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The Canadian Engineer

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TUNNEL SEWER SYSTEM AT EDMONTON

EXTENSIVE REINFORCED CONCRETE BLOCK TUNNEL SYSTEM OF SEWERS—METHOD OF BLOCK MANUFACTURE AND PLACING—NOTES ON TUNNELING AND JOINING UP SECTIONS

THE following brief description of the system of sewers serving that portion of the city of Edmonton on the north side of the North Saskatchewan River is abstracted from an extensive paper presented by Mr. A. J. Latornell, A. M. Can. Soc. C.E., city engineer of Edmonton, to the Canadian Society of Civil Engineers, on April 8th. A number of features peculiar to the city and its intersecting river combine to make the sewer system a very interesting one. Among these may be mentioned the rapid growth of the city, the wide variation in the stream flow of the Saskatchewan, and the water supply, which is drawn from the river at a point nearly opposite the centre of the city.

According to the paper, when the present sewerage system was designed the city had an area of 9,600 acres, 8,500 of which was on a plateau 146 to 206 ft. above the

Fig. 1.—Example of Open Cut and Tunnel Portal.

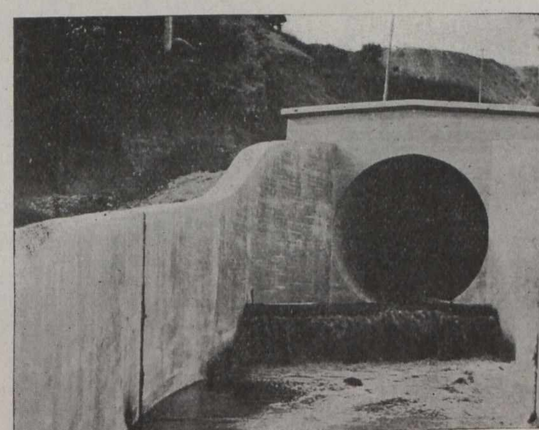


Fig. 2.—Finished Portal at Outlet of 10½-ft. Sewer.

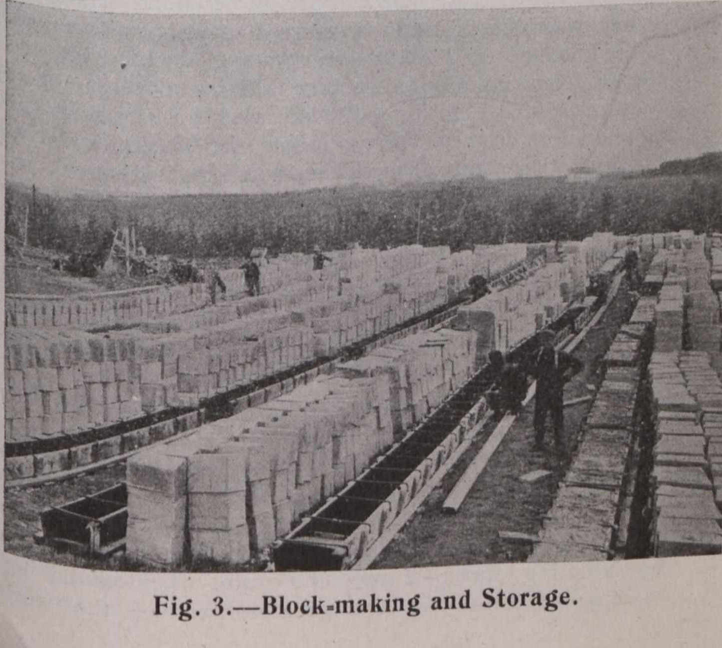


Fig. 3.—Block-making and Storage.

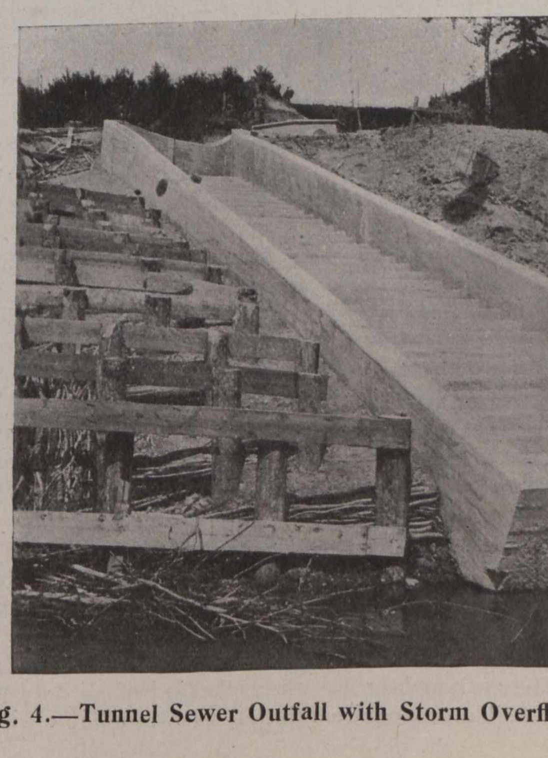


Fig. 4.—Tunnel Sewer Outfall with Storm Overflow.

river at low water, and 1,100 acres on flats about 34 ft. above low-water level. The river varies in width from about 400 ft. at low water, to about 650 ft. at flood. The variation in level between low and high water is about 15 ft., but on the occasions of one or two extreme floods it has been 30 ft. The flow at low water is about 1,200 cu. ft. per sec., and at average high water 50,000 cu. ft. per sec.

The portion of the city then served by sewers

storm run-off in the locality concerned, and outlined the considerations which led up to the adoption of a tunnel system of main sewers. These considerations were:

(1) The height of the plateau above the river.

(2) Favorable ground for tunneling.

(3) That steeper grades and consequently smaller sewers could be adopted, than would have been the case if the economical depth for open trenching had been adhered to.

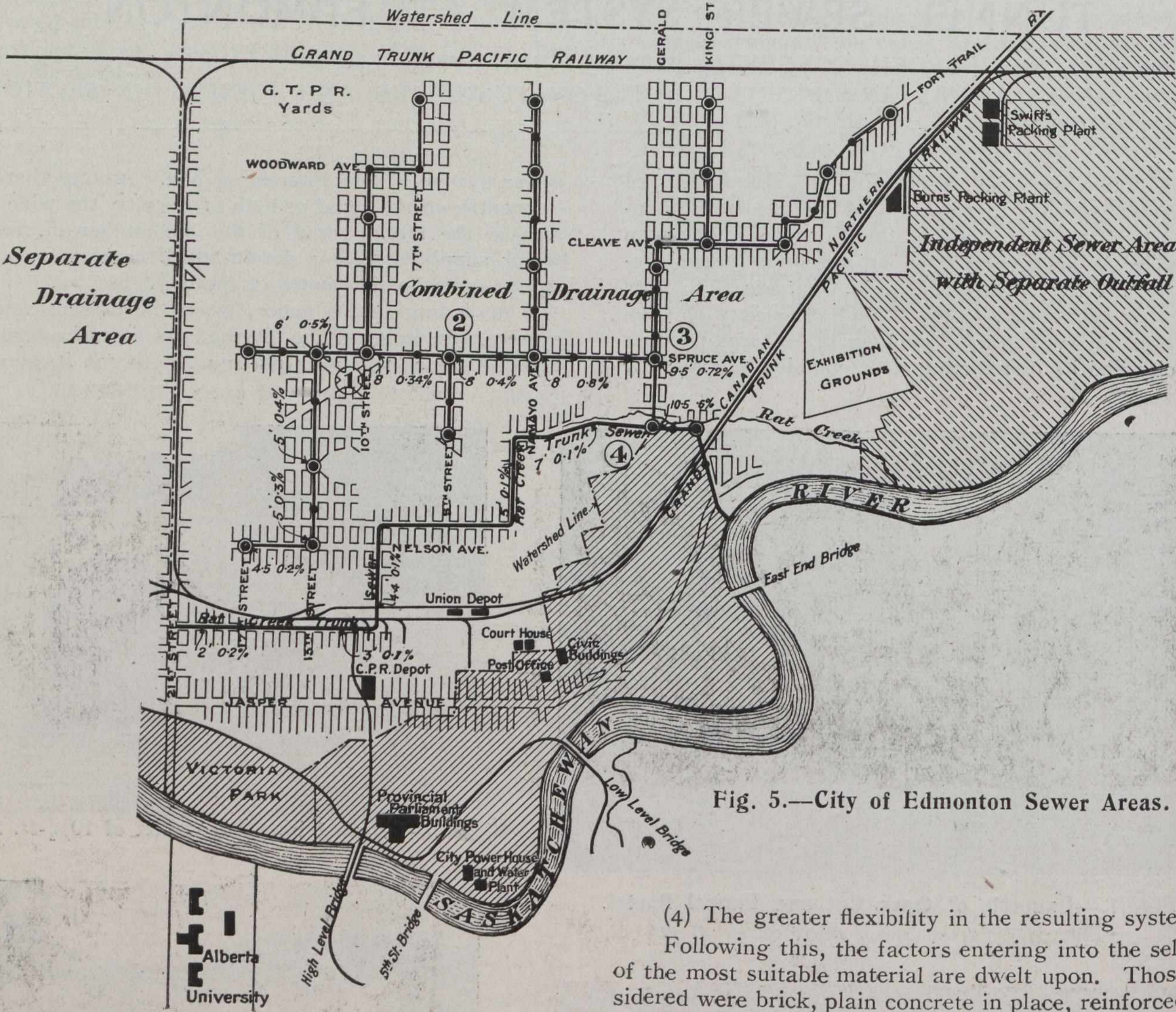


Fig. 5.—City of Edmonton Sewer Areas.

amounted to about 2,350 acres, and three systems were in use, *viz.*:—

(1) The Saskatchewan Avenue system, discharging into the river at Saskatchewan Ave.

(2) The Eastern system, discharging into the river at the north end of Frasers Flats (now Riverdale). This served the main business area of the city.

(3) The Rat Creek system, discharging into the bed of Rat Creek at a point about two miles from its outlet. From the discharge point the sewage flowed down the bed of the creek to the river as an open sewer. This was the latest, and was designed in 1905.

In 1909, preliminary data were collected for a comprehensive scheme of sewerage, the need of which had by that time become very much in evidence. In 1910 Mr. Alexander Potter, of New York, was called in as consulting engineer.

The author describes the collection of all data that it was possible to acquire relating to rainfall intensity and

(4) The greater flexibility in the resulting system.

Following this, the factors entering into the selection of the most suitable material are dwelt upon. Those considered were brick, plain concrete in place, reinforced concrete in place, and reinforced concrete blocks. The last-mentioned were adopted as best fulfilling all the necessary requirements. The form of reinforced block type adopted is shown in Fig. 6. Surrounding the blocks, and lying between them and the earthen walls of the tunnel, is a layer of about 4 inches of mass concrete.

The reinforcement consists of circumferential square twisted bars within the concrete or mortar which forms the circumferential joints of the sewer, and of longitudinal straps tying the blocks together as a solid unit. This reinforcement is designed to resist the external pressure on the sewer.

As these sewers are at depths below the surface varying from 50 to 100 feet, they may be subjected to considerable internal pressure when the area is fully built up. Steel reinforcement, in the form of flat bands around the outside of the blocks, is added to resist this pressure. Each circumferential band is made in two pieces joined by coupling shoes of special design. Textonious lugs superseded these on the greater part of the work.

Thorough test showed that this lug was equally reliable, and cheaper than the original design. The coupling shoes or lugs served to join the halves of the bands and to draw them up tight. The bands are designed to withstand the maximum hydrostatic or internal pressure, using a unit stress not exceeding the elastic limit of the steel. The provision of this reinforcement for internal pressure ignores the resistance of the clay walls around the sewer, which in most of the ground through which the tunnels pass would be sufficient provision against any probable internal pressure. The bands are also efficient under normal conditions, and enable less steel to be used in the concrete blocks than would be required if the bands were absent.

Two alternative cross-sections of the various sizes of sewer were designed for use in bad ground. These alternatives for the 4-ft., 4-ft. 6-in., 5-ft. and 6-ft. sewers are shown in Fig. 6, and those for other sizes are similar.

taken out of the forms, care being taken to prevent a breaking of the sharp corners. In another type of form used the blocks were cast on their sides.

The plant used consisted of concrete mixers, used chiefly in block making, electric hoists (41 in number) and a motor-driven conveyance.

Excavation work in the tunnels proceeded from shafts located at intervals of from 200 to 1,150 feet. In most cases the shafts were built up to form man-holes after completion of the sewer. They were rectangular in shape and timbered in the usual manner. A stiff gray clay with occasional pockets of sand constituted the material encountered and little timbering was necessary except where sand occurred.

On one part of the work, the shafts were sunk as circular excavations, timbered by means of sets of vertical lagging about four feet long, held in place by steel bands. These bands were in two parts, the ends being bent over

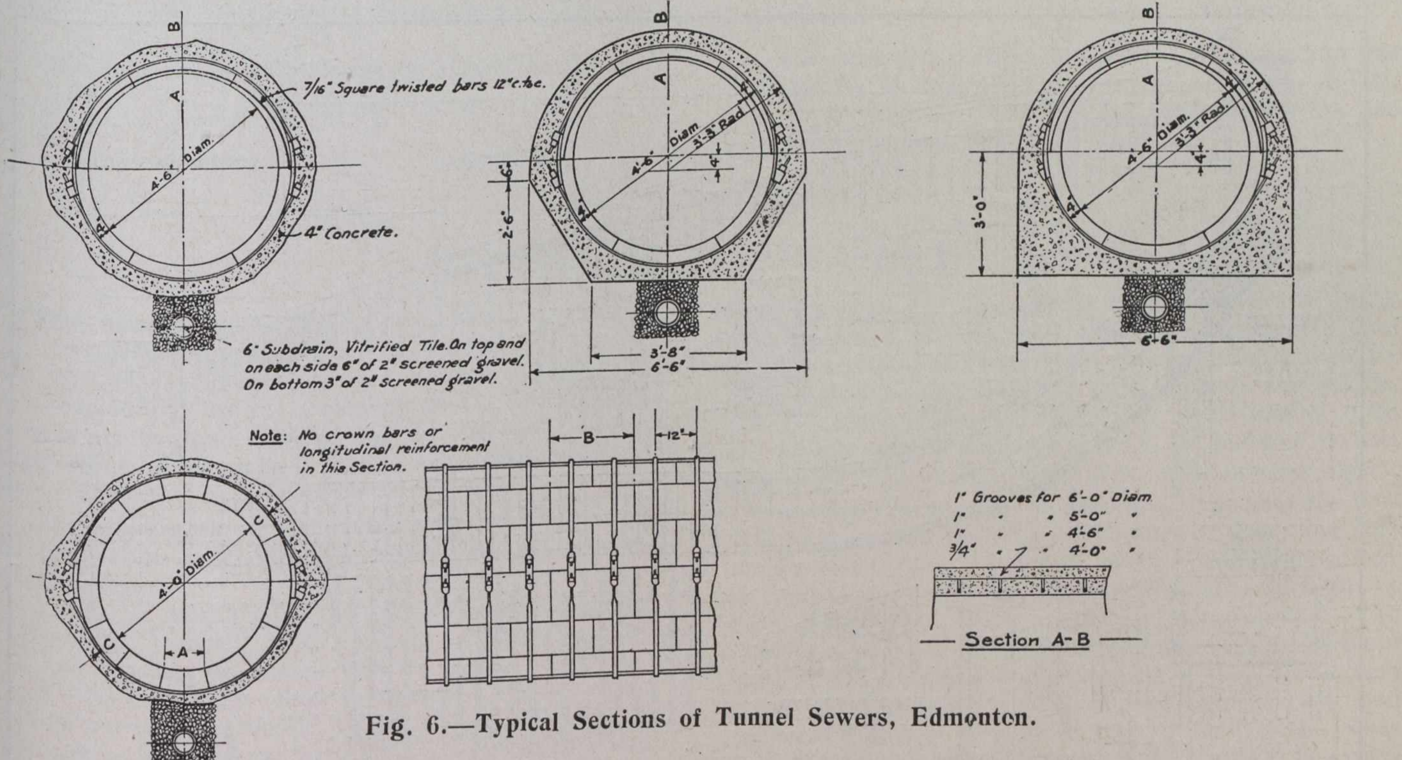


Fig. 6.—Typical Sections of Tunnel Sewers, Edmonton.

