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Volume 27. Toronto, December 31, 1914

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

PROGRESS ON THE NEW QUEBEC BRIDGE

SUPERSTRUCTURE ERECTION REVIEWED TO DATE—PROGRAM OF ERECTION—OFFSETTING DIFFICULTIES IN PIN CONNECTIONS ARISING OUT OF ALLOWANCES FOR DEFORMATION OF MEMBERS UNDER FULL LOAD.

By H. P. BORDEN,
Assistant to Chief Engineer.

WITH the close of the present season considerable progress is to be noted towards the erection of the new Quebec Bridge. During the summer of 1913 the approach spans on the north shore from the abutment to the anchor pier were fully erected. These two double lines of tracks, spaced 54 ft. centre to centre. The two inner rails were carried on the top flanges of the outside bridge track girders, the outer rails being carried on special erection girders resting on the falsework and thoroughly braced to the track girders themselves. The

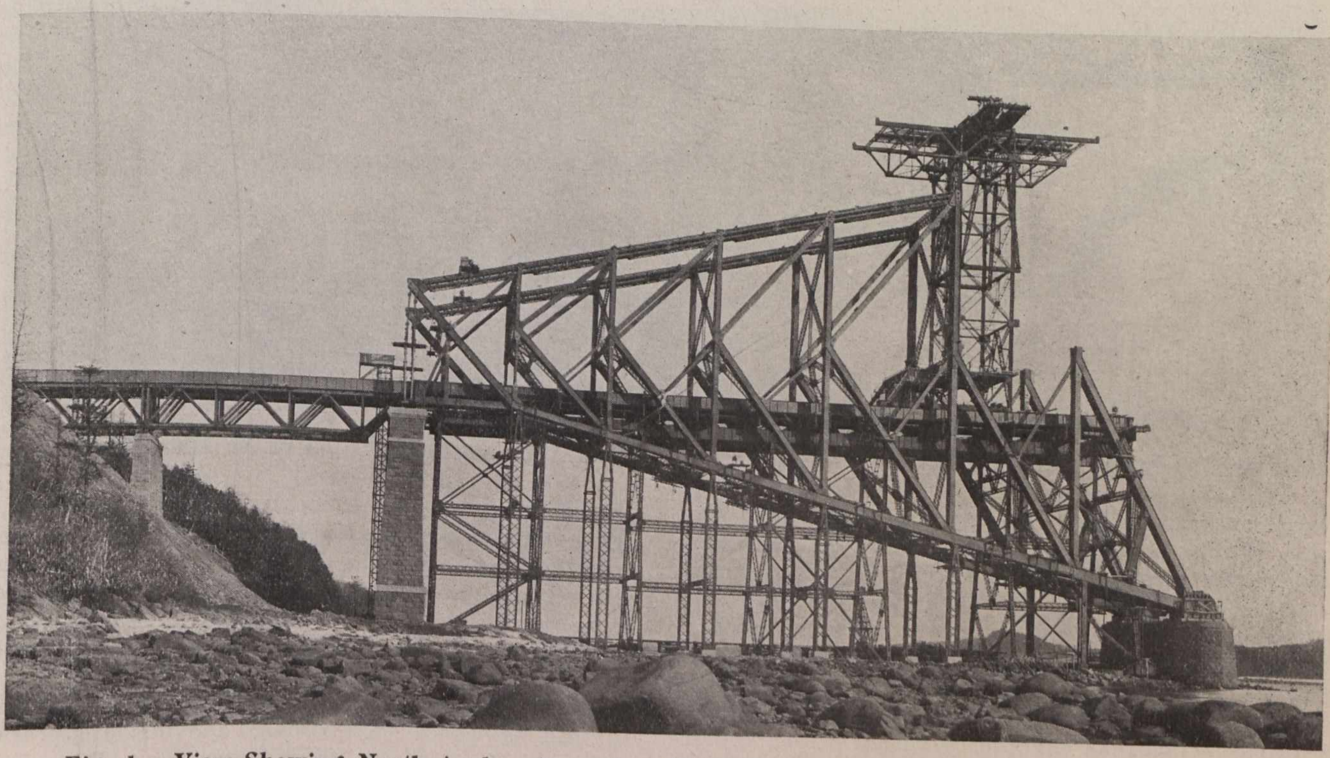

Fig. 1.—View Showing North Anchor Arm when Work Closed Down at the End of the Season.

spans were erected by derrick cars on heavy wooden and steel falsework. As these spans would have to carry the 1,000-ton erection traveler, and as the concentrated wheel loads from this traveler were considerably greater than the live loads for which the spans were designed, this falsework was made sufficiently strong to take care of these reactions.

During the winter of 1914 the traveler was erected on the shore, just north of the abutment and it was ready to move out early in May. This traveler was carried on

traveler was moved out over the approach spans to the anchor pier on May 18th, and proceeded to erect the inside falsework carrying the floor of the anchor arm on which the traveler runs.

The main floor beams of this floor were supported on special erection girders supported by this falsework and were located in approximately their correct positions. The main track girders, sub-floor beams and stringers were then erected in place and special girders erected outside the track stringers for the erection traveler.

When this falsework had been completed out to the north main pier the main shoes were erected, and the bases for these shoes were accurately placed and the entire shoe erected. An elaborate series of triangulations and measurements, extending over several months, were made to locate the longitudinal and transverse centre lines of these shoes. Once the bases had been placed in their proper position the rest of the shoe went forward rapidly, and a start on the erection of the bottom chords was made.

According to the program of erection, it was proposed to lay the bottom chords complete with their lateral bracing from the main shoe to the anchor pier, the main traveler moving back as the work progressed. When this had been done the traveler moved ahead again to the main pier and started the erection of the web members up to their middle intersection above the floor. This was carried back to the north anchor pier, after which the erection of the upper half of the web members in the top chord was effected, the traveler moving forward as the work progressed.

Work stopped for the season with the anchor pier completely erected with the exception of two upper panels near the main pier.

Owing to the deformation of all members under full load, it has been necessary to manufacture the compression members slightly longer and the tension members slightly shorter than their actual geometric length. On account of this fact there would naturally be difficulties in making the pin connections between the various members of the anchor arm in view of the fact that all these members are erected on falsework and consequently under no load except from their own weight. To offset this difficulty, the bottom chord was given a camber which would correspond to the deformations indicated by the Williot's or deformation diagram. In other words, after the bottom chord had been entirely riveted up from end to end, it was lowered a certain amount at each panel point by means of jacks at the foot of the steel falsework to correspond to this deformation. The final displacement, including deformation of falsework posts, amounted to zero at the main shoe, seven inches at the middle point, and five inches at the north anchor pier, varying practically uniformly between these points.

Owing to the length of this bottom chord, it was able to obtain this deformation without any difficulty.

To offset the effect of deformation of the web members from their own weight, and to enable pins to be driven without any difficulty, elongated holes were bored in the upper end of the upper tension diagonals and in all the eyebars in the top chord. The holes in the diagonals were elongated 2 inches and each eyebar ½ inch at each end, the elongation being made in the side of the hole nearest the centre of the member. By this means it was possible to drive these pins without any difficulty, the play in the holes being taken up as the cantilever arm is erected and stresses applied to the members of the anchor arm.

The driving of pins was materially facilitated by the fact that these pins are in duplicate, each pin going through two webs only of the 4-web members. This also applies to the top chords. In designing the driving rams for these pins it was estimated that heavy rams, weighing in the neighborhood of two or three tons, would be required. It was found in actual practice, however, that these were not necessary, and after the first one or two pins had been driven a steel rail 10 feet long, weighing 80 lbs. per yard, was used and pins in practically every case were driven home in from one to two minutes.

The maximum clearance allowed in all pin holes is 1/32 inch + 1/100 inch.

The amount of steel erected during the season just passed is about 15,000 tons, and this was practically erected in four months, from August 1st to December 1st.

A duplicate traveler is now being erected on the south side of the river and will be in commission the first thing in the spring. If the work is carried on according to programme, it is expected that the remainder of the anchor arm and the whole of the north cantilever arm as well as the south anchor arm, should be erected next season.

The St. Lawrence Bridge Company, Montreal, are the contractors for the superstructure. The work is being carried out under the supervision of the Board of Engineers, Quebec Bridge, composed of Mr. C. N. Monsarrat (Chairman and Chief Engineer), Mr. Ralph Modjeski and Mr. C. C. Schneider.

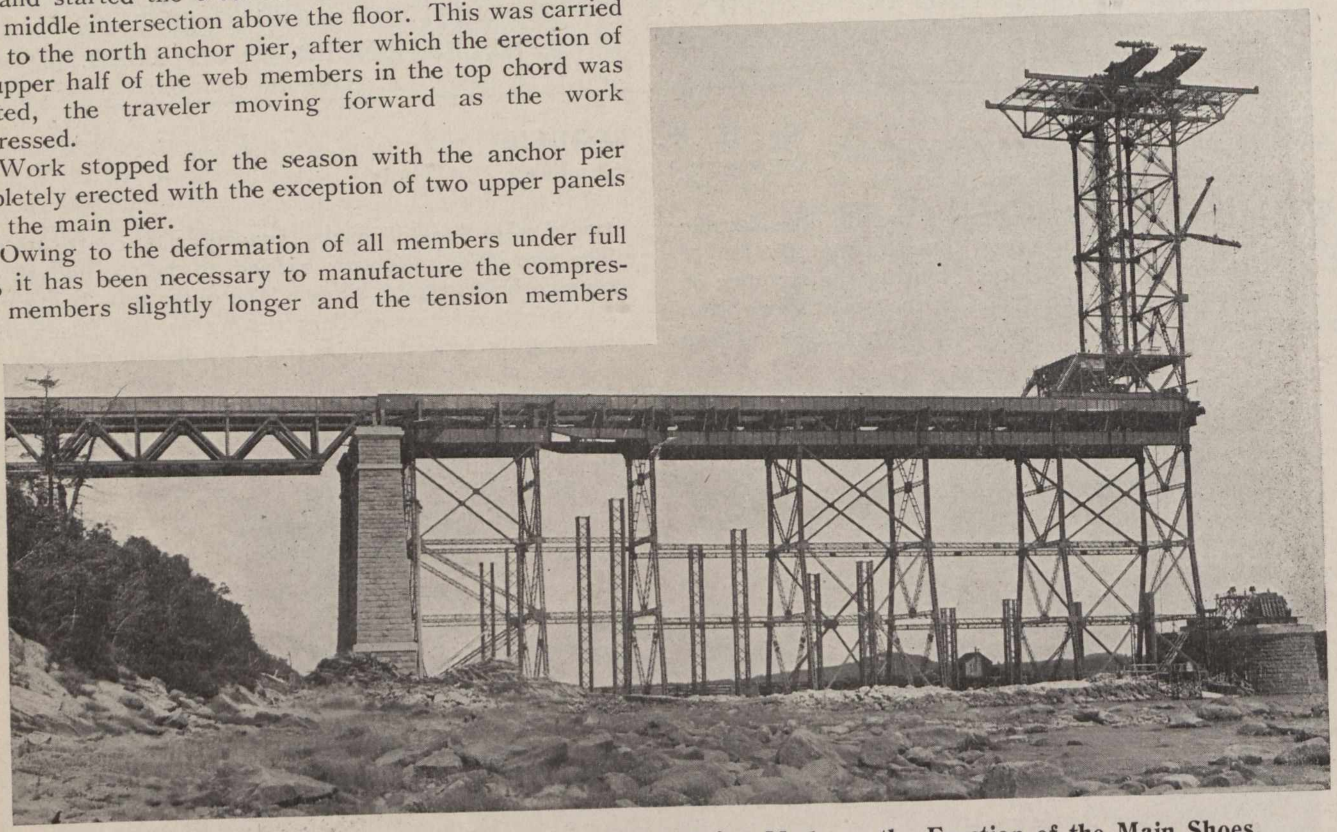

Fig. 2.—Falsework and Floor Erected, and a Start Being Made on the Erection of the Main Shoes.

ECONOMIC FEATURES OF THE ROGER'S PASS TUNNEL.

FROM time to time articles and notes of engineering interest have appeared in this journal on the five-mile, double-track tunnel which Messrs. Foley Bros., Welch and Stewart are driving through the Selkirk Range, in the vicinity of Roger's Pass, for the Canadian Pacific Railway Company. For a description of the engineering features of the undertaking the reader is referred to *The Canadian Engineer* for April 23, 1914, page 621. Maps and profiles of the old and proposed lines are illustrated therein to good advantage, and a reference to them will be of assistance in the following portrayal of the problem in economics which the revision of railway location has presented.

The following abstract from a paper by J. G. Sullivan, C.E., chief engineer of the western lines of the C.P.R., presents the factors involved in a study of the cost of operation via the present and proposed routes. We are indebted to the "Cornell Civil Engineer" for the information. (Mr. Sullivan is a graduate of Cornell University, Class '88.)

The data to be taken into account is as follows: Present location, total distance 23.1 miles, revised location 18.68 miles; grades consist, on the present location of 16.65 miles up hill for westbound traffic on maximum grade of 2.2%, 6.45 miles down grade same maximum with a total rise of 1,726 ft. and a drop of 692.1 ft. with 1,860 degrees of curvature on the up hill and 1,288 degrees on the down hill portion of the line. The revised location consists of 16.77 miles up hill with about 5 miles of 2.2% pusher grade, the balance 1% and a down hill run of 1.91 miles with a maximum 2.2% grade; a total rise of 1,178.2 ft. and a drop of 144.3 ft., with 635 degrees of curvature on the up hill grade and 66 degrees on the down hill. The average traffic for the years 1912 and 1913, which is made the basis of calculations, was 1,342½ passenger trains in each direction; the average weight of the passenger trains, exclusive of locomotives, was 443 tons; 980 of the passenger trains required pusher engines; the weight of the passenger and pusher engines for passenger trains was 175 tons each; there were 173½ freight trains in each direction per year; the average weight of the freight trains eastbound, exclusive of locomotives, was 950 tons; the average weight of freight trains westbound was 898 tons; all freight trains had to be pushed in both directions; weight of freight locomotives and pushers, 181 tons each. The tonnage eastbound and westbound was as follows:—

Eastbound.

1,342½	trains @ 443 tons each	594,727.5 tons
2,322	locomotives @ 175 tons each..	406,350.0 "
1,738½	freight trains @ 950 tons each	1,651,575.0 "
3,477	locomotives @ 181 tons each ..	629,237.0 "
	Total	3,281,889.5 tons

Westbound.

1,342½	trains @ 443 tons each	594,727.5 tons
2,322	locomotives @ 175 tons each..	406,350.0 "
1,738½	freight trains @ 898 tons each	1,561,173.0 "
3,477	locomotives @ 181 tons each ..	629,237.0 "
	Total	3,191,487.5 tons

Comparison of Comparable Factors Affecting the Cost of Operating Over Roger's Pass, via Present Line and via Tunnel Line, Now Under Construction, Average Traffic for the Years 1912 and 1913.

E. B. tonnage per year, including weight of engines, 3,281,890 tons.

Resistance to overcome, on present line.

Actual rise, 692.1 ft.	692.1 ft.	
Curve resistance, 1,288° × .04′	51.5 ft.	
Friction resistance, 6.45 mls. × 15′..	96.7 ft.	
Total		840.3 ft.

Resistance to overcome, tunnel line.

Actual rise, 144.3 ft.	144.3 ft.	
Curve resistance, 66° × .04′	2.6 ft.	
Friction resistance, 1.91 mls. × 15′	28.6 ft.	
Total		175.5 ft.
Difference		664.8 ft.

3,281,890 tons × 664.8 ft. equals 2,181,800,472 foot tons.

W. B. tonnage per year, including weight of engines, 3,191,488 tons.

Resistance to overcome, present line.

Actual rise, 1,726 ft.	1,726.0 ft.	
Curve resistance, 1,860° × .04′ ...	74.4 ft.	
Friction resistance, 16.65 mls. × 15′	249.7 ft.	
Total		2,050.1 ft.

Resistance to overcome, tunnel line.

Actual rise, 1,178.2 ft.	1,178.2 ft.	
Curve resistance, 635° × .04′	25.4 ft.	
Friction resistance, 16.77 mls. × 15′	251.5 ft.	
Total		1,455.1 ft.
Difference		595.0 ft.

