PAGES

MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Annual Meeting, Engineering Institute of Canada

Thirty-Third Annual Convention Most Notable in History of Organization—Registration Exceeded Six Hundred and Fifty—Review of Institute's Activities for Past Year--Reports of Technical Committees and Reports of Branches, of Which There Are Now Eighteen

IN reporting the thirty-third annual meeting of the Engineering Institute of Canada, which was held last week in Montreal superlatives are indispensable. The registration was the largest, the enthusiasm was the greatest, the spirit of good-fellowship was the finest, the social events were the most enjoyable, and the range of subjects covered was the widest in the history of the institute. The registration exceeded 650, of whom not more than 500 were Montreal members. Ottawa, Toronto and Quebec City led in the "out-of-town" registration, but there were fully 50 from other places in Ontario or Quebec, and there were also several members from the west, the Maritime provinces and the United States.

The retiring president, Lt.-Col. R. W. Leonard, of St. Catharines, Ont., opened the meeting at 10 o'clock Tuesday morning, January 27th, in the convention hall of the institute's building, 176 Mansfield street, but the seating capacity of that hall was insufficient, and it was decided to transfer all following sessions to the Windsor Hotel.

After Col. Leonard had welcomed the members, and the secretary had presented the minutes of the last annual meeting, the annual report of the council was received. This report stated that during the year new branches had been established at Sault Ste. Marie, Niagara Falls, Windsor and Peterborough, and that the Kingston branch had been revived. There are now 18 branches. The general activities of the institute during the past year were briefly reviewed, and it was stated that service to the individual member and to the profession had been the constant aim of the council. During the year there were added to the membership roll 52 members, 251 associate members, 58 juniors, 137 students and 5 associates; 14 resigned, and 6 were dropped from the roll for non-payment of dues; 38 deaths were reported, of whom 13 were killed in action. At present there are 3,657 names on the roll.

The report of the finance committee was the only report that received any adverse criticism of any kind. It revealed a deficit for the year amounting to $6,440. The expenditures totalled $39,006. The assets are now $112,780.

Reports of Committees

The library and house committee reported that no funds had been available during 1919 for purchase of technical books, but a number had been donated by the publishers.

The publications committee recommended that a volume of transactions be published again, and suggested that it include 18 papers read during the past year.

Brief reports of a formal nature were also submitted by the committees on steel railway bridges, international affiliation, engineering standards, uniform boiler specifications, and international electro-technical committee.

The Gzowski medal committee recommended the award of the 1919 medal to Phelps Johnson, G. H. Duggan and G. F. Porter for their papers on the Quebec bridge. The committee recommended that there be no award of the student's medal. The Leonard medal was not awarded as that committee had been appointed so recently that it considered the time too short for the necessary examination of papers.

Reports were received from most of the branches and adopted with little or no comment. Referring to the report of the Toronto branch, Prof. H. E. T. Haultain said much work yet remains to be done in Toronto in explaining the policies and attitude of the institute to the members of other technical societies and to the business men and politicians.

Letters of Regret

Fraser Keith, secretary of the institute, read 15 letters and telegrams from prominent business men, engineers and politicians who had been invited to attend the meeting, but who were unable to do so for various reasons. A letter from F. A. Bowman, of Halifax, declared that Nova Scotia intends to secure the Olympic athletic meet next year, and urged that the institute organize an international engineering congress to be held in that province at the same time.

It was announced that in order to assist the institute's journal, an additional fee of $2 per annum will be levied upon the membership. As the necessary amendment to the by-laws cannot be passed in time to be effective this year, it was requested that members voluntarily add $2 to their present annual dues. J. B. Challies, of Ottawa, suggested a "drive" for contributions to reimburse the treasury for last year's deficit, but this was opposed by H. H. Vaughan, W. J. Francis and R. A. Ross, all of whom declared that the institute is now carrying the peak of the load, and that under the budget system of controlling expenditures that is to be introduced by the newly-elected president, R .A. Ross, the deficit will be overcome within a few years without requiring any "drive."

The meeting was then adjourned for luncheon, which was held in the Rose Room of the Windsor Hotel. Out-of-town members and ladies were the guests of the Montreal branch. Walter J. Francis, chairman of the Montreal branch of the institute, presided at the luncheon, and with him at the head table were E. W. James, assistant chief engineer, Bureau of Public Roads, Washington, D.C.; Calvin W. Rice, secretary of the American Society of Mechanical Engineers; R. A. Ross, president-elect of the institute; Lt.-Col. R. W. Leonard, the retiring president; Brig.-Gen. Sir Alex. Bertram, hon treasurer; Sir John Kennedy, G. Herrick Duggan, H. H. Vaughan, and Phelps Johnson, past presidents; and Brigadier-Generals C. J. Armstrong and G. Eric McCuaig.

A brief address was given by Mr. Francis in proposing a toast, "The Ladies," and he then introduced Calvin W. Rice, who spoke briefly and informally on various phases of society activities. Mr. Rice declared that every technical man in the Dominion, of whatever nationality he may be, and whether he be living in the Dominion temporarily or permanently, should join the Engineering Institute of Canada; he owes his first allegiance to the society of the country in which he lives. All the societies are working toward the objective,—the advancement of the engineering profession. Mr. Rice stated that he intended to return to New York via

Toronto, and he intimated that he might be of some service to the institute in connection with the Ontario section of his society.

As a man grows in his profession, said Mr. Rice, he may desire to join other more specialized societies, and the institute should offer no objection to his doing so, but he should join the institute first.

The chief aim of the Engineering Institute, said Mr. Rice in conclusion, is the advancement of science, and in this its objects are identical with those of all other engineering societies in the world, excepting the German one, whose charter declared that the organization was for "the advancement of science *for the benefit of the Fatherland*"; how mistaken this qualification was, history has shown. The printed and avowed aim of the Engineering Institute, said Mr. Rice, is to render the maximum of service to the nation, but in this case the intent is broader and service to the nation means service to all mankind.

Paper on Modern Highway Problems

Mr. Francis then introduced E. W. James, who had been invited to deliver the principal luncheon address, and who spoke on "Modern Highway Problems." Mr. James' address appears practically in full upon another page of this issue.

The Tuesday afternoon session was called to order by President Leonard about 3.15 o'clock in the Ladies' Ordinary of the Windsor Hotel, and the room was well filled. William McNab presented the report of the scrutineers. As previously announced, R. A. Ross was elected president by acclamation. Mr. Ross is an electrical engineer, and a member of the Montreal Administrative Commission.

The new vice-presidents are: Brig.-Gen. C. H. Mitchell, dean of the faculty of applied science and engineering at the University of Toronto, and W. G. Chace, chief engineer of the Greater Winnipeg Water District.

The newly-elected members of council are: F. B. Brown and Julian C. Smith, Montreal; A. R. Decary, Quebec; F. A. Bowman, Halifax; J. B. Challies, Ottawa; E. R. Gray, Hamilton; Guy C. Dunn and B. Stuart McKenzie, Winnipeg; J. R. C. Macredie, Moose Jaw; Geo. W. Craig, Calgary; and H. W. Burwell, Vancouver.

Col. Leonard enquired whether there were any matters not on the program which the members would care to discuss, but no new business was brought forward. He then suggested a topical discussion on legislation. J. B. Challies outlined the status of legislation in Ontario, and briefly reviewed the bill suggested by the Joint Committee of Technical Organizations. B. M. Hill, H. E. T. Haultain and H. H. Vaughan expressed emphatic opposition to the J.C.T.O. bill and the applause indicated that the majority of members present preferred the E.I.C. bill. Fear was expressed that the J.C.T.O. bill would brand engineering as a trade rather than a profession.

Regarding Place for Next Annual Meeting

Col. H. J. Lamb invited the members to choose Toronto as the place for the next annual meeting. H. E. T. Haultain supported this invitation, referring to the enthusiasm and fine leadership that is being shown by the new chairman of the Toronto branch, R. O. Wynne-Roberts. The younger members of the branch are solidly behind Mr. Wynne-Roberts, said Prof. Haultain, and would work hard to make the next annual meeting a big success.

M. A. Lyons, of Winnipeg, extended an invitation on behalf of that city, and members from Regina supported Winnipeg so strongly that the members decided to leave the choice to the incoming council, but recommended to the council that either Toronto or Winnipeg be chosen as the place of the next annual meeting.

E. M. Proctor, Toronto, enquired what the council had done with the schedule of salaries proposed by the Toronto branch, and was informed by the secretary that it had not been discussed by council, but that he would put it on the agenda for discussion at an early date.

Col. Leonard read his retiring presidential address, discussing exhaustively the growth of Bolshevism and trade unions, showing their menace not only to capital but to civilization itself. He also touched briefly upon certain engineering developments in Canada and other countries during the past year. Col. Leonard then introduced the new president, R. A. Ross, who thanked the members for the honor conferred upon him and declared the session adjourned.

Over 400 guests assembled in the Rose Room of the Windsor Hotel, Tuesday evening, for the annual reception and dance. The program consisted of 22 dances, including one steps, fox trots and waltzes. Dancing commenced at 9 p.m., and continued until nearly 3 a.m. At 11.30 a buffet supper was served. There were bridge tables for those who did not care to dance. J. L. Busfield was chairman of the men's reception committee, and Mrs. H. G. Hunter had charge of the arrangements for the dance.

At 10 o'clock Wednesday morning, January 28th, President Ross opened the first general professional meeting of the Montreal branch, which was combined with the annual convention of the institute. "The Gateway of the Profession" was the title given to the morning's proceedings, which were entirely in the hands of educators.

Dr. R. F. Ruttan, professor of chemistry and director of the chemical laboratories, McGill University, read a paper on the training of the chemical engineer. He reviewed the present status of this highly specialized branch of engineering, and urged that the Canadian universities be better equipped for research work. He advocated the extension of the course to five years, with the last year to be spent at research stations to be established with the co-operation of the industries concerned.

Physics in Engineering Education

Dr. A. S. Eve, professor of physics, McGill University, read a paper on the importance of physics in engineering education. He expressed the hope that in the future engineers would be better physicists, and physicists better engineers. He reviewed the work of the physicist in the war, and outlined their part in research. The engineer, said Dr. Eve, is an admirable buffer or link between the physicist and the business or financial man, as the engineer is a man of great practical sense who can best determine and give effect to the economic worth of the physicist's discoveries. However, there should in the future be more engineers who are sound physicists, said Dr. Eve, and more physicists who are great engineers.

