a local product. The cost of construction on this line amounted to $2,680,000 per mile of double track.

The Hamburg subway, opened a few years ago, is part of a suburban system of which 3.41 miles is elevated 10 miles on the surface on private right-of-way and 4.15 miles underground. The construction is steel beam with steel bents in the centre of the tunnel and concrete retaining walls. Construction costs figured out at $1,000,000 per mile of double track and it is interesting to compare this extremely low cost with the figures prevailing in America of $2,250,000 to $3,000,000 per mile of double track.

Reinforced concrete for subway construction has been employed with success, notably in the Boston Boylston Street subway and in New York for the Hudson and Manhattan Railway.

The third type of construction is the deep level tube, which is preferable in some locations to the shallow subway. In London, England, where this line has been the furthest developed, the necessity of crossing under the River Thames as well as the existing underground railways and sewers was the main factor influencing the adoption of tubes. Added to this the presence of the blue clay belt from 40 to 200 feet below the street surface rendered it possible to mine by the use of a shield without blasting or any interference with the surface except at the shafts. The clay contains little rock or water-bearing strata; other locations are not so fortunate as London in this respect, however, and it is doubtful whether tubes could be driven through a subsoil like that of Toronto. In New York the deep level tube is economically impracticable except for river crossings on account of the rock and quicksand which would be encountered.

The depth at which the London tubes are driven, 60 to 200 feet below the street, is such as to cause no interference with foundations, and where necessary the railway cuts across a block instead of following the alignment of the street above. The method of shield construction forms a constant support to the soil above and little or no timbering is used. The shield consists of a steel cylinder about six feet long and the same diameter as the outside of the tunnel segments. The front of the shield forms a cutting edge and the back is provided with seven or eight hydraulic rams around the circumference. These rams obtain their purchase on the last tunnel segments bolted into place and drive the shield forward at the rate of about ten feet per day when working in clay. In the cover afforded by the shield the heading is driven and earth excavated by hand or by a compressed air excavator. Behind the shield as the work progresses the muck is run out along a tram line and the cast-iron tunnel segments are bolted into place. Afterwards the space outside the segments is filled with cement grout pumped through holes in the casting, thus protecting the segments from rust and decay by the elimination of air spaces.

The foregoing has briefly summarized the methods adopted in building railways of the three types.

Table I.—Average Length of Run on City Rapid Transit Systems.

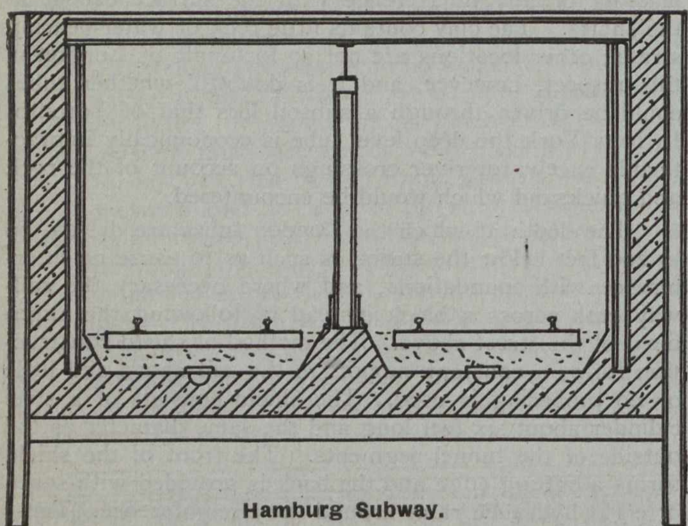
Railway.	Stops per mile.	Average run, feet.
Buenos Aires subway	3.10	1,690
North Western Ry., London...	1.20	4,400
District Railway, London	1.50	3,500
Inner Circle, London	2.10	2,510
Central London, London	2.10	2,510
South London Elevated	1.20	4,400
Interboro' Subway, New York.	2.40	2,200
Berlin Elevated	2.00	2,640
Hamburg Elevated	1.90	2,780
Average	1.95	2,700

Summarizing the costs, the investment per mile of double track for construction alone is:—

Elevated railway	$ 632,500
Subway	2,500,000
Tube	2,550,000

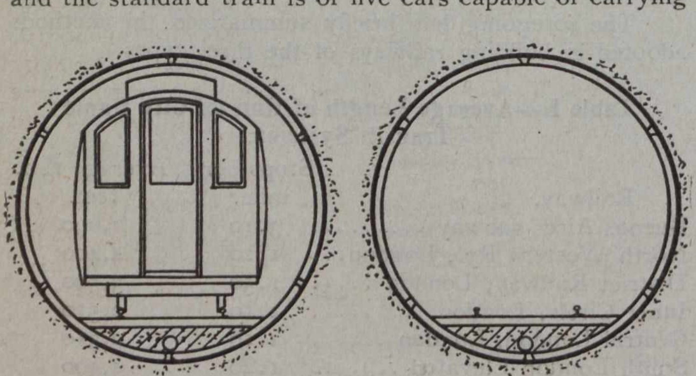
The above figures are purely construction costs; that is, they are quite independent of the traffic. The railway will cost just as much to build whether one or one thousand trains run over the mile of double track in a day. We have now to estimate and add to the above amounts the cost of the equipment of the road; that is, the cars, feeders, substations, shops and other items which are all dependent on the number of passengers carried.

The cars illustrated in this study for elevated and subway operation are typical of the more recent rapid transit practice without being quite as large as those now employed by the Boston Rapid Transit and the New York



Hamburg Subway.

Municipal Railways. Cars 70 feet long and 10 feet wide require so much extra clearance, especially at curves, that a much more expensive subway is necessary to accommodate them. The car illustrated, which is of a more normal type, is 60 feet long and 8½ feet wide, seating 64 passengers at the rush hour and carrying 180 in all. The weight of the car fully equipped but empty is 80,000 lbs., whilst loaded with 180 passengers it weighs 105,200 lbs. Its equipment consists of two 600-volt motors rated at 120 kw. each fully ventilated and multiple unit control, and the standard train is of five cars capable of carrying

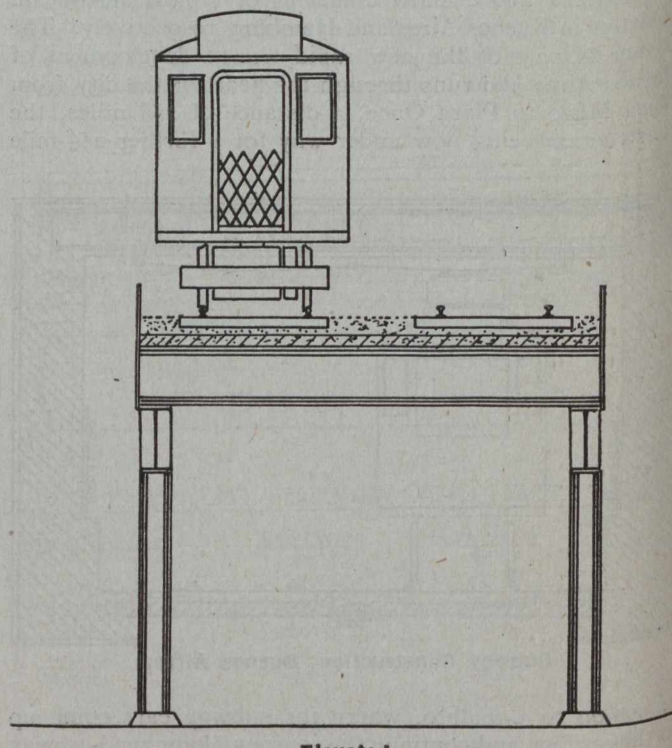


Tube.

Contract.	Quantity.	Unit price.	Cost.
Sinking shafts, excavating with shield, placing tunnel segments, grouting and finishing	..	....	$2,000,000
Track, roadbed and third rail	..	....	100,000
Stations, including elevators and fans	2	....	100,000
Repairs to roadway	..	....	20,000
Engineering and interest 15%	..	....	330,000
Total cost one mile double track tubes	..	....	2,550,000

a total of 900 passengers during the rush hours. Such a train as already mentioned can operate over elevated or subway tracks indiscriminately.

Turning to the tube car it will be seen that the capacity and weight are both lower than the above. Moreover, as mentioned before, space considerations permit of only the leading and trailing trucks of the five-car train being used to carry motors. In order to maintain the same schedule speeds as the subway train the rated kilowatts per ton must correspond with the figure 4.3 and to obtain this the four motors must each be of 200 kw. rated capacity. This involves certain disadvantages. For one thing, the weight of the train is largely concentrated on the leading and trailing trucks which is liable to throw more wear on the track, particularly at curves, than where the weight is more distributed. Secondly, motors of such heavy output for mounting beneath a car have to be of such compact design that full ventilation is not possible and there is not such a wide margin of power for emergencies. Furthermore, as already noted, the carrying capacity of the tube train per ton of gross weight is lower than that of the subway, consequently with the same speeds and headway the tube will be able to transport fewer passengers although its cost of construction is the



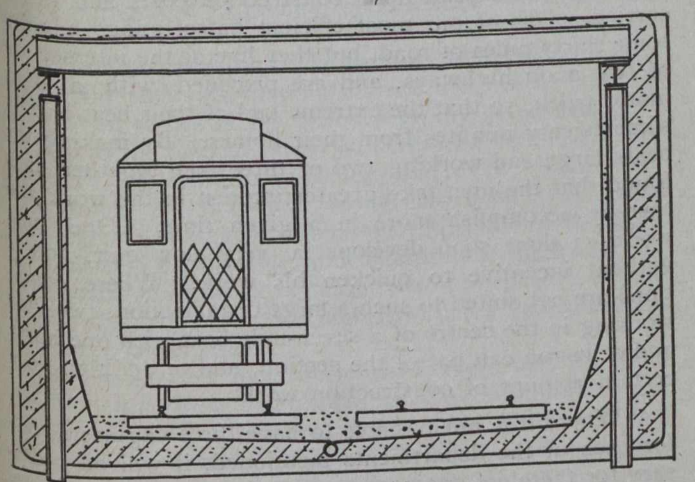
Elevated.

Contract.	Quantity.	Unit price.	Cost.
Structural steel	3,000 tons	$ 80.00	$240,000
Concrete footings	1,000 c.y.	10.00	10,000
" floor	5,000 "	5.00	25,000
Track, roadbed and third rail	....	....	100,000
Stations	2	25,000	50,000
Repairs to roadway	....	....	25,000
Property damage	....	....	100,000
Engineering and interest 15%	....	....	82,500
Total cost one mile double track, elevated	....	....	632,500

same or slightly higher than that of a subway. It may be said, however, that the tunnel need not be limited to a 12-foot bore; why not drive a 16 or 20-foot tube and obtain greater capacity? The answer is, of course, prohibitive cost. Approximately the cost of a tube tunnel increases as the 3/2 power of the diameter whilst the capacity is only directly proportional to the bore, so that the satisfactory economic limit for the latter is found to be around 12 feet and by far the greater mileage of tube railways are 12 feet inside diameter or less.

