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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

PROGRESS ON BLOOR STREET VIADUCT, TORONTO

ROSEDALE SECTION NEARLY COMPLETE—PIERS AND THREE OF THE FIVE DON SECTION ARCHES ARE IN PLACE—BIG PUBLIC IMPROVEMENT COSTING $2,500,000 WILL CHANGE TRAFFIC ROUTES OF TORONTO—PROBABLY LARGEST VIADUCT IN THE EMPIRE.

NO untoward event has to date marred the progress of the work on the Bloor Street Viaduct, Toronto. The contractors are up to or ahead of their schedules, and the work done appears to be of the highest order, both as regards steel and concrete. The viaduct gives every promise of becoming one of the boasts of Toronto, not only from architectural and engineering viewpoints, but also from the standpoint of economics, as it will mean a more consolidated and better welded "Greater Toronto."

For the past ten years the northeastern section of Toronto has grown quite rapidly. But as it is separated from the main portions of the city—central and western—by the huge natural barriers of the Don Valley and Rosedale Ravine, transportation of all kinds is of necessity very circuitous.

Fig. 1.—Don Section, Bloor Street Viaduct, Looking West from Pier A (near Danforth Avenue). Photo July 27th, 1916.

As is shown by Fig. 2, the Don Section of the viaduct will connect Danforth Avenue with the height of land around Castle Frank Road in the southern portion of Rosedale. The Rosedale section bridges the ravine, while the Bloor section, which is entirely a fill proposition, completes the highway to the corner of Bloor and Sherbourne Streets. Thus a through northerly route from east to west is provided, saving time in getting from the northeastern section to the downtown business district; also, the congestion of traffic over the Queen and Gerrard Street bridges will be greatly relieved.

The contract for the Don section was let to Quinlan & Robertson, Ltd., for $947,076.01. The sub-contract for the steel work was let to the Hamilton Bridge Works Co., Ltd. The general contract was signed December 17th, 1914, and order to commence work was given just one week later. The first sod was turned January 16th, 1915. Three years from December 24th, 1914, is the allotted time for completion of the work, with a bonus of $25 and a penalty of $100 a day. The time allowed is divided into various sections, such as for completion of piers, for completion of steelwork, for com-

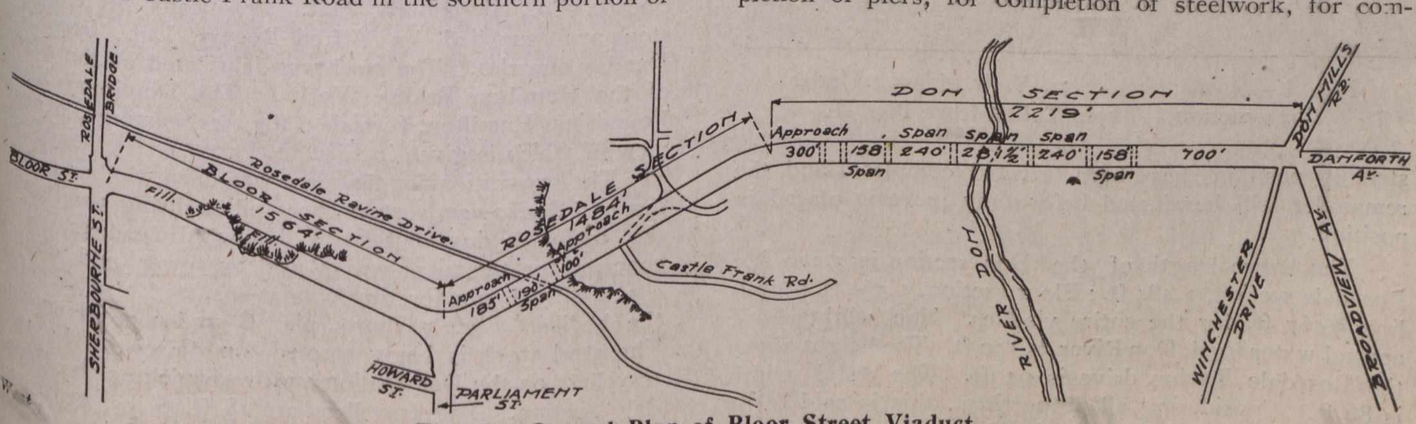

Fig. 2.—General Plan of Bloor Street Viaduct.

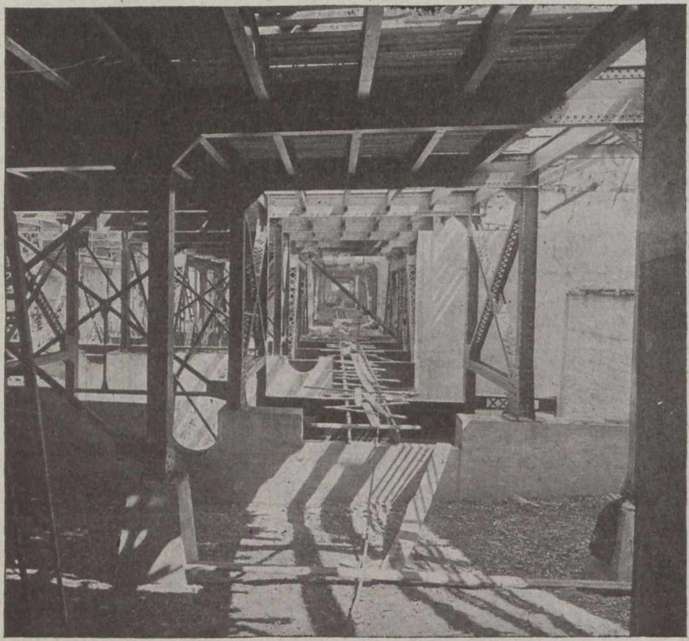

Fig. 3.—View Through One Side of Lower Deck, Rosedale Section, Looking East.

pletion of deck slabs, etc., and the bonus is paid or penalty collected at each interval. So far, this contract has been ahead of schedule.

There are two 158-ft. arches, two 240-ft. arches and one 281½-ft. arch in the Don section, measuring from pin to pin. The largest span—over the Don River—is approximately 300 ft. from centre to centre of piers. Approaches, steelwork and three of the five steel arches are in place. The two 158-ft. arches and one 240-ft. arch are in position, totalling 2,700 tons of the 5,700 tons in the whole section. About 60 per cent. of the

Fig. 4.—Rosedale Section, View of Arch Under Construction. Photo Taken from Pier H.

steel in position has been riveted complete, and the remainder will be riveted before any more is placed in position.

The entire length of the Don section is 2,219 ft.; Rosedale section, 1,484 ft.; Bloor section, 1,564 ft.; totalling 5,267 ft. for the entire viaduct. The height above normal water level, Don River, is 130 ft. The height above the Rosedale Ravine drive is 94 ft. The total width is 86 ft. Considering all proportions, this is said to be one of the largest viaducts in the British Empire. A sum of $2,500,000 was voted by the Toronto ratepayers in 1913 to cover the cost of the work, including expropriated land, paving, car tracks, and all other items.

The following figures for the Don section are the engineers' preliminary estimates, and while they have been somewhat altered by actual construction conditions, they are said to be approximately correct, and they give a good idea of the size of the undertaking:—

Total of excavation—Earth, 48,826 cu. yds.; rock, 870 cu. yds.; total, 49,696 cu. yds.

Concrete—1:2:4, 6,900 cu. yds.; 1:2½:5, 27,718 cu. yds.; 1:2¾:5½, 8,726 cu. yds.; total, 43,344 cu. yds.

Concrete reinforcing—Steel bars, 738,700 lbs.; expanded metal, 246,500 lbs.; total, 985,200 lbs.

Structural metals—Steel, 10,875,370 lbs.; cast steel, 362,000 lbs.; cast iron, 108,800 lbs.; lead, 14,780 lbs.; total, 11,360,950 lbs.

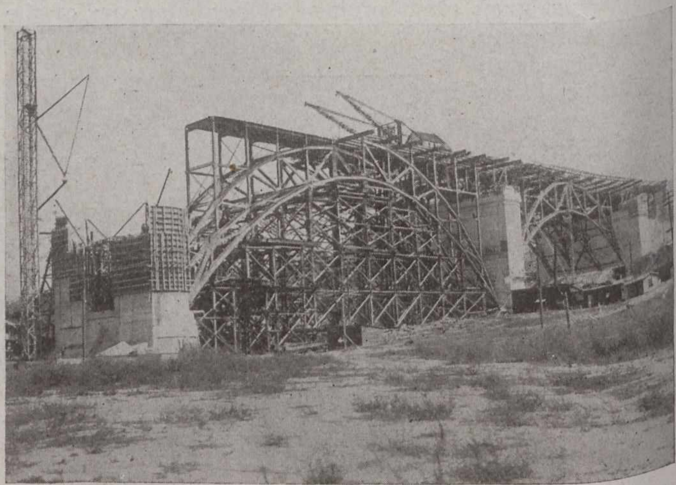

Fig. 5.—Don Section, Construction View of 240-ft. Arch on Falsework, Connecting Piers B and C. The 158-ft. Arch Connecting Piers A and B is Completed.

Granite—2,532 cu. ft.

Waterproofing—Track, 3,721 sq. yds.; roadway, 7,018 sq. yds.; total, 10,739 sq. yds.

Handrail—3,283 lineal feet.

Expansion joints—In floor, 20; in walls, 16; total, 36.

Grubbing—1.2 acres.

The cement for the Don section was supplied by the Canada Cement Co., Ltd., and Alfred Rogers, Ltd. Steel and Radiation, Ltd., furnished the expanded metal; and the Steel Co. of Canada, the steel bars for reinforcing. The greater part of the sand came from the W. T. Godson Co., Greenburn, Ont. Practically all crushed stone was supplied by Alfred Rogers, Ltd., from the Dundas quarries. The steel was fabricated at the plant of the Hamilton Bridge Works. The Dominion Steel Foundries, Hamilton, furnished the steel castings, a near view of which is given in Fig. 11.

The excavation for the piers was open, timber sheeting and Lackawanna steel sheet piling being used, and the material dug out with Hayward buckets. The concrete for the piers was placed by tower and chute, a 1:2¾:5½ mix for the foundations, and 1:2½:5 for the bodies. Fig. 5 shows pier C under construction. The steel work is being erected on falsework by two travellers on the Don section and by derrick on the Rosedale section. The travellers are 18 ft. 6 ins. centre to centre of truss, with a 10 x 12 hoisting engine. Each

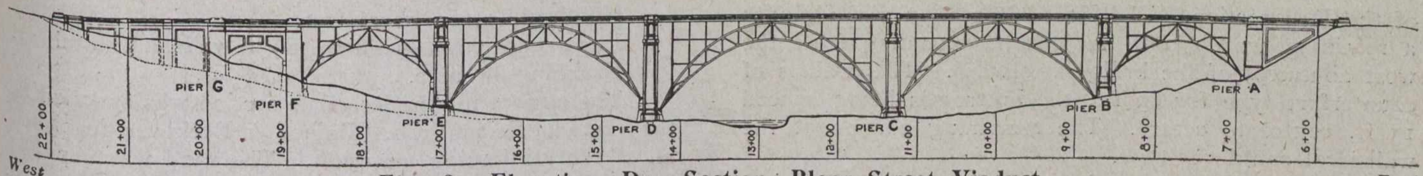

Fig. 6.—Elevation, Don Section, Bloor Street Viaduct.

carries 60-ft. double boom with maximum stride of 110 ft. On the Don section are also used two 20-ton guy derricks with 85-ft. masts and 60-ft. booms and one 7-ton guy derrick with 70-ft. mast and 60-ft. boom.

Ransome and Smith concrete mixers were used on the Don section, Beatty and Doty hoists, Beatty swingers on the derricks, Marion steam shovels, and Ingersoll-Rand air compressor plant.

All of the eight piers carrying the six main steel arches were carried down to rock, the elevation of the bottom of the foundations as placed being 2½ ft. or more below the mean elevation of the rock surface determined after excavation. The foundations of the piers range from 29 ft. to 46 ft. deep, approximately. A number of views of the foundation and pier work, and a description of general methods followed, appeared in a progress article in *The Canadian Engineer* of December 16th, 1915.

Another article on the Don section, in *The Canadian Engineer* of October 29th, 1914, reported the foundation tests and gave notes on the preliminary work attending the whole project. The design of the viaduct was also explained in that article with notes on the assumed working stresses, the assumed loads, etc. The arches are of the three-hinged, four-ribbed type. The concrete floor slabs are supported on steel. There is a 21-ft. 9-in. roadway on each side of the car tracks, while for the tracks 21 ft. has been allowed. On each side is a cantilevered sidewalk 10 ft. 9 ins. wide, carrying a curtain wall, as shown in Fig. 10. A general view of the upper deck is given in Fig. 9. Provision is made for a lower deck to connect with a future system of underground railways. Fig. 3 shows a view through one side of the lower deck, which will not be completed until needed. The tracks will run approximately along where the two temporary stringers are placed to provide a walk for inspection purposes. Just to the left of the track allowance of the lower deck will be noticed a semi-circular bed in the concrete along which will be carried a 42-in. water main. Another main is to be carried similarly through the other side of the lower deck. The clearance of each side of this deck is 14 ft. 6 ins. by 17 ft. 3 ins. high from top of rail. Fig. 4 shows rather clearly the spaces provided for the passage of the underground cars.

Fig. 7.—Rosedale Section, Bloor Street Viaduct, Looking South Along Ravine Drive.

The contract for the Rosedale section was let for $298,555.53 to the Dominion Bridge Co., Ltd., who awarded a sub-contract for the excavation and concrete work to the Raymond Construction Co., Ltd. The order to commence work was given March 24th, 1915, and two years were allowed for completion of the contract, with a bonus of $25 and a penalty of $50 a day. If the weather continues favorable, and the sub-contractors are able to get the handrail poured this fall, they will likely earn a bonus. The work on the 1,260 lineal feet of handrail has just commenced. Otherwise the concrete is nearly all in place

The Rosedale section includes but a single span, with a 190-ft. arch, pin to pin, as shown in Figs. 7 and 8. The western approach contains an 80-ft. span, masked by concrete, as does also the western approach

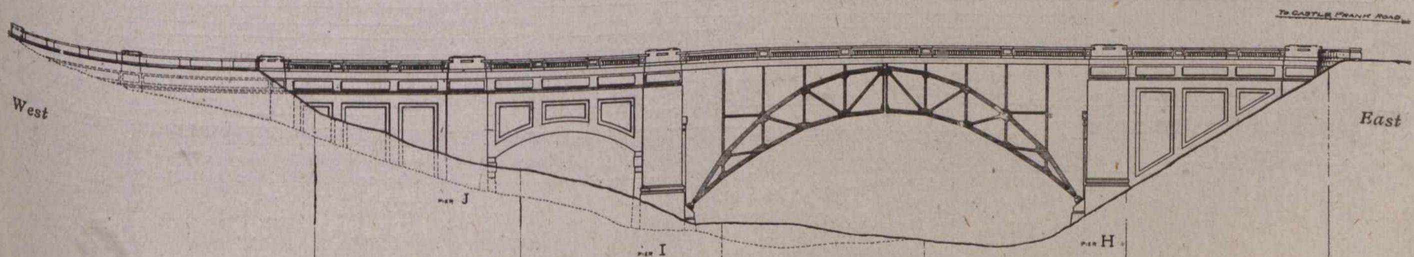

Fig. 8.—Elevation, Rosedale Section, Bloor Street Viaduct.

of the Don section. The Rosedale section also includes a retaining wall 170 ft. in length, extending from the west abutment of the bridge westward. This wall is of counterfort type for 69 ft., the buttresses being spaced 15 ft. centre to centre. The remaining portion of the wall is of cantilever type.

The span is a 3-hinged steel arch with a 64-ft. rise, and is similar in design to the five arches of the Don section. A description of the Rosedale section, with loading diagrams, etc., appeared in *The Canadian Engineer* of December 17th, 1914.