3,191,488 tons × 595 ft. equals 1,898,935,360 foot tons.

Total work done (extra)	2,181,800,472 foot tons.
	1,898,935,360 foot tons.
Total	4,080,735,832 foot tons.

1,000 foot tons equals approximately 1 horse-power hour. Assuming that 5 pounds of coal is consumed in doing one horse-power hour's work and that coal on locomotive costs $4.60 per ton, the saving in fuel will amount to:

$$\frac{4{,}080{,}736 \times 5 \text{ lbs.} \times \$4.60}{2{,}000 \text{ lbs. (one ton)}} = \ldots\ldots \$46{,}928.46$$

Extra Wages, Train and Engine Crews.

Present line.

6,162 trains for 23.1 miles,	142,342.2 train miles.
5,437 push. engs. for 23.1 mls.,	125,594.7 push. eng. mls.

Tunnel line.

6,162 trains for 18.68 miles	115,106.2 train miles.
5,437 push. engs. for 13 mls.,	70,681.0 push. eng. mls.

Amount saved { 27,236.0 train miles.
54,913.7 pusher engine miles.

27,236 train miles at 22 cents ....$	5,991.92
54,913.7 pusher miles at 25 cents	13,728.40
NOTE—25 cents to cover engine crew wages, cost of repairs to pusher locomotives and extra cost of maintenance account of running pushers.	
Extra cost maintenance of way, 4.42 miles at $200 plus 27,236 train miles at 20 cents	6,331.20
Extra cost, maintenance of way, account of extra number of degrees of curvature, assuming that 400° of curvature per mile would increase rate at 20 cents per train mile for maintenance by 30%.	
6,162 trains × 2,447° × 1/40 cents	3,769.60
Special maintenance, account 4½ miles snow sheds	85,000.00
Extra cost, maintenance of equipment 27,236 train miles at 21 cents	5,719.56
Extra cost maintenance of equipment, account of extra number of degrees of curvature, assuming that 400° of curvature per mile would increase rate of 21 cents per train mile by 40%.	
6,162 trains × 2,447° × 21/1,000 cents	3,166.47
Total annual saving in cost of operation.	$170,635.61

The rate at which traffic has been increasing would indicate that shortly after the work of constructing the tunnel was completed the traffic would have doubled. In this case, if no further economics were made in methods of operating this section of track, the annual saving on account of operating over tunnel line would be,

$85,635.61 × 2 plus $85,000 = $356,271.22

In arriving at the above figures no account is taken of whether line was single or double track and for comparative figures it was assumed that methods of operation would be the same. Now, as a matter of fact, the present single track line with double the present traffic would make the business too congested for economical single track operation. Therefore, it was apparent that it was time to study the question of double tracking the present line or seeking a new line for double track. It was decided to double track on the five-mile tunnel location with grades as noted above. Now, to operate successfully a five-mile tunnel we will require the installation of an electric plant and the purchase of electric locomotives. All the details of the proposed electrification have not as yet been worked out, but even if they were, the reader is not interested in the details of cost. He can see at once that the problem was to find out if the cost of operating and maintaining the tunnel line, taking into account the extra costs of operating on account of having a short section of electric operation and extra cost of maintaining tracks in the tunnel, plus the interest on the cost of building the new double track line including the cost of electrifying the tunnel would be less than the cost of operating and maintaining a double track line on the present location plus the interest on the cost of building the second track. The figures would not have been very decisive one way or the other were it not for the fact that there is now 4½ miles of wooden snow sheds on the present location which will be all done away with on the new location. The maintenance and cost of renewals of these sheds cost between $85,000 and $100,000 per year. To maintain and renew a double track wooden shed would probably cost at least 50% more than the above, so that with a saving of about $125,000 per year in maintenance and renewals of snow sheds and a calculated saving in operation and maintenance of $171,271.22 on a traffic that surely will be reached in the near future, there was no doubt as to the proper course to pursue.

As to the details of figuring economics of railway location, the writer is well aware that it is impossible to devise any method that will show absolutely that saving in cost of operating one line over another, but he believes that the method herein followed, namely, that of comparing cost of fuel on the basis of work done rather than on a train-mile or any other unit is much more logical and will give more reliable results than other methods that have been followed. The train-mile is possibly the best unit for comparison in cost of wages and for cost of maintenance of equipment. In figuring maintenance of way a fixed sum should be taken plus a rate per daily train rather than a fixed rate alone per train-mile, for the reason that a certain amount of expense must be incurred regardless of whether trains are run or not. The fixed sum of $200 per mile taken in this problem is probably about one-half the actual sum that would be assumed if the entire cost of maintenance was to be included in this fixed sum per mile plus the rate per train mile for the reason that cost of maintenance of terminals and other items are not affected by the details of location between fixed terminals.

Frictional resistance, normal conditions, warm weather, modern freight equipment, speed between 7 and 35 miles an hour,

$R = 2.2\,T + 121.6\,C.$

R = total resistance on level tangent.

T = total weight cars and contents in tons.

C = total number of cars in train.

This amounts to 4 lbs. per ton to 8 lbs. per ton, depending on whether cars are fully loaded or empty. This is equivalent to a rise of from 10 ft. to 20 ft. per mile. For mixed traffic a conservative estimate is train resistance equals rise of 15 ft. per mile.

It may appear that the rate of 25 cts. per actual pusher-mile covering the cost of repairs and engine crew wages and extra cost of maintenance is too high, but as a matter of fact it is very conservative for the repairs, maintenance and renewals of the locomotives alone will run somewhere between 7 cts. and 10 cts. per mile and we have had cases where the engine crew wages alone averaged 25 cts. per mile for the actual mileage run, on account of delays to the pusher.

The progress made since the commencement of operations was reviewed in an article in *The Canadian Engineer* for October 1st, 1914. A few weeks ago reference was made to the establishment by the contractors of a new record for hard rock tunneling of 817 feet in 30 days, with a maximum footage of 37 feet in a single day.

C.P.R. FREIGHT TERMINAL AT QUEBEC.

The Canadian Pacific Railway has under construction at Quebec a large freight terminal, consisting of an inbound shed 50 ft. x 600 ft.; an outbound shed, 30 ft. x 300 ft., with a transfer platform, 300 ft. in length between. The W. S. Downing-Cook Co. have the contract, and Mr. S. G. Newton is their superintendent on the work. Steel is furnished by the Dominion Bridge Co. Terminals were designed by the building and construction department of the C.P.R., of which department Mr. D. H. Mapes is superintendent.

The foundation and floors of the two sheds are of reinforced concrete, supported on Raymond concrete piles.

IMPROVEMENTS TO NAVIGATION IN AND AROUND MONTREAL HARBOR.

THE season's grain export from the Port of Montreal has been stated to be the greatest in history. The total amount of grain passing through the two elevators of the Harbor Commission, the Grand Trunk elevator and the floating elevator, was 73,628,132 bushels, not including a million and a half bushels of grain which had been bagged and shipped direct, or over 10,000,000 bushels handled by the elevators for local consumption.

During the year the Repentigny channel from Isle St. Therese to Lanoraie has been finished, completely buoyed, and opened to navigation for boats drawing less than 14 feet. Later it will be extended through the Sorel Islands by way of the Grand Channel to Lake St. Peter. This dredging is now nearly completed and the necessary lights will be placed in position next spring. As the result of dredging all season in Lake St. Peter, there is now a 35-foot channel for almost the entire length of the lake. Elevator dredges at St. Anne, Sorel, St. Tours, The Traverse, Varennes and Point aux Trembles, are doing the same work. In Montreal Harbor they are widening the ship channel.

Four elevator dredges, a stone cutter and two stone lifters have been removing rock in the Cap a la Roche district to make a channel with a minimum depth at low water of 30 feet and a width of from 450 feet in the straight parts to 600 feet at the curves. New lighthouses will be erected in this district next year to mark out the new lines.

In the north channel below Quebec dredging has gone ahead for a channel 1,000 feet wide with a minimum depth at low tide of 30 feet, as far east as the foot of the Island of Orleans. Two dredges have worked at it this season, and the Dominion Government has awarded the contract for a seagoing hopper elevator dredge to the Canadian Vickers Company. This will hasten the work, but with the rocky bottom it will probably take nearly five years to finish it.

About $2,000,000 has been expended by the Harbor Commission this year in dredging, renovating piers and wharves, building new sheds and wharves, and other work incident to the five-year programme of development undertaken by them at a total cost of $15,000,000. All this work has been under the direction of Mr. W. G. Ross.

The main dredging in the harbor was south of St. Helen's Island to a depth of 20 feet. The renovation of Victoria Pier and the old low wharves east of it has been continued with the ultimate object of completing 2,700 feet of new high level and 4,800 feet of low level wharves. This will provide new berths for small river boats opposite Bonsecours Market, and for ocean steamers just below shed sixteen and in the neighborhood of the two new steel and concrete sheds, which have just been completed, at a cost of about $400,000. Similar sheds will be built parallel to the current on the new Victoria Pier where a stretch of 1,800 feet of dock is completed.

The $15,000,000 programme for five years includes a new warehousing system, the electrification of the railway system and the extension of the tracks from Racine Pier to Point aux Trembles, and ultimately to Bout de L'Isle. The Canada Cement and the Armstrong-Whitworth companies have had wharves built this year.

In connection with the Lachine Canal, $500,000 has been spent this year to eliminate the curve, which proved dangerous to navigation at Cote St. Paul, and the new power house nearby will be completed next year. A larger intake at Cote St. Paul was finished this season. Above Cote St. Paul, a mile of new cement wharf has been built.

Adjoining the easterly limits of the harbor are the newly completed works of Canadian Vickers, Limited, where $3,000,000 worth of construction has been completed during the year in addition to the floating dry dock valued at $1,750,000. These works consist of an iron-workers' shed, constructed in 3 bays, one being 300 feet long and the others 500 feet each, the width being 50 feet; mechanics' shop, 100 ft. x 50 ft.; joiners' shop, 120 ft. x 100 ft., 2 stories; ship building berth, 500 ft. x 132 ft.; power house, gas plant, etc., in addition to a 1,000-ft. x 500-ft. filling out basin with reinforced concrete retaining walls. Between 4 and 5 miles of service tracks give connections with the C.P.R., C.N.R. and G.T.R. In this plant some 600 men are now busy, most of them on a million-dollar icebreaker for use in the St. Lawrence River by the Dominion Government, the second largest icebreaker in the world. It is hoped that the launching will take place next June. Next month they will start a new $835,000 bucket dredge, ordered by the Dominion Government. It is to be delivered early in 1916. During part of the season as many as 1,500 men were engaged. Twenty-seven vessels have been repaired in the dock during the summer.

A NEW SWISS TUNNEL.

The tunneling problems incident to the projection of railways in Switzerland and Northern Italy present features of considerable interest to engineers on this continent. The fact that several tunnels have recently been pierced has received comparatively small publicity owing to the prominence of military affairs in Europe. The Hauenstein base tunnel is 5 miles 94 yards in length. The Munster-Grenchenberg tunnel is slightly longer, being 5⅜ miles in length. The latter was commenced in November, 1911, and is being constructed by the Bernese Alpine Railway Co., the builders of the electrically equipped Lötschberg tunnel. (See *The Canadian Engineer*, October 30, 1913.)

The Munster-Grenchenberg tunnel is, according to "The Engineer" (London), costing about $5,000,000. It is being laid with a single track only, and will have steam traction. It will be used under the direction of the Swiss Federal Railways. The new tunnel pierces the Jura Range, the height of mountain overhead having a maximum of 2,624 ft. The chief difficulties encountered in its construction appear to have been due to subterraneous springs and water pockets. As in the Simplon tunnel (see *The Canadian Engineer*, May 14th, 1914) a difficulty arose, prior to piercing, owing to water having accumulated in one shaft, and great care had to be exercised not to allow it to flood the other shaft.

The tunneling has been done for the most part with Meyer hand-boring machines.

The period allowed for building is 3½ years. The masonry lining of the tunnel is already well advanced, and it is confidently expected that it will be entirely finished within the specified time.

A list of European tunnels with their locations, lengths, summit levels and dates of operation appeared in this journal for March 26th, 1914, page 508.

The Canadian members of the International Waterways Commission were in conference in Washington last week. It is stated that the subject under discussion was the matter of polution of boundary waters.

DESIGN, MAINTENANCE AND OPERATION OF PLANTS FOR TREATMENT OF SEWAGE.

At the recent convention of the American Public Health Association, held in Jacksonville, Fla., the question of sewage treatment received worthy consideration in the valuable progress reports presented by several committees of the association. One meriting careful perusal had to do with the design and operation of treatment works, and was submitted by the committee on sewerage and sewage disposal, consisting of Messrs. Geo. S. Webster, chairman; Frank A. Barbour, Geo. A. Johnson, Langdon Pearse, and F. Herbert Snow. A portion of the report is as follows:—

All disposal works should be recognized as machines which require intelligent supervision and which, if properly designed and maintained, can be made to produce just that quality of effluent which the diluting capacity of the local stream will render satisfactory. In this way greater general progress in the betterment of stream conditions will result.

It will frequently happen that, in small streams, the dry-weather flow can, with profit, be increased by the intelligent use of stored upstream water, and the discharge of a partly treated sewage thus made possible at all seasons.

Where the two-story type of tank is adopted care must be exercised that the tanks are not made too large, as under such circumstances they are liable to fail of their purpose by reason of the sewage in the settling chamber becoming septicized and creating nuisance.

Patented Processes.—Town authorities should not deal with the proprietors of any patented processes or devices for sewage treatment without the assistance of some competent advising engineer.

The treatment of sewage has always seemed to be a particularly fertile ground for the exploitation of patented methods, from the early days of the many processes of chemical precipitation to the present-day electrolytic treatment; many of these schemes, while apparently successful in the experimental plants, are entirely infeasible on a practical scale. There is danger in deducing results from small test apparatus without scientific study by a qualified expert; often the cost of such treatments, when undertaken practically, is prohibitive. The proprietor of a process who is looking for a contract will give a bond and make various propositions which appeal to the people of a town and in this manner lead them to favor the acceptance of such propositions. Many costly mistakes have been foisted on communities in this way.

Processes of Treatment.—Sedimentation and Sludge Digestion.—Usually the first process of treatment is the removal of the solid matters which have been maintained in suspension by the velocity of flow in the sewer. In the past, when the solids were allowed to settle in tanks in which the sewage flowed over and in contact with the putrescent deposits in the bottom, odors resulted. Also, when the deposit from such tanks, called sludge, was placed upon the ground or upon drying beds, the foul emanations added to the nuisance. But within recent years, two-story tanks have been devised and are in successful operation whereby the sewage is settled for a short period of time in the upper story and the sludge allowed to remain in the lower compartment of the tank sufficiently long for the decomposable matters to digest, and the settling sewage is kept from coming in direct contact with the digesting sludge.

Such tanks will discharge an effluent practically free of settleable matter in nearly as fresh a condition as when received. The gases evolved during digestion of the sludge away from contact with the sewage are principally methane or marsh gas and carbon dioxide, both of which are inodorous. Sludge withdrawn from such tanks after digestion is inoffensive, dries quickly and may be used for filling low land or for agricultural purposes with no danger of nuisance.

Oxidation.—If the conditions require more refined treatment than sedimentation, it becomes necessary to adopt processes for oxidation. This may be accomplished by means of intermittent sand filters, contact beds or sprinkling filters, the choice of which is largely dependent on the availability of different construction materials and the size of plant to be installed. Intermittent sand filters are only economical where large areas of sandy soil are available. The sprinkling filter, on the score of economy and on account of the maximum efficiency secured on a minimum area of land, is generally given preference; yet under certain conditions contact beds are justified.

The present-day tendency is to adopt processes which will maintain, as far as possible, aërobic conditions in the liquid at all stages through the plant; the maintenance of such aërobic conditions is the primary consideration in avoiding nuisance.

Disinfection.—As the purpose of disinfection is the destruction of pathogenic bacteria, in order to provide a double safeguard against water-borne diseases, it can be generally said that disinfection of sewage is an unnecessary refinement, unless the effluent of the sewage-treatment works is discharged into a water course adjacent to and above the intake of a water-purification plant, and even in such a case the responsibility of protecting the public health should rest upon the purification of the water.

It is not practical to disinfect crude sewage containing particles of organic matter of appreciable size, as with the usual period of contact it is impossible for the disinfectant to penetrate the solids.