The diagram showing the outline features of the two forms of car also shows the seating arrangements and it will be noted that a large proportion of the floor area is given over to standing space. This is in accordance with the most approved practice; it is accepted that a number of those travelling at the rush hours will have to stand up in the cars and the latter are so designed that they can stand comfortably rather than the alternative of providing the car with as many seats as possible and reducing both capacity and comfort.

Every railway has a certain tributary population who use the line regularly. Where only one railway system



Subway.

Contract.	Quantity.	Unit price.	Cost.
Excavation	275,000 c.y.	$ 4.00	$1,100,000
Concrete	50,000 "	7.50	375,000
Brickwork	1,000 "	15.00	15,000
Structural steel	3,000 tons	80.00	240,000
Waterproofing	40,000 sq. y.	.50	20,000
Track, roadbed and third rail	......	....	100,000
Stations	2	....	50,000
Relocating sewers, etc.	......	....	50,000
Underpinning	......	....	125,000
Repairs to roadway	......	....	100,000
Engineering and interest 15%	......	....	325,000
Total cost one mile double track, subway	......	....	2,500,000

exists serving all parts of a city the tributary population corresponds practically to the total inhabitants of the city. Where other means of transit exist the tributary population of each has to be calculated, usually upon a basis of time-saving on the assumption that the traveller chooses the quickest means of reaching his destination except where there is a difference in the cost of transportation. An elevated line offering frequent service at 16 miles an hour will divert through passengers from the street car tracks on which a 10-mile schedule is given to a greater extent as the distance from the downtown district increases.

Table 2.—Travelling Habit in Principal Canadian Cities.

City.	Population 1915.	Total journeys per year.	Journeys per inhabitant.
Montreal	600,000	155,529,438	259
Toronto	520,000	155,255,972	300
Winnipeg	233,000	53,640,490	230
Vancouver ...	138,000	46,330,096	336
Hamilton	116,000	17,062,871	147
Edmonton	68,000	11,886,810	175

It is, however, a mistake to generalize upon such matters as passenger movement which should be made the subject of a special study in every particular case. An estimate of the tributary population being reached, it is necessary to compute the average travelling habit which denotes the number of rides per person per year and varies from 300 to 360 for urban communities. For the city of Toronto the average value over the last two years was 315 whilst for Greater New York the figure was 356. Obviously the tributary population multiplied by the travelling habit gives the total number of trips over the railway per year and at the standard five-cent fare this total divided by 20 is the gross revenue in dollars.

In estimating the total cost of the equipment for an electric railway we are mainly concerned with maxima. In other words, the number of trains, size of feeders, size and number of substations and car houses are dependent not upon the average number of persons carried throughout the day but upon the maximum carried during the peak hour. On the other hand, it is the average passengers travelling from which our receipts are calculated, and this conclusion brings in the load factor. The ratio of average to maximum people travelling is always distressingly low in the case of rapid transit railways and may in some cases be too low to render the railway a paying proposition. We have already seen that the total annual passengers can be arrived at from an estimation of the tributary population and the travelling habit. Dividing this total by 365 gives the daily total and the problem remaining is to determine just how these passengers are distributed throughout the day.

Table 3.—Total Cost of Equipment for Rapid Transit Railways.

Passengers per hour, maximum.	Trains per hour.	—Trains per mile— Single.	Double.	Cost per mile, double track. Trains.	Feeders.	Sub-stations.	Car houses.	Total.
(A) Elevated Subway Lines.								
10,000	11.1	.70	1.40	$118,000	$ 7,000	$ 22,400	$ 14,000	$161,400
20,000	22.2	1.25	2.50	210,000	12,500	40,000	25,000	287,500
30,000	33.3	2.08	4.16	350,000	20,800	66,600	41,600	479,000
40,000	44.4	2.78	5.56	465,000	27,800	89,000	55,600	637,400
50,000	55.5	3.47	6.94	584,000	34,700	111,000	69,400	799,100
60,000	67.0	4.20	8.40	703,000	42,000	135,000	84,000	964,000
(B) Tube Lines.								
10,000	15.5	.97	1.94	109,000	9,700	31,000	19,400	167,100
20,000	31.0	1.94	3.88	218,000	19,400	62,000	38,800	338,200
30,000	46.5	2.90	5.80	325,000	29,000	93,000	58,000	505,000
40,000	62.0	3.90	7.80	437,000	39,000	125,000	78,000	679,000
50,000	77.5	4.85	9.70	545,000	48,500	155,000	97,000	845,500
60,000	93.0	5.80	11.60	650,000	58,000	170,000	116,000	994,000

ROAD ORGANIZATION.*

By Geo. S. Henry, M.P.P.,

Secretary, Ontario Good Roads Association; Member of Toronto and York Highway Commission.

ORGANIZATION is an essential in the successful carrying out of any large undertaking, and efficient organization in road work produces results just as surely as in railroad work or commercial enterprises.

Before we outline the organization which we consider suitable for road work, we would like to interject that much as we admire good organization, we are of the opinion that men of the proper type for the work they are undertaking are more essential than organization. Good men, men who know their work, although weak in organization but anxious to build roads, will accomplish better results than inexperienced, unambitious men, no matter how thorough their organization. Our conclusion therefore is, that in the organization which we will outline, good men must fill the positions to secure any real benefit from the organization.

The selection of a chief engineer is perhaps one of the most important appointments which would have to be undertaken.

If the work is large enough, the chief engineer may be able to form separate departments with experienced men as heads of each department, but as a rule the work is not of that character and it is in this situation that the larger provincial commission can give expert service to the road builder who is not expert.

Designing Engineer.—Taking it for granted, however, that the work is large, and a designing engineer can be employed who can take charge of the office work and the design of bridges, roads, culverts, etc., it will be found that such a man will be best employed giving his full time to office work. The designs thus prepared under the direction of the chief engineer will then be turned over to the constructing engineer.

Constructing Engineer.—The constructing engineer should, under the chief engineer, have full control of all construction work, whether done by day labor or under contract. Experience has shown that a proper combination of day labor work and contracting will give the best results. The day labor gangs under the constructing engineer act as a break on excessive profits by contractors, and the contractors constructing similar works are a splendid check on excessive costs by day labor, and it is in this connection that an efficient treasurer can show up concisely the costs under both methods. The number of gangs employed will depend upon the amount of work undertaken, but it will usually be found that an experienced foreman can do efficient work with gangs of from twelve to eighteen men.

Maintenance Engineer.—The maintenance engineer should have charge of all roads and structures as soon as the construction department is relieved of them by the chief engineer. As a rule, the construction department should not be relieved from the responsibility of new work for at least six months after completion. If immediately upon completion a department is relieved of responsibility, it will be found that certain essential details will be consistently skipped.

Maintenance work is not so spectacular, nor does it appeal so effectively to the community as construction work, and it is therefore frequently overlooked, but it is nevertheless one of the most important departments of road work.

The patrol system under a maintenance engineer is without doubt the most efficient and finally the most inexpensive method that can be adopted. The length of patrol will vary with local conditions, and the expenditure per mile will depend upon construction costs and traffic carried. One of our most efficient patrol gangs handles some thirty miles of road, but they live at the intersection of two main highways, and are provided with a light motor truck, so that the extreme end of their beat is only some twenty minutes from their homes. By making the beats large and working two or three men together, it is found that the men take greater interest in the work and thereby accomplish more in a given time. One man working alone soon develops a very slow gait, and is without incentive to quicken his work. Where conditions are not suited to such a large organization, two men working in the centre of a seven-mile beat with one horse and a wagon can patrol the section, and in addition do a certain amount of construction work.

Where it is not possible to have three engineers, one for each of the departments mentioned, it will be necessary for the chief engineer to take charge of each department, having where possible a superintendent who can carefully inspect the field work, and where necessary give directions to the foremen.

Foremen.—Because road work is new in Canada, foremen suitable for rural or even interurban road work are difficult to secure.

We have a large body of men trained for work in cities where there is every convenience of tools, machinery and special equipment, but a foreman for road work such as we are interested in should be of a different type. He should not only be able to handle men and do ordinary building, but in addition should be able to make use of every natural condition that surrounds his work. A cross between the "buck beaver" of the lumber camp and the "walking boss" of the railroad gang.

Commence the work with few outfits and train your men, and the next year you will be able to double your gangs by using these trained men. If there is much concrete work, organize a special crew for this work, making sure you have one man who can build and place forms.

*Abstracted from paper read before the Fourth Canadian and International Good Roads Congress, Ottawa, April 10-14, 1917.

Coal and iron production in the United States in 1916 exceeded all previous records. Approximate figures for the year's production announced by the United States Geological Survey show total shipments of iron ore from United States mines amounting to 75,500,000 gross tons. In 1915 the shipments were 55,493,000 tons. The value of the iron ore produced in 1916 was $178,935,000, which is an increase of nearly $78,000,000 over the value of the iron ore produced in 1915. Of the total production more than 66,000,000 gross tons were shipped from mines in the Lake Superior district and about 5,300,000 from mines in the Alabama district. The total of pig-iron production was between 39,000,000 and 39,500,000 gross tons. The year recorded an enormous rise in the market price. Southern Foundry No. 2 iron at Birmingham rose from $13.13 to $22. Northern No. 2 Foundry at Chicago rose from $18 to $29. Bessemer iron at Pittsburgh rose from $19.85 to $35.95. The bituminous coal production of 1916 is estimated by C. E. Lescher, of the United States Geological Survey, as over 509,000,000 net tons, an increase of more than 65,500,000 over 1915. The production of Pennsylvania anthracite was 88,312,000 net tons, which was about 600,000 tons less than in 1915.

METHODS OF DETERMINING THE ROADMAKING QUALITIES OF DEPOSITS OF STONE AND GRAVEL.*

By L. Reinecke,
Geological Survey of Canada.

(Published by permission of the Director of the Geological Survey, Ottawa).

THE Department of Mines of Canada has been engaged in examining occurrences of stone and gravel available for road construction since the summer of 1914. The purpose of this paper is to outline the methods that have been used in arriving at the relative values of the deposits in any given area.

Up to the present, surveys have been confined to the provinces of Ontario, Quebec and New Brunswick. Prospecting for first-class stone has been undertaken along certain navigable waterways, but most of the work has consisted of mapping and determining the quality of all deposits of bedrock, glacial stone and gravel, within hauling distance of certain highway routes and in certain cases over larger areas.

