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MISSING

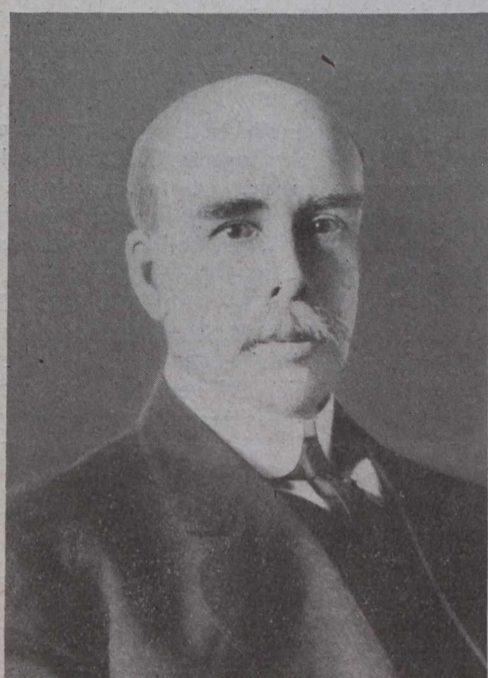
The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

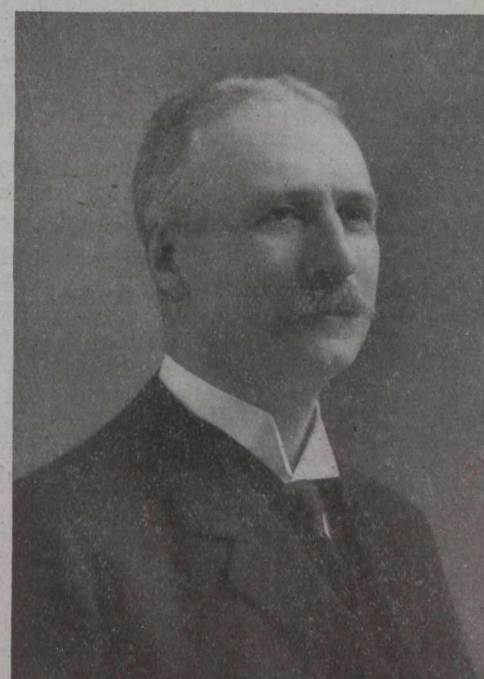
CANADIAN SOCIETY OF CIVIL ENGINEERS

THIRTY-FIRST ANNUAL MEETING TO BE HELD AT MONTREAL NEXT TUESDAY, WEDNESDAY AND THURSDAY—SUMMARY OF ACTIVITIES FOR PAST YEAR AND BUSINESS TO BE CONSIDERED NEXT WEEK.

CONFIDENT in the future of Canada and the Empire, determined to do their duty in avenging devastated Belgium, and proud of the part their profession has played in the war, the civil engineers of Canada will assemble in annual gathering at Montreal next week for the third time during the struggle, and for the thirty-first time in the history of the Canadian Society of Civil Engineers. The meeting will be held in the Society's building, 176 Mansfield Street, Montreal, and it is expected that several hundred engineers will be there.



Lieut.-Col. John Stoughton Dennis
President-Elect.



George Herrick Duggan
Retiring President.

The first session will open at 10 a.m., Tuesday, January 23rd, with the reading of minutes and the appointment of scrutineers. The reports of council, library committee, treasurer and finance committee will be received. After hearing the reports of branches, the meeting will adjourn at 1 p.m. for two hours.

In the afternoon session, the reports of the following committees will be discussed: Conservation, Roads and Pavements, International Electro-technical Commission, Steel Bridge Specifications, Educational Requirements, Sewage Disposal and Sanitation, General Clauses, and Steam Boiler Specifications.

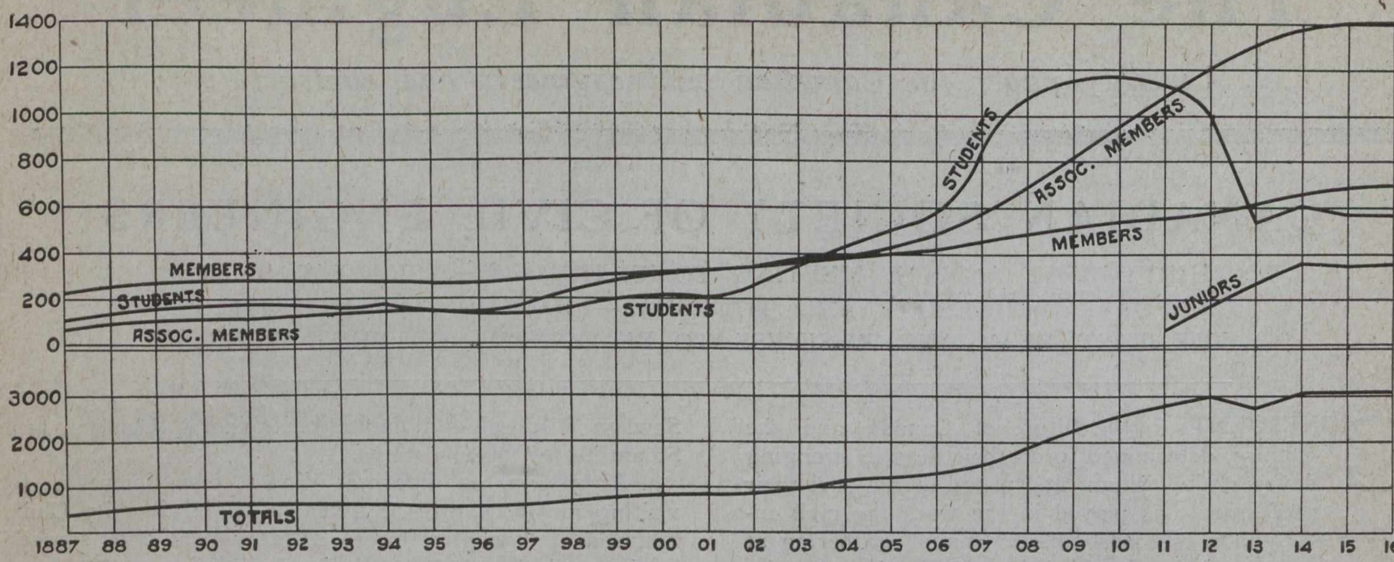
At 7 p.m. an informal dinner, complimentary to visiting members, will be given in the University Club, followed at 8.30 p.m. by an entertainment and smoker in the auditorium of the Society's building.

Inspection trips to various points of interest (including the munitions plants of the Dominion Bridge and subsidiary or allied companies) will be enjoyed Wednesday morning, and in the afternoon the members will continue to receive reports of committees and to act thereon. At 4.30 p.m. the retiring president will deliver an address.

At ten o'clock Thursday morning the members will meet to elect officers and councillors. The newly-elected president will take the chair, after which various new and unfinished business will be discussed, completing the annual meeting. In the afternoon there will be a session of the new council.

By courtesy of the Eastern Canadian Passengers' Association, members and their families who have paid a full one-way first-class fare going to the meeting, will be

CURVES SHOWING GROWTH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.



Top Curves Show Growth of Each Class of Membership. Bottom Curve Shows Growth of Total Membership.

returned free on presentation of a standard convention certificate signed by the ticket agent from whom the one-way ticket was procured. This is regardless of the number in attendance at the meeting.

The Retiring President—This annual meeting will mark the retirement from the presidency of GEORGE HERRICK DUGGAN, vice-president and general manager of the Dominion Bridge Co., Montreal. Mr. Duggan was elected to associate membership in the Society in 1888, and two years later qualified as member. He is a member of the Institution of Civil Engineers of Great Britain, the American Society of Civil Engineers, and the Canadian Mining Institute. He was vice-president of the Canadian Society of Civil Engineers in 1900, 1901, 1903 and 1908, and also served as councillor for the years 1894, 1896, 1898, 1899, 1904, 1907, 1912, 1913 and 1914.

Mr. Duggan is an enthusiastic sailor and was one of the founders of the Toronto Yacht and Royal St. Lawrence Yacht Clubs. He designed and sailed the winner of the Seawanhaka International Cup and successfully defended that prize from 1896 until 1901.

He was born in Toronto September 6th, 1862, the only son of the late John Duggan, Q.C., and Amelia (Tulloh) Duggan. He was educated at Upper Canada College, Toronto, and at S.P.S., Toronto University. He began his engineering career with the C.P.R., but in 1886 entered the employ of the Dominion Bridge Co., becoming chief engineer in 1891. In 1902 he became assistant to the president of the Dominion Iron & Steel Co. and in 1904 was appointed second vice-president and general manager of the Dominion Coal Co., but six years later he rejoined the Dominion Bridge Co. as general manager.

He is vice-president of the Montreal Ammunition Co., president of the Dominion Copper Products Co., director of the Royal Bank of Canada, director of the Montreal Trust Co., director of the Hillcrest Collieries, and chief engineer of the St. Lawrence Bridge Co., having entire charge, jointly with Mr. Phelps Johnson, of the New Quebec Bridge superstructure.

Among the clubs of which Mr. Duggan is a member are the Mount Royal, St. James, University, Engineers, and Forest and Stream, of Montreal; Royal Canadian Yacht, of Toronto; Royal Cape Breton Yacht, of Sydney; Royal St. Lawrence Yacht, and Garrison, of Quebec.

In a recent article, speaking of Mr. Duggan, the Toronto Globe said: "He carries as much sporting blood in him as can safely be carried by a man who must temper sport with business." About the same time the Canadian Century remarked: "Mr. Duggan is a big man, who, whether building bridges, managing the affairs of a huge coal mining company or designing and sailing small boats, is equally at home."

Early in the war both of Mr. Duggan's sons enlisted, one of them, Lieut. H. S. Duggan, R.E., being killed in action October 21st, 1915. Unfortunately a recent casualty list reported that the other son, Lieut. K. L. Duggan, of the Mounted Rifles, had been wounded.

The President-Elect.—Mr. Duggan will be succeeded as president by Lieut.-Col JOHN STOUGHTON DENNIS, C.E., D.L.S., D.T.S., assistant to the president of the Canadian Pacific Railway Co. Lieut.-Col. Dennis joined the Society November 21st, 1901, as a member and was a vice-president for the year 1907 and a councillor for the years 1906 and 1911. He is a past president of the American Society of Irrigation Engineers.

Lieut.-Col. Dennis was born at Toronto in 1856. His father was the late Lieut.-Col. John Stoughton Dennis, C.M.G., who was the first surveyor-general of Canada and subsequently the first Deputy Minister of the Interior. Dennis, Jr., was educated at the Toronto and Kingston Grammar Schools and Upper Canada College. He also graduated from the old military school at Kingston before the creation of the Royal Military College.

He served his articles as a Dominion land surveyor with the late Lindsay Russell, assistant surveyor-general, and was graduated and commissioned as a Dominion topographical surveyor in 1877. From 1872 to 1879 he was employed on survey work for the Dominion Government in Manitoba and the Northwest Territories. From 1879 to 1882 he was engineer and surveyor for the Hudson's Bay Co., and during that time he organized the Land Department of that company and laid out what is now the southern portion of the city of Winnipeg, constructing the first trunk sewer system in that part of the city.

In 1882 he resigned from the Hudson's Bay Co. and organized the firm of Dennis, Vaughan & Co., consulting engineers, Winnipeg, but three years later he rejoined the service of the Dominion Government as inspector of surveys, becoming chief inspector in 1892. In 1896 he entered the service of the Northwest Territorial Government as chief engineer, and in 1899 became Deputy Minister of Public Works, N.W.T.

At the age of forty-six he first joined the service of the Canadian Pacific Railway Co. as superintendent of irrigation and chief engineer of the large projects then being carried out by the company in Alberta. Subsequently he was appointed C.P.R. Land Commissioner for British Columbia, and in 1904 became assistant to the second vice-president at Calgary.

In 1910 his appointment was announced as manager of the C.P.R. irrigation and land interests in Alberta, and a few years later he was appointed western assistant to the president. About November 1, 1916, Lieut.-Col. Dennis was promoted to the position of assistant to the president of the C.P.R. at Montreal, and it is expected that he will have special charge of many of Baron Shaughnessy's interests during the latter's attendance at the House of Lords in England.

As can be assumed from his title, Lieut.-Col. Dennis has had considerable experience in Canada's militia. He served as a lieutenant in the Governor-General's Foot Guards at Ottawa for a short period after leaving military school, and in 1885 he commanded, with rank of captain, the Intelligence Scout Corps attached to General Middleton's Column during the Riel Rebellion, being mentioned in dispatches for service at the Battle of Betoche. He was transferred to the reserve of officers with brevet rank of major, and last year was gazetted lieutenant-colonel commanding the Calgary battalion of the reserve militia.

Nominees for Vice-President.—Two vice-presidents are to be elected this year, and one of them must be resident in District No. 1. The nominations are: G. R. G. Conway, bondholders' representative, Mexican Light and Power Co., Mexico City; J. M. R. Fairbairn, assistant chief engineer, Canadian Pacific Railway, Montreal; J. G. Legrand, bridge engineer, G.T.P. Railway, Winnipeg; C. N. Monsarrat, chairman, Quebec Bridge Commission, Montreal. The nominees who are resident in District No. 1 are Messrs. Fairbairn and Monsarrat.

The Council.—The nominees for council are as follows (two members are elected in District No. 1 and one member from each of the other districts):—

District No. 1—J. Duchastel, city engineer, Outremont; F. H. Pitcher, chief engineer, Montreal Water & Power Co., Montreal; R. A. Ross, consulting engineer, Montreal; Julian C. Smith, chief engineer, Shawinigan Water & Power Co., Montreal.

District No. 2—Horace Longley, of Norton-Griffith & Co., St. John; C. M. Odell, resident engineer, Dominion Coal Co., Glace Bay, N.S.

District No. 3—A. R. Decary, superintending engineer of the Province of Quebec, Public Works of Canada, Quebec; S. S. Oliver, consulting engineer, Quebec.

District No. 4—John Murphy, electrical engineer, Department of Railways and Canals, Ottawa; James White, assistant to chairman, Commission of Conservation, Ottawa.

District No. 5—G. A. McCarthy, railway and bridge engineer, Works Department, Toronto; E. W. Oliver, assistant to chief engineer, Canadian Northern Railway, Toronto.

District No. 6—A. T. Fraser, district engineer, Canadian Northern Railway, Edmonton; Wm. Pearce, assistant to executive, Department of Natural Resources, Canadian Pacific Railway, Calgary.

District No. 7—R. F. Hayward, chief engineer, Western Canada Power Co , Vancouver; J. H. Kennedy, assistant chief engineer, V.V. and E. Railway, Vancouver.

Extracts from Report of Council.—Elections during the year resulted in the following additions to the roll: 18 members, 69 associate members, 2 associates, 23 juniors and 34 students. One former associate member and one former junior were reinstated.

The following transfers were made: 23 associate members to the class of member, 18 juniors and 18 students to the class of associate member, and 27 students to the class of junior.

There have been removed from the rolls by resignation or on account of non-payment of dues, 10 members, 44 associate members, 3 associates, 9 juniors and 72 students. These resignations were due either to the fact that those concerned had ceased active engineering work or were, owing to lack of employment, unable to pay the annual dues.

Thirty-nine deaths were reported during the year, including 21 who gave their lives in the defence of the Empire. Of 14 deaths among associate members, 10 were due to wounds at the front.

At present the membership is 3,047, a decrease of 29 as compared with last year. The corporate membership showed an increase of 41, and there was an increase

Prof. Clement Henry McLeod, Ma.E.
Secretary, Can.Soc.C.E.

Quarter Century of Service

DURING the year 1916, Prof. C. H. McLeod celebrated the twenty-fifth anniversary of his appointment as secretary of the Society. When he took office in 1891—in the fifth year of the Society's existence—the total membership was only about 700. Prof. McLeod is one of the most widely known men in Society affairs. He has given a great deal of time, thought and energy to the work—energy which undoubtedly would have been more remunerative had it been turned to more utilitarian purposes. Despite the time occupied by Society affairs, however, Prof. McLeod has succeeded in scientific work, and is now vice-dean of the engineering faculty at McGill University. He is a Fellow of the Royal Society of Canada and a life member of the Royal Astronomical Society. Recognized as an authority upon astronomy, surveying and geodesy, many of his writings are used as texts in advanced courses.

of 19 among the juniors. The falling off in student membership—88—more than offset the other increases, however. This falling off was due considerably to transfers to higher grades of membership.

Meetings.—The council held twenty-nine meetings during the year. There were nine sectional meetings, six monthly meetings, and one special meeting of the society. The following papers and addresses were presented at these meetings:—

"Construction of the Rogers Pass Tunnel," by J. G. Sullivan.

"The Method Employed in Designing the Foundation of the Federal Palace, Mexico," by S. J. Fortin.

"Interesting Features of Reinforced Concrete Buildings in and around Montreal," by C. M. Morssen.

"Manufacture of Brass Cartridge Cases in Canada," by H. H. Vaughan.

"Economic and Strategic Aspects of Enlargement of Welland Canal and of Construction of Georgian Bay Ship Canal," by Col. R. W. Leonard.

"The Rules and Regulations of the Province of British Columbia relating to Annual Rental Fees of Water Powers," by E. Davis.

"The Latest Advances in Bayonet Fighting," by Capt. P. E. Nobbs.

"The Design of Passenger Terminals," by J. L. Busfield.

"Electrical Precipitation of Solids from Gases," by Linn Bradley.

"The Rolling and Floating Steel Caissons of the Levis Dry Dock," by L. R. Thomson.

"The Difficulties of Earth Slides in the Culebra Cut, Panama Canal," by John Murphy.

"Description of Original Diagrams for Making Military Scales," for interpolation of contours and reduction and enlargement of maps, by Lieut.-Col. F. A. Snyder.

"The Law and the Engineer," by Geo. H. Montgomery, K.C.

Description of a series of photographs from the western battle front, by Paul A. N. Seurot.

"The Aqueduct for the Greater Winnipeg Water District," by W. G. Chace, M. V. Sauer and D. L. McLean.

"Some Phases of Railway Work at the Front," by Lieut. Paul Ogilvy.

"Experiences as a Machine Gun Officer at the Front," by Capt. Jas. G. Ross.

"Bombing in the Front Line Trenches," by Capt. G. L. Dobbin.

"The Water Supply of the City of Port Arthur," by L. M. Jones.

"The High Tension Transmission Line Towers," by L. R. Thomson.

"Aviation Work at the Front," by Lieut. E. Laurie.

"Filtration Experience," by H. G. Hunter.

Discussion on the Proposed Specifications for Highway Bridges.

Committees.—Following have been the committees of council during the year:—

Library and House (S. P. Brown, chairman), Finance (R. A. Ross, chairman), Meetings (W. J. Francis, chairman), Board of Examiners (H. M. MacKay, chairman), Gzowski Medal and Students' Prizes (Phelps Johnson, chairman).

The Nominating Committee for officers for the year 1917 were Ernest Brown (chairman); Phelps Johnson, M. J. Butler, C.M.G., and F. C. Gamble (past presidents); G. G. Murdoch, A. Tremblay, G. A. Mountain, A. F. Macallum, J. Chalmers and E. A. Cleveland.

The other committees at work during the year were as follows:—

Educational Requirements (E. Marceau, chairman),

(Continued on page 58.)

Over Twenty-Two Percent. of the Total Membership of the Canadian Society of Civil Engineers Has Enlisted

Canada's Civil Engineers Rally to the Flag

SOCIETY MEMBERS ENLISTED, C.E.F.

Hon. Members	1
Members	67
Associate Members	290
Associates	3
Juniors	135
Students	182
Total	678

SOCIETY MEMBERS KILLED IN ACTION OR DIED OF WOUNDS.

Members	4
Associate Members	14
Juniors	9
Students	6
Total	33

Eighteen Corporate Members and Fifteen Juniors and Students Have Made The Supreme Sacrifice

POINTS OF INTEREST IN CONNECTION WITH SOME CONCRETE BUILDINGS RECENTLY ERECTED IN AND AROUND MONTREAL.*

By C. M. Morssen, M.Can.Soc.C.E.

SOME of the buildings are interesting by their size and exterior finish, some by their size and time of the year at which they were erected, and others are interesting from an engineering point of view, presenting complicated problems in the design of domes, arches, cantilevers, winding stairs, towers, etc.

The Orphanage.—In 1912 an orphanage building was erected in St. Laurent for the Order of the Rev. Grey Nuns. The building is about 250 feet long, and five stories high (basement and four stories). The whole structure is of concrete.

The exterior walls are 8 ins. thick, and are lined with hollow terra cotta to the interior. The foundation walls are of plain concrete, but the footings for walls and columns are of reinforced concrete. A large amount (about 15%) of clean one-man stones were embedded in the foundation walls, which are 20 ins. thick, and although the building is three years old, the foundation walls do not show any cracks. It is the writer's opinion that the lack of cracks is due to the free and careful use of large stones. A great number of concrete buildings where large stones were not permitted, show expansion cracks, especially in the foundation walls.

The basement walls and first floor of the orphanage were built in November, December and January, 1911. The reinforced concrete floor (about 20,000 sq. ft.) was finished in freezing weather. The work was stopped and resumed in May, 1912. In the spring, the concrete (4-in. floor) was rather soft on the surface, but in about three weeks the floor became very hard and tough. As soon as the warm weather set in, the floor was freely sprinkled with water twice daily. When the concrete was laid no special precautions were taken, with the exception of making sure that the sand and stone did not contain frozen particles. The concrete was allowed to freeze, and no coverings were provided. The floor proved a perfect success.