Odors and Their Avoidance.—The amount of odors depends largely on the freshness of the sewage and the method of treating and handling the sludge. The freshness of the sewage depends largely on time of travel and the design of the collecting system, on the adaptation of size to discharge, the provision for self-cleansing velocities and on the ventilation of the sewers so as to provide as much natural aëration to the liquid as possible. If the sewage is fresh or if, in other words, it contains dissolved oxygen, there will not be serious odors from the application or treatment of the liquid portion, provided the plant is maintained with no lodgment of sewage in pools or overloading of the surface of the filters.

There is a potential cause of odors in the sludge. But by the use of the more modern type of tanks, with thorough digestion of the decomposing solids and discharges on properly prepared sludge-drying beds, under favorable weather conditions, no odor of serious moment, noticeable more than a few hundred feet, should ever occur. Odors can be largely eliminated by good design, but their occurrence depends more particularly on proper supervision of the plant.

By the use of the two-story sedimentation tanks, which provide for the digestion of sludge, and by care in the management of the works, plants are operated in Europe and in this country where no odors are noticeable either from the sewage or from the sludge during drying.

In plants where other methods of treatment are adopted it is probable that odor will be produced. It has been estimated that at such a plant capable of treating the sewage of 50,000 people, with good management no odors should ever be apparent beyond 1,000 to 1,200 ft. from the works, even when sludge is being discharged upon the drying beds or in the spring when the filters are in bad condition, due to the past winter interfering with work being done on them.

With smaller plants this distance should be less, and with larger plants possibly more. By diffusion, of course, the odor becomes more faint as the above-named distances are reached, and beyond these distances no odor should be noticeable. What might be termed odors, strong enough to be disturbingly disagreeable to a person whose nasal sensitiveness is not affected by his knowledge of the source of the odor, should, perhaps, never be found at a distance more than one-third of those mentioned. It should, however, be noted that an odor from a sewage plant which, if from a farm would never be noticed or would be accepted as simply natural and reasonable, will generally develop complaints of nuisance. Sentiment, regardless of facts, frequently blames on an inoffensive sewage-disposal plant bad odors from other sources. In short, sewage-treatment works should be as isolated as is economically possible.

For the avoidance of odors, the fundamental considerations are the delivery of the sewage as fresh as possible at the plant, the application of the liquid portion to filters before the sewage has become stale, and the proper treatment of the sludge so as to render it comparatively odorless and easily handled.

Sewage-Works' Attractiveness. — Disposal plants should be made attractive by planting and parking, and no money can be better spent than this. The trees to some degree prevent the spreading of the odors, and in the planting of trees and shrubs the direction of the prevailing wind should be taken into account.

Local authorities, when they first take up sewage-treatment for consideration, frequently look upon the plant as a dump for municipal waste, and it never occurs to them that it is good policy to spend money to make the works so attractive that people will voluntarily make it the objective point of their Sunday afternoon strolls.

Such beautification and the proper maintenance of the appearance of the plant are the surest and best means of preventing complaints of odors or nuisance; this because of the psychological effect on those living near the plant, and also on the attendants, who unconsciously adopt a higher standard of cleanliness and care of the works.

Another notable report was that presented by the committee on sewage works operation and analytical methods. This committee consisted of Messrs. W. L. Stevenson, chairman; C. B. Hoover, H. C. McRae, Langdon Pearse, Geo. C. Whipple, and F. E. Daniels. One interesting feature of the report is its recommendation to the laboratory section of the association that it take up for consideration the improvement of the test for suspended matter in sewage. In respect to this test, to which it refers as a test for not only the amount but also the condition and physical characteristics of this suspended matter, the committee states:—

Suspended matter was first determined by the difference in the weight of the residue upon evaporation of a portion of the sample filtered through paper and another unfiltered. At the present time, the Gooch Crucible is generally used to obtain the weight direct. In both procedures the organic portion of the suspended matter was estimated by determining the loss of weight upon ignition. The Royal Commission on Sewage Disposal attempted to devise a method for determining the amount of suspended matter by means of the centrifuge. In the works of the Emschergenossenschaft a simple field method is in use for determining the bulk of the settleable matter by subsidence in graduated conical glasses.

None of these methods, however, furnish information concerning the size, physical condition or other characteristics so essential to know in the preliminary treatment of sewage. One of the reasons for this is the small size of the sample examined and the difficulties of obtaining a representative portion for analysis; for the inclusion or exclusion of a large size piece of suspended matter in a small sized sample will cause large variation in the result obtained.

The efficiency of all preliminary processes depends upon the removal of the settleable solids and, therefore, a test to measure them is of great importance.

It is, therefore, recommended that in sewage works operation some procedure for the determination of suspended matter be used and that analysts be urged to devise a technique to supply the information required.

Another recommendation of the committee urged that during the coming year analysts direct their attention to the simplification and standardization of the test for avidity for oxygen, or, in other words, a test for measuring by incubation the avidity of the sample of sewage or effluent for dissolved oxygen or its equivalent. The Royal Commission on Sewage Disposal developed a technique for such a test. Another method was developed by Mr. C. B. Hoover and is in use at the sewage treatment works at Columbus, Ohio, and still another has been devised by Dr. Arthur Lederer and is in use in the laboratories of the Sanitary District of Chicago. At present, a committee of the laboratory section of the association was about to propose a provisional procedure for such a test.

A NEW MANGANESE STEEL.

An improvement in manganese steel alloys is announced in a recent United States patent. Commercial manganese steel contains from 11 to 14 per cent. of manganese, and hitherto any attempt to produce a steel lower in manganese than 10 to 11 per cent. has tended to make a metal nearly as brittle as glass and unfit for commercial use. The invention is based on the discovery, made by the inventors, that a certain critical relation exists between the percentage of manganese and the percentage of carbon employed with it in the alloy, and that by proportioning the carbon ingredients in accordance with this relation, a steel may be obtained containing from 6 to 9 per cent. of manganese, or as low as 5 per cent., and "possessing to a very valuable degree the characterictic combination of ductility with hardness and the other important properties of the richer alloys." It is believed that there is a practical limit, around 5 per cent., for the diminution of the manganese, according to the invention. The ingredients of the product are perfectly brought together in a molten state, as is usually the custom with manganese steel alloys. After casting, the metal is properly water-toughened. The new alloy is a poor conductor of heat and practically non-magnetic.

LARGE EGYPTIAN PUMPING PLANT.

One of the largest installations of pumps in the world is being made for the Egyptian government, to drain Lake Mareotis, near Alexandria. The plant will consist of eighteen pumps of the Humphrey type, each capable of delivering 100,000,000 gallons of water a day through a lift of twenty feet. Each pump is eight feet eight inches in diameter.

AN ALTERNATIVE METHOD OF MACHINE-FIRING BY COAL OR GAS.

As the question of gas-firing is apparently coming into prominence again in some parts of the Dominion, and as in some directions there is plenty of discussion on the subject, our readers will no doubt be interested in the interesting installation recently completed by Edward Bennis & Co., Limited, Little Hulton, Bolton, Eng., at the South Staffordshire Mond Gas (Power and Heating) Company's works at Dudley Port, Tipton. The plant comprises eight producers, each capable of gasifying 20 tons of fuel per day of 24 hours, and generating sufficient gas to drive gas-engines of 2,000 h.p. continuously. The total capacity of the present section is thus equal to 16,000 h.p.

The fuel is brought by boat into the canal basin, or by rail onto the siding, both having been specially constructed, and is loaded by hand into bunkers; the entrance to these from the boats is a little above water-level, and at the ground-level from the trucks. From these bunkers the fuel is automatically fed into two conveyers, each having a capacity of 40 tons per hour, and which convey and distribute the fuel into the storage bunkers over each set of producers. The bunker over each producer will hold 40 tons; i.e., sufficient to keep the producer working for two days.

The gas, after leaving the producers, is thoroughly washed in mechanical washers, and after passing through the ammonia recovery and gas-cooling towers, is further purified by large centrifugal fans and then passed through the scrubbers and the meters, before being compressed and sent through the mains for distribution. The machine-stokers, which are arranged to burn either coal or gas, are of the Bennis sprinkler type, of which an integral feature is the self-cleaning compressed air furnace. The boiler plant of the gas company consists of three Lancashire boilers each 9 ft. x 30 ft. with extended flues, working at 120 lb. pressure. They are fitted with superheaters, the gases discharging into an economizer containing 4,000 sq. ft. of heating surface. The total grate area of each boiler is about 57 sq. ft.

Some time ago it was decided to substitute mechanical firing for hand-firing, and a definite guarantee was given by the stoker-makers that the evaporation of each boiler should not be less than 12,000 lb. of water per hour, with an over-load evaporation of 15,000 lb. per hour when desired for short periods, and an efficiency of 72% was also conceded.

The qualified staff of practical chemists employed by the gas company were entrusted with the task of making tests which should establish the results of the work actually done by the boilers. The tests showed not only that the guarantees were maintained, but an appreciable increase on the figures had been achieved. For instance, the overload evaporation of 17,000 lb. of water per hour from each boiler, instead of 15,000 lb. per hour, was obtained.

The gas company, prior to the installation, had found no little inconvenience owing to the fact that steam was required to be kept both during the night and from mid-day Saturday until Monday morning, when it was desirable that labor duties should stand at a minimum.

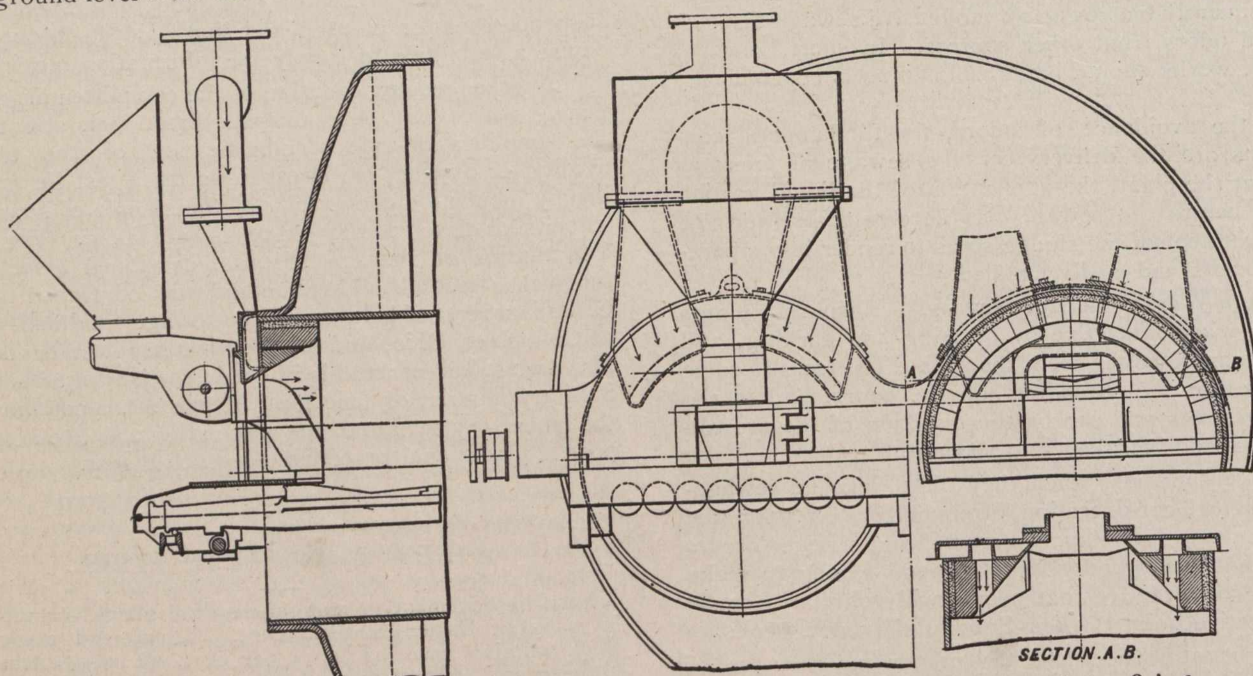

Fig. 2.—The stoker and self-cleaning compressed air furnace arranged for coal and gas-firing.

The problem was: could the mechanical stoking plant be so arranged that it could be coal-fed in the ordinary manner at ordinary times and the boilers gas-fired during the hours of night and at the week-ends? It was shown that, owing to the flexibility of the system of machine-stoking, illustrated herewith, the desired duality was perfectly practicable.

A reference to the illustration will show the gas ducts let into the top flange of the stoker front and secured by means of a gas-tight joint. The baffler plates which are situated behind the front are arranged with a passage, the outlet being over the grate; the gas passes thus from the ducts to the furnace. There are two ducts to each flue; that is, of course, four to each boiler, each pair containing a breeches pipe placed immediately behind the hopper and passing thence to the gas supply, constituting an extremely simple and satisfactory arrangement. It is, of course, essential that air should have access to the gas; a valve is, therefore, placed on the furnace front with an adjustable cover to regulate the amount of air supply. The air is conveyed into the furnace through a separate air duct and does not mix with the gas until it reaches the inside of the flue where ignition takes place.

For four years this dual system of firing boiler furnaces has been in operation at the works mentioned, and the results have been such as to justify the firm in applying the idea to all their extensions of boiler plant, since the method was first adopted. Repeat orders have been placed for machines of the same pattern to those already supplied, for their new installation of boilers. The secretary of the gas company states that the thermal efficiency obtained during a six months' run under all conditions and variations of load, including times when parts of the plant were off for cleaning and inspection, was 73%. The average quantity of water evaporated per boiler per hour for a month's run was 14,880 lb. During this period the boilers were fired with slack during the day, and gas-fired during nights and week-ends.

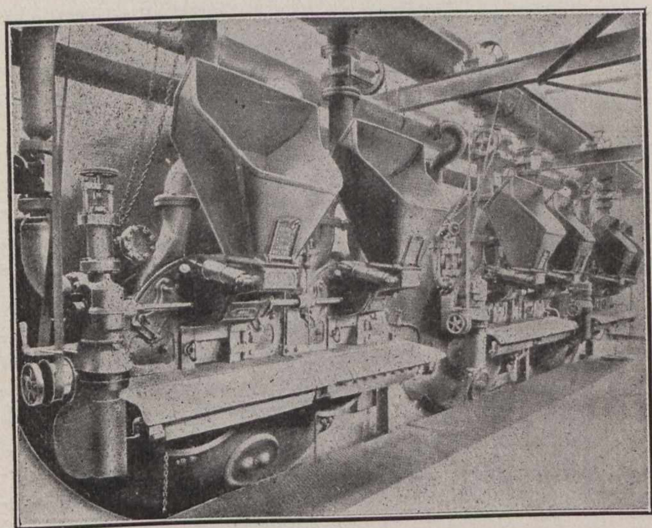

Fig. 1.—Stokers installation in the boiler-house of the South Staffordshire Mond Gas Company.

PRINCE RUPERT SHIPBUILDING PLANT.

The Grand Trunk Pacific dry dock and shipbuilding plant at Prince Rupert is being rushed to completion, and the close of the year will probably see all shops and tools ready for operation. The ship shed, served by two overhead cranes, is finished, as are also most of the auxiliary shops, including the boiler plant with its battery of six 400 h.p. water tube boilers; the power house, with two 1,000 k.w. generators, and electrically driven compressors to furnish air for the boring and driving tools. There is also a foundry capable of handling 20 tons of iron a day, a boiler and blacksmith shop with tools of large capacity and a machine shop with tools including a 76-inch swing by 50 feet between centres engine lathe, a 10-foot boring mill, a 6 by 6 by 20-foot planer, a drilling and milling machine, a 6-foot radial drill and many other similar tools.

Seven large pontoons have been built, three of them under the ship shed and four for the dry dock. Three of the latter are in place and the erection of the steel wings upon them is under way.

The machines have come in over the Grand Trunk Pacific lines. A yard locomotive crane has been used in their transfer to the shops. A 50-ton derrick has also been erected at the outer end of one of the piers.

PUBLIC UTILITIES AND THE PUBLIC.