The one with the flat base was used in wet sand or soft ground.

The 10-ft. 6-in. sewer ends near the river in an open rectangular conduit, the latter being intended to conduct the storm overflow to the river. The dry weather, or sanitary flow, will be tapped off in two lines of cast iron pipe and taken to the disposal plant when the latter is built. The bottom of the open rectangular conduit is in the form of steps. The entire outfall structure is of reinforced concrete. As part of it is below high-water mark, it would be liable to damage from logs or other floating material during high stages of the river, and to damage from ice jams in the spring. The details of a protection work of pile on the upstream side of the conduit are shown in Fig. 7.

The concrete blocks were made of a 1:2:3 mixture, the gravel or broken stone requiring to pass a 1-inch screen. Wooden forms lined with metal so as to give a smooth finish were used in the manufacture of most of them. In one type of form, as soon as the blocks had set sufficiently the sides were removed, leaving the blocks standing on a metal face. After about 48 hours they were

to form a flange. They were made heavy enough to resist distortion from the pressure of the walls of the shaft. In sinking the shaft, the excavation was made for about four feet, care being taken to have it trimmed truly circular and the right size. The first set of lagging and bands were then put in place, the bands being wedged out at their junctions to tighten them up against the lagging. Another four feet was then excavated, and the lagging put in directly below it and the bands then inserted. By placing one of the bands in position before putting in all the lagging, this latter operation was made easier. This type of shaft worked very well where the ground was good, and was somewhat cheaper than the rectangular.

Small charges of dynamite (½ to 1 stick) were used to loosen up the clay, after which the excavators took it out, using a mattock instead of a pick. These tools were also used in trimming the cross-section to shape. The material, as it existed in the face, possessed a rubbery elastic property, and a pick simply sank into it without loosening it. However, the material when excavated and exposed to the air changed its character, drying and breaking up similarly to the disintegration of lignite coal when exposed to air. The material was not a shale but a boulder clay having a number of stones scattered through it ranging in size from half an inch to small boulders.

The excavated material was transported on a small car to the foot of the shaft, where it was hoisted to an elevated track and dumped into wagons. The completed sewer followed the excavation closely, except where it was thought necessary to hold back to prevent injury from blasting. The shock was never serious, however, owing to the small charge used, and the completed work was never more than 15 feet from the face of the excavation.

The tunnel was electrically lighted, and the absence of forms facilitated the laying of a small track for the cars carrying the excavated material, and the blocks, etc., used in the sewer.

After the excavation in a length was completed the subdrain was laid. Then the concrete was laid in the bottom, to the level of the bottom of the blocks. The lower half of the hooping band was then placed on the concrete, and the invert block on top of the band. The remaining blocks up to the springing line were added, the backing concrete being placed as the block laying proceeded until the lower half of the ring was complete. A short wooden form extending partly into the finished sewer was then used to complete the upper part of the ring. The reinforcing crown bar, previously bent to the proper shape, was first placed in position against the face of the previous ring, so as to rest on the projection on these blocks. Block laying was then continued, care being taken to fill the joints between the blocks thoroughly, so that the reinforcing bar and the jointing irons would be surrounded by and bedded in the mortar. After the last block was placed at the top, the upper half of the hooping band was put on, the halves being connected by coupling shoes, and drawn up tightly by wrenches. After tightening the band the concrete backing was placed so as to fill the space between the blocks and the earth. The lower half of the ring having been extended meanwhile, the form was moved ahead and the process repeated.

In completing a junction of the sewer between any two shafts, the operation is very simple. After the excavation work on any two faces has been completed, the work of constructing the sewer on each side of the junction is carried on in the usual manner. A measurement is made of the gap between the two sections of sewer, before these approach too close, in order to ascertain how many tiers of blocks will be required to fill the gap. In this way it is often possible, by slightly increasing the width of the joints, to have the final tier of blocks just nicely close the final gap. At other times it is seen by the measurements that the final gap cannot be adjusted to a block in width except by too great a change in the width of the joint. In such cases, the final gap is closed by cutting the blocks to the required width. The lower portion of the sewer is thus completed with blocks without difficulty. The final gap in the upper half is made with mass concrete, working from each side up towards the crown, lagging being used to hold the concrete in place; these being added from time to time as the work progresses towards the crown. The last small portion at the crown is lifted or shoved into place. After the concrete has set sufficiently, the forms are removed and the work smoothed off, leaving the junction with the appearance of a wide joint.

The rate of progress was 30 to 36 feet of completed sewer in each face per week. In the 4-ft. 6-in. and 5-ft. sewers, two men worked at the face, one as car pusher, and two or three men on top, exclusive of hoistmen and foreman. The former served the two faces worked from his shaft, and the latter looked after several faces. In the 6-ft., 6-ft. 6-in. and 8-ft. sewers three men worked at the face, and there were two car pushers. Work was carried

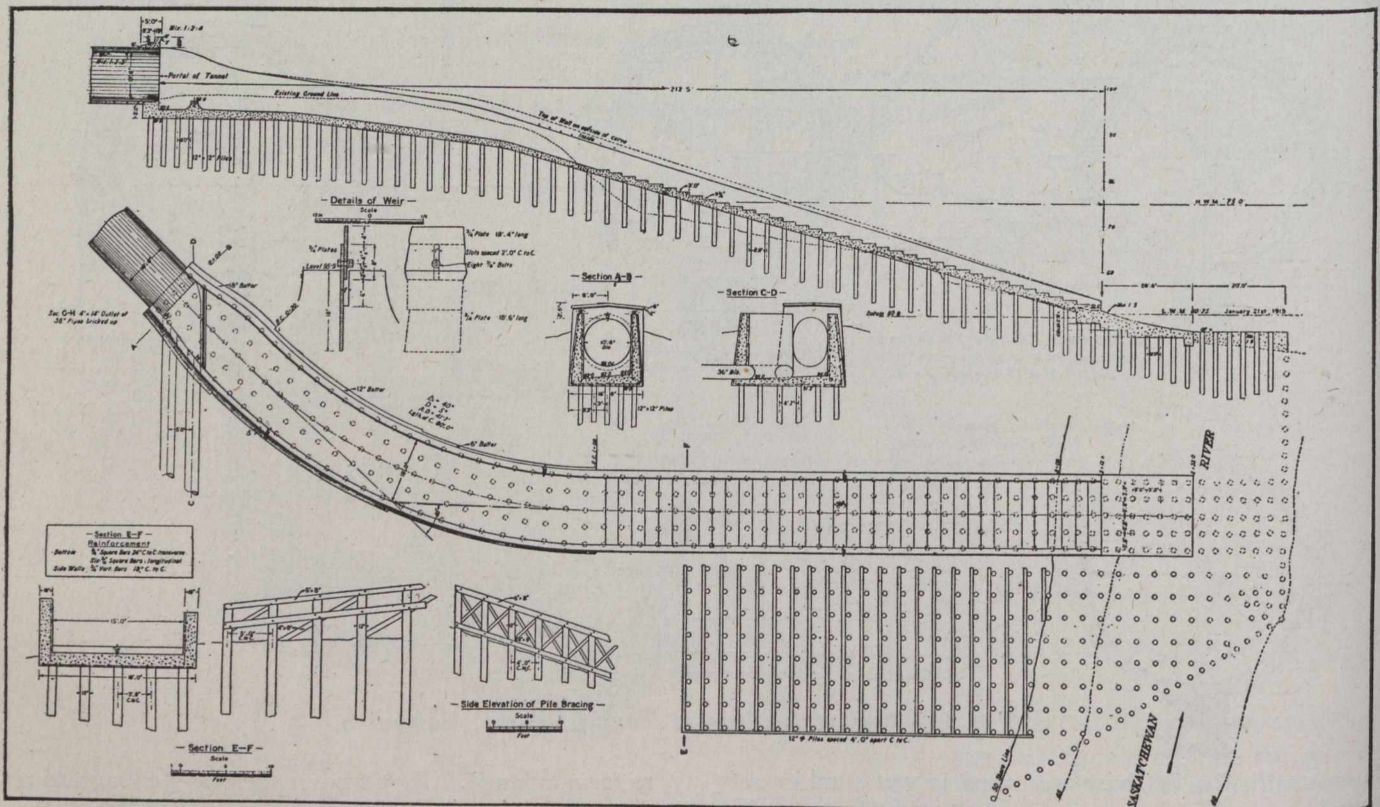


Fig. 7.—Plan, Profile and Details of Main Sewer Outlet, Edmonton.

on in two 10-hour shifts. At first the block laying was done by special men, but during most of the work excavation and block laying were done by the same men.

As soon as the sewer on each side of a shaft was completed, the manholes and drop connections were constructed. The contractors were allowed to use the block form of construction in the lower half of the sewer passing through the manhole. The shaft timbering was drawn as the work of building the chambers leading to the surface progressed. Both outside and inside forms were required in building the manhole barrel and drop connections. Part of the former was removed as the work progressed, and before the back filling was placed. The inside forms were removed from below.

The engineering organization of the work is represented in the diagram below:—

City Engineer,

|

Assistant Engineer in Charge of Sewerage and Drainage,

|

Resident Engineer in charge of Tunnel Sewer,

|

Instrument-men. Inspectors.

In setting out line, the general method employed was to suspend, by means of piano wire, two 20-lb. plumb bobs down the shaft, these being immersed in a pail of oil. The two wires were brought into line at the surface by means of a transit, which was then taken below and the line extended into the tunnels. The level was transferred down the shaft by means of a steel tape, the point so obtained being used as a bench mark in giving grade. As the two faces approached within 10 to 15 feet, an opening was driven through to allow the meeting of grades and alignment to be checked. No adjustments were necessary, as all faces met both in alignment and grade with almost perfect accuracy.

Progress charts were made and brought up to date every two weeks, the progress of each two weeks being shown in color, so as to make comparisons easy. The character of the ground passed through was also shown, chiefly as a matter of record, although it served also to explain many variations in the rate of progress.

The work was divided into several contracts, and was executed by Manders and Gregory, D. McGarry & Co., and H. C. Ulen Co. The Midland Construction Co. had a sub-contract from the H. C. Ulen Co.

REGULATION OF VEHICLE LOADING.

THE bill to regulate the load of vehicles operated on highways, introduced a few weeks ago into the Ontario Legislature by Geo. S. Henry, M.P.P., is reproduced below. Believing that a discussion of its contents by road engineers is advantageous at this stage, editorial reference is made to it elsewhere in this issue. The bill is as follows:—

His Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:—

1.—(*a*) In this Act "highway" shall include bridge.

(*b*) "Vehicle" shall include traction engine, trailer and motor vehicle.

2.—(1) No vehicle shall be operated and no object shall be moved upon wheels, rollers or otherwise over or upon any highway in any municipality in excess of a total weight of twelve and a half tons, or of four tons on any one wheel, including the vehicle, object and load, without first obtaining a permit as provided by section 3.

(2) No vehicle shall be operated or object moved over or upon such highway which has any flange, rib, clamp or other device attached to its wheels or made a part thereof which will injure the highway, and in any municipality other than a city, no vehicle, object or contrivance for moving heavy loads shall be operated or moved upon or over any such highway the weight of which resting upon the surface of said highway exceeds six hundred pounds upon any inch in width of the tire, roller, wheel or other object, without first obtaining such permit, unless such highway is paved with brick, block, bituminous surface or concrete base or concrete pavement.

(3) The owner, driver, operator or mover of any such vehicle, object or contrivance who has obtained the permit mentioned in section 3 shall nevertheless be responsible for all damages which may be caused to the highway by reason of the driving, operating or moving of any such vehicle, object or contrivance.

3.—(1) The municipal corporation or other authority having jurisdiction over the highway may, upon application in writing, grant a permit for the moving of heavy vehicles, loads, objects or structures in excess of a total weight of twelve and a half tons over said highway or for operating or moving over any such highway any vehicle, object or contrivance the weight of which resting upon the surface of said highway exceeds six hundred pounds upon any inch in width of tire, roller, wheel or other object.

(2) Such permit may be general or may limit the time and the particular highway which may be used, and may contain any special conditions or provisions which may be deemed necessary for the protection of said highway from injury.

4.—(1) No steam traction engine, with or without trailers, and no motor truck carrying a weight in excess of four tons, including the vehicle, shall be operated upon any such highway at a speed greater than fifteen miles an hour; and no such vehicle carrying a weight in excess of six tons, including the vehicle, shall be operated upon any such highway at a speed greater than six miles an hour when such vehicle is equipped with iron or steel tires, nor greater than twelve miles an hour when the vehicle is equipped with tires of hard rubber or other similar substance.

(2) The municipal corporation or other authority having jurisdiction over the highway may make regulations limiting any vehicle passing over a bridge to a speed not exceeding six miles an hour, provided that notice is posted up in a conspicuous place at each end of the bridge.

5. Any person who contravenes any of the provisions of this Act or any regulations made or permits granted under the authority thereof shall incur a penalty of not more than $100, recoverable under the Ontario Summary Convictions Act, which shall be paid to the municipal corporation or other authority having jurisdiction over the highway, and shall form a fund for the maintenance and repair of the highway.

6. Nothing in this Act shall affect the provisions of the Motor Vehicles Act or the Traction Engines Act.

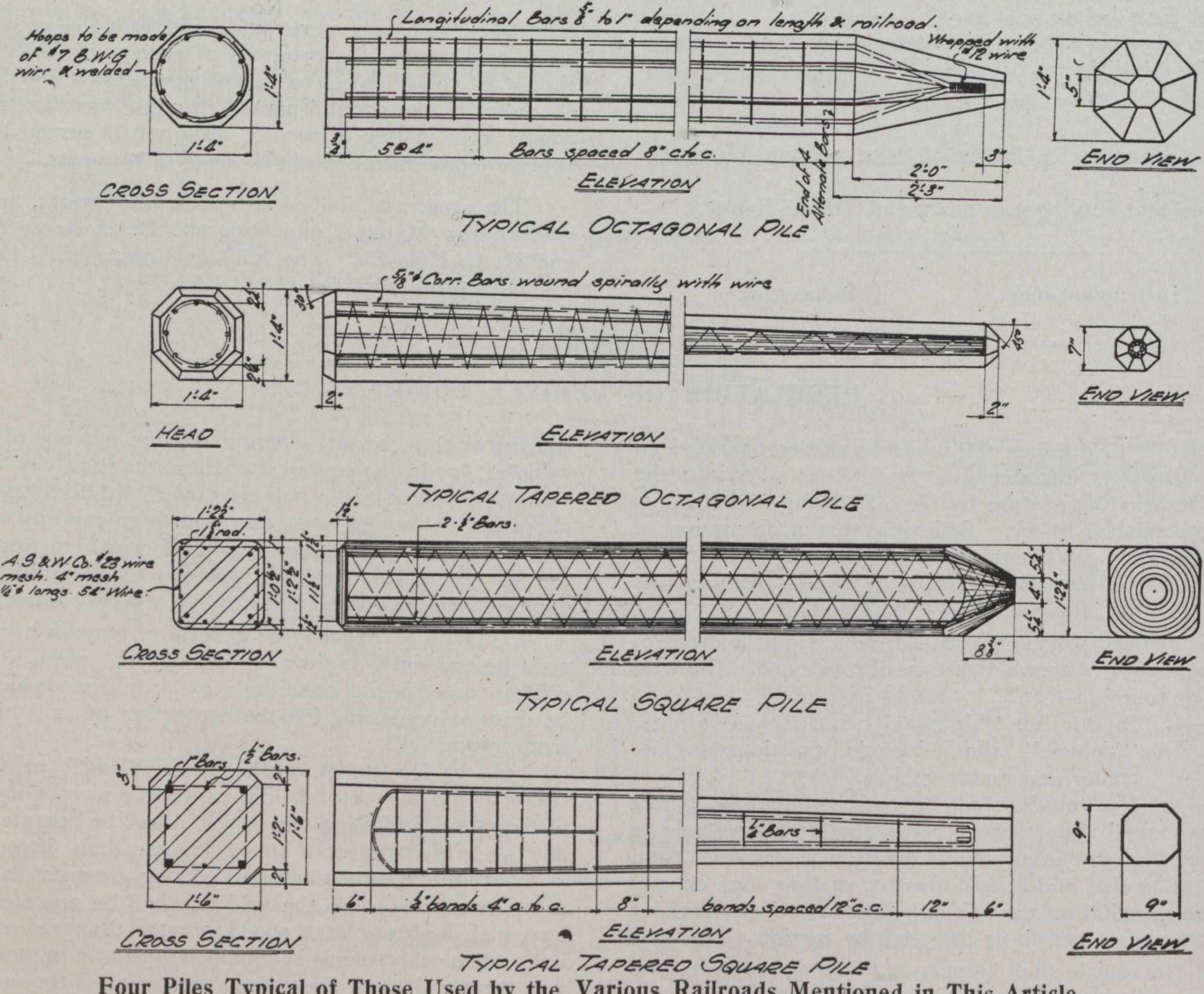
USE BY RAILROADS OF CONCRETE PILES.