The skeleton of this building, starting from the basement floor, is of steel. All columns and beams are fireproofed with stone concrete.

As the exterior walls are of concrete, the question of the exterior finish had to be decided upon. Several studies were made under the direction of the architect, Mr. A. Piche, and finally a small rough-cast finish was decided upon. This finish was made in the following way: The surface of the concrete was thoroughly cleaned, picked and washed. Immediately after the washing a thin layer of cement mortar (1 : 2) was applied and troweled to an even surface, and before the mortar had time to set it was picked rough with a special wooden brush. When completed, the outside finish was composed of small particles of mortar well troweled into a clean and rough concrete surface. The result is very satisfactory indeed, and the benefit of the adhesion of a well-applied mortar is obtained. After three Canadian winters not one square inch of the 7,000 sq. yds. of exterior finish scaled off, and the appearance is also very pleasant and uniform. The same method has been equally successful on other buildings.

As mentioned, several tests were made before a decision regarding the finish was reached, and a cement gun was also experimented with. The finish obtained with the cement gun was good in appearance, but the method had to be abandoned because of the very expensive scaffolding which would have been required to cover the whole building with gunite.

The ordinary way of obtaining a rough-cast was also investigated, and it was ascertained that the throwing of mortar pebbles against the wall gives an appreciable percentage of waste, and the recoil weakens the adhesion between the mortar and the concrete wall.

The Old Folks' Home.—The Old Folks' Home, built for the same Order, is of still larger proportions, being 400 feet long, and having an area of 40,000 sq. ft. per floor. This building is all of reinforced concrete. The outside walls are 9 ins. thick, and the floors are mostly made of tile and concrete. The work on the foundation was started in October, 1913, and finished in February, 1914.

The floor is made of 8-in. tile with concrete beams at 16-in. centre to centre, the whole being covered with 2 ins. of concrete.

(Continued on page 71.)

*Abstract of paper presented to the Canadian Society of Civil Engineers.

CHARTER MEMBERS
Can. Soc. C. E.

SIR JOHN KENNEDY
Consulting Engineer, Montreal.

HUGH DAVID LUMSDEN
Consulting Engineer, Orillia, Ont.

HENRY SKEFFINGTON POOLE
Spreyton, Guildford, Surrey, Eng.

BRIG.-GEN. HENRY N. RUTTAN
Consulting Engineer, Winnipeg.

SIR COLLINGWOOD SCHREIBER
Consulting Engineer to the Dominion Government.

PERCIVAL W. ST. GEORGE
Consulting Engineer, Montreal.

HERBERT WALLIS
Consulting Engineer, Montreal.

Membership, Can. Soc. C. E.

	1914.	1915.	1916.
Honorary members	10	8	8
Members	674	693	709
Associate members	1,372	1,409	1,434
Associates	36	34	33
Juniors	352	357	376
Students	615	575	487
Total	3,059	3,076	3,047

ANALYSIS OF CHICAGO BY-LAW FOR FLAT SLABS

RECENT TESTS CONDUCTED IN TORONTO BY THE CITY ARCHITECT'S DEPARTMENT AND PROF. PETER GILLESPIE SHOW THAT THE CHICAGO CODE FOR FOUR-WAY TYPE OF CONSTRUCTION IS UNDOUBTEDLY CONSERVATIVE.

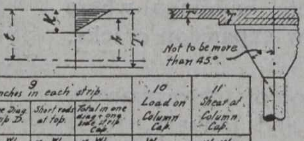
By **WILLIAM WORTH PEARSE, C.E.,**
City Architect and Superintendent of Building, Toronto.

At the time of approving the plans for several large buildings based on the Chicago code for flat slab four-way type of construction, the writer made an analysis of the Chicago by-law which may interest *Canadian Engineer* readers.

By an examination of this analysis it will be noted that apparently the Chicago code is based on the theory of a beam of uniform section rigidly fixed at both ends. The negative bending moment for the full width of the panel over the supports would then be $-\frac{WL}{12}$; and the positive bending moment for the full width of the panel midway between the supports, $\frac{WL}{24}$.

TABLE I.

Maximum allowable steel stress 18000 lbs. per sq. inch.
Maximum extreme fibre stress concrete 700 lbs. per sq. inch.
Note:- This Table is for Four Way Type of Construction only.



1 Safe Live Load Lbs. per sq. ft.	2 Side of Square Panel	3 Total load on one panel W	4 Diam. of Column Cap	5 Area of Column Cap. Sq. feet	6 Side of Square Depression	7 Slab Thickness: Through Depression Inches T	h	Slab for Strip B Inches T'	h'	Slab for Strip D Inches T"	h"	8 Average dead weight of slab Lbs.	9 Steel in sq. inches in each strip: One side Strip B. $M \cdot \frac{WL}{80}$	One Diag. Strip D. $M \cdot \frac{WL}{120}$	Short rods at top. $M \cdot \frac{WL}{120}$	Total in one diag. + one side strip Cap. $M \cdot \frac{WL}{30}$	10 Load on Column Cap. Wc	11 Shear at Column Cap. W-Wc
40	16'-0"	30800	3'-6"	9.0	5'-4	9.5	7.04	6.0	4.4	6.0	4.0	80.2	.93	.69	.69	1.55	1386	29400
100	"	46000	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.4	1.02	1.02	2.32	1940	44100
125	"	52500	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.59	1.17	1.17	2.66	2150	50300
150	"	58800	"	"	"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.78	1.3	1.3	2.97	2480	56300
200	"	73300	"	"	"	10.5	7.92	6.5	4.84	6.5	4.34	86.4	2.02	1.5	1.5	3.3	2900	70400
250	"	88000	"	"	"	11.5	8.8	7.0	5.28	7.0	4.78	93.5	2.22	1.63	1.63	3.56	3300	84100
300	"	104000	"	"	"	12.5	9.66	7.5	5.72	7.5	5.22	100.5	2.44	1.78	1.78	3.82	4000	100000
40	17'-0"	39800	4'-0"	11.2	5'-8"	9.5	7.04	6.0	4.4	6.0	4.0	80.2	1.27	.95	.95	2.14	1730	38100
100	"	54000	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	1.57	1.15	1.15	2.72	2430	51600
125	"	61000	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	1.79	1.3	1.3	3.08	2700	58300
150	"	68400	"	"	"	10.0	7.5	6.5	4.84	6.5	4.34	85.6	2.0	1.45	1.45	3.42	3000	65400
200	"	83000	"	"	"	10.5	7.92	6.5	4.84	6.5	4.34	85.6	2.42	1.77	1.77	3.96	3600	79400
250	"	100000	"	"	"	11.5	8.8	7.25	5.5	7.25	5.0	96.0	2.58	1.85	1.85	4.3	4300	95700
300	"	118000	"	"	"	13.0	9.9	8.0	6.16	8.0	5.66	106.5	2.72	1.95	1.95	4.5	5050	113000
40	18'-0"	40000	4'-2"	13.2	6'-0"	9.75	7.26	6.25	4.62	6.25	4.12	82.5	1.3	.95	.95	2.21	2040	38000
100	"	62500	"	"	"	11.0	8.36	7.0	5.78	7.0	5.28	92.7	1.62	1.16	1.16	2.99	3000	60000
125	"	70000	"	"	"	11.0	8.36	7.0	5.78	7.0	5.28	92.7	1.84	1.33	1.33	3.4	3340	67500
150	"	79000	"	"	"	11.5	8.8	7.0	5.78	7.0	5.28	93.3	2.05	1.46	1.46	3.6	3750	75200
200	"	95000	"	"	"	11.5	8.8	7.0	5.78	7.0	5.28	93.3	2.46	1.76	1.76	4.32	4400	90600
250	"	115500	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	105.8	2.83	2.02	2.02	4.8	5220	110300
300	"	134000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	111.2	3.05	2.18	2.18	5.3	6000	128000
40	19'-0"	45500	4'-4"	14.2	6'-3"	10.0	7.5	6.5	4.84	6.5	4.34	85.7	1.48	1.1	1.1	2.57	2240	43300
100	"	71000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.05	1.5	1.5	3.6	3240	67800
125	"	80000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.30	1.68	1.68	4.05	3600	76400
150	"	89000	"	"	"	11.0	8.36	7.25	5.5	7.25	5.0	95.5	2.56	1.88	1.88	4.5	3940	85100
200	"	108000	"	"	"	11.5	8.8	7.5	5.72	7.5	5.22	99.4	2.98	2.18	2.18	5.2	4250	103800
250	"	130600	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	112.7	3.14	2.26	2.26	5.44	5800	124800
300	"	153000	"	"	"	14.0	10.56	9.0	7.04	9.0	6.54	118.7	3.44	2.46	2.46	6.12	6560	146400
40	20'-0"	53000	4'-6"	16.0	6'-8"	11.25	8.58	7.0	5.28	7.0	4.78	92.5	1.68	1.23	1.23	2.75	2740	50300
100	"	80000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.34	1.71	1.71	3.85	3850	76100
125	"	90000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.62	1.92	1.92	4.35	4250	85700
150	"	100000	"	"	"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.93	2.13	2.13	4.82	4650	95300
200	"	124000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	3.36	2.44	2.44	5.75	5500	118500
250	"	147000	"	"	"	14.0	10.36	9.0	7.04	9.0	6.54	118.6	3.49	2.51	2.51	6.32	6600	140400
300	"	170000	"	"	"	15.0	11.44	9.5	7.48	9.5	6.98	126.2	3.80	2.7	2.7	6.6	7600	162400
40	21'-0"	60000	4'-9"	17.7	6'-10	11.5	8.8	7.25	5.5	7.25	5.0	95.0	1.92	1.4	1.4	3.19	3080	56900
100	"	91000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.59	1.88	1.88	4.4	4350	86600
125	"	102000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.91	2.1	2.1	4.95	4800	97200
150	"	113000	"	"	"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	3.22	2.32	2.32	5.49	5250	107700
200	"	138000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.0	112.0	3.66	2.65	2.65	6.38	6350	131600
250	"	167000	"	"	"	15.0	11.44	9.5	7.48	9.5	7.0	126.0	3.91	2.79	2.79	6.8	7500	159500
300	"	191000	"	"	"	16.0	12.32	10.0	7.92	10.0	7.42	132.8	4.25	3.0	3.0	7.22	8650	182300
40	22'-0"	67600	5'-0"	19.0	7'-3"	12.0	9.24	7.5	5.72	7.5	5.22	100.0	2.17	1.6	1.6	3.58	3400	64200
100	"	103000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	2.86	2.06	2.06	5.0	4900	98100
125	"	115000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	3.19	2.3	2.3	5.56	5360	109600
150	"	127000	"	"	"	13.5	10.12	8.5	6.6	8.5	6.1	113.7	3.52	2.54	2.54	6.15	5850	121100
200	"	154000	"	"	"	14.0	10.56	9.0	7.04	9.0	6.54	118.7	4.0	2.88	2.88	7.15	6900	147100
250	"	186000	"	"	"	16.0	12.32	10.0	7.92	10.0	7.42	133.0	4.35	3.04	3.04	7.4	8300	177700
300	"	213000	"	"	"	17.0	13.2	10.5	8.36	10.5	7.86	140.7	4.7	3.32	3.32	7.95	9500	203500
40	23'-0"	77500	5'-3"	21.2	7'-8"	12.5	9.66	8.0	6.16	8.0	5.66	106.0	2.42	1.78	1.78	4.1	3960	73500
100	"	114500	"	"	"	13.75	10.34	8.75	6.82	8.75	6.32	115.6	3.23	2.32	2.32	5.65	5500	109000
125	"	127500	"	"	"	14.25	10.78	8.75	6.82	8.75	6.32	115.6	3.58	2.59	2.59	6.05	6157	121300
150	"	141000	"	"	"	14.25	10.78	8.75	6.82	8.75	6.32	115.6	3.96	2.86	2.86	6.4	6700	134300
200	"	173000	"	"	"	15.0	11.44	9.5	7.48	9.5	7.0	126.2	4.42	3.15	3.15	7.7	8000	165000
250	"	206000	"	"	"	17.0	13.2	10.5	8.36	10.5	7.86	140.6	4.7	3.36	3.36	7.95	9500	196500
300	"	237000	"	"	"	17.75	13.86	11.0	8.8	11.0	8.3	146.5	5.15	3.66	3.66	8.75	10700	226300
40	24'-0"	86500	5'-6"	23.4	8'-0"	13.5	10.12	8.25	6.38	8.25	5.88	109.0	2.7	1.97	1.97	4.55	4600	81900
100	"	126000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	3.58	2.56	2.56	6.1	6300	120000
125	"	141000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	4.0	2.87	2.87	6.82	6900	134000
150	"	155000	"	"	"	14.5	11.0	9.0	7.04	9.0	6.54	119.2	4.4	3.16	3.16	7.5	7450	147500
200	"	192000	"	"	"	16.5	12.76	10.0	7.92	10.0	7.42	133.6	4.85	3.45	3.45	8.0	9150	18[illegible]000
250	"	228000	"	"	"	17.5	13.64	11.0	8.8	11.0	8.3	146.6	5.17	3.66	3.66	8.9	10600	217400
300	"	261000	"	"	"	19.0	14.96	11.5	9.24	11.5	8.74	154.0	5.65	4.0	4.0	9.3	12300	249000

Assuming there were two continuous beams of width L running at right angles to each other, each carrying one-half the total live and dead loads, the individual moment over the support being $-\frac{WL}{24}$, and at the centre a positive moment of $\frac{WL}{48}$.

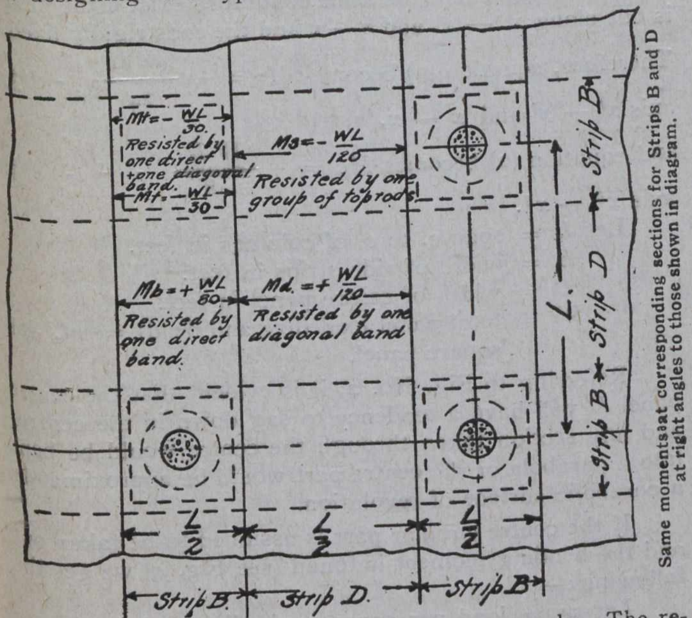
This can readily be proved by adding together $\frac{WL}{120}$ and $\frac{WL}{30}$, the moments for the ½ panel strips called for in the Chicago code, which sum equals $\frac{WL}{24}$, and also by adding together the centre positive moments $\frac{WL}{80}$ and $\frac{WL}{120}$, which sum equals $\frac{WL}{48}$. The problem then resolves itself into determining what proportion of $\frac{WL}{24}$ and $\frac{WL}{48}$ is taken respectively by the centre and side strips.

In the following analysis I have endeavored to arrive at an approximate method, which agrees in a surprising degree with what has been adopted in the Chicago code, I have assumed that the line of contra-flexure around the centre of the panel is a circle, whereas actually from experiments on a rubber slab conducted by F. J. Trelease, it is an average between a square and a circle. I have also found this to be true by a number of tests on actual structures. However, for ease in figuring I have taken the circle as a basis, and by checking a number of cases I have found that it makes very little difference in the results.

It is apparent that the Chicago code does not take into consideration Poisson's ratio, nor does it make any allowance for arch action or tension in the concrete. This, of course, gives an additional factor of safety, and from tests which have recently been conducted in Toronto by Mr. Mylrea, of the city architect's department, in conjunction with Prof. Gillespie, of the University of Toronto, the Chicago code is undoubtedly quite conservative.

After looking over a large number of discussions on the flat slab type of construction, I was unable to find anything throwing any light upon how the Chicago code was derived, and I am therefore not in a position to say whether my method is the same as was used by the Chicago experts in drafting their by-law, but at any rate the results check, and my method is more or less based along theoretical lines.

In Table No. 1 I have endeavored to furnish information that may be useful for the architect or the engineer in designing this type of construction according to the



NOTE.—The strips are for design purpose only. The reinforcement is arranged as shown in Figure V.

Fig. No. 1.

Chicago code. The dimensions given are those I believe to be the most economical. I have assumed that the concrete is stressed up to 700 lbs. per square inch and that the steel is stressed up to 18,000 lbs. per square inch, and due to the very satisfactory tests this department has conducted, I am prepared to allow these stresses in the future for this method of design. This table may be used for what is known as the four-way system. The two-way system will probably require the table to be considerably modified.

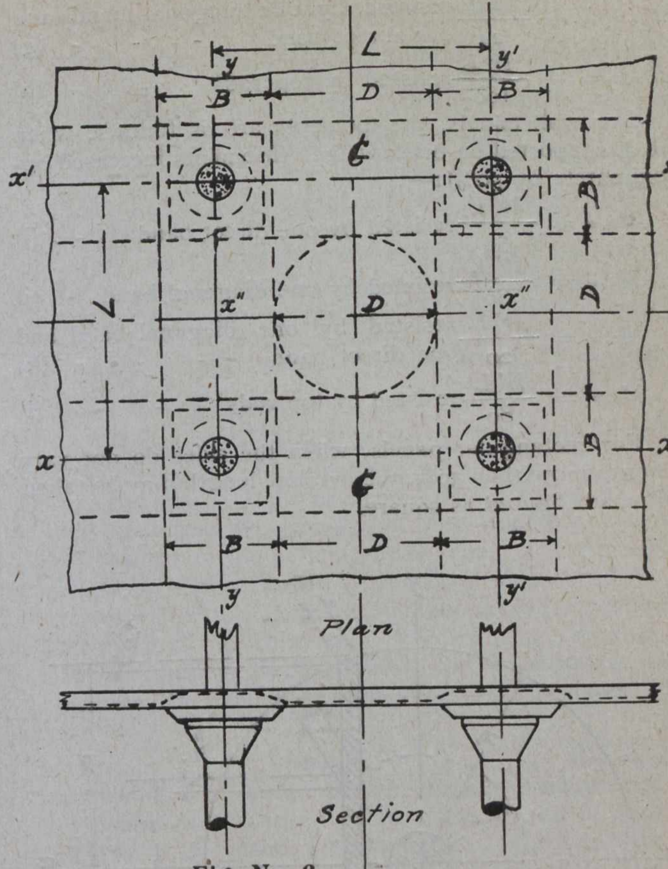


Fig. No. 2.

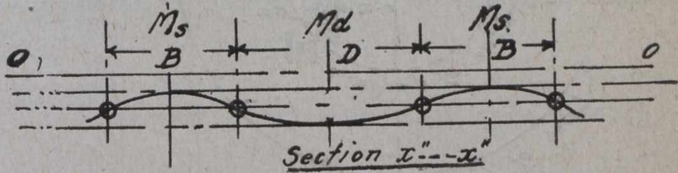


Fig. No. 3.

$M = 112\ bt^2$ when $S = 18{,}000$ and $C = 700$.

$M = \left\{ \begin{array}{l} \text{bending moment in inch-lbs.} \\ \text{for } 3/4\% \text{ of steel.} \end{array} \right.$

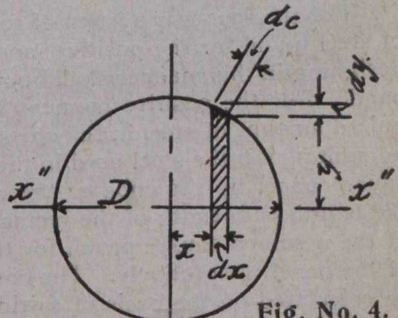


Fig. No. 4.

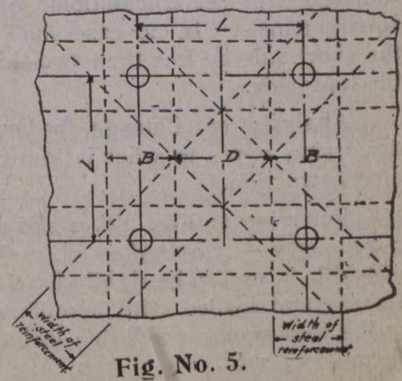


Fig. No. 5.

Chicago By-law for Flat Slabs.—This discussion refers to what is known as the four-way type of construction.

W = total panel load (live and dead) = wL^2 for square panel.

L = span in feet.

B = width of direct band = $\frac{L}{2}$. D = width of centre band = $\frac{L}{2}$.