At the Conference of American City Mayors, held at Philadelphia November 13 and 14, 1914, Mr. Delos F. Wilcox, consulting franchise and public-utility expert, New York, presented a paper which dealt in a clear-cut way with the factors which enter into the problem of relationship between the public and the privately owned public utilities serving it. The antagonism between the two bodies was commented upon in our issue of last week. This antagonism is responsible for the undue prolonging of many sorely needed developments, as the experiences of many of our cities will testify. Mr. Wilcox approaches the question from an intelligent and thoroughly studied position as the subjoined extracts from his paper show.

In discussing the antagonism mentioned above he observes that while this antagonism often assumes exaggerated, unintelligent and even fantastic forms, and while there is a substantial community of interest along many lines between the public and the utility corporations, we must not blink the fact that there is a permanent and fundamental conflict of motives between them. No amount of regulation and no possible development of good-will and the spirit of co-operation can change the fact that private corporations operating municipal utilities do so for profit and for as much profit as they can get, while the consumers and the public strive to get as much service as they can at the least possible cost.

The discussion of plans of campaign against high rates, poor service, political interference, financial tyranny and all the rest of the evils which we have set out to smite can only lead to confusion of counsels unless we clearly grasp certain underlying issues involved in the relations between the cities and the public utilities. Without having definite thoughts on these issues, we can not think straight on anything else, and without knowing what any particular speaker's thoughts upon them are, the rest of us can have no measure by which to gauge the importance or fathom the meaning of what he says.

The underlying issues are:

(1) What shall be the recognized character of public-utility investments

(2) What shall be the attitude of the city toward public utilities as money-earning enterprises?

(3) What attitude shall the cities take toward ultimate municipal ownership?

Mr. Wilcox answers these questions in the following manner:—

Character of the Investment.—Public-utility investments should be placed upon a non-speculative basis, and their security should approximate that of municipal bonds.

In the establishment of the non-speculative character of these investments, cities should not undertake to make good past losses.

So far as future investments in the standard utilities are concerned, the cities should assume the risks of loss due to unforeseen causes, and should substantially guarantee the integrity of all investments made at the request or with the approval of public authority.

Public Utilities as Money-earning Enterprises.—In my judgment, public utilities should not be regarded as a legitimate source of profit to be used for the relief of general taxation.

Compensation for franchise grants, and special taxes or license fees imposed upon public-service corporations should not be encouraged, unless the proceeds of such compensation or taxes are to be used in paying for the property.

Every individual public utility should be made to render a clear account of itself and, as a general rule, should be self-supporting.

Public-utility services should be rendered as nearly at cost as practicable, except that the rates should include a sufficient contribution to retire the investment within a definite period of time.

Public utilities should receive credit for all the service rendered by them to the city and its various departments, but only under unusual conditions should the city assume to subsidize a public-utility service out of the proceeds of taxation or otherwise.

Ultimate Municipal Ownership.—In my opinion, cities should not assume that public utilities are to remain permanently as private investments under private operation.

On the contrary, they should assume that all the well-established utilities will sooner or later be publicly owned, private capital being entirely excluded from the public streets except as it is loaned to the city.

In their franchise grants, and in all contracts affecting rates or granting privileges, the cities should establish the option to take over the utilities either at pleasure or at reasonable fixed intervals.

Wherever possible, the cities should go still further and without more delay definitely set in motion the machinery necessary to compel the gradual withdrawal of private capital from the public streets and the gradual acquisition of the utility plants by the cities as public property.

HIGHWAY INVESTIGATION IN SASKATCHEWAN.

The highway commissioners of Saskatchewan are endeavoring to secure accurate information dealing with every road in the province, and with this end in view the board has asked the collaboration of all councillors and secretary-treasurers of the rural municipalities. The officials are being supplied with maps and asked to supply information dealing with the following points: Graded roads in good condition, proposed roads already graded or new roads which should be graded, parts of proposed improvements that require immediate attention, graded roads that should be improved by cutting down hills and widening grades, government bridges not shown on the plan, bridges urgently required, etc. It will be seen from these questions that when the information is accurately tabulated the highways commission will have an accurate record of the condition of all roads in the province.

MANUFACTURE OF WOOD ALCOHOL.

In the course of investigations of the wood-distillation industry of New York by the college of forestry at Syracuse, it was found that the removal of the tariff on grain alcohol had hurt the market on wood alcohol in such a way as to make it hardly profitable to produce wood alcohol at this time. Chief products of the destructive distillation of wood are charcoal, wood alcohol, and acetate of lime. Charcoal is used for gunpowder, for fuel, in the manufacture of iron, and for various poultry and animal foods. Acetate of lime is used almost wholly in the dye industries. Wood alcohol is used largely as a solvent and for various chemical purposes. Beech, birch, and maple are the best woods for the production of wood-distillation products; heartwood is better than sapwood because it does not contain so large a percentage of moisture. Elm, chestnut, and cherry are not desirable woods for the wood-distillation industry because they contain too much tannin, gums, etc.

A Consolidation has been effected of the Lake Shore Railway Company and the New York Central Railway Company. The merger involves $300,000,000.

ROAD IMPROVEMENT.*

By W. A. McLean, C.E.,
Commissioner and Chief Engineer of Highways for the Province of Ontario.

THE present era is remarkable as one of rapid and convenient travel, transportation and communication. In this it is distinguished from all preceding ages. Invention has shown more marked advance in this phase of modern civilization than in any other. Every refinement has been sought, and vast expenditures have been made on steam and electric railways, ocean and lake steamship lines, harbors and canals, express, postal, telephone, telegraph and cable services. The motor vehicle is becoming a necessity for the transaction of business and even the air has been conquered as a practical medium for human locomotion. All these have not lessened but rather have increased the need for better common roads, and the demand for their improvement is accumulating with marked intensity.

The road situation of to-day presents many problems. It is doubtful if road conditions will ever be without their problems, for changes are constantly taking place, requiring an equivalent adjustment in methods of dealing with them. But it is also true that the present generation has opportunity to advance in this regard far beyond reasonable heritage or desires—for in general common road construction has been neglected, has been side-tracked and forgotten in the hurry of railroad construction.

New demands are pressing; advanced methods of construction are needed; old systems of organization are inadequate; old abuses and prejudices are persistent; opportunity for reform and progress is abundant and urgent.

The work of this association, and particularly that of the annual convention, is to its active members a matter of continuous but ever-reviving interest. Until the last ten or fifteen years, road construction in the open country was well served by water-bound stone and gravel, and was governed by established practice. Roads were built for horse-drawn traffic only, and the weight of loads was comparatively light. With the general use of rapid motor vehicles an entirely new form of wear has been added to that of steel tires and steel-shod horses; the weight of loads has largely increased, placing a much greater demand on road foundations and on bridges; the use of roads has greatly increased, especially on highways carrying suburban and interurban traffic. Road-building is in a reformative stage, and the annual accumulation of experience is steadily shedding new light on a very complex problem.

The growing difficulties of road construction and maintenance are not without their reward. The increased use of the roads means their increased usefulness. The possible service that may be performed by the common road is in proportion to the efficiency of the vehicle. The motor passenger vehicle and the motor truck have greatly advanced the general public value of the common road; and whereas good roads were regarded, a few years ago, as solely of rural concern, urban centres have become keenly alive to their value, and are willing to bear a fair proportion of the cost. The value of roads as a means of travel and transportation has increased manyfold. Instead of the farming population being expected to meet the entire cost, it is now fully conceded that, as regards

*Presidential address, American Road Builders' Association Convention, Chicago, December 15th, 1914.

main roads, cities must share the burden as with any other department of transportation.

Correlation of Facts.—The number of elementary materials used or dealt with in road-making is strikingly few, and, with minor exceptions, these materials are included in a brief list—sand, clay, gravel, broken stone, asphalt, tar, oils, vitrified brick, creosoted wood, stone setts, and Portland cement.

To these may be added a few materials of local service, such as oyster shells; or proprietary binders, such as Rocmac or Glutrin. While the elementary materials are few in number, the range in quality is wide, their combinations are many, conditions of traffic are of varying degree, and such factors as climate, workmanship and cost must be considered.

In the solution of road problems, at the present time, effort should be largely given by scientific engineers to the accumulation of facts respecting road materials and their action under climate and traffic. Much has been done in the past five years in this regard, and it is confidently expected that the next five will do more. Experience will then more nearly approximate the anticipated life of new materials and new methods. The status of knowledge respecting road construction in the next five years will largely depend on the care and thought with which we, at the present time, assemble and correlate obtainable facts. This is a matter which should be especially impressed upon municipal bodies, and co-operation with their engineers obtained, in order that experiment, test, and the collection of data may be effectively carried out.

Roads should be built according to traffic. To a proper solution of the problem of road construction and maintenance, there is much need of the general acceptance of uniform traffic standards. Traffic, in relation to the results from a paving material, is sometimes loosely described as "light," "medium" or "heavy." These terms have all grades of meaning according to locality. In one district 200 vehicles a day would be considered heavy traffic, while in another 2,000 vehicles might be medium traffic. When traffic standards have been clearly defined, and data is accumulated as to behavior and cost of a material under definite degrees of traffic, our experience can become of much greater usefulness. What is needed is a greater accumulation of fact, correlated with definite standards of traffic.

Work Should Not be Delayed.—Road-building is a slow process. In the northern States and Canada there are only about one hundred actual days in the year to be fully depended on. A mile a month for six months of the year is reasonable progress for one outfit of machinery.

There are limitations as regards labor and material which cannot be exceeded without greatly increasing the cost of the work. If a community needs a good general system of roads to-day the work should have been commenced twenty years ago. If a system is needed twenty years hence, it should be commenced now.

Permanent Roads.—The term "permanent" as applied to roads is somewhat misleading, and is not always appreciated by the general public. In the full sense of the word, there is no such thing as absolute "permanency." It is merely a relative term. But it is important, in making safe provision for financing road undertakings, that the matter be clearly understood. For all practical purposes, expenditure for the purchase of road allowance may be regarded as permanent; earthwork and certain drainage of an adequate kind may be regarded as permanent; substantial concrete culverts and bridges may be regarded as permanent; heavy road foundations may be permanent. But there is no such thing as a permanent road surface. Traffic and natural disintegration cause the wear and decay of any road surface that can be employed, and adequate provision should be made for the repair and renewal of the surface.

To meet the immediate needs of traffic throughout the United States and Canada, a large amount of construction must necessarily be carried on that cannot be considered of a "permanent" kind. To attempt the task of immediately building, for all traffic, roads that would have a maximum of permanence would be as impossible as it would be economically unwise. A large part of the farm traffic can, for the present, be best served by roads of moderate cost, lightly surfaced with broken stone or gravel, but carefully graded and drained. In many localities even good earth roads (but well graded and drained) maintained by use of the log-drag must be depended upon to meet the needs of traffic, owing to sparse population or the absence of local gravel, stone, or other suitable surface material.

The most unfortunate results have, however, arisen in the treatment of main roads on which, though expensively built, an effort has been made to maintain a heavy bituminous or other high-class surface on a totally inadequate foundation.

Much discussion has taken place during the past year on the subject of road foundations, and has arisen largely from those who attended the International Road Congress in London last year, as a result of their observation of practice in Great Britain and in Europe. European practice in all classes of permanent road construction has undoubtedly in the past tended to greater mass in the foundation than has been generally adopted on this continent. If past practice abroad has proven the need for the massive foundation, it would seem that, on this continent, the use of light foundations should be critically considered, with a view to the adoption of a greater depth of stone and the more general use of Telford or equivalent foundations, particularly for main roads, on which heavy traffic is assured. In the construction of strong foundations there is opportunity for permanency, which will at the same time reduce the cost of repair, for a large outlay may readily arise from attempts to maintain a good surface on an insufficient and yielding foundation.

Fair Distribution of Cost.—A fundamental necessity in creating a system of roads is that the cost shall be fairly and equitably levied on those who benefit. Failure to do so has done much to retard road-building in the past. If the general public feel that the cost of roads is borne in a reasonable degree by those who should contribute, much opposition will vanish. If the farmer feels that he is being asked to build roads for motorists of the cities, he is naturally opposed to proposals for road development on such a basis. Out of this has grown much of the opposition in some localities to the construction of trunk and State roads. A close study of the farmer's viewpoint by advocates of trunk roads will throw light on the road situation as a whole, and will indicate that a successful road policy in any province or state should make provision for the improvement, if not of all roads, at least of those more directly serving farm traffic. Broadly, trunk roads run from city to city, and are commonly parallel to the steam railway. The market roads on which rural traffic most frequently concentrates, radiate from the station, villages and shipping points, and are, in general, at right angles to the trunk roads so often advocated for motor traffic.

Trunk roads are a necessary adjunct of any system of roads. They are desirable, and should be built. They frequently form part of a system of local market roads, but must be more substantially built to serve the more severe traffic.

It is difficult, however, for even the most patriotic farmer to rest satisfied with beautiful pictures and illuminative newspaper descriptions of the splendid roads of his own state—roads he never sees—while he has still to drive through the mud axle-deep to his local market or shipping point, with nothing being done to remedy that condition. Rural residents of every good farming community want good roads, and are willing to meet a reasonable outlay for them—nor are they opposed to trunk roads if the cost is levied upon the proper source.

A farming community, insofar as is consistent with its prosperity, can fairly be asked to contribute such amount per mile of road as would properly meet the needs of local traffic. For more expensive construction for motor traffic the remainder of the cost should be met from a source representing the contribution of cities or other communities benefited.

Market roads without trunk roads are commonly opposed by cities quite as much as the farmers oppose trunk roads when provision is not made for market roads. Upon a plan of road improvement which includes both, all the people can agreeably unite.

It is not intended to convey the impression that all roads can be built at a stroke, and that a durable road can be at once built to every farmer's gate. There must be a starting point. For this purpose certain roads must be selected for the immediate improvement, others to take their turn later. A study of local traffic conditions will indicate the roads on which traffic seeks to concentrate, and, commencing with these, the general system can be developed from year to year.

There should be no conflict of interest between the two classes of roads. The one is a necessary adjunct of the other in a complete system of roads. The great need is that the value of both should be recognized and adequate measures taken to develop both concurrently; but there should be no effort to substitute one for the other.

Bond Issues.—Much difference in opinion and practice exists with respect to the issuance of bonds for road construction. At one extreme are those who oppose all bonded debt for public roads, while at the other are those who advocate bonds maturing in forty and fifty years. It is probable that, as in most cases of widely divergent opinion, the true solution is in a moderate middle course.

The primary construction of a great system of roads has, in all countries, required large initial expenditure, such as can only be procured by distributing the repayment over a term of years. The construction of main roads, and even good market roads, is as a rule carried on in very disjointed sections, and at a sacrifice of workmanship, if the cost is provided by annual levy only. The necessary initial outlay can, as a rule, be sustained only by borrowed funds.

It may be asserted as a further truism that the term for retiring the bonds should not exceed the useful life of the work. Again, repayment in the briefest possible period is favorable in that the total interest charges are reduced.

In considering the matter, the road structure may be divided into several portions: The system of drainage; the earth sub-grade; the foundation; bridges and culverts, and the wearing surface.

Judging the future by past experience, it may be estimated that long-term bonds for certain portions of the work are justifiable. An effective system of open and under drains, deep cuts, extensive fills, and an adequate width of earthwork; a Telford, concrete or other heavy foundation; concrete or heavy steel bridges and culverts are all of long durability, and may justify long-term debentures. The road surface, on the other hand, has a comparatively short life, and will seldom justify a debt of more than five or ten years' duration. Adequate maintenance is in all cases essential.

The methods of finance as regards the issuance of bonds may thus be based on the life, not of the surface only, but of the several portions of the structure; the bonds for surface costs to be retired in not more than five or ten years, while the long-term period may be applied to what may be more truly termed the "permanent" portion of the work.

It might be logical to approach the matter on the basis of a general estimate, meeting a proportion of the cost, approximately 50 per cent., by long-term bonds, the remainder, or 50 per cent., covering surface costs, to be retired, according to the life of the pavement, in from five to ten years.

To go even further on the ground of safe finance, and to pay something for immediate benefit, a portion of the cost might be met out of the annual levy; but that as a rule is difficult, and may tend to reduce the amount available for adequate maintenance. It need not be added that to meet the cost of maintenance by the issue of bonds should be regarded as a criminal method of finance.

Town-planning.—Town-planning is a matter with which road-builders, we believe, should be closely identified. In this let us not be misunderstood. By "Town-planning" we do not mean the preparation of artistic plans and beautifully imaginative reports frequently employed for municipal advertisement and the promotion of speculative subdivision schemes.