THE Committee on Masonry of the American Railway Engineering Association presented a progress report at the annual meeting last month that provides some very useful data on the subject of concrete piling. Most of the information was derived from replies to circular letters, a summary of these replies appearing herewith in Tables I. and II. The following abstracts from the report will also be found of interest:—

The concrete piles generally used are of the reinforced type, though in several cases plain concrete piles have been used. They are usually of 16-in. short diameter, whether square or octagonal. The Santa Fe Railway Company vary the short diameter, using the formula D = 7 in. + ¼ in. L, where L equals length of pile in feet. The piles are used both tapered and straight section, the latter type being more commonly used.

A large variance is shown in the amount of steel reinforcement used, both longitudinal and transverse. The greater portion of the piles have ¼-in. rods for transverse reinforcement, whether spiralled or hooped. Steel mesh is used in a few cases and in one case additional steel reinforcement is used in the head of the pile. The Chicago, Burlington & Quincy Railroad is one of the roads that uses steel mesh for reinforcement.

The cost of the concrete piles at point of manufacture varies considerably; this is probably due in a large measure to the method of bookkeeping, or as to what is considered a proper charge against the actual cost of the piling; the number of piles manufactured and the available plant and labor for manufacturing the piles are also factors that may influence the cost. The variation in the cost per linear foot of pile as given in the attached table is also due to the use of different quantities of steel reinforcement, some roads using a design providing considerably more steel than others. For instance, the cross-sectional area of steel used by the Burlington runs 4.25 lbs. per linear foot, Illinois Central 12.5 lbs. per linear foot, and the Milwaukee 17.5 lbs. per linear foot.



Four Piles Typical of Those Used by the Various Railroads Mentioned in This Article.

The cost of driving the piles also varies considerably, but this should be expected, as the nature of the soil, the accessibility of the work, the traffic conditions and the number of piles driven at a given structure affect the cost of driving to a certain extent. Thirty-five cents per linear foot, however, seems to be a fair average cost under ordinary conditions. This cost includes handling costs, which vary from 10 to 12 cents per linear foot. Several of the answers indicate that it costs little more to drive concrete than wooden piling.

The general opinion seems to be that in cases where there is permanent moisture and no danger of future drying out, wooden piling is the cheaper; where the line of permanent moisture is low, concrete piling is the most economical.

No eastern railroads seem to have used concrete

(Continued on page 456.)

TABLE I.—Concrete Piling—Tabulation of Cost Data

Railroad	Cost of piling at point of manufacture per linear foot	Cost of handling per lin. ft.	Cost of driving per linear foot	Total cost in place per linear foot	Character of material through which driven	Remarks
Atchison, Topeka & Santa Fe	64c manufactured under contract at bridge site	32c for handling and driving		96c	Missouri river mud mixed with sand. Boulders near bed-rock	Contract provided free haul of material over company's lines. Cost of handling covers cost dragging pile from place moulded to place driven 40c to 50c per pile to cut off when not driven to grade
Baltimore & Ohio	$74\frac{9}{10}$c	$10\frac{1}{10}$c	$51\frac{7}{10}$c includes cost of driving and pulling steel. Steel approx. 5c per ft. of pile	\$1.36$\frac{7}{10}$	Strata of firm clay just below cut off line	Cost of making and handling based on 9,400 lin. ft. piling, which includes 125 ft. extra piling for breakage and 500 ft. driving heads. Cost of handling high because of special conditions. Driving based on 8,775 ft.
Canadian Pacific	$1.06	39c for handling and driving. Includes work train service		$1.45		
Chicago, Burlington & Quincy	35c per lin. foot including loading on cars		Cost of driving too variable to give cost unit			Experience is that it costs little or no more to drive concrete piles than wooden piles
Rock Island Lines	85c including cost of falsework as skidways and forms. 67c without above items		38½c	$1.23 including all expenses, except freight, $1.05½ without cost of forms, skidways and freight	Greater portion in Arkansas in sand fill. In Kansas and Oklahoma in natural ground 6 and 7 mos. same as hard pan	Driven with drop hammer which necessitated engine service and shifting of tracts to get to place where piling was to be driven
Illinois Central	66c	$12\frac{3}{10}$c for unloading	$20\frac{8}{10}$c	$99\frac{1}{10}$c		Average for 1,494 piles on Tenn. double track Max. penetration, 23 ft., max. length, 40 ft. Min. " 12 ft., min. " 20 ft. Average " 18 ft., aver. " 27 ft.
Northern Pacific	65c (Darling's letter) 69c (Burt's letter)		Cost of driving too variable to give fair estimate. 98c per lin. ft. average of 6,786 lin. ft. driven			
Chicago, Milwaukee & St. Paul	85c in yards where locomotive derrick can be used		On double track trestle not under traffic 204 piles at 39c			
Fort Worth & Denver City	58c to 78c. 60c a fair average		One job 4,278 lin ft. at cost of 77c			Cost of driving includes cost of unloading, train service, fuel, and work train expense
New York Central & Hudson River			Contractor record showed 10c actual driving cost	$1.38 to $1.60		
New York, New Haven & Hartford				Simplex piles cost 94c in place, average for 191 piles		
Penn. Lines (North-west System)			35c for 2,800 foundation piles and 2,200 piles for retaining walls			
Wheeling & Lake Erie	98c for material and labor		44-40 ft. piles for 29½c; 35-40 ft. piles for 28c. For scales 46 40 ft. piles 12½c			

TABLE II.—REPORTED USE OF

Railroad	For what purpose have these piles been used?	What type of re-inforcement is used?	How long was the piling allowed to cure before driving?	How was the piling driven?
Atchison, Topeka & Santa Fe Ry.	Foundations	Corrugated round bars, wrapped with wire	60 days	No. 2 Vulcan Steam Hammer with 1½ in. jet of water
Baltimore and Ohio System	"	Plain square rods and spiral hoops	Minimum, 38 days Maximum, 82 days Average, 60 days	6,000 lb. drop hammer of from 5 ft. to 20 ft. drop
Boston & Maine R.R.	Foundations for buildings		30 days	Water jet and hammer
Canadian Pacific Ry.	Re-inforced concrete trestles	Square twisted rods, longitudinal and circular	From 35 to 60 days	Steam hammer with specially designed protection block
Canadian Pacific Ry. (Western Lines)	Concrete trestles	Longitudinal and spiral wrapping	28 days minimum	Steam hammer
Chicago, Burlington & Quincy R.R.	All purposes for which piles are used	Corrugated bars and A.S. & W. Co's. No. 23 wire mesh	Minimum allowable time, 3 weeks	Steam and drop hammer
Chicago, Milwaukee & St. Paul Ry.	Concrete trestle to support rail walls in "U" abutments	Square ¾ in. deformed bars, longitudinal. ¼ in. spiral reinforcement	From 30 to 60 days	Both drop and steam hammer. Jet used in sand
Chicago Rock Island Lines	Foundations for bridges and buildings	Spiral wire and bars	From 30 to 40 days	Steam rubber cushion
Cleveland, Cincinnati, Chicago & St. Louis Ry.	Building foundations and various other foundations	Mesh and rods ½ in. rods	Chenowerth pile, 3 and 4 weeks	Chenowerth by drop hammer. Raymond piles by driving steel mandrel
Delaware & Hudson Co.	F'd'tion for new b'ld'g			Steam hammer
Delaware, Lackawanna & Western R.R.	Foundations	None	Poured in place mould	Shells driven, filled concrete "Simplex" method
Fort Worth & Denver City R.R.	Bridge bents	¾ in. twisted bars and Am. St. & W. Co's. 4 in. mesh	Minimum, 60 days	Steam hammer with cast iron cap. Handled like timber piles
Grand Trunk System	For elevators and shop foundations	None	Poured in place mould	"Simplex" method
Illinois Central R.R.	Concrete trestle bents and foundations		30 days	Steam hammer with water jet and without jet
Kansas City Terminal Ry.	Support of structures in any soil			Steam hammer
Louisville & Nashville R.R.	For found't'ns for bridge masonry and re-inforced concrete to wharf	Square twisted longitudinal and circular bars	Not less than 30 days	Drop hammer 3,500 lbs. Timber pilot pile used. Water jet and hammer
New York Central & Hudson River R.R.	Masonry foundations	System of bars including, skew re-inforcement "Raymond"	From 1 to 10 months. Average, 3 months	Drop hammer for Cummings pile. Steam hammer for Raymond
New York, New Haven & Hartford R.R.	For freight house foundations	None	Poured in mould	"Simplex" method
Northern Pacific Ry.	Re inforced concrete trestles and re-inforced bank blocks for ends of bridges in fill	Deformed bars	60 days, or more	Ordinary track and skid driver, 4,500 lb. hammer
Northern Pacific Ry.	Concrete trestle bents and ab't'm't found'tions	Round longitudinal rods and steel wire hoops	16 months	4,600 lb. hammer and water jet
Norfolk & Western Ry.	For work where timber would decay	Deformed bars longitudinal	Over 30 days	6 ton hammer, low drop
Pennsylvania Lines (Southwest System)	Foundations of b'ldings, retaining walls and bridges	Round rods with spiral hooping	30 days	Drop hammer for "Cummings" pile; steam for "Chenowerth"
Pennsylvania Lines (Northwest System)	Foundation dock retaining walls. Foundations of buildings	Round steel rods	30 days	Steam hammer
Pittsburg & Lake Erie Railroad	Foundations of masonry	Straight rods	30 days	"Simplex" method. Pre-moulded piles. Piles formed in place.
Southern Pacific Lines	Under piers for Los Alamos viaduct	No re-inforcement used. Double well casing filled with concrete		
Wheeling & Lake Erie Railroad	Foundation for scales and bridge abutments	Round rods and hoops 12 in. c. to c.	About 60 days	Both steam and drop hammer. Vulcan steam hammer

CONCRETE PILES BY RAILROADS

What percentage were broken in handling?	What percentage were broken in driving?	What was the cost per lin ft. of various types purchased, exclusive of freight?	What was the cost per lin. ft of those manu-f t'd by your company, exclusive of freight?	What was the cost of driving? (Give number driven, whether foundation or in bridge bent).	What length of piles were driven for foundations and bridge bents?	What is your opinion of the concrete pile for foundation work in bridge bents?
None	Few shattered heads when pile hit obstruction		Contract price, $0.64	Contract price, $0.33	30 ft. and 35 ft.	Favor concrete where permanent moisture is not assured
2%	78% shat'rd on top where no re-in-f'rc't was placed			Contract price in place, $1.35	Purchased in lengths of 30, 35, 40 and 42 feet	Experience on first structure encouraging
None	None. Easy driving through filling and mud	Rect. $1.09 for 19, $0.99 for 10. McArthur $0.60			Rect. pile, 12 to 14 ft. McArthur pile, aver. length 17 ft.	
"	None		$1.04 per lin. ft.	About $0.44 for 184 driven	From 27 to 35 ft.	
1%	"		$1.06 per lin. ft.	96 piles @ 36 ft. cost $0.39 per lin. ft.	From 27 to 36 ft.	O.K.
1%			$0.35 per lin. ft. ready to drive	About the same as timber pile	From 16 to 50 ft.	Should be used where timber might decay. Val'ble in b'dge bents
	Few heads shattered		Aver. cost, $0.85	204 piles, 30 to 35 ft., driven for $0.39	From 16 to 35 ft.	Desirable where there is danger of decay to timber pile
2% of rolled pile. None of moulded	5% of rolled pile. None of moulded		$0.85 per lin. ft.	$0.38½ by work train service. $0.28½, self propelled	From 20 to 30 ft.	Consider concrete piling a great saving
"	"	$0.90 to $1.10		$0.20 to $0.25	12 to 20 ft., Chenowerth. 25 to 40 ft., Raymond 25 ft.	Good in foundations
None	None	1400 piles @ $1.30 per lin. ft.		84 piles cost $4004.87 in place or $1.30 per lin. ft.	Average length 36 ft. 8 in. for 84 piles	
One	Less than 1%		$0.60 average per lin. ft.	4278 lin. ft. piling in bridge bents @ $0.77 per lin. ft.		Excellent for bridge bents
None	None			1632 piles cost $39543 or $1.14 per lin. ft.	21 ft. 3 in.	Very good
Less than 1%	Less than 2%	20 ft. @ $0.60; 25 ft. @ $0.649; 30 ft. @ $0.68; 35 ft. @ $0.40 and $0.80		$0.21 for driving. $0.12 for handling. 4000 piles used	Bridge bents, 20 to 40 ft. Foundations, 20 ft.	Favor concrete where part is above low water
				50,000 ft. @ $1.05. 50,000 ft. @ $1.00 100,000 ft. @ $0.95	From 18 to 30 ft.	Use in dry soil when more economical than spread footing
Negligible	Tops badly battered. Excess length provided ac'nt hard dr'v'g	No piles purchased	Cost shown on drawing G 11343 about $0.69	Cost of driving and jetting pile at Tennessee River, $12.00	From 25 to 45 ft.	Prefer timber pile when always wet
None	None broken, but 5% to 10% damaged on the head	Contract price in place from $1.38 to $1.60		$0.10 per lin. ft. from contractor's record	From 20 to 48 ft.	Use concrete where foundation is above ground water
"	None	"Simplex" pile cost $0.94 per lin. ft. in place, 1908			Longest, 38 ft. 10 in. Shortest, 22 ft. 10 in. Average, 30.74 ft.	Good opinion of Simplex pile 1906 and 1907
Very small number	Tops battered but no piles broken		About $0.65		Driven in lengths of 15, 20, 25 and 30 ft.	Economical for reinforced concrete trestles and bank blocks on high fills
None	A few battered on top		$0.69	6768 lin. ft. driven @ $0.98 per lin. ft.	From 16 to 25 ft.	Concrete good where c'd't'ns bad for timber
"	None	$2.00 per lin. ft. driven		Two 60 ft. piles per day at cost of $24	40 ft. and 60 ft.	Satisfactory results
10 out of 283 Cummings pile were b'k'n in handling	Cummings, 1.3%. No Chenowerth piles were br'k'n			500 Simplex @ $1.05. 384 " @ $1.38. 280 Chenowerth @ $1.50. 289 Cummings @ $1.32 to $1.46	From 12 to 56 ft.	All right for foundation work. Never used in bridge bents
None	1/5 of 1%	Dock pile $1.15 Elev'or w'k $1.25 Conway job $1.25		2800 @ $0.35. 2200 @ $0.35	Dock piles were 30, 40 and 50 ft., others 16 and 20 ft.	Very good for foundation work
"	None			Moulded in place, $0.80. Premoulded in place, $1.61¼	25 ft.	Good concrete pile O.K.
				Total cost in place, $0.91 per lin. ft.	Average 20 ft.	
None	About 50% of tops broken off		About $0.98	44-40 ft. piles @ $0.29½ 35-40 ft. " $0.28 46-40 ft. " $0.12½	40 ft.	Very satisfactory and economical

USE BY RAILROADS OF CONCRETE PILES.