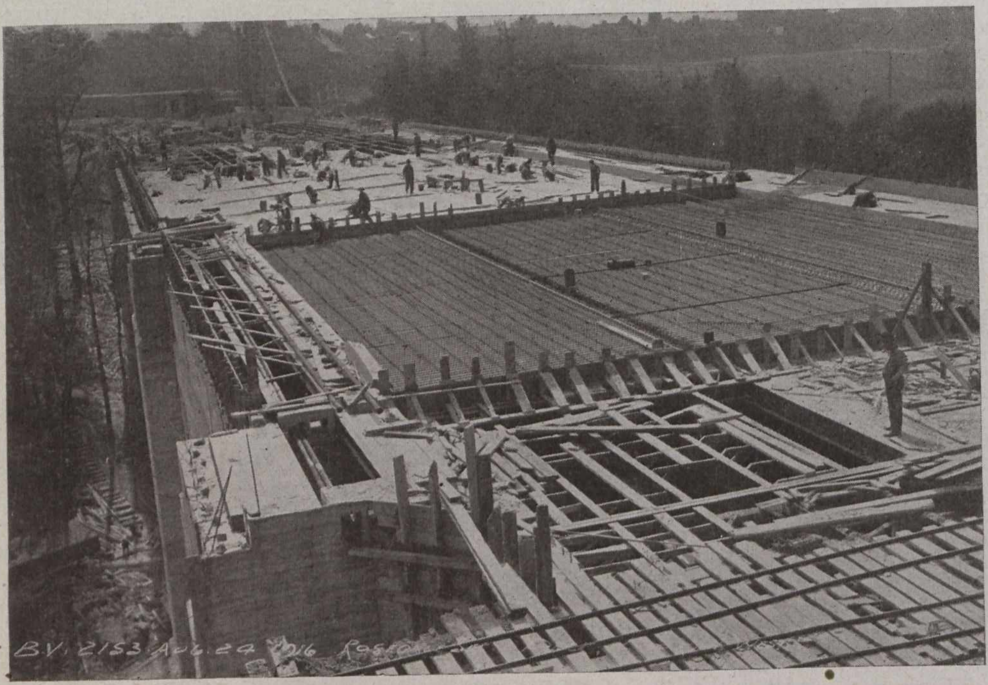

Fig. 9.—Upper Deck, Rosedale Section, Looking West.

Following are the engineers' estimates for the Rosedale section:—

Total of excavation—Earth, 30,842 cu. yds.; rock, 166 cu. yds.; total, 31,008 cu. yds.

Concrete—1:2:4, 2,250 cu. yds.; 1:2½:5, 12,651 cu. yds.; 1:2¾:5½, 1,847 cu. yds.; total, 16,748 cu. yds.

Concrete reinforcing—Steel bars, 364,327 lbs.; expanded metal, 88,728 lbs.; total, 453,055 lbs.

Structural metals—Steel, 2,639,530 lbs.; cast steel, 75,000 lbs.; cast iron, 37,720 lbs.; lead, 5,990 lbs.; total, 2,758,240 lbs.

Granite—455 cu. ft.

Waterproofing—Track, 1,306 sq. yds.; roadway, 2,578 sq. yds.; back of retaining wall, 460 sq. yds.; total, 4,344 sq. yds.

Handrail—1,260 lineal feet.

Expansion joints—In floor, 8; in walls, 13; total, 21.

Grubbing—1 acre.

The cement for the Rosedale section was supplied by the Canada Cement Co. Baines & Peckover furnished all of the reinforcing materials. The sand was supplied by the Lake Shore Sand and Gravel Co., and the crushed stone by Alfred Rogers, Limited. The steel was fabricated by the Dominion Bridge Co., Toronto. The steel castings were made in Cleveland, Ohio.

Smith mixers were used on the Rosedale section, and Beatty hoists, Thew shovels, Adams dump wagons, Greening wire rope, Owen clamshells, Lakewood dump buckets, and Ingersoll-Rand air compressor plant.

The entire viaduct was designed by, and its construction is proceeding under the supervision of, the following officials of Toronto's Department of Works: R. C. Harris, commissioner of works; Geo. G. Powell, deputy city engineer; G. A. McCarthy, assistant engineer of railways; Thos. Taylor, designing and construction engineer; Geo. Oksvik, principal assistant; Chas. E. Stilson, field engineer, Don section; John Ryckman, field engineer, Rosedale and Bloor sections; and Wm. E. Janney, engineer in charge of surveys and measurements. The architectural features of the concrete work were designed by Edmund Burke, consulting architect, Toronto.

T. T. Black is representing Quinlan & Robertson in Toronto, and is their resident engineer on the Don section, while Frank Munro is general superintendent. Hamilton Bridge Works Co. are represented by J. Gordon Jack. W. F. B. Rubidge was resident engineer for the Dominion Bridge Co. until September 1, 1916, when he was succeeded, upon resignation, by A. F. Ramsperger. E. J. Cotes is general superintendent for the Raymond Construction Co.

In a recent monthly report of the Bell Telephone system some interesting figures were presented regarding the extent of the company's operations throughout the world. On July 31 last the company had 19,122,921 miles of wire, enough to girdle the earth 765 times, an increase of 1,177,390 miles over the same date in 1915. The company had 9,549,630 stations, 6,290,826 owned and 3,258,808 connected, an increase of 665,892 over a year ago.

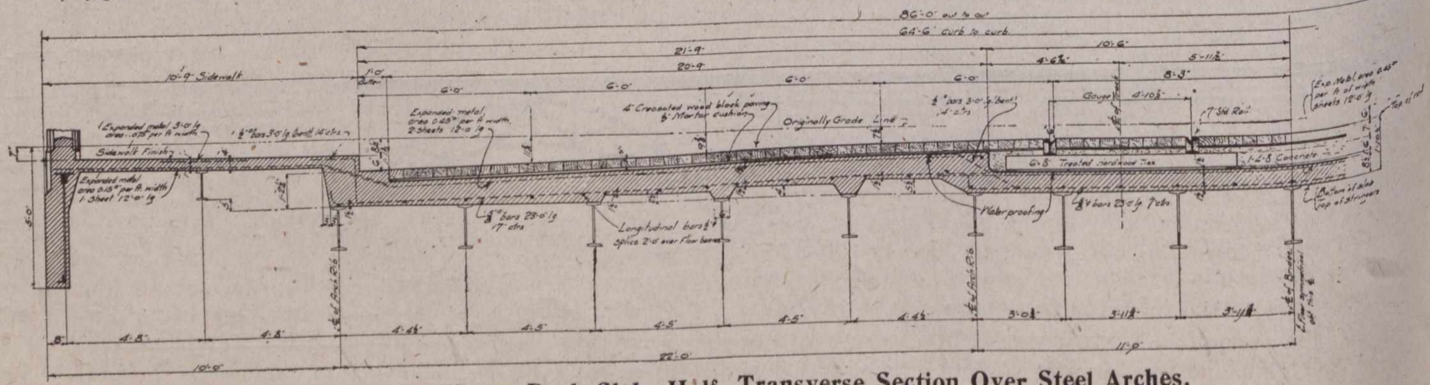

Fig. 10.—Upper Deck Slab, Half Transverse Section Over Steel Arches.

HALF-YEARLY REPORT OF ONTARIO BUREAU OF MINES.

According to the report of the Ontario Bureau of Mines the returns of products for the first six months of 1916 shows a material increase in value of all metals over that for the first six months of 1915, with the single exception of iron ore.

So far as gold is concerned, if the present rate of production is maintained, Ontario should reach the $10,000,000 mark for 1916, as compared with $8,500,000 for 1915. Of the total yield, the Porcupine camp contributed all, with the exception of $545,434 produced by the Croesus in Munro township, the Rognon near Dryden, the Tough-Oakes at Kirkland Lake and the

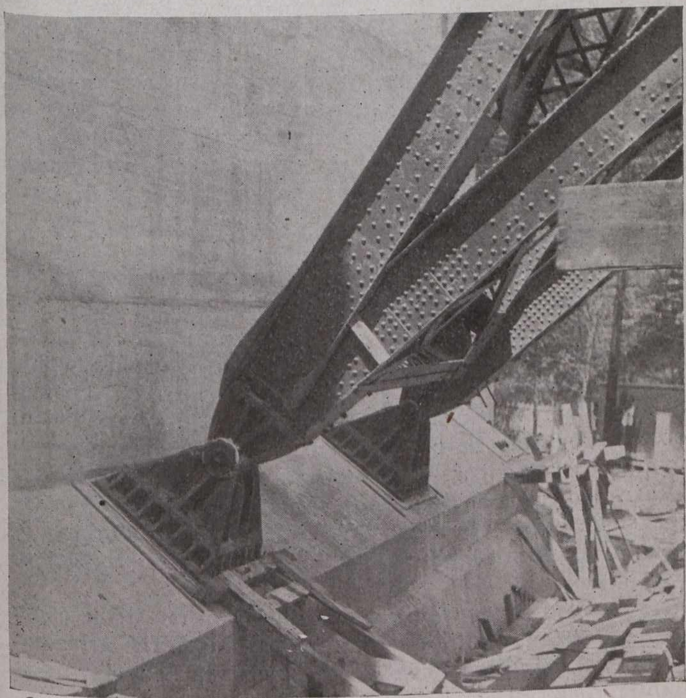

Fig. 11.—Type of Steel Castings Used for Bottom Pins, Bloor Street Viaduct. (See opposite page.)

Canadian Exploration Company at Long Lake, near Sudbury.

Since the beginning of 1916 the price of silver has advanced considerably, the average being 62½ cents per ounce, low 56½ and high 77¼ cents. As a result, production has been stimulated, and the value as compared with 1915 figures shows a considerable increase.

With the outbreak of war the European market for cobalt oxide was suddenly cut off. However, new markets and new uses for metallic cobalt have improved the situation. High-grade steels are now produced from cobalt alloys. Metallic cobalt production is greatly in excess of last year.

The output of metallic nickel shows an increase over the 1915 production, which was not marketed during the six months' period.

Apart from the nickel-copper deposits of Sudbury, there has been a revival of copper ore mining in Ontario, partly due to the high price of the metal.

The smelters of the Canadian Copper Company at Copper Cliff and the Mond Nickel Company at Coniston are turning out nickel-copper matte at an unprecedented rate. The production, as compared with the first six months of 1915, shows an increase of nearly 40 per cent. The valuation of the metallic contents of the matte has been made on a basis of 10 cents per pound for copper and 25 cents for nickel. The figures given for metallic copper and nickel separately show that the prices were over 18 and 42 cents per pound, respectively.

Molybdenite occurs widely in Ontario, but is mined chiefly in Renfrew county. It is wanted at the present time for use in the manufacture of high-speed tool steel, and for this purpose molybdenum will probably replace tungsten to some extent. The demand for molybdenum steel to be used in munition factories comes largely from the allied nations, Britain, France and Russia. Molybdenite concentrates containing 85 per cent. or more of MoS_2 are worth about $1 per pound. Ferro-molybdenum is now (September) being manufactured for the first time in Canada by the Orillia Molybdenum Company at Orillia, and the Tivani Electric Steel Company at Belleville.

The only shipments of iron ore were from the Magpie mine, operated by the Algoma Steel Corporation of Sault Ste. Marie. Although iron ore production shows a decrease as compared with the same period in 1915; that of pig iron shows a material increase, both in tonnage and value.

Product	Quantity 1915		Quantity 1916	Value 1915	Value 1916
				$	$
Gold	173,021	oz.	235,060	3,570,072	4,822,740
Silver	11,101,909	,,	10,267,743	5,188,763	6,188,269
Copper	....	lbs.	77,795	....	14,368
Cobalt (metallic)	....	,,	121,817	....	103,677
Nickel (metallic)	....	,,	13,933	....	5,899
Molybdenite (concentrates)	....	,,	12,631	....	13,075
Cobalt and Nickel oxides	141,500	,,	401,408	56,812	204,638
Copper in matte	8,523	tons	11,426½	1,704,600	2,285,096
Nickel ,,	15,182	,,	20,651½	7,591,000	10,325,766
Iron Ore ,,	134,077	,,	80,698	288,296	243,268
Pig Iron	225,940	,,	295,349	2,856,040	4,424,496

ASPHALT PRODUCTION IN UNITED STATES.

The total amount of natural asphalt produced in the United States during 1915 was 75,751 tons. The yearly production was small until 1888. Since that year it has ranged from 40,000 to 100,000 tons. In 1915, 21,739 tons came from Utah, 19,311 tons from Kentucky, 17,794 tons from California, and 16,907 tons from Oklahoma. There was also a small amount from Texas, which is included with Kentucky in the above figures. In the same year, 138,248 tons of natural asphalt was imported, 101,502 tons of which was from Trinidad and Tobago, and 32,098 tons from Venezuela. This is rather less than the average amount imported during the past five years. The reason for the decreasing consumption of natural asphalt in the face of the increased demand for asphalt products is the growing importance of the manufactured asphalt industry. In 1902, 20,826 tons of asphalt was manufactured from domestic petroleum, while in 1915, 664,503 tons was produced from the same source. In addition, asphalt made from Mexican petroleum, which was negligible in amount until recently, amounted to 388,318 tons in 1915.

Great Britain has purchased the entire supply of synthetic nitrate in Norway, thereby preventing exportation of this requisite in the manufacture of ammunition by Germany, according to a statement made at San Francisco, Cal., recently, by J. M. Humphreys, manager of a large British nitrate corporation, who was in that city en route to Chile. Mr. Humphreys stated that he plans to put into operation at the nitrate fields of his company in Chile a new process for extracting and elaborating nitrate that will cut the cost of production in half.

BRICK ROADS.*

By Vernor M. Peirce and Chas. H. Moorefield.

IN forming a roadbed upon which a brick pavement is to be constructed, the essential features to be considered are: (1) Thorough drainage, (2) firmness, (3) uniformity in grade and cross-section, and (4) adequate shoulders.

Thorough drainage can be secured for any particular road only by means of a careful study of the local conditions which affect the accumulation and "run-off" of both the surface and ground water. These conditions vary considerably even in the same locality, and no set of rules can be given which would cover all cases. For example, the material composing the roadbed may be springy, and in this case tile underdrains will probably be necessary. On the other hand, extremely flat topography may make it necessary to elevate the grade considerably above the surrounding land. The nature of the soil, the topography, and the rainfall must all be considered if a system of drainage is to be planned properly.

The second requirement, firmness, can be secured only after the road has been properly drained. Soils which readily absorb moisture can not be properly drained in wet weather and should not be permitted to form a part of the subgrade. In order that the subgrade may be unyielding, it is also necessary that the roadbed be thoroughly compacted. In forming embankments the material should be put down in layers not over 8 inches thick, and each layer should be thoroughly rolled. In excavation, care should be exercised, if the material is earth, not to permit plows or scrapers to penetrate below the subgrade. The subgrade in both excavation and embankment should be brought to its final shape by means of fine grading with picks and shovels and rolling.

When completed, the subgrade should be uniform in grade and cross-section; otherwise the foundation must be made unnecessarily thick where depressions occur, in order that its grade and cross-section may be uniform and its thickness not less at any point than that required. The subgrade should be repeatedly rolled and re-shaped until the desired shape is secured. If curbs are constructed independent of the base they should be set before the final finishing, in order that they may be made to serve as a guide for this work.

The shoulders should never be less than 4 feet wide and should consist of some material which compacts readily under the roller and does not readily absorb water. Not infrequently one of the shoulders is made sufficiently wide to form an earth roadway parallel to the brick pavement. Such an arrangement serves to relieve the pavement of considerable traffic during favorable seasons and also affords some advantage to horse-drawn traffic. The general method of constructing shoulders for brick roads is not essentially different from that employed for other types of pavements.

Curbing.—Brick pavements, as generally constructed, should be supplied with strong, durable curbing, both on the sides and at the ends. Otherwise the marginal brick will soon become displaced by the action of traffic, and their displacement will, of course, expose the brick next adjoining, so that deterioration might eventually spread over the entire pavement. Properly constructed curbing, on the other hand, will hold the pavement as in a frame and enable the brick to present their combined resistance to the destructive influences of traffic.

Satisfactory curbs may be constructed of stone, Portland cement concrete, or vitrified clay shapes made especially for this purpose. Wood has also been used for curbs to a limited extent, but when it is considered that the life of a brick pavement under ordinary conditions should far exceed the life of any wood curb which might be devised, the economy of employing a more durable material is readily apparent.