Aerial surveys have been undertaken near St. John and Moncton, New Brunswick, in Two Mountains and Soulanges counties, Quebec, and in Kent, Essex and part of Carleton counties in Ontario. Belts of country adjoining 270 miles out of the 560-mile length of the Windsor-Toronto-Montreal highway and 150 miles of the 175-mile length of the Prescott-Ottawa-Montreal highway have been examined and mapped.

The usefulness of work of this kind to the road-builder is dependent in large degree on the accuracy with which the road-making value of the materials is determined, and it is in the hope of receiving suggestive criticism regarding the methods used that this outline is presented.

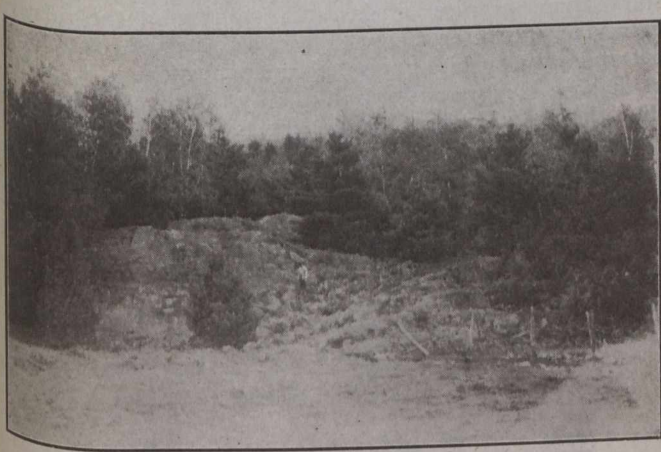


Fig. 1.
Deposit of diabase, near the Montreal-Hull-Ottawa road.

Three classes of road material—bedrock, boulder deposits and gravel—are encountered in this work and each has its own problems.

Bedrock.—A certain amount of general information is gathered regarding nearly all bedrock occurrences, but our main concern is to first classify the bedrock according to its road-making value, and then to study the different classes to find the causes of variation in strength and to determine the distinguishing marks of good stone. Knowing these, the fieldman is enabled to classify the many occurrences of bedrock that cannot be tested.

*Abstracted from paper read before the 4th Canadian and International Roads Congress, Ottawa, April 10-14, 1917.

The route survey along the north shore of the Ottawa River, between Hull and Montreal, will serve as an example of the information obtained regarding bedrock. In this instance areas of bedrock lying within two miles of the road were mapped and numbered. The photograph (Fig. 1) is an example of a diabase dike deposit.

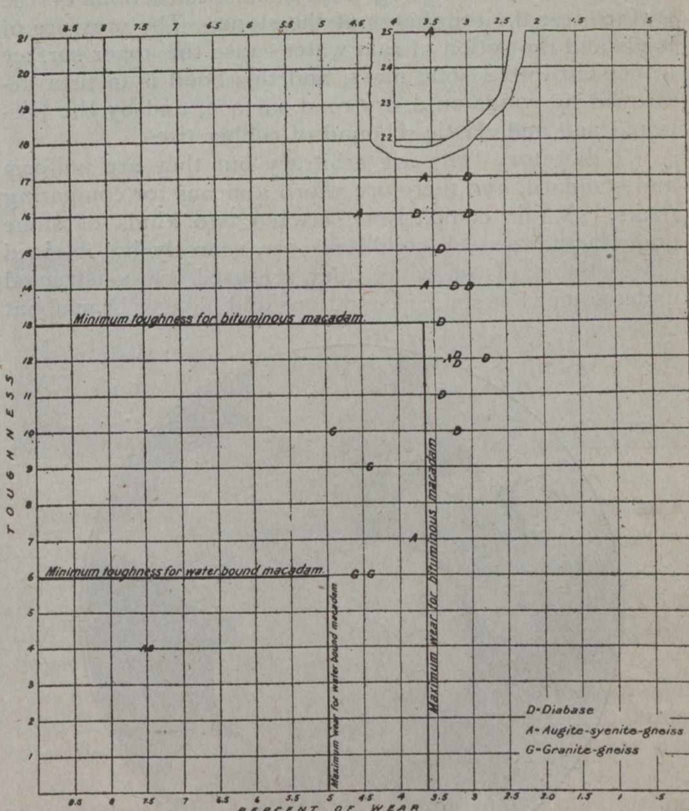


Fig. 2.
The relative percent. of wear and toughness values of the three most abundant classes of stone near the Montreal-Hull road.

The information given regarding it includes a description of its quality, the statement that about 100,000 cu. yds. of diabase can be obtained from the deposit above ground water level, that it can be economically quarried, and is about two miles from the proposed highway and a railroad.

Determination of Relative Value.—In order to discover the relative quality of the stone available in the area, the rocks were first divided into geological formations and the formations into rock types. Rocks made of the same mineral particles, under the same conditions, at about the same time, and subjected since then to the same earth stresses, are, under this system, grouped together. Certain of the groups, from the previous experience of road-builders with material of a similar kind, can be at once rejected. In this area, after rejecting certain soft, coarse, crystalline limestones, friable sandstones and much altered gneiss as unfit for road work, there remained six classes of stone. A number of samples of each of these were then tested in the laboratory and their behavior under the action of traffic studied wherever that was possible. Upon the results of the tests, modified by data regarding the uniformity of the product obtainable, and other considerations, decisions regarding the usefulness of the rock types in road surfaces were based.

Laboratory and Service Tests.—A digression may be made here to discuss the laboratory and service tests. Of the five standard tests performed in the laboratory the most important are those of per cent. of wear or abrasion, toughness, and cementing value. The standard methods of making the tests have been fully described by Jackson.[1] They simulate the action of traffic on fragments of broken stone in a road-bed. Loads passing over a broken-stone road abrade the fragments at the surface and cause slight movement and internal abrasion between the fragments in the road mass. The blows of horses' hoofs and of swiftly moving vehicles bouncing from small obstructions on the surface test the toughness of the stone. The pressure of loads and the action of rain water cause the upper surface to cement into a solid mass, and this bond is in turn destroyed by winds on a dry road surface, and by the frictional pull and elastic rebound of rubber tires.

Laboratory tests are arbitrary but they are uniform and standard, and therefore afford a means for comparing rocks. A fair comparison between two kinds of stone under actual service conditions can scarcely be obtained unless the roads on which they are used are constructed under somewhat similar conditions and have to bear about

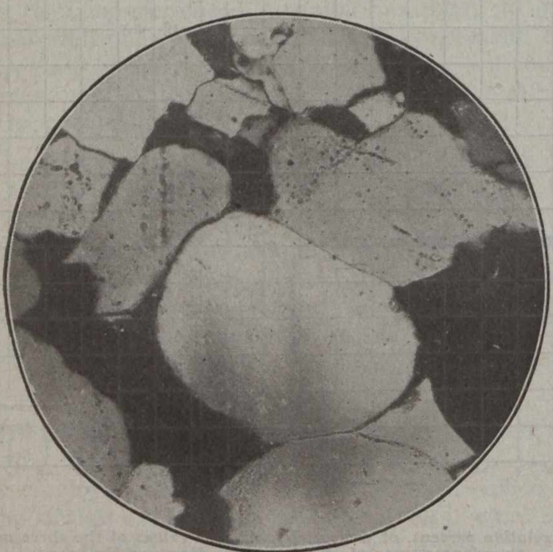


Fig. 3.

Thin section of Potsdam sandstone. Toughness 4, percent. of wear 8. Enlarged about 40 times. The large dark and white areas are mineral grains; the black lines between grains are voids in the rock.

the same kind and amount of traffic. Where road-building has just begun, such a means of comparing two types of stone are in most instances not available. The comparison of laboratory and service tests have enabled engineers to specify certain laboratory values for stone to be used under certain conditions of traffic and on certain road surfaces. Thus the lowest allowable toughness for stone in the surface of waterbound macadam is placed at 6, the highest allowable per cent. of wear at 5.[2] For moderately heavy traffic the stone should have a toughness of from 10 to 18 and for traffic of 250 vehicles per day and over, over 18.[3] For bituminous macadam, which is generally used only when the traffic is fairly heavy, a minimum toughness of 13 and a maximum wear of 3.7 is called for.[4]

In Fig. 2 the results of tests for toughness and wear upon three of the better classes of stone that are found near the Montreal-Hull Road are shown graphically. The limiting toughness and per cent. of wear of stone suitable for waterbound and bituminous macadam are indicated by

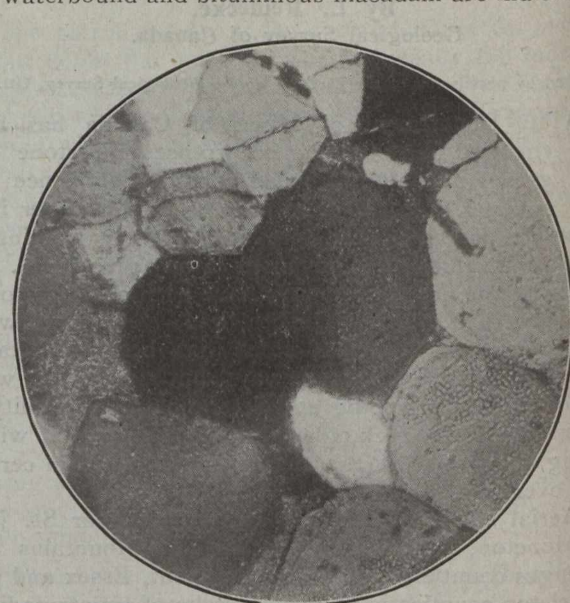


Fig. 4.

Calcareous sandstone of the Beekmantown formation, toughness 8, percent. of wear 3.6. Enlarged 50 times. The original round sand grains have become angular by crystalline growth of silica in the void spaces, all other voids filled with a lime cement.

heavy lines in the figure. It is evident that the strength of the samples of augite syenite gneiss and of the diabase are about equivalent and that both give much better results than granite gneiss. In judging of the relative values of the three classes, however, diabase is placed before augite syenite gneiss, because the stone in a deposit of diabase is more uniform in quality than the gneiss. On the other hand, when granite gneiss is the only stone available, for a certain stretch of road, the more massive and less altered portion of the deposit is recommended.