Referring to Fig. No. 1 it will be noticed that the bending moment for the side strips half-way between the column centres is $M_b = \frac{WL}{80}$ (resisted by one direct band) - - - - - - - - - - (a)

Bending moment for the centre strip half-way between the column centres is $M_d = \frac{WL}{120}$ (resisted by one diagonal band) - - - - - (b)

Bending moment for the side strips over the column cap is $Mt = -\frac{WL}{30}$ (resisted by one direct and one diagonal band) - - - - (c)

Bending moment for the centre strip along the column centres is $Ms = -\frac{WL}{120}$ (resisted by top rods) - - - - - - - - (d)

For wall panels, the moments are as follows when slab is supported by wall columns. (Moments increased approximately by 20%):—

$M_{b.w} = \frac{WL}{66}$ resisted by one direct band - - - - (e)

$M_{d.w} = \frac{WL}{100}$ resisted by one diagonal band - - - - (f)

$M_{t.w} = -\frac{WL}{24}$ resisted by one diagonal band and one direct band - - - (g)

$M_{s.w} = -\frac{WL}{100}$ resisted by top rods - - (h)

For wall panels, the moments are as follows, when slab is supported on brick walls. (Moments increased approximately by 50%):—

$M_{b.w} = \frac{WL}{54}$ resisted by one direct band - (i)

$M_{d.w} = \frac{WL}{80}$ resisted by one diagonal band - (j)

$M_{t.w} = \frac{WL}{20}$ resisted by one diagonal band and one direct band - - - (k)

$M_{s.w} = \frac{WL}{80}$ resisted by top rods - - (l)

For rectangular panels, when the sides do not vary in length more than 50%, the average length may be taken and panels figured as square.

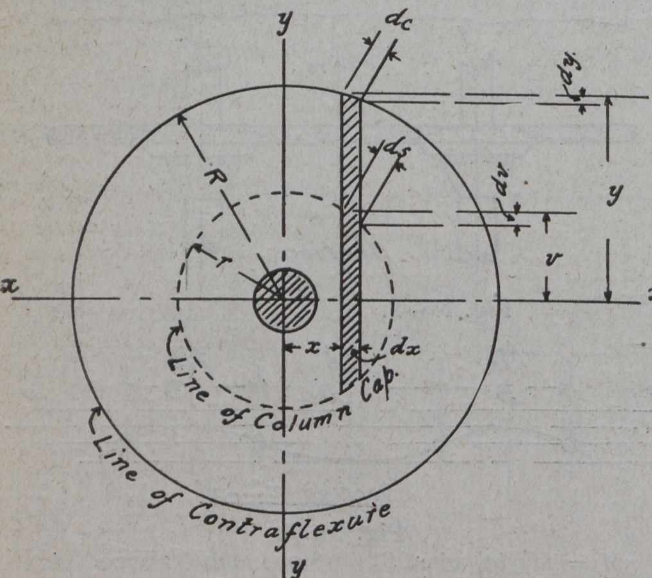


Fig. No. 6.

For the four-way system of reinforcement the amount of steel found for the positive moment of each strip D by designing in this manner shall be that used in the diagonal band. For the positive moment in each strip B, the required amount of steel in the cross-band shall be obtained by multiplying the steel used in the design of the assumed square panel by the cube of the ratio found by dividing the length or breadth of the rectangular panel by the side of the assumed square panel, for the long and short sides of the panel, respectively. The compressive stresses shall be calculated on the basis of a width equal to one-half of the side of the assumed square panel, and on the assumptions used in the calculations of compressive stress in square panels. In no case shall the amount of steel in the short side be less than two-thirds of that required for the long side.

Analysis of Chicago By-law for Flat Slabs.—This discussion refers to what is known as the four-way type of construction.

Referring to Fig. No. 2 and assuming the slab to be cut along $y - y$ and $y' - y'$, making a continuous beam of width L, and to be rigidly fixed at each end, of uniform section and loaded with a uniformly distributed load of w lbs. per square foot (this includes live and dead load) then $W = wL^2$.

Let Mr = bending moment in foot-lbs. at point of support for entire width of slab.

Mc = bending moment in foot-lbs. at centre of panel for entire width of slab.

Then $Mr = -\frac{WL}{12}$ - - - - - - (1)

and $Mc = +\frac{WL}{24}$ - - - - - - (2)

It is evident that the same conditions exist if the plate is cut along $x' - x'$ and $x - x$ and the ends rigidly fixed.

Therefore, equation (1) becomes $Mr = -\frac{WL}{24}$ - - (3) axis $x' - x'$ and $x - x$,

and equation (2) becomes $Mc = +\frac{WL}{48}$ - - - (4) axis $x'' - x''$.

Let L = span c. to c. of columns in feet.
B = width of side strips in feet.
D = width of centre panel in feet.
W = total panel load (live and dead) = wL^2 for square panel.

Referring to Fig. No. 2, it is evident that the centre panel D will have a tendency to sag down in the centre, and any section taken through the centre would be bent into a parabola or the centre part would be approximately a parabolic surface of revolution.

If the centre circular part is assumed to be taken out and the bending moment is found (see Fig. 4) we get the following:—

Let w = load per square unit (live and dead) and
w' = load per lineal unit of circumference.

Then $w' = \frac{rw}{2}$ - - - - - - (5)

Then the differential moment of one strip $d.x.$ would be $d\,(m) = \left(\frac{rw}{2}\right) y.\, dc - \frac{w}{2}\ y^2\, dx$ - - (6)

Substituting for dc and y in terms of x, equation (6) reduces to

$$d\,(m) = \frac{w}{2} x^2\, dx \quad - - - - - (7)$$

$$\text{and } \frac{Md}{2} = \frac{w}{2}\int_0^r x^2\, dx = \frac{w}{2}\,\frac{r^3}{3} = \frac{wr^3}{6}$$

or $Md = \frac{wr^3}{3}$ = bending moment across axis $x'' - x''$ - - - - - - (8)

But $r = \frac{D}{2}$,

Therefore, $Md = \frac{wD^3}{24}$ - - - - - (9)

Referring to Fig. No. 5, and the conditions shown, then

$B = .414\,L$ - - - - (10)
$D = .586\,L$ - - - - (11)

$D^3 = .2L^3 = \frac{2}{10} L^3$ - - - (12)

Substitute value found in equation (12) for D^3 in equation (9), then

$$Md = +\frac{wL^3}{120} \quad - - - - (13)$$

But $W = wL^2$, substitute in equation (13)

$$Md = +\frac{wL}{120} \quad - - - - (14)$$

The bending moment given in equation (14) is resisted by one diagonal band, and it is the same as given by the Chicago by-law. (See equation "b".)

By referring to equation (4) it will be noticed that the total bending moment across axis $x'' - x''$ is $Mc = + \frac{WL}{48}$, and it was just found by equation (14) that the bending moment for the centre panel is $Md = + \frac{WL}{120}$.

Therefore $Mb = Mc - Md = \frac{WL}{48} - \frac{WL}{120} = + \frac{WL}{80}$ (15)

or $Mb = + \frac{WL}{80}$ = bending moment in side panels and is resisted by one side panel B. This is the same as the Chicago by-law. (See equation "a".)

Referring to equation (3).

$$Mr = - \frac{WL}{24}$$

Let w = load per square foot.
p = load per unit length of line of contraflexure.
q = load per unit length of line of column cap.
Mt = bending moment across axis $x - x$. (See Fig. 6.)

Fig. 6 shows the approximate line of contraflexure around column centre. It is not a circle but most authorities assume it to be so.

The approximate bending moment may be found across axis $x - x$ as follows, and is what is given for Mt. See equation (c).

If a differential strip is assumed of a width of dx, then $dm = p\,dc\,y + w\,y\,dx\frac{y}{2} - q\,ds\,v - w\,v\,dx\frac{v}{2}$ (16)

Substituting the following values and then integrating,

$$y = \sqrt{R^2 - x^2}$$
$$dc = \frac{R\,dx}{y}$$
$$ds = \frac{r\,dx}{v}$$

Then

$$\frac{Mt}{2} = pR\int_0^R dx + \frac{w}{2}R^2\int_0^R dx - \frac{w}{2}\int_0^R x^2\,dx - qr\int_0^r dx - \frac{w}{2}r^2\int_0^r dx + \frac{w}{2}\int_0^r x^2\,dx \quad (17)$$

$$\frac{Mt}{2} = pR^2 + \frac{w}{2}R^3 - \frac{w}{6}R^3 - qr^2 - \frac{w}{2}r^3 + \frac{w}{6}r^3 \quad (18)$$

Substituting following values in equation (18)

$$p = \frac{wL^2 - w\pi R^2}{2\pi R}$$
$$q = \frac{wL^2 - w\pi r^2}{2\pi r}$$
$$R = \frac{L}{4}$$
$$r = \frac{L}{8} \text{ approximately.}$$

Then equation (18) becomes

$$\frac{Mt}{2} = 57\,wL^3$$

or $Mt = 28.5\,wL^3$ - - - - - (19)

but $W = wL^2$

then $Mt = 28.5\,WL$, resisted by one diagonal band and one straight band - - - - - - - (20)

Referring to equation (c) it will be noticed that the Chicago code gives Mt as $-\frac{WL}{30}$, which is very nearly the same as is given by equation (20).

But $Mr = -\frac{WL}{24}$ = total moment for the full width of the slab along column centres, and taking $Mt = -\frac{WL}{30}$ then $Ms = Mr - Mt$.

Therefore, $Ms = -\frac{WL}{24} + \frac{WL}{30} = -\frac{WL}{120}$ (21)

Ms is resisted by short rods at top of concrete slab.

This is verified by Trelease in his experiments on a rubber slab as he found that

$Ms = Md$ which was found to be $\frac{WL}{120}$. See equation (14.)

Shearing Stresses Allowed by the Chicago Code.—The allowable unit punching shear on the perimeter of the column capital shall be three-fiftieths (3/50) of the ultimate compressive strength of the concrete, as given in section 546 of the building ordinance. The allowable unit shear on the perimeter of the drop panel shall be three-one-hundredths (3/100) of the ultimate compressive strength of the concrete. In computing shearing stress for the purpose of determining the resistance to diagonal tension the method specified by the ordinance shall be used.

Mixture	Ultimate compressive strength per sq. in.
1 cement, 1 sand, 2 broken stone, gravel or slag	2,900
1 cement, 1½ sand, 3 broken stone, gravel or slag	2,400
1 cement, 2 sand, 4 broken stone, gravel or slag	2,000
1 cement, 2½ sand, 5 broken stone, gravel or slag	1,750
1 cement, 3 sand, 7 broken stone, gravel or slag	1,500

MOUNT ROYAL TUNNEL COMPLETED.

Official announcement was made last week by the Canadian Northern Railway that the Mount Royal tunnel is now practically completed, and that a large gang of men are at work in laying the permanent trackage through the tunnel.

Sir Donald Mann is now considering the tenders that have been received for the temporary terminal, costing about $150,000, which will be erected at the corner of Lagauchetiere and St. Monique Streets. Contract will be let almost immediately for the removal of 240,000 cu. yds. from this site, and of this amount 140,000 cu. yds. will be taken through the tunnel as fill for the company's yards at Cartierville.

It was stated by C.N.R. officials last week that regular trains would be running into Montreal by next June. The lighting of the tunnel will be considered later on. Two 80-ton electric locomotives are now in use in the tunnel and four more will be purchased for the regular service.

TORONTO ENGINEERS' CLUB NIGHT.

"Club Night" was observed last evening by the members of the Engineers' Club of Toronto. Informal dinner was served at 7 p.m. to a representative gathering, many members having been attracted by the announcement of a talk on the organization and operation of Toronto's works department by R. C. Harris, commissioner of works.

A GRAPHIC METHOD OF DETERMINING CENTRE OF GRAVITY AND MOMENT OF INERTIA.

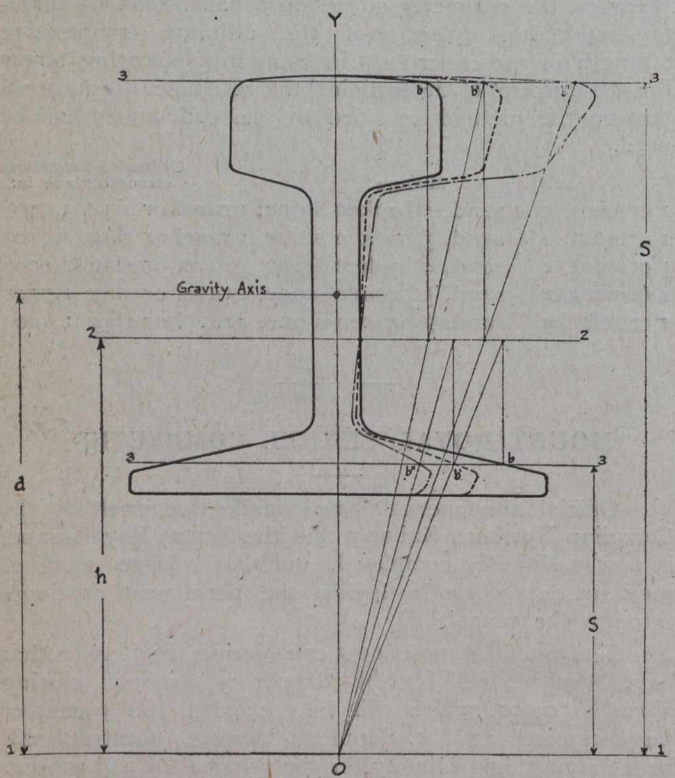
By H. B. Wrigley.

THE centre of gravity and moment of inertia are properties well known for common sections of beams, shafts, etc., but for other sections, as rails, automobile axles, machine frames, crane-hooks, etc., where the outline is such that the integration in the expressions for centre of gravity and moment of inertia is difficult, the following graphic method will be found convenient.

Let it be required to locate an axis passing through the centre of gravity of the rail shown in the figure.

Draw axes 1—1 and 2—2 at a convenient distance h apart, parallel to the required axis.

Draw any line as 3—3 parallel to 2—2 and project the points b—b on 2—2; from O and through the intersections on 2—2 draw straight lines intersecting 3—3 at



b'—b'; continue this process by determining other points b'—b' and connect them to produce a transformed section.

(a) The statical moment, M, of a plane surface with respect to an axis in the plane is equal to the sum of the products of the elementary areas and their distance from the axis considered, or, it is the product of the area of the plane surface and the distance of its centre of gravity from the axis.

Measure the area of the original section and let A denote this area; also let d be the distance from 1—1 to the gravity axis; then by definition $M = Ad$. Measure the area of the transformed section b'.....b' and let A_1 denote this area; then, M, for the original section $= hA_1$,

therefore $d = \frac{hA_1}{A}$, which will now be proved.

Let e denote the distance from axis O—Y to b;
e' the distance from axis O—Y to b';
ew an elementary area;
S the distance of ew from axis 1—1.

It will be noticed that $\frac{e}{h} = \frac{e'}{S}$, hence $e = \frac{e'h}{S}$.

By definition (a)
$$M = ew\cdot S \ldots\ldots + ew\cdot S = h(e'w \ldots\ldots + e'w) = hA_1$$

but $M = Ad$, therefore $d = \frac{hA_1}{A}$

To determine the moment of inertia of the section with respect to its gravity axis.

Project the points b'—b' on 2—2; from O and through the intersections on 2—2 draw straight lines intersecting 3—3 at b''—b'' and through these points construct a second transformed section.

(b) The moment of inertia I of a plane surface with respect to any axis as 1—1 is the sum of the products obtained by multiplying the area of each element of the surface by the square of its distance from the axis.

(c) The moment of inertia I of a plane surface with respect to any axis as 1—1 is equal to the moment of inertia I with respect to a parallel axis passing through the centre of gravity of the surface plus the product of the area of the surface by the square of the distance between the axes; then $I = I_g + Ad^2$.

Measure the area of the transformed section b''.....b'' and let A_2 denote this area, then for the original section $I = h^2 A_2$, therefore $I_g = h^2 A_2 - Ad^2$, the required moment of inertia.

Let e'' denote the distance from axis O—Y to b''.

It will be noticed that $\frac{e'}{h} = \frac{e''}{S}$ and $e' = \frac{he''}{S}$; also that $e' = \frac{eS}{h}$ as before; hence $S^2 = \frac{h^2 e''}{e}$

By definition (b)
$$I = ew\cdot S^2 \ldots\ldots + ew\cdot S^2 = h^2 (e''w \ldots\ldots + e''w) = h^2 A_2$$

ROAD MAP OF ONTARIO IS BEING MADE.

A road map of Old Ontario, that portion of the province south of a line drawn from Renfrew to the apex of the Bruce peninsula, is in course of preparation. When completed it will show all roads together with the location of waterways, railroads, cities, towns, villages and post offices. Improved roads will be shown in colors and fenced and unfenced roads indicated by distinguishing signs. The scale of the original map is two miles to the inch, and when completed it will measure approximately 10 by 20 feet. A map of reduced scale will be issued for general use.

AMERICAN ROAD BUILDERS' ASSOCIATION.

The fourteenth annual convention of the American Road Builders' Association will be held in Mechanics' Building, Huntington Avenue, Boston, Mass., February 5th to 9th, 1917. It has been the custom for six years to hold the convention of the American Road Builders' Association as the American Good Roads Congress. The object of this is to bring together individuals of all classes interested in roads and streets, not only from a technical and scientific standpoint, but from a civic point of view as well. The programme for the convention and congress is now in course of preparation. The secretary is E. L. Powers, 150 Nassau Street, New York.

PORTAGE AVENUE IMPROVEMENT, EDMONTON

DESCRIPTION COVERING THREE YEARS' WORK ON A WESTERN THOROUGHFARE—CONSTRUCTION METHODS.

By C. C. SUTHERLAND, B.A.Sc., A.M.Can.Soc.C.E.,
Roadways Engineer, Edmonton.

DURING 1916 the city of Edmonton completed the improvement of Portage Avenue for the Hudson's Bay Company. This is a notable thoroughfare and a general description covering the three years' work on it will be of interest to readers of *The Canadian Engineer.*

At the time that property known as the Hudson's Bay Reserve was thrown open for sale, the company promised the purchaser that certain improvements, such as grading, paving, plank walk construction, sewer and water, and the extension of electric light and telephone, would be undertaken. The company then entered into an agreement with the city whereby these utilities would be extended at the company's expense, in lieu of the corporation extending its street railway along Portage Avenue.

Portage Avenue is one of the two diagonal roads cutting the reserve. Commencing in the down-town district it leads in a northwesterly direction out towards the Grand Trunk Pacific and the Edmonton-Dunvegan Railway shops. It will also handle considerable of the traffic from the town of St. Albert and Mornville district to the northwest of the city.

The total length of this street is 9,911 lineal feet, with a total width between property lines of 100 lineal feet. This area is covered with 55,609 square yards of regular pavement on a 6-inch concrete base, 24,300 square yards of pavement on the street railway allowance, 249,379 square feet of concrete walk, with 17,444 lineal feet of combined curb and gutter. The total cost of this work was $411,345, of which amount the Hudson's Bay Company took $341,761, and the city $69,584. From the above figures it will be seen that the pavement, including the street railway allowance, has cost the company $3.34 per square yard, or for the completed street at the rate of $34.50 per lineal foot. The concrete walk construction cost $62,361, or at the rate of 24.7 cents per square foot, while the combined curb and gutter cost 75 cents per lineal foot.

In deciding on a cross-section for this avenue, consideration was given to the probable through traffic as a leading road, and also of the traffic ordinarily accommodated on a retail business street. But, as will be seen from the accompanying cross-section (Fig. 1) the wide street allowance between property lines gave ample room for both pedestrian and vehicular traffic.

About midway along the avenue at the point where Kingsway Avenue intersects Portage Avenue, a large area, known as Strathcona Square, was left for road and park purposes. In this district, with a tendency for the growth of the city to the northwest, it was thought that this intersection might well become a very busy one and for that reason the first consideration was given to traffic facilities, to see that all intersecting streets were carried through without obstruction, and that pedestrian traffic was given protection. Fig. 2 shows the adopted design, but at present only that portion covered by Portage Avenue has been constructed.

In providing drainage for this street and all side streets running into it, a storm-water sewer was built under the south roadway and offset from the street railway tracks a distance of 10 feet in order to avoid any possible settlement of the new trench. This sewer is not continuous, but leads into the city system at three points, one at 105th Street, one at 108th Street and the other into the tunnel sewer by a drop manhole at 113th Street. The leads carrying the drainage from the catch-basin silt-well to the manhole at the street intersection are all 8-inch connections.