(Continued from page 452.)

piling for bridge bents. Several of the western railroads have used concrete piling to a considerable extent and found it to be good and permanent construction.

In many cases, concrete piling has been used for supporting small abutments, where placed on embankments, as this type of construction is more economical on account of the saving in the cost of expensive high abutments.

CREOSOTED WOOD BLOCK PAVEMENTS.*

By Andrew F. Macallum, B.A.Sc., C.E.,
City Engineer, Hamilton, Ont.

FOR fifty or sixty years before wood blocks were subject to treatment many pavements were laid in the United States and Canada for roadways and sidewalks. In this country mostly round cedar blocks were used, although the north sidewalk of King Steet East, Toronto, Ont., was paved with a patented block, known as the Nicholson pavement. These pavements, while satisfactory for a year or two, soon decayed, and in a comparatively short time were removed. In most of these pavements little care was taken in laying or in the preparation of the foundation, which was generally plank laid upon the natural ground. After years of repeated failures attention was directed to the use of preservatives, which, in the first experiments made, consisted in placing thoroughly dried blocks in a bath of creosote heated to a temperature of about 210° F., until about three pounds per cubic foot of creosote was absorbed. While these pavements were fairly successful, it was soon realized that the best results could not be secured by dipping the blocks, and the blocks were then treated with creosote under pressure until they absorbed from ten to twelve pounds of oil per cubic foot. Such a pavement, laid in Indianapolis in 1898, gave such good results that city engineers began to appreciate the possibilities of treated wooden blocks and better results were obtained.

On Tremont Street, in Boston, a wood block pavement, treated with creo-resinate process, composed of one-half creosote oil and one-half resin, was laid in 1898. The writer saw this pavement last October, and it was still in good condition after sixteen years of heavy traffic.

A small piece of similarly treated wood block was laid on the west side of Yonge Street, at Front Street, opposite the head office of the Bank of Montreal, in 1896, and was still in good condition when taken up for a new pavement about two years ago. The writer also examined such pavements in New York on Church and Warren Streets after they had been in use for nine years under the heaviest kind of traffic, and they were still in good condition. In the city of Hamilton probably more treated wood block pavements have been laid than in any other city in Canada, and the first pavements laid in 1909 are as good as when laid, and, although subject to the heaviest traffic in that manufacturing city, have not to date cost a cent for maintenance.

These examples, which I have mentioned, are but a few of the numerous examples showing permanence and suitability of this form of pavement for streets carrying heavy traffic.

I may say that it has also been laid on residential streets, where the residents assume its greater cost as compared to asphalt for the added comfort through its quietness under traffic.

The wood principally used has been long-leaf (yellow) Southern pine, which from experience has been found to give excellent results. Most specifications now, however, admit Norway pine and tamarac and white birch as a result of experimental pavements laid in Minneapolis, which showed the suitability of these woods. No doubt other species of wood make satisfactory pavements, but on account of the incomplete knowledge of their value city engineers, as a rule, prefer a wood that has proved satisfactory.

The blocks are from three to four inches wide and vary in depth from three to four and one-half inches, with a length of from five to ten inches. As for all timber specifications, the blocks should be sound, free from large or loose knots, shakes, worm-holes and other similar defects. As to the proportion of sap and heart wood, the present specifications are not very rigid, as experience has shown that treated blocks having both sapwood and heartwood do not vary in their wearing qualities.

The preservative used is a creosote oil having a specific gravity of from 1.08 to 1.14, containing a percentage of tar, free from carbon. Coal tar oils are used in preference to water gas creosote, as sufficient experiments have not yet been carried out with the water gas creosote to determine its relative value.

The writer has been corresponding with a number of city engineers with a view of obtaining opinion as to the most satisfactory amount of treatment required per cubic foot of block, according to the experience of each city, and in replies from twenty cities in the United States has ascertained that six of these cities use 16 pounds, two of them 18 pounds, and twelve of them 20 pounds, depending to some extent on local conditions.

Laying the Pavement.—The base for wood block pavements should be of concrete, from five to six inches deep, having the crown parallel to the finished crown on the blocks. An uneven or irregular base is detrimental to any pavement, as it is liable to cause a depression in the surface to hold water, which the repeated impacts of wagon wheels is certain to increase, giving an uneven surface. Upon this concrete base is placed either a sand or mortar cushion. This cushion is usually one inch deep, and has its surface struck by templates to a surface parallel to the contour of the finished pavement. Where sand is used, the sand is such that it will all pass through a quarter-inch screen, besides being clean. If a mortar cushion be used, some engineers use a proportion of one of cement to three of clean sand, to which sufficient water is added to insure the proper setting of the cement. Other engineers obtain good results by mixing and placing the cement and sand dry. This cushion is simply a means of securing a uniform surface for the blocks to rest upon and distribute the load. Alongside or between street car tracks, however, or on grades, sand cushions are apt to become uneven or flow, caused by the vibration of the rails, or by water getting in alongside the rails, so that under these circumstances a concrete cushion should be used. Away from the car tracks the question of whether a sand or mortar cushion should be used is a matter of opinion. Sand gives a better cushioning effect and the blocks do not have to be rolled so soon after laying as when a mortar cushion is used.

English and French practice does away with this cushion altogether, but the concrete base is finished off

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* Read on March 26th at the Canadian and International Good Roads Convention, Toronto.

as smooth as a concrete sidewalk and to the exact contour of the surface of the pavement. This extra care and workmanship obtain results that are excellent, inasmuch as the finished surface of the blocks has no depression, and consequently the wheels cause no impacts.

In most cities it is not possible to lay the blocks shortly after coming out of the treating plant, and the hot sun and wind during shipment and before laying is apt to check the blocks and cause oil to exude. The blocks should be piled closely when delivered on the street and sprinkled before laying.

Generally, the blocks are laid at right angles with the curbs, with an expansion joint at each curb of from three-quarters to an inch and a half, according to the width of the pavement. Alongside the curbs three rows of block are laid parallel to the curbs, with the expansion joint next to the curb. Placing a longitudinal row of blocks, with an expansion joint, on each side is sometimes done, but is not good practice, as the single row of blocks between the joints will almost certainly rise up about the level of the adjoining pavement as the joints close up. Cross expansion joints have been used also by the writer when the treated block used had been piled on a street for several months, but for fresh blocks, properly treated, they are not necessary on streets of heavy traffic. On streets of light traffic, however, there should be cross expansion joints, placed from thirty to fifty feet apart and having a width of about three-quarters of an inch. It is hardly necessary to say that the blocks should be laid with the grain vertical and having the joints in adjacent rows, broken by a lap of about two inches. The blocks should be laid neither too loose nor too tight, so that a block can be raised without disturbing the surrounding blocks, or one-eighth of an inch apart. After the pavement is laid it should be rolled thoroughly with a roller varying from three to five tons until a perfect surface has been secured, with no depressions and the blocks firmly in place. There should be no difficulty in this, as the usual specification for blocks allows of a variation of but one-sixteenth of an inch in depth, so that if the foundation and cushion have been properly laid there is usually very little trouble about depth of the blocks.

Alongside street railway tracks and about manholes special care should be taken in laying the blocks. It is usual in such cases to thicken the cushion so that the blocks shall be about one-quarter of an inch above the wearing surface of the rail or cover, and in a very short time the traffic will rub these blocks down to the level of the rail. Alongside rails, to prevent water flowing down and under the blocks, two methods are used: one is to place a specially cut creosoted plank under the rail to give a vertical surface against which the blocks are paved, and the second and usual method is to plaster the web with a rich mixture of sand and cement to the width of the rail-head, and the blocks are then laid against this. As with other pavements it has been found that the girder lip-rail is more satisfactory than the ordinary tee-rail, unfortunately in use in most towns, for the permanence of the block on the inside or gauge side of the rail. Incidentally, it may be said that no pavement will be satisfactory alongside a street railway track if the rails lack sufficient weight, stiffness and foundation to prevent movement, especially at the joints.

There is diversity of opinion among engineers as to the best joint filler to be used. The American Society of Municipal Improvements recommend a suitable bituminous filler when the blocks are laid upon a sand cushion and a sand filler when laid on a mortar cushion. It is claimed for the bituminous filler, which fills the joints between the blocks two-thirds their depth (the remaining depth filled with sand), that it makes an absolutely waterproof pavement, and that it eliminates all expansion difficulties, as each block is surrounded with an individual expansion joint. Unless the filler is a suitable asphaltic cement, with a high melting point and low penetration, there is apt to be a sticky surplus left on the surface. This filler will cost about 15 cents a square yard more than a sand filler.

A cement grout filler has been used, but unless the traffic can be kept off the pavement for at least ten days it is little superior to a sand filler.

The sand filler is generally used on streets of heavy traffic, the sand being coarse and sharp grained, and preferably heated before placing. The writer has used with excellent results a bituminous filler between and one foot outside of street railway tracks and a sand filler for streets. From results obtained he does not consider the extra expense in using bituminous filler justified for such streets unless the traffic be very light. On bridge floors it is better practice to use a bituminous filler with the blocks. After the pavement is rolled sand to the depth of about half an inch is spread over the surface and the street is thrown open to traffic.

This method of construction is satisfactory up to a three per cent. grade, beyond which the blocks are laid in a different manner. The crown should be as light as possible, being just sufficient to shed the water freely, which applies also to the pavements between street railway tracks.

When the grade of the street exceeds three per cent. a creosoted lath is inserted between each cross-row of blocks to leave a space of about ⅜ of an inch. The lath fills this space practically for two-thirds of the depth of the block and a bituminous filler is used. This method of laying the blocks forms a good foothold for horses, and is satisfactory up to and including a six per cent. grade.

One of the criticisms made of treated wood block pavements is that it is slippery, but in the writer's experience he has found that there is very little difference between these blocks and sheet asphalt pavements. When covered with a light frost or snow, or when the weather is foggy and damp, the pavement may become objectionably slippery.

In traffic observations made at Philadelphia, New York and other cities the evidence shown by the engineer at these places indicated that where treated wooden block and granite blocks were on parallel streets 70 per cent. of the teaming went on the wooden block.

On Stuart Street, in the city of Hamilton, the writer laid treated wooden blocks between the street car rails and granite block between the outside rails and curbs, the pavement being on a five per cent. grade. Although most of the traffic was of a heavy teaming nature, it was found that fully 80 per cent. of the traffic, except on wet days, was on the wooden block.

The first cost of wood block pavement is undoubtedly higher than that of most of the other paving materials, averaging in the city of Hamilton from $2.85 to $3.00 per square yard, exclusive of grading. When its cheapness of maintenance, ease of cleaning, low tractive resistance and durability are taken into consideration, this pavement, with its relatively high first cost, will compare favorably and prove ultimately cheaper than one lower in first cost.

THE DESIGN OF REINFORCED CONCRETE T-BEAMS.

By E. G. W. Montgomery,
Bridges Branch, Department of Highways, Saskatchewan.

To those who are called upon to design reinforced concrete T-beams, it is hoped the following simple, yet accurate, method will commend itself. It is equally applicable to the design of important or unimportant beams, and needs no elaborate tables to help out its findings.

Without going into reasons in this brief treatment of the subject, it might be stated that to commence the design of a T-beam by assuming a width of flange, is to begin wrongly. It will presently be shown that the ratio of width of flange to width of stem, being dependent on

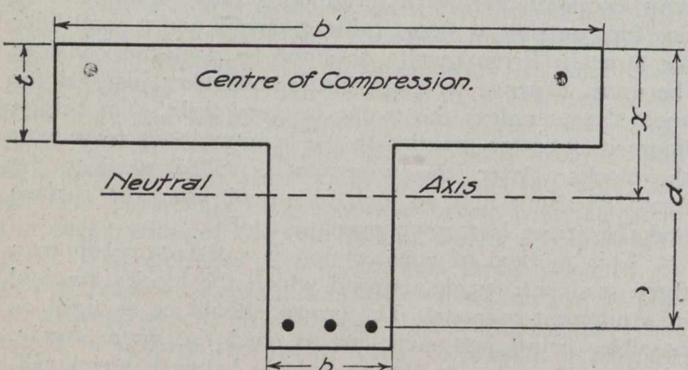

Fig. 1.

the position of the centre of compression, can be (as it ought to be) directly derived from a consideration of that position. The actual dimensions are then obtained in two short steps.

Beginning, then, by predetermining the position of the centre of compression, a short and simple procedure leads to a T-section that is equally strong in tension and compression—a section in which the stresses remain as originally assumed.

In the following equations the position of the centre of compression is measured from the top of the slab, and the equations are general for any T-section.

1. When centre of compression is at $\frac{2}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 6t)}{t^2(4t - 3x)} \quad \text{- - - and ``}t\text{''}$$

must lie between $\frac{3}{4}x$ and $\frac{5}{6}x$ - - - (1)

2. When centre of compression is at $\frac{1}{2}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(2x - 3t)}{t^3} \quad \text{- - - and ``}t\text{''}$$

must be less than $\frac{2}{3}x$ - - - - (2)

3. When centre of compression is at $\frac{3}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 9t)}{t^2(t + 3x)} \quad \text{- - - and ``}t\text{''}$$

must be less than $\frac{5}{9}x$ - - - - (3)

4. When centre of compression is at $\frac{4}{5}t$

$$\frac{b^1}{b} = 1 + \frac{x^2(5x - 12t)}{t^2(9x - 2t)} \quad \text{- - - and ``}t\text{''}$$

must be less than $\frac{5}{12}x$ - - - - (4)

When the centre of compression lies somewhere between $\frac{1}{5}t$ and $\frac{2}{5}t$, the neutral axis falls within the slab, and the design for a simple beam obtains. Such a section would have practical value only for small beams.

Equivalent area under compression =

$$A_c = bx + \left[t\,(b^1 - b)\left(2 - \frac{t}{x}\right)\right] \quad \text{- - - (5)}$$

$$B.M. = M.R. = \frac{A_c \times f_c}{2} \times \text{lever arm} \quad \text{- - (6)}$$

$$A_s = \frac{A_c \times f_c}{2 f_s} = \frac{B.M.}{f_s \times \text{lever arm}} \quad \text{- - - (7)}$$

$$b \times d \geqq \frac{\text{Max. Shear}}{120} \quad \text{- - - - - (8)}$$

To illustrate the method of treatment, suppose it be required to design a T-section for a bending moment of

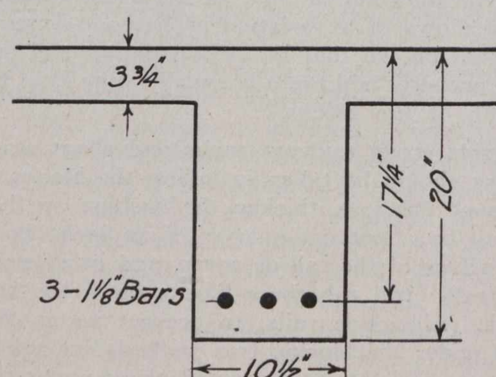

Fig. 2.

722,000 in.-lbs. and maximum shear of 19,000 lbs.—the further data being: Span = 19 feet; spacing = 6 feet; slab = 3¾ in.; f_c = 650 lbs.; f_s = 16,000 lbs. (The example is taken from second edition "Taylor & Thompson, etc.," *vide* pp. 469 and 470.)

Commence by locating the centre of compression at, say, $\frac{t}{2}$. Then from equation (2) x must be greater than $\frac{3}{2}t$.

Assume $x = 6.5''$, then $d = 17.167''$ and lever arm = $17.167'' - \frac{3\frac{3}{4}''}{2} = 15.292''$.

Substituting values of x and t in equation (2), $\frac{b^1}{b} =$

$$1 + \frac{6.5^2 (13 - 11.25)}{(3\frac{3}{4})^3} = 2.4; \text{ therefore } b^1 = 2.4b.$$

Substituting values in equation (5)

$$A_c = 6.5b + [3.75 (2.4b - b) (2 - \frac{3.75}{6.5})] = 13.971 b.$$

Substituting in equation (6)

$$722{,}000 = \frac{13.971 b \times 650 \times 15.292}{2}$$

whence $b = 10.398''$ and $b^1 = 24.955''$.