Dean C. H. Mitchell opened the discussion on the papers by Dr. Ruttan and Dr. Eve. There are 810 students, he said, enrolled in Toronto's engineering faculty this year, of which 405 are first-year men, and 60% are returned soldiers. Of the 405, nearly one-quarter, or 87 to be exact, have chosen chemical engineering, which is one of the eight departments of the faculty. Electrical engineering is the second most popular choice, while civil engineering is a rather poor third, although there are certain special reasons for that, declared Dean Mitchell.

The popularity of the chemical engineering course, he said, merely reflects the opinion of the country that the development of Canada's natural resources is going to demand many trained chemical engineers. There will be room for them all eventually—but how are we going to absorb all these men in industry as soon as they are turned out by the university? As a start, said Dean Mitchell, the institute should back up his slogan, "Buy Canadian brains."

Relation of the University to Industry

There must be a growing understanding between the universities and industry, said Dean Mitchell. The universities must lead and must keep their ears to the ground. They must anticipate the demand for men of specialized training, and when industry calls for men of certain abilities, the universities must be in a position to say that they have already trained such men and that the men are available.

Dean Mitchell also reviewed the necessity for co-operation between industry and university in summer work, so that the students can gain practical knowledge of details of actual working problems.

The movement toward a 5-year university course was touched upon by the speaker, who urged that all possible elementary work be taught before the student leaves the high schools and preparatory institutions.

Dr. Frank D. Adams, dean of the faculty of applied science, McGill University, agreed with the suggestion made by Dr. Eve that the universities should carry the curriculum through a specialized fifth year, but he would prefer to raise the entrance standards if it were possible to do so, which it is not at present, excepting by very gradual steps. If the entrance requirements were to be raised so as to eliminate the work of the present freshman year, there are not two schools in the province of Quebec that would be able to feed students into the university.

Fundamentals Necessary to Engineer

It is unfortunate in many respects, said Dr. Adams, that the student must spend the first two years acquiring a great quantity of very diversified information of quite fundamental and elementary character, and that he does not get any interesting engineering work for such a long time that many students become discouraged. The student should be thoroughly impressed with the value of this fundamental information, said Dr. Adams. He pointed out the difficulty of making an engineer in four terms of seven or eight months each, but was glad to say that pre-war records of McGill showed that 86% of the engineering students worked all summer every summer in some engineering capacity, and thus added to their education.

Dr. Adams referred to the efforts of McGill to keep abreast of the times in engineering education by the establishment of new courses such as engineering economics and engineering law.

Arthur Surveyer, member of the board of governors of the University of Montreal (formerly Laval University), discussed the papers from the standpoint of the French-Canadian university, and urged the importation of more French engineering experts to teach the young men of Quebec province. He also urged that the students be taught how to study, and that it should not be assumed that they know the proper methods of obtaining results through concentration. Mr. Surveyer presented his case in a very able manner and received the heartiest applause of the morning.

Chas. F. Scott, professor of electrical engineering at Yale University, New Haven, Conn., and past president of the American Institute of Electrical Engineers, concluded the discussion. He opposed specialized training at the expense of general education. An engineer should be able to use all technical specialties in attaining his ends. He should be able to "take up anything and put it through." He should have a general training in all basic engineering principles and the specialization should be left to his own individuality as it develops.

E. J. Mehren, editor of "Engineering News-Record," New York, agreed with Prof. Scott that better engineers are needed. He said that the members present would be astonished if they knew the lack of engineering forethought in the construction of highways to-day. Yet the Romans had good roads and made good concrete. Any attempt to build highways to-day on the Roman methods would bankrupt a nation, and it is not known just how they made their concrete. It must have been by very expensive methods, said Mr. Mehren, and no doubt would not be practicable to-day.

Need for Better Engineers

There is no shortage of engineering administrators, said Mr. Mehren, and no need to endeavor to train better administrators, but there is a need for better engineers. Above all else there is a demand for the type of man who can delve into the science of a problem, break it down and get at the elements in the way that E. W. James and his assistants in the Bureau of Public Roads are doing, and along the lines fololwed by the men who have recently advanced to a very marked degree the science of proportioning the materials entering into concrete mixtures.

At 1 p.m. the meeting adjourned for lunch, which was served at the plant of the Northern Electric Co., Ltd., with the president of that firm as host. Special street cars carried the party from the hotel to the plant, and moving pictures were taken by a Pathé representative while the engineers were boarding the cars, and a group photograph after their arrival at the plant. After a very enjoyable luncheon, R. A. Ross thanked Mr. Sise, the president of the Northern Electric Co., for his hospitality, and congratulated him upon the plant, which is one of the largest and most modern industrial establishments in Canada. Mr. Sise responded briefly and told the several hundred guests that the plant was theirs for the afternoon. The guests were taken, forty at a time, in huge freight elevators, to the top of the 8-story plant, and they walked along every aisle of each floor, finishing their visit at the steam-turbine-driven power plant on the ground floor. The building occupies a ground area of over 4 acres, and the trip trough the plant required over two hours of steady walking. A guide was assigned to every 20 men, and explained briefly the various interesting operations in the manufacture of electrical wire and cable of all kinds.

Annual Banquet

The annual banquet of the institute was held Tuesday evening in the Rose Room of the Windsor Hotel. It was the most elaborate and most successful banquet ever held by the institute. A beautifully engraved menu card contained a long list of delicacies that defied the food shortage and flaunted the H.C. of L. After the guests had partaken more or less fully of eight solid courses, not to mention those of a liquid nature, the president, R. A. Ross, who acted as toast master, started the speeches with the toast to the King. Dean Mitchell proposed the toast to the province of Quebec, and Hon. Charles Marcil, M.P., replied. Col. Leonard proposed the toast to the engineering profession, and the reply was by Prof. Scott. Mr. Ross toasted the kindred professions, and the replies were by Justice E. F. Surveyer and B. K. Sandwell.

The "Engineering Activities of the Province of Quebec" was the general descriptive title given to the third and last day's proceedings. The two sessions on Thursday were held in Windsor Hall, as the Ladies' Ordinary had been found considerably too small for the crowd on Wednesday morning, and for the second time during the meeting, larger quarters had to be found.

R. A. Ross opened the morning session Thursday promptly at 10 o'closck, but shortly afterwards he requested Dean Mitchell to preside, as he was called away on matters of civic administration.

Quebec's Policy as to Water Powers

Oliver Lefebvre, chief engineer of the Quebec Streams Commission, reviewed the policy of the province of Quebec in respect to water powers. He explained the method of leasing and the steps taken by the provincial government to ensure a reasonable measure of control over the water powers. He said that capital will not invest where the conditions are drastic or arbitrary. He quoted some of Mr. Amos' statistics on water powers in Quebec province, and also the totals of those compiled by the Dominion Water Power Branch and the Commission of Conservation, and then outlined the organization and work of the Quebec Streams Commission, particularly in regard to the St. Maurice, St. Francis, and Ste. Anne de Beaupre storage reservoirs, and showed the great beneficial effect that these dams have had on the minimum flow of the rivers. With the exception of the Gatun reservoir, in connection with the Panama Canal, the St. Maurice storage reservoir is the largest in capacity in the world. Gatun stores 183 billion cu. ft., St. Maurice 160 billion. Mr. Lefebvre also outlined very briefly the work that the commission now has under consideration, which includes at least four more storage dams, totalling several million dollars in estimated cost.

Theo. J. Lafrenierè, sanitary engineer to the provincial board of health, reviewed the public health acts of Quebec.

The first was passed in 1849 during a cholera epidemic, but this applied to times of epidemic only. The first permanent act was passed in 1886. Probably the first order ever issued in Quebec in the interests of public health was in 1667, when it was decreed that privy pits be established and refuse taken care of without public nuisance. In 1706, inspection of bread and meat was started. Several years later the chief of police of the province visited Montreal and determined the slopes of the streets in the more thickly settled part, ordered the construction of sewers and declared it a misdemeanor to throw rubbish into the streets.

Sanitary Engineering in Quebec

In 1745 the first census was taken but after that health matters showed no progress or change until 1795 when the colony was threatened by a typhus epidemic in Ireland, and quarantine measures were adopted in regard to ships until the captains had given full information and guarantees. From 1815-21 there was a smallpox epidemic that was fought with vaccination. In 1832, during a cholera epidemic, the provincial government appointed a health commission of 16 members, and in 1849, during another cholera epidemic, they passed a health act giving certain powers to this central board and permitting them to exercise these powers during any epidemic. This act was invoked during the epidemics of 1854, 1866 and 1885, and again in 1919 during the influenza epidemic.

In 1870 a municipal code was passed giving each municipality power over buildings, water works, sewers and infections diseases. From 1870-85 this act was but little used, but in 1885 there was a smallpox epidemic and the following year a permanent board of health, consisting of 6 members, with power to control conditions anywhere in the province, was appointed and began active work. Amendments to the act, passed in 1890 and 1893, made it a really useful act. In 1893 a statistician, and in 1894 a chemist and bacteriologist were appointed, and in 1909 a sanitary engineer. In 1911 the province was divided into districts with officials in charge of each district. The board consists of 8 doctors, 1 dentist and 1 engineer, but the engineer's commission has just expired.

The board has the power to enforce municipalities to obey its mandates, and it can also issue orders to individuals or companies. Plans for water works or sewerage extensions must be submitted to the board by a graduate engineer. He must submit general and detailed plans, accompanied by a report when necessary. If a water supply is derived from a surface source, the plans must provide for purification; if from an underground source, a map showing all buildings, etc., within 1,000 ft. of the source, must be filed with the board.

440 Water Works Systems in Quebec

Raw-water by-passes for fire protection must be sealed by a representative of the board and opened only when necessary, but this subject is being discussed now by the board and it is entirely probable that dual connections will be entirely forbidden.

Sewage treatment is ordered wherever the pollution is unduly great. The Public Utilities Commission appoints an abritration board to determine the division of costs when municipalities are ordered to build joint sewerage systems, use common water works intakes, etc., in the interest of health.