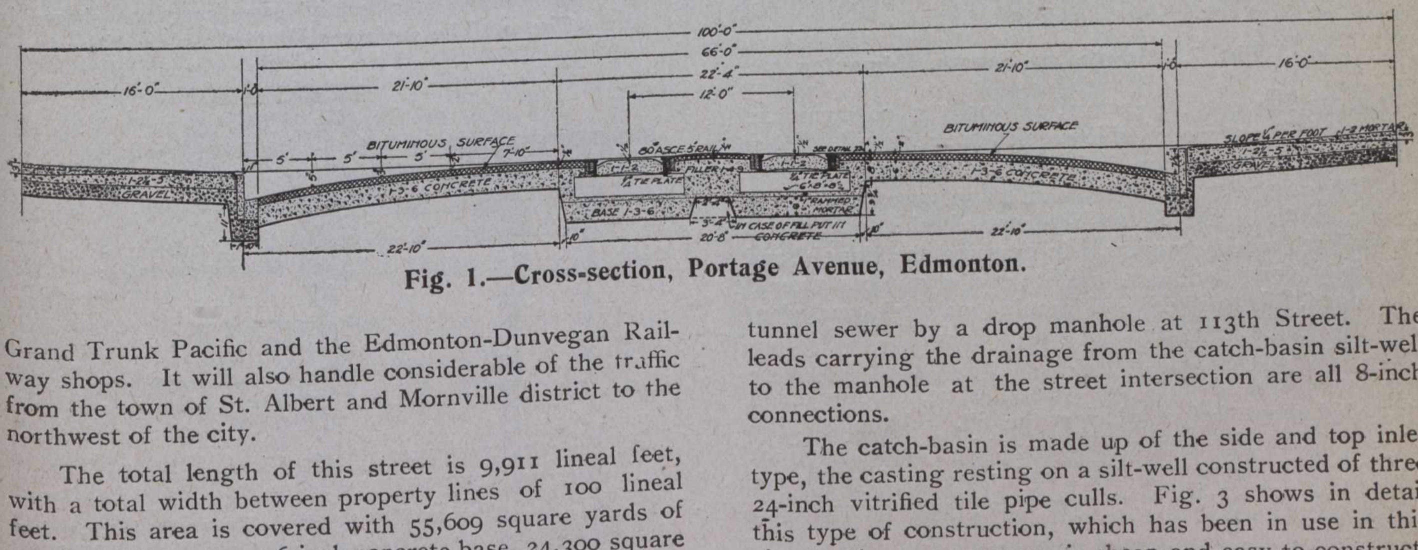


Fig. 1.—Cross-section, Portage Avenue, Edmonton.

The catch-basin is made up of the side and top inlet type, the casting resting on a silt-well constructed of three 24-inch vitrified tile pipe culls. Fig. 3 shows in detail this type of construction, which has been in use in this city for the past 10 years, is cheap and easy to construct, and so far has given good satisfaction.

The ground covered by Portage Avenue has a gradual rise from 101st Street to 121st Street, but is somewhat rolling, and two large sloughs are crossed, one at 108th Street, and the other at 115th Street. The knolls on each side of the sloughs were covered with from one to two feet of black loam resting on a heavy clay. Two years previous to the beginning of permanent construction, this street was graded with a roadway 30 feet wide. Contemplating future construction, this roadway was graded with an offset from the centre line sufficient to clear the street railway allowance. This was found to be a great help as material teams and traffic continued to use the old graded roadway during the construction of the street railway tracks.

The total construction from 101st Street to 121st Street was completed in three years, a third each year. The first section of paving and street railway construction was completed in 1914 by the National Paving Company of Winnipeg, the balance was completed in 1915 and 1916 by the Crown Paving Company of Calgary and Edmonton. The concrete walks constructed on the three sections were built by Messrs. Swanson & Kaline. In carrying out this work, the contractors did their best to make this street one of the finest in the city.

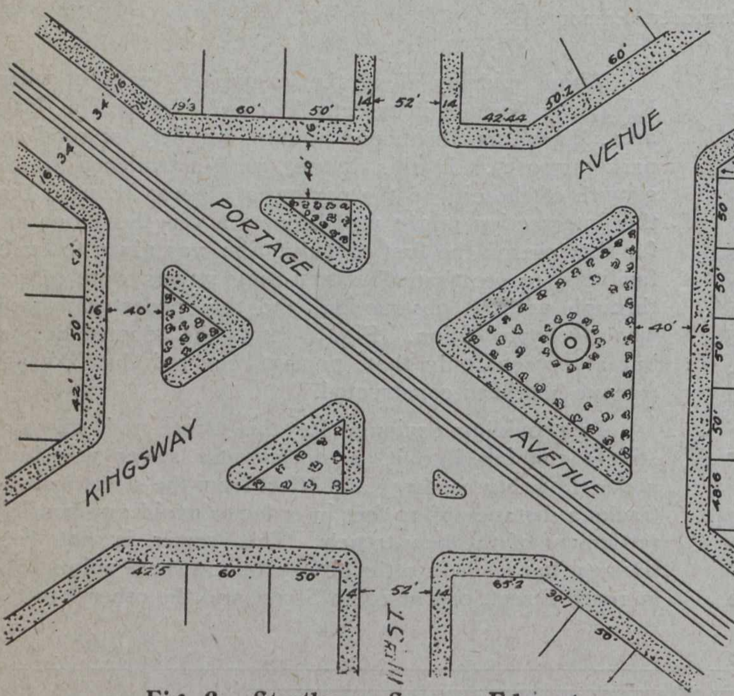


Fig. 2.—Strathcona Square, Edmonton.

In taking out the excavation for the roadway and sidewalks, over 32,000 cubic yards were removed. All of the sidewalk excavation and the roadway excavation of the first section was moved with dump wagons, but the rough grade of the last-two-thirds of the street was moved with wheel scrapers. In crossing the slough, and especially along the edges, a great deal of muskeg ground was found. In such cases all mouldy materials was taken out down to the clay, and the grade allowed to stand until well dried out before refilling. When grading the roadway across the sloughs two years before, corduroy had been laid down before placing the fill. Although the corduroy material was still in condition and one might be inclined to leave it in place under a three-foot fill, yet it was thought advisable to remove all such material and refill.

Fills were made by dumping material in layers of 8 to 10 inches before rolling, but it was often found that after the wheelers had travelled over a lift for some time, that the ten-ton power roller had little or no effect.

The curb and gutter constructed on this street is the combined type, built continuous throughout the block, with thin plate joints every 8 feet and with regular ¾-inch expansion joints each 50 feet. The body of the curb and gutter is made up of concrete mixed in the proportion of 1 part cement, 2 parts sand and 4 parts crushed rock or washed gravel, with limiting size of one inch. The mortar surface is made up in the proportion of 1 part cement to 2 parts sand. On construction done during 1916 a 6-inch gravel cushion was placed under the curb and gutter section to act as a drain, the lower end of each block being joined up to the catch-basin. We have watched these connections during and after a heavy rain and by the large amount of water reaching the silt-well, it is evident this gravel drain has justified its construction.

Concrete walks were constructed on each side of the street. The excavation was taken out and after the subgrade had been rolled with a light power roller, it was covered with 4 inches of gravel to form a cushion. Most of the subsoil in this city is of a heavy clay formation which cracks badly during cold weather and it was to insulate the concrete walk slab from the clay foundation that the practice of laying a gravel cushion was adopted. The concrete slab is made up of a base 4 inches thick and followed immediately with a mortar surface one inch thick. The concrete in the base is mixed in the proportion of 1 part cement to 2½ parts sand and 5 parts clean gravel or crushed rock. The surface is given a rough brush finish.

Expansion is provided by placing ¾-inch joints across the walk every 50 feet, with a ¾-inch joint along the edge of the walk at the back of the curb. The joints are partly filled with sawdust, the top being sealed with a light grade asphalt.

In constructing the roadway the subgrade was prepared in the usual way, and then covered with a concrete base six inches thick. In mixing this concrete base only washed gravel or crushed rock was used, and mixed in the proportion of 1 part cement to 3 parts sand to 6 parts stone. This material was mixed in a batch mixer, and hauled to the street in horse carts, as shown in Fig. 4. The surface was then struck with a tem-

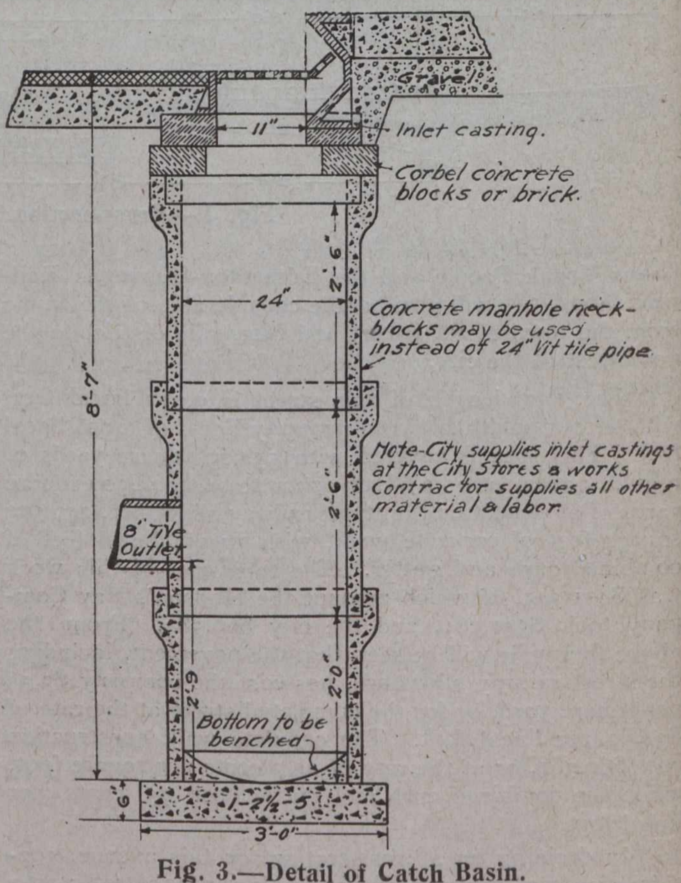


Fig. 3.—Detail of Catch Basin.

plate resting on the gutter at one end and on a grade board at the other end. The surface of the base was left rather smooth. After the base had set sufficiently to safely carry the roller, a 2-inch asphaltic concrete surface was laid. On the first section, between 101st Street and 106th Street, the mineral aggregate has a rather coarse grading, while the mineral aggregate of the remaining two sections laid by the Crown Paving Company is a fine grade mixture.

In checking the quality of material used on the work, samples of cement were tested from each car and the

Fig. 4.—Concrete Being Hauled to Job in Carts.

material held pending the seven-day test. In addition to cement tests and a general inspection of all materials used, a rather extensive series of tests were carried out on cylinders of concrete taken from the work each day. After allowing to set up in water for a period of 28 days, the samples were taken to the University of Alberta for testing. It must be admitted that the results were not satisfactory. The difference in temperature from spring through summer to fall, together with what one might call the personal equation of the inspector taking the samples in the cylinders, all combined to make the results so erratic as to be of little value except as a rough check. It might be that if one man took all the samples, and cured them in a constant temperature, the results would be more uniform.

In constructing the double track in the street railway allowance, our standard section for 12-foot centres was used. After the subgrade had been prepared a 6-inch concrete base, made up in the proportion of 1 part cement

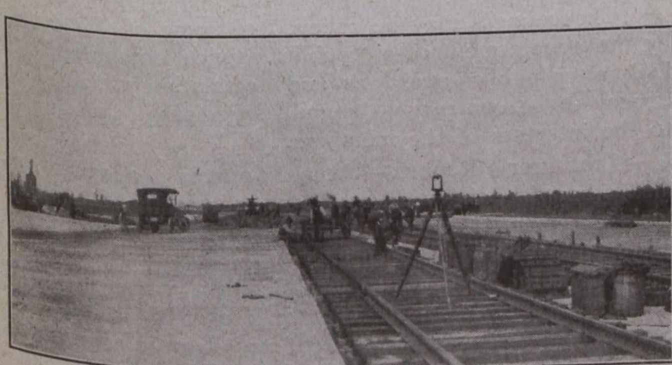


Fig. 5.—With Track to Grade, Filler is Poured up to Bottom of Proposed Pavement.

to 3 parts sand to 6 parts washed gravel or crushed rock, was laid. As soon as this base had sufficiently set the skeleton track was assembled, spiked and bonded. In bringing the track to grade and alignment, wooden shims were used, but care was taken to keep them well out at the ends of the ties in order that the mortar from the filler would work under the ties and form a good bearing directly beneath the rail. With the track to grade, as partly shown in Fig. 5, the filler is poured up to the bottom of the proposed pavement. Fig. 6 shows the method of pouring filler on two tracks at once.

The rails used in the track work were 5-inch 80 lbs. A.S.C.E. section, and in making joints at the rail lengths, continuous joint plates were used. Care was taken to see that a tie was placed under each end of the joint. On a part of this year's work we ran out of continuous joints, and in looking for a substitute we adopted a 34-inch angle splice bar with six holes. Under this joint we placed three ties, one at each end with one directly under the joint. On top of the ties at each joint and for three ties on each side were placed ¼-inch tie plates. We have found the joints to be a weak point in track construction, and for that reason are paying special attention to them.

In paving between the gauge lines, two methods were used. On the first section, between 101st Street and 106th Street, grooved sand stone block sets were laid along the rail and the space between laid with a two-inch asphaltic concrete surfacing. On the remaining two sections a rich concrete slab of 1 : 1 : 2 mixture and four inches thick was laid between the gauge lines. On the outside of each rail a double row of treated wood blocks was laid, the space under the ball filled with a treated wood filler strip. In setting the wood blocks a mortar bed was first laid on top of the concrete filler, and after allowing sufficient time to

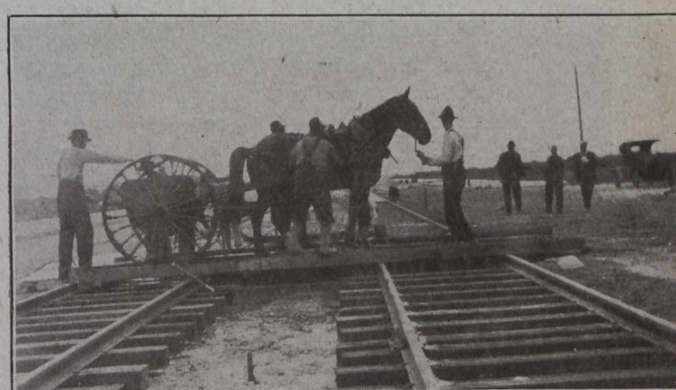


Fig. 6.—Shows Method of Pouring Fill on Two Tracks at Once.

set, was painted with a ¼-inch coat of hot asphalt and followed immediately with the wood blocks. The same result may be obtained by dipping each block in a pail of hot asphalt before laying on the mortar bed. On the last section of the work the inside of the rail was painted with an asphaltic paint before the concrete slab was poured, the idea being to prevent the concrete from bonding to the rail. It is recognized that a rail laid on wooden ties will move up and down, as it should do to give a certain amount of resilience to the track, and in order to provide for this movement without affecting the adjoining pavement, the asphaltic joint on the inside, with the wood blocks on the outside, were introduced.

This work was started under City Engineer A. J. Latornell, now captain in the 75th Battery, with Mr. A. W. Haddow in direct charge, and completed by Mr. A. W. Haddow, now acting city engineer.

Large contracts for lumber, aggregating 16,500,000 feet, exclusive of an open order for all the clear spruce available, have been placed by the Imperial Government with British Columbia mills.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

(Continued from page 48.)

Sewage Disposal and Sanitation (A. Surveyer, chairman), Steel Bridge Specifications (P. B. Motley, chairman), Conservation (James White, chairman), Electro-Technical Commission (L. A. Herdt, chairman), Reinforced Concrete (W. J. Francis, chairman), General Clauses for Specifications (H. Holgate, chairman), Roads and Pavements (W. A. McLean, chairman), and Steam Boiler Specifications (L. M. Arkley, chairman).

The awards of the Gzowski medal and of prizes for the best students' papers will be announced during the annual meeting. As no papers have been presented on mining or metallurgical subjects during the year, there will be no award of medals in these subjects.

A provincial division has been duly constituted under the provisions of By-law No. 56 in the district of Alberta, thus establishing the second provincial division within the society.

The membership of the branches at the date of the last annual meeting was as follows:—

	Corporate.	Non-Corporate.	Total.
Quebec	73	26	99
Ottawa	166	56	222
*Kingston	14	13	27
Toronto	134	83	217
Manitoba	107	37	144
Calgary	43	9	52
*Vancouver	112	20	132
Victoria	54	10	64
Edmonton	33	9	42
Regina	21	2	23
	757	265	1,022

*As reported for 1915.

Under the provisions of an act of the Quebec Legislature, members residing within the province have been exempted from service as jurors.

A very considerable amount of time was occupied during the year in council meetings and by specially appointed committees in connection with the question of the employment of alien engineers by the government. A general statement as to the position of this matter was recently communicated to the membership. It is still under advisement, and such further progress as may be made will be reported from time to time.

A circular letter has been addressed to branches, pointing out that the interests of the profession in Canada will be served by giving attention to engineering matters of importance in the locality of the branch. The Calgary branch rendered a very important service to the city in the early portion of this year by reporting on the construction of a bridge over the Bow River, in regard to the stability of which there was contention. This report completely exonerated the city engineer from the aspersions cast upon him by an alderman, and the action of the branch met with the approval of the board of control and the citizens generally.

In Montreal the local members of the council, during the autumn of 1915, made representations to the city's board of control as to the advisability of going forward with the aqueduct power project. No action having been taken by the city authorities, a number of rate-paying engineers, acting independently of the society, made further representation, and on the invitation of the city authorities made an exhaustive study of the project and have presented a report which completely sustains the position taken by council of the society.

The Quebec bridge excursion, in which the membership was invited to participate, was attended by upwards of 160 members of the society and their friends.

In accordance with the instructions of the last annual meeting the council at an early date in 1916, took measures to constitute the committee on society affairs. Its election was completed on April 18th, and the committee named as its chairman Prof. H. E. T. Haultain on May 16th. A progress report of this committee has been prepared, of which the following is a summary:—

Committee on Society Affairs.—A progress report was issued on November 20th by the committee on society affairs, of which Prof. H. E. T. Haultain is chairman and E. W. Oliver secretary.

A number of recommendations made to the committee by various members were transmitted to the membership for the latter's consideration. The committee found diversity of opinion on several important points, and stated that some of the features of the situation called for further deliberation before final opinion could be expressed. Several sub-committees are still at work.

Among the recommendations submitted to the membership, it is interesting to note a proposed change of name from "Canadian Society of Civil Engineers" to "Canadian Institute of Civil Engineers" as suggested by Mr. Geo. Mountain at the last annual meeting. It is advised that the entire by-laws be redrafted. Systematic publicity in the public press is recommended, and also a systematic effort to have recognized university engineering professors identified with the society so as to secure the co-operation of the universities.

The nominating committee and councillors should be elected by districts, stated the progress committee, and efforts should be made to obtain annual grants from the provincial and Dominion governments.

It is proposed to create a new classification in membership, to be known as "retired members," for which the annual fee will be nominal, for those members over 65 years of age who have been corporate members of the society for over 20 years and who desire to be so classified.

The council may be relieved of some of its duties by the appointment of a "public service committee" to look after public questions and legislation which may appear to be contrary to sound engineering practice or to the interests of the members.

Treasurer's Report.—From a financial standpoint, as also otherwise, the year 1916 was successful, the auditor's statement showing a balance of $3,642, being excess of receipts over expenditure.

The total expenditure was $20,084, while the total receipts were $23,726. The bulk of the receipts, of course, was from fees collected, and it is interesting to note that $2,485 was collected on entrance fees, and especially that $6,512 was collected of fees in arrears—an accomplishment upon which the officials of the society are to be congratulated.

The assets total $113,998, which includes $10,775 cash on hand, $5,000 arrears of fees (estimated value), and $180 debentures. The society's property, house, furniture and books are valued at $97,804.

The only liabilities of any very considerable amount are accounts payable $5,409, rebates due to branches $1,659, and mortgage on property $20,000.

Library and House Committee.—Purchases during 1916 were not made in excess of money presented to the library. Only seven books were purchased, but ten were presented to the society by members and forty-three by non-members. Six additional exchanges were effected, making ninety-seven papers received regularly by the society. A special collection of literature bearing on the regulations relating to the employment of engineers by governments, states and cities is being compiled.

Committee on Steel Bridge Specifications.—This committee had twenty meetings during the year, which were attended by most of the Montreal members, the other members having participated by post.

A draft specification was prepared and sent out to the branches for discussion, and it is recommended that this discussion be continued during 1917. Views of all interested authorities are desired so as to have the specification take such form that it will be possible for provincial, municipal and other bodies to adopt it. In the meantime it is proposed that the committee continue its work, including the preparation of a specification for movable bridges, and the revision, where necessary, of the present railway bridge specification. It is suggested by the members of the committee that the committee should go out of office automatically every two years, and that its personnel be chosen as follows: One representative from each of the branches and four members residing at or near headquarters. This arrangement would have the effect of providing at all times a working committee, which would prepare details for discussion for the committee as a whole.

While movable bridges were not included in the preliminary drafts of the highway bridge specification, and were not included in the railway bridge specifications that have been issued, the committee gave consideration to this feature, feeling it to be necessary for complete specifications.

The committee suggests that a mechanical and electrical engineer, conversant with movable bridge practice, would be of great service in this connection, and suggested that the new committee be empowered to add to its number or to consult such experts as may be necessary to draft a complete specification.

International Electro-Technical Commission.—This committee reports that during the year 1916 the work of the commission, as in 1915, was more or less restricted, due, of course, to the war, which must of necessity materially affect all international bodies.

In June, however, the committee had the pleasure of a visit from Mr. C. Le Maistre, of London, England, the general secretary of the commission, the members meeting in Ottawa and discussing with Mr. Le Maistre various matters relating to the commission's present and future activities. At that meeting Mr. Le Maistre stated that while matters naturally could not go ahead in just the same way as formerly, still everything possible was being done by the central office and the various sub-committees to put things in shape so that material progress can be made shortly after conditions return to normal.