The essential principles of town-planning are largely based on adequate provision for present and future traffic requirements, together with subordinate matters of street and road design.

The question of town-planning is one which should arouse interest in every progressive town and city. The United States and Canada are passing through a period of growth and expansion which, we trust, may long continue, and proper foresight in this regard is a necessity.

The past tendency to allow towns and cities to follow unguided growth has resulted in many objectionable and unfortunate conditions which could readily have been avoided, but which may now only be remedied at much expense.

The Housing and Town-planning Act of England, a recent measure, is accomplishing much, in enabling land-owners and municipalities to enter into agreements for mutual benefit. Main and radial thoroughfares are provided, parks and open spaces are laid out subject to agreement, industrial areas are set apart, residential districts are fixed, and streets, drainage, grades, water supply and many other details are decided upon in a manner that gives every opportunity for favorable and least expensive growth. The advantage to both the public and the land-owner is apparent.

No doubt many towns and cities on this continent, now comparatively small, are destined to a very considerable growth, and by well-devised measures, the gradual widening of existing streets, the opening of new streets, grouping of public buildings, etc., could be provided for; so that town-planning may be applied not only to new areas, but to the favorable treatment of old districts and the removal of existing defects. Practical town-planning is of much value in meeting the present and future traffic needs of urban communities.

Present Financial Influences.—The influence of the war on the financial situation is a feature of much importance as regards the present and immediate future of road-building on this continent. On the declaration of war by European powers in August last, while much uncertainty was felt, there was remarkable freedom from panic in the money markets of the world. Since the commencement of hostilities there has been a decided improvement. Crops, on the whole, in the United States and Canada have been good, and farmers are receiving good prices for their produce. While the flotation of municipal bonds is difficult, and capital is showing a natural timidity, there is a growing tone of optimism which promises much.

While municipalities and state governments of the United States are feeling the effect of war conditions, Canada is more directly influenced, and is, at the same time, meeting a heavy war expenditure.

The borrowing opportunities for Canadian governments are restricted, and while loans for large undertakings are seriously handicapped, means are being developed through local capital to meet necessary and desirable outlay.

The construction of roads for war relief has been largely accepted as a logical measure, and while rural municipalities, with a continuance of good crops and prices, will be in an excellent position to carry on the work, the ability of provincial governments to aid large undertakings may not be correspondingly favorable. Here private capital has, in at least one marked instance, stepped into the breach, and the construction of a concrete highway from Toronto to Hamilton (about forty miles) has been organized and commenced since September 1st. A proposal to construct a main road from Montreal to Windsor, across the Province of Ontario (over 500 miles in length), as a great memorial to the Canadian expeditionary forces, has been received with much public favor, and it is not improbable that construction may be commenced as a war relief measure.

The final effect on road construction must largely depend on the duration of the war. Should the struggle, with its tremendous waste, be prolonged for three years, as is predicted by an eminent authority, the ultimate influence on financial conditions is impossible to estimate. Should it be concluded in a year, as many hope, the present feeling of optimism will assuredly not be without substantial foundation.

RAILWAY CONSTRUCTION AT SALISBURY, ENGLAND.

Large numbers of the Canadian troops at Salisbury have recently been engaged in the construction of a light railway to serve their various camps. The roads, which were of a temporary nature, had given way under the strain of heavy tractor and motor truck traffic, engaged in the haulage of supplies. A contract was awarded to Sir John Jackson & Co. for the construction of this service railway, and Canadian engineers, many of them graduates of the universities of this country, Toronto, McGill and Queen's, are engaged in its construction.

In addition, the Canadian engineers have charge of the construction of a water supply system at Bulford and Larkhill.

THE EFFECT OF FROST UPON CONCRETE.*

By John Hammersley-Heenan, Assoc.M.Inst.C.E.

THE engineer who is called upon to carry out work in Canada during the winter finds that the methods of construction which were satisfactory in the summer will need considerable modification to suit winter conditions.

Concrete work, especially the lighter forms of reinforced concrete, used in building construction needs greater care and supervision. As a result of considerable experience gained during the last few years, it can be said that the freezing of concrete will not damage it if it has first had a chance to set under favorable conditions for about two days. The effect of the freezing is simply to delay the process of hardening, which will again proceed under suitable conditions, and will eventually attain its full strength. If concrete is frozen before it has commenced to set, it will not be injured if precautions are taken to prevent it from freezing again after it thaws until it is sufficiently hardened to withstand the effects of subsequent freezings. It is alternate freezing and thawing during the process of setting that causes the damage.

To meet the foregoing conditions, when carrying out concrete work in winter, it is necessary to devise means of mixing the concrete with materials freed of frost, placing it in the forms before it has commenced to freeze, and then protecting it and keeping it warm for about two days. After that it may be allowed to freeze without fear of its being damaged.

In the case of concrete in mass, of large bulk, it is unnecessary to apply external heat, as the large body of concrete will generate sufficient heat during the process of hardening to enable the mass to set; all that will be necessary is to protect the outside of the concrete so as to keep the heat in. This can best be done by covering the concrete with clean straw.

For light sections of concrete, such as in reinforced concrete, poured at a temperature not below 22 deg Fahr., some engineers allow salt to be used in a proportion not exceeding 10 per cent. There are many arguments for and against its use. The author prefers not to use it, except in marine works when the concrete is mixed with sea-water and the salt is admitted in that form. He has found that, instead of using salt, good results will be obtained for temperatures that do not fall below 22 deg. Fahr. by heating the water with a steam-hose taken from the mixer-boiler, and when necessary placing a few coke or wood fires on the heaps of sand and crushed stone, the usual precautions being taken to protect the concrete when in the forms, as described later.

For lower temperatures than those referred to above greater precautions must be taken to heat the ingredients by means of steam coils or radiators.

The concrete having been mixed, and the portion of the work to be carried out decided upon, the floor immediately below it should be partitioned off with tarpaulins, and coke stoves arranged under the floor slab, allowing about one stove to every 800 sq. ft. of floor space. All loose dirt and snow must be removed from the forms with brooms, and a steam hose should be applied to remove all ice and frost, the steam playing continuously over the forms in advance of the concrete, thus

*From a paper read at a meeting of the Institution of Civil Engineers (Great Britain) December 2, 1914.

warming them in readiness for the concrete. The concrete should be poured quickly and continuously, and as each section is completed a tarpaulin may be drawn over it, supported on wooden strips about 6 in. above the surface of the concrete. In most cases this protection will be sufficient, but during very cold weather it will sometimes be found necessary to form a sort of tent over the floor, in which extra stoves are placed to protect the workmen and the upper surfaces of the concrete.

Great care must be taken to have the fires kept burning continuously for two days, after which the concrete may be allowed to freeze without fear.

The work must be examined from time to time until it is found to be hardened sufficiently. During summer working the author has allowed the supports from the underside of slabs to be removed in four days, but on other occasions four weeks have not been found to be too long.

There are many examples of concrete works which have stood the test of time without showing any signs of being affected by frost; but, on the other hand, a few cases have been reported of very serious corrosion due to the action of frost, such as bridge piers and reinforced-concrete piles.

Judging from the information available at present, concrete exposed in air in a dry locality need not be affected by frost any more than good building stone, and probably it will stand much better. Concrete always submerged under water is protected and need cause no anxiety. But concrete alternately wetted and frozen must be protected from frost. On work which is being carried out at Halifax, Mr. John Kennedy, M.Inst.C.E., is protecting the concrete piles between high and low water with a covering of wood about 2 in. in thickness, which it is hoped will prevent the action of frost.

TWO TELEGRAPH SYSTEMS AMALGAMATE.

An arrangement has just been consummated between the Great North-Western Telegraph Company and the Canadian Northern Telegraph Company. Commencing on January 1st, 1915, these two large telegraph systems will be operated as one under the name of the Great North-Western Company. Within the next few months, the lines and offices of the Western Union Telegraph Company in the Maritime Provinces will be operated by the Great North-Western Company, which will then have the largest telegraph system in Canada, it covering the country from the Atlantic to the Pacific. They will have over 1,700 offices in Canada and direct connection with 22,000 offices of the Western Union Telegraph Company in the United States, as well as with eight transatlantic cables, six of which have landing stations in Canada. This insures to the Canadian public a telegraph and cable service with and from Canada unique in its completeness.

Mr. Z. A. Lash, K.C., continues as president, and Mr. Geo. D. Perry as general manager of the Great North-Western Company.

Scientifically speaking, there is no such thing as a waste product, and the word waste has become current because of the lack of knowledge of how to transform residual matter into a marketable commodity. In the study of fuels, for instance, the enormous quantities of carbonaceous substances which exist in different forms, and which have not been utilized or treated in order to extract from them the valuable products they contain, are now being brought into the sphere of commerce by the introduction of new processes. A study of the history of these processes is exceedingly interesting, and indicates very clearly how the theorists have been groping towards the end which appears now to be susceptible to early attainment.

SHEAR AND PROBLEMS ARISING THEREFROM.*

By H. Kempton Dyson.

THE determination of stresses and strains in materials has formed the subject of many investigations. The usual mode of attacking the problem involved has been often referred to as the "mathematical theory of elasticity," which is, however, an all-embracing title that should rightly cover the whole subject. In its narrower aspect it means the mathematical analysis of stresses and strains in an elastic medium that is homogeneous and non-granular. Seeing, however, that such a material is purely imaginary, the mathematical analysis, though strictly exact in itself, may not conform to the facts of the experiment. The mathematical analysis that has arisen from such consideration is a most powerful assistant to the engineer, and by the adoption of suitable functions to suit the peculiarity of the composition of each material, will, within the limits of elasticity, afford many important relations that accord with the facts determined by experiments. Mathematics, including, in large part, the processes which have been evolved by consideration of the ideal elastic substance, have only comparatively recently been applied to another mode of approaching the determination of the stresses and strains in materials in which their granular nature is recognized and their resistance and deformation expressed in terms of the intermolecular forces and motions. Prof. Sir J. A. Ewing has put forward in a tentative way a theory of electrical attraction between molecules, while Prof. A. Rejtö, of Budapest, has worked out in considerable detail a theory dependent upon molecular friction.

Various hypotheses to account for rupture in bodies under stress have been advanced by writers from the point of view of the mathematical relations of a homogeneous, non-granular elastic material. Lamé assumed that material was ruptured when the greatest tensile stress reached a limiting value. Poncelet, followed by Sain-Venant, assumed that failure occurred when the greatest extension reached a certain limit. Tresca, followed by G. H. Darwin, suggested that rupture occurred at a limiting value of the largest difference of the greatest and least principal stresses, while Colomb made a somewhat analogous suggestion that failure occurred when the greatest shear reached its limiting value. This view, in recent years, has received much support from experiments conducted by Mr. J. J. Guest, with the consequence that it is often termed "Guest's Law."

The stress at any point can be completely specified by only six components on rectangular axes, three being normal and three tangential to the three planes, in which three axes lie, and further, three planes can be determined upon which the resultant stresses are wholly normal. Such planes are called principal planes, and the stresses across such planes are called principal stresses. The directions of the principal stresses are generally called the axes of stress.

Various experiments on steel and cast-iron specimens under combined stresses clearly seem to show that when rupture occurs the maximum shearing stress is far more constant for ductile materials than the maximum principal stress, but not so for a brittle material like cast iron, where the reverse order of things applies. Brittle materials are weak in tension, and the author of this paper

*From a paper read December 3, 1914, before The Concrete Institute (Great Britain).

offers the opinion that rupture of materials ductile occurs by shearing, but that rupture of brittle materials occurs by tension. Rupture by compression stress alone never occurs. If materials are ruptured under a thrusting load it is by the shear or the tension that is induced thereby, as will be referred to in greater detail hereafter. It is suggested that ductile materials are distinctive in their structure in that they are crystalline in structure and appear to break down by sliding along the cleavage planes of the crystals.

The writer, working on his assumption that brittle materials of distinctly granular structure fail by weakness in tension, has made an analysis of the conditions of rupture of a granular mass in which there is cohesion. The analysis proceeds on allied lines to Rankine's analysis of frictional stability, with the difference that cohesion is not ignored. Various analyses of the stresses existing under such a mode of failure have been put forward by writers on the strength of materials. It has been supposed that brittle materials under stress should fail on planes inclined at an angle of 45 degrees to the direction of the stress. With ductile materials under direct tension the analysis appears to be approximately correct, though Prof. Rejtö contends that the angle of slipping is a characteristic property of the materials and varies with different materials. It is well known that tension specimens draw out at the point of rupture into a conical and cup-like form of fracture, the angles at the faces of the cup being approximately 45 degrees.

In compression, however, with ductile materials the relation does not appear to hold with the same degree of accuracy, the very nature of ductile materials being to swell in compression, and as they swell so their area increases. The stress cannot be increased beyond a certain point, at which they become permanently deformed, according to geometric laws, so that there is no indication of elasticity or tendency to return to the primitive shape. By microscopic inspection of the faces of such compression blocks a justification of the ordinary analysis is, however, found in that ridges are noticeable upon the surfaces showing where the material has slipped upon the cleavage planes of the crystal structure, which slippings occur approximately at 45 degrees. The customary mode of analysis proceeding on the lines of the mathematical theory of elasticity for non-granular and homogeneous elastic solids, as we have seen, leads to the reasonable explanation as regards ductile materials. Navier made a further assumption in an attempt to explain why brittle material did not fracture on planes at angles of 45 degrees, but, as with cast iron and concrete, at some angles inclined in the neighborhood of 30 degrees to the axis of the compressive stress. His assumption was to consider that materials failed by sliding on an oblique plane, and that the friction on that plane had to be overcome as well as the shearing resistance of the material. The author of this paper was led to his other mode of analysis whereby the material was considered as a granular mass with cohesion, by knowing that later experiments did not appear to agree with the values derived by Navier's analysis. Experiments had, indeed, shown that the resistance of concrete to direct shear was very different to the shearing value which was found by Navier's analysis, and punching experiments on concrete specimens again showed different values. The shearing values for concretes determined by different modes of analysis and experiment were found to be different. It remained, therefore, to see if some reasonably uniform relation could be found between the resistance to shearing forces derivable from experiments on direct shear, and from the analysis of the shear stress induced by direct compression. This relation appears to consist in the dependence of the resistance to shear upon friction and cohesion, or as the latter might equally well be termed, tension. A uniform relation is found between the experiments on building stones, concrete, and cast iron in respect to failure under tension, compression and shear. The author next refers to the relations between the bending moments and shearing forces on beams.

Reference has already been made to the fact that experiments tend to show that rupture of ductile materials under compound stress occurs by shearing stress on oblique beams, to have regard to the point where maximum shear will occur. This is often calculated for vertical or horizontal planes, but it requires determination on oblique planes. As regards joist sections, if the web were fairly slender the maximum intensity of shear stress is found at the connection between the web and the flange and not upon the extreme fibre. This points to the conclusion that our standard sections ought to be investigated with regard to their possible weakness at the shoulders,, as such weakness might be very serious in beams of short span.

It is well known that webs need to be stiffened by the provision of vertical stiffeners under point loads to prevent crushing and buckling of the web, and the provision of stiffeners to prevent the rib buckling by diagonal stress is also adopted more or less empirically (seldom by theoretical determination) in the case of plate girders. From the fact that the directions of the principal stresses crossed each other at right angles, at an inclination to the neutral axis of about 45 degrees, the web is in the condition of a strut, so that stiffeners may require to be provided either in the form of vertical or inclined members in order to convert the plate girder into a lattice girder.

In reinforced concrete we have a somewhat analogous position. Reinforced concrete beams are quite a distinct type in themselves, because they pass through two stages in their resistance to cross-breaking. In the first stage the steel remains uniformly connected to the concrete in which it is imbedded. In the second stage the steel slips through the concrete for part of its length and the concrete cracks in the tension portion, so that the beam becomes converted into a form of construction which, in different modes of reinforcing, would appear to consist of either a concealed arch with a steel tie, a trussed beam analogous to the trussed timber beam, or a frame. Frames subjected to transverse loading are, of course, subjected to shearing forces, but the effect of the shearing forces is naturally very different on frames from that on a girder with a solid web or upon arches. A shearing force diagram only consists of the plotted values of the tendency to shear it asunder which the load exerts upon the structural member. We can, therefore, have a shearing diagram equally applicable to a beam, an arch, or a frame, but the manner of using the diagram for determining the internal stresses which result from the shear forces must be different in each case.