Any municipality that has been ordered by the board to construct works does not have to submit a money by-law to its ratepayers. The only orders issued to municipalities to date have been to direct one to change its water supply source, one to build a reservoir, two to build sewers, and four to merge their interests in a common sewerage scheme. Most of the board's power over municipalities was granted only in 1916, however, and the war was then a factor in the situation, but now the board intends to force an improvement in certain sanitary conditions.

In the province of Quebec there are now 860,000 people supplied with filtered water and 170,000 with chlorinated water. The latter figure does not take into account filtered water that is also chlorinated. There are 440 water works systems. Half of these are very small, but 192 serve over 500 people. Of the 1,300,000 people served by these 192 plants, 86% drink river water, 4% drink lake water and 10% get spring or well water. It is the intention of the board to order filtration or chlorination plants for all river supplies. Some of the lake and spring or well supplies are of very good quality.

Alex. Fraser, assistant chief egnnieer, Department of Roads, Quebec province, read a paper on "The Evolution of the Public Roads Problem in Quebec Province."

Until 1841 the roads of the province were under the Grand Voyer, said Mr. Fraser. In 1796 a bill was passed appropriating a small sum for the construction and repair of roads. In 1827 a special committee investigated conditions pertaining to trunk roads. But up to 1907 the roads of the province were generally in bad shape under the statute labor and individual portion systems. The Good Roads Act which was passed in 1907, and its amendments of 1908, 1909 and 1911, changed the situation. The province has spent nearly $25,000,000 in encouraging highway construction since 1911. Last year there were built 341 miles of gravel road, 93 miles of Macadam, 7 miles of penetration Macadam, 3 miles of bituminous concrete and 6¾ miles of cement-concrete. There are 1,700 miles in the province's present program of construction, some with federal aid and some to be built without federal aid.

Road Problems in Quebec

Mr. Fraser stated that it is estimated that 80% of the traffic of the province uses only 20% of its 40,000 miles of roads, and that 40% of the traffic goes over the roads that have already been improved. The trunk highways built since 1911 include the King Edward Highway, the Montreal-Quebec Road (the Gouin Highway), the Levis-Jackman Road, the Sherbrooke-Darby Line, the Montreal-Chambly Highway and the road from Riviere-du-Loup, to Edmunston N.B.

In 1919 the province authorized 336 municipalities to do maintenance work on improved local roads, and 204 did such work on a total of 535 miles of Macadam or gravel roads. Hundreds of tests on stone, gravel and other materials were made last year in the department's own laboratory.

In discussing Mr. Fraser's paper, W. A. McLean, deputy minister of highways for Ontario, stated that of the 55,000 miles of roads in that province, 42,000 are graded and in use and half of them are superior to earth roads. Ontario expects to spend fully $12,000,000 annually for the next five years on road construction, said Mr. McLean, and after that probably more each year. His program is to get the traffic over cheap surfaces on good foundations, he said, and then improve the surfaces. In Ontario the department has scheduled 10,000 miles which it hopes to get into excellent condition as quickly as possible. Of this, the counties will take care of 8,200 or 8,400 miles, and the province directly through the department will construct 1,600 or 1,800 miles. There will be cement-concrete, asphaltic-concrete, bituminous penetration and to a considerable extent gravel or Macadam pavements (preferably oiled with asphalt or tar, said Mr. McLean).

French System of Roads for Ontario

By the end of the current year, said Mr. McLean, he hoped to have a highway from Quebec boundary to Windsor that will be reasonably passable and considerably superior to an earth road, and over which anyone will be able to travel in any weather as fast as their car can carry them. And in passing over this main route, said Mr. McLean, it will be noticed that past substantial expenditures have provided branch roads extending into all parts of the province. While there is a good system of market roads at present, a through artery has hitherto met with opposition due to the scattered population along the route.

French should be the official language of road building, said Mr. McLean, because the French have a finer system of primary construction than any other nation. In planning Ontario's roads he is endeavoring to follow the French system.

Willis Chipman discussed Mr. Lafreviere's paper in a most interesting and instructive manner. Whe he started practice as a consulting engineer in Ontario, there was not a sewage disposal nor a water purification plant in Canada. He had seen the various systems introduced—some by promotors who lacked good faith, and these systems have passed away or are passing—and believes there is great progress yet to be made in sewage disposal.

Tendencies to Nationalize

Maintenance is the key to success in sanitary structures just as it is in roads, said Mr. Chipman, but here the engineer suffers from the machinations of the professional politician who always prefers to mortgage the future than to raise the present tax rate. Many structures needing only repair and maintenance have been abandoned unnecessarily.

Mr. Chipman called attention to the fact that there is not one engineer on the Ontario board of health. He says it largely rests with the engineers themselves to decide when they will take matters into their own hands and improve these conditions.

Mr. Chipman also called attention, practically without comment, to the very great increase in tendency to nationalize everything. First the canals, then the steam railways, now the radial railways in Ontario, and the water supply systems to a certain extent, and he thought that the public is looking to the engineers for guidance in these matters.

There have been many encroachments on the status of the engineer, said Mr. Chipman, and the engineers should support the movement for legislation and get some recognition from the provinces. They should also persuade the schools and universities to give the engineers better training in English so that they can express their ideas in as clear a manner as can other professional men.

Wise Administration of Power Regulations Necessary

Prof. Peter Gillespie drew attention to a resolution adopted two years ago urging that the institute secure the appointment of engineers to the boards of health.

J. B. Challies, director of water power for Canada, in discussing Mr. Lefebore's paper, said that water power development is largely a matter of administration of the power regulations; that capital is timid and must not be frightened away from Canada by restrictions that are unduly onerous. He particularly called attention to a remark made by Prof. Scott in replying to a toast at the banquet,—namely, that the demand for central electric power is doubling every five years. If that demand be projected into the future, and if it continues at the same rate of increase, the task ahead of Canadian hydro-electric engineers is no mean one. Mr. Challies stated that the unit cost of the Quebec Streams Commission's work compares very favorably with other similar work.

C. H. Keefer, consulting engineer, Ottawa, voiced an appreciation of the Public Utilities Commission as an enormous asset to the province of Quebec.

Closing Business of Convention

The last business or technical session of the convention was held Thursday afternoon, when the following papers were read: "The Policy of the Air Board of Canada," by Lt.-Col. O. M. Biggar; "The Pulp and Paper Industry," by F. van Bruyssel; and "Quebec's Forests," by G. C. Piché, chief of the Forest Service, Department of Lands and Forests, Quebec.

The convention closed Thursday evening with a smoker and concert in the Rose Room, Windsor Hotel, with several hundred in attendance. There were no speeches but an excellent program of vaudeville entertainment by Wilkie Bard, the English Comedian, and numerous other performers from local theatres. Toward the end of the evening several of the leading players from the Chu Chin Chow company joined the party and added to the entertainment. The "hit" of the evening was the recitation of two of Dr. Drummond's poems by Chas. Godwin. Like all previous sessions of the convention, it was unanimously agreed that the smoker was the best ever held by the Engineering Institute of Canada.

FLOW IN UNIFORM CHANNELS WHEN THE WATER-SURFACE IS NOT PARALLEL TO THE INVERT*

By Prof. Alex. H. Jameson, M.Inst. C.E.

In ordinary cases of flow in open channels of uniform section, the water surface is parallel to the invert, and it is to such "uniform flow" that the ordinary formulæ apply whether of the Chezy form, $v=C(mi)^{1/2}$, or in the much more satisfactory and modern form, $v=cm^xi^y$. For convenience, call the uniform depth of the water for a given discharge at a given gradient the "normal depth" for that discharge at that gradient in the given channel. If, however, the depth of the water is increased above the normal—e.g., by passing over a weir which can only pass the given discharge by raising the water surface there, the water surface can be no longer parallel to the invert, but forms a "backwater curve" for a long distance back before the water regains its normal depth. Similarly, if there is a sudden drop in the bed or the water passes over a weir which does not require to pass the given discharge, a head equal to the difference between normal level and weir level, the water surface forms a "drop-down curve" from the normal water level at a long distance back to the level necessitated by the weir or drop (which latter is similar in effect to a weir). In such cases the depth, water area, velocity and hydraulic mean depth vary along the channel, consequently so does the gradient of the water surface. In addition the "velocity head" $(v^2/2g)$ is constantly decreasing (or increasing) and the water surface must fall less (or more) steeply to provide for this change in the kinetic energy of the water. A third case of "non-uniform" flow occurs when the invert of the channel is level or rises against the flow. Here the water surface must fall, and as the depth decreases it must fall, as before, in a curved profile.

This subject is treated at considerable length in Gibson's and in Merriman's "Hydraulics," but only for the case of a very broad and shallow channel of rectangular section (such as some rivers and canals), which is very different from the conduits used by water engineers. This has been done to employ a section in which the hydraulic mean depth equals the depth of the channel at every point, as this alone gives a purely mathematical solution. Even then the solution is one of considerable difficulty, and to simplify it tables of the "backwater" and "drop-down" functions for various values of (depth/normal depth) have to be used. In addition, the Chezy formula is used to simplify the mathematics, but without varying the "constant" with the varying hydraulic mean depth, which, of course, is essential to obtain at all accurate results.

In the appendix the author shows that if what he calls the "flow-function," $\phi=dl/dh=[l-(v^2b/ag)]/[i-i^1]$ is plotted as a curve for various depths, h, of the water in the channel, where v is the velocity for that depth—i.e. (discharge/area), b=breadth of the water surface, a=water area at that depth, $g=32.2$ as usual, i=the gradient of invert and i^1=the calculated gradient of the channel to discharge the given quantity of water at a uniform depth h, then the *area* of this curve between any two depths h_1 and h_2= the *length* 1_1-1_2, in which the *depth* increases or decreases from h_1 to h_2. This function is not difficult to calculate once the *water areas*, and hence the velocities and hydraulic mean depths, have been found at a sufficient number of depths, while i^1 can be found by an "alignment diagram" from the hydraulic mean depths and velocities, or from charts giving gradients, hydraulic mean depths and velocities.

As shown in the appendix, $1/\phi=dh/dl=[i-i^1]/[l-(v^2b/ag)]$=rate of change of depth with length along the channel. When h="normal depth," $i^1=i$, the rate of change of depth is zero, and the depth remains constant. This is, of course, as it should be. When $(v^2b/ag)=1$—i.e., when $v=(ag/b)^{1/2}[=(gh)^{1/2}$ in a rectangular conduit), the denominator becomes zero, and the rate of change becomes *infinite*—

*From paper read before the Institution of Water Engineers.