Stone curbing may be made from any hard, tough stone which is sufficiently homogeneous and free from seams to admit being quarried into blocks not less than 4 feet long, 5 inches thick, and 18 inches deep. On account of their ordinarily homogeneous structure, granite and sandstone are probably more used for curbs than any other kind of stone.

All stone curbing should be hauled, distributed, and set before the subgrade is completed. The individual blocks should be not less than about 4 feet long, except at closures, and should ordinarily have a depth of from 16 to 24 inches, depending on soil conditions and on whether the curb is to project above the surface, forming one side of the gutter. The neat thickness need never be greater than 8 inches and, where the traffic conditions are not severe and the quality of the stone is good, a thickness of 6 inches will ordinarily prove satisfactory. Stone curb should always be set on a firm bed of gravel, slag, or broken stone, not less than 3 inches thick, or on unusually firm earth, and should be provided with a backing of the same material on the shoulder or sidewalk side.

Where suitable stone is not readily available or when from any cause the cost of stone curbing would prove excessive, a curb constructed of Portland cement concrete may frequently be advantageously used. Concrete curbs may be constructed alone or in combination with either a concrete gutter or a concrete foundation. When constructed alone they should have approximately the same cross-sectional dimensions as stone curbs and should be constructed in sections about 8 to 10 feet in length.

Vitrified clay curbing should be set in much the same manner as that described for stone curbing. The principal additional requirement is that, since vitrified clay is a lighter material than stone and the curb sections are ordinarily shorter, the bedding must be made correspondingly more secure in order to prevent displacement.

The Foundation or Base.—A firm, unyielding foundation is one of the most essential features of a brick pavement. This fact can be more readily appreciated when it is considered that the surface of a brick pavement is made up of small individual blocks, any one of which might be easily forced down, causing unevenness in the surface, if the foundation were poor; and since the ability of the pavement to resist wear depends very largely on the smoothness of the surface, every reasonable precaution should be taken to prevent any unevenness from developing. The fact that more brick pavements have failed on account of defective foundations than from any other cause should never be lost sight of by those planning and supervising this class of work.

The proper type of foundation or base depends largely on the material composing the subgrade and the character of traffic for which the road is designed. Where the traffic is comparatively light and the subgrade is composed of some firm material which does not readily absorb water, a very satisfactory base may be constructed of broken stone. Where the traffic is comparatively heavy or where the material composing the subgrade is at all unstable, a monolithic concrete base should be used. Bases consisting of a course of brick laid flat upon a

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previously compacted layer of gravel or broken stone have sometimes been used, and pavements constructed upon bases of this kind, ordinarily called "double-layer" pavements, have in general proved satisfactory. At the present time, however, such bases can rarely be constructed at less cost than the more durable concrete bases, and they will therefore be given no further consideration here.

Broken-stone bases should be from 6 to 8 inches thick after compacting and should be constructed in two or more courses just as in the case of first-class macadam roads. The stone should be durable, and should be graded in size between certain reasonable, fixed limits. It should be uniformly spread on the road, either from dumping boards by means of shovels or from wagons especially designed to spread the material as it is being dumped. Where whole loads are dumped in one place and then spread out to the required depth, it is very difficult to obtain uniform density. Usually those spots where the loads are dumped are more densely compacted than the rest of the base, and this lack of uniformity very soon manifests itself by producing unevenness in the surface of the pavement. The broken stone should be compacted in the usual manner by rolling with a power roller weighing not less than about 10 tons, and sufficient stone screenings and coarse sand to fill the voids should be spread and flushed into the base while the rolling is in progress. When complete the base should present a surface uniform in grade and cross-section and parallel to the proposed surface of the finished pavement.

Concrete bases are unquestionably better adapted for brick pavements than any other type. They are practically monolithic in form, nearly impervious to water, and possess a relatively high crushing strength. All of these qualities may be obtained with a relatively "lean" concrete if the subgrade has been properly prepared. Under ordinary circumstances a satisfactory base may be constructed of concrete composed of 1 part of Portland cement, 3 parts of sand, and from 5 to 7 parts of broken stone or screened gravel.

The precautions most necessary to observe in preparing sand foundations may be briefly described as follows:

(1) The road should be so graded and drained as absolutely to prevent the foundation from becoming saturated with either storm or ground water after the brick are laid.

(2) The entire roadway should be thoroughly saturated with water while it is being compacted, and a roller weighing not less than 10 tons should be used for compacting. Dry sand can not usually be compacted by rolling.

(3) Adequate stone or concrete curbs should always be provided. At present wooden boards are being used in lieu of curbs for many of the Florida roads, and in some cases this substitution can perhaps be justified by the immediate necessity for improving a large mileage of roads without suddenly increasing taxation to an unwarranted burden. On the other hand, it seems very doubtful if any community which can not afford proper construction in the beginning should select such an expensive type of surface for their roads.

(4) The material composing the foundation should be of a uniform character and free from vegetable matter of any kind. After the curbs are set, the foundation should be rerolled and reshaped until it is firm and unyielding and conforms to the required grade and cross-section. In order to accomplish this final shaping, the sand must be kept moist, and it is usually necessary to provide a pipe line along the work to supply water for sprinkling the foundation.

Trueing the Surface.—After the pavement has been laid and all defective brick have been replaced to the satisfaction of the engineer, the next step is to sweep the surface clean, and smooth out all inequalities by means of ramming and rolling. The rolling should be done with a power roller weighing from 3 to 5 tons, and the pavement should ordinarily be rolled in both longitudinal and diagonal directions. The longitudinal rolling should be done first, and should begin at the curbs and progress toward the crown. The roller should pass at least twice over every part of the pavement in each direction. In order to neutralize any tendency which the brick may have to careen under the roller, the number of forward trips over any part of the pavement should equal the number of trips backward over the same part.

In places where it is impracticable to use the roller for trueing the surface—such, for example, as along the curbs or concrete gutters or around manholes—the brick should be brought to a true surface by means of ramming. For this purpose a wooden rammer loaded with lead and weighing from 80 to 100 pounds may be used. The blows of the rammer should not fall directly upon the brick, but should be transmitted through a 2-inch board laid parallel to the curb.

After the pavement has been trued up, as described above, it should be inspected again for broken or otherwise damaged brick, and also for those which have settled excessively, owing to some lack of uniformity in the bedding. All defects should be corrected, and the areas disturbed in making the corrections should be brought to a true surface by tamping or rolling. When the work of trueing the surface is finished, the brick should be evenly bedded, but the amount of bedding material forced up into the joints should be inappreciable. If this is not the case, it is evidence that either the bedding has been poorly prepared or the rolling has been excessive.

Filling the Joints.—In order to keep the brick in proper position and protect the edges from chipping it is necessary to fill the joints with some suitable material before the road is opened to traffic. The materials which have in the past been most commonly used for this purpose are sand, various bituminous preparations, and a grout made of equal parts of Portland cement and fine sand mixed with water.

Sand is the least expensive of these materials, but there are several very serious objections to its use as a joint filler: (1) It does not protect the edges of the brick; (2) it is easily distributed in cleaning the pavement and is likely to be washed out by rain on steep grades; (3) it does not entirely prevent water from penetrating through to the foundation; and (4) it does not bond the individual brick together and so enable them to present a concerted resistance to traffic.

The bituminous fillers vary considerably in quality and efficiency, but all are more or less unsatisfactory. One of the principal objections to their use is based on their tendency to run out of the joints into the gutters during warm weather and to crack and spall out during cold weather. This tendency can, of course, be partially overcome by exercising proper care in selecting the materials. It should also be noted in their favor that brick pavements, the joints of which have been filled with bituminous preparations, are ordinarily less noisy than those in which a Portland cement grout filler has been used. The grout filler is unquestionably very much superior from a standpoint of durability, however, and the excessive noise under traffic which has been frequently observed in connection with its use can be largely eliminated by the use of proper bituminous expansion cushions along the curbs. It is, therefore, recommended as better adapted for filling the joints in brick pavements than any other material which has been commonly used for that purpose.

When the joints of a brick pavement are properly filled with Portland cement grout the individual brick are firmly bonded together and, since the material composing the joints scarcely wears more rapidly than the brick, the edges of the brick are well protected.

WATER DEPARTMENT ORGANIZATION AND MANAGEMENT UNDER MUNICIPAL CONTROL.*

By H. A. Whitney,
Hydraulic Engineer, State Railroad Commission, San Francisco

THIS paper has been prepared for an ideal case of a water system which serves a population of somewhat over 100,000 people. Many of the offices as shown on the chart and described herein may be combined or eliminated when the system is smaller or when the growth of population is not rapid. On the other hand, when the growth is rapid or when the population is considerably larger than 100,000, the organization may be enlarged to suit the conditions. While this plan of organization applies specifically to a municipality, yet with slight changes it may be arranged to suit a public utility.

When the operation and management of a municipally owned water department comes under the control of the city government, provision should be made that there be no political interference. The governing board should consist of from three to five citizens chosen by the mayor and approved by the council. The board should appoint the water-department manager.

At each of the regular monthly meetings of the water-board the manager should submit a report showing:

(1) The revenues from the various sources.
(2) The disbursements for various items.
(3) The amount of cash on hand.
(4) An estimate of the amount of interest accumulated from last report.
(5) An estimate of the amount of depreciation of the system from last report.
(6) Cost of maintenance for the past month.
(7) Cost of operation during the past month.
(8) Growth of the system during the past month.
(9) Increase in services during the past month.
(10) The average amount of water used per day.
(11) Progress of construction.
(12) Proposed extensions.
(13) Recommendations for future requirements.
(14) Advice as to the best means for financing construction work.

He should also prepare and submit all special reports when so required by the board.

The manager should administer the affairs of the water department through three divisions, namely, (1) Administration, (2) Engineering, (3) The Advisory Division. The operation of the department should be under three bureaus, namely, (1) Water Supply, (2) Sales and Accounting, (3) Distribution.

The Division of Administration.—The division of administration should be under the direct control of the secretary of the water department. This division is segregated into four sections, namely, Correspondence, Requisition, Orders, Employment.

Correspondence: The secretary should conduct official correspondence. Letters sent from the department office, or from one branch of the department to another should pass through the secretary's hands. In the latter case, copies may be filed with the secretary and the original sent direct where quick results are necessary. All files for correspondence should be kept in the office of the secretary. Routine correspondence is handled by the secretary. Important letters are referred to the manager.

Requisitions: Requests for material should be written by the superintendents of the various bureaus and passed to the secretary, who orders the material from the various supply houses entering a classification number upon the requisition according to the job upon which it is to be used, or noting it as for stock.

Orders: All orders should pass through the division of administration and be signed either by the manager or by the secretary. Service orders and repair orders are generally passed direct to the bureaus of conservation or operation but important construction orders are taken to the manager for approval. All construction and service orders should have an estimate and diagram attached. Each order should be stamped with a classification letter and the job number before leaving the secretary's office.

Employment: Workmen should be hired through the division of administration. A card should be filed for each employee showing name, telephone number, age, and nationality, also the persons recommending him. Room should be left for notations such as "when hired"—"reason for leaving"—"personality"—"type of workman," etc. When a superintendent is in need of men he should notify the secretary, who will communicate with the applicants. If a foreman wishes some man who has been laid off he can notify the secretary to that effect. The timekeeper should see that employment cards are filled out when the men start work.

The Division of Engineering.—The Division of Engineering is in charge of the hydraulic engineer. In the smaller municipalities this office may be held by the manager. The hydraulic engineer shall be responsible to the manager for the operation of the bureau of water supply, the bureau of sales and accounting and the bureau of distribution. To this end he shall have direct control of the engineering division, which should be separated into eight sections as follows:

1. Surveying. Under this section will come the laying out of the lines and grades of all reservoirs, dams, pipe-lines, buildings, conduits, flumes, etc., together with such topography as may be needed.

2. Drafting. All planning, designing, and drafting for buildings, dams, pipe-lines, details, reservoirs, conduits, and flume details should be done in the office of the division of engineering.

3. Maps and Plats. Maps of the distributing system and transmission mains should be kept up to date as well as plats showing the location of all service connections. Such construction maps as may be necessary would come under this section.

4. Construction. The superintendence of the construction and the inspection of all structures such as pipe-

*Abstract of address delivered before the San Francisco Association of Members of the American Society of Civil Engineers, July 20, 1916.

lines, dams, reservoirs, stand pipes, conduits and flumes would be in charge of this section.

5. Specifications. All standard and special specifications of structures and details of same whether for construction work or on requisitions would be written under the direction of the engineer in charge of this section.

6. Rainfall and run-off records as well as the gauging of the various streams and platting of the records would be attended to by the engineer having this work in charge.

7. Investigations. Investigations for electrolysis, durability of meters, condition of structures, and proper type of improvements, would be under this section.

8. Engineering Reports. Reports of an engineering nature such as condition of dams, reservoirs, conduits, pipe-lines, rainfall, run-off, and future improvements, would be under this section.

In the smaller cities one engineer might have several or all of these sections under his charge. All requests for materials and all orders issued to the various bureaus should pass through the division of engineering to the secretary.

The hydraulic engineer should have a series of forms prepared and the superintendents of the various bureaus so instructed that they will render daily reports of all work done, including costs. He should be able to adjust his work so that he will be able to give the manager a report each Saturday of the cost of each job for the week ending the previous Thursday. This, if properly kept up, can be done without employing an experienced high-priced bookkeeper. This report should have the following features:

1. It should show the cost of materials.

2. It should show the comparative cost with the amount estimated.

3. It should be a system of bookkeeping without books, which files the original memorandum, saving the cost of copying and avoiding errors.

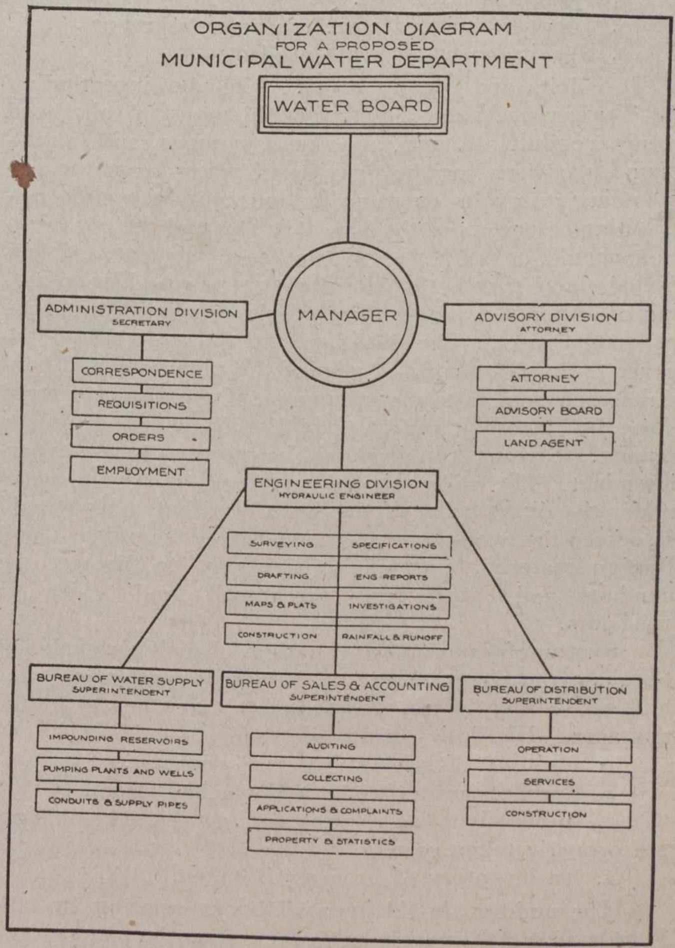
4. It should show the amount of labor and material put into the job to date.

A progress sheet showing the various jobs and a general summary of same should be prepared for the benefit of the manager at the board meetings.

The Bureau of Water Supply.—The bureau of water supply should be in charge of a superintendent whose duty would be to direct the various station operators in the performance of their duties and report to the hydraulic engineer, the progress of all work under his supervision as well as supply him with such information as will enable him to report to the manager the general condition of the water system at all times, both as regards the operation and maintenance. Under his charge will be: (1) The impounding reservoirs; (2) pumping plants and wells; (3) conduits and supply pipes.