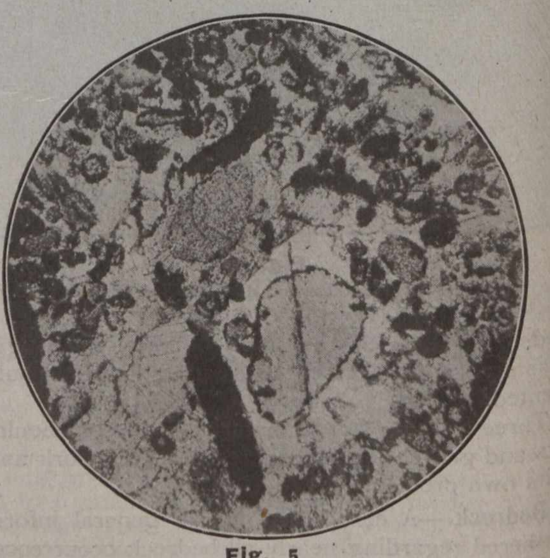


Fig. 5.

Trenton limestone enlarged about 20 times. Percent. of wear 4.7, toughness 4. Note the dark and light grains of calcite and the long cracks along cleavage planes.

When it is possible to separate geological formations into areas, as in the case of part of the Ottawa-Prescott survey, the outcrops within whole areas may in many cases be at once rejected. The formations in this neighborhood consist of bedded sediments, dolomites, lime-

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[1] Jackson, Frank H., Jr., "Methods for the Determination of the Physical Properties of Road Building Rock," U.S. Dept. of Agric., Bull. 347, Washington, D.C., 1916.

[2] "Progress report of the special committee on materials for road construction and on standards for their test and use." Amer. Soc. Civil Engineers, Proceedings of the Annual Meeting, June, 1917, p. 1621.

[3] Hubbard, Prevost and Jackson, F. H., Jr. "Relation between properties of hardness and toughness of road-building rock." Journ. Agric. Research, Washington, D.C., Feb., 1916, p. 906.

[4] "Specifications for broken stone and gravel roads," adopted Oct., 1914. by Amer. Soc. of Municipal Improvements, Indianapolis, Ind., p. 7

stones, shales and sandstones, and the stone worth considering occurs in four formations. A number of samples were tested from each, and compared in the manner indicated above for the Hull-Montreal route. It was found that certain dolomites and calcareous sandstones of the Beekmantown formation gave uniformly better results than the others. They were, therefore, recommended as the best available local material. Service tests substantiate this conclusion. Where dolomite is used on the roads near Ottawa it has stood up well in certain instances under traffic up to about 200 vehicles per day. The limestones of the Chazy, Black River and Trenton formations, on the other hand, which are commonly used near and in Ottawa, usually wear to dust, and holes rapidly under similar conditions of traffic.

Causes of Differences in Value.—The method of laboratory tests has the disadvantage that usually only one out of five or ten of the deposits examined in the field can be tested, and the sample tested is only a small portion of a large deposit. More frequent and close sampling is not often practicable, and the results of the tests are, moreover, in many cases not available until after the field work is done. For efficient work, therefore, it is necessary for the field man to know the distinguishing marks of a good road stone, and the best way to arrive at them is to discover the causes of the difference in strength and cementing value of stone. For this purpose both the microscope and chemical analyses are used. Careful and extensive comparison of the microscopic texture with the results of laboratory tests upon road stones have been carried on at the Office of Public Roads at Washington.[1] The results of this work have furnished a basis for classifying the main rock classes in regard to their road-building qualities. But just as men of the same race and age differ greatly in their powers of endurance and their capacities for absorbing food, for instance, so do rocks of the same class vary in strength and cementing value. The characteristics of the rocks in each particular field must, therefore, be studied in order to do effective work.

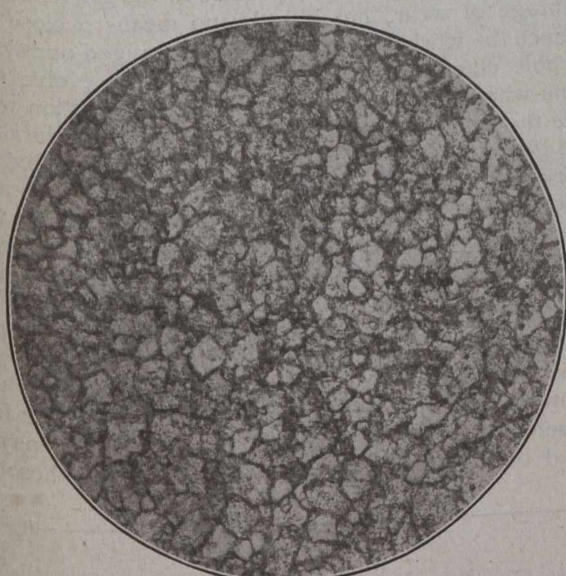

Fig. 6.

Beekmantown dolomite enlarged 100 times. Percent. of wear, 4.4, toughness 13. The dirty grains of dolomite are of about the same size and closely packed together.

In the two thin rock sections shown in Figs. 3 and 4, the cause of the greater strength of the calcareous sandstone associated with the Beekmantown dolomite over that of the sandstone without lime-cement is apparently caused by secondary crystalline or angular outline, and to the calcareous cement which fills all voids in the rock, even cracks of 3/10,000 of an inch wide, as shown in Fig. 4. This lime-cement, which is the principal cause of the difference in strength, can be recognized in the outcrop and is therefore a help to the field man in selecting the better rock in the field.

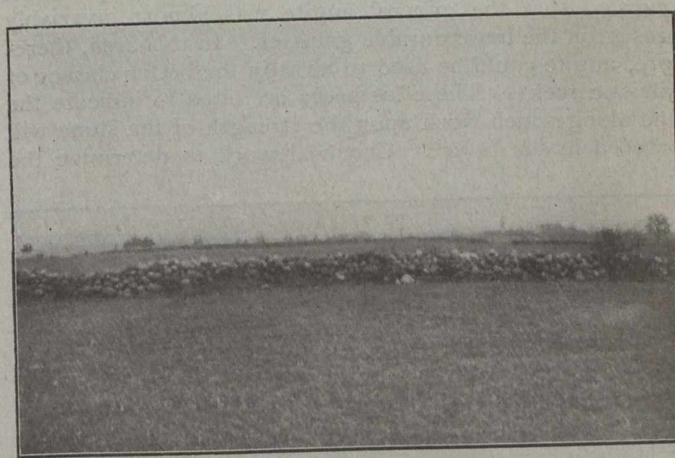

Fig. 7.

Boulder fences near Kemptville, Ont. They consist of about 95 percent. hard and 5 percent. soft boulders.

A comparison of the thin sections of Beekmantown dolomite with Trenton limestone (Figs. 5 and 6) shows that the dolomite consists of dark grains of even size packed closely together, the limestones consist of dark, irregular grains loosely held together by pure white grains. All of the grains in these specimens are made up of the minerals dolomite or calcite which cleave easily in three directions. In the uneven coarse-grained rocks the cleavages in the large white grains form relatively large planes of weakness—a fitting starting place for cracks in the rock. In the fine, even-grained dolomite the short cleavage in one grain is usually in a different plane from that in the adjacent grain and an incipient crack starts with a rough surface and does not develop as easily. It is inferred, also, that impurities such as those in the dark grains tend to prevent slipping along the cleavage planes and so strengthen the rock. Chemical analysis and the weathering of the stone proves that the impurity in dolomite is extremely fine silica, in the form of silt. In

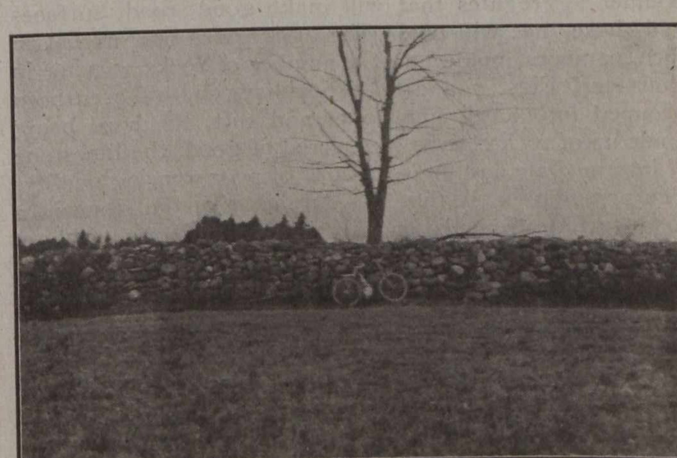

Fig. 8.

A boulder fence near Spencerville, Ont. It carries 90 percent. of limestone.

[1] Lord, E. C. E., "Relation of mineral composition and rock structure to the physical properties of road materials," U.S. Dept. Agric. Bulletin 348, 26 pp., 1916.

this region, then, fine, compact, even-grained dolomites that weather to silt can be considered by the field man of better road-making quality than limestone of irregular texture.

In the case of the gneisses referred to before as occurring along the Hull-Montreal route, microscopic work revealed that the mineral augite was almost invariably present in the more durable gneisses. In this area, therefore, augite could be used to identify the better classes of gneissic rocks. These instances are cited to indicate the line along which work upon the strength of the stone will proceed in the future. Chemical work to determine the

Fig. 9.
A good concrete gravel near Kemptville, Ont. Pebbles 95 per cent., limestone 5 soft; impurities in very small amount.

causes for the variation in cementing value has been begun but has not so far yielded results of value.

Boulder Deposits or Fieldstone.—Fieldstone or glacial boulders are found piled in fences and heaps in cleared farming country and form an important source of road material.

The composition of the boulder aggregates is an average of estimates of composition made for practically every fence, the yardage is measured fence by fence and compiled for the area.

Here, again, the problem is to distinguish between boulder aggregates that will make good road surfaces and those that will not. The aggregates are, except in rare instances, made up of a number of rocks varying in character, Figs. 7 and 8. They have in this area been grouped into hard, limestone, and soft, the hard being made up of rock classes considered of good, the limestone of intermediate and the soft stone of poor wearing quality. The presumption is that the durability of the stone in a road surface depends on the relative amounts of these three classes present in the aggregate.

Experiments are being carried on in the laboratory of the Department of Mines to determine the per cent. of wear of aggregates consisting of various proportions of durable, intermediate and soft rocks. The idea is to find standards by which the durability of a boulder aggregate may be judged of in the field. It is necessary for the field man to have some idea of the relative durability of the bedrock from which these boulders come, before he can use this classification to advantage in the field. Because of the many miles of road that will have to be built of crushed fieldstone in Canada, we believe that results along this line will be of value.