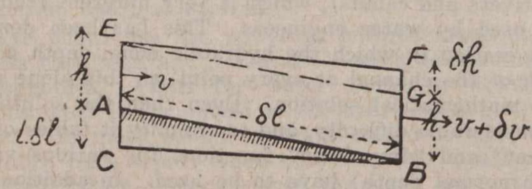
i.e., the water surface becomes vertical, and a "standing wave" is produced. The depth at which this occurs may be called the "critical depth,"—viz. (v^2/g) in a rectangular channel. In the neighborhood of this depth, however, the shape of the water profile cannot be determined exactly by this method, as there is a considerable inclination of the water surface to the bed, so that the stream lines are far from parallel and the square of the mean velocity differs widely from the mean square of the velocities. There is also sure to be a loss of energy due to shock in the case of a "rising standing wave," similar to a sudden expansion in a pipe, while a "falling standing wave" is really a weir effect. For a level bed $i=0$; while for a rising bed i is negative.

Usually the gradient i is small, and the "critical depth" is much below the "normal depth." In this case, if the depth of the water is reduced by a valve to or below the critical depth, a "standing wave" is produced, the water surface rising vertically to normal depth (see paper by Gibson in "Proceedings," Inst. C.E., Vol. 197, in which this result was verified by experiment). If a channel has a very deep slope, and, therefore, low normal depth, the critical depth may be above the normal depth; in such cases, when depressed by a valve below normal depth, the surface rises in a gradual curve to normal depth, while when raised above critical depth—say, by a weir a standing wave is produced, and the water jumps the obstacle instead of ponding up behind it in a "backwater" curve.

The practical importance of these curves, if verified by experiment, is obvious. If the water engineer knows the shape of the water surface curve, the depth of his channel can be designed to follow it without waste of material in side walls of unnecessary height, or without risk of overflow or of putting pressure on his conduit if closed, through under-estimation.

Appendix

In the figure let AB be a very short length of the invert of a channel of uniform section, and EF be the correspond-



ing water surface. Let sin $ABC=i$. Let h and v be the depth and mean velocity at A, while $h+\delta h$ and $v+\delta v$ are depth and velocity at B. Then total head at A=total head at B+ resistance A to B, or $i\delta l+h+(v^2/2g)=h+\delta h+[(v+\delta v)^2/2g]+i^1\delta l$ [where i^1=loss of head per unit length for velocity v and depth $h=(fv^2/2gm)$ or better $K(v^p/m^q)$].

Then $i=(\delta b/\delta l)+(v/g)(\delta v/\delta l)+(\delta v/2g)(\delta v/\delta l)+i^1$. Now if δl and therefore δh and δv are reduced to zero, this becomes $i=(dh/dl)+(v/g)(dv/dl+i^1=(dh/dl)+(v/g)(dv/dh)(dh/dl)+i^1$, as v is a function of h only in a uniform channel. Therefore $(dh/dl)=[i-i^1]/[l-(v/g)(dv/dh)]$ giving the *slope* of the water surface.

But $v=(Q/a)$ where Q is the constant discharge, therefore $(dv/dh)=(Q/a^2)(da/dh)=-(Q/a^2)b=-v(b/a)$, as $\delta a=b\delta h$, where b=breadth of water surface. Therefore, $(dh/dl)=[i-i]/[l-(v^2b/ag]$ and $(dl/dh)=[l-(v^2b/ag)]/[i-i^1]$. Therefore $l_2-l_1=\int_1^2\{[l-(v^2b/ag)]/[i-i^1]\}dh=\int_1^2 \phi dh$=area of ϕ, h curve from h_1 to h_2.

(N.B.—In a rectangular conduit b=constant, and $a=bh$. Therefore $(v^2b/ag)=(v^2/gh)$.)

Members of the Canadian committee to consider the construction of a Peace Memorial Bridge at Buffalo have been notified that a bill authorizing the naming of a special American commission for this purpose has successfully passed Congress and Senate. The Buffalo branch of the joint international committee of twenty-five is now planning to get down to active work.

SLAB VALUES OF "GUNITE"

RECENTLY a series of tests were started designed to show the slab values of "Gunite." The first of these tests under official observation has now been completed. The tests were made on 4 ft. slabs, 2 ins. thick, with loose ends, not making any allowance for continuous beam action. A summary of the results of the test are given herewith and are really noteworthy:—

SHORT SUMMARY OF TESTS MADE ON SLABS OF "GUNITE" 2 INS. THICK, 4-FT. SPAN, 28 DAYS OLD, BROKEN JANUARY 20-21, 1920

Slab.	Mixture.	Rein. sq. in. per ft. of width.	1st deflec. at lbs.	Last deflec. at lbs.	Broke at lbs.	Equiv. dis. load.	Lbs. per sq. ft.	Average.	Gross average.
1	...1–3	0.20	1/16–2775	11/16–11440	12352	16469	823		
2	...1–3	0.20	1/16–3360	5/8– 9716	10301	13735	687	766	
3	...1–3	0.20	1/16–2606	5/8–11292	11832	15776	789		
8	...1–2½	0.20	1/16–3877	9/16–12492	13130	17507	875		783
9	...1–2½	0.20	1/16–3261	5/8–11832	12493	16657	833	833	
10	...1–2½	0.20	1/16–3220	5/8–10001	10394	13859	693		
4	...1–3	0.10		7/16– 6798	7373	9831	492		
5	...1–3	0.10	1/16–3331	½– 8556	9040	12053	602	555	
6	...1–3	0.10	1/16–3906	7/16– 8466	9228	11510	570		
7	...1–2½	0.10	1/16–3861	7/16– 8378	9500	12667	633		602
11	...1–2½	0.10	1/16–3180	5/8– 8372	8847	11796	598		
18	...1–2½	0.10	1/16–4373	9/16–10124	10705	14273	714		
12	...1–3	0.15	1/16–2709	5/8–10111	10465	13953	698		
13	...1–3	0.15	1/16–3218	5/8– 8425	8722	11629	581		
14	...1–3	0.15							671
15	...1–2½	0.15							
19	...1–2½	0.15	1/16–4371	9/16–10176	11184	14912	745		
20	...1–2½	0.15							

Thus slabs with 0.20 reinforcements have a safe load of 157 lbs. per sq. ft., with a factor of safety of 5, or 196 lbs. with a fac. safety of 4.

Slabs with 0.10 rein. have safe load of 120 lbs. with E.S. 5 or 150 with F.S. 4.

Slabs with 0.15 rein. have a safe load of 134 lbs. with E.S. 5 or 168 with F.S. 4.

Tests made by putting platform on top of rollers carried on ¾-in. x 3-in. straps, placed at one-third points. Pig iron was piled on top of this platform and deflections read at each addition of 500 lbs.

Reinforcement of expanded metal furnished by the Consolidated Expanded Metals Co. 2¼-in. mesh of areas indicated metal at ⅜ in. from bottom of slab.

At the eighteenth annual convention of the Canadian National Clay Products' Association, which opened on Wednesday, January 21st, at Toronto, the following officers were elected for 1920: Past-president, Thomas Kennedy, Swansea; president, William Burgess, Todmorden; vice-presidents, Ryland H. New, Hamilton, Millard F. Gibson, Toronto, T. H. Graham, Inglewood; and secretary-treasurer, Gordon Keith, Toronto.

Leaside Engineering Co., Ltd., Leaside, Ont., has organized a contracting department, and is prepared to enter into contracts covering the construction of pulp and paper mill plants, Hydro-Electric power developments, industrial plants, factories, warehouses, bridges, wharfs, etc. The company in the past has constructed a large shell plant, consisting of six buildings, for the United States government; wire plant for Canada Wire and Cable Co., Ltd.; tire mill for Dominion Tire Co. at Kitchener, Ont.; complete sets of railway and locomotive shops at Moncton, N.B., Halifax, N.S., and Charlottetown, P.E.I.; 10,000 h.p. Hydro-Electric plant at Cobalt, Ont., for British Canadian Power Co.; 20,000 h.p. Hydro-Electric plant at Beaupre, Que., for Laurentide Power Co., besides a large number of smaller contracts. The company will be represented by Edward C. Warren as manager and J. R. Nichols as general superintendent, both of whom have been in the organization for a number of years and in charge of the above-mentioned undertakings.

MODERN HIGHWAY PROBLEMS*

By E. W. James
Assistant Chief Engineer, Bureau of Public Roads, Washington, D.C.

HIGHWAY engineering is going to become one of the most important branches of engineering science. It is not only on the technical side that highway engineering has become important, but on the administrative side of human life. Very few men have ever crossed the Firth-of-Forth bridge, but I venture to say there are very few men who have not used a highway. Our grandfathers, and also most of our fathers, had to build their own roads, and consequently when it comes to road-building to-day, most people think it is a "family" affair, and that they are all able to do it. That is one of our modern highway problems.

It is unnecessary to say here what is at the bottom of modern highway problems. It is unnecessary to give statistics and figures indicating the changes that have occurred in motor traffic during the last ten years, and in respect to motor trucks in the last 3½ years. There is adequate machinery for motor vehicle registration throughout the United States and Canada, and this provides approximately correct figures which show absolutely what is the source of all of our modern highway problems and troubles.

Growth of Motor Traffic

Fifteen years ago automobile traffic on our highways was negligible; 3½ years ago motor trucking on our highways was negligible; to-day the business presents an entirely new set of problems for the highway engineer.

There are two aspects to the question. First, there is the administrative side and its importance. In the United States we have passed this problem and I believe that we have in a measure solved it. Twenty-seven years ago we had no state highway departments; twenty-four years ago we had only two state highway departments; to-day we have forty-eight state highway departments in active operation. The reason for that fact is just this: The growth of this new motor traffic, and the increased radius of its operation, made it absolutely imperative that the poor towns and poor counties should not stand in the way of road development and construction. Further, that towns and counties, rich and poor, should do their construction systematically in a manner articulate with that of their neighbors, and that roads should be built uniformly good across the country.