The Impounding Reservoirs. Under this subdivision will be the policing of the water-sheds to see that they are at all times kept in a sanitary condition as well as protected from fires, and that the creek beds are free from drift or other substances dangerous to pipe-lines and conduits. Roads and trails should be kept in a passable condition for vehicles or foot travel. Weeds and brush should be kept from the reservoir site below the probable high-water mark for the ensuing year. When so ordered by the hydraulic engineer the reservoir should be treated with copper sulphate or other chemicals to destroy the algae and to keep the water in a pure and sanitary condition. The operation of the inlet and outlet valves should be done only upon the orders of the superintendent. A record should be made each day of the gauge height of the water in the reservoir. When possible, stream-gauge and rain-gauge readings should be sent each day to the hydraulic division for record, as well as the records from the evaporation pans. Minor repairs to the dams and other structures should be made from time to time as needed.

Pumping Plants and Wells. The gathering of all ground waters from galleries and tunnels will come under this subdivision. Records should be sent to the hydraulic division showing the rise or fall of the water plane from day to day as well as the rainfall upon the water-sheds, and the quantity of water drained from the gallery. The operation of galleries should be directed by the foreman in charge, but maintenance and repairs should be under the direction of the superintendent. The operation of the wells should be in charge of the pump operator, the repairs and maintenance under the direction of the superintendent. A record of the pumping-head and the ground-water level should be sent to the hydraulic division each day together with data showing the quantity of water pumped from each well, the amount of fuel or power used, and the time the pump was out of service, together with the reason for the interruption.



When the system is extensive the maintenance and operation of the various pumping stations should be under the immediate direction of a chief pumping-station operator. He should have direct charge of all station operators and instruct them in their duties; see that the various stations run in harmony; that they are kept stocked with operating supplies, and report all accidents and breakdowns. At regular intervals a complete record of each station should be sent to the superintendent showing the amount of fuel or power used; the amount of other supplies consumed; what supplies were received; the amount of water received from various sources and the amounts of water delivered to the various reservoirs or other structures and at what pressures.

When filters are used the plant should be in charge of an experienced operator. A daily report should be sent to the superintendent showing:

1. The character of the raw water filtered.

2. The amount of coagulant used per 1,000 gallons filtered.

3. The loss of head before filtration.

4. The loss of head after filtration.

5. The amount of suspended matter in the raw water.

6. The proportion of suspended matter removed by filtering.

7. The proportion of water used for washing the filters.

8. The supplies needed.

9. Supplies received since the previous report.

10. Repairs or betterments needed.

Conduits and Supply Pipes. The above portion of the Bureau of Water Supply should take in all head works, conduits, tunnels, aqueducts, syphons, and supply-mains necessary for the delivery of water from the impounding reservoirs or pump stations, into the main distributing reservoirs of the city. To this end the organization should be so perfected that each element as mentioned above may be kept in proper repair and in operating condition. A pipe-walker should be placed in charge of each district. The duties of the walker would be to cover the path or right-of-way of the pipe-lines and conduits each day, note what damage, if any, has occurred since his previous report. He should make all minor repairs. Serious trouble should be reported to the superintendent. The walker should operate all valves and gates under the direct order of the superintendent. He should also keep the head-gates and tunnels free from debris and foreign material, and take precautions to protect the conduits and canals from threatened land slides or washouts.

Bureau of Sales and Accounting. This bureau should be under the direct charge of the superintendent of sales and accounting, who reports directly to the hydraulic engineer. His duties are to see that

1. Auditing of accounts is done properly.

2. Accounts are collected and receipts given.

3. Applications for services are issued and complaints are properly taken care of.

4. An inventory of property is taken.

The auditor should keep all books relating to the Department of Water, keep a check upon the finances and take charge of accounts either receivable or payable. He should prepare a monthly statement for the manager showing the condition of the finances of the department. All money for water bills is received by the collector, whc turns over all delinquent bills to the auditor.

The section of applications and complaints makes out contracts for water, issues orders for service installation, gives information to the public pertaining to the water system, hears complaints, reads meters and issues repair orders for those in a faulty condition, inspects house-services and issues notices to those who are wasting water on account of leaky fixtures, investigates the system for the purpose of determining whether water is being used illegally, or if the department is receiving the proper revenue for water served.

The section of property and statistics accounts for material received or disbursed, takes inventory of material in stock, keeps detailed statistics of pipes, valves, fittings and other material in the various structures of the water department, inspects the distributing system and sees that repair orders are issued for leaky or faulty hydrants, valves, or other fixtures that may be noticed by the inspector, issues requests for requisition for new stock as needed.

Bureau of Distribution. The Bureau of Distribution is under the direct charge of the superintendent of distribution who in turn has under him a foreman of operation, a foreman of services, and a foreman of construction. Requests should be made out for all stock needed in order to supply the various foremen working under him with the necessary material. The superintendent should keep account of orders issued for stock and see that the same is delivered in ample time. He should advise the various section foremen as to the most efficient methods of pursuing their work, and report to his superior the progress of all work under his supervision.

The foreman of operation should have charge of machine shop, meter and other repair, blacksmith and carpenter work, department stables, storage yard and pumping plants within the city.

The foreman of services has charge of the installation of screwed pipe, including service connections and extensions. The tapping of the mains, lead connections and the installation of meters is performed under his direct orders. Standpipes for hose connection, public fountains, and watering troughs are placed under the immediate direction of this foreman. Repairing of leaks is also done by the foreman of services, except large breaks in the cast iron mains, which may be done by the foreman of construction.

The foreman of construction, when the size of the department requires the services of a man in this capacity, has charge of the laying of cast-iron pipe and all other distributing mains. The cleaning and repair of reservoirs and standpipes should be performed by the foreman of construction. In cities of small population the duties of the foreman of services, foreman of construction, and even the foreman of operation may be performed by one man. In cities of 40,000 population or under there is generally no foreman of operation or services and no superintendent of distribution. The hydraulic engineer or some similar official acts as manager, issuing his orders direct to one man who acts in the capacity of superintendent of distribution, foreman of operation, services, and of construction.

Advisory Division. The Advisory Division should be in charge of the attorney for the water department.

He will pass upon contracts and specifications prepared by the division of engineering, try lawsuits in behalf of the Department of Water, pass upon land titles and sales, prepare all legal documents, and advise the manager as to legal methods of procedure. The attorney shall be chairman of the Advisory Board, which consists of the attorney, the hydraulic engineer, and the secretary. Its duties are:

1. To advise the manager as to the best methods of procedure when requested.

2. To pass upon the advisability of initiating lawsuits.

3. To decide upon the best method of settling damage claims.

4. To pass upon claims presented by contractors to the department.

5. To decide such other matters as the manager may bring before the board. The land agent shall have charge of the buying, listing, specifying, and selling of all lands owned or leased by the Department of Water, and shall obtain rights-of-way when so ordered through the attorney by the manager.

CHLORINATION OF WATER.

By Joseph Race, F.I.C., City Bacteriologist, Ottawa.

IN *The Canadian Engineer* of March 16, 1916, pages 345-346, certain experiments were described which indicated that the germicidal effect of hypochlorite could be considerably enhanced by the addition of an equivalent of ammonia. The difficulties encountered during the translation of the laboratory experiments to the practical working scale were also given, and it was suggested that the loss of available chlorine noted after the admixture of the aqua ammonia and bleach solution could be eliminated by permitting these solutions to mix for only a few seconds before being discharged into the water that it was desired to treat.

The dosing apparatus in the experimental plant referred to (capacity 200,000 gallons per day) was rearranged and the dilute bleach and ammonia solutions, after passing through the usual controlling apparatus, were brought together in the injection pipe at a point 8 feet away from the raw water intake pipe. In this way the period of contact, before thorough dilution with the raw water, was reduced to a minimum.

After the adoption of this method of admixture excellent results were immediately secured and the dosage was gradually reduced until the purity of the treated water was adversely affected. The dosage was retained at this figure, approximately 0.23 parts per million of available chlorine and 0.12 parts per million of anhydrous ammonia, for a period of several weeks. The results of the daily tests, together with those of the main plant where 20 million gallons per day were being treated with straight hypochlorite, are given in the following tables. These results have demonstrated that the process is eminently practical and can be used to advantage when bleach is abnormally high in price.

A further example of the efficiency of this process was found during a series of experiments on the disinfection of the water of a swimming pool at the Ottawa Y.M.C.A. This pool was being extensively used by the various military units stationed in Ottawa in addition to the members of the association, and it was found that frequent changes of water were necessary in order to prevent complaints. The cost of raising the temperature of the water 20 to 25 degrees Fahrenheit quickly became a serious financial consideration and the writer was requested to suggest some method of disinfection which would enable the water to be retained for at least 7 days. Hypochlorite was first used, but even with doses as high as 3 parts per million of available chlorine aftergrowths rapidly occurred and total bacterial counts of 50,000 to 100,000 per c.cm. were repeatedly found; the B. coli index was usually 2 to 5 per c.cm.

Hypochlorite treatment at this dosage was a total failure and it was deemed undesirable to use larger amounts on account of the tendency of hypochlorite to cause irritation to mucous membranes.

Chloramine treatment was next used and after the attendant had become thoroughly conversant with the proper method of application thoroughly satisfactory results were secured. The treatment finally adopted was 1 part per million of chlorine together with 0.5 parts per million of ammonia, and this treatment when conscientiously carried out produced a water containing less than 100 bacteria per c.cm. and free from B. coli.

The elimination of aftergrowths by the chloramine treatment is due to the non-absorption of the germicide so that all of the added substances are available for the destruction of bacteria.

It has been suggested that the influence of the ammonia is to increase the oxidizing activity of the chlorine but this view is not supported by the evidence available. If the oxidizing effect were accelerated, the mixture would be even more readily absorbed by waters containing readily oxidizable organic matter than hypochlorite alone. Experiments demonstrate the reverse, for it was found that on adding 10 p.p.m. of available chlorine as hypochlorite to the Ottawa River water, about 35 per cent. was absorbed in 5 minutes at 60° F. and 60 per cent. within 1 hour; if an equivalent of ammonia were first added to the solution, only 1.4 per cent. of the available chlorine was absorbed in 1 hour and 3.2 per cent. in 20 hours.

COMPARISON OF HYPOCHLORITE AND CHLORAMINE TREATMENT

BACTERIOLOGICAL RESULTS

1916	Raw Water: Bacteria per c.cm. Agar 1 day at 37° C.	Raw Water: Bacteria per c.cm. Agar 3 days at 20° C.	Raw Water: B Coli Index per 100 c.cms.	Treated with Hypochlorite Alone: Bacteria per c.cm. Agar 1 day at 37° C.	Treated with Hypochlorite Alone: Bacteria per c.cm. Agar 3 days at 20° C.	Treated with Hypochlorite Alone: B Coli Index per 100 c.cms.	Treated with Hypochlorite Alone: Available Chlorine p.p.m.	Treated with Hypochlorite and Ammonia: Bacteria per c.cm. Agar 1 day at 37° C.	Treated with Hypochlorite and Ammonia: Bacteria per c.cm. Agar 3 days at 20° C.	Treated with Hypochlorite and Ammonia: B Coli Index per 100 c.cms.	Treated with Hypochlorite and Ammonia: Available Chlorine p.p.m.	Treated with Hypochlorite and Ammonia: Ammonia p.p.m.
Mar. 15—31	44	238	35.7	4	12	<0.14	0.90	4	12	0.14	0.22	0.11
Apr. 1—19	3,099	14,408	195.5	32	56	0.50	1.10	33	246	0.74	0.25	0.13

PERCENTAGE REDUCTION

	Hypochlorite Alone: Bacteria per c.cm. Agar 1 day at 37° C.	Hypochlorite Alone: Bacteria per c.cm. Agar 3 days at 20° C.	Hypochlorite Alone: B Coli Index per 100 c.cms	Hypochlorite Alone: Available Chlorine p.p.m.	Hypochlorite and Ammonia: Bacteria per c.cm. Agar 1 day at 37° C.	Hypochlorite and Ammonia: Bacteria per c.cm. Agar 3 days at 20° C.	Hypochlorite and Ammonia: B Coli Index per 100 c.cms.	Hypochlorite and Ammonia: Available Chlorine p.p.m.
Mar. 15—31	90.9	95.8	99.9+	0.90	90.9	95.0	99.7	0.22
Apr. 1—19	98.9	99.6	99.7	1.10	98.3	98.9	99.6	0.25

COST OF MATERIAL PER MILLION IMPERIAL GALLONS

	Hypochlorite Alone	Hypochlorite and Ammonia
Mar. 15—31	$0.945	$0.456
Apr. 1—19	$1.158	$0.530

Calculated on Bleach at $3.50 per 100 lbs. and Aqua Ammonia (26° B) at 5½ cents per lb.

Again, the oxidizing effect of hypochlorite can be measured by its bleaching effect on dyestuffs and Rideal (Journal Royal Sanitary Institute, xxxi., No. 2, 1910, p. 40) has shown that the addition of an equivalent of ammonia to hypochlorite solutions reduces the bleaching efficiency to approximately 2 per cent. of the original value. These results have been confirmed by the writer and conclusively prove that the enhanced germicidal effect of chloramine is in no way connected with oxidation.

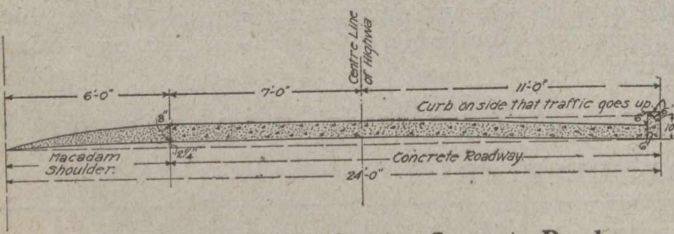
Further studies on substances containing the chloramine group (:NCl) by Dakin et al (Journal Royal Society 1916, B. 89, 232-251) would suggest that the usual conception of the germicidal effect of chlorine and hypochlorites being due to oxidation may be erroneous and that the action should be at least partially attributed to the chloramine derivatives produced by the action of chlorine on amino acids and protein.

A SPECIAL HILLSIDE SECTION OF THE TORONTO-HAMILTON HIGHWAY.

By H. S. Van Scoyoc,
Chief Engineer, Toronto-Hamilton Highway.

MUCH of the natural soil in the district traversed by the Toronto to Hamilton highway is light and sandy, making the problem of maintaining the shoulders and the slopes in cut and fill a rather serious one. The material seems to catch in grass comparatively easily, particularly on the shoulders where the washings from the roadway both fertilize and seed the soil. Two years observations of the heavy cuts and fills in the Lorne Park section made it evident, however, that some special treatment was necessary to prevent undermining in that locality.

While the maximum grade on which concrete can be safely used is still an open question, experience has



Special Hillside Section for Concrete Road.

shown that with a grade approaching four per cent. horse-drawn vehicles tend to seek the shoulder on the down-hill side; that is, the concrete provides a satisfactory footing so far as pulling the loads up the hill is concerned, but the brakes are more effective in going down-hill if the wheels are on an earth or broken stone shoulder.

The section shown in the accompanying drawing was designed with the idea of providing a fairly wide broken stone shoulder for down-hill traffic, as well as a crown which would tend to throw all of the surface water towards a six-inch integral curb which was constructed on the up-hill side. The position of the curb and shoulder change from one side to the other at the low points in the grade.

Catch basins were built at the low points and at intervals of approximately 300 feet on the grades. While there have been no severe storms since the work was completed, such rains as have occurred have been quite readily handled.

THE DESIGN OF STEEL STACKS.*

By W. A. Hitchcock.

AS books on structural design do not usually consider the design of the modern self-supporting steel stack, it is hoped that this brief, concise treatment of the subject will be of interest to the designer and engineer. Some new formulas are given and it is believed that all the diagrams shown are new.

The design of the steel stack will be considered under six subdivisions, *viz.*: (1) Working stresses; (2) Minimum thickness of plate in the shell; (3) Minimum size of foundation; (4) Minimum size of anchor bolts; (5) Riveting; (6) Base plate.