Nothing has, of course, been done during the past year towards the holding of any further congresses. Presumably the 1917 meeting, originally scheduled to be held in Petrograd, will be postponed.

Prof. L. W. Gill, the member of the Canadian committee who is at the front, continues to command a battery somewhere in France.

With the exception of Mr. W. A. Duff, of Winnipeg, who resigned during the year, the committee remains as before.

Conservation Committee.—The advance of conservation, of general industrial improvement, in Canada has been impelled and facilitated during the past year by the most powerful stimulus. Progress toward the better utilization of the resources of the Dominion has naturally attained greater momentum in the form of a national necessity than it could be expected to achieve as an inadequately realized desirability, awaiting the creation and support of effective public sentiment. The events of 1916, and especially of the past few weeks, have served to emphasize more forcibly than ever the relation of economic efficiency to national strength and safety.

As a result of recent action the future economic development of the Dominion will benefit by the aid and guidance of systematic industrial research. The appointment of the Industrial Research Commission by the Dominion government and the corporate enterprise of the Canadian Pacific Railway in promoting scientific research will enable Canadian industry to utilize the services of two highly organized institutions. In the same manner as the forest industries are now in receipt of the services of the Forest Products Laboratories at Montreal, every form of industry should be enabled to avail itself of expert assistance in the solution of its peculiar problems. To achieve the maximum results industrial research must be linked up with a thorough system of technical education.

Town planning progress merits special mention as a conservation movement. Aside from its bearing on public health, town planning seeks the economical use of public funds. During the opening decade of the century Canada invested approximately $600,000,000 on municipal growth, largely for civic improvements. Heavy additional expenditures have been made since 1910. The efficient investment of capital on such a large scale cannot be secured as long as municipal development continues in haphazard manner. Adequate legislation and administrative machinery must be provided to control and guide urban expansion. During the past year distinct progress has been made in this direction and it is hoped that every province in the Dominion will shortly possess proper provision for thorough control of housing and town planning.

In practically every branch of primary production and natural resources the war has created special conditions and conservation problems. In many instances the national waste due to failure to utilize our opportunities to the full extent has been greatly reduced. This applies particularly to water powers, the development of which is proceeding rapidly. Similarly, with regard to mining, renewed activity in both basic and subsdiary undertakings has taken place and thorough study of the status of our mineral industries has been undertaken.

It is gratifying to record the decision of the Ontario government to remodel its forest protective service along the most approved lines. The remarkable development of our pulp industry indicates the potential value of our forests and the wisdom of affording the most efficient protection obtainable. The work of determining the extent of our timber resources progresses steadily, surveys of British Columbia and Saskatchewan forests have been completed during the past year.

Committee on Roads and Pavements.—This committee has presented a full report of the year's work, together with proposed standard specifications for crushed stone, gravel, sand and asphaltic road oils. For abstract of the committee's report see page 64.

ARCHITECTURE AND THE GRAND STAND.

By C. V. Johnson, A.M.Can.Soc.C.E.

JUDGING from the examples of grand stands which have more or less recently made their appearance on this continent, particularly with reference to the fireproof structures, it would appear that the co-operation between architect and engineer is not all that it should be, and as far as this particular type of building is concerned the engineer has apparently had things pretty much his own way, with the result that the country has been presented with many structures designed principally with a view to space and public safety rather than aesthetic beauty. This is indeed unfortunate, as the grand stand is essentially an item of considerable importance in the general scheme of any exhibition ground or public place of amusement, and as such may be made to harmonize with the surrounding buildings without detracting from its usefulness and "factor of safety." It is perhaps a debatable question whether the grand stand belongs in the province of the engineer or the architect, but in any case it would appear that a greater "rapprochement" between the two would have a decidedly improving influence on the general result.

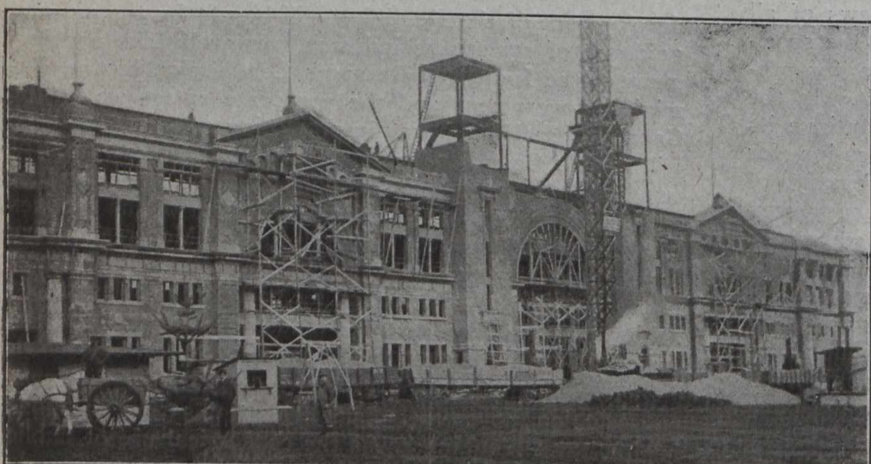


Fig. 1.—Facade.

The writer is unable to say whether the numerous concrete structures of this kind, which have been erected in nearly all parts of Canada and the United States, are due to engineers or architects, but judging from their fine air of stability and remarkable unanimity in lack of beauty, would incline to the opinion that the trained eye of the successful architect has had little or nothing to do with the design. This may appear flattering to the architect and the reverse to the engineer, but it will be apparent to the unprejudiced observer that, taking into consideration the different training of the two professions, it is not unnatural. There does not seem to be much room for doubt that the average engineer of to-day, when called upon to design a structure of a certain capacity and given load, human or otherwise, does not concern himself primarily with the superficial beauty of it. It is just on this point where many of us fail to realize our fallibility. In such a case it would appear to be the part of wisdom to turn the job over to a competent architect for a superficial plan, and then proceed to prepare the main supporting body in accordance with the best engineering practice. In following this course the engineer is not laying himself open to criticism, as an engineer is not supposed to be an artist, nor does his training as a rule include a course in architecture, however much it might be desirable. Experience has shown that an architect will, when he finds himself confronted with an engineering problem with the solution of which he is not familiar, call in an engineer to solve it for him. This is certainly not to his discredit; in fact rather the contrary, as although architecture and engineering are very closely allied, they are two distinct professions. This being the case, does it not seem natural that an engineer, when called upon to design a structure, should call in an architect to assist him with the finer points of appearance with which his own training has not familiarized him? In these days of steel and concrete, when the plasticity of the latter can be advantageously used to an unlimited extent, it is a great pity to see massive and extremely ugly structures, some of which have the general appearance of up-ended platforms, with windows stuck in them at regular intervals. Not the least of these monstrosities is the average modern fireproof grand stand, and it is time to wake up to the fact that they can, and should, be made with some idea of architectural effect—especially in view of the fact that such a course would entail little or no greater expense.

In this connection it is refreshing to note that a signal departure has been made from the pre-conceived ideas of grand stand design, in the erection of the building now under way for the Provincial Exhibition Commission of Quebec. This structure is unique in design and reflects great credit on the architect for the many fine points of superiority over previous designs for similar structures. It is unfortunate that the work is not as yet sufficiently advanced to illustrate the full beauty of the facade but nevertheless the accompanying illustration (Fig. 1) will give a fair idea of what it will be when completed.

The structure is primarily Doric in design, although radical departures have been made by the architect in his details, these reflecting an originality for which he is justly noted. The facade itself with its columns and arches is one which, while originating in part with the early Dorian idea of column supports, is nevertheless somewhat cosmopolitan, while retaining a symmetry of effect very pleasing and unstilted to the eye.

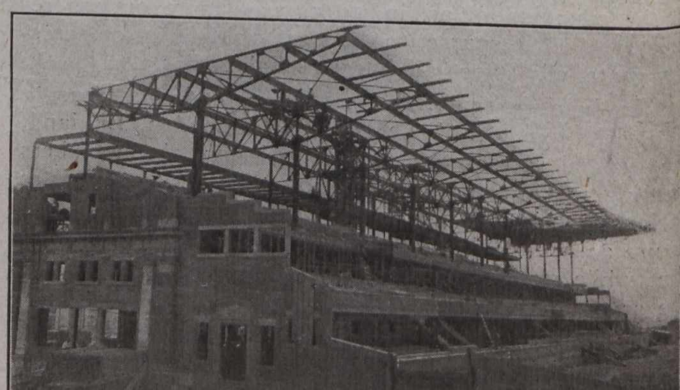


Fig. 2.—Front View, Illustrating Galleries.

Another notable departure conceived and carried out is the series of galleries for the accommodation of the public (Fig. 2). These galleries consist of three tiers, one above the other, constructed on the cantilever plan, thus obtaining the maximum of seating capacity and shelter, under a minimum of roof cover. This system is unique in Canada and the United States, although there is one such in France but having only two tiers of galleries.

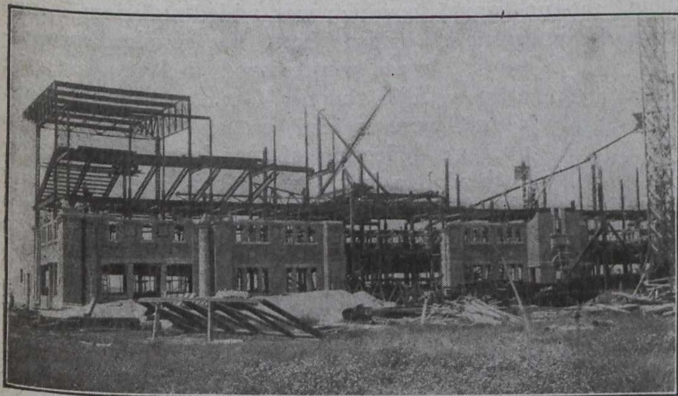


Fig. 3.—Seven Weeks Prior to Exhibition Time.

The structure, which is 365 feet long over all, has a seating capacity of 6,340 persons, and a standing room accommodation for probably 1,000 additional. In addition to this the interior, which is very spacious and contains three stories, will consist of offices for the various departments, a theatre, restaurants, kitchens, galleries, promenades, etc.

The building is of fireproof construction throughout, resting on concrete foundations, with steel-framed superstructure, brick exterior walls, and terra-cotta interior partitions finished in plaster. The ornamental work, such as columns, cornices, lintels, sills, etc., is principally artificial stone, or, in other words, fine concrete, although in the upper story some of the smaller columns, railings, etc., are of ornamental iron construction. The interior floors are of concrete throughout, the upper ones being reinforced with rib metal, and the whole with a cement top finish. The outside galleries are also of concrete, laid on corrugated metal, which is arched between supporting beams of steel. The stairs leading to the galleries and those of the interior, are of unit concrete construction, each step having been moulded separately and laid in cement mortar on steel channel stringers.

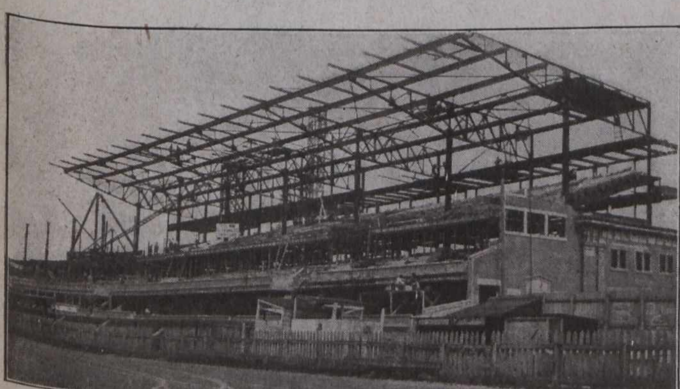


Fig. 4.—One Month Prior to Exhibition Time.

The whole building, which will be completed for the coming Exhibition in August, is one of which the city of Quebec may be justly proud; and the architect, Mr. G. Emile Tanguay, senior member of the firm of Tanguay & Lebon, deserves great praise for conceiving and carrying out a scheme which bids fair to revolutionize the design of such structures on this continent.

The general contract for this work was awarded to, and carried out by, the firm of Joseph Gosselin, of Quebec and Levis, and the sub-trades were supplied and erected by the following Quebec firms: Ornamental ironwork, L. H. Gaudry & Co., Limited; plumbing, Fortunat Gingras; wiring and lighting, Goulet and Belanger; roofing and sheet metal work, Eugene Falardeau; and structural steel, the Eastern Canada Steel & Iron Works.

The concrete work was almost entirely placed by means of the Insley spouting method, which was found to be very efficacious in the various stages of the work.

For the accompanying illustrations the writer is indebted to Mr. G. H. Lovett, inspector for the Exhibition Commission, and Mr. H. E. Balfour, assistant engineer for the general contractor. The photograph illustrated in Fig. 3 was taken July 8th, and Fig. 4 July 28th, from which it is interesting to note the progress of construction, and the fact that all three tiers of seats were completed and ready for the accommodation of the public on the 20th of the following month, together with the walls, stairs, etc.

ANNUAL MEETING OF CANADIAN MINING INSTITUTE.

The annual meeting of the Canadian Mining Institute is to be held in Montreal March 7th, 8th and 9th next.

Among the papers either definitely or tentatively promised are the following: "Industrial Preparedness," by Mr. Arthur D. Little; "A Plea for the Union of Capital and Labor," by Hon. Col. David Carnegie; "The Future of the Coal Trade of the Empire," by Mr. Allan Greenwell; "Zinc Electrolysis," by Mr. E. P. Mathewson; "Flotation Processes in the Treatment of Tailings in the Cobalt District," by Mr. John M. Callow; "Sodium Sulphide Precipitation of Silver at the Nipissing Mine, Cobalt," by Mr. R. B. Watson; "Mining and Metallurgical Practice in the Porcupine District," by Mr. A. R. Globe; "Metallurgical Practice at the McIntyre Mine, Porcupine," by Mr. A. Dorfman; "Countercurrent Decantation," by Mr. L. B. Eames; "The Concentration of Molybdenite," by Mr. H. H. Claudet; "The Utilization of Canadian Molybdenite," by Mr. J. W. Evans; "Methods of Mining at the Magpie Iron Mine," by Mr. A. Hassellring; and "Notes on Potash," by Mr. C. W. Drury.

During the first half of 1916 the output of the French coal mines totalled 10,600,000 tons, as against 9,700,000 tons during the first half of the previous year.

The national forests of the United States yielded the Republic a revenue of $2,481,469 in 1915, as compared with $2,437,710 in 1914, $2,467,590 in 1913, $2,157,356 in 1912, $2,026,906 in 1911, and $2,090,148 in 1910.

Whilst copper extraction in Greenland has been left in abeyance, not for want of ore, but on account of the high freights and high prices for fuel, the graphite production is increasing and the work being extended. The deposits are large and the percentage of graphite greater than in most other deposits outside Ceylon. American machinery has been installed and the manufacture of crucibles will be taken up in earnest.

ROAD CONSTRUCTION AT CAMP BORDEN.

By R. T. Bell.

THERE has been laid to date at Camp Borden approximately eight miles of concrete and asphalt macadam roadway. Hughes Avenue, the main thoroughfare, is built of concrete, and extends from the ordnance buildings at the north end of the camp to the Y.M.C.A. building, with side roads to Logie Avenue and the hospital. This road is 22 feet wide; 18 feet of concrete and a 2-foot shoulder of crushed stone on either side. A crown of 2 inches was allowed on this roadway, the concrete at the centre being 8 inches deep. Logie Avenue is of asphalt macadam as is also the loop to the station. This road is 20 feet wide and was built in two courses, the base being 4 inches of 2-inch crushed limestone and the top dressing 2 inches of ½-inch limestone with an asphalt binder.

Section of Concrete Road Completed.

The conditions to which the concrete roads were subjected is unique in the history of concrete road construction. They were thrown open to traffic but three days after being laid and up to the time of writing this article not a crack had appeared. Only in one place did a failure occur; this at the junction of two sections and was due to carelessness in mixing, the proper amount of cement having been omitted in a couple of batches, during the night shift.

The concrete gangs were run night and day as the existing sand roads were rapidly becoming impassable owing to the enormous amount of traffic, and it was an urgent necessity to complete these to assist transportation and to allay the dust nuisance, the old roads being a foot deep in dust. As much as one thousand feet of road was laid in the two shifts. A one-half yard Austin cube mixer was used with caterpillar traction, the materials being delivered to the mixer by teams on a planked subgrade. A 1:1½:3 mix was used, the material used being pit-run gravel to which was added sufficient 2-inch crushed limestone to bring this to the required proportions. Joints were placed 30 feet apart, the joint material being ¾-in. by 8-in. asphalt. These were placed on an angle with an average deflection of two feet, thus making each slab a keystone. This prevented any abrupt jar being felt at the joint, as no two wheels of any vehicle would be crossing at one time. It also gave the slab a chance of lateral movement in event of heaving or settlement of the sub-grade, which it would not have were the joints at right angles to the road. This style of joint is used in the state of New Jersey and has proved very satisfactory.

In grading the road, great care had to be taken to set the grades to eliminate fills as much as possible, as no time could be allowed for settlement. In any case where a fill did occur it was thoroughly wetted down as made. The grading was done with a Keystone traction digger, the skimmer scoop being used. The daily average was 500 feet.

The material encountered was sand and in no case did quicksand or clay occur. The drainage was excellent and there is little fear of raised slabs through heaving on account of a wet subgrade.

The excavating shovel was followed by a gang of from six to ten men fine grading, the subgrade being planked directly behind them. This plank was teamed ahead as the mixer advanced.

The mixing gang varied considerably on account of the difficulty of getting labor, the intense heat making it almost impossible to hold men.

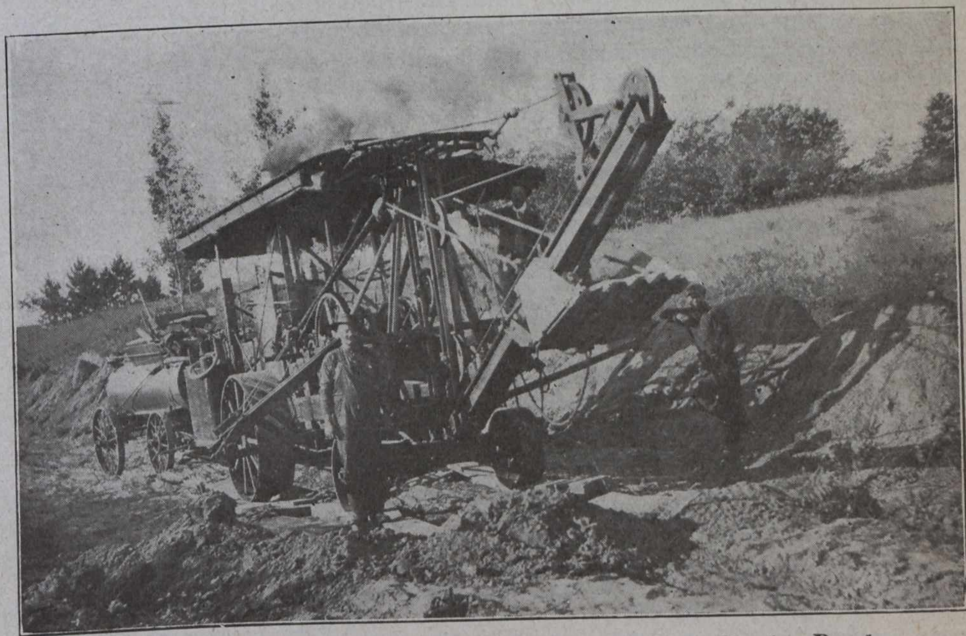
Concrete Mixer.

Owing to the shortage of water on account of the immense consumption during the hot spell it was impossible to keep the concrete wetted down and the seasoning was only of a very perfunctory kind.

A census was taken of the traffic on Hughes Avenue which showed an average of 108 vehicles per hour, this traffic being of a very heavy kind, such as motor trucks, commissariat wagons, etc.

After the road had been in use for about a month all joints were gone over with a wire brush and wherever needed filled with asphalt.

Knowing how this road has stood after being subjected to most trying conditions, the writer begins to have some doubt as to the advisability or necessity of the various costly and slow processes which are sometimes used in the construction of cement roads. Theoretically this road should have gone to pieces long ago, but it shows no sign of doing so as yet.



Keystone Tractor Shovel Used for Grading All Camp Borden Roads.

MANITOBA BRANCH.

The Manitoba Branch of the Canadian Society of Civil Engineers held a regular meeting on January 4th. Prof. E. Brydone-Jack delivered an address on "The Relation of the Society to Scientific and Industrial Research." He referred to the absolute need for organized effort in research and investigation, emphasized by the war. He gave the history and details of organization of the British Committee on Scientific and Industrial Research, followed by that of the Canadian committee, which is being formed along lines similar to the British committee, and also of the committee appointed by the university faculty, all indicating the development of public sentiment along this line.

The British committee consists of a committee of the Privy Council, an advisory council of experts, and standing committees on engineering, metallurgy and mining.

The paper was followed by a lively discussion, after which the meeting went into business session and adopted the following resolutions:—

That the Manitoba Branch, Canadian Society of Civil Engineers, is heartily in accord with the idea of establishing research laboratories at the various industrial centres throughout Canada and would urge for favorable consideration, by those in charge, the establishment in Winnipeg of an experimental station for physical and chemical research relating to western industrial and civic problems.