Persons may be misled in connection with shearing force diagrams as applied to frames by reason of the similarity between the use of the diagram for calculating stresses in a beam and frame. Whereas the application is close in the case of concentrated loads applied at the connection points of the frame, in the case of distributed loads the shearing force diagram is not so closely related. The fact that the area of the shear force diagram up to any point is equal to the numerical value of the bending moment at that point in the case of freely supported beams will often be found of considerable service in practice, while the feature that the point of maximum bending moment is the point of zero shear, which is of general application to free, fixed, and continuous beams, is of common employment for the determination of the maximum bending moment.

The fixing of one end and one end or the other have an effect upon the distribution of the shear along the length of a beam. Partial fixity as occurs with continuous beams will affect the shear in similar fashion, and it should be noted also that partial loading of continuous beams (i.e., loading any or all of the spans wholly or in part) will result in different distributions for the shear and gives different reactions on the supports. For this reason the current practice of generally taking the load on the support next to the end of three or more continuous equal spans as equivalent to the load on one span is considerably in error, as is the practice of taking the shear as the same as on a freely supported span. For the determination of shear throughout the length of beams required to sustain travelling loads where these point loads are applied at several points of the span and can move throughout the span, use is made of influence line methods. The shear in the webs of beams is applied to the flanges. This may be considered generally as a gradually increasing thrust from the ends of a beam and tends to cause lateral flexure of the compression flange considered as a long strut.

When the web is stiffened either vertically or obliquely, the stiffeners act as struts, and the web takes diagonal tension like the diagonals of a frame. This diagonal tension tends to cause vertical secondary bending of the flanges between the panel points, which should again be taken into account in the detailing of plate girders.

If the stiffeners are arranged vertically, they convert the girder into practically a Pratt truss, where the stiffeners are in compression. If the spacing of the stiffeners is closer together than the arm of the beams apart, the diagonal tension may still be considered as inclined at 45 degrees, the system becoming one of superimposed trusses. If the stiffeners are diagonal the girder becomes an N-truss. In riveted joints not only the shearing resistance of the rivets but the safe-bearing stress on the plates or other members through which they pass must be studied. Very often the bearing stress is less than the bearing resistance. In using that value, however, it should be remembered that the holes in which the rivets are inserted are punched or drilled large enough to enable the rivet to be inserted easily. Consequently, when the rivet is closed it will have the larger diameter of the hole.

Reinforced concrete beams are quite a special form of construction, because the stresses are induced in them in different ways according to different modes of arranging the reinforcement, and according to the amount of reinforcement; that is to say, a reinforced concrete beam may prefer to act as a flat arch with a tie rod if it is able to hold up in such a form with less stress than it would in some other fashion. On the other hand, if it acts as a beam, the conditions are different in the case where the stress is such as not to have ruptured the concrete by tension therein from the case where the concrete is cracked. Generally, some parts of all reinforced concrete beams are in the uncracked condition, and really require analysis on the lines of a homogeneous section, the materials, however, having different moduli of elasticity both for the concrete in tension and compression and the steel. In the majority of cases the reinforcement is insufficient in amount to prevent cracks occurring at some point or points in the beams, and then when cracks appear it means that the steel has moved in the concrete, and that the construction either consists of a trussed beam or a framed beam in part or in whole. Where the reinforcement is inclined at the ends there is an obvious analogy to a trussed timber beam. Such a type of reinforcement is quite appropriate for point loads. When the cranked bars are in combination with straight horizontal bars a practical type of reinforcement is provided which forms a sort of half-way house, and can equally well resist point loads or distributed loads. In the latter case not only do the straight bars produce one sort of beam action, but the cranked rods resist the shear in that the inclined pull in the bars affords a vertical component at every part of the length to resist the shear.

The resistance to the shearing force of a beam must, in the presence of cracks, be altered to the manner in which an arch, a truss, or a frame resists shearing force. Diagonal cracks in nowise preclude the concrete from taking diagonal compression parallel to such cracks.

It was early found in practical work that it was advantageous to reinforce beams against shearing force in other manners than by trussing members. Either alone or in combination with such vertical reinforcements, web members (either vertical or diagonal) were provided. Numerous patents have been taken out for various forms of separate web members, though often they can be economically provided by turning up the main bars. Where other practical and theoretical conditions preclude one from using so many bars as would enable one to turn up the bars at the proper additional separate members the system may be a double one. The frame action of vertical and inclined web members generally belongs to two types. In the first case, where vertical web members are employed the construction becomes a kind of N-truss, in which the concrete forms compression members and the steel the tension members. In the diagonal form the construction becomes practically a lattice girder. In both types of construction the frames may be, and often are, superimposed; that is to say, the spacing of the vertical members or of the diagonal web members is frequently fairly close.

It should be borne in mind that the theoretical analysis of the stresses in materials is in the nature of a speculation; it is an attempt like all scientific theory to explain the facts, but with the progress of investigation further facts come to light which cause us to modify the former theory. In that way there is a gradual improvement and greater exactitude about theories. But their chief purpose must always remain to draw the attention to the practical engineer to what is happening, likely to happen, or what may possibly happen, and in practical design the complications of refinements in theory are too great to permit of adoption. The practical engineer, by study of the theory, will, however, be able to make his own simplifying assumptions for approximate calculations, which will enable an economical and safe structure to be erected satisfactory in all the directions indicated by elaborate analysis.

Moore's wharf, which handled all the shipping at Skagway, Alaska, including freight for the interior over the White Pass Road and the Yukon River, was destroyed by fire, the loss being estimated at $60,000. Warehouses and contents valued at $150,000 were also wiped out.

Asphaltic concrete must be laid hot and rammed until the surface is smooth. Care must be taken that the materials are properly heated, that the place where it is to be laid is absolutely dry, and that ramming is done before it chills or becomes wet. The rammers should be heated in a portable fire.

Editorial

NICKEL PRODUCTION AND CONTROVERSY.

Since the beginning of the war the daily press has given much space to editorial discussion of the export of nickel. Last week the president of one of the large refining companies issued a statement, as a result, no doubt, of the adverse criticisms which have been given publicity here and there. The point at issue is whether or not the metal, or its oxide, finds its way either directly or indirectly to the armament manufacturers of the enemy, after it has been reduced at refineries, none of which are situated in Canada, the metal therefore being exported before treatment.

A statement of the world's nickel production, and the demand that there is upon it, may not be amiss.

Of the total production, that of Canada forms by far the greater part, and this country has been looked forward to by all world powers, as the source of the metal. The nickel mines of Ontario, chiefly around Sudbury and Coniston, loom large in the affairs of the manufacturers of many important commodities. Of the mineral output of Canada, Ontario comes first with over 40%, British Columbia produces 20%, Nova Scotia 13.4%, while the output of the other provinces is in each case below a rating of 10%. Of the metallic output, nickel is second in quantity (copper leading by a wide margin), and third in value (silver and gold being ahead of it). Of this nickel production, the Sudbury and Coniston mines turn out all except 0.06%, which comes from Dundonald Township, also in Ontario. Compared with the output of the world, Ontario's production in tons is as follows:—

Year.	World's production.	Ontario's production.
1913	30,000	24,838
1912	28,500	22,421
1911	24,500	17,049
1910	20,100	18,636
1909	.....	13,141

The balance of the nickel supply, *i.e.*, what is not produced in Canada, is largely controlled by France and comes from the mines of New Caledonia, which, in 1913, produced about 5,000 tons of matte.

The remaining countries that possess nickel deposits, small in size and importance, are the United States, Norway, Greece and others. Some of the mines, chiefly those in the United States and Norway, ceased operation owing to the great Ontario development. That their production was small is evidenced by the fact that fifteen years ago the annual production of nickel ranged around 7 tons.

The much-talked-of metal has an important use in nickel plating and coinage, but the publicity centering around it at the present time is because of its vastly greater use in the manufacture of nickel steel. Besides its consumption in bridges, etc., nickel steel is much used in the manufacture of armor plate and in many kinds of war munitions.

Since France and Canada, the producers of this coveted ingredient of material for siege guns, etc., are not allied with the manufacture, for Germany, of these and other instruments of war by Krupp's and Tyssen, it has been a matter of considerable comment as to the source of nickel supply that is being drawn upon at the present time by the enemy. In this connection it is interesting to go back to a number of years ago when the suggestion was made, and obtained considerable support, that the export of Ontario nickel ores, matte, or metal, should be prohibited, or limited, to all countries other than Great Britain. The question was considered of vital importance at the time, and since the outbreak of the present war it has received considerably greater attention. Late in October an Order-in-Council was issued by the Canadian government prohibiting the export of nickel to alien countries. It read: "To all foreign parts in Europe and on the Mediterranean and on the Black Seas, save Great Britain, France, Russia (except the Baltic ports), Spain, and Portugal."

As the result of this prohibition (considering it for its effect on mineral production alone), it must be expected that other countries will revive the mining of nickel to as large an extent as possible, and that nickel statistics for the next year or two will probably show the effect of this incentive. Norway's ore contains as high as 2% of the metal, and the electrolytic refineries at Christiansand, with a capacity of about 400 tons annually, are now reported to be at work. Something is to be said about electrolytic nickel, in that, although it has a high degree of purity, the power consumption is so large as to render the process uneconomical, except in a country where current is low priced, as in Norway. Except for a relatively small recovery of nickel in connection with the electrolytic refining of copper, the United States depends entirely upon the Sudbury mines for its supply.

Although Canada figures so prominently in supplying the world with nickel, she has neither nickel refineries nor nickel-steel mills of her own. Processes have been tried out during the past quarter century, but with no success from an economic point of view. The result is that our raw material leaves the country, the Mond Nickel Company sending its product to Wales, and the International Nickel Company refining its metal in New Jersey. Thus the question of what are purported to be economic conditions prevails over ideal conditions, and the Canadian nickel industry is an industry only in so far as it raids a very important natural resource.

Observations have been made, although there is no proof of foundation, that Germany has been drawing her supplies of nickel for naval armament indirectly from the Canadian nickel mines in the Sudbury district. Once the matte is exported, it is claimed, the refiners are at liberty to dispose of the refined product as they please. The proportion which under normal conditions finds its way into the German market, has been stated to be about 60%. The criticisms are illuminated by the allegation that the Krupp Company were, when the war broke out, influential stockholders in one of the nickel corporations. It is further stated that the requirements of the government, that companies with Dominion charters file a list of shareholders annually, has not been complied with in this particular instance.

Whether any or all of these observations are founded upon truth, it is hard to state. At any rate, the latter add fuel to the argument of the former, and to the implication that the Canadian government's Order-in-Council is not preventing an important product of the Dominion finding its way to the enemy, to be used against the British Empire in the present conflict.

Mr. Monell, in his recent announcement, as president of the International Nickel Company, emphatically states that full information as to the destination of shipments of nickel, made by his company, has been in the possession of the Dominion authorities since the outbreak of the war, and that they are currently kept cognizant of all exports of nickel, as well as of all local shipments of the company. It has been stated that no sooner were hostilities declared than the government and the company had a mutual understanding, and the former was given assurances that no part of the output would be furnished either directly or indirectly to Germany or Austria.

This is the situation and we are not venturing any recommendation to the British Admiralty, in competition to a number that have already been given publicity, some of them displaying more crudeness than loyalty to the welfare of the Empire. It would appear that a number of writers on the subject have overlooked the fact that the British War Office is a remarkably wide-awake organization, and that it is impossible to conceive of its having overlooked the importance of the nickel situation. The co-operative scrutiny to which nickel is being subjected by the Canadian and British governments is such as to warrant a continued production, and assurances that no part of it is being employed by a country unfriendly to the Empire. At the same time, it brings clearly to our mind how desirable it would be if Canada at the present time handled the nickel situation from the ore to the finished product. It is to be hoped that the national security involved therein, as emphasized in the present controversy, will lead to a counteraction against the argument that refinement of nickel at the point of production is not, in this instance, the best procedure. To say that with the present state of the art any material change in such economic conditions (as at present exist) would react in a manner most detrimental to the Canadian nickel industry, is to make a statement that is not self-supporting.

PROPOSED STANDARD SPECIFICATIONS FOR ONE-COURSE CONCRETE STREET PAVEMENT.

IN our issue of December 17th, 1914 (page 753), appeared a set of proposed standard specifications for one-course concrete highway. These specifications are to be submitted, for adoption, at the February meeting of the American Concrete Institute. Another set to be submitted covers one-course concrete pavement and is almost identical with the specifications published in the article mentioned above. The clauses and other respects in which there is a difference are enumerated below.

The two sections devoted to materials and grading are identical, with the exception that the cross-sectional drawings and profile referred to as Fig. 1, in the former set, refer to Fig. 1 as presented herewith. Section 3 is as follows:—

17. Drainage.—The contractor shall construct tile or other drains as shown in the drawings attached hereto. Tile to be laid in the trench at least............inches wide, and............feet deep below the top of the adjacent curb. Such trench shall be back filled with crushed stone or pit run gravel with sand removed, which after light tamping shall be....... ....inches in depth.

18. All catch basin and manhole tops and all covers of openings of any kind shall be readjusted to the grade by the contractor at his expense.

Section 4, on subgrade, is identical with the exception of the second paragraph, which reads: "The street shall be graded from curb to curb to the proper subgrade to permit of the specified thickness of paving materials being laid to bring the finished surface of the pavement to the lines and grades as shown in the plans."

Section 5, devoted to forms, is the same in both specifications.

In Section 6, the note referring to crown and thickness of concrete reads as follows: "The thickness of the concrete at the edges shall not be less than six (6) inches. When pavements twenty (20) feet or less in width are to be built on approximately level ground and a flat subgrade is to be used sufficient fall for drainage at the sides of the pavement along the curb shall be provided by giving the roadbed the same grade as that proposed for the gutter. The crown of all pavements shall not be more than one-one-hundredth (1/100) of the width, except when deemed advisable by the engineer—the crown of a pavement built on a crowned subgrade may be increased to one-fiftieth (1/50) of the width to provide sufficient fall for drainage along the sides of the pavement at the curb."

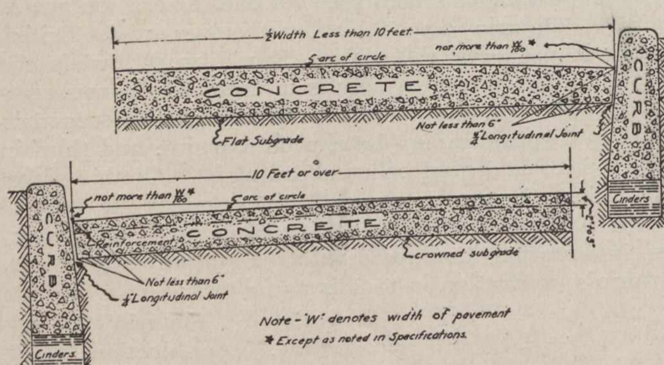

Fig. 1.—One-course Concrete Pavement.

In the section covering joints the figure referred to is Fig. 1, as shown herewith.

Specifications covering measuring materials, mixing concrete, reinforcing, are the same in both specifications. In the clauses covering the placing of concrete, that having to do with finishing, in this instance, reads as follows:—

36. Finishing.—The surface of the concrete shall be struck off by means of a template or strike board, which shall be moved longitudinally or crosswise of the pavement. Concrete adjoining the metal protection plates at transverse joints shall be dense in character, and any holes left by removing any device used in installing the metal protection plates shall be immediately filled with concrete.

After being brought to the established grade with the template or strike board, the concrete shall be finished from a suitable bridge, no part of which shall come in contact with the concrete. The concrete shall be finished with a wood float in a manner to thoroughly compact it and produce a surface free from depressions or inequalities of any kind. The finished surface of the pavement shall not vary more than one-quarter (¼) inch from the true shape.

The specifications relating to curing and protection, and to the construction of shoulders, are the same in both.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

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BOOK REVIEWS.

Pumping by Compressed Air. By Edmund M. Ivens, B.E., M.E. Published by John Wiley & Sons, New York City; Canadian selling agents, Renouf Publishing Company, Montreal, Que. First edition, 1914. 244 pages, 106 illustrations, 6x9 ins., cloth. Price $3.00 net. (Reviewed by A. S. L. Barnes, Hydro-Electric Power Commission of Ontario.)