Nomenclature.

H = height of stack in feet above any section;
d = outside diameter of the stack in inches;
d' = inside diameter of the stack in inches;
D = outside diameter of the stack in feet;
s' = unit stress in plate due to weight of stack above section;
s = unit stress in plate due to wind pressure;
S = total unit stress in plate;
E = efficiency of riveted joint;
T = thickness of plate in inches;
P = pressure of wind on projected diameter, lb. per square foot;
D' = diameter of the foundation in feet, assuming a circular section;
h = height of foundation in feet;
W_o = weight of steel stack;
W_1 = weight of stack lining;
W_t = weight of foundation;
b = diameter of each anchor bolt in inches;
B = diameter of the anchor bolt circle in feet;
t = allowable tension in a bolt at unit distance from the axis;
x = distance from axis to any bolt in feet.

Loads and Working Stresses.—The following working stresses are recommended:

Plates, tension and compression		16,000 lb. per sq. in.
Shop rivets, shear		12,000 lb. per sq. in.
	bearing pressure	24,000 lb. per sq. in.
Field rivets, shear		9,000 lb. per sq. in.
	bearing pressure	18,000 lb. per sq. in.
Anchor bolts, tension		15,000 lb. per sq. in.

Wind pressure: The wind pressure is assumed to be 20 lb. per sq. ft. on the projected diameter. (Prussian engineers use 17 lb.)

Weight of concrete: The weight of concrete is taken as 150 lb. per cu. ft.

Efficiency: The average value for efficiency for double riveted joints is taken as 0.70; the average value for single riveted joints as 0.50.

Minimum Thickness of Plate in the Shell.—For a stack as shown in Fig. 1 (a), the overturning moment due to wind pressure is

$$M = P \times D \times H \times 12 \times \tfrac{1}{2} H = \tfrac{1}{2}.12PDH^2 \text{ in. lb.} \quad (1)$$

or,

$$M = \tfrac{1}{2}PdH^2 \text{ in. lb.}$$

The resisting moment at any section is given by

$$M = \frac{\pi(d^4 - d'^4)s}{32d}; \text{ but } d' = (d - 2T), \text{ therefore}$$

$d'^4 = (d - 2T)^4$, giving, if we neglect powers of T higher

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*Journal of Engineering, University of Colorado.

than the first which may be done as T is very small as compared with d, the resisting moment,

$$M = \frac{\pi \times 8 \times d^3 T s}{32 d} = 0.7854\ d^2 T s \qquad (2)$$

Solving equations (1) and (2),

$$s = \frac{P d H^2}{2 \times 0.7854\ d^2 T} = \frac{0.053\ P H^2}{D T} \qquad (3)$$

or the stress per lineal inch along the circumference is

$$S' = \frac{0.053\ P H^2}{D} \qquad (4)$$

If E be taken as the efficiency of a riveted joint, equation (2) becomes,

$$M = 0.7854\ d^2 T s E \qquad (5)$$

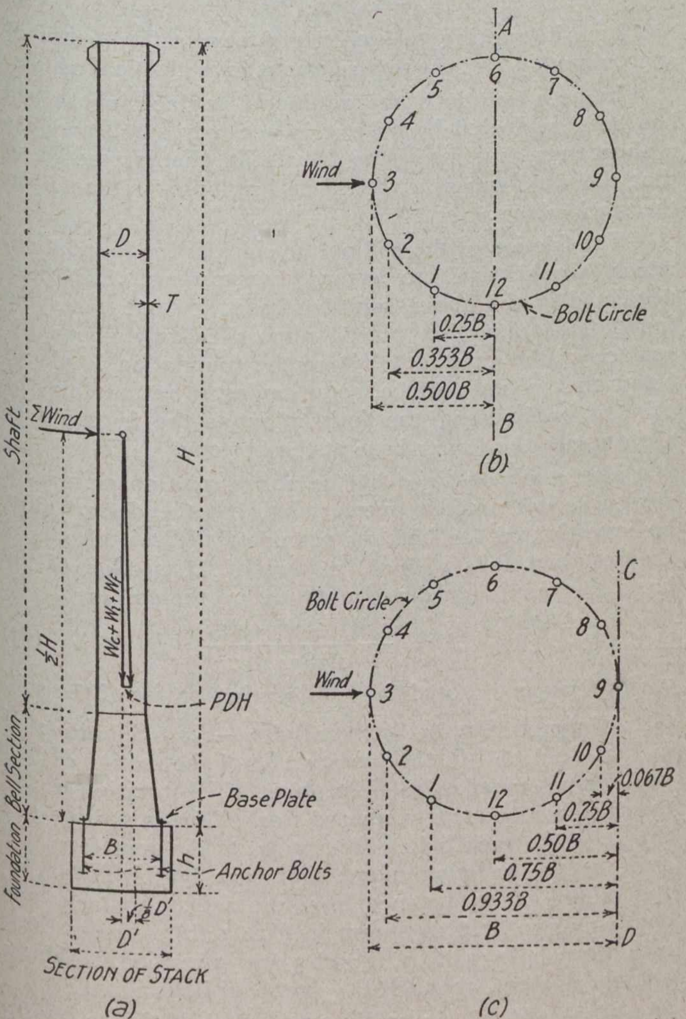

Fig. 1.

Solving equations (1) and (5) for T, we have

$$T = \frac{P d H^2}{2 \times 0.7854\ d^2 s E} = \frac{0.053\ P H^2}{D f E} \qquad (6)$$

which gives the thickness of plate necessary at any section to resist the moment due to wind pressure, for any fiber stress, f, and any efficiency.

The unit stress at any section due to the weight of the stack above the section is,

$$s' = \frac{W}{24 \pi D T} = \frac{490 \pi D H T}{144 \pi D T} = 3.4\ H \qquad (7)$$

Therefore the total unit stress in the plate at any section is given by

$$S = 3.4\ H \pm \frac{0.053\ P H^2}{D T} \qquad (8)$$

It is evident from equation (8) that the stress due to weight of stack above the section may be neglected up to a height of over 400 feet with an error of less than one per cent.

The weight of the lining has been neglected as it is usually carried by the foundation. In special cases it may be carried on angles riveted to the shell. In such cases the weight should of course be included.

Taking P as 20 lb. per sq. ft., f as 16,000 lb. per sq. in., and E for double-riveted joints as 0.70, equation (6) gives the safe minimum thickness of plate for double-riveted horizontal joints as,

$$T = 0.0000947\ H^2/D \qquad (9)$$

Taking E as 0.50, we have for the safe minimum thickness of plate for single-riveted horizontal joints,

$$T = 0.0001326\ H^2/D \qquad (10)$$

Equations (9) and (10) have been plotted as shown in Figs. 2 and 3. These diagrams give the safe minimum thickness of plate to resist the moment due to wind pressure for any given height and diameter.

Example: Determine the thickness of plate for a stack 16 feet in diameter with double-riveted horizontal joints, with a height of 240 feet above the section.

Enter Fig. 2 with the diameter at the top, and follow down the vertical line through 16 till the height, 240 feet, is reached, and read 3/8-in. plate as the thickness required.

For permanent structures 1/4-in. is recommended as the minimum thickness of plate to be used at any time, though 3/16-in. plate has been used for the upper 30 feet of some comparatively temporary stacks.

Thus starting with 1/4-in. plates at the top, the diagram gives the distance down from the top at which a change of thickness is required. The diagrams are arranged to read from the top downward to correspond with the method of designing. The design is carried in this way from the top down to the top of the bell section. It is customary to use plates for the bell section 1/16-in. thicker than the plates immediately above the bell. These plates are placed vertical with butt joints and single outside straps, though in small stacks the bell section is often built up of circumferential plates.

In stacks of large diameter, the thin plates of the upper sections may require stiffening to guard against lateral collapse. This is usually done by riveting rings made up of angles on the inside of the stack.

It is interesting to note that some engineers recommend that the bell section be made 1/7 the total height above the foundation and that the diameter of the bell at the foundation be 1½ to 2 times the diameter of the stack. These proportions are pleasing to the eye. The development of modern æsthetic taste cannot be ignored entirely by the designer. His stack should be structurally secure and also well proportioned. A neat cornice at the top of the stack is also desirable because of these considerations.

Minimum Size of Foundation.—First Solution: As the kern for a circular section is $D'/4$, the resultant of the weight of the stack, stack lining, foundation, and wind pressure must cut the base at a point not greater than $D'/8$, as shown in Fig. 1 (a). Therefore, equating the resisting and overturning moments,

$$(W_o + W_1 + W_f)\ D'/8 = \tfrac{1}{2} \cdot 20 \cdot DH\ (H+h) \qquad (11)$$

or

$$D' = \frac{80\ DH\ (H+h)}{W_o + W_1 + W_f} \qquad (12)$$

which gives the minimum diameter of foundation that will insure compression over all portions of the base.

If h be neglected as being very small in comparison with H, and in like manner W_o and W_1 be neglected as being small as compared with W_f, an approximation which will evidently give values for D' which are on the safe side, the expression for D' may be simplified to,

$$D' = 80\ DH^2/W_t \qquad (13)$$

But $$W_t = \tfrac{1}{4}\cdot\pi D'^2 \times h \times 150 = 117.8\ hD'^2 \qquad (14)$$

Setting this value of W_t in equation (13) and solving,

$$D' = 0.879\ (DH^2/h)^{\frac{1}{3}} \qquad (15)$$

If h be taken as equal to 0.4 D', a common proportion,

$$D' = 1.14\ (DH^2)^{\frac{1}{4}} \qquad (16)$$

Equation (16) will usually give a sufficiently accurate value for D', though in some cases it may be desirable to make an exact solution by means of equation (12) after the value from equation (16) is obtained.

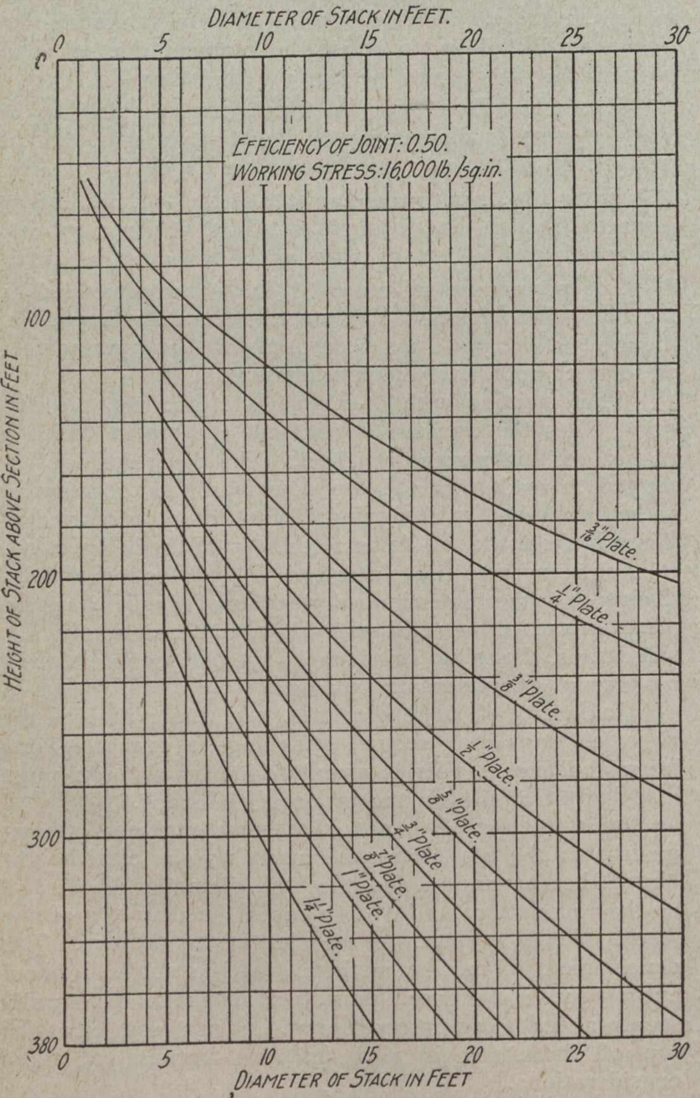

Fig. 2.—Thickness of Plates.

Equation (16) has been plotted in Fig. 4 so that the minimum diameter of foundation for any given height and diameter is easily obtained.

Example: Determine the minimum diameter of concrete foundation for a stack 15 feet in diameter and 175 feet high, assuming that the height of the foundation is 2/5 the diameter. Enter Fig. 4 with the diameter, follow down vertical line through 15 till the height of 175 feet is reached and read 30 feet as the required diameter.

Second Solution: The overturning moment at the top of the foundation is

$$M = 10\ DH^2 \text{ ft. lb.} \qquad (17)$$

The weight of the foundation, as found before, is

$$W_t = 117.8\ hD' \qquad (18)$$

Taking moments about an axis tangent to the leeward side of the foundation, and neglecting the resisting moment due to W_o and W_1 as small compared with equation (17), the resisting moment is

$$M = W_t D'/2 = 58.9\ hD'^3 \qquad (19)$$

If a safety factor of 2 be taken, equation (19) becomes

$$M = 29.45\ hD'^3 \qquad (20)$$

Solving equations (17) and (20),

$$D = 0.6976\ (DH^2/h)^{\frac{1}{3}} \qquad (21)$$

If h be taken as 0.4 D' again, we have,

$$D' = 0.960\ (DH^2)^{\frac{1}{4}} \qquad (22)$$

It is interesting to note that for a safety factor of approximately 2¼, the two solutions give identical results.

In both solutions the additional surface in the bell has been neglected because it is not only small and has a short arm, but also is usually somewhat protected so that the wind pressure would be less upon it than upon the stack above.

The friction of the soil on the sides of the foundation, which would tend to retard overturning, has been neglected in the above solutions as in some cases the foundation may be placed almost entirely above the surface of the ground. Where the foundation is placed below the ground surface, some saving in volume may be effected by building the foundation as the frustrum of a cone with the larger base at the bottom.

The result obtained by the above solutions insures a design secure against overturning, but the design must be investigated for bearing power of the soil also. As the resultant falls within the kern of the section of the base, the maximum direct pressure on the soil is

$$F = \frac{2(W_o + W_1 + W_t)}{0.7854\ D'^2} \qquad (23)$$

which must not exceed the safe bearing power of the soil.

Minimum Size of Anchor Bolts.—First Solution: If in Fig. 1 (b), A—B, the gravity axis of the section of bolt circle, be assumed as the axis about which rotation occurs then the bolts on the windward side will be in tension and the stress in each bolt will vary as its distance from the axis, or the resisting moment of each bolt will vary as the square of its distance from the axis. A stack base containing 12 bolts is shown in Fig. 1 (b). Under these conditions bolts 1, 2, 3, 4 and 5 are in tension. The resisting moment, then, of the group of bolts is

$$M = t\Sigma x^2 = t\ [(\tfrac{1}{2}B \sin 30°)^2 \times 2 + (\tfrac{1}{2}B \sin 60°)^2 \times 2 + \tfrac{1}{2}B)]$$
$$= t\ [2(0.25) + 2(0.75) + 1]\ B^2/4 = 0.75\ B^2 t \qquad (24)$$

The moment due to wind pressure is

$$M = \tfrac{1}{2}PDH^2 \qquad (25)$$

therefore

$$t = M/\Sigma x^2 = PDH^2/1.5\ B^2 \qquad (26)$$

The stress in bolt 3, which will be the maximum stress in the group of bolts, is

$$tB/2 = PDH^2/3B \qquad (27)$$

If the fiber stress in a bolt be taken as f, then equating actual stress in bolt 3 to the allowable stress,

$$0.7854 \times f \times b^2 = PDH^2/3B \qquad (28)$$

Solving for b,

$$b = 1.538\ H(PD/fB)^{\frac{1}{2}} \qquad (29)$$

Taking P as 20 lb. per sq. ft. and f as 15,000 lb. per sq. in. the diameter of anchor bolt for a group of 12 bolts is

$$b = 0.0238\ H(D/B)^{\frac{1}{2}} \qquad (30)$$

For the general case of n number of bolts it may be shown that $\Sigma x^2 = nB^2/16$, then equating actual to allowable stress in outermost bolt as before, we have

$$b = 2.26\ H(PD/nfB)^{\frac{1}{2}} \quad (31)$$

which gives the diameter of the anchor bolt for any wind pressure, any number of bolts, and any fiber stress.