We had many poor towns and counties, and for years they stood in the way of highway development. The growth of our state-aided system is the direct solution of that problem of administration. Three years ago another advance step was taken when the federal government officially stepped in and continued the process of development. We found that where the state-aid systems solved the problem of the poor towns, there was nothing to equalize the differences between state and state excepting the federal government, and three years ago the federal government assumed its place along with the states, and to-day we have without doubt the biggest program of highway construction that has ever been undertaken in the history of mankind.

Large Program for 1920

It has been estimated by the Bureau of Public Roads that during the present year funds amounting to $633,000,000 will be available for road construction in the United States. That is one year's program, but we do not expect to use all that in one year. It took ten years to build the Panama canal, and the funds available for our roads next year would build that canal twice over. That will give some idea of the extent and importance of this subject in the minds of the people of the United States.

*Excerpts from address at the annual meeting of the Engineering Institute of Canada, January 27th, 1919, Montreal, Que.

The solution, so far as we have gone in the United States, is of interest to the engineers of Canada and the Canadian government, for the reason that you have paid us the high compliment of coming to the United States for a study of the federal aid laws, and there is on your statute books to-day a law formulated in principle on our Federal-Aid Act of 1916, and I had the honor of having had a hand in some of the early details of that Act and in preparing rules and regulations giving force to that Act, and you have adopted rules similar to ours in the states, because your law is based largely on ours.

Uniform Laws for Controlling Vehicles

The next obvious step to be taken by us will be the solution of the administrative problems of modern highway building. Shall there be federal highways, planned, built and maintained by the federal government exclusive of the states? Personally, I am of the opinion that the United States will be able to hold the states well in line in respect to their different highway systems.

The injection of the federal government into the highway situation not only solves the question of modern construction to meet modern traffic, but it paves the way directly for the next step to come; and I think that most adminstrative officials interested in such matters recognize fully that the next step to take is the passing of more or less uniform laws for the control of motor vehicles; for registration and licensing of automobiles; for the construction and maintenance of highways; and, for the general uniform control of the highway situation.

The conclusion of this part of the matter is this: That the gradual development (first by the state and then the federal government) that we have seen in the United States seems to be adequate, and, so far as we know, is the only adequate solution to meet modern highway conditions. However, I leave that for your consideration and for your encouragement, inasmuch as you are to-day just entering that final stage of the matter.

Problems of Modern Traffic

Now I wish to turn to the technical problems that modern traffic present to us and to give passing mention of this most important matter.

In the first place, our general cross-section design has been tremendously influenced by modern traffic. The weight and quantity of traffic has so increased that where we used to build, to take a typical example, 5 or 6 ins. of concrete on a concrete road—I know many in the province of Quebec as well as Ontario are familiar with that construction—we now use 6 ins. on the sides and 8 ins. in the centre, or what we call 6-8 construction. A great many are built 7-9, and in New Jersey we are building 8-10, averaging 9 ins. thick, or an increase of practically 50% over our former designs of 3½ years ago.

This is because of a very interesting fact. We have come to recognize that there is in railway work a detail which also affects our designs as highway engineers, and that is the question of impact. The bridge engineer is familar with impact as well as is the railway and other engineers, but the highway engineer never bothered about it until the failures that occurred of some of our highest types of roads, two winters ago, brought us face to face with the fact that impact destroyed our roads.

A month or so ago one of our men got up at a meeting and said that a true cylinder rolling over a true plane should cause no impact, but unfortunately we cannot build our roads as a true plane and our auto and truck wheels are not true cylinders, so that we do, as a matter of fact, develop impact. It starts its work at the slightest imperfection in a hard-surfaced road. It is exactly as if a man working with a sledge attacked the road at that point, and a man with a sledge can cut his way right across a 6-in. road. We have had concrete roads and brick roads, and brick roads on concrete base, and all kinds of road construction, go to pieces almost promiscuously due to impact. This question of impact is one we are facing in cross-section design, and because of additional quantity of traffic, the widths of our roads must also be modified. Road-building is expensive anyway, and when you add a foot to a mile of road it costs considerable money, but we are adding to-day practically 3 ft. to the width of our standard roads.

Of 444 concrete pavements built under federal aid in the United States, 8% were 15 ft. wide, 36% were 16 ft., 42% were 18 ft. and 8% were 20 ft. In other words, we are building to-day just as many 20-ft. roads as 15-ft. roads, and almost half of the concrete work we do is 18 ft. wide. This is a serious problem to the engineer and to the men who finance the roads, whether the county or the state, and adds at least one-fifth to the normal construction of the surface.

Importance of Drainage

Then there is the question of drainage. This presents to us to-day some new thought. I wish someone would coin a new word for drainage, so that when the highway engineer talks about it someone will "sit up and take notice." We have talked and talked about it, yet we go right on building roads in such ways that one would think that we had never heard of drainage or that we don't believe in its efficacy.

The question of capillarity is one of the most interesting things that highway engineers are now thinking about, and I hope before the Bureau of Public Roads finishes experiments now being made, that it will have come to some definite opinions as to the effect of capillarity. We know now that capillarity, with a source of free water available, will soak a subgrade to the point of physical saturation, for a height of 18 ins. above the source of free water, in 24 hrs.; and that the same capillary action will bring water 5 ft. horizontally in 24 hrs. That is an interesting thing. We have lots of places in the United States where roads went to pieces a foot above the water. In New Jersey it has affected construction costs to the tune of $10,000 to $15,000 a mile, and in order to save our surfaces we have got to go to that expense.

This means that the modern highway engineer must get back to the teachings of Telford and Macadam. We are going to go back in construction to the large-interstices base.

We are studying and developing the so-called "blacktop" or bituminous construction, which was the first step in meeting the problem of traffic ten years ago, and we are carrying it to a higher degree of usefulness. The tendency is to introduce bitumen of lower penetration. We are using bitumen with penetration as low as 60 to 80, and have automatic distributing machines for putting it down. We are introducing mixed bases for use in the west where water is not readily available for concrete making or water-bound macadam construction. We are laying two-course bituminous construction in order to give greater stability under certain conditions.

Exact Effect of Impact

We are now conducting a very valuable series of experiments in regard to impact. We are observing carefully and measuring the impact of a truck operating over obstacles of vairous sizes from ¼-in. to ½-in. high. We are conducting separate experiments on various kinds of pavements and with different bases; in some cases with saturated bases, and it is wonderful to observe what impact will destroy. We hope soon to know the exact effect of impact, and to know within very definite limits just what will cause failure of pavements. I may say that the whole future of auto-trucking depends upon the results of these experiments.

When we consider that big money is provided indiscriminately for an 18-ft. or 20-ft. track for a truck to roll over at the will of indiscreet and more or less irresponsible drivers, I think we can see that if the destruction by motor trucks cannot be successfully met, that the treasuries will draw their purse-strings rather tightly against the construction of roads for motor-trucking. This is a far-reaching problem, because the destruction by trucks is enormous.

We are also making investigations in regard to the resistance to abrasion. A number of years ago in Detroit, a machine was exhibited that reproduced the action of horses' hoofs, and so determined abrasion. That shows how recently the problem has changed. To-day to study abrasion we do not imitate hoof action, but we are using a machine with five 1,000-lb. cast-iron wheels, and by speeding it we soon determine the life of a pavement. We can put a brick pavement, for example, through its paces in the course of six weeks, simply by giving it such traffic as it would normally get in fifteen or twenty years in the ordinary manner of traffic on the open road.

That raises a most important point,—the question of road construction. We used to build roads by the mile; the time has now come when we have to build them by the square yard. We are purchasing tens of thousands of dollars of materials annually; we have got to know what we are purchasing and what we are paying for. That means laboratory control. We will have to be able to interpret laboratory results in a better manner than ever before.

There have come under my notice lately a number of cases where a laboratory man has thrown out materials which a skilled field man could use by mixing. That alone is a most important thing, and must receive attention to save waste at this time of material shortages.

The science of highway engineering is in its infancy, and it stands to-day on the threshold of a large development.

U.S. Government Does Not Enter Construction Field

In order that I may leave one more word of service with you, I will go back to the administrative side. I would say that in the States, in solving our problem, we have learned that with the state organizations, which is parallel to your provincial organizations, we should rely on the states to carry out the construction. The United States government does not enter into construction. We depend on the states for that, and for this reason: We must handle it at arm's length. Otherwise we would have to duplicate a large field organization, and so we are acting and finding it better to act, through the state departments.

This is an imporant subject to us all; the development that will follow the construction of a well-articulated system of roads is almost immeasurable. Certainly congress and the government of the United States would not appropriate hundreds of millions of dollars annually for road construction unless they felt that in so doing they were bettering the nation.

You have started on a federal program of about five mililons of dollars a year for four years. We also began on five million a year, but our impetus was so tremendous it has almost run away with the American congress, and that is some undertaking.

You will no doubt find it necessary, as we have found it necessary, to develop men particularly skilled in highway engineering and construction. You have excellent instrumentalities. Al that is needed is in your universities, and I am sure you have the engineerng talent among the young men of the provinces, and if they go into highway work and do their part in developing the highways and the highway system of the nation, they will be giving the greatest service to the nation that is possible, and that, I understand, is the goal which your society has set for itself.

Algoma Steel Corporation plan to erect a new structural steel mill to cost about $6,000,000.

Geo. G. Anderson, the Los Angeles irrigation expert retained by the Alberta government, stated at a conference with the provincial cabinet minsters that the proposed irrigation scheme in the northern Lethbridge district was entirely feasible, and that he had satisfied himself that an adequate water supply was available. He had found the survey work already done by the Dominion government to have been carried out with great carefulness and accuracy, but the estimate of cost that had been currently accepted, largely on local and unofficial authority, he believed to be considerably under the amount that would actually be required.

WATERSHED LEAKAGE IN RELATION TO GRAVITY WATER SUPPLIES*

By Robert E. Horton
Consulting Engineer, Voorheesville, N.Y.

PROBABLY everyone has noticed the apparent difference in yield sometimes occurring in the case of small adjacent similar drainage areas. When the precipitation, soil and cultural conditions for such areas are similar, the difference in yield is no doubt due to watershed leakage.

Watershed leakage may be defined as the passing of waters underground from one topographic drainage basin into another. The area tributary to a stream at any point may be considered as the drainage basin at that point. Watershed leakage often occurs from the upper to the lower portions of the same drainage basin, that is to say some of the waters naturally tributary to the stream above a certain point do not enter the stream above the point, but pass underground into the stream at some lower location.