Now, if b^1, as derived, is permissible, having regard to span and spacing; and if b provides a stem sufficiently strong in shear, then the section is acceptable and may be completed by solving for A_s. If both conditions are not satisfied, the trial must be repeated with a new value for x.

The dimensions derived above satisfy conditions, and the completed section might be as shown in Fig. 2.

THE LOW COST ROAD.*

By Philip P. Sharples, New York City.

THE road problem should be considered from rather a broad standpoint. We have a problem; we wish to know what is the most economical road to build in any one situation. It is not an easy, but a very difficult problem, one that has many ramifications. Not only must we think of the exact economical situation, but we must think of the social aspect of the situation, as road builders are rather apt to neglect it on the whole. It is, however, a very important consideration. In addition to hauling our goods to market, and doing it in a way to bring biggest returns, we also must consider our wives and children. The road should, therefore, so provide for them that they can have easy intercourse with their neighbors, so that they can go to school easily, and get some little enjoyment out of life as well as bare existence. In considering the road problem, therefore, we should take this social aspect into consideration, and oft times build a little higher class road than we otherwise would, from a pure economy standpoint.

We wish ultimately to have roads over which we can travel during every month of the year in any kind of vehicle that may be good for that season, and to do this—as a general rule—we must choose a little bit higher type road than would suit the bare necessities of the case. When we come to choosing the type, we have quite a large range to choose from. From a cost standpoint we start with the dirt road which can be put in shape and kept passible for as little expenditure as $10 or $12 per mile per year; then we have the gravel road, costing to build about $1,200 a mile; then we take quite a jump to the macadam road, which costs about $7,500, and the tar macadam at $9,500. Then there is also the concrete road which would cost us perhaps $14,000 to $16,000 per mile, or, with a 2-in. bituminous top on it, $18,000 to $20,000 per mile; then we have the brick road, costing perhaps $25,000 per mile, or thereabouts. These figures are very general, but what I want to illustrate is that we have a series of roads for which we can pay almost anything we wish. We have a wide range, but must choose the one particularly suited to the conditions to be provided for. We must look at the use the road is going to be put to, the amount of money we have to spend, and also the amount of money we can get to maintain the road. In choosing along this wide range we want to keep down the cost of the roads as much as possible, and choose as low a type as will do the work we want to do.

*Delivered at the Road Convention at the Manitoba Agricultural College, March 5, 1915.

It is a great mistake, economically, to choose a type of road that is better than we need for the purpose. It it a little hard to illustrate this point without going to extremes. In New England temporary roads are built for hauling logs out of the woods in winter time, and perhaps the road will only be used one winter. Naturally not much money can be spent on it. On the other end of the scale let us take the main street of a very large city, say the approach to the Brooklyn Bridge in New York City. That thoroughfare receives perhaps more travel than any other in the United States, and it would be economy to build the very best type of pavement regardless of cost. These are the two ends of the problem, and any local engineer must choose a road somewhere between those two types.

In this country, you must choose the low types very often, but it pays to put in the best of the type and to provide for excellent maintenance. It is a great mistake to neglect the low cost roads. It often leads to extravagance in the community. I have seen districts where high cost roads have been built just because the low cost roads were not properly maintained. The low cost roads, kept in condition, would have answered the needs of the community and as a greater mileage could be built and maintained than with the high cost section built, the whole community would have been better off.

It is not to be expected that such a community will take care of the high cost road. In a few years the wreck of the high cost section will probably, for the sake of a little maintenance, be on a par with the other poor roads.

Instead of stepping on to the next high cost road, it often pays to put more maintenance on the next lower type. For instance, instead of building a gravel road you could get along with a dirt road, if you kept it in good shape, and you are able to keep a good many miles of dirt road for what it would cost to put in a gravel road. Perhaps where a macadam road would be useful you could put in a gravel road and keep it up well, and make it answer.

In the same way a macadam or tar macadam properly maintained will do the work of the high cost roads. It is necessary, however, to provide for the proper maintenance of whatever type is chosen. This I realize more and more as I look at the road problem throughout this country, and as I have seen it in France, England and Scotland. Over abroad this subject of maintenance has been more thoroughly learned and they appropriate money for it rather freely. In England, for instance, it costs them $600 to $700 a mile for maintenance of macadam roads. In this country you do not find many places where they appropriate money for road maintenance freely. It is now being done in Massachusetts. It is necessary, with the new style of traffic, to spend considerable money in upkeep in order to make macadam roads resist. In Massachusetts, macadam roads require annual maintenance somewhere along $600 per mile per year, or about the same as in England for the same traffic.

Gravel roads can be made and maintained cheaper where they can be used, but traffic conditions in the above

State have changed so that it is absolutely necessary to build these higher type roads to hold up under the traffic. You will find by and by, even in Manitoba, that you must step up to the higher type whether you want to or not.

A great mistake is being too often made in not providing for maintenance. It seems to me folly to provide money for local road improvements and turn them over to some body without instructions for annual maintenance. The principle laid down yesterday, that maintenance should not be taken care of out of debenture funds is absolutely correct. It should not be; but, at the same time, it seems to me that a province investing in roads should make provision out of the annual tax levy to provide an annual maintenance fund. In most of the progressive states now a good part of this maintenance fund is provided in some form of wheel tax. The automobiles are getting the brunt of it. In Massachusetts about $500,000 is raised from automobiles through registration or license fees, and while automobilists object very strenuously to a special tax, they do not object to a tax to be applied to the upkeep of the roads. This provides an easy way of getting maintenance money, and the people who have to pay seem to do so very cheerfully when they know it is to be applied to the roads and used economically. If the tax is not raised in that way, it has to be raised in some other way. To make the auto pay for upkeep seems to be a cheerful way out of the difficulty.

The personal equation in road work is a very great one; and too much attention cannot be paid to securing good men for good road work. Live men who attend road conventions, who take every means to learn their business and take pride in the local roads, should be obtained. The engineering part of the question must receive more and more attention, as we go up the scale of roads. Certainly the problems are becoming more difficult, and it takes more technical training to understand the new problems. Old engineers have had new problems confront them, and have begun, as it were, to go to school again; these conventions are a good thing. You learn a lot, and also run up against other men at work on the same problems as yourselves. The mere exchange of ideas is worth all the trouble and cost of the road school. You meet the man across the way on an equal footing and can talk your problems over to much better advantage. We must work together, and the more we can exchange ideas and get on to the little kinks of our neighbors, and give ours, the easier the whole problem becomes.

INTERNATIONAL ENGINEERING CONGRESS.

Members of various American engineering societies taking part in the International Engineering Congress to be held in San Francisco, September 20-25, 1915, will be interested to note that the following headquarters have been selected:—The headquarters of the American Society of Civil Engineers, and of the American Institute of Electrical Engineers, will be at the St. Francis Hotel. The American Society of Mechanical Engineers will be at the Clift Hotel, and the American Institute of Mining Engineers, at the Bellevue.

The Grand Trunk Pacific Railway has announced that contracts have been let and other arrangements made for the installation of crude oil as locomotive fuel on their passenger engines to be operated between Prince Rupert, B.C., and Jasper, Alta., a distance of 718 miles. It is expected that this installation will be complete by next June. The announcement does not cover the use of oil-burners on freight engines, it is understood that these will continue to use coal, at least for the present.

CONCRETE BALLASTED DECK CONSTRUCTION OF RAILWAY VIADUCTS.

THE use of concrete ballasted decks on steel railway bridges has extended during recent years to structures of considerable size. Several viaducts on the new line of the Chicago, Milwaukee and St. Paul through Montana, as well as others on the Santa Fe, Illinois Central and Burlington, bring the subject of solid floor bridge construction prominently to the attention of railway engineers. The "Railway Age Gazette," in commenting upon this feature of construction, to be found most frequently in the middle west, traces in an interesting way its development since the origin of solid floor construction in Chicago about 10 years ago, when it was employed for track elevation subways. According to the account, it was, in that instance, necessary to construct solid floors to prevent moisture from seeping through the bridge to the street below. The heavy cost of maintenance, the special track construction required and the noise created by the shallow steel floors first used, led to the adoption of concrete slabs carrying the ballast and standard track construction. A similar development was also brought about near this time by the necessity for greater protection of timber bridges from fire, leading the Santa Fe, the Rock Island, and other roads to apply creosoted timber ballasted decks to these structures. The resulting uniformity of track construction and more satisfactory riding qualities soon led to the adoption of the same type of deck on other structures.

The choice between creosoted timber and concrete ballasted decks is purely an economic one. On roads such as the Santa Fe, passing through large timber areas and possessing extensive treating facilities, the timber deck is somewhat cheaper, although the difference is not great. The difference in weight is also not a material factor. Therefore, on roads not accessible to a suitable supply of timber or without treating facilities, a concrete deck is as economical as creosoted timber at the present time, and its relative economy will increase materially with the rising cost of timber.

Confined at first to track elevation, subways and other short spans, the use of the solid floor has been extended gradually until the St. Paul, the Santa Fe, and several other roads have made this standard for all deck girder structures and are applying it on many through and deck spans of medium length. The St. Paul has placed such a deck on several 135-ft. deck girder spans and on deck truss spans 160 ft. long. While not important for short spans, the increased dead load resulting from the solid floor becomes of greater consequence as the length of span is increased. However, the advantages of the solid floor are resulting in a general increase in the length of spans to which this type of floor is being applied. The Santa Fe is placing a creosoted timber ballasted deck on spans 306 ft. long in its bridge crossing the Missouri River at Sibley, Mo., and the New York Connecting Railroad is using concrete ballasted deck on the entire elevated section of its four-track line nearly 10 miles long, including the Hell Gate arch with a span of 1,000 ft.

With the concrete ballasted deck built in units, several difficulties are presented to the designer. In the first place, when casting a large number of slabs in forms it is very difficult to insure exact uniformity of dimensions. Any error in the forms becomes cumulative and noticeable when multiplied in a number of slabs. The joints between the different slabs have not been waterproofed in any way and there has been some fear that with the moisture and fine particles of ballast dropping down between the slabs onto the upper flanges of the girders there would be some deterioration of the girders. However, a recent examination of one of the earliest structures of this type which has been in service for seven years, failed to reveal grounds for any serious fear from this source. Another problem which has been given attention has been the tendency for the individual slabs to creep or move longitudinally along the structure. While this movement has been minor, it has been noticed in several structures. To prevent this, a recent design of the St. Paul provides for a spacing angle to be riveted to the upper flange of the girder in the field with one leg extending between the adjacent slabs. These, however, are minor details of design which do not affect the practicability of the solid floor deck as a whole.

Several advantages are derived from this type of construction. Probably the most important is that of economy in maintenance cost. With the open floor replaced by the standard ballasted track construction, it is estimated that the cost of maintenance per foot of track on the bridges is reduced one-half. At the same time, a better line and a uniform riding track are secured, while the more or less pronounced jar resulting from passing from one form of track construction to another at the ends of open floor bridges is eliminated. Also, a ballasted deck rides as quietly as the adjacent embankment, while the track may be maintained by the regular track forces without the necessity of calling a bridge gang from time to time. A further advantage which may be considered sentimental, but which is present, nevertheless, is the appearance of added strength which the solid floor gives to the layman.

WORLD'S COPPER PRODUCTION, 1845-1914.

The production of copper in the world for the 69 years from 1845 to 1914 is given in the following table. The figures are in long tons of 2,240 lbs.:—

Year.		Production.	Year.		Production.
1845-1879	......	1,587,540	1897	......	398,955
1880	......	153,959	1898	......	429,156
1881	......	163,369	1899	......	469,309
1882	......	181,622	1900	......	487,331
1883	......	199,406	1901	......	511,279
1884	......	220,249	1902	......	542,293
1885	......	225,592	1903	......	589,628
1886	......	217,986	1904	......	650,474
1887	......	223,798	1905	......	701,252
1888	......	258,026	1906	......	712,000
1889	......	261,205	1907	......	710,000
1890	......	269,615	1908	......	727,321
1891	......	278,917	1909	......	825,178
1892	......	310,683	1910	......	855,000
1893	......	303,250	1911	......	895,150
1894	......	321,163	1912	......	1,010,725
1895	......	334,565	1913	......	1,003,227
1896	......	373,361	1914	......	917,131

For the past 20 years the United States has furnished about 55 per cent. of this production.

MAGNETIC PROPERTIES OF ALLOY STEELS.

In the proceedings of the American Society for Testing Materials appears a paper by J. A. Matthews, in which it is shown that the magnetic properties of hardened alloy steels vary with the physical characteristics of the metal. Alloys hardened by quenching in oil give a lower permeability and residual magnetism but a higher coercive force than those quenched in water. The size of the cross-section of the metal also has an influence, varying according to the hardness of the metal.

GOVERNMENT WHARF AT VANCOUVER.

THE Department of Public Works, Canada, has under construction at Vancouver a wharf, some of the details of which are illustrated and described below.

The works in connection with its construction include lines of timber cribs, sheathed with reinforced concrete, and filled with stone ballast. The superstructure is of concrete. Its length is 800 ft. and its width 300 ft. At the shore end of the wharf are two bulkheads of timber cribwork similarly faced with reinforced concrete, and supporting a mass concrete superstructure. The cribs will be placed upon a foundation consisting of layers of rubble and broken stone and the two lines of cribs will be filled in to the level of the coping of the concrete superstructure, and at the back of the bulkheads to the railway right-of-way, as shown in Fig. 1. The work involves excavation in earth and rock to a depth of 36 ft. over the area covered by the cribs, and to a depth of 35 ft. over the slips at each side of the wharf. The total quantity of

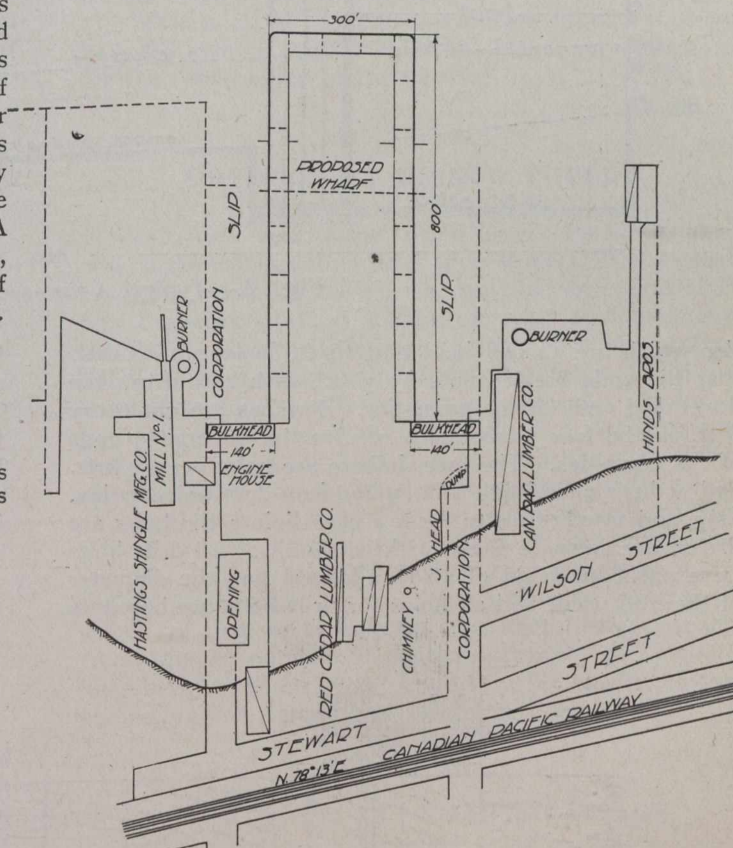

Fig. 1.—Location of New Wharf and Bulkheads.

rock excavation is approximately 108,000 cu. yds. Of this quantity about 100,000 cu. yds. will be used as ballast for cribs and foundations. When completed, the coping of the wharf will be 22 ft. above datum.

The sides and outer end of the wharf are built of timber cribs, each about 100 ft. long, 37 ft. wide and 39 ft. high, so that, after sinking, their top will be 4 ft. above low water spring tide. The specifications recommend their construction in a floating dry dock, or a scow without deck, to such a height that they may be launched and floated. When fully constructed to a height of 10 ft. with the concrete sheathing, it is estimated that the cribs will draw about 7 ft. of water, ballasted to float level. It is intended that one or two chambers of the cribs be left empty to permit dewatering, should conditions necessitate.