Equation (31), for a wind pressure of 20 lb. per sq. ft. and a fiber stress of 15,000 lb. per sq. in. becomes,

$$b = 0.0824\ H(D/nB)^{\frac{1}{2}} \quad (32)$$

This may be written in the form,

$$b = C_1 H(D/B)^{\frac{1}{2}} \quad (33)$$

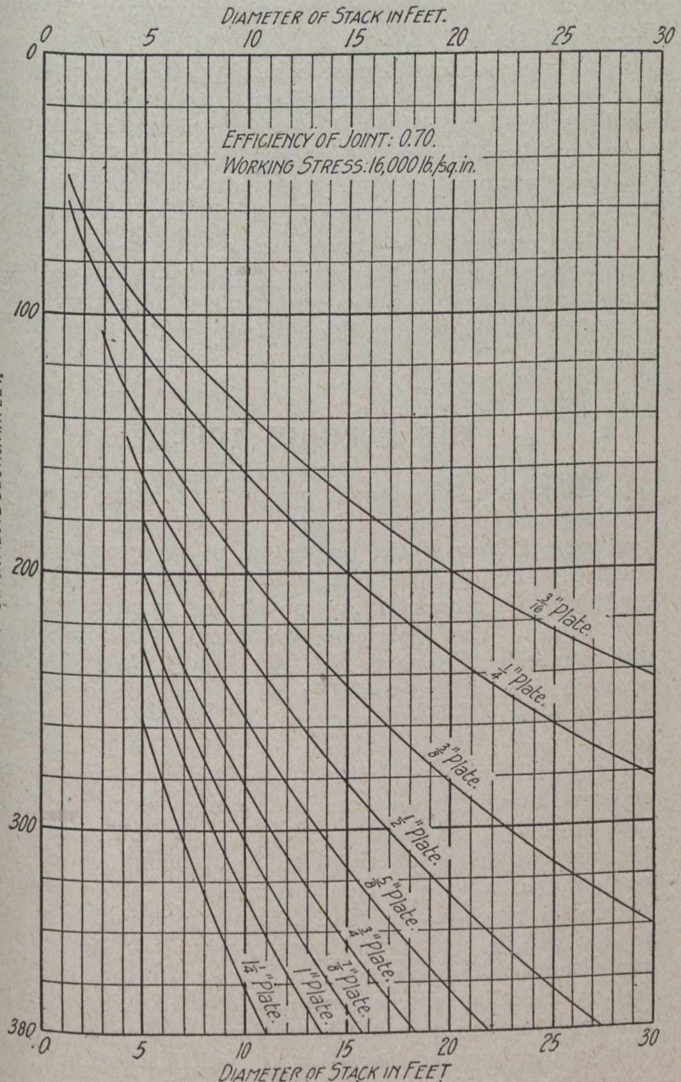

Fig. 3.—Thickness of Plates.

Values for C_1 were computed for number of bolts varying from 6 to 36 and the values plotted in Fig. 5.

Example: What diameter of anchor bolt is required for a stack 16 feet in diameter and 175 feet high, if 15 bolts are used in a bolt circle 25 feet in diameter?

From Fig. 5 the value of C_1 for 15 bolts is found to be 0.0212. Substituting this value in equation (33), it is found that a bolt 2.96 or, say, 3 inches in diameter is required.

Second Solution: If the stack be assumed to rotate about an axis tangent to the leeward side of the bolt circle, as shown by C-D in Fig. 1 (c), all the bolts but one will be in tension. As before, the stress in each bolt will vary as its distance from the axis and the resisting moment of each bolt will vary as the square of its distance from the axis.

$$\Sigma x^2 = [2(0.134)^2 + 2(0.5)^2 + 2(1.5)^2 + 2(1) + 2(1.866)^2 + (2)^2]\ B^2/4 \quad (34)$$

or

$$\Sigma x^2 = 4.5\ B^2$$

For the general case of n bolts it may be shown that

$$\Sigma x^2 = 3nB^2/8 \quad (35)$$

Therefore, solving as before,

$$b = 1.70\ H(PD/nfB)^{\frac{1}{2}} \quad (36)$$

For the same load and fiber stress as before, for 12 bolts we have,

$$b = 0.0137\ H(D/B)^{\frac{1}{2}} \quad (37)$$

which is only about 60 per cent. of the value given by equation (30).

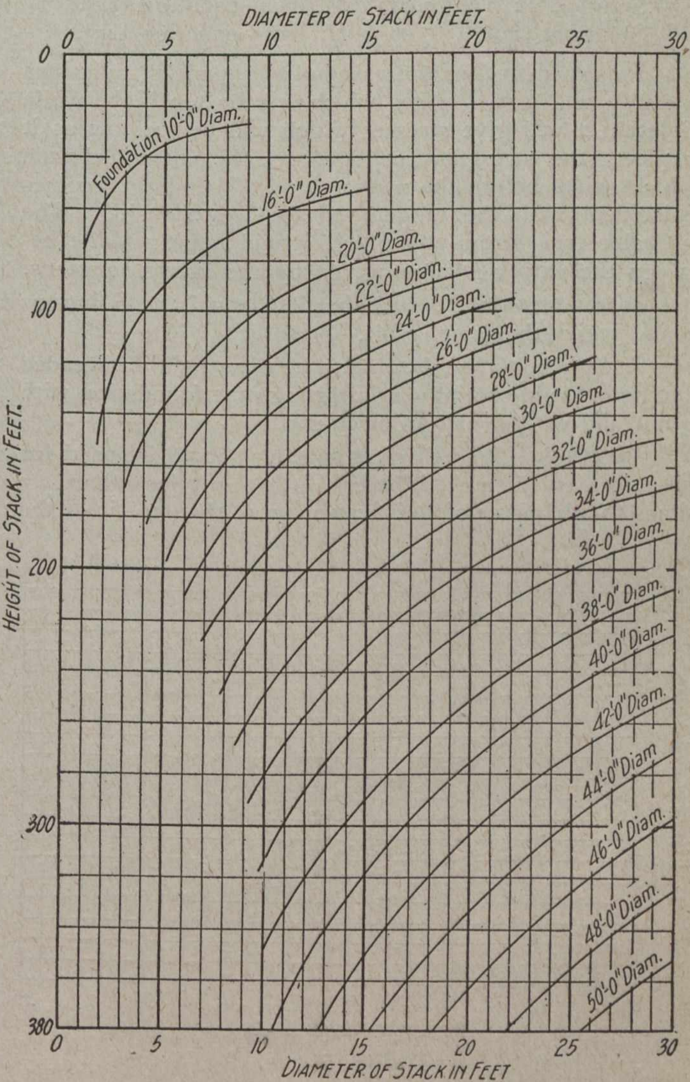

Fig. 4.—Diameter of Foundation.

Setting the same load and fiber stress in equation (36), we have,

$$b = 0.04764\ (D/nB)^{\frac{1}{2}} \quad (38)$$

Again this may be written in the form,

$$b = C_2 H\ (D/B)^{\frac{1}{2}} \quad (39)$$

Values for C_2 have been plotted in Fig. 5 that the results given by Solutions 1 and 2 might be compared.

Third Solution: From equation (4) the stress per lineal inch along the circumference at any section is $S' = 0.053\ PH^2/D$. Therefore the stress in each anchor bolt will be $S'p$, where p is the distance between the bolts in inches. Therefore, equating actual and allowable stresses,

$$0.7854 \times f \times b^2 = 0.053 \frac{PH^2}{D} \times \frac{12\pi B}{n} \times \frac{D}{B} \quad (40)$$

Solving for b,

$$b = 1.595\ H(P/nf)^{\frac{1}{2}} \quad (41)$$

For 12 bolts and with same load and fiber stress as before,

$$b = 0.02377\ H \quad (42)$$

For the general expression for any number of bolts and the same load and fiber stress,

$$b = 0.0823\ H(1/n)^{\frac{1}{2}} \quad (43)$$

Comparison of Solutions: For a comparison of the solutions, take the case of 12 anchor bolts and assume B equals $3/2D$. Then the values for b are:

Solution 1: $b = 0.0193\ H$, from equation (30).
Solution 2: $b = 0.0112\ H$, from equation (37).
Solution 3: $b = 0.0237\ H$, from equation (43).

It is evident that the assumptions made in Solutions 1 and 3 will give stresses which will be too high, while Solution 2 will give stresses which will be too low as it neglects the stress in the bolts on the windward side which exists before the neutral axis of bending becomes coincident with the tangent on the leeward side. The probable true stress, therefore, would appear to lie between the extreme values given by the above solutions.

It is interesting to note that if B equals D, Solutions 1 and 3 give the same result.

Anchor bolts should always be upset at the threaded end and should extend nearly through the foundation with a nut and washer at the lower end.

Riveting.—A small rivet spacing should be used for all joints to insure tightness, being not less than 2.5 times the diameter of the rivet or more than 16 times the

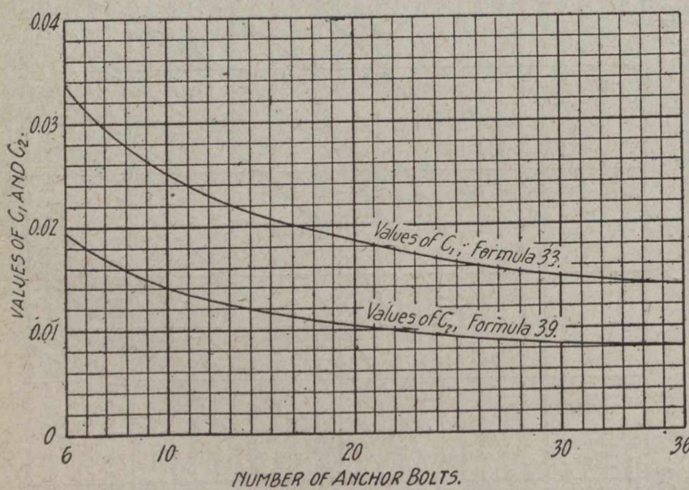

Fig. 5.

thickness of the plate. A single-riveted lap joint is commonly used for the vertical joints, while a double-riveted lap joint is used for the horizontal joints. It is very desirable that the horizontal joints should be water-tight, that the water running down the inside of the stack, which becomes strongly acid, may not get into the joints and cause corrosion, and also that the water may not run through the joint and give the outside of the stack a very untidy appearance.

It will be found that the above recommended rivet spacings and joints will give ample strength at any section for direct stress or shear.

The connection of the shell to the base plate must be carefully investigated to insure a sufficient number of rivets to transfer the stress from the plates to the base plate. Equation (4) gives the stress per lineal inch along the circumference for a diameter D, therefore the stress per lineal inch at the base plate will be,

$$S' = 0.053\ PH^2/B \quad (44)$$

From this equation the necessary rivet spacing is easily obtained.

Base Plate.—The base plate is commonly of cast iron, made up of sections from 20° to 180° of arc in length, which are firmly bolted together. The shell is riveted to the base plate and the anchor bolts pass down through it. Another form of base plate consists of a ring of angle iron around the inside of the shell, with short pieces of angles, placed vertically and in pairs that the anchor bolt may pass down between, riveted to the outside of the shell.

Each section of the cast base plate may be designed as a beam with a uniformly distributed load due to the wind pressure transferred through the plates, and two or more reactions due to the anchor bolts. The width of the base plate must be investigated also that the allowable bearing power of the concrete foundation be not exceeded.

Most authors have advocated a cut-and-try method for stack design, which might or might not involve many trials before a solution was obtained. The methods here presented should obviate this difficulty and lead to direct results.

THE TYPHOID TOLL.

Before the last annual meeting of the American Waterworks Association George A. Johnson, consulting engineer of New York, presented a noteworthy paper entitled "The Typhoid Toll." This paper was discussed by thirty-five representative physicians, engineers and sanitarians. The American Waterworks Association, in order to give this paper of Mr. Johnson's the widest possible circulation, together with the discussion, is issuing it in pamphlet form, and it will contain from 125 to 150 pages. It is a non-scientific treatment covering the general subject of typhoid fever, its causes and means of prevention. To give the information which the paper and discussion provided the widest possible circulation the association is offering to sell quantities of this pamphlet at a very reasonable price so as to bring it within the reach of everyone. Single copies up to a total of 100 will be sold for 20c. per copy or 25c. per copy if the discussion is included; 100 copies, $15 per hundred, $18.75 including discussion; 100 to 500 copies, $14 per hundred, or $17.50 with discussion; over 500 copies, $12.50 per hundred, or $15.75 with discussion. It is hoped that by this means the paper will be given great publicity and that it will help in the securing of a better water supply and better all round sanitary conditions in general. The copy containing the discussion is strongly recommended. This is a splendid opportunity for those who are concerned with matters of this kind to obtain a mine of good advice and sound information at a trifling cost, at the same time enabling them to disseminate information which is along the right lines, and it is hoped that great numbers of these pamphlets will be purchased and distributed.

J. M. Diven, Troy, N.Y., is secretary of the American Waterworks Association.

The railways which enter the city of Chicago have spent $100,000,000 upon the elimination of grade crossings within the city limits. When all the crossings shall have been eliminated the cost will be something like $200,000,000.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

CONTENTS.

BOOK REVIEWS.

Bridge Engineering. By J. A. L. Waddell, D.Sc., LL.D., M.Am.Soc.C.E., etc., etc. Published by John Wiley & Sons., Inc., New York. First edition, 1916. In two volumes. 2,177 pp.; profusely illustrated; 6 x 9 ins.; cloth. Price, $10 net. (Reviewed by H. M. Mackay, M.Can.Soc.C.E., M.Am.Soc.C.E., Professor of Civil Engineering, McGill University.)

This important work may, in a sense, be considered to have grown out of the author's previous well-known book, De Pontibus. But as the amount of matter is at least seven times as great, it is evident that it will occupy a very different place in engineering literature. It differs from the ordinary treatises on bridges in that, for the most part, the calculation of primary stresses is taken for granted. This seems a desirable feature, inasmuch as this particular field is well covered by numerous other works. Nevertheless, there is a full discussion of the various methods of calculation in common use; and a considerable amount of space is devoted to the computation of secondary, temperature and other statically indeterminate stresses, and to the deflection of beams and framed structures. While beginners may possibly get a better grasp of the principles involved in this connection from other works, the discussion of the methods for the elimination or reduction of secondary stresses is much fuller and more satisfactory in the present volumes. The treatment of the stresses in reinforced concrete bridges of all types is quite full, and is accompanied by many useful diagrams to facilitate computation.

On the other hand, the distinctive feature of the work is the extended treatment of almost innumerable questions which are briefly dismissed or entirely passed over in other books. Special attention may be directed, among others, to the chapters on Alloy Steels in Bridgework, Intensities of Working Stress, First Principles of Designing, Detailing in General, Shopwork as Affecting Bridge Design, Floors and Floor Systems, Laterals and Sway Bracing, Determination of Waterways, Estimates, Office Practice, Inspection, Erection and Falsework, Maintenance of Traffic, and Maintenance and Repairs. Throughout, the author's point of view is that of a consulting engineer, whose interests are those of his client. While true economy is always kept in the foreground, excellence of design is never subordinated to practices whose chief object is the cutting of shop costs to the irreducible minimum. Nor does the author hesitate to condemn the system, as prevalent here as in the United States, of leaving the design of structures in the hands of bridge contractors. In the treatment of shopwork as affecting design, however, the views of such well-known representatives of the bridge companies as Messrs. Wolfel of the McClintic-Marshal Co., and Reichman of the American Bridge Co. are fully given.

Metal arches, cantilevers, suspension bridges and movable bridges of all classes are treated in a general way. The treatment of foundations is also relatively brief; but many examples of difficulties encountered and expedients adopted in the author's practice are mentioned.

Very full and valuable data are given on the weights of steel in superstructures, and the quantities in piers and abutments. No other treatise which we can recall compares with the present one in this respect.