Watershed leakage may also be defined as a condition where the boundary of the ground water horizon supplying the stream is not coincident with the surficial watershed line. Nearly all large artesian systems involve watershed leakage, but this discussion will be mainly limited to its occurrence in conjunction with the surficial ground water horizon.

Watershed leakage from the upper to the lower portion of the same drainage basin, or from the lower portion of a tributary to the stream it enters is commonly called "underflow" in the west. Its occurrence requires that the ground water horizon shall lie below the level of the stream bed. In such cases water may be lost from the stream directly by percolation from the stream bed, or there may be no such loss, since the bed of the stream frequently becomes water-tight or impervious as a result of the silting up of the pores in the stream bed material.

A stream channel of this character has been described by O. E. Meinzer as an "insulated stream." If there is loss from the stream channel, all the water may disappear during the dry season and the stream become intermittent in a given reach, having a visible or surface flow only during floods, such run-off as occurs at other times being in the form of underflow. This condition is a common one on rivers of the plains.

Watershed leakage on a large scale, as in the case of plains streams, or underground rivers in limestone regions, is obvious. It is the occurrence of similar conditions on a

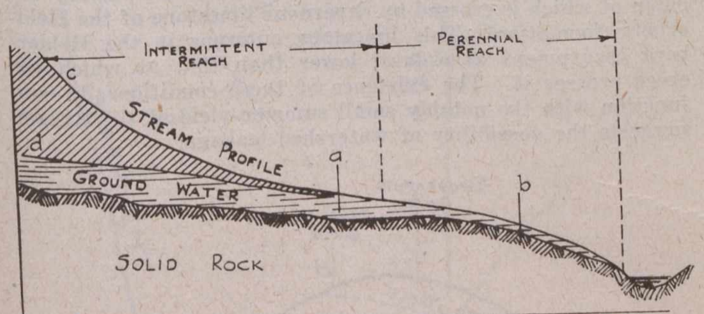


Fig. 1—Watershed Leakage from Upper to Lower Portion of Same Basin

small scale, where the phenomenon is not obvious, or might not even be suspected, to which attention is especially called. As will be pointed out, watershed leakage, of sufficient extent to seriously affect the accuracy of estimates of stream yield or run-off, is more likely to occur in conjunction with the basins of small streams than in conjunction with larger rivers.

Many gravity water supplies, and some high head power developments and irrigation systems, are dependent on the yield of relatively small drainage basins, which often lie at high elevations. Rainfall records in such basins, and gaugings of the yield of such small areas, are much less common than in the case of large drainage basins, and in estimating the available yield it is frequently necessary to depend upon studies based on rainfall and water losses, gaugings of other streams, or these data in conjunction with limited gaugings of the stream in question.

On account of the simplicity and uniformity of conditions commonly prevailing over the area tributary to a small

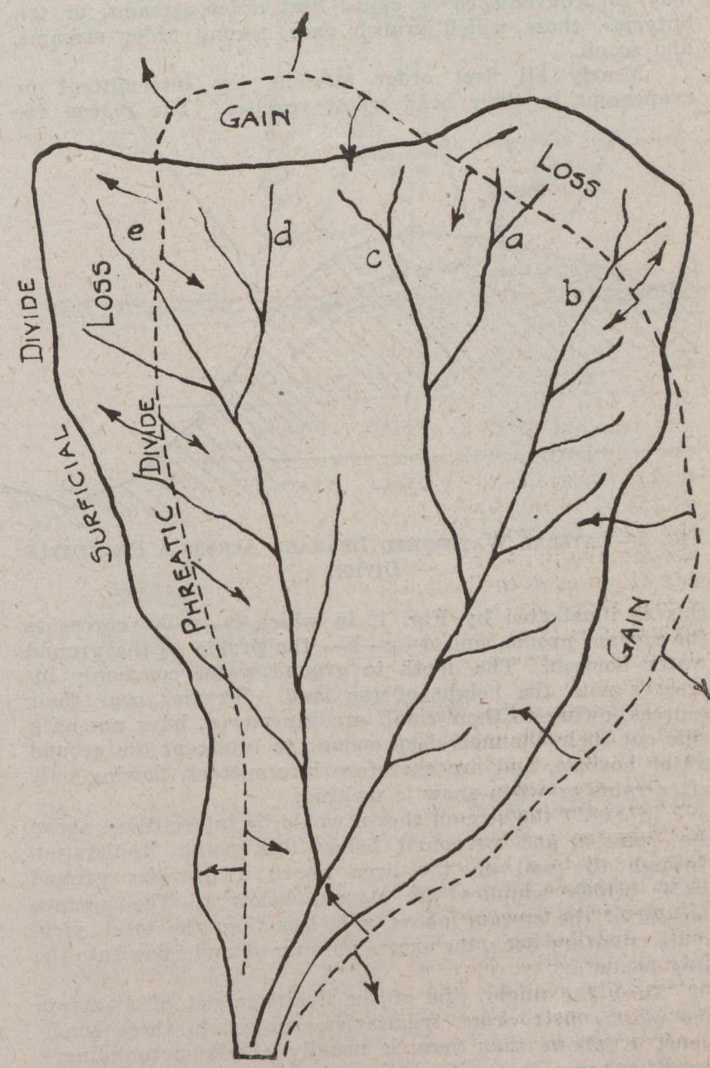


Fig. 2—Conditions Favoring Watershed Leakage
Arrows indicate direction of flow of ground water.

stream, gaugings of the run-off from small areas should afford valuable data for the determination of the laws of stream flow. Conversely, it should be possible to estimate the water losses from such small areas more readily and accurately than in the case of large areas with complex and diversified soil and cultural conditions. In either case it is necessary, in order that the results may be correctly applied, that the basins under consideration should not be affected by watershed leakage.

In view of the considerations which have been presented, it appears that when any small drainage basin is proposed as a source of upland or gravity water supply, or for similar uses, where watershed leakage is liable to occur, if possible, the yield should be determined by gaugings. In the absence of a long gauging record, measurements during a dry period, in conjunction with observations of rainfall, are very desirable. If the occurrence of watershed leakage is suspected, the drainage basin should be examined with reference thereto. During high water, watershed leakage on a limited scale may effect the run-off of a drainage basin but little, since the ratio of ground water supply to surface run-off is then often relatively small. Gaugings taken during low water,

*Abstracted from paper read before the New England Water Works Association.

may, however, show results per unit of topographic area considerably greater, or less, than those obtained from adjacent similar basins not subject to watershed leakage. A critical study of the underground water conditions may reveal evidence of watershed leakage sufficient to fully account for the apparent anomalous result of the gaugings.

Conditions of Occurrence of Watershed Leakage

Streams or their tributaries which have no branches may for convenience be called first order streams, or tributaries, those which branch once, second order streams, and so on.

Nearly all first order streams are intermittent or evanescent in their head water reaches. The reason for

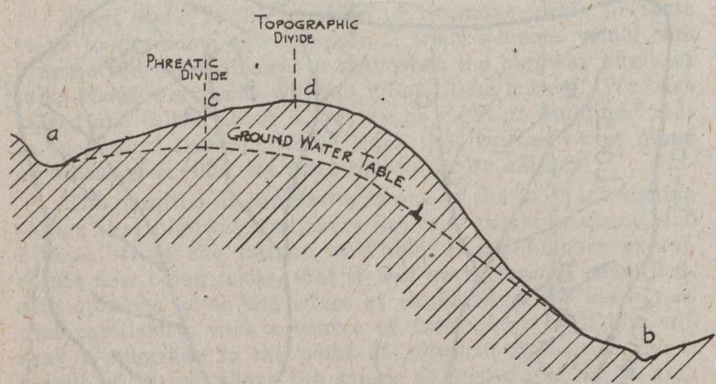


Fig. 3—Lateral Watershed Leakage Across a Permeable Divide

this is illustrated by Fig. 1, in which c—a—b represents the stream profile, and d—g—b— the profile of the ground water horizon. The depth to ground water commonly increases with the height of the land. Streams near their sources, owing to their small eroding power, have not as a rule cut their channels deep enough to intercept the ground water horizon, and are therefore intermittent, flowing only after rains or when snow is melting.

In Fig. 1 the stream shown would be intermittent above the point a, and perennial below this point. Infiltration through the soil on the area above a provides ground water which supplies the stream below a. The surface run-off of the stream above a is less than the total yield of its tributary area, the excess passing as underflow into the area below a.

Since the finger tips of the drainage net of a stream are mostly first order tributaries, subject to these conditions, it follows that there is usually a belt surrounding a drainage basin just within the watershed line (excepting in case of very impervious areas), from which the run-off occurs partly through the intermittent surface streams, and partly through the underflow of ground water to lower levels.

If the dividing ridge between two drainage basins is impermeable, there will be no watershed leakage. Watershed leakage in general only occurs where there is a continuous ground water horizon under both drainage basins or portions of drainage basins affected.

In general, the flatter the dividing ridge and the more sparse and infrequent the streams, the greater as a rule is the likelihood of watershed leakage. In large flat permeable areas the topographic and underground water divides will frequently cross and recross. The run-off relations for the headwater ramifications of the river system may thus be rendered very complex, there being inversion to one and diversion from another such tributary. Taken over the whole of a large area the local effects will often be largely neutralized.

Such conditions are illustrated by Fig. 2, in which the solid line indicates the topographic, and the dotted line the phreatic or underground water divide. In this case, taking the basin as a whole, the surficial and underground drainage areas are about equal. Some of their individual tributaries have their yield increased, as c and d, while the yield of others, as a, b and e, is greatly decreased, by watershed leakage.

The ratio of the area to the perimeter of a drainage basin increases in proportion to the area. Watershed leakage from a large basin usually occurs around the perimeter, so that the effect of watershed leakage on a given perventage of the periphery of a large drainage basin is less, relative to the total yield of the basin, than in the case of a small drainage basin. The likelihood of the occurrence of opposite effects, tending to neutralize one another, is always greater in the case of large than in the case of small areas. As a result of these conditions, the occurrence of watershed leakage in a sufficient degree to materially affect the accuracy of estimates of run-off is more probable in the case of small than of large drainage basins.