The timber bottom floor will have its joints caulked to insure watertightness. British Columbia fir or spruce will be used in the crib construction.

The platforms upon which the cribs will be constructed consist of 18 x 12-inch timbers, 39 ft. 3 ins. long, bolted horizontally to each other every 3 ft. with 1-inch round drift bolts 24 ins. long. The platforms will be supported on blocks at sufficient height to permit of bolting, etc. The platforms are to be watertight.

According to the design adopted, the face and end timbers are 12 x 12 ins. (with the exception of the lower tier which are 12 x 18 ins.) and 26 ft. in length, laid so that the ends break joints by 5 ft., with 2 ft. from the dovetailed ends of the cross-ties. Notches are cut every 8 ft. in the face timbers, to receive the dovetailed ends of the cross-ties. The face timbers are bolted every 8 ft. and at both ends, with 1-in. round iron drift bolts 27 ins. long and fitted so as to form a close joint; the bolts are driven on alternate sides of the dovetails. All drift bolts have upset heads 3/8 of an inch larger than the diameter of the iron used, and all holes for drift bolts are bored 1/8 of an inch smaller than the size of the iron used. The two bottom tiers of face timbers are further secured every 8 ft. to the bottom platform with 1-in. iron machine bolts.

The cross-ties are of square timber 12 x 12 ins., 38 ft. 6 ins. long, in one piece, and with the exception of the first top pier, which is placed 4 ft. apart, c. to c., the cross-ties are placed 8 ft. apart, c. to c. The ends of the cross-ties passing through the face timbers have dovetails 9 x 12 ins. at the throat, and splaying 1½ in 12 on the sides. They project 12 inches out from the outer face of the cribs and 6 ins. from the inner face.

The cross-ties are bolted, at each intersection with the longitudinals ties, with 1-in. round iron drift bolts 24 ins. long. The first bottom tier of cross-ties are bolted to the bottom platform with 1-in. screw bolts, 45 ins. long.

The longitudinals are of square timber 12 x 12 ins. and 25 ft. 6 ins. long, spliced with a half lap 18 ins. long, all splices being made on a cross-tie. The longitudinals passing through the end timbers of the cribs are dovetailed for the cross-ties and project 6 ins. from the end faces. The first bottom longitudinal is bolted at every two feet to the platform with 1-in. drift bolts 24 ins. long.

The spaces between each tier of all the cross-ties is to be filled with pieces of timber 12 x 12 ins., the ends butting closely against the longitudinals so as to form a solid timber wall; all the filling pieces are bolted with ¾-in. round iron drift bolts 24 ins. long, driven 1 ft. from each end.

Vertical posts 12 x 12 ins., are placed at the angles formed by the intersection of every second row of cross-ties with the longitudinals and at every angle formed by the cross-ties and outer face timbers. The posts are frequently in two lengths, spliced with a half lap 2 ft. long and two machine bolts 1-in. diameter. The posts are fastened to every second tier of face timbers with 1-in. machine eye-bolts, and to every third cross-tie and longitudinal with 1-in. machine bolts, the eye-bolts serving also as anchors for the reinforcing steel rods.

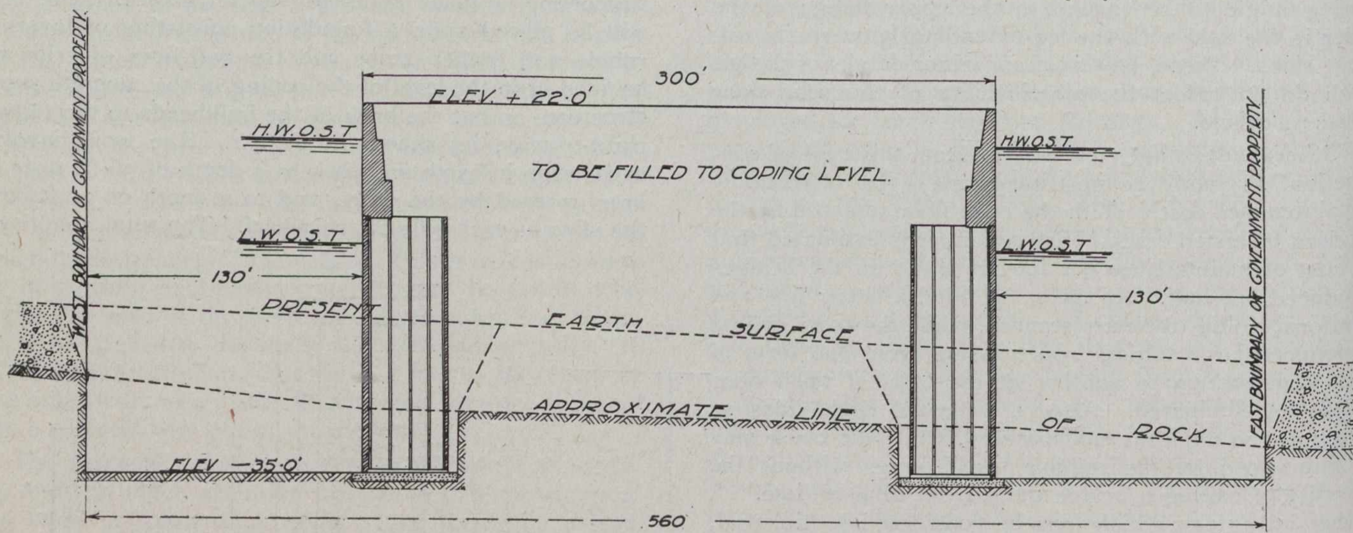

Fig. 2.—Typical Cross-section of Wharf.

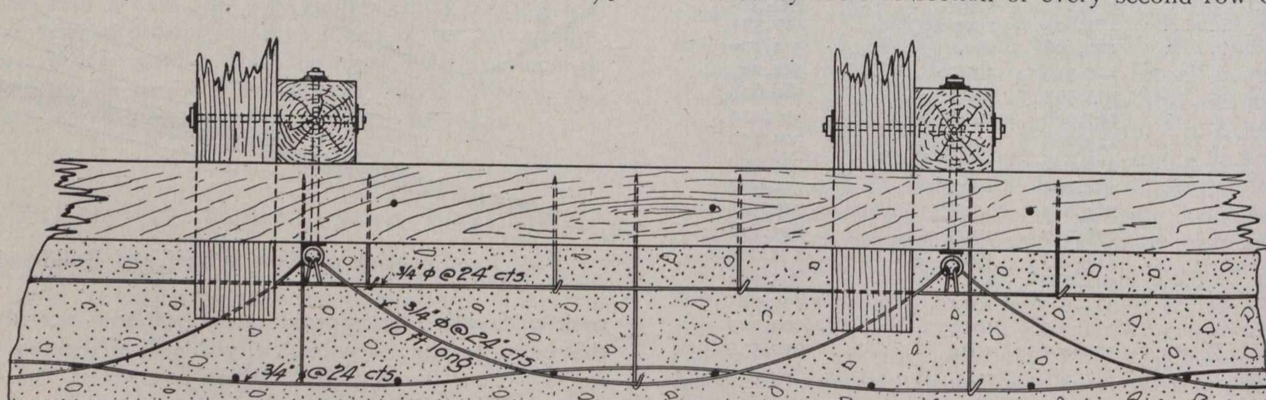

Fig. 3.—Detail of Reinforcement in Face-wall.

The cribs are partly decked with 12 x 12-in. timbers in lengths of 24 ft. or over, all butted on cross-ties and fastened with 1-in. round drift bolts 27 ins. long. The top of the deck is provided with anchor bolts, or dowels made of ¾-in. steel driven 11 ins. in the timbers and projecting 15 ins. above the top surface, the upper 3 ins. of the bolts being bent at right angle. The anchor bolts are placed 5 ft. apart longitudinally and about 4 ft. apart transversely.

The bulkheads at the inner end of the wharf are built of similar cribs. They are of different widths, according to the depth of water The width is at least 65 per cent. of the total height of the wall, including the superstructure. The crib sites for the bulkheads is dredged to rock, made moderately level by blasting, and the bottom of the cribs is built to conform to the rock foundation.

All the timber cribs are to be sheathed with concrete 2 ft. in thickness on the outer face and 1 ft. thick on the ends and rear faces. The specifications call for a 1:2:4 concrete, deposited in uniform layers of 6 to 8 ins. continuously around the four sides of the crib, tamped in the corners and around the steel bars. It is to be mixed rather wet, no surplus of water, however, being allowed

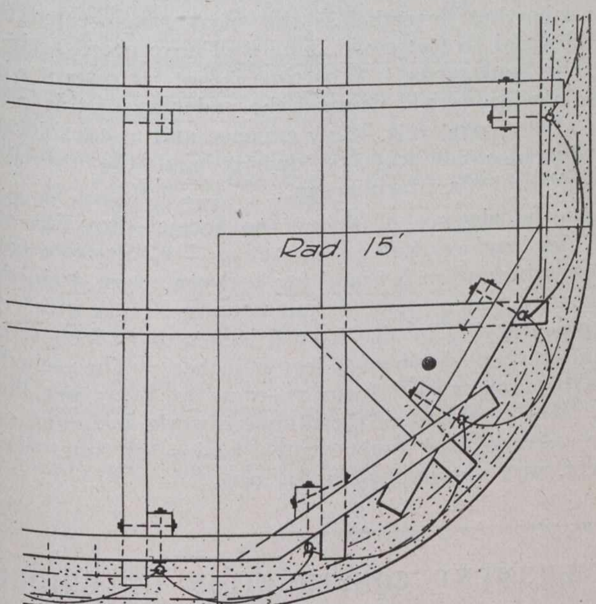

Fig. 4.—Detail of Rounded Corner at Wharf Entrance.

to flood the moulds. Concrete surfaces are to be coated with a neat cement wash, the outer faces of the wharf, including the superstructure, from the level of 2 ft. below low water spring tide, to receive two coats. The lower parts of the wall are necessarily coated before launching the cribs.

The concrete is anchored to the timber structure by bent drift bolts driven in each face timber; two and three bolts between each row of cross-ties, also by bent rods hooked in the eye-bolts passing through the vertical posts as shown. The bent anchor bolts, 1 in. in diameter, project out from the timber face 27 ins. and 7 ins. alternately from each tier of timber. They penetrate the timber 12 ins. Steel rods ¾-in. in diameter are also driven through the projecting ends of the cross-ties. Vertical rods ¾-in. in diameter are also placed 3 ins. from the outer face of the concrete. All reinforcing steel consists of plain bars. The specifications call for open hearth medium steel, with ultimate tensile strength of at least 60,000 lbs. per sq. in., an elastic limit of not less than one-half the ultimate strength, and elongation not less than 22 per cent. in 8 ins. It is to bend cold 180° around a diameter equal to the thickness of the piece tested without fracture on outside of bend.

The superstructures of the wharf and bulkheads consist of mass concrete. The outer or exposed faces of the concrete is to be finished for a thickness of 6 ins. with a granolithic concrete; the two classes of concrete to be deposited separately by using face boards. Where the mass concrete is more than 4 ft. wide, sound stones of moderate size is allowed in the concrete not closer than 6 ins. between any stone and not closer than 1 ft. from the faces. The mass concrete is composed of a 1:3:5 mix.

Two walings of B.C. fir, 15 x 18 ins. are to be placed on the outer faces of the wharf and bulkheads, in lengths of 30 ft. and over, jointed with a half lap of 2 ft. and fastened at every 5 ft. to the concrete superstructure with anchor bolts 1¼-in. diameter and 18 ins. of their length in the concrete.

At distances of about 60 ft. apart, along both sides and the end of the wharf cast iron bollards will be placed on the concrete superstructure.

Messrs. Henry, McFee and McDonald, of Vancouver, have the general contract from the Dominion Government for the construction of the wharf.

DRYDOCK AT PRINCE RUPERT.

In a few months the Grand Trunk Pacific drydock, now under construction at Prince Rupert, B.C., will be ready for operation. With the possible exception of the San Francisco dock, it will be the most commodious on the Pacific Coast. Brief descriptions have already been published in these columns concerning its general design and the machinery with which it is equipped. The following table gives some interesting data as to measurements, capacity, etc.: Length of dock over all, 600 feet (lifting capacity 20,000 tons); number of sections (steel wings), 3 independent units; length of middle section, 270 feet (lifting capacity 10,000 tons); length of each end section, 165 feet (lifting capacity 5,000 tons); length of middle and one end section, 435 feet (lifting capacity 15,000 tons); length of two ends together, 330 feet (lifting capacity 10,000 tons); number of pontoons (wood), 12; width in clear between wings, 100 feet; draft over blocks, 30 feet; pumps, 12-inch centrifugal, electrically operated.

IMPORTANCE OF ROAD DRAINAGE.

At the course of lectures given at the Agricultural College, Winnipeg, a month ago, Prof. W. J. Gilmore stated that in the average season on each mile of road, fifty feet wide, in the Red River Valley there fell 16,500 tons of water. The vast volume of water, together with that running into and held by the side ditches where drainage is poor, shows the absolute need for perfect drainage systems. "All the factories in the world," stated Prof. Gilmore, "cannot build good roads machinery enough to make a good road that will stay good unless some method is adopted of removing the surplus water."

At Fond Du Lac, Lake Athabasca, Northern Saskatchewan, it is claimed that a ledge of silver three feet deep and three miles long, has been discovered by British Columbia prospectors. When assayed, the samples ran $11,000 to the ton.

CONSTRUCTION OF THE KINGSWAY, B.C.

THE following notes relating to the construction and maintenance of the interurban road between New Westminster and Vancouver are from an address recently delivered before the Vancouver Branch of the Canadian Society of Civil Engineers by Mr. Fred. L. Macpherson, municipal engineer of Burnaby, B.C. This thoroughfare is the shortest and most direct of the three principal highways between the two cities. For the most part it lies along the high ridge of land on the Burrard Peninsula, on a route originally known as the False Creek Trail. Its length is about 7 miles, 4½ miles in Burnaby and the remainder in the municipality of South Vancouver. The highway terminates with paved portions situated within the limits of each city. There is a length of 0.65 mile in New Westminster and another of 1.15 miles in Vancouver, which were completed in the years 1911 and 1912. The interurban portion was linked up in the year 1913.

For many years previously the scheme for a paved interurban highway had been frequently discussed, but it was not until the matter was endorsed by the Provincial Government that the scheme was realized and the two largest cities in the lower mainland thereby linked up with a continuous paved highway.

In the construction of this road particular regard was entertained for combining the utility of the paved city street with the aesthetic features of an interurban highway. The road was re-surveyed and opportunity taken for considerable re-alignment and straightening out of undesirable jogs and inconsistencies, permanent survey monuments being subsequently established along the centre line of the highway. The profile was carefully prepared so as to reduce the heavier grades and yet preserve the natural contour of the country, generally so pleasing to the eye.

Illustrative of the heavy mixed traffic on this highway, undernoted are the traffic records taken on the Burnaby portion on September 26, 1913, shortly after its completion and recently on the 9th March, 1915, between 8 a.m. and 6 p.m. (ten hours):

	Sept. 26, 1913.	March 9, 1915.
Automobiles	359	507
Auto trucks	32	51
Auto cycles	13	28
Bicycles	25	43
Wagons and vans	41	57
Rigs	78	51
Total No. of vehicles	548	737

Obviously the recent incursion of the "jitney" buses is accountable for the increasingly large number of automobiles using this highway. The immediate effect of the opening of the continuous paved highway was the more general adoption of interurban transportation of freight by auto truck, resulting, according to available comparative figures, in a saving to some wholesale mercantile firms of $1 per ton.

According to the speaker, in the Vancouver portion the paved width of 56 feet appeared to be proper proportioning of the 99-foot road reservation to meet existing and future traffic conditions. The grading was very heavy, involving several deep fills which were allowed to settle for about a year before the paving was commenced. As fills, particularly those composed of different materials, cannot wholly settle in such a time, it is questionable, observed Mr. Macpherson, whether or not reinforcement of the concrete foundation would have been justifiable. Particular reference was made to the track construction which was surfaced with granite block. In spite of all that is said regarding the loosening of the blocks under the jarring action of street car traffic this piece of track work is to-day wholly intact and presents a very substantial and finished appearance.