That the Branch urge upon the Society in annual meeting assembled, consideration of the question of recommending to the Canadian Scientific and Industrial Research Committee the appointment of a standing committee on engineering and the nomination of certain members on such standing committee not exclusive of western representation.

That the chairman appoint a committee to make a special local study to forward the purposes of the Canadian Scientific and Industrial Research Committee.

Unloading Aggregates with a Byers Hoist at Camp Borden.

According to the railways statement made to parliament by the minister of railways, there were on March 31, 1916, 2,970 miles of railway in New Zealand, compared with 2,955 miles on March 31, 1915, an increase of fifteen miles.

STANDARD SPECIFICATIONS FOR ROAD MATERIALS

COMMITTEE OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS SUBMITS DRAFT OF PROPOSED SPECIFICATIONS FOR CRUSHED STONE, SAND, GRAVEL AND ASPHALTIC ROAD OILS—ABSTRACT OF THE COMMITTEE'S REPORT.

During the year 1916 a committee of the Canadian Society of Civil Engineers has been at work collecting data concerning the construction of various types of roads and streets, and formulating tentative standard specifications to guide the engineer in the purchase of road materials.

The members of the committee were W. A. McLean (chairman), W. P. Brereton, F. W. Doane, Jules Duchastel, J. E. Griffith, G. Henry, Edgar James, A. F. Macallum, A. J. McPherson, Paul Mercier, W. P. Near, George Powell and C. H. Rust.

Following is an abstract of the report prepared by this committee for the forthcoming annual meeting of the Society:—

The report of this committee for 1915 stated that printed forms would be sent to the municipal engineers throughout the Dominion with a view to securing data concerning the construction of pavements of various types. From year to year separate forms were to be sent on which data concerning the service rendered by these pavements would be itemized.

On further consideration it was decided to revise both forms and while the changes in the forms for recording data concerning construction were of a minor nature, consisting for the most part in a change in arrangement of items, that for recording data concerning the history of pavements was entirely revised. In place of the general information indicated on the original form the information has been itemized in detail. This will insure greater uniformity in the manner in which the information is received as well as facilitating the filling out of the forms by the engineers who are co-operating with the committee.

During the early part of the summer six copies of the form entitled "Data Concerning the Construction of Pavement" were sent to engineers in each of forty-three cities and towns in the Dominion as well as to members of the committee. A number of these have not been returned owing to changes of address of the engineers, the lack of detailed data or the absence of permanent street improvement in a number of municipalities. Hearty co-operation, which has been appreciated by the committee, has been received from a number of engineers, and much valuable information has been collected. Further co-operation is desired by the committee during the coming year.

The forms were sent out during the construction season and while a number of engineers expressed their willingness to furnish the information desired, they found it impossible to devote the time to the collection of it on account of the pressure of work. It is the intention of the committee that copies of both forms be in the hands of engineers shortly after the beginning of the new year, as at this period of the year more time is available for attention to office duties and the records of the previous season's work are still accessible. The list of the municipalities from which reports have been received, with the general location of the streets reported on and the type of pavement laid, is as follows:—

LIST OF PAVEMENTS REPORTED

Municipality.	Street or Road.	Pavement laid.
Montreal S., Que.	Rainville Bvd.	Concrete.
" " "	Desaulniers Bvd.	Asphaltic Concrete on 5″ Concrete.
St. Lambert, Que.	Victoria Ave.	Bitulithic on 5″ Concrete.
" "	Desaulniers Bvd.	Bitulithic on 5″ Concrete.
Westmount, Que.	Upper Belmont	Sheet Asphalt on 6″ Concrete.
" "	Wood St.	Sheet Asphalt on 6″ Concrete.
Quebec Province	King Edward H'way	Bituminous Macadam.
" "	Sherbrooke to Derby line	Tar Macadam.
Quebec City	DeSalaberry	Granite Block on 6″ Concrete.
" "	Salaberry St.	Asphaltic Concrete on 6″ Concrete.
" "	St. Louis	Sheet Asphalt on 6″ Concrete.
" "	Hermure	Asphaltic Concrete on 6″ Concrete.
" "	Hamel	Asphaltic Concrete on 6″ Concrete.
Stratford, Ont.	Wellington	Tar Filled Macadam on 5″ Concrete.
" "	William	Tar Filled Macadam on 5″ Concrete.
York County, Ont.	Vaughan Rd.	Tar Macadam.
" " "	Yonge St.	Waterbound Macadam.
North Bay, Ont.	McIntyre	Waterbound Macadam.
Welland, Ont.	N. Main	Wood Block on 5″ Concrete.
" "	Cross	Brick on 5″ Concrete.
" "	Hellems Ave.	Brick on 5″ Concrete.
" "	Division	Brick on 5″ Concrete.
" "	S. Main	Brick on 6″ Concrete.
" "	Catherine St.	Brick on 6″ Concrete.
" "	W. Main	Brick on 6″ Concrete.
" "	E. Main (2 sections)	Brick on 6″ Concrete.
Victoria, B.C.	Cormorant	Sheet Asphalt on 6″ Concrete.
" "	Richmond Ave.	Sheet Asphalt on 5″ Concrete.
" "	Cormorant	Sheet Asphalt on 6″ Concrete.
" "	Richmond Ave.	Sheet Asphalt on 5″ Concrete.
Oshawa, Ont.	Richmond	Concrete.
" "	Simcoe	Concrete.
Toronto, Ont.	Grace Terrace	Bitulithic on 5″ Concrete.
" "	St. John's Rd.	Bitulithic on 5″ Concrete.
" "	Keele St.	Bitulithic on 5″ Concrete.
" "	Quebec Ave.	Sheet Asphalt on 5″ Concrete.
" "	Keele St.	Sheet Asphalt on 5″ Concrete.
" "	Earl St.	Sheet Asphalt on 5″ Concrete.

Municipality.	Street or Road.	Pavement laid.
Toronto, Ont.	Alberta Ave.	Sheet Asphalt on 5″ Concrete.
" "	Main St.	Sheet Asphalt on 6″ Concrete.
" "	Wellington St. W.	Sheet Asphalt on 6″ Concrete.
" "	Christie St.	Sheet Asphalt on 8″ Concrete.
" "	Alexandra Bvd.	Concrete, 6″ thick.
" "	Glencairn Ave.	Concrete, 6″ thick.
" "	Lytton Bvd.	Concrete, 6″ thick.
" "	Bracondale Hill Rd.	Brick on 5″ Concrete.
" "	Bain Ave.	Brick on 5″ Concrete.
" "	Scarborough Rd.	Brick (hillside) on 5″ Concrete.
" "	Wells St.	Asphaltic Concrete on old Macadam foundation.
Kingston, Ont.	Aberdeen St.	Bituminous Concrete on 4″ Concrete.
" "	William St. (3)	Bituminous Concrete on 4″ Concrete.
London, Ont.	Ridout St. (2)	Asphaltic Concrete on 6″ Concrete.
" "	York St.	Asphaltic Concrete on 6″ Concrete.
" "	Bradford St.	Concrete.

Specifications for Materials.—The formulating of specifications for natural products, such as crushed stone, gravel, and sand, which can be directly used in all localities, is impossible. In many localities the greater portion of the cost of these materials is that paid for transportation. Hence material of high quality which can be procured within short distance of the work in one locality would reach a prohibitive cost in another.

The committee has therefore endeavored to draw up specifications which cover materials of good quality under normal commercial and natural conditions. It is recognized that in some districts these specifications as they stand will not be applicable, but the ideal striven for has been to secure a specification that may be a guide, from which specifications best suited to local conditions can be drafted.

The classifying of materials into different grades according to qualities reduces the necessity of redrafting the specifications. In localities where materials of certain grades cannot be secured economically and the nature of the work permits the use of material of inferior qualities, it will only be necessary to specify the particular grade required, when the specifications for work are drafted.

The extensive use of laboratory tests results may be considered inadvisable by some engineers. At the present time laboratories are not available in all municipalities, but resort to laboratory tests is rapidly growing and even at the present time tests are being conducted by some of the universities in the Dominion. It is felt that it is only a matter of time till every large municipality will submit all materials to laboratory test prior to accepting them.

The properties assigned to the different grades have been selected from the study of results of tests made under the direction of the chairman of the committee as well as from the study of the results of tests conducted by various highway organizations.

In reading the specifications it must be borne in mind that they are for the supply of materials only. The classes of work in which the materials are to be used, unless such materials are confined only to such classes, have not been stated. The specifications for the construction of various types of pavements will state definitely the class, size, etc., of the materials which are to enter into the construction of the particular pavements.

Drafts of the specifications as considered by the members of the committee residing in Toronto were sent to all members. Where suggestions regarding changes in minor points were made these have been incorporated, but where changes of importance have been suggested these are indicated at the end of each specification in order that they may receive the consideration of the society.

The committee reports progress in the drafting of specifications for the supply of bituminous materials. The rapidly increasing use of these materials for the protection of road surfaces renders it advisable that a reliable specification be in the hands of engineers at the earliest moment.

Work was commenced on three grades of asphaltic road oils, but at the same time it was realized that there were a number of other grades of this material as well as refined tars, etc., favored by engineers. The specifications which follow for bituminous materials have not been placed before all the members of the committee and are therefore to be considered as a progress report only.

It is the intention of the committee that a series of general clauses be drawn up which will take into consideration suggested form of tenders, suggested system of payments and methods of inspection of materials. Following are the proposed tentative specifications:—

CRUSHED STONE.

Definition.—1-1.—Crushed stone shall be bedded rock or boulders which have been broken by mechanical means into fragments of varying shapes and sizes. It shall not contain more than 10 per cent. by weight of soft or friable material. Material of which the particles are coated with dirt or have the edges worn off will not be accepted.

Weathered Stone.—1-2.—No crushed stone shall be accepted which shows signs of being disintegrated or reduced in quality by the action of the weather.

Crusher Run.—1-3.—Crusher run shall be the product of the crusher, of which not more than 8 (eight) per cent. by weight shall pass a ¼ (one-quarter) inch opening.

Sizes of Stone.—1-4.—The following schedule of sizes shall be used, with the percentages of material larger than the maximum and smaller than the minimum openings respectively, as shown. The sizes of opening shall mean the diameter of circular openings in steel or iron plates. The percentages shall be determined by weight.

The sizes of stone with the openings by which they are obtained are as follows:—

Name of size	Maximum size of opening in inches	Maximum per cent. retained by max. size of opening	Minimum size of opening in inches	Max. per cent. passing minimum size of opening
5 inch	5	3	4	8
4 "	4	3	3	8
3 "	3	3	2½	8
2½ "	2½	5	2	10
2 "	2	5	1½	10
1½ "	1½	5	1	15
1 "	1	5	½	15
½ "	½	7	¼	15

Screenings.—Screenings shall be material all of which shall pass a ¼ (one-quarter) inch screen.

Mineral Dust.—Mineral dust shall be finely pulverized stone of which not less than 80 (eighty) per cent. by weight shall pass a 200 mesh screen.

Tests on Stone.—1-5.—In addition to fulfilling the foregoing requirements, crushed stone shall be classed into three grades, according to qualities which shall be determined by tests conducted in a properly equipped laboratory. The properties determined shall be: coefficient of wear, toughness and absorption. Material meeting the requirements of any of the grades with respect to coefficient of wear and toughness but failing to meet the requirement with respect to absorption may, on consideration of the engineer, be classed with the higher grade.

Grades of Crushed Stone.—Crushed stone shall be classed under one of the following grades:—

1-6.—Grade "A" is a rock which has a toughness of not less than 18 (eighteen), a coefficient of wear of not less than 14 (fourteen), and an absorption of not more than 0.6 (six-tenths) pounds per cubic foot.

1-7.—Grade "B" is a rock which has a toughness of not less than 10 (ten), a coefficient of wear of not less than 7 (seven), and an absorption of not more than 1.0 (one) pound per cubic foot.

1-8.—Grade "C" is a rock which has a toughness of not less than 7 (seven), a coefficient of wear of not less than 5 (five) and an absorption of not more than 1.5 (one and five-tenths) pounds per cubic foot.

1-9.—Grade "D" is a rock that does not meet the requirements of any of the above grades and which may be used only on consideration by the engineer.

GRAVEL.

Definition.—2-1.—Gravel shall consist of naturally formed fragments of tough durable rock, well graded in size from the smallest to the largest, free from flat, elongated particles, and shall not contain more than 15 per cent. by weight of soft friable material. It shall not contain an excess of clay nor an excess of loose or adhering dust, vegetable loam or other deleterious matter. It shall be satisfactory to the engineer in all respects.

Screened Gravel.—2-2.—"Screened gravel" is gravel fulfilling the above requirements which is screened into one or more of the sizes defined in Section 1-4 of the "Specifications for Crushed Stone."

2-3.—"Run of bank gravel" is gravel fulfilling the requirements of Section 2-1 of this specification, which shall be classed under one of the three grades shown below according to qualities determined in a properly equipped laboratory. The properties determined shall be the coefficient of wear and the proportions of the various sizes of particles present.

The coefficient of wear shall be determined on material passing a screen having circular openings 2 (two) inches in diameter and retained by a screen having circular opening ½ (half) inch in diameter. The test shall be conducted in the same manner as that for determining the coefficient of wear of crushed stone. Run of bank gravel shall be classed according to the following grades:—

2-4.—Grade "A" is a run of bank gravel containing a large percentage of pebbles of igneous rocks. It shall not contain more than 5 (five) per cent. by weight of material which shall be retained on a screen having 4 (four) inch circular openings, and not more than 45 (forty-five) per cent. by weight of material which shall pass a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 3 (three) per cent. by weight of clay or loam nor have a coefficient of wear of less than 14 (fourteen).

2-5.—Grade "B" is a run of bank gravel containing a smaller percentage of igneous rock pebbles. It shall not contain more than 5 (five) per cent. by weight of material which is retained by a screen having 4 (four) inch circular openings nor more than 60 (sixty) per cent. by weight of material retained by a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 9 (nine) per cent. by weight of clay or loam nor have a coefficient of wear of less than 11 (eleven).

2-6.—Grade "C" is a run of bank gravel composed chiefly of pebbles of sedimentary rock. It shall not contain more than 5 (five) per cent. by weight of material which is retained on a screen having 4 (four) inch circular openings, and not more than 80 (eighty) per cent. by weight of material which passes a screen having ¼ (one-quarter) inch square openings. It shall not contain more than 12 per cent. by weight of clay or loam nor have a coefficient of wear of less than 7 (seven).

2-7.—Grade "D" is a run of bank gravel which does not meet the requirements of any of the above grades and which may be used only by written permission of the engineer.

2-8.—When so directed by the engineer, gravel shall be crushed. The material so produced shall conform to the requirements of "screened gravel" or "Run of bank gravel" as directed by the engineer.

SAND.

Concrete Sand.—3-1.—Fine aggregate for concrete shall consist of natural sand, composed of hard, tough, durable particles, graded from fine to coarse. When dry, not more than 5 (five) per cent. shall be retained on a sieve having 4 (four) meshes per lineal inch; not more than 20 (twenty) per cent. by weight shall pass a sieve having 50 (fifty) meshes per lineal inch, and not more than 4 (four) per cent. shall pass a sieve having 100 (one hundred) meshes per lineal inch. It shall not contain more than 3 (three) per cent. by weight of clay or loam.

Mortar Tests.—3-2.—Sand in addition to meeting the above requirements shall give a mortar strength equal to or higher than the minimum value at any of the ages shown in the following table:—

Age at test.	Minimum strength of 1 : 3 mortar.
72 hours	1.25 times A
7 days	1.10 times A
28 days	1.00 times A

Where "A" is the strength of 1 : 3 standard Ottawa sand mortar specimens of same form and size made by the same operator using the same cement and the same amount of water.

The tests shall be made on mortars composed of 1 (one) part Portland cement and 3 (three) parts of fine aggregate or standard Ottawa sand, by weight. The test specimens shall be made, stored and tested in the same manner, under approved laboratory conditions and according to recognized standards of practice. Each value shall be the average from tests of no fewer than 3 (three) specimens.

Cement.—3-3.—The cement used in all tests shall meet the requirements of the specifications for Portland cement of the Canadian Society of Civil Engineers, as revised in 1916.

Stone Screenings.—3-4.—Stone screenings from a hard, tough, durable rock may be used as fine aggregate by written permission of the engineer and provided it meets the requirements of mortar strength.

Sand for Bituminous Construction.—3-5.—Sand for use in bituminous pavement construction shall consist of hard, tough, durable particles. It shall not contain more than 1 (one) per cent. of clay or loam. When dry, not more than 8 (eight) per cent. shall be retained on a sieve having 8 (eight) meshes per lineal inch, and shall not vary more than 5 (five) per cent. from the following:—

Screen mesh per lineal inch.	Percentage by weight retained.
8	10
30	20
50	27
80	20
100	15
200	7
	1
	100 Pass

Cushion Sand.—3-6.—Cushion sand shall be clean and sharp, and not more than 10 (ten) per cent. by weight shall be retained on an 8 (eight) mesh sieve. It shall not contain more than 10 (ten) per cent. by weight of clay or loam.

Grout Sand.—3-7.—Grout sand shall be clean, sharp and well graded. Not more than 8 (eight) per cent. by weight shall be retained on a 20 (twenty) mesh sieve, and not more than 30 (thirty) per cent. on a 100 (one hundred) mesh sieve. It shall not contain more than 5 (five) per cent. of clay or loam.

Mortar made in the proportion of 1 (one) part of cement to 3 (three) parts of sand by weight shall show a tensile strength at least equal to 40 (forty) per cent. of a similar mortar made of standard Ottawa sand, mixed in the same proportions and stored and tested in the same manner.

ASPHALTIC ROAD OILS.

General.—Asphaltic oils shall be classed into three grades, each containing the minimum percentage by weight of asphalt, of 50 degrees penetration, as follows:—

Light oil shall not contain less than 40 per centum asphalt.
Medium oil shall not contain less than 60 per centum asphalt.
Heavy oil shall not contain less than 80 per centum asphalt.

All oil, in addition to meeting the requirements of one of the above grades, shall have the following characteristics as determined in the laboratory. All tests shall be conducted according to the latest methods recommended by the American Society for Testing Materials.

The requirements are as follows:—

1. It shall be obtained by the refining of asphaltic or semi-asphaltic petroleum or by the combination of solid or

semi-solid native asphalts with asphaltic petroleums or derivatives thereof, which melt on the application of heat.

2. The various hydrocarbons composing it shall be present in a homogeneous solution.

3. It shall be free from water and sediment.

4. It shall not contain acid nor sulphur in sufficiently large quantities to attack rubber or rubber compositions.

Light Oil.—Light oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.92 (ninety-two one hundredths) at 77 degrees Fahrenheit (25 degrees C.).

2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue remaining has a penetration (5 seconds, 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 (fifty) degrees, the residue shall meet the following requirements:—

(a) It shall amount to not less than 40 (forty) per centum and not more than 50 (fifty) per centum of the original oil by weight.

(b) It shall have a ductility at 77 degrees Fahrenheit of not less than 25 (twenty-five) centimetres (Dow mould).

(c) It shall have a melting point of not more than 160 (one hundred and sixty) degrees Fahrenheit and not less than 130 (one hundred and thirty) degrees Fahrenheit when tested by the ball and ring method

3. Fifty grams of the oil upon being maintained at a temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical vessel 2¼ inches in diameter and 1½ inches deep shall not lose more than 25 (twenty-five) per centum nor less than 10 (ten) per centum by weight.

4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum.

5. It shall be soluble at air temperature in 76 degrees Beaume paraffin petroleum naphtha distilling between 140 and 190 degrees Fahrenheit to the extent of not less than 85 (eighty-five) per centum and not more than 95 (ninety-five) per centum.

6. It shall yield not more than 8 (eight) per centum by weight of fixed carbon on ignition.

7. It shall show a flash point of not less than 120 (one hundred and twenty) degrees Fahrenheit when tested in an open cup.

8. It shall not contain more than 5 (five) per centum by weight of paraffin scale.

Medium Oil.—Medium oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.94 (ninety-four one hundredths) at 77 degrees Fahrenheit.

2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue has a penetration (5 sec., 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 degrees, the residue shall meet the following requirements:—

(a) It shall amount to not less than 60 (sixty) per centum and not more than 70 (seventy) per centum by weight of the original oil.

(b) It shall have a ductility at 77 degrees Fahrenheit of not less than 25 centimetres (Dow mould).

(c) It shall have a melting point of not more than 160 (one hundred and sixty) and not less than 130 (one hundred and thirty) degrees Fahrenheit, when tested by the ball and ring method.

3. Fifty grams of the oil upon being maintained at a temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical dish 2¼ inches in diameter and 1½ inches deep, shall not lose more than 12 (twelve) per centum nor less than 7 (seven) per centum by weight.

4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum by weight

5. (a) It shall be soluble at air temperature in 76 degrees Beaume paraffin petroleum naphtha to the extent of not less than 83 (eighty-three) per centum and not more than 90 (ninety) per centum.

(b) When 20 C.C.'s of naphtha solution, obtained by treating 1 gram of oil with 100 C.C.'s of 76 degrees Beaume petroleum paraffin naphtha at air temperature, is evaporated upon a glass plate, the residue shall be adhesive and sticky, but not oily.

6. It shall yield between 8 (eight) per centum and 12 (twelve) per centum by weight of fixed carbon on ignition.

7. It shall show a flash point of not less than 150 (one hundred and fifty) degrees Fahrenheit when tested in an open cup.