Gravel.—Gravel is the last and perhaps the most difficult of the deposits with which we have to deal. Gravel areas are mapped in the field and numbered in the same way as the bedrock and fieldstone areas, the numbers differing in color for each of the three kinds. Information regarding the gravels is compiled in two tables, one describing the character of the gravel, the other giving information regarding its exploitation and uses. In the table dealing with the character of the deposits, depth of weathering, texture or grading of sizes, impurities and pebble composition are given. The relative amounts of boulders, gravel and sand as given are correct only for the pits examined. Gravel deposits vary so much throughout their extent that an average of the texture cannot be obtained except by sinking test pits or auger holes. Except in the case of the silt content, no field method has been devised as yet for estimating the percentage of impurities present. There is a great need here for laboratory and field work, because of the importance of the influence of the impurities and fine silt content upon the strength of concrete and in sheet asphalt work.

The gravels are tested in the laboratory for abrasion and cementing value and a mechanical analysis is made to determine the proportions of the different sizes present below three inches. An attempt has been made to trace a relationship between pebble composition and laboratory tests upon wear. A broad relation was established between the percentage of soft pebbles in the gravel and the percentage of wear, but it is by no means a close one, and since the work was done we have changed our system of pebble classification in the endeavor to evolve some scheme whereby an estimate of pebble composition would enable the field man to predict more closely the durability of the gravel he was examining. It should be stated that the present standard methods for making the abrasion test for gravel are not wholly satisfactory, and the wear of the gravels on roads has in certain instances confirmed the conclusions drawn from their pebble composition rather than from the results of laboratory tests. Figs. 9 and 10 illustrate a good concrete gravel and a poor gravel deposit near the Ottawa-Prescott Road.

As this outline indicates, many of the methods used for determining the value of road materials are far from satisfactory and we believe that improvements may be effected both by close co-operation both with those en-

Fig. 10.
A poor gravel near Ottawa. 20 to 40 percent. of the pebbles are of soft stone, and an appreciable amount of clay, iron oxide and lime carbonate is present.

gaged in road building and with men who are testing stone and gravel in other laboratories.

The writer very gratefully acknowledges the courtesy and help he has received from road engineers and especially from the Ontario Highway Department. He is no less indebted to the men in charge of the testing laboratories of the Office of Public Roads in Washington and

at Columbia University, with whom our laboratory is now co-operating in work looking toward the general improvement of the laboratory tests upon road stone and gravel.

Summary.—In order to determine the road-making values of the rocks in a certain district they are first divided into formations and then into rock types. Their average values and the variation in strength and cementing value of each type is obtained by laboratory tests on a number of samples and the results thus obtained are compared with actual service tests in the roads wherever possible. Laboratory studies with the microscope and by chemical analyses are then undertaken to discover the cause of such variations in order to furnish data which will enable the field man to distinguish a good stone from a poor one in the outcrop. With a working knowledge of the strength of the bedrock in a district, an attempt is made to devise a classification of the kinds of boulders in the fieldstone deposits in such a way that their composition expressed in percentages of durable, intermediate and soft boulders will bear a direct relation to their percentage of wear as determined in the laboratory, and to their durability under traffic conditions. The pebbles in the gravels of the district are classified in a manner that will bring about the same result. The impurities present and the texture or grading of the gravels are studied in order to furnish advanced data as to their probable value in concrete and sheet asphalt work.

AMERICAN WATERWORKS ASSOCIATION.

The 37th annual convention of the American Waterworks Association will be held May 7-11, 1917, at Richmond, Va.

Monday, May 7th, will be devoted to meeting of the executive committee, registration, and the delivery of the president's address.

Tuesday.—Forenoon session: Regular order of business; announcement of officers elected for 1917-1918. Reading papers. "Recent Tendencies and Progress in Waterworks Practice," John W. Alvord; "The Use of Concrete in Waterworks Structures, With Special Reference to Its Resistance to Elemental Action," R. J. Wig, U.S. Bureau of Standards. Discussion by J. Waldo Smith, Allen Hazen and others. "Water Supply for Military Camps," John D. Kilpatrick; "Enforcement of Standards for Water for Interstate Carriers," H. P. Letton.

Afternoon session: Reading papers. "Reliability in Pumping Station Design," Clarence Goldsmith; "Improved Efficiency of the St. Louis Pumping Stations," Leonard A. Day; "Pumping Station Efficiency in Boston," O. A. Doane; "Pumping Station Costs and Efficiency Records," Mark Wolff. Discussions by Carleton E. Davis, Theodore A. Leison, and others. "Relations Between Water Departments, Companies and the Public," W. C. Hawley; "Relations Between a Water Department and the Public," A. A. Reimer.

Evening session: Reception in auditorium of The Jefferson (the room in which the meetings are held). Music, dancing and refreshments, provided by Waterworks Manufacturers' Association.

Wednesday.—Forenoon session: Reading papers. "Some Problems in Filtration Plant Operation," Louis I. Birdsall; "Decarbonation and Removal of Iron and Manganese from Ground Water at Lawrence, Massachusetts," Frank A. Barbour; "A New Form of Screen Chamber" (illustrated by lantern slides), John H. Lance.

Evening session: Reading papers. "History of Cast Iron Pipe Prices," Burt B. Hodgman; "Experience with Submerged Pipe Line in Water Supply of Puerto Barricas, Guatemala," T. Howard Barnes; "Troubles in Constructing a 48-inch Submerged Main," F. W. Cappelen; "The Effect of Covering a Service Reservoir," John Gaub.

Thursday.—Forenoon session: Reading papers; topical discussions. "Thawing Frozen Water Mains by Electricity," Henry B. Machen. Discussion by William I. McMane, Harry M. Beardsley, and others. "Trench Machine Work," William W. Brush. Discussion by I. M. Higbee, George G. Earl, Beekman C. Little, John C. Tiernt, of Oradale, N.J., N. J. Whealem, Elizabethtown, N.J., Leonard Metcalf (data from Indianapolis, Denver and Los Angeles), and others. Experience papers. "Unusual Experience in Laying 24-inch Pipe," D. W. French; "Leakage from Joints of Vitrified Pipe Used to Convey Water Under a Low Head," William W. Brush; "Leaks from High Pressure Fire Service Mains," Henry B. Machen. Discussion by Carleton E. Davis, and others.

Afternoon session: Experience papers. "Forty-five Years' Experience in Waterworks," E. E. Davis; "The Formation of a Bonding Company to Promote Water Sales and Sanitation," F. C. Jordan; "Lead Wool and Its Advantages," Robert J. Thomas; "Methods of Determining and Plotting Meter Capacities," Fred B. Nelson; "Lowering Ground Water Levels," Clarence L. Kirk; "Results of Experiences and Experiments with Wrought Iron and Steel Service Pipes," Alex. Milne. Question box and topical discussions. List of questions and topics in separate program.

Evening session: Reports of officers and standing committees, as follow: Executive committee, secretary, publication committee, treasurer, finance committee, membership committee, nominating committee. Reports of the following special committees: Electrolysis, Albert F. Ganz, chairman; representatives upon National Electrolysis Committee, D. D Jackson, chairman; Standard Specifications for Hydrants and Valves, Beekman C. Little, chairman; Constitution, Morris R. Sherrerd, chairman.

Thursday.—Chemical and Bacteriological Section. Forenoon session: Reading papers. "Standards of Water Supply," W. J. Orchard; "Determination of B. Coli," William Mansfield Clark, U.S. Bureau of Animal Industry; "Quality of Water and Tests for B. Coli," Abel Wolman, Maryland State Board of Health.

Afternoon session: Reading papers. "Manganese in Water Supplies," Edward Bartow and H. P. Corson; "New Electric Chlorine Plant of the Montreal Water and Power Company," F. H. Pitcher and James O. Meadows; "Chloramine Treatment at Ottawa, Canada," Joseph Race.

Friday.—Forenoon session: Reports of the following special committees: Private Fire Protection Services, Nicholas S. Hill, chairman; Depreciation, John W. Alvord, chairman; Revision of Standard Specifications for Cast Iron Pipe, John H. Gregory, chairman; Revision of Standard Specifications for Wrought Iron Pipe, A. A. Reimer, chairman; Water Consumption, Edward S. Cole, chairman; Prevention of Stream and Lake Pollution, Theodore A. Leisen, chairman; Mechanical Analysis of Sand, Philip Burgess, chairman; City Planning, Ernest P. Goodrich, chairman; Classification of Technical Literature, Nicholas S. Hill, Jr., chairman. Topical and general talks for the good of the association.

Afternoon: Entertainment by the city of Richmond. A special train will leave the Main Street Station promptly at one o'clock, for the Richmond settling basins; thence to the Richmond pumping station, where luncheon will be served, followed by dancing and picnic features. Return to city by trolley at the convenience of the members.

CANADA'S RAILROAD PROBLEM

ANALYSIS OF THE ADVANTAGES OF GOVERNMENT OWNERSHIP—RAIL AND WATER FACILITIES—ELIMINATION OF THE WASTES OF COMPETITION

By W. T. JACKMAN, M.A.,
Department of Political Science, University of Toronto.

THE present juncture in our national development, when great questions are pressing upon us for appropriate solution, brings before the public, among other vital issues, the problem as to what is to be done regarding the railways of the country. Probably there is no other phase of our economic life which is of greater importance to all classes of the people. The value of the transportation services brings before each of us, whether engaged directly in business or indirectly affected by business interests, the intimate relation which so clearly exists between the welfare of the railways and that of the general public, that I venture to advance some considerations which may help to set this far-reaching transportation problem in its proper light. But, before proceeding further, may I say that I am not writing with any partisan purpose in view, nor am I endeavoring to put forth a panacea for the relief of all the railway ills of the country; my aim is to impartially consider some aspects of this great question which need to be kept perpetually before us, especially in view of the many advocates who are urging a complete change in our policy of dealing with these vast interests. We should not seek any such change without serious study as to the probabilities of the outcome. May I reiterate that in treating this subject I am anxious to be just to all classes, both to those who are in favor of and those opposed to government ownership of the railways. Only by seeing the problem from all sides can we weigh the relative merits of government and private ownership so as to come to a judicious conclusion. Leaving aside any bias, therefore, let us look at the problem with judicial mind.

The importance of the railways to the country and the difficulties encountered by them in the financing of their operations have been so great as to cause the government last year to appoint a railway board of inquiry composed of experts, to go into the situation thoroughly and report its findings and recommendations. This board has recently completed its labors and from the statements published in advance of the report itself, it seems as if a majority of that body were in favor of the nationalization of the Canadian Northern and Grand Trunk systems. Of these two, the Canadian Northern has been unable to meet a large portion of its fixed charges, and the Grand Trunk Pacific, a subsidiary of the Grand Trunk Railway Company, while unable to meet any of its fixed charges, has also had a large deficit in its operating expenses. These facts have compelled the two companies to appear before parliament and ask that body to advance them the necessary assistance to enable them to discharge their financial obligations. From all appearances, these companies, if left under present control, may have to seek such aid for several years, for both of them have been expending largely on capital account in the construction of new lines through undeveloped territory in the West, and it is inevitable that, until the traffic of this western country is increased to such an extent as will permit the roads to pay their own way, assistance must be obtained from other sources than the traffic. Because of the necessity of obtaining relief from governmental sources, the railways, it is said, should be taken over by the government; and one of our leading dailies closes an editorial on "Canada's Railway Problem" with the sentence: "The next grant of public money for railways must carry public ownership with it." Taking the utterances of the press in connection with the foregoing recommendation of the board of inquiry, it is manifest that there is a strong sentiment in favor of this proposed change.