The South Vancouver portion extends from Boundary Road to Knight Road, a distance of 2¾ miles. The original recommendation adopted by the council of the then municipal engineer was for a creosoted wood block pavement 42 feet wide on a 6-inch concrete base, estimated to cost approximately $347,000, or about $7 per foot front, the probable life of the pavement being estimated as 20 years. The encouragement of local industry seems to have been the principal reason for the selection of this type of pavement. However, the Provincial Government, who had promised a grant of $10,000 towards the work, insisted on an asphaltic mixture pavement.

Doubtless there were initial difficulties and expense connected with the widening of the existing 66-foot road reservation but nevertheless the speaker suggested that an additional 10 feet could quite well have been sacrificed from the boulevards. "The time is not far distant when traffic conditions will demand the widening of this pavement at comparatively heavy expense and at considerable inconvenience to property owners and the travelling public," said Mr. Macpherson.

In the absence of sewers no special provision was made for surface water drainage. The concrete catch basins, which were few and far between, were drained to the nearest water course or intersecting streets with vitrified pipe varying in size from 6 inches to 12 inches, laid at an average depth of 4 feet 6 inches. The schedule costs of same varied from 75 cents to $1.35 per lineal foot. The total cost of the drainage work, including concrete culverts and timber catch basins at intersecting streets, was approximately $14,000.

GOVERNMENT CONSTRUCTION OF BRIDGES IN QUEBEC.

In a recent speech in Montreal Sir Lomer Gouin, Premier of Quebec province, stated that the provincial government was continuing to subsidize the construction of steel bridges. Some 260 bridges had already been put into service and 56 were now under construction. This has entailed an expenditure, since 1908, of about $700,000. Since 1912 the Government has abolished 11 toll bridges and 6 level crossings at a cost of about $1,400,000.

RESUMPTION OF WORK ON HUDSON'S BAY RAILWAY.

Steel-laying operations were resumed on March 24th at Mile 214 on the Hudson's Bay Railway. It is expected that the work will be within 40 miles of Fort Nelson when operations cease in the fall. The contract for the steel cantilever bridge across the Nelson River at Manitou Rapids, on the Hudson's Bay Railway, has been let to the Canadian Bridge Co., Walkerville, Ont., is it stated by J. W. Porter, chief engineer.

COST METHOD FOR CONTRACTORS.

By H. Barrett Power.

Among contractors, particularly those engaged in enterprises of smaller size, there are many who have kept practically no records on jobs which they have completed, and which would otherwise provide valuable data from which to estimate for future work, and therefore, they can only arrive approximately at the figures which they use as a means of estimating.

There are other contractors who keep all their records of their various jobs in a small note book only, which they carry with them at all times. Have any of these men ever stopped to consider the possibilities of losing their only available records, and incidentally their only means of tendering on new work?

The contractor should overcome this practice, and install in his office or home some methodical system by which, presuming that his note book is lost, he will experience no difficulty in supplementing its contents.

To begin with, his foreman should keep a thorough record of all details which are involved in the work he has in charge. For instance, if his employer wishes to estimate on some work out of town, and which is some distance from the nearest railway siding, how is he going to figure on the haulage of his materials unless he has kept records for this phase of the work? Haulage is only one of the various details of which the foreman should keep a record. For the sake of lessening his duties somewhat, he may argue to his young employer, who is always ready to confide in him, that hauling material has no immediate effect upon the practical cost of the work. He may also argue that all the records that are absolutely necessary for him to keep are those of work connected only with the actual construction of a job.

The foreman should make out and send into the office each night a "daily report sheet." The accompanying form (Fig. 1) is filled out, showing a sidewalk contract, taken as an example.

This sheet shows: the class of work, station or location of the work, quantity completed, and the average haul, if any, required on materials when not quoted as f.o.b. job. It also acts as a time-sheet report, showing the different classes and priced labor employed on a job, the total hours of labor, and also the amount of cement used. The lower part of this form deals with miscellaneous details, such as extras, materials, plans or letters received, visitors to the job, weather conditions and remarks.

DAILY-REPORT-SHEET.

CONTRACT Harvie Crescent Sdwk DATE Aug. 9/14.

CLASS-OF-WORK.	STATION OR LOCATION.	DIMENSIONS.	QUANTITY.	AVERAGE HAUL.	FOREMAN (.40¢)	LABORERS (.20¢)	BRICKLAYERS	CARPENTERS	ENGINEERS	finishers (.30¢)			TEAMS	CEMENT-USED.	TOTAL COST.
Excavating (grading)	4+00 to 4+75	4'-0" wide	4 c. yds.			5									1 00
Placing forms	3+00 to 4+00					10½									2 10
Spreading cinders	" to 3+75	4'-0" x 4"	3 c. yds			4½									90
Concreting base	" "	" "	8 "			23								26 bgs	4 60
" surface	" "	" "	2.3 "			23				14				27 "	8 80
Supervision					9										3 60
TOTALS					9	66				14				53 "	21.00

EXTRAS - nil -

MATERIALS-RECEIVED - 120 bags cement, - 10 cu. yds. gravel, - 12 cu. yds. sand, - 6 cu. yds. crushed stone, - 22½ cu. yds. cinders, -

PLANS-OR-LETTERS-RECEIVED. - nil -

WEATHER - fine and warm - VISITORS - Mr. Bell, -

REMARKS - nil -

R. B. Smith. FOREMAN.

Fig. 1.

When these reports are received at the office each day, they are entered into the "cost record book" by the clerk or bookkeeper, as per Fig. 2. The contractor will then be equipped with a method of recording figures that he may require for future computations.

COST-RECORD-SHEET.

CONTRACT. Harvie Crescent Sdwk.

DATE. 1914.	EXCAVATION			FORMS		CINDERING			CONCRETING-BASE			CONCRETE-SURFACE				Foreman	
	C. YDS.	HRS.	AMT.	HRS.	AMT.	C. YDS.	HRS.	AMT.	C. YDS.	HRS.	AMT.	C. YDS.	HRS.	AMT.		Hrs	amt.
Aug. 9.	4.	5	1 00	10½	2 10	3.	4½	90	8.	23	4 60	2.3	37	8 80		9	3 60
" 10	6	7	1 50	4	80	5	7	1 60	8.	21	4 50	2.1	35	8 30		9	3 60
TOTALS.	10	12	2 50	14½	2 90	8	11½	2 50	16	44	9 10	4.4	72	17 10		18	7.20

Fig. 2.

The columns of this form may be changed to suit the various classes of work, such as bridges, sewers, sidewalks, etc.

Fraser and Chalmers of Canada, Limited, announce that on May 1st, their head office in Montreal, will be transferred from 4 Phillips Place to No. 59 Beaver Hall Hill.

NEW INCINERATOR AT BERLIN, ONT.

At Berlin, Ont., there has just been completed a garbage and refuse incinerator that differs in design from most of the other incinerators that have been constructed in Canada.

It is a two-cell incinerator, of 25 tons daily capacity. These cells are operated separately, each cell having its own water and ash pit, oil burner, grate, drying hearth, baffle wall, flue, feeding holes, valve-controlled hot air blast, oxygen duct, pyrometer coupling, pressure gauge dampers and doors.

The walls are built of 9-inch fire brick with 1-inch asbestos insulated material between the fire brick and the common brick. The arch is built of 2-inch fire brick, 1-inch insulating material and 1-inch air space. There is a 13-inch thickness of common brick between each cell. The furnaces are so built that each cell can be relined from the inside without disturbing the exterior walls or roof, or without interfering with the operation of the adjoining cells or plant.

The drying hearth upon which all garbage and refuse falls slopes towards the fire grates, and is in a direct line with the heat from the grates on its way to the combustion chamber flue. At this point all combustible material is destroyed by the flames passing through the garbage, and the wet material is dried. When dry, this material is raked onto the fire grates.

A pull-down door is situated in the centre of the clinker door, and is used for stoking the fire, and pulling down the dried material. A large clinker door gives easy access to the entire grate area for clinkering, and is of the guillotine type, opened by counterbalanced weights.

A motor-driven suction fan draws through the ducts any foul air, smoke, and dust arising from the charging floor, furnaces or clinkering and ash passage. This air is then carried to a regenerator, where it is heated by waste gases passing on their way to the stack, and is then conducted to the ash pits under the grates.

The combustion chamber is designed for the combustion of all gases, the collection of dust, and so that the gases will get on increased rolling motion for the proper mixing of the gases. A temperature of 1,400° F. is maintained in the combustion chamber.

At the end of the combustion chamber, the animal chamber is located. The carcass is lowered by mechanical device onto the cross arch, which is especially designed to keep the carcass suspended, allowing the heated gases to pass around on all sides, and preventing the animal from dropping down into the dust. An oil burner is here affixed for the purpose of accelerating the rapidity of consumption of the carcasses when a number are brought in at a time, in cases of epidemics or stable fires, or when the furnaces are not in operation.

A second combustion chamber, or fume consumer, is built just beyond the flue from boiler and by-pass from animal chamber. After the heated gases leave either of the two flues, they rise over a bridge wall specially constructed with chequered holes. The second combustion chamber is beyond the bridge wall and is so designed as to again increase the rolling motion and the mixing of the gases. Here, again, fresh, heated oxygen and hydrogen are admitted to accelerate the combustion of any gases that may escape from the main combustion chamber, or gases that emanate from the carcass.

The contract for the incinerator was awarded to the Ideal Incinerator and Contracting Company, Limited, of Toronto, and the incinerator was designed and constructed by that company.

SEWAGE PUMPING PLANTS.

The following notes relating to sewage pumping plants in a few Canadian cities are from the "Municipal Journal":—

Edmonton pumps part of its sewage against a 50-foot head, using a duplicate installation of motor-driven centrifugal pumps controlled automatically by float. The plant has given very little trouble; is visited by a sewer maintenance man once a day.

Hamilton pumps a portion of its sewage, about 9,470,000 gallons, against a maximum head of 22 feet, using centrifugal pumps with 6-inch to 10-inch discharge operated by direct acting steam engines and Canadian Westinghouse motors of 75 h.p. The sewage passes through bar screens with one-inch clear space. The plant is operated by eight men, whose wages amount to $7,000 a year. The city proposes to install this year another plant with a capacity of six million gallons per day against a 40-foot head.

Stratford pumps all its sewage, 900,000 gallons, against a 17-foot head, using an 8-inch Canadian Foundry turbine pump, 750 r.p.m., operated by a 10-h.p., 220-volt, 3-phase, 25-cycle induction motor, started and stopped automatically. Sewage first passes through septic tanks and screens. The plant is operated by one man. Annual cost of operation, $700.

Toronto pumps about 40 per cent. of its sewage, nine million Imperial gallons, against an 18-foot head, using two vertical centrifugal pumps with a capacity of 12 cubic feet per second each, and one with a capacity of 36 cubic feet per second, operated by 3-phase, 25-cycle, variable speed, vertical motors, two of 75 h.p. and one of 200 h.p. Sewage passes through screens with ½-inch bars and ½-inch spaces, which are cleaned automatically. The plant is operated by six men in 8-hour shifts. Annual cost of operation, $16,000.

Vancouver uses two temporary and one permanent installation with a capacity of 620 gallons per minute for a 25-foot lift. The permanent installation consists of Yeomans vertical submerged 3-inch and 6-inch pumps operated by 3-phase, 60-cycle, 220-volt motors, which are stopped and started automatically by a Cutler-Hammer switch. Sewage reaching small pump is screened, that for larger pump is not. One man on full time looks after the three plants. Annual cost of operation, about $3,000.

RAILWAY BUILDING IN ALBERTA.

Hon. A. L. Sifton, Premier of Alberta, outlined in the Legislature last week the railway policy of the province for the present year. According to it a loan estimated at $2,000,000 will be made to the Canada Central Railway. The exact amount is not to be more than 80 per cent. of the cost of the line from McLellan, on the Edmonton, Dunvegan and British Columbia Railway, to Peace River Crossing. Another resolution calls for additional guarantees for the Canadian Northern Western from $13,000 per mile to $18,000 per mile on the Oliver-St. Paul de Metis line north-east of Edmonton, and the third gives a bond guarantee of $20,000 a mile for a 60-mile extension of the Edmonton, Dunvegan and British Columbia line, to tap the Grande Prairie country.

Editorial

THE HENRY VEHICLE LOADING BILL.

One of the bills introduced at the recent session of the Ontario Legislature and allowed to stand until the session of 1916, is an "Act to regulate the Load of Vehicles operated on Highways." The bill was introduced by Geo. S. Henry, member for East York, and the wonder is that such a measure had not been introduced before.

Ontario has been spending millions in roads and bridges and each year the manufacturer has been supplying engines and motors of greater and greater tonnage until the loading on pavements, highways and bridges is far in excess of their capacity. Yet, the province has been remarkably lax in the matter of taking precautions to protect its investments in county road systems, or the pavements on the town and city streets.

Perhaps the fact that Mr. Henry is secretary of the Ontario Good Roads Association and a member of the York Highway Commission, caused him to give this matter some attention. At any rate, legislation of this nature is much needed.

In view of the fact that it passed its first and second readings at the recent session and was then consigned to a committee for further investigation and debate, to be brought up again next year, the measure should be carefully analyzed and studied by road engineers and superintendents in order that the benefits of their knowledge and experience may be applied to it. Ample opportunity for a full discussion of its several clauses now exists and some useful information on highway loadings that may have a bearing on the final wording of the bill should be forthcoming.

The operative sections of the bill and those that are of particular interest to the highway and city engineer are published elsewhere in this issue of *The Canadian Engineer*.

It will be seen from a study of the clauses that in some respects the bill is similar to the Act now in force in Massachusetts, "relative to the operation of motors and engines."

In Massachusetts they allow a total load of fourteen tons per vehicle and a load per inch of tire of eight hundred pounds. Mr. Henry, in his bill, has limited the total load to twelve and a half tons, with a further proviso that not more than four tons on any wheel nor more than six hundred pounds per inch of tire be permitted. It would, therefore, appear that the Henry bill is much more restrictive in character than best practice has yet approved, and it remains to be seen whether such restrictive measures are warranted.

The specifications for bridge design within Ontario have been figured in the past for loads of fifteen tons, of which two-thirds may be on the rear axle; *i.e.*, ten tons per axle or five tons per wheel. As far as total loads are concerned, it would appear that the purpose of the bill is to make them less. We are not sure that this is wise. Roads and bridges in the past have been designed for heavier loads than the bill allows. This has cost money and, if the measure is enacted, the people will not be allowed to make full use of their investment.

It is no answer to say that with time both bridge and pavement weaken. They are designed with a factor of safety of 5 or more and so are amply protected.

The clause allowing a load of only six hundred pounds per inch of tire may also require some modification as the loading to-day is in excess of this amount.

However, with the principle of the bill we are in full accord; *i.e.*, fixing the limits to which a road may be loaded and thus make it possible for engineers to design their pavements to meet requirements common to all municipalities in the province.

EFFECT OF VARYING AMOUNT OF WATER IN CONCRETE MIXING.

In a paper read before the Connecticut Society of Engineers recently, results are given of a series of careful tests made to determine the effect of varying the percentage of water in concrete. Summarized, the conclusions drawn are as follow:—

The percentage of water has a direct bearing upon the strength of concrete. Nevertheless, it is the exception rather than the rule that the engineer concerns himself with the question of mixing beyond seeing that the proper proportions of sand, stone and cement are used. Careful tests are made of the cement and steel, both standard articles put out by firms which have reputations to maintain; on rare occasions the water is analyzed, but no attempt is made to control the mixing. On some pieces of work the contractor is furnished the cement, so that there will be no temptation to skimp on materials. He is then given the liberty to mix these materials as he sees fit. He may aim to get the maximum strength out of them, but it is probable that he will strive rather to keep the cost of mixing and placing at a minimum.