8. It shall not contain more than 5 (five) per centum by weight of paraffin scale.

Heavy Oil.—Heavy oil shall have the following characteristics:—

1. It shall have a specific gravity of not less than 0.96 (ninety-six one hundredths) at 77 degrees Fahrenheit (25 degrees Cent.).

2. When evaporated in an open vessel at a temperature between 450 and 500 degrees Fahrenheit until the residue has a penetration (5 seconds, 77 degrees Fahrenheit, No. 2 needle, 100 grams) of 50 (fifty) degrees the residue shall have the following requirements:—

(a) It shall amount to not less than 80 (eighty) per centum by weight of the original oil.

(b) It shall have a ductiliy at 77 degrees Fehrenheit of not less than 40 (forty) centimetres.

(c) It shall have a melting point of not more than 160 (one hundred and sixty) and not less than 130 (one hundred and thirty) degrees Fahrenheit when tested by the ball and ring method.

3. Fifty grams of the oil upon being maintained at a uniform temperature of 325 degrees Fahrenheit for 5 hours in a cylindrical vessel, 2¼ inches in diameter by 1½ inches deep, shall lose not more than 5 (five) per centum by weight.

4. It shall be soluble at air temperature in pure carbon bisulphide to the extent of not less than 99.0 (ninety-nine) per centum by weight.

5. (a) It shall be soluble at air temperature in 76 degrees Beaume paraffin petroleum naphtha to the extent of not less than 75 (seventy-five) per centum and not more than 90 (ninety) per centum by weight.

(b) When 20 C.C.'s of naphtha solution, obtained by treating 1 gram of oil with 100 C.C.'s of 76 degrees Beaume petroleum paraffin naphtha at air temperature, is evaporated upon a glass plate, the residue shall be adhesive and sticky but not oily.

6. It shall yield between 8 (eight) per centum and 14 (fourteen) per centum by weight of fixed carbon on ignition.

7. It shall have a flash point of not less than 290 degrees Fahrenheit when tested in an open cup.

8. It shall not contain more than 5 (five) per centum by weight of paraffin scale.

The United States has furnished nearly 80 per cent. of Great Britain's imports of semi-finished steel since the war started, whereas previous to the war the United States furnished less than 20 per cent. of such imports and Germany nearly 80 per cent

Invar is a nickel steel containing about 36 per cent. nickel, together with about 0.5 per cent. each of carbon and manganese. Its most remarkable property is its extremely small thermal expansion at ordinary temperatures, owing to which quality it is now used for making steel tapes for precision measurements. Its mechanical properties are about as follows: Tensile strength, 50,000 to 85,000 lbs. per sq. in.; elongation, 40 to 50 per cent.; reduction ot area, 40 to 65 per cent.; and Brinell hardness, 160.

The largest electrically-driven reversing rolling mill at present in operation in America is that of the Bethlehem Steel Company, at Lehigh. It is a 35-in. blooming mill. Altogether there are at work, or in course of erection, eighteen electrically-driven reversing mills in the United States and Canada. According to Mr. Jefferies, of the Steel Company of Canada, the power required for a rolling mill owned by this company working much below its normal capacity amounts to 21.5 kilowatt hours per ton.

A bill to permit American power plants to withdraw 20,000 feet of water per second from Niagara Falls, the full amount permitted by a treaty with Great Britain and Canada, was passed on January 4th by the house at Washington, 274 to 82. The present use of 15,600 feet per second is insufficient, it was argued, to supply industries on the American side which have been deprived of power from the Canadian side now diverted to war plants. The power companies must pay $100 a year per cubic foot. The bill now goes back to the Senate.

REPAIRING TIMBER CRIBWORK

By A. E. Eastman, A.M.Can.Soc.C.E.

THE cribwork referred to in this article is on the north side of the lower entrance to one of the old locks of one of the canals of the St. Lawrence River canal system. While this lock is not used except in case of emergency, this entrance and cribwork are in general use as a dock for the landing of local freight from river boats, and also as the landing place for a ferry, making six to eight trips daily. These facts were necessary to consider when carrying on the work, and also the use to which the completed work would be put.

maximum is again reached. This maximum varies, generally following a six or seven-year cycle.

The work done on the cribs as described was carried out in the fall, when the water was comparatively low.

While there was no current along this cribwork, there was an almost constant fluctuation or "tide," the rise and fall being three or four inches and occurring at about twenty-minute intervals. Owing to this "tide" practically all elevations were taken by instruments, soundings being used but little.

Work was begun by tearing down Crib No. 1 and the bridge over the opening between Cribs 1 and 2. A floating derrick was used to assist in this, as well as handling material, or any work possible to use it for. This tearing

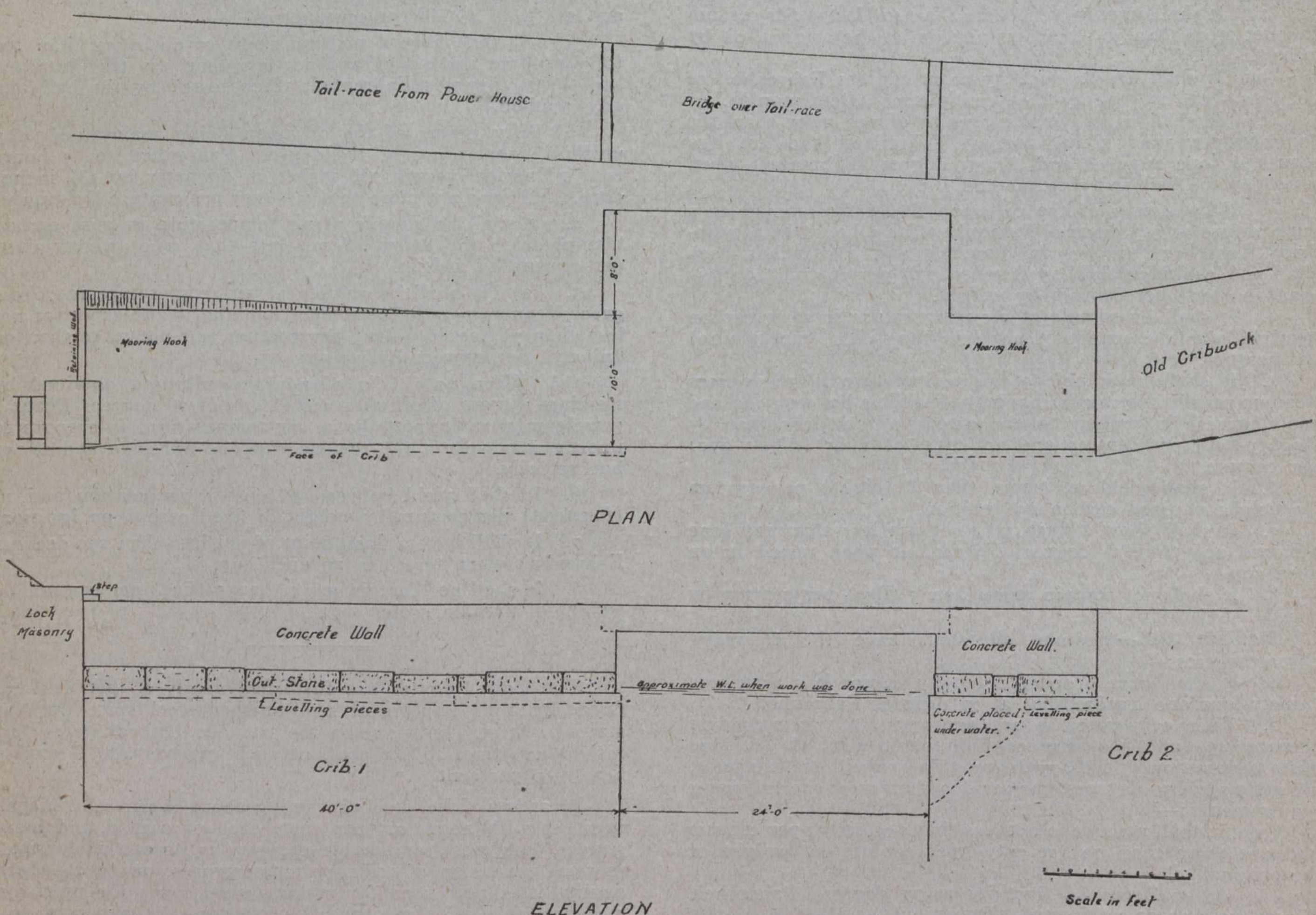


Fig. 1.—General Plan of Work.

The cribwork as a whole consisted of a number of timber cribs about 40 ft. x 12 ft., about 24 ft. apart, this space being bridged with timber stringers and a floor of plank. The work described refers to cribs 1 and 2 only, these being nearest the lock masonry.

The cribs had been built for a good many years and were in need of repair. In general, it may be said that the plan adopted for these repairs was to tear the cribs down to below water and build a superstructure of concrete, stone and steel, the elevation of the top of the new structure to be the same as that of the old.

The St. Lawrence River is not subject to spring freshets as smaller streams are; the high-water stage of the year being in June and the water then gradually falling till the lowest stage is reached in about February or March, when the water begins to rise again until the

down was a somewhat slow process. The timbers having been well bolted, and the stone filling had to be removed by hand and piled to one side for future use. Fair-sized boulders were found to have been used in crib filling, and below water caused some trouble. Another cause for slow progress was the smallness of the service grounds, as old material could not be placed where it would interfere with delivery of new material, or the progress of the work.

The whole top of the crib was not removed, but only sufficient to allow the new wall to be built along the face of the crib and the end next to Crib No. 2.

As before stated, the crib was torn down till a sound course was encountered under water, which varied from a few inches to a couple of feet at the then stage of the water. After all material necessary had been removed, elevations were taken every foot along the top of the crib as left, and the results platted. Levelling sticks were then framed and well bolted in place with ¾-inch drifts. These levelling pieces were to come to within about six inches of the water surface. The well-known method of driving these bolts was used, an iron pipe with a rammer. It may be said that in planning the work no elevations could be pre-determined except the elevation of the top of the finished work, all others being governed by circumstances as they arose.

When possible to avoid it, it was not desired to place concrete below water line, and to overcome this, cut stones were placed on these levelling pieces. These were stone of first-class quality that had been prepared for use in the lock walls and other masonry when the canals were enlarged some years ago, but had not been used. These stone varied from 16 ins. to 22 ins. in thickness, but all of one thickness were grouped together as much as possible and were placed with the face six inches back of the face of the crib, or if there were a variation from a straight line in the crib they were placed at such distance that the finished work would be straight. The floating

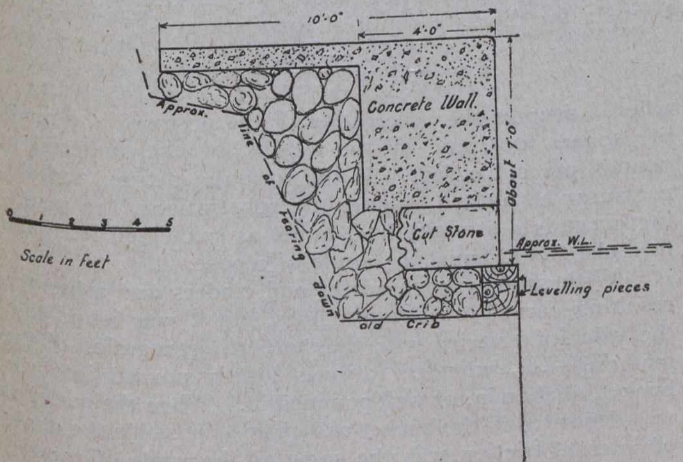


Fig. 2.—Section of Concrete Wall and Slab on Cribs.

derrick came into use in placing these stone. It was also the idea in using these stone to have them occupy as much as possible of the space between maximum high and minimum low water, mentioned in a previous paragraph.

After these stone were placed, the forms for the wall were put up and the concrete wall was poured. The concrete for the whole work was about a 1:3:5 mixture, gravel being used instead of sand and crushed stone. The concrete was mixed by hand and either shovelled directly into the forms, or wheelbarrows were used when more convenient. To give a good face to the wall the concrete was well worked along the face forms. No reinforcing was used in the wall or slab on the cribs, but "plums" were permitted, some of the old crib filling being used.

Fig. 1 shows the general plan of the finished work and Fig. 2 a typical cross-section of the concrete wall and slab on cribs No. 1 and No. 2 as built.

As mentioned, this cribwork is used as a dock, but for small boats as a rule, so instead of mooring posts, iron hooks for mooring were placed. These hooks worked freely around the top of a vertical 2-inch iron pin about 2 feet long, securely anchored when the concrete was placed. The hooks are sufficient for all traffic using the dock.

On the end wall on Crib No. 1 a bridge seat was made to carry the I-beams that were to form the stringers of the bridge across the opening between cribs 1 and 2. The bridge could not be placed, however, till the wall on Crib No. 2 was finished, so after the concrete on Crib No. 1 had set, work was begun on Crib No. 2.

As shown on Fig. 1, there is an angle in Crib No. 2 and this angle was fixed as the finishing point for the work for the season and so Crib No. 2 was torn down only as far as this angle.

Work of tearing down this crib was carried on as on Crib No. 1, but the outer corner was found to be in very poor condition and sound timber was not found till a point four or five feet below water was reached. It was found that, owing to the condition of the crib, it would be advisable to build this corner up with concrete

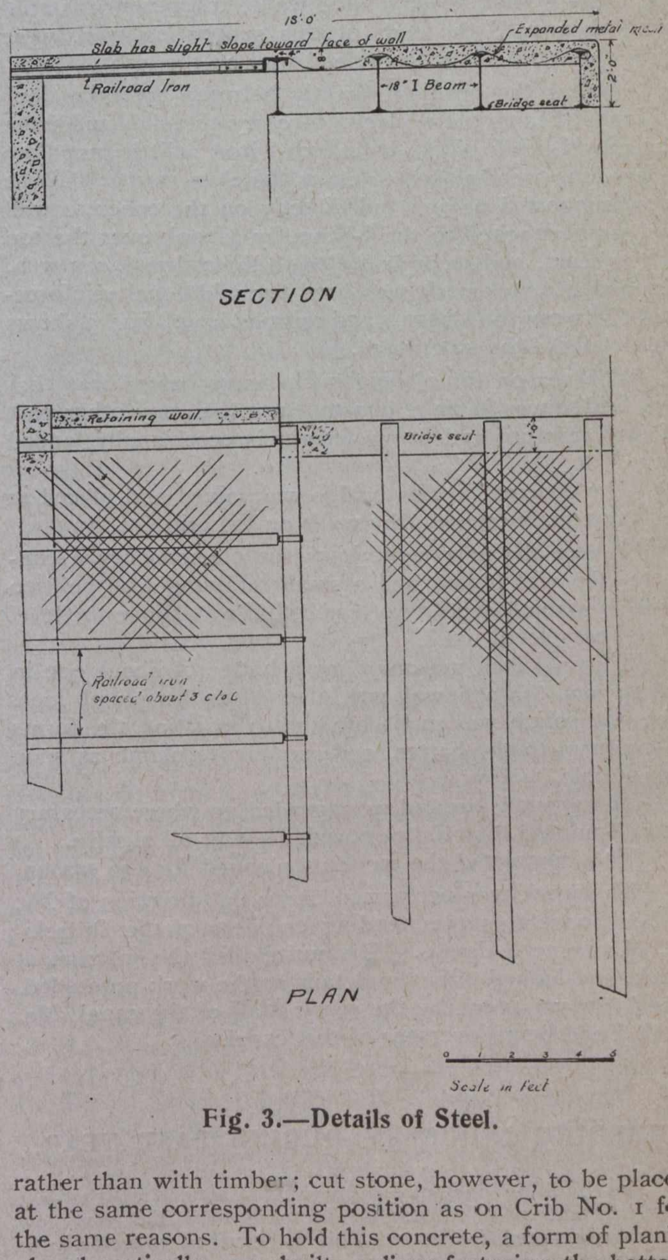


Fig. 3.—Details of Steel.

rather than with timber; cut stone, however, to be placed at the same corresponding position as on Crib No. 1 for the same reasons. To hold this concrete, a form of plank, placed vertically, was built, a diver fastening the bottom ends of the plank, while the top ends, being well above water, were secured to the crib. The concrete was deposited through a pipe and allowed to set well before the form was removed.

After removing the form the cut stone were placed and the wall erected as on Crib No. 1. The wall ended vertically at the angle mentioned and will serve as an expansion joint when this work is continued.

On beginning the work of bridging the opening between Cribs 1 and 2 several points had to receive consideration. As will be seen from Fig. 1, the tailrace from a power house runs just back of the cribwork, and care had to be taken to prevent the wall of this tailrace, which is built of light timber, from giving way and allowing the water to run between Cribs 1 and 2. Also, the top slab would here need to be wider than on the cribs and provision must be made to carry this additional width; the walls of the tailrace could not be interfered with in any way or touched by the new work. It was decided to make the slab at the opening about eight feet wider than on the cribs, and a wall one foot wide, built to the required elevation and a little longer than the opening between the cribs, was built eight feet back of the crib slabs to carry the bridge slab. Very light walls, to prevent material running around the ends of this supporting wall, were built connecting it with the end wall on the cribs.

Across the opening directly between the cribs four 18-inch I-beams were placed to carry the slab and from the rear I-beam pieces of railroad iron a little less than 8 feet long were placed to carry the extra width. These were supported at one end directly on the concrete wall and were attached to the I-beam by a hook over the top of the beam, and securely bolted to the railroad iron web. Expanded metal mesh was used for additional reinforcement between the I-beams and railroad iron. Fig. 3 shows the details of the steel work.

The reason for placing such heavy beams was that this bridge was in more constant use than any other part of the structure and heavy freight is occasionally landed there.

The concrete in this bridge was mixed and placed in the same manner as on the walls on the crib.

Where the new work joins the old masonry a concrete step was placed and a small retaining wall built to hold up a small quantity of earth that was above the level of the completed work.

This old lock masonry has a batter of about one in twenty and the new wall was planned with a plumb face. The connection was made by slightly twisting the forms to conform to the batter, and running to plumb as soon as possible.

The grounds around were graded up where necessary and all unused material removed, leaving all sightly.

This completed the work as planned for the season.

The work was performed under the direction of Mr. C. D. Sargent, superintending engineer of the Ontario-St. Lawrence Canals. The writer did the instrument work, and looked after the details as the work proceeded. The labor was done by the repair staff of the canal, Mr. J. C. Boyd being overseer of this canal.

BUILDING INDUSTRY DURING PAST YEAR.

The building industry throughout Canada for the last year has shown a substantial increase over the very low figures registered for 1915. This is ascribed principally to the increased demands of war industries, but domestic requirements have been responsible for no small part of the increased activity. One important feature of the development of the industrial life of the Dominion is the large number of United States manufacturing concerns which are establishing branches in Canada, partly as the result of a realization of the advantages which are bound to accrue in the ordinary course of events from the industrial expansion which is regarded as inevitable after the war, and also the possibility of trade arrangements which will promote commerce between the allied countries.

EXPERIMENTS ON EARTH PRESSURES.

In a paper read before the Institution of Civil Engineers, Mr. P. M. Crosthwaite gives a short account of Rankine's theory of earth pressure, and the principles and assumption on which it is founded, together with descriptions of former investigations—namely, those of the late Sir George Darwin, and Messrs. Goodrich, Wilson, Bell and Meem. The author concludes that of the experiments made by these investigators to investigate the lateral pressure of earth, those in which model walls were used are of greatest value, but points out that if models are of any size the experimental difficulties are almost insuperable.

The author's experiments, a number of which are described and illustrated in the paper, were made by loading a plunger with known weights and measuring the penetration when the plunger had come to rest after the application of each weight. The materials were enclosed in an open bucket, and their weight was determined.

With those data the value of ϕ, the angle of internal friction, can be obtained from Rankine's well-known formula for the safe depth of foundations—

$$d = \frac{P}{W}\left(\frac{1 - \sin. \phi}{1 + \sin. \phi}\right)^2$$

when d denotes the penetration, P the pressure in pounds per square foot, and W the weight of the material in pounds per cubic foot. If the formula is true, and the pressures be plotted against the penetrations, the resulting curve is a straight line, and ϕ as calculated from the formula should equal the angle of repose.

With sand, garden earth, and cinders and ashes the resulting curves are straight lines, but it was found that the value of ϕ varied with the state of aggregation of the material—*i.e.*, whether it was lightly poured into the bucket, shaken in, or well pounded in. When the material was deposited in the bucket as lightly as possible the angle of internal friction was the same as the angle of repose, but with more consolidation the angle was much greater.

From these materials the author concludes that Rankine's theory holds, provided the proper angle of internal friction is used and not the angle of repose. If, however, this angle is used it would be necessary to introduce a factor of safety into the formula, for a wall designed without one would be theoretically just strong enough and no more. In Rankine's formula there is no factor of safety, and it is concluded that Rankine saw this, and used the angle of repose as covering the worst conditions that need possibly be provided for. The author's experiments show that, for the materials tested, work designed by Rankine's formula, using the angle of repose, would have a factor of safety of 2½ to 4, and he considers that these are not unreasonable figures for such materials.