More than 250 pages are devoted to specifications governing all classes of bridgework, and the work ends with a very extended glossary of the terms used in bridge construction, and a well-arranged index.

The author is to be congratulated in that he has withheld from his readers little or nothing communicable, which he has gathered from his extended experience. He has projected his personality into his work with unusual frankness; and while some may regard this as a defect in a technical work, others will, no doubt, deem it not the least interesting feature. Complete agreement with all the author's views, so fully set forth, is not to be expected. It may be said, however, that, whether considered as a whole or in detail, the book makes for the highest class of bridge engineering. It seems likely to prove indispensable to most bridge engineers; and it is certainly a veritable mine of information for all beginners.

The Construction of Roads and Pavements. By T. R. Agg, C.E., Professor of Highway Engineering, Iowa State College. Published by the McGraw-Hill Book Co., New York. First edition, 1916. 432 pages, 116 illustrations, 6 x 9 ins., cloth. Price, $3.00 net. (Reviewed by H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission, Toronto.)

This new highway book brings with it the atmosphere of the typical middle western state college or university. The outstanding characteristic is an endeavor to present information in a way that makes it of practical benefit to people who are actually doing things. The author states that the book is primarily intended as a text in a college course on roads and pavements. It will be found valuable by highway engineers, both as a book of reference and as a hand-book, as it contains numerous tables and diagrams. It is largely a compilation, the sources of information being current periodical literature and other treatises on highway construction, but in the main the material has been well selected. Especially valuable are the examples of good practice following the discussions on the various types of roadways. They present in brief form the specifications actually in use in localities that have secured satisfactory results with the types in question.

The chapter headings are: (1) The Development of Highway Systems; (2) Surveys and Plans for Roads; (3) The Design of Rural Highways; (4) The Construction and Maintenance of Earth Roads; (5) Testing Non-bituminous Road Materials; (6) Sand-Clay Roads; (7) Gravel Roads; (8) Waterbound Macadam Roads and Pavements; (9) Concrete Roads and Pavements; (10) Vitrified Brick Roads and Pavements; (11) Wood-block Pavements; (12) Stone-block Pavements; (13) Bituminous Road and Pavement Materials; (14) Dust Layers and Bituminous Carpets; (15) Penetration and Mixed Macadam Roads and Pavements; (16) Sheet Asphalt and Asphaltic Concrete Surfaces; (17) Selection of Type of Surface for Rural Highways; (18) Selection of Type of Pavement Surface; (19) The Design of Pavements; (20) Tests for Bituminous Road and Paving Materials. Glossary index.

The material in Chapter 1 is good, but it dismisses with a rather brief discussion the ever-increasingly important subject of highway administration. Chapters 2, 3 and 4 require no special mention. Chapter 5 will be read with special interest by the engineer in general practice who has not followed closely recent developments in materials testing. While some of the tests described as, for example, those on vitrified paving blocks, are well known, most of them are of comparative recent origin. This is particularly true of the tests on sand, stone and gravel.

Chapter 6 satisfactorily describes a type of road which deserves a more extensive trying-out by Canadian road builders than it has yet received.

Chapters 7 and 8 describe two well-known forms of improved highways.

Chapter 9 (Concrete Roads and Pavements) deserves special notice, for it is one of the best discussions on this comparatively recent type of paving that has as yet appeared. It is an unprejudiced statement of present practice and its tendencies. As long as the phenomenal increase in motor traffic continues there must be a growing interest in this type of construction for the more important roads as well as for many of the streets in villages, towns and cities.

Chapters 10, 11 and 12 describe well-known types. Canadian engineers will be specially interested in Chapter 11, for much of the material on wood-block paving is from a recent paper by A. E. Macallum, formerly city engineer at Hamilton, Ont. Mr. Macallum's success with this form of construction is widely known.

Chapters 13, 14, 15, 16 and 20 are a thorough treatise on present practice with the various forms of bituminous paving.

Chapters 17 and 18 are of value, but develop no rule-of-thumb by which the very serious problem of selecting the most suitable material for any particular case can be solved.

The chapter on design of pavements contains more than the usual amount of information. The sections on unsymmetrical streets, intersections, and car track paving are noteworthy.

While primarily a work on construction, it is a question if more importance could not profitably be attached to problems of maintenance. A chapter on guardrails would be of interest as would a section on street signs. There also should be room for a discussion of the aesthetic side of highway improvement. There are some typographical errors which will no doubt be corrected in later editions. The general appearance of the book is pleasing. The illustrations have been carefully selected and practically all of the plans and sketches are unusually legible. There is a real need for this up-to-the-minute book on highway construction.

The Control of Water. By Philip A. Morley Parker. Published by George Routledge & Sons, Limited, London, Eng. 1,055 pages, 283 diagrammatic sketches, 6 x 9 ins., cloth. Price, $7.00 net. (Reviewed by T. H. Hogg, C.E., Assistant Hydraulic Engineer, Ontario Hydro-Electric Power Commission.)

The full title of this book is "The Control of Water as Applied to Irrigation, Power and Town Water Supply Purposes." As the author states in his preface, "it is essentially the product of actual engineering experience and should not be regarded as a text book, but rather as a manual for engineers in active work." This premise should be carefully noted by those interested in its subject matter, for the author assumes on the part of the reader an initial knowledge of his subject that may be considered as rather unusual.

The book is divided into sixteen chapters, entitled Preliminary Data, General Theory of Hydraulics, Gauging of Streams and Rivers, Gauging by Weirs, Discharge of Orifices, Collection of Water and Flood Discharge, Dams and Reservoirs, Pipes, Open Channels, Filtration and Purification of Water, Problems Connected with Town Water Supply, Irrigation, Movable Dams, Hydraulic Machinery Other Than Turbines, Turbines and Centrifugal Pumps, Concrete, Ironwork and Allied Hydraulic Construction. These chapters are followed by a series of hydraulic tables, and graphic diagrams for the solution of hydraulic problems, and the column is closed by a very complete index.

This book is undoubtedly one of the most complete, published at the present time. The ground covered is tremendous, and one marvels at the painstaking labor necessary to collect and prepare it. The author appears to have investigated personally most of the recent literature of hydraulics, dealing with special conditions, such as the standing wave, back water curve, and the bore. His treatment, while in many cases not complete, is usually full and adequate.

The most complete treatment of the surge tank, both simple and differential, published in text book form is given, and there appears for the first time, to the writer's knowledge, the arithmetic integration method of investigating the surges induced in pipe lines under varying conditions of velocity. This feature alone is worth the price of the volume to the hydraulic engineer who has not had occasion or time to develop the method himself.

The writer has no hesitation in recommending the book to those of the profession interested in the control of water, as the most complete and accurate available in the English language.

Engineering Applications of Higher Mathematics—Part II. Problems on Hydraulics. By V. Karapetoff. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. 103 pages, 50 figures, 5¼ x 8 ins., cloth. Price, 75c. net. (Reviewed by T. H. Hogg, C.E., Assistant Hydraulic Engineer, Ontario Hydro-Electric Power Commission.)

This volume forms Part II. of the engineering series by the author and covers "Problems on Hydraulics."

Part I. was published about four years ago and covered problems of machine design. The present volume contains problems selected from various branches of hydraulics, in the solution of which it is necessary to use calculus and analytic geometry. The remainder of the work is comprised of three other volumes on thermodynamics, mechanics of materials and electrical engineering.

The contents include chapters on Water Pressure on Submerged Surfaces, Depth of Immersion of Floating Bodies, Time of Discharge of Liquids from Vessels, Form of Liquid Jet Problems for Water Supply, Best Form of Channel Section, an appendix and a list of reference works.

The book will probably receive its widest use among engineering students.

Power Transmission by Leather Belting. By Robert Thurston Kent, M.E. Published by John Wiley & Sons, Inc., New York City. First edition, 1916. 114 pages, 37 illustrations, 5½ x 8¼ ins., cloth. Price, $1.25 net. (Reviewed by S. C. DeWitt, Federal Engineering Co., Toronto.)

We have read this book very carefully and find compiled in a comparatively small space an extremely large amount of useful information. For the mechanic, Chapters 3, 5 and 6, as well as the tables in back of the book, will be found of great service.

Chapter 4, which deals with the theory of transmitting power by belting, is beyond the ordinary mechanic, but to those who have had a fair education in lower mathematics this article will prove interesting. The chapters on Belt Maintenance, Fastening Belts, and Belt Dressings, are useful to everyone and are well worth studying by the belt user. The book is very complete and those who will take the time to read it carefully will find that for a small outlay in the cost of the book they can save many dollars in the plant.

Steam Power. By C. F. Hirshfeld, M.M.E., formerly professor of Power Engineering, and T. C. Ulbricht, M.E., M.M.E., formerly Instructor, Sibley College, Cornell University. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. 420 pages, 5¼ x 8 ins., 232 figures, cloth. Price, $2.00 net. (Reviewed by Prof. Robert W. Angus, Toronto University.)

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After giving some general physical ideas and briefly discussing the properties of steam, the author enters at once upon the discussion of the steam engine, which he deals with quite fully in about nine chapters, discussing the diagrams, compounding, the slide valve, regulation, etc., and devoting one chapter to the turbine. The entropy diagram has also been briefly touched on, but is beyond the scope of this treatise.

Following a chapter on condensing apparatus the book deals with the subject of combustion, treating fuels, boilers and recovery of heat waste, completing the work by a discussion of feed pumps and auxiliaries.

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Chapter 1 deals with history and development. Many readers will be surprised to find that the gas engine was proposed as early as 1678, the idea being to use the explosive force of gunpowder as a motive power.

It appears that coal gas was originally produced with the idea of using it in a gas engine, and that its employment for lighting purposes was a later development. Further on in this chapter the author refers to the late B. H. Thwaite, whose energies were devoted to the employment of blast furnace gas for driving gas engines. Mr. Garrard, however, omits to relate that after having made many vain attempts to induce the steel manufacturers of Great Britain to take up his idea, Mr. Thwaite finally went over to Germany, where it was adopted successfully on a very large scale in many instances, and it was only after several years, when the British firms could be shown the advantages which the German steel companies had gained from the adoption of this scheme, that Mr. Thwaite was able to make any headway in Great Britain. Since then a good deal has been accomplished.

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There is a short section devoted to producer gas plant and the Humphrey explosion pump is briefly described, although the latest development of this last very unusual type, utilizing a solid piston for high head, has come on the market too late for inclusion in this book.

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This publication should be useful to the engineering student or apprentice, and to anyone who desires to obtain a general knowledge of the types of engines dealt with.

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Anyone who has had to do with the study or teaching of thermodynamics recognizes the difficulty of the subject, and also that a good deal of the difficulty arises from the lack of mathematical preparation on the part of the student. Any book, therefore, which will assist in this way will be welcome.

The author has divided his book into six chapters, dealing with problems on perfect gases, saturated steam, entropy and heat transfer in boilers and in each of the chapters has dealt with a few of the problems that arise, the examples of good practice following the discussions on the various types of roadways. They present in brief form the specifications actually in use in localities that have secured satisfactory results with the types in question.

The chapter headings are: (1) The Development of Highway Systems; (2) Surveys and Plans for Roads; (3) The Design of Rural Highways; (4) The Construction and Maintenance of Earth Roads; (5) Testing Non-bituminous Road Materials; (6) Sand-Clay Roads; (7) Gravel Roads; (8) Waterbound Macadam Roads and Pavements; (9) Concrete Roads and Pavements; (10) Vitrified Brick Roads and Pavements; (11) Wood-block Pavements; (12) Stone-block Pavements; (13) Bituminous Road and Pavement Materials; (14) Dust Layers and Bituminous Carpets; (15) Penetration and Mixed Macadam Roads and Pavements; (16) Sheet Asphalt and Asphaltic Concrete Surfaces; (17) Selection of Type of Surface for Rural Highways; (18) Selection of Type of Pavement Surface; (19) The Design of Pavements; (20) Tests for Bituminous Road and Paving Materials. Glossary index.

The material in Chapter 1 is good, but it dismisses with a rather brief discussion the ever-increasingly important subject of highway administration. Chapters 2, 3 and 4 require no special mention. Chapter 5 will be read with special interest by the engineer in general practice who has not followed closely recent developments in materials testing. While some of the tests described as, for example, those on vitrified paving blocks, are well known, most of them are of comparative recent origin. This is particularly true of the tests on sand, stone and gravel.

Chapter 6 satisfactorily describes a type of road which deserves a more extensive trying-out by Canadian road builders than it has yet received.

Chapters 7 and 8 describe two well-known forms of improved highways.

Chapter 9 (Concrete Roads and Pavements) deserves special notice, for it is one of the best discussions on this comparatively recent type of paving that has as yet appeared. It is an unprejudiced statement of present practice and its tendencies. As long as the phenomenal increase in motor traffic continues there must be a growing interest in this type of construction for the more important roads as well as for many of the streets in villages, towns and cities.

Chapters 10, 11 and 12 describe well-known types. Canadian engineers will be specially interested in Chapter 11, for much of the material on wood-block paving is from a recent paper by A. E. Macallum, formerly city engineer at Hamilton, Ont. Mr. Macallum's success with this form of construction is widely known.

Chapters 13, 14, 15, 16 and 20 are a thorough treatise on present practice with the various forms of bituminous paving.

Chapters 17 and 18 are of value, but develop no rule-of-thumb by which the very serious problem of selecting the most suitable material for any particular case can be solved.

The chapter on design of pavements contains more than the usual amount of information. The sections on unsymmetrical streets, intersections, and car track paving are noteworthy.

While primarily a work on construction, it is a question if more importance could not profitably be attached to problems of maintenance. A chapter on guardrails would be of interest as would a section on street signs. There also should be room for a discussion of the aesthetic side of highway improvement. There are some typographical errors which will no doubt be corrected in later editions. The general appearance of the book is pleasing. The illustrations have been carefully selected and practically all of the plans and sketches are unusually legible. There is a real need for this up-to-the-minute book on highway construction.

The Control of Water. By Philip A. Morley Parker. Published by George Routledge & Sons, Limited, London, Eng. 1,055 pages, 283 diagrammatic sketches, 6 x 9 ins., cloth. Price, $7.00 net. (Reviewed by T. H. Hogg, C.E., Assistant Hydraulic Engineer, Ontario Hydro-Electric Power Commission.)

The full title of this book is "The Control of Water as Applied to Irrigation, Power and Town Water Supply Purposes." As the author states in his preface, "it is essentially the product of actual engineering experience and should not be regarded as a text book, but rather as a manual for engineers in active work." This premise should be carefully noted by those interested in its subject matter, for the author assumes on the part of the reader an initial knowledge of his subject that may be considered as rather unusual.

The book is divided into sixteen chapters, entitled Preliminary Data, General Theory of Hydraulics, Gauging of Streams and Rivers, Gauging by Weirs, Discharge of Orifices, Collection of Water and Flood Discharge, Dams and Reservoirs, Pipes, Open Channels, Filtration and Purification of Water, Problems Connected with Town Water Supply, Irrigation, Movable Dams, Hydraulic Machinery Other Than Turbines, Turbines and Centrifugal Pumps, Concrete, Ironwork and Allied Hydraulic Construction. These chapters are followed by a series of hydraulic tables, and graphic diagrams for the solution of hydraulic problems, and the column is closed by a very complete index.

This book is undoubtedly one of the most complete, published at the present time. The ground covered is tremendous, and one marvels at the painstaking labor necessary to collect and prepare it. The author appears to have investigated personally most of the recent literature of hydraulics, dealing with special conditions, such as the standing wave, back water curve, and the bore. His treatment, while in many cases not complete, is usually full and adequate.

The most complete treatment of the surge tank, both simple and differential, published in text book form is given, and there appears for the first time, to the writer's knowledge, the arithmetic integration method of investigating the surges induced in pipe lines under varying conditions of velocity. This feature alone is worth the price of the volume to the hydraulic engineer who has not had occasion or time to develop the method himself.

The writer has no hesitation in recommending the book to those of the profession interested in the control of water, as the most complete and accurate available in the English language.