This book forms a welcome addition to the comparatively scant literature of the subject with which it deals. While the efficiency of this method of pumping is admittedly low, there are undoubtedly cases where its advantages in other ways outweigh this drawback. For example, to adopt it for pumping clean water to a high head, in a case where there would be men available for attending to the plant at all times would, in most cases, be fallacy but to pump sewage to a moderate head at, say, some underground point, as is frequently done, where special attendants would be needed to look after a comparatively small isolated plant there can be few systems comparable with pneumatic sewage ejectors, which carry out the functions of pumping by compressed air and can at the same time handle sewage as no ordinary form of pump could do, while their action is entirely automatic.

The author cites a case of an air pumping system, for water replacing an old steam pumping plant, in which an over-all efficiency of only 24 per cent. was obtained, albeit an over-all saving of $1,310 per annum was effected.

In this particular case it would, however, be interesting to know what saving could have been effected by putting in a modern steam engine and dynamo driving an electric motor coupled to a turbine pump.

Compressed air pumping is being rather extensively used now for another purpose, viz., pumping water from wells. To accomplish this, several different systems, all embodying the same basic principle, but differing in detail, have been devised. The idea is to force air down the well, under pressure, and allow it to bring up some water in traversing its natural upward path to the ground or some higher level.

Owing to the very low efficiency of these systems at high heads it is preferable, if the total lift be considerable, to carry it out in two or more stages if the conditions will warrant this being done.

Careful and well-illustrated descriptions of several of the best known systems of this kind are given in the book, together with a statement as to their advantages and limitations.

The book is well written, and where formulae are introduced they are of a simple and easily understood nature. The two closing chapters deal respectively with the "flow of compressed air in pipes" and the "flow of water in pipes." At the end is a copious index. The work should prove very useful to both the student and the engineer engaged in dealing with pumping problems.

Concrete-Steel Construction, Part I., Buildings. By Henry T. Eddy, C.E., Ph.D., Sc.D., and C. A. P. Turner, C.E. Minneapolis. First edition, 1914. Published by the authors. Cloth, 6x9 ins., pp. xv.+438, 98 illustrations. (Reviewed by C. R. Young, B.A.Sc., C.E., assistant professor of Structural Engineering in the University of Toronto.)

Although the object of the authors of this book is to advocate concrete-steel construction in general and the mushroom system in particular, the work shows some attempt to cover the general principles of design and execution of reinforced concrete work in buildings. In their efforts to secure the adoption of methods of design that will permit reinforced-concrete construction to successfully compete with timber construction, they do not always remain on firm, well-tried ground. To the discriminating reader, however, the book will be a valuable one.

The text is divided into fifteen chapters. Some of these are given captions, but for about half of them the variety of subjects treated in a single chapter is so great as to preclude their comprehension in a single heading.

Chapter I. is of general interest and applicability. It covers the origin of concrete construction, materials, mixing and handling of concrete and forms. The treatment of the last subject is meagre, the only design shown being one for a column used in connection with the mushroom system.

Chapter II. deals with general types of floor construction, variation of strength with thickness and span, theoretical treatment by proportion of typical panels and deflection of slabs.

Chapter III. is devoted to beams. The methods of analysis and design presented are those of the Joint Committee, except in the matter of diagonal tension and bond which are given original treatment.

In Chapter IV. beam action and slab action are compared through the application of the laws of bond shear and the theory of work, and in Chapter V. is presented the authors' theory of the strength and flexure of the standard mushroom type of construction. The method of analysis followed is, in general, that already set forth by Dr. Eddy in his book "The Theory of the Flexure and

Strength of Rectangular Flat Plates." Indeed, this monograph has been incorporated in the present volume. The soundness of the theory has already been the subject of discussion in the columns of *The Canadian Engineer.* (See issues of September 25th, November 6 and November 27th, 1913.)

Chapter VI. institutes many comparisons of the stresses and deflections as calculated and as shown forth by actual tests. The close agreement of the results is considered by the authors a convincing justification of their theory. So far as floor panels are comparable in size and proportions with those tested, the methods of calculation adopted will probably closely predict the actual behavior of the tested floors, but with any appreciable variation from these proportions the theory propounded by the authors would not likely receive such strong support.

Moments in two-way and four-way flat slabs are fully discussed in Chapter VII.

Chapter VIII. deals with columns and Chapter IX. with foundations. The remaining chapters cover the elements of economic construction and cost of reinforced concrete work, reinforced concrete as a fireproof form of construction, concrete under disintegrating forces, finishing, the relation of the engineer and the constructor to concrete building work, and many other matters.

As a general text for reinforced-concrete construction the book is inferior to at least two well-known treatises. Except so far as it applies to flat-slab construction, it is not so valuable a work on building construction in reinforced concrete as one of the books mentioned above. For those who have to do with flat-slab construction, however, the book is invaluable, but its usefulness so far as other forms of construction are concerned, is limited.

Mechanism of Steam Engines. By Prof. W. H. James and M. W. Dole, of the Massachusetts Institute of Technology. Published by John Wiley and Sons, New York; Canadian selling agents, Renouf Publishing Company, Montreal. First edition, 1914. 170 pages, 183 illustrations, 6 x 9 ins., cloth. Price $2.00 net. (Reviewed by R. W. Angus, Professor of Mechanical Engineering, University of Toronto).

This book is intended as an elementary treatment of the kinematics of steam engines and turbines. It discusses only the mechanisms and some of the resulting motions without any effort to deal with the properties of steam, and must not be mistaken for a general book on steam engines.

After a brief introduction a general description of the simple engine and indicator are given along with some illustrations. Chapters II., III. and IV. deal with descriptions and sectional illustrations of several simple valves and the analysis of the valve motions by diagrams, the Zeuner and Reuleaux valve diagrams being largely used, a knowledge of the principles of these diagrams being practically assumed as only very brief proof is given. The solutions of a number of problems are worked out in the book.

Chapters V. and VI. deal with the different methods of controlling engines either by throttling or automatic cut-off governor or by means of riding cut-off, corresponding valve diagrams being shown. Other chapters treat of multiple valve engines, e.g., Corliss, link motions and valve setting.

The remaining two chapters, X. and XI., are entirely devoted to steam turbines and their governors and valve mechanisms, the treatment being entirely descriptive.

Structural Engineers' Handbook. Data for the Design and Construction of Steel Bridges and Buildings. By Milo S. Ketchum, C.E., Dean of the College of Engineering and Professor of Civil Engineering, University of Colorado. Published by McGraw-Hill Book Co., New York City. First edition, 1914. 896 pp., 400 illustrations, 260 tables, 6 x 9 ins. Flexible leather. Price $5.00 net.

As the name implies, the handbook is expressly for the structural engineer, but its service extends itself to the student or, as the author states, "engineer who has had a thorough course in applied mechanics and the calculation of stresses in structures. One feature of the work that meets with approval at first sight is the size of book chosen, as we are more disposed to consider the 6 x 9-inch page as a standard. This size of page has proved a great factor in the book under consideration, as it has permitted a clear portrayal of diagrams, as well as an easily read type in large but important tabulated quantities. The printing and binding are excellent, and the index, which in the opinion of the reviewer requires more attention in a handbook than it usually receives, will be found exceedingly serviceable.

Proceeding into the subject-matter of the work, the chapters are found to be unusually complete and are here and there supplemented by carefully selected lists of references to which authorities the engineer may betake himself, if desired, for more detailed information.

The scope of the handbook, according to chapter headings, is as follows: Steel Roof Trusses and Mill Buildings; Steel Office Buildings; Steel Highway Bridges; Steel Railway Bridges; Retaining Walls; Bridge Abutments and Piers; Timber Bridges and Trestles; Steel Bins; Steel Grain Elevators; Steel Head Frames and Coal Tipples; Steel Stand Pipes and Elevated Tanks on Towers; Structural Drafting; Estimates of Structural Steel; Erection of Structural Steel; Engineering Materials; Structural Mechanics, and the Design of Steel Details. The book is divided into two parts, the first including (as the above chapter headings suggest) a discussion of the design of structures, together with data and details for the design of steel bridges and buildings; and the second part containing tables for structural design, including those giving the properties of rolled sections, and of built-up sections for chords, columns, struts, plate girders, etc., and data for standard structural details.

The author defines it to be a source book and not a treatise. He thus defines the function of a handbook, and it is evident that he has kept constantly in view the field which he desired the book to cover. Structural engineers, designers, draftsmen and students of the subjects of which it treats, cannot afford to overlook this handbook.

Mechanical Properties of Wood. By Samuel J. Record, M.A.M.F., assistant professor of Forest Products, Yale University, Forest School. Published by John Wiley and Sons, New York City; Canadian selling agents, Renouf Publishing Company, Montreal. First edition, 1914. 165 pp., 52 half-tone illustrations, 6 x 9 inches, cloth. Price $1.75 net.

Students of forestry to whom a knowledge of the technical properties of wood is essential, will find this a most instructive volume, quite free from highly technical treatments, and, in fact, quite readable by anyone interested in wood. An important feature of the work is the inclusion therein of a discussion of the factors affecting these mechanical properties, and the methods of timber testing.

The work is presented in three parts, the first, the mechanical properties of wood, taking up fundamental considerations, tensile compressive, shearing and transverse strengths, toughness, torsion, hardness, and cleavability. The second part deals with factors affecting the mechanical properties of wood, such as rate of growth, weight, density, color, knots, insect and fungus injuries, temperature, preservatives, etc., etc. Part III. is devoted to timber testing, and takes up, forms of material used, moisture determination, machinery appliances, beam testing (large and small), and tests for impact, hardness, cleavage, tension, spike-pulling, etc. One appendix gives a sample working plan of the U.S. forest service. Another gives strength values for structural timbers. A bibliography in three parts well portrays the extent of literature on the subject.

Cement Specifications. By Jerome Cochrane, B.S., C.E., M.C.E. Published by D. VanNostrand Company, New York. First edition, 1912. 101 pp., illustrated, 6x9 ins., cloth. Price $1.00 net.

According to the full title of this work, it is a treatise on cement specifications, including the general use, purchase, storage, inspection and test requirements of Portland, natural, puzzolan (slag), and silica (sand) cement, and methods of testing and analysis of Portland cement. In the compilation of the work the author expresses himself as having endeavored at all times to present a set of specifications that would not only be consistent throughout, but which, at the same time, conform to modern practice. He recognizes the futility of endeavoring to draw up specifications which will meet all conditions of engineers and all constructional and manufacturing conditions of actual work, and he observes that it was useless to expect that all provisions incorporated in the specifications would be applicable to every class of construction work. This is mentioned by the way, for the reader will find that the presentation of the subject, growing in importance as the uses of cement are magnified, is clear, complete, and one well worthy of reference.

Besides the introduction, the divisions of the book are as follows: General Conditions Governing Use of Cement; Furnishing Cement to the Contractor; Purchase of Cement from Manufacturers; Delivery and Storage; Inspection and Tests; Test Requirements; Methods of Testing; Significance of Tests; Methods of Chemical Analysis; Bibliography of Specifications; same of Foreign Specifications.

Materials of Machines. By Albert W. Smith, director of Sibley College, Cornell University. Published by John Wiley and Sons, New York City; Canadian selling agents, Renouf Publishing Co., Montreal. Second edition, 1914. 215 pp., 36 illustrations, 5x7½ ins., cloth. Price $1.25.

The first edition of Prof. Smith's work was published about twelve years ago. The subject matter has been entirely re-written and brought up to date for the present edition. Its title may be better defined by stating that it is an elementary treatise on metallic materials used in the construction and operation of machines. This is presented in two parts, the first dealing with the manufacture of materials, to which four chapters are devoted, viz., Preliminary Considerations of Fuels; Electric Furnaces; Refractory Materials; Outline of the Metallurgy of Iron and Steel; and, the same of copper, lead, tin, zinc and aluminum. The second part deals with the physical properties of materials, as follows: Testing Materials; The Equilibrium of Iron and Carbon; Cast Iron; Steel; Heat Treatment of Steel; Non-ferrous Alloys; Selection of Materials for Machines. The first part is written as an essential preliminary to the study of the second, while the second part presents some very desirable information for those who design, construct and operate machines. The information which this book contains is not easily collected, and its presentation in a single, small volume will be welcomed with considerable interest by engineers interested any way in the construction and operation of machines.

PUBLICATIONS RECEIVED.

Ontario Railway and Municipal Board.—Eighth annual report (to December 31st, 1913). 588 pp.; 6 x 9 ins.

Weights and Measures, Gas and Electricity.—Part 2, reports and statistics of inland revenues, Canada, 1914. 54 pp.; 6 x 9 ins.

Municipal Department of Hygiene and Statistics of Montreal.—Report for 1913, by Dr. S. Boucher, M.O.H. 104 pp.

United States Bureau of Mines.—Fourth Annual Report of the Director, for year ending June 30th, 1914. 101 pp.; 6 x 9 ins.

Agriculture and Immigration.—Report of Department, Province of Manitoba, for 1913. 125 pp.; illustrated; 6 x 9 ins.

Determination of the Co-efficient of Expansion of Mercury at Low Temperatures.—By C. B. James. A reprint from the transactions of the Royal Society of Canada. 8 pp.; illustrated.

Tide Tables.—Two bulletins, prepared by W. Bell Dawson, superintendent, Tidal and Current Survey, Department of Naval Service, Canada. One relating to Eastern coasts and the other to Western coasts.

Analyses of Mine and Car Samples of Coal.—Bulletin 85, United States Bureau of Mines, relating to samples collected in 1911, 12 and 13, giving tabulated analyses and descriptions of samples by states and counties. Illustrated.

The Crow's Nest Volcanics.—By J. D. MacKenzie. Published by the Geological Survey, Department of Mines, Canada, as museum bulletin No. 4. It relates to general geology, petrography, discussion, summary and conclusions. 37 pp.; illustrated.

Commission of Conservation, Canada.—Fifth Annual Report, 1914, giving proceedings of the fifth annual meeting, held at Ottawa, January, 1914. 288 pp.; illustrated; 6 x 9 ins.; cloth. James White, assistant to chairman, Commission of Conservation, Ottawa.

Department of Naval Service.—Annual Report for year ending March 31st, 1914. 100 pp.; illustrated; 6 x 9 ins. It contains reports on naval branch fisheries protection service, survey of tides and currents, hydrographic survey branch and radio telegraph branch.

The Expansive Force of Ice.—(See *The Canadian Engineer*, December 10th, 1914, page 741.) A 20-page reprint from the transactions of the Royal Society of Canada. Prepared by Prof. H. T. Barnes, and Messrs. J. W. Hayward and Norman M. McLeod. Illustrated.

Notes on the Sampling and Analysis of Coal.—By A. C. Fieldner for the United States Bureau of Mines. Published as technical paper 76. 61 pp.; illustrated. Collection of samples; methods of analysis; interpretation and accuracy of analytical results; classification, etc.

Ontario Highway Legislation.—A compilation of Ontario highway laws, prepared under the direction of Mr. W. A. McLean, commissioner of highways, and appended to his annual report on highway improvement, 1914. (See *The Canadian Engineer*, December 17th, 1914, page 767.)

Dundee Falls and Falls Village Developments.—A handsomely illustrated booklet, descriptive of these developments for S. D. Warren and Co. and Connecticut Power Co., respectively. Reprint from Stone and Webster Public Service Journal. S. and W. Engineering Corporation, New York.

Fire Prevention.—Reports on various activities of the British Fire Prevention Committee, 8 Waterloo Place, Pall Mall, London, S.W. 40 pp.; illustrated, including Committee's record for 1913; portable chemical fire extinguishers; self-contained smoke helmets; the Committee's inquiry office, etc.

Geographic Board of Canada.—Thirteenth Report, ending March 31st, 1914. It contains all decisions from inauguration of Board up to that date. Also list of counties in Canada and townships in Ontario, Quebec and Nova Scotia, and parishes in New Brunswick. As an appendix, it has an outline of the physical geography of Canada.

Analysis of Coal with Phenol as a Solvent.—A 41-page illustrated bulletin (No. 46), issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill., prepared by S. W. Parr and H. F. Hadley. Deals with the division of bituminous coal with phenol as a solvent for resinic material while the cellulose residuum is insoluble.