The experiments on clay give altogether different results, for instead of the penetration varying at the load, it varies as the square of the load, and the penetration curves are parabolas. Those results, which were altogether unexpected, are completely confirmed by larger experiments carried out by Messrs. Coode, Matthews, Fitzmaurice and Wilson, and by Mr. McAlpine in New York.

The author is unable to give any physical explanation as to why the penetration in clay should vary as the square of the load, but leaves it to the physicists. The law must be capable of some rational explanation, and, if true, it upsets all earth-pressure theories when they are applied to clay; for all accepted theories assume that the angle of internal friction is the same as the angle of repose, and that its value is independent of the pressure. It is suggested that the subject is worthy of further investigation, but that such could hardly be made by a private individual, for the work is tedious, each experiment taking from 24 to 48 hours. Moreover, if the investigation is to be properly carried out, physical and chemical analyses of the clays will be required that could only be made in a well-equipped physical laboratory.

In connection with the earth slides experienced at the Panama Canal, it has been suggested that in clay and shale cuttings there is a critical depth beyond which the sides will not stand, and the author's experiments on clays clearly show that for these this must be the case. Where ϕ is independent of the pressure, the depth of the cutting cannot affect the stability of the slope, but where the angle decreases with the pressure, it is evident that eventually a depth will be reached beyond which its sides will not stand.

This decrease is clearly shown in one experiment on mud, for which the angle for a pressure of 0.25 ton per square foot was 17 degs. — 15 min., which decreased to 2 degs. 10 min. at a pressure of 1.25 tons per square foot, when it was little better than a liquid.

NO ROAD SHOW AT WINNIPEG.

It has been decided not to hold the Canadian and International Road Congress at Winnipeg this year, announced Secretary McNamee at Toronto this week. The first congress was held in Montreal in 1914, the second in Toronto in 1915, the third in Montreal last winter, and it was voted at the third congress that the fourth be held in Winnipeg. Secretary McNamee visited Manitoba recently, and now states that there is no building in that city which could house the exhibits, and that other conditions also make it inadvisable to go west this year. It has not been decided yet just where the congress will be held this year, but Ottawa is now being favorably mentioned.

ANNUAL MEETING, TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting for the election of officers for the ensuing year was held at the Engineers' Club on January 11th. Following will be the executive officers for the year:—

Chairman, E. W. Oliver; secretary-treasurer, L. M. Arkley; executive, H. G. Acres, A. H. Harkness, T. T. Black and E. G. Hewson.

G. A. McCarthy, retiring chairman, will also act as a member of the executive.

Reports of the various committees were received. G. A. McCarthy was elected to represent the Toronto branch on the committee of technical society representatives, recently organized to devise means by which engineers who have not enlisted or undertaken munition work may help in carrying on the war. It was suggested that a committee be appointed by the executive to aid in making members of the branch better acquainted, and the new executive will probably deal favorably with the suggestion.

POINTS OF INTEREST IN CONNECTION WITH SOME CONCRETE BUILDINGS RECENTLY ERECTED IN AND AROUND MONTREAL.

(Continued from page 49.)

In the second half of January, 1914, the weather was very severe, and the top layer of concrete was quite frozen as soon as laid down. The only precautions taken were to heat the sand, stone, and water, and thoroughly clean the forms, tiles and steel with a powerful steam jet. The floor when completed was left without any protection for the balance of the winter. When work was resumed the concrete floor was perfect, and the concrete was harder and better than in similar floors made in very hot weather, when no special precautions are taken to protect the concrete from drying out.

These two buildings represent proof that not only mass concrete but concrete floors from 2 ins. to 4 ins. thick may be made in winter without any other precautions than heating the materials. Any additional protection after the concrete is placed is not necessary, provided the forms will remain until the concrete has set and acquired the necessary strength to carry the imposed loads.

In cases where completion is essential, by a given date, and the forms have to be removed as soon as possible, special arrangements have to be made to cure the concrete during the cold weather. Arrangements of this kind were necessary during the construction in Montreal of a seven-story building, at the corner of St. Lawrence and Duluth Streets. The building was started November 7th, 1913, and possession had to be given on May 1st, 1914. There were about 2,000 yards of rock to excavate. Concreting was not started until the end of December, 1913, and was carried on during the winter season.

The outside walls being also of concrete, the following methods were followed:—

Before any concrete was placed the forms for two floors including walls were completed, the upper floor serving as a protection to the lower one. The supports of the upper floor were placed on concrete blocks. A complete hot air heating system was installed in the basement, and during the placing of the concrete, as well as during the curing, a temperature of about 40° F. was maintained in the building. All materials were heated, and the forms as well as all stop joints were thoroughly cleaned with a powerful steam jet. This method was used from beginning to end, and the success was complete. The work was going on day and night, irrespective of the weather, and some of the floors were poured when the outside temperature was about 20° below zero. Test blocks were made on each floor, and left under the same conditions as the floor. Before the forms of a floor were struck, the blocks were investigated. The test blocks as well as the walls and floors showed clearly that in winter the setting of the concrete takes place from the inside to the outside. The heat generated by the chemical process of the setting of the cement probably maintains the inner temperature above the outside temperature, and these conditions are probably more favorable to the setting of the concrete than the ordinary summer conditions, when the outside of the concrete is drying out and setting quicker than the inside. There is also another fact in favor of winter-made concrete and that is the elimination of laitance. This elimination of laitance is more thorough in winter than in summer. In columns poured in winter the laitance on the top will be 2 ins. to 3 ins. thick, whereas in summer on a column of the same dimensions, and the same quality of cement, the laitance will hardly be ¾ in. to 1 in. thick. If not removed carefully this laitance accumulating at the top of columns and sometimes at the bottoms of beams may cause trouble, and the success of winter-made concrete is to some extent dependent upon the careful removal of the laitance. If concrete work can be carried on successfully in winter, cement finish should not be attempted at all.

The success of a cement finish depends on the adhesion between the relatively thin coat of cement mortar and the concrete base. It is easy to understand that the freezing of the thin mortar finish will separate it from the base, and failure must result. It is the bond between the cement finish and the base, which is affected by frost, and not the cement finish itself.

The question of winter-made concrete is very important, especially for Canada, where in many provinces the winter season is longer than the summer, and it is now well established that concrete operations can be and are being carried on successfully in winter.

St. Michael's Church.—A striking example of the adaptability of concrete to complicated structure is given by the St. Michael's Church now being constructed at corner of St. Urbain and St. Viateur Streets, in Montreal.

The church proper covers an area of about 170 ft. x 90 ft. (exterior dimensions). There are really no columns in this church, and the whole structure is built of plain and reinforced concrete. The style is Byzantine. The layout, from the general engineering point of view, was made in detail by the architect, Mr. A. Beaugrand-Champagne. The design of the dome and supporting arches was by Prof. E. Brown.

The church is founded on rock. The basement ceiling is carried by flat arches 54 ft. clear span, having a rise of 30 ins. The arches are 18 ft. centre to centre, and are connected with a flat slab 7 ins. thick.

The main auditorium is covered by a dome 74 ft. diameter. This dome is carried by four full centre arches, each 52 ft. diameter, which arches are being carried down to rock by four strong tower abutments. The dome is about 118 ft. above the sidewalk and 110 ft. above the auditorium floor.

The tower is 170 ft. high. The outside walls are all covered with Greendale brick and terra cotta. The domes and roofs, however, are finished in concrete, the domes having received a colored waterproof cement finish about 1 in. thick, showing green shamrocks on a white field. The green color was obtained by mixing a green pigment with the ordinary cement, and the white coloring is obtained by the use of Atlas white cement.

The main cupola is carried on a series of semi-circular arches fixed rigidly into a heavy ring of concrete reinforced with steel bars in the form of circular hoops. There are six semi-circular arches, 36 ins. deep, 12 ins. wide at the bottom, and 6 ins. wide at the crown. At the crown the arches are connected by a disk 4 ft. diameter and 36 ins. deep.

For the computing of the stresses in the concrete and steel the total weight of the cupola, including suspended ceiling, wind, snow, etc., was taken at 150 lbs. per square foot, the cupola being of uniform thickness of 5 ins.

The six semi-circular ribs are reinforced with four 1⅛-in. square twisted bars, two near the top and two near the bottom and connected with stirrups about every 12 ins. The cupola, which is of a uniform thickness of 5 ins., is reinforced with half-round bars at 6-in. centre to centre.

To ascertain that under the most unfavorable conditions the stresses in the concrete and steel will always remain within the safe limits many assumptions were made.

The cupola was first designed without ribs and of a uniform thickness of 8 ins., following the theory given by E. Collignon "Cours de Mecanique, p. 631." The theory as given by Collignon shows that in a spherical cupola the stresses in the material used are independent of the thickness of the cupola, and are determined only by the diameter of the cupola and the specific gravity of the material used. With hoops made of ½ square bars, and placed 9 ins. centre to centre, the stresses in the steel concrete would be kept within the safe limits. The thickness of the cupola will be rather governed by the stiffness to be attained than by the safe stresses. However, taking into consideration the large proportions of the cupola, it was decided to provide arch ribs as described above, and making assumptions rather more severe than the actual conditions warranted, the stresses in the steel and concrete were kept within the safe limits. Notwithstanding this fact that the cupola was designed assuming unfavorable conditions, from an economical point of view the concrete cupola was the cheapest. As built, the cupola is about 40% cheaper than a Gostavino tile cupola, and about 50% cheaper than a steel structure fireproofed with concrete or tiles.

The half spherical cupola at the rear having a diameter of 52 ft. and the small 20-ft. cupola at the top of the tower are of uniform thickness, and are reinforced with hoops made of round ½-in. bars.

The four main arches carrying the cupola, the cantilevers and the arches in the basement were designed following the established methods. The winding stairs and the large windows were also made of reinforced concrete, although no established formula were available.

The Long Sault Development Co.'s project for the construction of a dam across the St. Lawrence River in connection with its power development scheme, has been finally quashed, the U.S. Supreme Court having dismissed the company's appeal against the ruling of the New York courts annulling its franchise. This matter has been before the courts for several years, and has been persistently fought at every stage by the Dominion Marine Association and the Shipping Federation of Canada, on the ground that it would interfere considerably with the safe navigation of the St. Lawrence River.

The committee on sewage works operation of the American Public Health Association has made an analysis of sewage treatment plants in the following fifteen states: California, Illinois, Iowa, Kansas, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Texas, Virginia and Wisconsin. The total number of plants reported was 1,294. Of these, one-third are designed for populations of less than 500; over one-half for populations between 500 and 10,000; and only 7 per cent. for populations over 10,000. Only 29 of the 1,294 plants are equipped with complete laboratories, and of this number 17 are in the State of Pennsylvania.

The Governor-General of Korea has issued new mining laws to supplant those of 1906. They consist of 64 articles based on the mining law of Japan. The most important provision is that in future foreigners as individuals will be prohibited from obtaining mining concessions in the country, and the granting of such concessions is to be limited to Japanese subjects born or "legalized," and the latter must have their head office in Korea. Mining rights already in existence and held by foreigners are not to be interfered with. Priority of application will probably no longer ensure the grant of mining rights, although this is not expressly stated in the new ordinance.

Editorial

CANADIAN SOCIETY OF CIVIL ENGINEERS.

Every member of the Canadian Society of Civil Engineers whose time is not occupied in munitions or other war work should make a special effort to attend the thirty-first annual meeting of the society in Montreal next week.

To be present at a national gathering of the men of his profession is a duty that every member owes not only to himself but to the profession. The three days of association with his fellow engineers next Tuesday, Wednesday and Thursday will greatly benefit each and every one.

Not to speak of the change of scene and air and the other benefits of a little vacation of this sort, the new ideas that will be gathered by each engineer who attends the meeting, and the stimulus and inspiration to be obtained from the contact with many of his most successful fellows, will return to the traveller a big dividend upon the comparatively small outlay. Attention is called in this connection that the railways are offering return passage at single fare rates.

MERCIER'S REPORT ON THE AQUEDUCT.

Paul E. Mercier, city engineer of Montreal, has submitted a report to the Montreal city controllers which replies to the aqueduct criticisms made last November by the ratepaying engineers of Montreal. Because it was written in English only, the report was not adopted by the controllers, who referred it back to Mr. Mercier with the request that it be translated into French. A Montreal newspaper, however, secured one of the advance copies of the report and has published liberal extracts from it. Assuming that the newspaper has quoted Mr. Mercier's report correctly, he apparently disagrees with the ratepaying engineers and flatly disputes their statements.

Mr. Mercier again intimates that the scheme has already been reported upon by other engineers, and he mentions other arguments that are differences of opinion rather than of facts, but a large part of his report is made up of quotations of facts and figures which are materially different from the facts and figures set forth in the ratepaying engineers' report. It should be easy for an impartial board to determine which set of facts and figures is correct and to find why the discrepancies occur.

As an example of the difference in facts between the two reports, it is noted that the ratepaying engineers say that the capacity of he headrace would be reduced to an average of about 7,000 h.p. in winter, even assuming that no frazil troubles be experienced. Mr. Mercier claims that water gauge readings extending over a period of nineteen years have been studied, and that the theoretical water horse-power was less than 13,000 for only one day.

In replying to the ratepaying engineers' argument that the bottom would be eroded, the retaining walls undermined and much other damage done if higher velocities of water were obtained, Mr. Mercier says that he does not think that a concrete floor would be so affected.

The ratepaying engineers state that about $5,200,000 has already been spent, including an allowance of $300,000 for boulevards, bridges, fencing and cleaning up, but no allowance for the claims of the Cook Construction Co. Mr. Mercier states that the amount of money that has been spent exclusive of filtration plant and pumping is $4,013,510. About $5,581,000 will be required to complete the work, says Mr. Mercier.

The ratepayers say that the minimum capital cost, based on the maximum safe capacity of the plant as designed, will be $1,515 per h.p.; Mr. Mercier says that the capital cost will be $737 per h.p. if all items are charged against the power development.

The minimum fixed charges and operating expenses will amount to $757,000 per annum, say the ratepayers; they will amount to $479,800, says Mr. Mercier.

The minimum fixed charges and operating expenses will be $108 per h.p. per annum, say the ratepaying engineers; this figure should be $40, says Mr. Mercier.

Mr. Mercier justifies an expenditure of $40 per h.p. per annum, whereas the city is now buying power for $20 (twenty hours) to $30 (twenty-four hours) per h.p. on contract from the private power companies, by asking who can state what the city would have to pay for electric energy in 1920, and by stating that the city cannot afford to gamble on the problematic future cost of power "when it can, at the actual market price, have its own water power and street lighting system at a lower cost or even at the same cost and be totally independent of any probable future trust."

It was pointed out in *The Canadian Egineer*, November 11th, 1915, that the power contract manager of the Montreal Light, Heat & Power Co. stated that his company is prepared to contract with the city for 10,000 h.p. (6,000 h.p. for pumping and 4,000 h.p. for lighting) at $25 for 24-hour power or $20 for 20-hour power.

The Canadian Egineer also stated in the above-mentioned issue that the city has the club that it could use on the private power companies of going to Quebec for a hydro-electric bill similar to Ontario's in case a fair contract with the companies should ever be found impossible.

Mr. Mercier suggests that a commission of two engineers and one business man be appointed to advise the controllers. We heartily concur in this suggestion. In the May 18th, 1916, issue of *The Canadian Engineer* suggested that an independent commission should be appointed consisting of "three qualified engineers, a banker who is conversant with the city's finances—Sir Frederick Williams-Taylor would be most acceptable—and, as chairman, some prominent Montreal business man who has the welfare of the city at heart and who has been efficient and successful in general business matters, but who has never 'mixed in' politically."

If Mr. Mercier's suggestion of two engineers and one business man be carried out by the controllers, we would strongly urge that Sir Frederick Williams-Taylor be appointed as the business man and chairman of the commission, and that the Montreal city council appoint one of the two engineers and the Canadian Society of Civil Engineers, the other.

PERSONAL.

H. OCCOMORE has been appointed chairman of the water commission of Guelph, Ont.

H. A. WOODS, M.Can.Soc.C.E., chief engineer, Grand Trunk Pacific Railway, Winnipeg, is away on a three months' vacation, and it is understood he will resign.

Dr. FRANK D. ADAMS, of McGill University, Montreal, was chosen president of the Geological Society of America at the organization's annual meeting held in Albany, N.Y., on December 28th.

H. E. WHITTENBERGER, general superintendent of the Ontario lines of the Grand Trunk Railway, suffered a painful accident at Black Rock recently when the brake lever on the rear of his private car flew around and struck him across the forehead.

Major ARTHUR E. DUBUC, A.M.Can.Soc.C.E., commanding the 22nd Battalion, is among the officers mentioned in the New Year's honor list. He received the D.S.O. Before going on active service he was the district engineer in Montreal for the Department of Public Works. He has been twice wounded.

Lieut. I. W. KLINGNER, of Toronto, who went overseas last February, going into the trenches in July with the 10th Canadian Engineers, has been awarded the Military Cross. He is a graduate of the School of Practical Science, and was connected with the C.P.R. construction department.

E. P. MATHEWSON, general manager of the British America Nickel Corporation, Limited, Royal Bank Building, Toronto, was awarded the gold medal of the Metallurgical Society of America for his achievements in metallurgy during the past year at the annual meeting of the society held in New York recently. Mr. Mathewson was educated at McGill University.

Temporary Major WILLIAM GRANT TYRRELL, son of Dr. J. B. Tyrrell, 546 Sherbourne Street, Toronto, has been mentioned in despatches for distinguished conduct at the front. He was in charge of railway construction work with the British Expeditionary Force in Egypt. He is a graduate of the R.M.C., Kingston, and belonged to the Royal Engineers. At one time he was in charge of the construction of military camps in the province of Quebec.

W. P. COOK, chairman, Public Utilities Commission, Port Arthur, Ont., and M. M. INGLIS, manager, Port Arthur Civic Railway, who attended the American Electric Railway Association's annual convention at Atlantic City recently, presented a report upon improvements in connection with the operation of street railways and their adaptability to Port Arthur's needs, at a meeting of the Port Arthur Public Utilities Commission recently.

A. K. GRIMMER, A.M.Can.Soc.C.E., of St. Andrews, N.B., has been given a commission in the Canadian Engineers. Lieut. Grimmer was graduated from the University of New Brunswick in 1904, and afterwards was city engineer of Fredericton for two years and also filled the same position at Medicine Hat for about five years. He was later engaged on the teaching staff of the University of Manitoba, Winnipeg, and just recently returned to St. Andrews, where he began private practice.

GEORGE HERBERT DAWSON, B.A.Sc., A.M. Can.Soc.C.E., surveyor-general of British Columbia, has resigned that position. Mr. Dawson, who was born in Quebec 50 years ago, went to the Pacific coast in 1889 after having been in the engineering department of the C.P.R. for three years on the Quebec division. He occupied the position of assistant city engineer in Vancouver for two years and later he was engaged in private practice in the same city for about ten years. He was appointed to the position he has just vacated in 1911. Since the start of the war Mr. Dawson has been given the appointment of western representative of the Imperial Munitions Board.

OBITUARY.

BERTRAM DAWSON, president of the Dickson Bridge Works Co., Campbellford, Ont., died on December 31st, at the age of 36 years.

Lieut. ARTHUR JAMES MOTYER, B.A., B.Sc., formerly engaged as an engineer by the Canadian Westinghouse Co., Hamilton, has been killed in action.

Lieut. E. GUY DUNSTAN, son of Mr. Kenneth J. Dunstan, manager of the Bell Telephone Company, Toronto, who was reported missing in July, is now stated to have been killed in action.

HUGH McCULLOCH, president of the Goldie & McCulloch Co., Limited, Galt, Ont., passed away on January 8th at the age of 61 years. He was born in Galt on September 7th, 1856, and was educated at the Whitby Grammar School and Upper Canada College, at the completion of which he served an apprenticeship in the shop of which his father, the late Mr. Hugh McCulloch, Sr., was then president. When the company was incorporated in 1891 and took over the business of the firm of Goldie & McCulloch, he was appointed secretary-treasurer, which position he held until he was elected vice-president in 1898, assuming the presidency on the death of his father in September, 1910. Mr. McCulloch was closely associated with various other manufacturing concerns in Galt, having been at the time of his death vice-president of the Galt Malleable Iron Co., Limited, also of the Galt Art Metal Co., Limited, and a director of the Galt Gas Light Company.

THOMAS MALCOLM, one of the best-known railway contractors in the Maritime Provinces, died recently at Campbellton, N.B., after a prolonged illness. He was born in New Brunswick in 1854, and was employed at an early age in the construction of the Intercolonial, while later on he was connected with the late John J. Macdonald on section B of the Canadian Pacific around Lake Superior. With Messrs. Boswell and Ross he built the Temiscouata Railway from River du Loup to the head of the St. John River. Some years ago Mr. Malcolm secured a charter for the construction of a line of railway from Campbellton, N.B., on the Bay de Chaleurs, to St. Leonards, on the St. John River, a distance of 110 miles, and for years he put his best energies into the construction of this enterprise, which he considered of vital interest to the province and to the Dominion, the road being completed several years ago under the name of the International. Some time since the International was leased by the Dominion Government with a right to purchase, and is to-day operated as a part of the Intercolonial. Mr. Malcolm was at one time interested with the late Hon. John Costigan in the Quebec & New Brunswick Railway, a line surveyed over about the same route as that followed to-day by the Grand Trunk Pacific from Chaudiere to Moncton, but the government took over that work.