It is not our purpose here to endeavor to settle this vexing problem. It has too many ramifications to be treated lightly or to be summarily disposed of by a few glib statements as to the evils of private ownership and the advantages of government ownership. Nor can we settle it by pointing to a few instances of private railways whose managements have been corrupt and have flagrantly broken faith with the public, much less by taking certain examples of government ownership which have been successful and holding these up as models upon which to pattern our system of administration. It will be much to the advantage of this country if the Ottawa government refuses to act hastily in this matter. In such a momentous issue, nothing is gained by precipitate action and nothing really advantageous is lost by taking time to consider all sides of the case. We think it would be unwise to use the present exceptional circumstances—a time of tremendous stress on account of the war and the dislocation of industry, a time of intense mental unrest—as the occasion for changing a system of transportation which has grown up gradually during the past sixty years, responding to the country's needs, showing wonderful adaptability and displaying initiative and ability of a high order. Such a system of administration, under which the extension of the transportation facilities has been of untold service in the development of agriculture, trade and manufactures, and which has been to a large extent responsible for the great prosperity and increasing wealth of this country, should not be cast aside unless there is at hand a new and better system which would indubitably carry on this service with equal or greater results. Let us, then, consider briefly, but carefully and deliberately, the proposed change and weigh the arguments pro and con with unbiased judgment.

First of all, what are the arguments in favor of government ownership in Canada?

The necessity on the part of the Dominion government to meet the guarantees of bond interest for the Canadian Northern and Grand Trunk Pacific railways without having any immediate control of these roads would seem to be contrary to any sound business policy. Any private corporation which has assumed the payment of interest on its bonds must be given full control of the property; and ostensibly the same prerogative would be expected in the case of a public corporation like the government which wished to conduct its affairs on strict business principles. The assumption of responsibility is correlative with the exercise of rights. But, in the case of these two roads, it would seem that the government has undertaken to guarantee and pay the interest on the bonds without having the privilege of controlling the financial operations of the companies. How long would any private enterprise endure which continued year after year to pay sums of money for expenditures over which it had no control? Bankruptcy would soon issue from such a course. The only reason it is not so with the government is that the latter makes its revenue large enough by taxation to meet its expenditure, while in the case of a private concern the course is just the opposite—its expenditure must be kept within its revenue. But although the government is in this respect fundamentally different from a private enterprise the same business principles which are recognized as judicious in the latter are the only principles upon which the former should act. To go contrary to these would be to court loss of confidence on the part of those who endeavor to exercise judgment and discretion in human affairs.

By government ownership of the railways it is hoped that both rail and water facilities would form one harmonious unity, operated for the public welfare. There are certain kinds of transportation which can only be done, or can be done most efficiently, by railway; and there are other kinds of traffic for which water transportation would seem to be more suitable. With the great system of inland waterways we have potential facilities which our government is wisely developing. Immense sums have already been spent in improving these waterways and the harbors upon them and yet, because the railways and waterways are not co-ordinated into a unified system much of the benefit from the navigation on the Great Lakes has not been conserved. Whenever definite steps have been taken by the government to enlarge or improve the canals and to preserve and extend navigation facilities of all kinds, the railways have consistently opposed anything which seemed likely to divert traffic to the water. Large interests have been secured by them in the water fronts of the important shipping centres, and for their own advantage they have been diligent in preserving these lands best adapted to navigation uses. Naturally, it has never been the policy of the railway companies to welcome their rivals. They have invariably sought to restrain such rivalry. But under government control and ownership these conflicting interests could be harmonized so that each would fulfil its own particular function with the greatest economy and acceptability to the public. And why should not the public receive the greatest advantage from the transportation facilities which are maintained by the contributions of the public?

Another important factor supporting the contention in favor of government ownership is that thereby the wastes of competition would be eliminated. It was long held that competition was the life of trade and that every business was naturally competitive. But we have outlived that day and can see that certain kinds of enterprise are naturally more monopolistic than competitive. Legislative bodies in Canada, as well as elsewhere, have, however, not abandoned the view that prevailed in the early railway era that the public interests can be most effectively guarded by authorizing the construction of two or more lines along the same general route. To have two or three separate and competing railway companies, each with its own complement of necessary facilities, and the multiplication of lines, stations, offices and officials with the vast expense connected with their maintenance, is to conduct the business in the most uneconomical method possible. The railway companies themselves early recognized this wasteful policy and endeavored to get together into working agreements; but legislatures, ignorant of the real nature of the railway business, have, under the strong pressure of railway interests, sanctioned the construction of new lines where the existence of the latter has been a sheer waste of public funds, thinking thereby that they were upholding competition in furtherance of the public welfare.

How great has been this duplication or triplication of lines in Canada a casual inspection of our railway system will reveal. The fact that railway magnates themselves have been the aggressors in this movement does not alter the fact that legislatures should have resisted appeals of this kind. Nor can we say that such appeals have yet ceased; on the contrary, the financial forces are even now arrayed to secure similar additional concessions for the building of unnecessary lines of railway, while other portions of the country are in great need of the facilities of transportation. Under a system of government ownership this great waste of capital could be avoided if we had those in the government who were invariably willing to exercise as much economy in the management of the country's affairs as a business man shows in the conduct of his own private business.

Another motive leading to government ownership is that by this means equality of treatment would be given to all persons and all localities; in other words, that there would be no longer any personal or local discrimination. The reason for it would have disappeared, since government is intended to look after the welfare of all alike. It must be acknowledged that our railways have in the past been the means of building up large shippers to the detriment of the small shippers; and before the formation of our board of railway commissioners it is unquestionable that preferential treatment was given to favored persons and localities. Even at the present time, one has but to examine the decisions and judgments of this board to see the volume of complaints of this kind which come before it for adjudication.

If all the work of this arm of the government could be avoided and equitable conditions and rates be furnished to all communities and individuals without fear or favor, a long step would have been taken in the promotion of sound business morality. In most instances, the existing inequalities have been due to the fact that powerful interests recognized the fact that by their strong representations to the railway companies the latter would frequently accede to their wishes; but if the railways were owned and operated by a government whose members could resist all pleas of private interests there would be no more occasion for this kind of favoritism. Under this system there would surely be the much desired equality of opportunity for all.

Government ownership would be desirable also from the financial standpoint; at least this is claimed by those who advocate this method of administration. Under ordinary conditions, the credit of the government is so good that it can borrow all the funds it needs at 4 or 4½ per cent., perhaps less; while private companies have to pay 5 to 6 per cent. for their capital requirements. In the financing of a great enterprise this saving would amount to a large sum in the aggregate; so that the amount of the fixed charges to be paid would be considerably lower. Again, since the government would operate the road at cost, no dividends would have to be paid. The savings effected from these two sources alone would be very great; consequently, under government management the revenues would not need to be so great and the result would be seen in either lower rates or increased service to the public. This assumes, of course, that public management will be as economical, efficient and productive as private management.

An argument, which is being worked to the fullest extent under existing war conditions, is that for purposes of national defence the government should own the railways. In order to make these facilities for transportation most effective for the carriage of troops, subsistence, munitions and the raw materials for the manufacture of munitions the carriage of all other commodities, even though they pay higher rates of conveyance, must be relegated to a place of secondary importance. But when the railways are left in private hands the tendency is to take first that traffic which will pay the higher rates. Moreover, when, as in the case of the Canadian Pacific Railway, a large block of shares is owned by German or other foreign stockholders, there is great danger that the foreign influence may be so strong as to dictate the policy of the road, and thus the efforts toward using the railway for national purposes may be rendered nugatory or partially unavailing. The example of the state-owned and operated railways of Germany in aiding the mobilization of soldiers and supplies along the various fronts, and the example of England in assuming control of her railways during this emergency, have given additional emphasis to the need of having the railways completely devoted to the promotion of the national, as opposed to the private, interests.

Finally, it has been said that roads like the Grand Trunk Pacific and National Transcontinental have been intended to further primarily the interests of colonization in the great West. Settlers will no longer go, as in early years, where there are no transportation facilities. Railways must be put through in advance of or synchronously with settlement and as this project of settlement of men upon the land is for the national development, the railways designed to advance this project should also be national. Private capital does not like to invest in an enterprise of this nature in which years must elapse before the road obtains sufficient traffic to pay the operating charges, to say nothing about profits. This is exactly the condition confronting the roads above mentioned. The National Transcontinental is owned and is being operated by the government, and the chairman of the board of directors of the Grand Trunk Railway Company has requested the government to take over the Grand Trunk Pacific. It is known that the National Transcontinental line passes through a stretch of country which is as yet in its infancy so far as the capacity of furnishing traffic is concerned; the settlements along the route are widely scattered and years may elapse before a sufficient amount of tonnage can be provided to make the railway pay.

Much the same may be said of the Grand Trunk Pacific; a long stretch of the road is put through undeveloped territory and as there are no lateral lines to act as great feeders for the main line it may be a few years before adequate traffic can be obtained to pay reasonable returns on the capital invested. It is in connection with such enterprises, therefore, that public aid and support can be reasonably invoked. If private capital is averse to adventuring itself in this kind of investment without having the backing of the government to assure the financial soundness of the business, it would seem as if the government might appropriately take complete control of this enterprise without reference to private capital at all.

The government, being a permanent institution, can afford to wait for a long time before receiving financial returns from such a venture; in time, with the growth of the traffic of a developing territory, the roads which at first were unremunerative would be found to yield ample revenues, and then the government could be rewarded for the great advances made by it in the earlier years. But this contrasts strongly with the conditions attending the investment of private capital, which, if it do not receive immediate and ample returns, will prefer to seek more profitable forms of investment.

[NOTE:—The above article is the first of a series of three. In his second article, Mr. Jackman will discuss the disadvantages of government ownership of Canadian railroads. In the third article he will review suggested remedies for existing difficulties. This series will be of particular interest to those who read W. F. Tye's suggested remedy, published in *The Canadian Engineer* for February 1st, 8th and 15th, 1917, and Sir Thomas Tait's article in the April 12th, 1917, issue of *The Canadian Engineer*. Engineers will naturally place more credence in the theories advanced by Messrs. Tye and Tait, who are experienced railroad engineers and thoroughly familiar with conditions in Canada, but the opinions of Mr. Jackman, expressed from the economic viewpoint alone, will no doubt be of interest and value to those who have followed the whole discussion.—EDITOR.]