A condition necessary for the occurrence of watershed leakage is the existence of an outlet for ground water at a level lower than that of the stream draining the basin from which the water is derived. If the divide between two adjacent drainage basins is not impervious, and the stream on one side has cut to a lower level than the other, the lower stream may receive watershed leakage from the higher basin. Such leakage may occur either through sand and gravel, or through non-impervious rock, such as sandstone or limestone, under suitable conditions. Figs. 3 and 4 illustrate this.

In Fig. 3 the streams a and b are parallel, and the figure shows a cross-section of their valleys, and of the ridge between them. While the form of ground water table is generally similar to that of the overlying soil, under the conditions shown, the ground water divide would generally be to the left of the topographic divide, and if the soil were permeable, the stream b would receive the ground water from a strip c—d, the surface run-off from which is tributary to the stream a. In this case it is assumed that there are deep permeable deposits above the rock. These conditions may be reversed, as shown in Fig. 4, by the existence of impervious rock with suitable dip.

In Fig. 4, if the rock were horizontal, or the deposits of permeable materials were of great depth, the conditions would be similar to those in Fig. 3. In the presence of impervious rock dipping towards the upper stream, the ground water divide is thrown over to the right, and stream a receives the ground water flow from a strip c—d of area, the surface run-off from which is tributary to the lower stream.

Fig. 5 illustrates further the occurrence of watershed leakage due to permeable rock strata of suitable dip. Fig. 5 shows conditions existing relative to Schoharie creek, the basin of which is crossed by cavernous limestone of the Helderberg formation. This limestone outcrops in the Helderberg escarpment at a level lower than that at which the creek crosses it. The existence of these conditions, in conjunction with the notably small summer yield of the stream, suggests the possibility of watershed leakage.

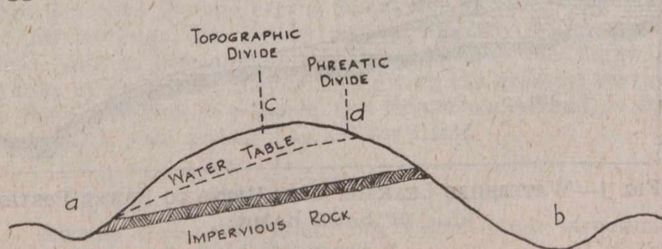


Fig. 4—Lateral Watershed Leakage Induced by Dip of Impervious Rock

Conditions under which small direct tributaries of large streams may lose ground water by underflow are illustrated by Fig. 6. The area directly tributary to the large stream, between the smaller streams, is the triangle a—b—c, but the ground water from a considerably larger area enters the main stream directly, reducing the yield of the tributaries. This condition is likely to occur around a lake margin, or on a broad valley plain, filled with alluvial deposits.

An impervious rock divide at the surface will, of course, prevent watershed leakage between adjacent basins, and if the soil is so shallow that there is no perennial ground water underneath the basin the effects of watershed leakage, if any, will be greatly reduced. The mere existence of rock strata in suitable position to permit of watershed leakage, cannot be taken as positive evidence that such leakage occurs, since the water passages in rocks rapidly decrease in size and number, as a rule, as the depth below the surface increases. However in limestone regions it is possible that formations which at one time became honeycombed with solution channels have been subsequently depressed and overlain with other materials, affording opportunity for watershed leakage on a large scale. Conditions similar to these have given rise to the great springs of water in Florida, for example, Silver Spring, which yields a constant flow of about 700 cubic feet per second, and has but little visible tributary area.

Watershed Leakage in Regions of Deep Glacial Deposits

In glaciated regions the topographic drainage basin of a stream often includes numerous undrained depressions. These contribute no direct surface run-off to the stream, but may contribute largely through underground flow. This constitutes sub-watershed leakage, occurring within the main drainage basin itself.

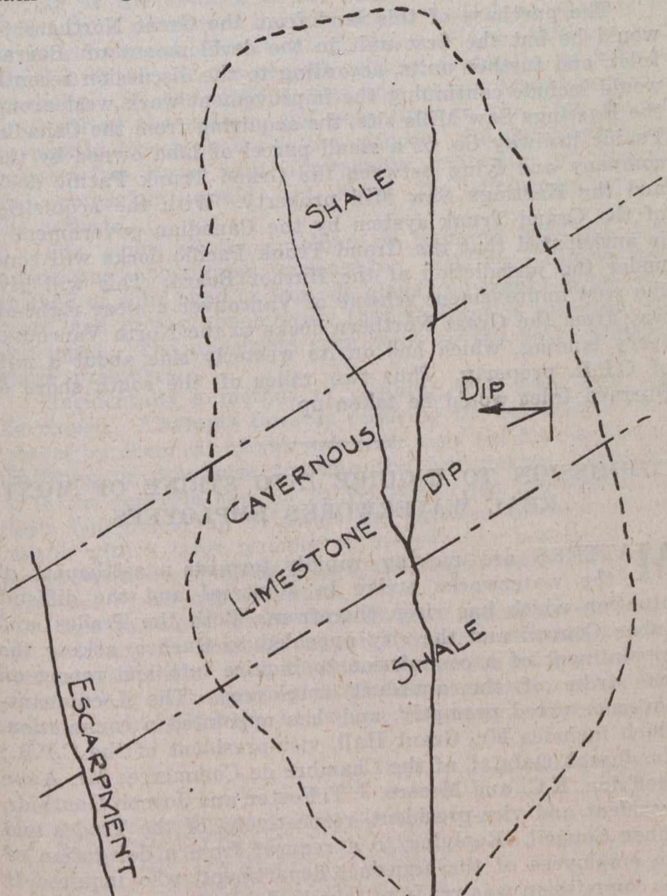


Fig. 5—Watershed Leakage Resulting from Dip, Permeable Strata

A considerable percentage of the area within the basins of the upper Kalamazoo, Grand and Huron rivers, in the deeply filled pleistocene deposits of southern Michigan, contributes to the streams only through watershed leakage of underground depressions.

Small glacial lakes at somewhat different levels, and separated by low divides of loose materials, often afford examples of watershed leakage.

It is common to hear the statement that a certain well, lake or stream has no visible sources, but is spring-fed, and has an inexhaustible supply.

In a region where rainfall exceeds evaporation no hidden or unusual source is needed to maintain a lake in a basin or depression with an impervious bottom. Precipitation on the lake surface above is sufficient. Lakes maintained in this way are usually, however, susceptible to drought, for then the supply is cut off, and the evaporation loss is usually at a maximum. In some cases lakes with no visible inflow or

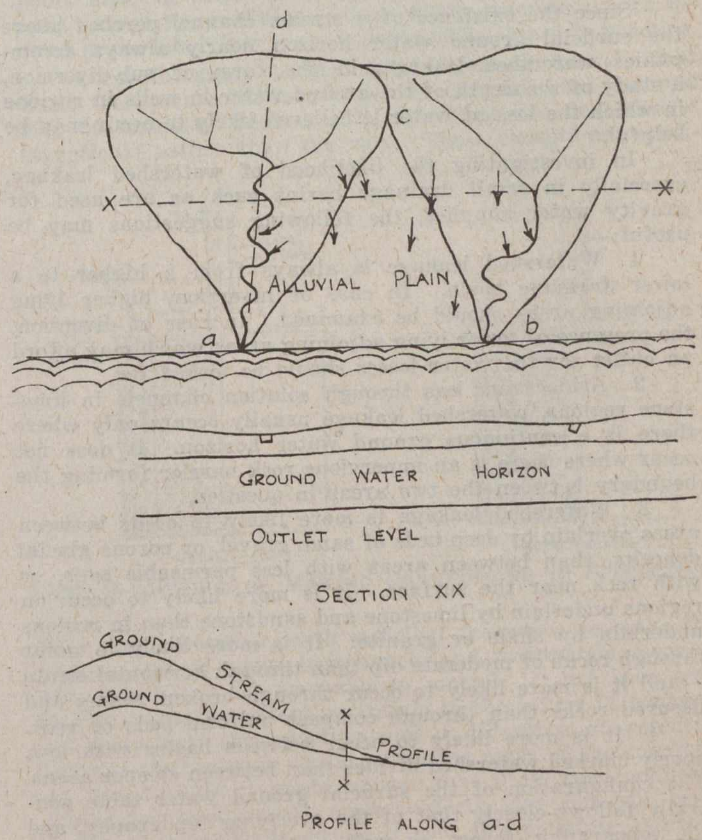


Fig. 6—Conditions Suitable for Watershed Leakage Under an Alluvial Plain

outflow are merely great natural wells, often of glacial origin and extending below the general ground water horizon, such for example as Lake Ronkonkoma on Long Island. Such natural wells may be depended upon for considerable water supplies, but such cases are rare, and lakes on ponds having no visible sources, and which must derive their supplies mainly by watershed leakage from surrounding areas, require careful investigation before adoption as sources of water supply.

Detection of Watershed Leakage

The writer has felt that the practical utility of geology as an aid to engineering could be materially increased, especially along hydraulic lines.

The detection of watershed leakage affords an opportunity for the use of geologic knowledge in the interpretation of stream flow records. Cases where watershed leakage is suspected are very numerous. There are not many instances, however, where sufficient data for full determination of the question are available. Such determination requires in general actual gaugings of the stream in question; gaugings of other streams are needed for comparison, so that the relation of the measured run-off or water losses to the normals for a similar drainage basin, free from watershed leakage, can be determined. In general, water losses are less variable than either precipitation or run-off, and conclusions based on comparisons of water losses are therefore more reliable.

A map of normal water losses for a region would be a valuable aid in such studies, and could be used in a manner similar to the use of maps of normal chlorinal content, in the study of water analyses. The writer has such normal water loss maps for the Eastern United States in preparation. If a study of the run-off and water losses of a given drainage basin indicates that these are abnormal, and suggests the probability of watershed leakage, a geologic study of the drainage basin may be made. It is difficult to lay down satisfactory general rules for such a study, but obviously the character, uniformity and depth of the soil overlying the basins, as well as the dip of the underlying rock, are important.

Since the existence of a stream channel perched above the surficial ground water horizon nearly always accompanies watershed leakage, in the form of sub-diversion, a study of the depth of the ground water in wells in regions in which the loss of water is believed likely to occur may be helpful.

In investigating the likelihood of watershed leakage, especially in small drainage basins such as are used for gravity water supplies, the following suggestions may be useful:—

1 Watershed leakage is always from a higher to a lower drainage basin. In case of inversion, higher lying adjoining areas should be examined. In case of diversion, the presence of lower lying adjoining areas which may afford an outlet for the water losses should be looked for.