Engineering Applications of Higher Mathematics—Part II. Problems on Hydraulics. By V. Karapetoff. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. 103 pages, 50 figures, 5¼ x 8 ins., cloth. Price, 75c. net. (Reviewed by T. H. Hogg, C.E., Assistant Hydraulic Engineer, Ontario Hydro-Electric Power Commission.)

This volume forms Part II. of the engineering series by the author and covers "Problems on Hydraulics."

Part I. was published about four years ago and covered problems of machine design. The present volume contains problems selected from various branches of hydraulics, in the solution of which it is necessary to use calculus and analytic geometry. The remainder of the work is comprised of three other volumes on thermodynamics, mechanics of materials and electrical engineering.

The contents include chapters on Water Pressure on Submerged Surfaces, Depth of Immersion of Floating Bodies, Time of Discharge of Liquids from Vessels, Form of Liquid Jet Problems for Water Supply, Best Form of Channel Section, an appendix and a list of reference works.

The book will probably receive its widest use among engineering students.

Power Transmission by Leather Belting. By Robert Thurston Kent, M.E. Published by John Wiley & Sons, Inc., New York City. First edition, 1916. 114 pages, 37 illustrations, 5½ x 8¼ ins., cloth. Price, $1.25 net. (Reviewed by S. C. DeWitt, Federal Engineering Co., Toronto.)

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The real value of the book appears to be in presenting a number of mathematical applications of calculus and geometry as they are used in thermodynamics, and in doing this it serves a valuable purpose. Many students are taught mathematics in such a way as not to recognize its practical value, and this book should be a stimulus to them and also a reference book when reviewing some of the principles after they have been forgotten.

The collection of problems given at the end of the chapters will also be helpful.

PUBLICATIONS RECEIVED.

Public Works Department.—Annual report for 1915 of the Department of Public Works, Manitoba.

Canadian Society of Civil Engineers.—By-laws and list of members of Ottawa Branch. Published July, 1916.

Ontario Good Roads Association.—Proceedings of the fourteenth annual meeting of the Ontario Good Roads Association, 1916.

Precise Levelling.—Vol. 3, No. 6 of the publications of the Dominion Observatory, Ottawa. W. F. King, C.M.G., LL.D., director.

Topographical Surveys Branch.—Annual report of the Topographical Surveys Branch, Department of the Interior, Ottawa, for the years 1914-15.

Year Book, 1915, of the Swedish Chamber of Commerce for the United Kingdom (Inc.), 5 Lloyd's Avenue, London, E.C. Secretary, Louis Zettersten.

Standards for Electric Service.—Circular No. 56 of the Bureau of Standards, Department of Commerce, Washington, D.C. S. W. Stratton, director.

Magnetic Properties of Cobalt.—By Herbert T. Kalmus, B.Sc., Ph.D., and K. B. Blake, B.Sc. Published by the Mines Branch, Department of Mines, Ottawa.

Water Rights Branch.—Report of the Water Rights Branch, Department of Lands, British Columbia, for the year ending December 31st, 1915. William Young, comptroller.

Concrete Swimming and Wading Pools and How to Build Them.—An 18-page illustrated leaflet issued by the Portland Cement Association, 111 West Washington Street, Chicago, Ill.

Federal Aid Road Act.—Circular No. 65 issued by the United States Department of Agriculture, Washington, D.C., containing rules and regulations of the secretary of agriculture for carrying out the Federal Aid Road Act.

Manitoba.—Map showing the disposition of lands of this province corrected to January 1st, 1916. Prepared in the Railway Lands Branch, Department of the Interior, Ottawa, under the direction of Mr. F. C. C. Lynch, superintendent.

Levelling Operations.—Report on levelling operations from their inauguration in 1908 to October 31st, 1914, with a summary of the results. Published by the Topographical Surveys Branch, Department of the Interior, Ottawa.

Canadian Society of Civil Engineers.—Report of annual meeting held in Montreal January, 1916. Seventy-three pages and cover. Distributed by the society only to members, or upon special requests approved by the council of the society.

Dynamic Balance.—A 13-page illustrated leaflet, containing an abstract of a paper by N. W. Akimoff, presented at the spring meeting of the American Society of Mechanical Engineers. Describes the machine of the Dynamic Balance Machine Co., Philadelphia, Pa.

The History and Development of Gold Dredging in Montana.—Bulletin 121, Bureau of Mines, Department of the Interior, Washington, D.C. By Hennen Jennings, with a chapter on placer mining methods and operating costs by Charles Janin. Sixty-three pages, illustrated.

American Road Builders' Association.—Proceedings of the thirteenth annual convention of the American Road Builders' Association, held at Pittsburgh, Pa., February 28, 29, March 1, 2 and 3, 1916, together with reports of the executive committee, secretary and treasurer, presented at the annual meeting, February 4, 1916, list of members, etc. Published by the association, 150 Nassau Street, New York. Secretary, E. L. Powers.

Specifications for Vitrified Brick Pavements.—Two pamphlets about 45 pages each, which are being distributed gratuitously by the National Paving Brick Manufacturers' Association of Cleveland, Ohio. One contains specifications for laying vitrified brick pavements upon green concrete with cement grout fill, and the other contains specifications for what is called the sand-cement super-foundation type with cement grout fill.

CATALOGUES RECEIVED.

Auto Starters.—A 15-page illustrated pamphlet issued by the Canadian Westinghouse Co., Hamilton, Ont., describing their auto starters for squirrel-cage induction motors.

War Munitions.—Illustrated booklet describing the war munitions manufactured by the Canadian General Electric Co., Limited, and subsidiary company, Canadian Allis-Chalmers, Limited.

Surveying Instruments, Etc.—Catalogue for 1916 of E. R. Watts & Son, Canada, Limited, 45 Bank Street, Ottawa, manufacturers of surveying and other instruments of precision, drawing material, etc. Contains 229 pages and is well illustrated.

Milburn Oxy-Acetylene Welding and Cutting Apparatus.—Catalogue No. 24, issued by the Alexander Milburn Co., 1418-1428 W. Baltimore Street, Baltimore, Md., describing, with illustrations, the Milburn products, including gas plants for industrial buildings, portable acetylene lights, oxy-acetylene welding and cutting apparatus, etc.

Leffel Turbine Water Wheels.—Bulletin No. 54, issued by the James Leffel & Co., Springfield, Ohio, and distributed in Canada by Wm. Hamilton Co., Limited, Peterborough, Ont., who are the Canadian manufacturers of Leffel lines, including Samson water turbines, type Z turbines, Francis type turbines for medium and high heads with scroll or volute casings, etc. Bulletin No. 54 contains 32 pages and cover and is profusely illustrated. As it is in three colors throughout, the illustrations are very good. It is printed on coated paper and the whole arrangement is attractive. Considerable technical data is tabulated and presented.

Editorial

EMPLOYMENT OF ALIEN ENGINEERS.

Basing their case upon the appointment of Prof. G. F. Swain as consulting engineer to the Railway Board of Inquiry, the council of the Canadian Society of Civil Engineers has protested to the Government against the appointment of alien engineers. The text of the protest was published in full in our last week's issue, together with a review, from a news standpoint, of Sir Henry Drayton's reply, of the board's scope, and of Prof. Swain's biography.

With the general principles involved in the protest, all Canadian engineers will agree most whole-heartedly, but it is unfortunate that the protest was not based upon a more flagrant case. There have been many previous appointments of American engineers for which there were no justifying circumstances such as exist regarding the Swain appointment. The statistics compiled by the engineer of the Railway Board of Inquiry must be absolutely divorced from local bias and self-interest, or else the report of the board, when based upon those statistics, will be worthless. We hold no brief for the board, but we can readily see numerous possible objections to the appointment of Canadian railway engineers for this particular work.

It would be unfortunate if the government of Canada, or of any province or municipality in Canada, were to lay down any hard and fast rule that would bar them from getting the best advice obtainable, especially in a case like this where the whole future of Canada and hundreds of millions of dollars are involved.

The Canadian engineering profession cannot afford to be too narrow in its views of such matters. It cannot adopt "closed shop" methods.

There is another side to the matter, however. While the employment of foreign specialists may be at times fully justified, there is no reason under the sun for Canadian cities, governments or individuals going abroad for engineers to design filtration plants, retaining walls, reservoirs, aqueducts, bridges, sewers, highways or other similar items in the usual run of engineering work, unless unusually special problems are involved which call for a knowledge of practice and experience in other countries. It would be unwise to burn our bridges behind us to such an extent that we could not employ a foreign specialist if the public were to need him, but, generally speaking, the Canadian engineer need take off his hat to no other country!

Our municipal engineers average a hundred percent higher in ability than do the usual political incumbents of such positions in the United States. Compare our consulting engineers as a class and as a whole with the average man in the United States who calls himself a consulting engineer (again noting that in this case, like in all others, there are many exceptions) and the comparison is not detrimental to the Canadians. In the hydro-electric field, Canadian engineers indisputably lead the world. In bridge building, road construction, railroad work and other engineering lines, the percentage of Canadian failures is, to say the least, no greater than those of other countries.

Our schools are well equipped, the raw material that they receive is equal to any, and if we haven't as many world-renowned engineers as has the United States, it is merely because Canada is not so populous. Surely Canadian engineers should be allowed the full benefit of whatever field exists in this country for their activities, and should not be burdened with foreign competition any more than is really necessary.

Yet we should not wish to be unfair or unwise in our demands for legislation. It has been alleged by some that the alien labor law of the United States bars out Canadian engineers, and that our legislation should retaliate. A representative of *The Canadian Engineer* made a special trip to the United States this week to find out whether that is really the case. Consultation with corporation counsels, U.S. district attorneys, U.S. chief immigration inspectors, state engineers, municipal engineers and U.S. army engineers, shows that they do not interpret the alien labor law in such manner. One section of the U.S. law bars out foreign labor of all kinds, but a qualifying section makes exception of persons belonging to any regularly recognized learned profession. All authorities agreed that engineering is a learned profession, and that Canadian engineers or engineering contractors who are university graduates, or who are members of any recognized engineering society such as the Canadian Society of Civil Engineers, are at entire liberty to practise or transact business in the United States. Some few states have state laws, corresponding to our own Manitoba and Quebec Acts, that might interfere, but such laws are said to be exceptional.

It is not at all unprecedented for Canadian engineers to receive appointments or supervise work in the United States. As an instance, R. A. Ross, of Montreal, was employed by Judge Hammond, then corporation counsel of Buffalo, as an expert in a power and light rate investigation, and was so engaged for a considerable period, his fee being paid by the municipality.

But such instances are few and far between. They are negligible compared to the number of American engineers who have been retained by Canadians, yet they show that the U.S. alien labor law has not invited any legislative retaliation. The present administration at Washington may have very recently decided to interpret this law differently, and, if so, Canada would be justified in meeting the U.S. attitude should there be any clear evidence showing a change of policy.

Legislation is not needed; patriotism and self-interest alone should give the Canadian engineer a square deal at home. The government surely must recognize that! Yet, in this case, the appointment of Prof Swain seems more commendable than the appointment to the chair of the Railway Board of Inquiry of a man who controls important railroad interests in Canada, and who has affiliations and competitions that cannot but unconsciously color his viewpoint.

REMOVAL FROM BRITISH BLACKLIST.

Announcement of the removal of the following Americans from Great Britain's trade blacklist was made in the London "Official Gazette" of September 8th: Electro-Bleaching Gas Co., of New York and Niagara

Falls; Richard Neuhaus, of the Electro-Bleaching Gas Co.; and Gravenhorst & Co., of New York.

The Canadian Engineer is very pleased to hear of these removals; the fewer our enemies the better. It is certain that these firms must have satisfactorily established their bona fides with the British Government, or their names would not have been removed from the blacklist. The removal is prima facie evidence that in those particular cases there was some misunderstanding which evidently has since been cleared up to the satisfaction of the authorities.

In our issue of July 27th we expressed regret that these firms, or any United States firms, should have given cause to be blacklisted, and it is pleasing to note that so far as these two firms are concerned, no cause evidently was actually given for their names being retained on the blacklist. While no truly patriotic Canadian engineer or municipality would deal with any firm while reasons existed for that firm's name being on Great Britain's blacklist, the removal of the above three names from the blacklist should, of course, in all fairness to those firms, clear them of any prejudice, and there should now be no reason for Canadians abstaining further from doing business with those firms if dealings with them should appear desirable or advantageous.

EDUCATION IN ROAD BUILDING.

For some time past considerable stress has been placed upon the subject of education in the design, construction and maintenance of modern pavements. Our universities have been more active in their efforts to see to it that highway engineering should have a more important place in the curricula of our engineering schools.

Millions of dollars are being spent annually for better roads and until the building of all of these roads is done intelligently and scientifically no doubt many thousands of dollars will be wasted every year.

Practically every resident of city and county is vitally interested in good roads whether conscious of it or not, and it behoves all to do what they can to be sure that the construction of them is carried on with the minimum of waste.

All over Canada there are engineering students who have deliberately chosen the field of highway engineering as a life work. Our universities are responding to the demands of these men and laying themselves out to give the kind of specialized training in highway engineering that will fit a student to take up the work intelligently. In these universities the student gets an excellent training in highway economics and highway administration with all the subdivisions which such a course includes.

There is, however, another phase of the question in which we as a people are a little behind. While the universities are giving more specific attention to highway work it is questionable if enough is being done along the line of what may be termed popular education in the subject of road building. Much information on the subject is to be found in government reports, pamphlets and technical journals which, if properly used, would be of much value, but unfortunately the men available for the work are not as a rule students and the book learning, good as it is, is not suited to their needs.

In this respect we might well copy the example of our neighbor to the south. No money is spent directly by the Federal Government of the United States or actual road construction except for experimental or demonstration purposes. The work of the office of Public Roads is purely educational and both the technical and popular sides are provided for. For the scientific road builder reports are printed and bulletins are issued giving results of investigations and experiments, which in their arrangement and up-to-date character of their contents are a vast improvement over the general run of text-books. And for the benefit of the man on the job the same office undertakes, as the best method of teaching the work, to build sections of road of various kinds in numerous localities. This work is carried on under the direct supervision of government engineers, an important part of whose duties is instruction of the men on the work in the correct principles and methods of road building. In this way the government is doing a very profitable work; the locality receives benefit in the form of a section of improved road; while the men of the locality receive free the best instruction available, and are fitted to continue the good work.

PERSONAL.

DE GASPE BEAUBIEN, consulting engineer of Montreal, has been on a visit to France.

Major WILLIAM ASHPLANT, formerly city engineer of London, Ont., has been wounded in France.

H. A. KEE, formerly mine superintendent at the Nipissing mine, Cobalt, is now in charge of the Kerr Lake mine.

G. G. UNDERHILL has joined the staff of L. G. Mouchel & Partners, engineers, as their Montreal representative, with office in the New Birks Building.

ROWLAND KING, graduate of the Michigan School of Mines, has accepted the appointment of general superintendent of the mine and mill of the Highland Mining and Development Co., near Ashcroft, B.C.

J. DUCHASTEL DE MONTROUGE, M.Can.Soc. C.E., and president of the Dominion Good Roads Association, has just returned from a visit to the Maritime Provinces in the interest of the good roads movement.

CHARLES J. BARR, formerly general superintendent of the Tennessee Coal, Iron and Railroad Company, Ensley, Alta., has been appointed general manager of the Algoma Steel Corporation. Mr. Barr is a Canadian and belongs to Lindsay, Ont.

W. F. FERRIER, of Toronto, and Prof. J. C. GWILLIM, of Kingston, were in British Columbia recently, making investigations for the Dominion Government relative to certain minerals concerning the occurrence and development of which information is required.

OBITUARY.

Sergt. WILLIAM DUNCAN MILLICAN, of Winnipeg, Man., was killed in action on August 28th. He was a civil engineer and an active member of the Manitoba branch of the Canadian Society of Civil Engineers. From 1909 to 1911 he was on the staff of the civic power construction department at Point du Bois and for a time was employed on work in the Greater Winnipeg Water District. He also was with the Canadian Northern Railway as resident engineer. For two years, previous to his enlistment, last April, with the Canadian Engineers, he was in the office of W. M. Scott, consulting engineer, Sterling Bank Building, Winnipeg.