"HYDRO" STRUCTURAL MATERIALS LABORATORY.

A structural materials department has been organized in the laboratory of the Hydro-Electric Power Commission of Ontario. The laboratory building is on Strachan Avenue, where the whole testing work of the Commission is centralized. In the structural materials department are conducted all non-electrical tests. The equipment at present includes apparatus for testing cement and for making some tests on concrete aggregates and mortars. There is under consideration, however, the installation of a compression testing machine of 200,000 pounds capacity and a Universal machine of 50,000 pounds capacity. These will enable the laboratory to make tensile, compression and bending tests over a wide range.

The tests on cement include all the physical tests required by the standard specifications for Portland cement adopted by the American and Canadian Societies of Civil Engineers, and by the American Society for Testing Materials. The equipment includes a complete set of Tyler sieves from ¼ mesh to 200 mesh, also a 100 and 200-mesh sieve specially calibrated by the Bureau of Standards for making check tests on fineness, a Vicat and a Gilmore apparatus for determining time setting, specific gravity flask, tensile testing machine, a set of briquette moulds and storage basins, balance, a moist closet, etc. Equipment is also available for making some of the standard tests on sand and aggregates, but this is not yet complete.

Considerable experimental work is being done in connection with tests and test equipment for the concrete work on the proposed generating station at Niagara. This is to determine a standard method of procedure in the testing of sand, mortars and aggregates. The importance of testing work of this nature is now universally recognized.

Other test work done by this laboratory includes galvanizing tests on line construction material received in the storehouse, tests on paints, varnishes, wood preservatives, etc. This work is expanding as the needs of the Commission enlarge and will be an important part of the testing service rendered by the laboratories.

Work has been commenced upon the construction of a storage reservoir of ample dimensions for furnishing the city of Pachuca, Mexico, and its neighbouring villages with an ample supply of pure water—something that is greatly needed.

REPAIRING GRAVEL AND STONE ROADS.*

By R. M. Smith, B.Sc.,
Assistant Engineer, Dept. of Public Highways, Ontario.

WE have all classes of roads and as many as they are they all need repair. The concrete, the asphalt, the brick, the wood block, have become fairly well standardized in their method, most municipalities operating along same lines. Why, we ask, cannot the repairing of stone and gravel roads become just as consistent? Is it because of the ever-changing conditions or is it a simple case of neglect on our part? Two years ago an article read at the first conference discussed at some length a method of caulking horses' shoes that the road might not be torn up. At the present time we have almost forgotten the horse-drawn vehicle and on every hand you hear the words "automobile traffic." The cities have constructed roads to meet this traffic, but the cost of these would be prohibitive in the country, so what is the next best thing?

Many miles of macadam and gravel roads have been constructed throughout the province and now that they are constructed, how shall we keep them in repair under this above-mentioned automobile traffic conditions?

There are two things which should be remembered: First, roads deteriorate rapidly if neglected,—frost, heat, water, drought and traffic tending to flatten the surface and mix it up so badly that it is pounded into the subgrade; second, the macadam or gravel road constructed at present time will not stand up under the increasing traffic without attention.

Construction or resurfacing a macadam or gravel road must never be undertaken until ditches are provided and culverts have the proper outlet. To get the water away from the road should be the first consideration; too often this, the most important item in resurfacing or construction, is neglected. The idea seems to be to place the stone on the road as fast as possible, round it into shape regardless of mud holes, soft spots and drainage, letting the water take care of itself. It is not the intention of this paper to go into the method of construction, or drainage, however, but certainly the method of construction has all to do with the method and cost of repair. Often we see gravel being dumped into a mud hole on a clay road or a soft spot in a gravel road being filled with something else. Sometimes we see bituminous patches on a macadam road which apparently have no oil elsewhere. Mixing materials in this way either causes bumps or hollows. Repair a clay road with clay; a broken-stone with stone and a gravel with gravel.

Macadam Roads.—Repairing a macadam road should be started as soon as the road is constructed. It is practically impossible to construct a water-bound macadam that under the traffic of to-day will not rut. Automobiles are like sheep,—if one starts a rut the next one follows. The first rain fills the rut with water and the trouble has started. "Allow no ruts to form" should be the motto of road superintendents; keep the surface round and smooth. This enables the water to get more quickly to the ditch and eliminates bumps and holes that would form otherwise. Broken stone, the same size as used in the upper course, should be used for filling ruts; it must be tamped to place, the finished surface a trifle higher than the surrounding surface, to allow for consolidation by traffic. Pot holes are repaired in Europe by the removal of material to depth of wearing course, stone then replaced, tamped to grade with stone chips as top dressing. Bituminous material may be added, either before or after placing. Rolling in spring when road is soft has also brought good results. The earth shoulders should be trimmed up from time to time with road scraper that water may run freely to the ditch. Continuous repair is the only way to increase the life of the road. Too often roads are constructed and are left to themselves from two to three years—sometimes a considerable time longer—without the slightest attention. We must convince ourselves that repairs are essential and immediately the road is completed, not a year or so later. The greatest care that we can exercise during construction will not entirely remove all the soft spots and these soon start to put in their appearance. A few loads of material dumped conveniently along the road at the time of construction will be handy to fix just such a place. The next question that arises is: Who is to make the repairs? We must provide systematic method of repair and maintenance. Too little attention has been given to this end of the work. How often we drive on the country road directly after it has been constructed and see signs of ravelling and rutting that with a few minutes' attention could be made as solid as surrounding surface.

Combination of Hand Plow and Roller.

The continuous patrol system that has been advocated by engineers both in Canada and the United States has either not found favor in Ontario or else we have neglected to carry the idea far enough. The railroads have their sectionmen who keep the track and surface in repair, why cannot the same system be applied to our public roads? Until such a system is inaugurated we will have the same high cost of resurfacing every few years. To save money to our councils and province it is essential that we realize immediately the importance of systematic maintenance and take steps to remedy the evil that has existed since road construction in Ontario began. When our shed starts to leak, we patch it; when our road surface is penetrated why not give it the same attention? Only one case exists, to the writer's mind, where patrol systems with continuous maintenance might not be to advantage, and that is where road is constructed of a soft material that is plentiful and easily obtained.

The time must come, however, when patch work and the best system of patrol will not suffice to keep the surface in shape; then it must be resurfaced. Where the road is full of pot holes the scarifier or picks bolted to rear wheels of roller can be used to advantage. The

*Abstracted from paper read before the Third Annual Conference on Road Construction. Held in Toronto, March 27-30, 1917.

scarifier brings the stone to surface, making a better bond for the new material when placed upon the road. The surface is then watered and consolidated with the roller. Where in the original construction the stone was of a considerable depth this method of resurfacing may be sufficient for a year or so. However, if in the original construction the surface was thin, new material must be added. It is advocated by many engineers that where more than three inches of material is being placed on the old surface it should not be disturbed, but new material applied, watered and rolled just as in new construction. On a considerable mileage of our country roads we have gone a step further than this and added a bituminous material in our resurfacing. This has several important advantages,—it makes a surface that is impervious to water, has better wearing qualities, is dustless, and eliminates the high crown we dread so much in new construction, ½ inch to the foot being considered quite sufficient to carry water to side ditches.

Gravel Road.—A gravel road will not compact without months of traffic, no matter how well it has been rolled during construction, and maintenance work should begin immediately the road is open for traffic. As with any type

Grader at Work.

of road, the method of construction determines its length of life. A gravel that is dumped along the road in numerous piles with no care taken to spread or shape it, simply makes it that much more inconvenient to the travelling public.

The drainage should first be given consideration; the ditches, the culverts, waterways of all descriptions must have free and unobstructed outlets. The fact that we are simply going to construct a gravel road does not lessen the liability. This province at the present time has a considerable mileage of properly constructed gravel road that favorably compares with our macadam. The life of the gravel road depends upon the drainage and foundation. A road that is properly graded and ditched adds considerably to the appearance of the country in general.

The preparation of the subgrade depends partly upon the traffic expected and partly upon the amount of money to be expended. Proper alignment having been secured, the surface is brought to grade by use of grader wheel, scraper and roller. There are two methods of construction generally used,—surface and trench. The surface method consists of bringing the roadbed to the proper grade, as explained above, and placing the gravel upon it, care being taken to draw all large stones to the centre of the road that they may be covered by following material. The road is then rolled or allowed to be consolidated by traffic. The trench method is a little more expensive. A trench is made along the centre of the road, material being moved to the sides to act as shoulders to keep the gravel in place. The gravel is then placed upon the road, evenly spread and rolled. When second course of material is applied it is of sufficient depth to spread slightly over shoulders making a more even and better wearing surface. It has been claimed that no advantage results from rolling but certainly the public will not drive on the side of the road, cutting the shoulder away if its surface is rolled and put in proper shape. Gravel roads so far in Ontario have not been constructed with addition of bituminous material. They have, however, been built in the States but not with the same success attending the use of stone. The gravel with its rounded pebbles does not consolidate and bind together as with the angular and irregular shaped material.

To maintain a gravel road the same system of patrol applies as in macadam, the ruts must be kept filled and the surface smooth. The road drag is probably the best tool for this purpose, particularly the first year after construction, when it should be used after wet weather while the road is in a soft condition. The road drag will not have the same effect as the road ages, unless a period of wet weather exists for some time. Patching should be done when the road is in a wet condition as the new material added will bond to the old and compact much better than when in a dry state. It is also easier to locate bad places by the standing water. Care should be taken in filling these holes that the material is only raised above the surrounding surface sufficient that upon consolidation the new surface is level. Patching and the road drag, with attention to ditches and culverts, will keep a gravel road in condition until it needs resurfacing.

WEEKLY RAILWAY EARNINGS.

The following are the weekly earnings of Canada's transcontinental lines during April:—

	1917.	1916.	Inc. or dec.
Canadian Pacific Railway.			
April 7	$2,830,000	$2,482,000	+ $348,000
April 14	2,833,000	2,577,000	+ 256,000
April 21	2,708 000	2,343,000	+ 365,000
Grand Trunk Railway.			
April 7	$1,215,768	$1,155,486	+ $ 60,282
April 14	1,103,119	1,024,505	+ 78,616
April 21	1,085,031	1,059,661	+ 25,370
Canadian Northern Railway.			
April 7	$ 736,200	$ 677,000	+ $ 59,200
April 14	881,600	668,900	+ 212,700
April 21	765,600	634,300	+ 131,300

An association, to be known as the Society of Terminal Engineers, has received a charter, under the laws of New York State, for the purpose, among other things, of promoting the study of terminal engineering and mechanical freight handling.