American Society for Testing Materials.—Committee reports, being Part I. of the proceedings of the 17th Annual Meeting (1914). It includes reports on ferrous metals; non-ferrous metals; lime, cement and clay products; miscellaneous materials; preservative coatings, etc.; miscellaneous subjects. 484 pp.; illustrated; 6 x 9 ins. Secretary, Ed. Marburg, University of Pennsylvania, Philadelphia, Pa.

CATALOGUES RECEIVED.

Matheson Joint Pipe.—A handsomely illustrated 40-page booklet, descriptive of this system of piping for high and low pressures. Issued by the National Tube Co., Pittsburgh, Pa.

Directory of Piston Ring Sizes.—A 68-page booklet for users of automobiles, motor cycles, cycle cars, trucks, tractors, and engines. Issued by the Burd High Compression Ring Co., Rockford, Ill.

Variable Release Air-Brake Equipment. — A 12-page booklet describing this type of automatic air-brake equipment, its chief advantages, general design, operation, etc. Issued by the Canadian General Electric Co.

Drag-Line Excavators.—Leaflets descriptive of glasses, B, H, and K, of the Lidgerwood line, setting out specifications and illustrating the machine in use. Exclusive agents in Canada, Canadian Allis-Chalmers, Limited.

Lackawanna Deseaming Process for Rail Sections.—A bulletin published by the Lackawanna Steel Co. describing this method of improving the quality of rails. A most interesting discussion of the subject, well presented and carefully illustrated.

Worm-Gear Chain-Blocks.—A 4-page leaflet (Bulletin B 10) on the construction of a chain-block designed for a load of 60 tons, and regularly tested to 90 tons. Issued by the manufacturers, the Herbert Morris Crane and Hoist Co., Limited, Montreal and Toronto.

Oxy-Acetylene Welding and Cutting and Its Applications.—An extensive publication issued by L'Air Liquide Society, Toronto, Montreal and Winnipeg, enumerating and illustrating the application of the Autogenous welding process in the different trades. Fully illustrated.

Hoisting Machinery.—A 144-page catalogue, well illustrated and durably bound. Published as Catalogue No. 3 of Marsh and Henthorn, Limited, Belleville, Canada. Sales agents, Mussens, Limited, Montreal. Fully descriptive of their types of hoisting engines and auxiliary apparatus.

Gas-Electric Motor Cars and Locomotives.—Bulletin No. 44,300; 8 pp.; illustrated; of special interest to railway men on branch line service of steam roads and on interurban railway service, to which this class of equipment is specially adapted, issued by the Canadian General Electric Co., Toronto.

Cochrane Multiport Valves.—A handsome, well-illustrated, 72-page catalogue of multiport valves for back-pressure service, atmospheric relief in vacuum service, flow service, and bleeder or extraction service. Catalogue 601. Harrison Safety Boiler Works. Selling agents in Canada, Canadian Allis-Chalmers, Limited, Toronto.

REPORTS OF COMMITTEES, CANADIAN SOCIETY OF CIVIL ENGINEERS.

THE Council of the Canadian Society of Civil Engineers has recently issued, for the consideration of members prior to the Annual Meeting of the Society in Montreal, January 26-28, 1915, the reports of a number of standing committees. Ample opportunity is thus being given to each member for acquiring a thorough knowledge of the findings, as submitted, so that intelligent action may be taken with regard to them when they come up for consideration at the afternoon session of the first day of the meeting. We present herewith a summary of the submitted reports.

Report of Committee on Rails.—The committee, consisting of Mr. H. G. Kelley, chairman, and Messrs M. J. Butler, G. A. Mountain, J. M. R. Fairburn and A. F. Stewart, recommended the adoption by the Society of the rail specifications of the American Railway Engineering Association. The investigations and experiments of the engineers of the committee of that association have been carefully studied by the above committee and their findings, covering both chemistry and mill practice, have produced the specification now well known as the "A.R.E.A." rail specification. A copy of it is presented.

Report of Committee on Track.—This committee consists of Mr. H. R. Safford, chairman, and Messrs. W. A. Bowman, C. B. Brown, S. B. Clement, A. Crumpton, F. P. Gutelius, R. M. Hannaford, R. L. Latham, D. MacPherson, E. W. Oliver, A. F. Stewart, J. G. Sullivan, C. Warnock and A. C. MacKenzie.

The committee devoted itself to the study of two subjects: (1) Size and spacing of ties. (2) The proper method of measuring efficiency of track forces. The study of another subject, viz., Terminal facilities in cities for freight, including private sidings and cartage arrangements was, with the consent of the Council, postponed for the present. For a study of the two above-mentioned subjects the committee presents forms for the purpose of collecting from the membership as much needed data as possible bearing upon the question of track maintenance. Thereby relative values of the various features entering into track work may be arrived at, the idea behind the study being to work out some basis for equating these values as an aid to the proper distribution of allowances for track work.

The committee expresses its belief that the present method of apportioning track expenditures is too general and that no well-defined means exists for properly measuring the relative needs of the different sections and districts, with the vastly different conditions which affect cost. A good deal of data must be collected to this end.

Progress is reported on the specifications for the size and spacing of rails and discussion is invited. Suggested programs for study are presented. (For the 1913 report of the committee on track the reader is referred to *The Canadian Engineer* for January 22, 1914, page 203).

Report of Committee on General Clauses and Specifications.—This committee consists of Mr. H. Holgate, chairman, and Messrs. E. G. M. Cope, R. de L. French, W. Chipman and J. G. G. Kerry. A carefully compiled form of general clauses is presented, from which it is evident that much correspondence, study, revision and alteration has been devoted to the subject. By the use of it, it is suggested, the form of contract and of specifications may be very much abbreviated.

The committee recommends that all contracts should embrace, in one document: (1) The agreement or contract itself; (2) the tender or a certified copy of it; (3) the specification; (4) the general clauses; (5) the signed drawings as tendered on, and (6) any modified drawings agreed to prior to signing of contract.

Report of the Committee on Concrete and Reinforced Concrete.—The committee consists of Mr. Walter J. Francis, chairman, and Messrs. S. Baulne, E. Brown, E. Brydone-Jack, J. Galbraith (deceased), P. Gillespie, H. M. Mackay, E. S. Mattice, C. N. Monsarrat, Michael Morssen, P. B. Motley, and H. Rolph.

This committee presented a draft at the annual meeting last January of the standard general specifications for concrete and reinforced concrete. It brought forth a certain amount of discussion at the meeting. (For the draft and this discussion relating thereto, see *The Canadian Engineer*, January 22, 1914, page 198, and February 5, 1914, page 274, respectively). Subsequent discussions from branches and individual members were invited and varied contributions totalling 30,000 words, were received.

In his letter of transmittal, Mr. Francis refers to the loss the committee suffered in the death of Dr. John Galbraith.

The series of tests advocated at the last annual meeting were made during the year. The Atlas Construction Company, Limited, through their president, Mr. C. M. Morssen, M. Can. Soc. C.E., a member of the committee, made sixty-four 8 in. x 12 in. concrete beams, 11 ft. long. In the laboratories of McGill University these beams were tested under the direction of Prof. H. M. MacKay and Prof. Ernest Brown, both members of the committee. All the beams were tested to destruction, some at the age of two months and the balance at the age of three. The results were most conclusive, and were subsequently considered by the committee. Since that time weekly sessions of the committee were held, and the draft was analyzed and deliberated upon in greatest detail.

Nickel in the form of nickel sulphate and as metallic nickel is saved from the electrolytes used in refining blister copper. Most, if not all blister copper carries a little nickel which goes into solution, and gradually accumulates in the electrolyte. During 1913, according to the United States Geological Survey, an equivalent of 481,565 lbs. of nickel, valued at $79,393, was thus saved by refineries. About one-fourth of the product was produced as electrolytic nickel.

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Coast to Coast

Ottawa, Ont.—A new road is proposed between Ottawa and Prescott, to be financed in a manner similar to the Toronto-Hamilton road. It is estimated to cost $10,000 per mile, and is 58 miles in length.

Ottawa, Ont.—Mr. D. W. McKughlin, engineer-in-charge of the Hudson's Bay terminal works at Port Nelson, reports that splendid progress has been made on the terminal and harbor works during the past season.

Vancouver, B.C.—As a result of some vessel dragging an anchor or grappling-hook while passing through the First Narrows one of the two 18-inch water mains recently laid across the bed of the Narrows, and supplying the city with 3,000,000 gallons of water per day from Capilano, was pulled apart, and the other dislodged from its proper position.

Saanich, B.C.—The long-proposed extension and improvement of the Lake Road in South Saanich municipality is about to become a reality. Tenders are already in hand, and it is expected that the contract will be awarded without delay. The estimated cost is $29,500. This improvement involves the construction of a subway under the Victoria and Sydney Railway, and a culvert to drain surplus water from the Swan Lake district. Considerable grading is required on a section of the road about 6,000 yards in length. Another road improvement in this vicinity entails the expenditure of about $30,000 on Shelbourne Street.

Port Arthur, Ont.—The Western Dry Dock and Shipbuilding Co., Limited, of Port Arthur, have taken out a building permit for a forge shop to cost about $30,000. Besides the construction of steamships, this company will manufacture engines and boilers of all kinds, hoisting and excavating machinery, structural steel and cabinet work. In the last two years they have turned out several large steamships, and are well equipped for the manufacture of the above machinery. This company have also received a large order from the British Government for shells and other war materials.

Edmonton, Alta.—The next piece of construction that will be effected by the Canadian Northern Railway is reported to be a branch line from Edmonton to Peace River Landing or Dunvegan the key to the Peace River and Grande Prairie country. Already a line from Edmonton has been completed for a distance of sixty miles to a point in the immediate neighborhood of the source of the Prairie River. From this point the branch will be directed north-west to either of the two places, thus giving an all-rail route from Edmonton to the homesteading country in the Peace River and Grande Prairie district.

Moose Jaw, Sask.—Bills before the Dominion government asking for new railway charters include one relating to the Brule, Grand Peace River Railway Co., seeking the right to construct railway, telegraph and telephone lines, commencing at Brule Lake, on the main line of the Grand Trunk Pacific and Canadian Northern Railways, north-westerly to Grande Prairie, thence north-westerly to a point in British Columbia, connecting with the terminus of the Pacific and Great Eastern Railway at or within the Peace River block, also commencing at Grande Prairie northerly to the Pacific, Peace River and Athabasca Railway at or near the point where the railway crosses the Montagneuse River, passing at or near Spirit River settlement, and crossing the Peace River at or near Dunvegan, approximately 400 miles in all.

PERSONAL.

Capt. A. J. McPHERSON, Deputy Minister of Public Works for the Province of Saskatchewan, is commanding the Regina Field Company of Canadian Engineers.

A. C. MORRISON, of Ottawa, has been appointed inspector of gas and electricity for the Ottawa Inspection district, to succeed Mr. A. A. Couvrette, resigned.

K. S. MacLAUGHLIN, B.A.Sc., superintendent of Metals Chemicals, Limited, Welland, Ont., is suffering from serious injuries sustained in a laboratory explosion last week.

R. S. WINTER, of Medicine Hat, Alta., has been appointed gas superintendent in succession to Mr. Wm. Craft, who has resigned from this civic position owing to ill-health.

G. H. FERGUSON has been appointed Minister of Lands, Forests and Mines for the Province of Ontario, assuming the position held by Premier Hearst prior to the latter's being appointed Premier.

Capt. T. C. IRVING, M. Can. Soc. C.E., of the Irving-Moffat Electric Steel Co., and vice-president of Robert W. Hunt and Co., will command the divisional engineers of the Canadian expeditionary force, about to leave Salisbury Plain for service in France and Belgium.

H. C. BARBER has joined the sales force of the Standard Underground Cable Co. of Canada, Limited, of Hamilton. Mr. Barber is a graduate of the Faculty of Applied Science of the University of Toronto. He has been with the Toronto Hydro System and the Hamilton Hydro Department, also with the Packard Electric Company, of St. Catharines.

E. G. MATHESON, M. Can. Soc. C.E., superintendent for the Foundation Co., Limited, on the construction of the substructure for the Canadian Pacific Railway bridge over the Pitt River, described the undertaking in an illustrated address given at the regular meeting of the Vancouver Branch of the Canadian Society of Civil Engineers, held on December 18th last.

OBITUARY.

At Kingsville, Ont., Mr. A. W. Weatman, superintendent of the W.E. and L.S. Railway, was electrocuted last week while engaged in putting a snowplough into service.

Thos. Blackwood, Deputy Inspector of Mines in the Province of Nova Scotia, lost his life by an explosion in one of the shafts at Stellarton, N.S., last week. Mr. James Brown, superintendent of the mine for the Acadia Coal Co., accompanied Mr. Blackwood on his trip of inspection, and was also killed, and Mr. Alex. Sutherland, manager of the mine, had a very narrow escape.

The death occurred on December 17th of Mr. F. X. Dion, president of the Lauzon Engineering Co., Limited, engineers and contractors, of Levis, Que. The late Mr. Dion was a well-known figure in business circles in the Province of Quebec.

The extraction of gasoline from natural gas, according to a bulletin issued by the United States Geological Survey, has become one of the chief adjuncts of the natural gas industry in the United States. The production in 1913 was almost double that in 1912.

Recent elections to the class of Associate Member in the American Society of Civil Engineers included the names of Mr. G. W. Harris, office engineer, Mackenzie, Mann and Co., Limited, Port Arthur, Ont.; Mr. C. S. Millard, manager and chief engineer for Francis S. Swales, architect, Vancouver, B.C.; and Mr. L. R. Thomson, designer, Dominion Bridge Co., Limited, Montreal.

PRESERVATION OF RAILWAY TIES.

At a recent meeting of the Society of Chemical Industry in Montreal two interesting papers were read on the subject of timber preservation. Dr. John S. Bates, director of the Forest Products Laboratories of Canada, gave an account of the work which has been done in the laboratories, and summarized investigation of conditions governing the durability of timber. The work has included a study of pulp and paper-making. Mr. W. B. Campbell, B.Sc., a member of the laboratory staff, read a paper on the preservation of wood, dealing with the various forms of rot which affect timber and clearly showed that the best method of increasing the durability of timber used for railway ties was to impregnate the wood with some substance poisonous to the organism that caused rot. In this connection he mentioned substances soluble in water, such as zinc chloride, and substances oily in nature, such as creosote oil. Mr. Campbell dwelt upon the advances of properly creosoted wood block paving, etc. The papers were followed by some valuable discussion, some of the participants being Prof. W. D. Walker, of Queen's University; Dr. Milton Hersey, Mr. J. A. DeCew, Mr. Fred. B. Brown, and Dr. S. Kirsch.

A committee was formed to investigate the feasibility of rendering wood fireproof, and to make specific proposals to the Government for legislation that would encourage the establishment of such a chemical study. The following were appointed to this committee: Mr. T. H. Wardleworth, chairman of the local branch of the Society; Dr. R. F. Ruttan, Dr. Milton Hersey, Mr. J. A. DeCew, Mr. C. F. Bardorf and Mr. A. G. Spencer.

COMING MEETINGS.

AMERICAN FORESTRY ASSOCIATION. — Annual meeting to be held in the Woolworth Building, New York City, January 11th, 1915. Secretary, P. S. Ridsdale, Washington, D.C.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Annual Convention to be held at the King Edward Hotel in Toronto, January 26, 27, and 28, 1915. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Twenty-ninth annual meeting, to be held in Montreal, January 26th, 27th and 28th, 1915. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

AMERICAN CONCRETE INSTITUTE.—Eleventh Annual Meeting, to be held in Chicago, February 9th to 12th, 1915. Secretary, Edward E. Krauss, Harrison Building, Philadelphia, Pa.

EIGHTH CHICAGO CEMENT SHOW.—To be held in the Coliseum, Chicago, Ill., from February 10th to 17th, 1915. Cement Products Exhibition Co., J. P. Beck, General Manager, 208 La Salle Street, Chicago.

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

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

In a paper read before the Duluth meeting of the American Peat Society, Dr. Peter Christianson calls attention to some of the possibilities of peat as a metallurgical fuel, especially in the iron and iron-ore industry of the Lake Superior iron district, that is, in the beneficiation or preliminary treatment, and in the smelting, of the ore.