Of course, it must be admitted that the strongest mixture is not always the most desirable or economical. In preparing the specimens for these tests it was found necessary, when making mixtures containing more than 27.5 per cent. of water, to increase the proportions 10 per cent. in order to fill the moulds. This indicates an increase in density which was obtained at a loss of strength. However, in some cases this is highly desirable. Often bulk and impermeability are the two requisite features. In reinforced-concrete structures a moderately wet mixture is far more practical than a dry one; but it must not be forgotten that the use of wet mixtures increases the cost of materials. An increase in density means a corresponding increase in raw materials. The additional water weakens the concrete, and therefore a richer mixture or lower unit stresses must be used. The former is preferable, for the beams and columns in concrete building are always heavier than the corresponding members of steel or wooden structures.

If a wet mixture is used, the engineer should be cautious in permitting the removal of the forms at an early date. In some of the tests the wet mixtures were very slow to develop their strength. The use of such consistencies in practice would necessitate extreme care.

It might be a month or more before the forms could be struck with any feeling of security.

The question of consistency is not altogether a laboratory question. The increased cost of materials due to the use of wet mixtures may be more than balanced by the saving in placing; but the engineer should bear in mind that consistency has a direct relation to strength, and if he permits a wet mixture he should provide for the same in his design. In any event he should control the details of the mixing.

LETTER TO THE EDITOR.

A Slide Rule for Sewer Calculations.

Sir,—The writer has had occasion to use the Crane rule in sewer calculations for a considerable time. Some of the changes that he has found it convenient to make in it may be of service to others.

The rule, as at present sold by one of our prominent instrument firms, is believed by the writer to have too many marks on it, and is too small. He had one made for his own use in which everything was doubled in size. The spaces were simply taken off the Crane rule with the dividers, and stepped twice on the new one. It was found necessary to insert marks for 14-in., 16-in. and 27-in. pipes in the third line. The confusing marks for n=.011 and n=.015 were omitted from that line, only those for n=.013 being retained. The McMath formula and the marks for egg-ended sewers were also omitted, the rule being made with only one face.

Another set of marks, in red, on the second line of the rule, shows the mean velocity with pipes flowing full, and has proved very useful in finding the time of concentration in a sewer system. As no mention has been noticed of their use by anyone else, the following description of them may be interesting.

Suppose the red velocity-mark for sewer pipes 15 inches diameter is required. The slide is set with 15 inches on the third line opposite, say, 2 per cent. grade on the fourth line. The mark "full" on the second line is then found standing opposite 8.8 cubic feet per second on the first line, showing that the 14-inch pipe, when flowing full, will deliver at that rate. Divide 8.8 by the sectional area of the pipe in square feet (the calculation of this by the ordinary slide rule is quite near enough): $8.8 \div 1.23 = 7.2$. The mean velocity of the water in the 15-inch pipe at 2 per cent. grade is thus 7.2 feet per second. The slide being retained in the last position, a red mark is made on the second line opposite 7.2 on the first line, and numbered 15 inches. If we wish to know the discharge and velocity at a grade of, say, 0.55 per cent., the 15-inch mark on the third line is shifted so as to be opposite 0.55 on the fourth line, when the black mark "full" on line 2 will stand opposite a discharge of 4.6 second-feet on line 1, and the red mark 15 inches will stand opposite a velocity of 3.8 feet per second on line 1, no other change being required in the position of the slide. A few minutes' work will give the set of red marks for all sizes of pipe.

J. PORTER, B.E.

Vancouver, B.C., April 6, 1915.

Portland cement was manufactured in the United States in 1914 to the extent of approximately 88,514,000 bbls., as compared with 92,097,131 bbls. in 1913. The estimated shipments during 1914 were 86,715,000 bbls., compared with 88,689,377 bbls. in 1913.

TAR MACADAM.

By Henry J. Scott, Toronto.

THIS material has been very much under discussion lately among road engineers and superintendents, particularly during the recent road conference in Toronto. It is now some years since it came into use in England, and considerable experience has been gained since its adoption. It was first sought after as a remedy for the dust nuisance due to the enormous increase of automobile traffic along the highways. Statistics soon showed that, in spite of the increased initial cost, it was economical to use tar macadam, and since then experience has dictated improvements which have rendered it still more desirable.

Sufficient attention was not at first given to the first or foundation layer. In consequence, water percolating through the interstices of the material rendered the substratum soft, with the result that the surface sank in places, making a very uneven road as the first sign of wear. This was particularly noticeable on roads which were, as at first, simply dressed with a coating of tar macadam 2½-in. mesh, and then top-dressed with a finer coating. The next improvement was the scarifying of the old macadam roads and crowning them to the necessary convexity, the water percolating through in this case being drained by the original macadam foundation layer.

This represented a great improvement, but a still better result is obtained by protecting the foundation from wet percolating through the interstices of the 2½-in. metal by first laying a coating of ¾-in. to ½-in. metal. This should be rolled and crowned to a slightly greater convexity than the finished surface is required to be. The 2½-in. metal should then be laid and finished off with another dressing of ¾-in. to ½-in. and rolled with a not too heavy roller.

If sufficient attention is paid to this first foundation layer so as to render it waterproof, a heavy foundation of large stone is not necessary in the case of ordinary highways, where the increasing traffic of a town has not to be dealt with.

Another point to consider is the material. This is divided into two classes: (1) the matrix, (2) the binder and its application.

The first can be again divided into two classes: natural stone and artificial material. Undoubtedly the best matrix is a hard natural stone of close texture, not easily friable with the action of traffic and not susceptible to changes of temperature. A good limestone or granite fills these conditions. Slag, however, from the nature of its production, is full of internal strains, and although a crushing test may show it actually stronger than a natural stone sample, it is always liable to be fractured by a blow, especially after changes of temperature.

A road, subject exclusively to ordinary horse-drawn traffic is subject to a pulverizing action similar to the blows of a hammer. A road subject exclusively to automobile traffic is subject to an entirely different action. There is little or no surface friction, but it is subject to the strain equal and opposite to the impulse required to propel the traffic. This creates attrition between the integral parts of the road. In the case of ordinary macadam roads, perhaps the greatest contributory destructive factor is the suction of the tires which draws out the dust. This is negligible in the case of tar macadam, unless the matrix itself breaks and becomes pulverized.

In the use of slag this contingency is more probable than in the use of natural stone on any road subject to traffic of horses and iron-tired wheels. The fracture of a unit of slag in a road means its disintegration into a number of small particles. These may to some extent be cemented or held together by the flow of the tar, which has considerable viscosity, but even in this, the most favorable case, a weak spot is created. Natural stone, on the other hand, is not so liable to fracture. Even if fracture occurs, it does not necessarily carry with it the disintegration which invariably follows the fracture of slag when subject to repeated blows, such as from horse traffic. Whether natural stone or slag be used, care should be taken to select a good sample. The writer has seen some granites far inferior to a medium slag for the purpose of road construction. Slag varies in quality far more than natural stone. The slag from a blast furnace will often vary in quality very considerably in 24 hours. This very property is an index as to how a furnace is running and the quality of the iron produced. Therefore, it is very necessary, in using slag as a matrix, to keep the quality up to standard.

The penetration of the tar into the matrix is not an essential in preparing the material. As a matter of fact, the penetration of tar into any medium likely to be used for roads is small. The oily product in the tar will penetrate to a slight extent into soft granite limestone or slag, but as this has no binding properties and in no way strengthens the matrix, it can be left out of consideration. The use of tar is simply and solely as a surface binder and should only be considered as such. The application of it to the matrix is carried out in various ways. The matrix should be dry and also in order to obviate the possibility of over-charging it with tar, which would be waste of material and also have a softening effect on the road, it is undoubtedly better to heat it. This also ensures a better spreading of the tar on the surfaces of the matrix.

The writer has inspected a plant at blast furnaces where slag is put through the crushers and arrives at the tar plant at a convenient temperature. This would be an ideal condition were it not for the fact that selection of good slag has to be made by an inspector at the crushers. If this is not done there is no check on the material road contractors are buying. Mixing is best done in rotary tubular mixers and there are improved additions to a machine of this description which render the process very perfect.

A summary of the above remarks is as follows:—

The best matrix for tar macadam is natural stone selected for the same purpose as ordinary macadam. Where slag is used as a matrix careful selection should be made.

It is not recommended for incessant and mixed traffic, it being particularly unsuitable for constant horse and iron-tired wheel traffic.

BEARING VALUE OF SOILS.

The American Society of Civil Engineers has appointed a special committee to codify the present practice on the bearing value of soils for foundations and to report upon the physical characteristics of soils in their relations to engineering structures. The committee has prepared three sets of questions asking (1) for results of tests for bearing value of soils; (2) for data as to the bearing value of soils from existing structures; and (3) for local practice as to the bearing value of soils. Answers to any or all of these series of questions are requested from every one having information concerning them. The lists of questions will be sent to any one willing to answer any of them, by Robert A. Cummings, chairman of the committee, 221 Fourth Avenue, Pittsburg, Pa.

Coast to Coast

Toronto, Ont.—The expenditure on colonization roads in New Ontario will be $306,000 this year, compared with $562,959 last year.

Toronto, Ont.—The estimates of the Dominion Department of Public Works, which passed in the House on April 3rd, included over $1,000,000 for a new post office to be erected in Toronto.

Regina, Sask.—There is under contemplation the construction of a subway under the C.P.R. tracks at Hamilton St. The subway will be one block in length and its construction will probably be proceeded with this year.

Victoria, B.C.—The last section of the concrete flow line of the Sooke Lake water supply system is now being laid by the Pacific Lock Joint Pipe Co., and a few miles more of pipe are required to complete the undertaking. It is expected that it will be finished early next month.

Maisonneuve Que.—The Montreal Water and Power Co. has made the suggestion to the city that it buy the waterworks plant owned by the company within its confines. The suggestion is the result of a request from the city that the company reduce its water rates.

Cisco, B.C.—Ballasting operations commenced a few weeks ago on short stretches of the Canadian Northern Pacific line left unballasted between this point and Yellow Head Pass last winter. These stretches total about 250 miles of unballasted track. A number of stations, water tanks and sidings are also being constructed.

Winnipeg, Man.—The city has $467,000 available for expenditure on local improvements this year. The Main St. subway will be paved at a cost of about $20,000. Outer waterworks extensions will cost $7,500. About $60,000 will be spent on street and lane openings. The balance of the amount was divided up among the seven wards of the city.

Vancouver, B.C.—Proposals have been advanced for reclaiming 42 acres of the False Creek flats. The Vancouver Harbor Commission has been granted this tract of land by a Dominion Order-in-Council, and it is stated that it will be converted into an industrial area. A 200-ft. channel on the south side and a 350-ft. channel on the north side, 12 ft. and 20 ft. deep respectively is planned. Bulkheads will protect the area. It is estimated that about 80,000 ft. of lumber will be used in the construction of the latter, and about a million yards of filling will be required in the reclamation work.

Montreal, Que.—Grand Trunk Railway grade separation is again a live subject of debate in this city. The civic officials suggested numerous modifications to the plans prepared by the G.T.R. for the elevation of its tracks, but any progress has been held back as the Dominion Railway Commission has not been supplied with details regarding these modifications. A municipal committee, under the presidency of Mr. Alfred Lambert, has submitted another proposition, that of eliminating the objectionable level crossings by reconstructing between Notre Dame St., the canal, and Bonaventure Station, the tracks and sidings, and driving tunnels under the canal instead of bridges over it. The plan, however, did not meet with very enthusiastic support.

PROGRESS ON VANCOUVER SEWER TUNNELING.

Work is at present under way on the three remaining tunnels, in the vicinity of Hereward, Wilson and Beau Streets and Seaview Terrace of the city's northwest sewer system. The underground work is being carried on simultaneously from three shafts, one at the corner of Hereward and Wilson Streets, a second on Beau Street, and the third at Seaview Terrace. About 35 men are engaged at this work, averaging about seven feet of excavation per day per shaft, or about 120 feet per week for the three gangs. Up to date the cost has figured out at from $12 to $15 per foot, instead of $20, as estimated for the tunnel work. In addition to the tunneling, a large proportion of the open trenching work has been done and concrete pipe laid. The rate of progress to date makes it certain that the whole work will be completed considerably in advance of the estimated time. Tunneling should be completed in about 4 months. Of the total length of the work from the Gorge waters near Verne Terrace, to the outfall at Macaulay Point the tunnel work constitutes approximately 7,000 feet.

PERSONAL.

H. M. BURWELL, of Hermon and Burwell, consulting civil engineers, Vancouver, is leaving the firm to establish a consulting engineering office of his own in that city. He has been a member of the firm since 1887. From 1904 to 1906 he was engineer in charge of construction of the Coquitlam Lake hydro-electric development, and from 1906 to 1913 was engineer in charge of Vancouver waterworks extensions and of the Pitt Meadows reclamation work.

BEN. HUGHES, a prominent mining journalist of Northern Ontario, is editor of a new publication called "The Northern Miner," devoted to the mining interests of that district.

SIR WILLIAM PRICE has announced his retirement from the chairmanship of the Quebec Harbor Commission.

E. G. W. MONTGOMERY, whose interesting article on the design of reinforced concrete T-beams appears in this issue, was formerly district engineer for the Department of Public Works, India.

G. A. BUTLER succeeds C. S. Ogilvie as assistant engineer of the Belleville division of the Grand Trunk Railway. The appointment is announced to be of a temporary nature, Mr. Ogilvie having enlisted for active service.

OBITUARY.

Word has been received of the death in Florida of Mr. W. J. McDonald, a well-known railway contractor of Eastern Canada. For many years he was a partner in the firm of Ryan and McDonald, who built part of the G.T.P. north and west of Quebec City, and parts of that road in New Brunswick. He also built part of the T.N.R. near Sudbury. He also had connection with the Saguenay Construction Company, which built the most difficult part of the Quebec and Saguenay Railway.

In the earth slide which demolished part of a mining camp at Britannia Beach, B.C., a few weeks ago, Mr. C. E. Copeland, a mining engineer, well known in Western Canada, met his death. He was 25 years of age and was connected for several years with the Britannia Mining and Smelting Company.

On March 27th, Mr. John Bryden, mining engineer, died at Victoria, at the age of 84. In 1863 Mr. Bryden became superintendent of the Vancouver Coal Mining and Land Co., from which he resigned, after about fifteen years' service, to superintend the Wellington Collieries. In 1902 he was appointed to a commission to report upon the safeguarding of life and property in coal mine operations.

The death occurred in Oshawa, Ont., on April 8th of Mr. John Cowan, president of the Ontario Malleable Iron Company, which position he had held for 43 years.

VANCOUVER BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

On April 1st Mr. J. MacLaughlin, resident engineer for the Government at the harbor works, Victoria, read a most interesting paper to the members of the Vancouver Branch of the Canadian Society of Civil Engineers concerning the harbor improvements at that point. Mr. G. R. G. Conway presided.

The speaker described the design and construction of the $5,000,000 breakwater and jetties, the former costing about $2,700,000, and the latter about $2,300,000.

A proceeding in the construction of both the breakwater and the wharves was the dumping of a quantity of fine gravel on the site to form a core for the larger base. Around this core was dumped rough gravel to a height of about 48 feet, making a triangular base. A sort of submarine plough, consisting of a rectangular piece of loose timber, was drawn along the top of this base to keep the top level. The use of the plough, which was weighted with about 16 tons of rock, under water obviated the necessity of employing divers.

In the case of the breakwater, one of the faces of the rough gravel base was beyond a certain height, composed of huge granite boulders, blocks weighing from six to sixteen tons.

The concrete breakwater and piers were to be erected on these bases, the two piers giving berthing facilities to a vessel of a maximum draft of about 37 feet.

COMING MEETINGS.

TORONTO ELECTRICAL SHOW.—The second annual exhibition, to be held in the Arena, Toronto, April 12th to 17th. Secretary, Mr. E. M. Wilcox, 62 Temperance Street, Toronto.

AMERICAN WATERWORKS ASSOCIATION.—The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

AMERICAN FORESTRY ASSOCIATION.—Special meeting to be held on October 20th at the Panama-Pacific International Exposition, San Francisco, Cal. Secretary, P. S. Ridsdale, Washington, D.C.