From a study made of the water supply for the Panama Canal it has been ascertained that an average of 7.21 million cubic feet of water was used for each through lockage from ocean to ocean; that an average of 12,787.47 million cubic feet of water was wasted over Gatun spillway, or a sufficient quantity of water to make 1,773 through lockages each month. Based on 30-day operation, this would mean 59 lockages per day over and above the average traffic for the past year. According to the latest annual report of the Governor of the Panama Canal, the maximum number of lockages which can be made in 24 hours is 48, assuming that one vessel leaves the upper flight at Gatun just as another enters the lower chamber, and vice versa, both chambers being used.

Editorial

WATER WASTE.

In many of our cities and towns there appears to be little or no attempt at conservation of water. Those who are opposed to the metering of water, claim that it would not be in the interests of public health to do anything which would in any way cause consumers to economize in the legitimate use of water. That objection may appear to be well taken but, on the other hand, there is ample evidence, as disclosed by reports of not a few municipalities in Canada and elsewhere, that so long as there is water in the reservoir the profligate waste goes on unchecked. In fact, lack of judgment in this respect has frequently caused alarm and danger.

Considering that the majority of water supplies throughout the country have to be pumped once and sometimes twice, that many of them are filtered and some of them chemically treated, is it just fair that water should be regarded "as free as air"? Is it not in reality a manufactured product with manufacturing costs accompanying it?

In this connection it is interesting to note the results of an experiment which was carried on in Philadelphia some time ago. That city had for long been regarded as the most pronounced sinner among the larger cities, so far as wastage of water was concerned. An ordinance was secured permitting the installation of meters. A vigorous house-to-house inspection was inaugurated. Thousands of leaky fixtures were located and repaired.

This was followed by a very determined campaign for the detection and repair of leaks in mains.

By the elimination of this waste Philadelphia has been able to add materially to its water pressure both for fire and municipal purposes.

On a smaller scale many other municipalities are just as guilty as Philadelphia was before it tackled the problem in an aggressive and business-like manner.

The season of the year is upon us when there is a tendency to be more lavish in the use of water for sprinkling lawns, etc., and the problem of water conservation will no doubt force itself again upon the attention of municipal engineers and waterworks officials.

HOW LONG WILL THE WAR LAST?

A well-posted American, with a knowledge of German conditions, last month predicted the end of the war within sixty days. His judgment was based upon the acute financial condition of the Central Powers. The popular forecast, which has a habit of changing as rapidly as events move, is that the struggle will end in October. This has received a measure of support in the statement of the Right Honorable William Hayes Fisher, in an address in England last month, in which he said: "We did not intend to stand more than three years of war. Germany's idea was to starve us out before we could knock her out. What we want is to knock the enemy out this year, and we are beginning to do it."

In his latest book, Mr. H. G. Wells, who still believes "in the western push, if only we push it for all we are worth," says the war may go on into 1918 or 1919. Food riots, famine, and general disorganization will come before 1920 if it does. Mr. Wells discusses his subject after a tour of Italy, France and Great Britain. It is the lack of public knowledge of actual conditions in Germany, however, which largely prevents everyone from making predictions of value as to the war's end. This deficiency is supplied to some extent by Oscar King Davis, for some months staff correspondent of the New York Times in Berlin. He returned with Ambassador Gerard. That there is practically complete solidarity in Germany concerning the war, is a fact which Mr. Davis claims is the main element in Germany's strength.

After analyzing the situation there, he says: "Germany may go on for a year or even a little more. Then it may be want of food, or money, or men, or all together that brings her down. Always provided that her foes are able to go along at the same speed they are now showing. I do not believe that Germany can last much, if any, more than another year. If the Entente Allies can outlast that, I believe they can bring Germany down. If Germany has bad crops this year, it will be comparatively easy. If she has good crops, it will be more difficult, but still I believe it will be done, for her financial needs are driving her even more inexorably than her food situation, and no help is in sight for that."

In short, the Central Powers are weakening rapidly; the Allies are increasing in strength, and have received an important additional reinforcement by the United States war declaration.

KITCHENER, ONTARIO.

In Ontario, there was a town of Berlin. Some of its residents are of British and some of German stock. Most of the German stock there are good Canadians. Some have German sympathies. Those sympathies were organized and active. So we had a Canadian town which, though it flew the Union Jack, harbored German sympathies and certain other characteristics which are not recognized in a British country. That this sentiment is widespread was evident whenever Berlin travellers went out to sell goods. They were told to get out of the buyer's office. A movement was initiated to change the name of the town to Kitchener. This was done after considerable opposition which, unfortunately, was slapped with a political hand instead of being stamped with a British foot.

Merchants know that Kitchener was once Berlin and they have boycotted the industries in that town. Being distant buyers, they could not always know who are the Kitchener firms believing in British ideals. So that these firms may not suffer for the acts of any pro-Germans who may still exist in Kitchener, there has been established the Kitchener Manufacturers' Association of the British League. Its members are manufacturers who fought for the city's change of name and opposed all efforts to retain the name Berlin. The new organization has its own trade mark, which is reproduced here. This will be attached to all shipments made by its members. The merchants of Canada will make no mistake in patronizing firms whose goods bear this trade mark, for it signifies that those firms have done unpleasant but necessary work in combatting an undesirable influence in a British Dominion.

PERSONAL.

ALEXANDER ALLAIRE, M.E., M.Can.Soc.C.E., formerly manager of the Foundation Co., Limited, and latterly a member of the engineering staff of the Foundation Co. of New York City, has resigned from that company to become vice-president of Fraser, Brace & Co., contractors, 1328 Broadway, New York.

HARRY DARLING, formerly manager of the Dome Lake mines in Porcupine, Ont., has left for California, where he will look after the Crown Reserve interest at the Globe mine. RALPH REGNALL is now manager of the Dome Lake mines.

Lieut. CHARLES S. DeGRUCHY, B.Sc., Montreal, a junior member of the Canadian Society of Civil Engineers, has been slightly wounded at the front. In February he was awarded the Military Cross. Prior to joining a draft of the field artillery he was assistant engineer at the Halifax Ocean Terminals.

HORACE J. EASTMAN, mining engineer of Rossland, B.C., has enlisted for active service in the Universities platoon.

THOMAS FINDLEY, former vice-president and assistant general manager of the Massey-Harris Company, Limited, Toronto, has been elected president and general manager to succeed the late Sir Lyman Melvin-Jones.

EDWIN ROY GRAY, B.A.Sc., formerly deputy city engineer and latterly joint manager of the works department at Hamilton, Ont., has been placed in charge of the works department of Hamilton with the title of city engineer and manager of the waterworks and sewage disposal works.

JOHN H. GREGORY, M.Am.Soc.C.E., announces that the firm of Hering & Gregory, consulting engineers of New York City, has been dissolved. Mr. Gregory will continue in practice as a consulting hydraulic and sanitary engineer.

E. A. HAMEL, A.M.Can.Soc.C.E., has been appointed on the permanent engineering staff of the city of Quebec, as assistant to City Engineer W. D. Baillairge.

Brigadier-General F. O. W. LOOMIS, D.S.O., of D. G. Loomis & Sons, contractors, Montreal, has been awarded the Colonial Officers' Decoration for long service. General Loomis was recently wounded, but has now resumed his duties at the front.

F. L. MacPHERSON, M.Can.Soc.C.E., for the past eight years municipal engineer for Burnaby, B.C., has resigned to accept a provincial government appointment as engineer for engineering district No. 5, which includes the electoral districts of Revelstoke, Slocan, Rossland, Trail and Kaslo. Mr. MacPherson is an associate member of the Institute of Civil Engineers of Great Britain.

S. L. SQUIRE, of Waterford, Ont., has been appointed by Hon. F. G. Macdiarmid, Minister of Public Works, Ontario, to the position in the Highways Department of municipal adviser. He is a former president of the Ontario Good Roads Association.

F. TISSINGTON, chief engineer of MacKinnon, Holmes & Co., Limited, Sherbrooke, Que., has resigned his position and is taking a short holiday before commencing work again.

A. R. WHITELAW, who for the past year has been engineer in charge of the construction and equipment of a new boxboard plant for the Northumberland Paper & Electric Company, Limited, at Campbellford, Ont., will supervise the construction and equipment of the power house for the Hydro-Electric development on the Madawaska River at Calabogie, Ont.

OBITUARY.

HARRY GOULDING AKERS, son of the late John Akers, K.C., Toronto, and a graduate of the School of Practical Science of the class of 1907, died suddenly of heart failure at Yorktown, Virginia, at the age of 30. When war broke out he volunteered for active service, but was rejected. He then went to the United States, where he was employed with munition firms.

Lieut. J. D. ARMSTRONG, of the Topographical Surveys Branch, Department of the Interior, Ottawa, has been killed in action. After graduating from McGill University he was connected with the Grand Trunk Pacific in construction work. He was a student member of the Canadian Society of Civil Engineers.

S. R. BADGLEY, who designed Massey Hall, Toronto, died recently in Wycliffe, Ohio, near Cleveland. Mr. Badgley had reached an advanced age and was looked upon as one of the leading architects in the middle States.

D. McKAY, general superintendent of the Yellowhead Pass mines, Alberta, was killed recently by a fall of coal in No. 5 mine. The deceased was well known in mining circles around Edmonton, being formerly in charge of the Twin City mines, Edmonton.

JOSEPH ROVER ROY, A.M.Can.Soc.C.E., for twenty-one years a civil engineer in the employ of the Public Works Department, Ottawa, died on April 25th. He had been ailing for some weeks. The deceased was born in Montreal, the son of the late Rover Roy, Q.C., for many years city attorney of Montreal.

DEGREES CONFERRED BY UNIVERSITY OF TORONTO.

The following have been granted degree of B.A.Sc. with honors by the faculty of Applied Science, University of Toronto:—

Civil engineering—H. A. Babcock, A. E. Berry, R. S. C. Bothwell, F. C. Christie, R. W. Hurlburt, R. C. Manning, R. D. Ratz, C. E. Tilston, V. Topping.

Mining engineering—H. L. McClelland.

Mechanical engineering—A. M. Snider.

Architecture—A. S. Mathers, H. R. Watson.

Applied chemistry—J. V. Dickson.

Electrical engineering—W. A. R. Offerhaus, A. A. Tufford.

The degree of Civil Engineer (C.E.) was last week conferred by the University of Toronto upon Messrs. C. J. Townsend and Thomas Taylor, Toronto, and W. G. Smith, Victoria, B.C.