2 Aside from loss through solution channels in limestone regions, watershed leakage usually occurs only where there is a continuous ground water horizon. It does not occur where there is an impervious rock barrier forming the boundary between the two areas in question.

3 Watershed leakage is more likely to occur between areas overlain by deep beds of sand, gravel, or porous glacial deposits, than between areas with less permeable soils, or with rock near the surface. It is more likely to occur in regions underlain by limestone and sandstone than in regions underlain by shale or granite. It is more likely to occur through rocks of moderate dip than through horizontal strata —and it is more likely to occur through broken, seamy and fissured rocks than through compact uniform beds of rock.

4 It is more likely to occur between basins with low, poorly marked watershed divides than between steeper areas. The configuration of the surficial ground water table generally follows closely that of the overlying topography, and the topographic forms, as well as the geologic conditions, should be taken into account.

Summarizing:—The shallower the soil mantle, and the closer to the surface the rock, the steeper the slopes, and the more impervious the soil and rock, the less is the likelihood of serious watershed leakage.

GAS AND OIL FIELDS OF ALBERTA

D. B. DOWLING, S. E. Slipper and F. H. McLearn are the authors of a memoir entitled, "Investigations in the Gas and Oil Fields of Alberta, Saskatchewan and Manitoba," recently issued by the Geological Survey Branch of the Department of Mines. D. B. Dowling deals with the structure and correlation of the formations underlying Alberta, Saskatchewan and Manitoba. The geology of southern and central Alberta is described by S. E. Slipper, and F. H. McLearn writes on the cretaceous deposits of Peace and Athabasca valleys. An appendix gives the records of strata of some fifty-two selected wells, compiled by D. B. Dowling, and the memoir is illustrated by a number of sketch maps and figures showing well sections.

Charles Henderson, of Welland, Ont., was appointed chairman, and A. Hyatt, of Ridgeville, secretary, of the Suburban Road Commission for the city of Welland, which met for organization on January 19th. The commission fixed the limits of the roadways over which their jurisdiction will extend, and the work done by the commission will be under the superintendency of the County Road Superintendent. Funds for the work of the commission are made up in the following manner: For road-building—County, 30%; city, 30%; province, 40%. For road maintenance—County, 40%; city, 40%; province, 20%.

VANCOUVER HARBOR BOARD EXTENSIONS

FROM the Great Northern docks to the North Vancouver ferry landing has become the ambitions of the Vancouver Harbor Board. The entire plan, when completed, will commence at the Great Northern docks, run along the property now owned by the Weaver Estate, the Great Northern waterfront, the city of Vancouver, across Heatley Avenue, along the Hastings Mill site, the small parcel owned by the C.P.R., and including the Grand Trunk Pacific docks. This would give the government and the National Railways nearly a mile of water frontage, and at several points would permit of overhead approaches to all the docks by the railways.

It is understood that representatives of the Great Northern Railway have appeared before the Harbor Commissioners and offered that portion of the company's property to the west of the present Great Northern docks for a sum equivalent to the original cost of the property, plus the taxes and the interest on the money invested. This will bring the price of the property, it is said, under $800 per foot and will give the Harbor Board about 800 feet of water frontage in a westerly direction to a piece of property about 100 feet wide owned by the city of Vancouver adjacent to the Heatley Avenue wharf.

The purchase of this land from the Great Northern Co. would be but the first unit in the development of Burrard Inlet, and further units, according to the discussion recently, would include continuing the improvement work west around the Hastings Saw Mills site, the acquiring from the Canadian Pacific Railway Co. of a small parcel of land owned by that company and lying between the Grand Trunk Pacific docks and the Hastings Saw Mill property. With the acquisition of the Grand Trunk system by the Canadian government it is anticipated that the Grand Trunk Pacific docks will come under the jurisdiction of the Harbor Board. This will give the port improvement scheme of Vancouver a clear right-of-way from the Great Northern docks to the North Vancouver ferry landing, which has on its westerly side about a mile of C.P.R. property. Thus two miles of the south shore of Burrard Inlet would be taken up.

COMMISSION TO INQUIRE INTO STRIKE OF MONTREAL WATERWORKS EMPLOYEES

MATTERS are moving rapidly towards a settlement of the waterworks strike in Montreal and the difficult situation which has risen therefrom. Both the Trades and Labor Council and the city appealed to Quebec, asking the appointment of a commission to inquire into and report on the strike of the aqueduct employees. The Lieutenant-Governor acted promptly, and has appointed a commission, which includes Mr. Grant Hall, vice-president of the C.P.R.; Mr. Joseph Quintal, of the Chambre de Commerce; Mr. Aime Geoffrion, K.C., and Messrs. J. T. Foster and Joseph Gauthier, president and vice-president, respectively, of the Trades and Labor Council. Replying to a request from a delegation of the employees of the aqueduct department, who inquired if the commission was ready to take back all the men, and under what conditions, the following statement was made:—

"The commission replied there could be no question of taking back the old employees of the aqueduct department before the responsibility of the strike had been established, and they asked the men to support the appeal to Sir Lomer Gouin, that a commission be appointed as soon as possible, and that a decision be rendered within the shortest possible delay.

"The commission declared they were in sympathy with the employees who had been drawn into the strike, but that the commission had no sympathy for those who were the instigators of the strike.

"The Administrative Commission gave a summary to the delegation of the negotiations that had taken place between the commission and the union delegates, and they emphasized the fact that the negotiations had not been completed when the employees quit work."

ELECTROLYSIS OF CONCRETE

THE following observations on this subject are taken from Technologic Paper No. 18 issued by the United States Bureau of Standards. The bureau conducted a great many long time tests of the effect of electric current on concrete reinforced with steel.

They show that with reinforcing iron anode at very low current densities, rusting of iron and cracking of concrete eventually occur, although the damage may not be evident until a lapse of from four to eight years. The cathode effects noted in former tests showed no progress. For the benefit of engineers who may have forgotten some of their knowledge of electricity it may be stated that when the current of electricity flows from the iron to the concrete the iron is anode, and when the current flows from the concrete to the iron, the iron is cathode. The type of specimen and the method of making connections is illustrated in Figs. 1 and 2.

Fig. 3 illustrates the effect of a high voltage with the iron as anode. Fig. 4 illustrates the softening of the concrete near the cathode. By trying specimens of concrete from which the sodium and potassium salts were removed by electrolysis, it was proven that the disintegration of the mortar at the cathode is due to an accumulation there of sodium and potassium by the current and there appears to be a consequent liberation of them of the silicates and aluminates of the set cement with a formation of soluble products. It was obvious that this action would continue until all of the sodium and potassium in the path of the current had been drawn to the cathode. On the other hand, cement free from any appreciable quantities of sodium and potassium would not show the disintegration at the cathode.

The cause of the cracking of concrete with the iron anode was investigated thoroughly. Yielding cylinders used instead of solid steel or iron, developed no cracks in the concrete, and proved conclusively that an interior pressure was developed. The physicists even went so far as to measure these pressures.

Incidentally a method of cleaning iron from rust was developed. Attempts towards reducing the efficiency of corrosion by chemical means met with very indifferent success. Painting or otherwise treating the iron before embedding it in the concrete has not as yet been tried thoroughly, the tests being held up to await the outcome of some experiments with a large number of preservative paints for iron as preventives of natural and electrolytic corrosion in the presence of air and moisture.

The judicious distribution about a structure of courses of masonry or concrete of high specific resistance offers large possibilities as a contributory means at least toward minimizing electrolysis in reinforced concrete in those cases where electrolysis might be expected to occur. Investigations

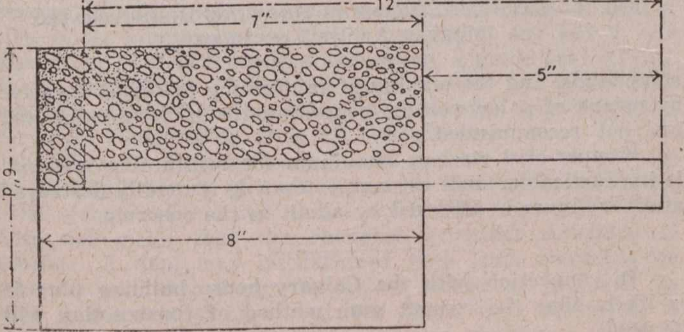


Fig. 1—General Type of Specimens Used

were accordingly undertaken to ascertain the specific resistance of very wet concrete of different proportions, methods by means of which its specific resistance might be increased, and also the specific resistances of samples of the two commonly used building materials, granite and limestone, in both wet and dry condition. In a search for an effective and durable insulating coating which might be applied to the surface of concrete some tests were made of a number of waterproofing and damp-proofing paints and membranes.

Possibilities of Trouble from Electrolysis in Concrete Structures Under Practical Conditions

The matter has been studied from the practical standpoint also, in order to determine, as far as possible, to what extent the conditions under which concrete can be injured in the laboratory may be expected to obtain in practice.

A careful study of the data shows conclusively that while there are conditions under which reinforced concrete may be seriously injured, such conditions are nevertheless exceptional rather than the rule. These exceptional conditions occur, however, with sufficient frequency to make the problem one of great importance, and fortunately most of these conditions are amenable to control. It has been seen that the most important essentials to the injury of concrete by electrolysis are moisture and a difference of potential between electrodes in contact with the mass of the concrete. At first thought it might appear that these two conditions are almost omnipresent, since perfectly dry concrete, especially below grade, is seldom if ever found; while as every electrical engineer knows, there are few places in our cities at the present time where appreciable differences of potenial can not be found between any two points more than a few yards apart. The statement in regard to the rarity of dry concrete is made advisedly, since only the most minute quantities of moisture are necessary in order to impart to concrete a considerable conductivity. On the other hand, the concrete has to be made very wet in order to impart to it a maximum of conductivity, and any reduction of the moisture content below the saturation point causes an increase in its resistance and a consequent decrease in the current which will flow through the concrete under a given potential gradient. The condition mentioned above, that the electric current must flow between electrodes in contact with the concrete, should be emphasized. The conduction being electrolytic, the reactions taken place only at the electrodes, and in the absence of such electrodes no reactions occur within the concrete.

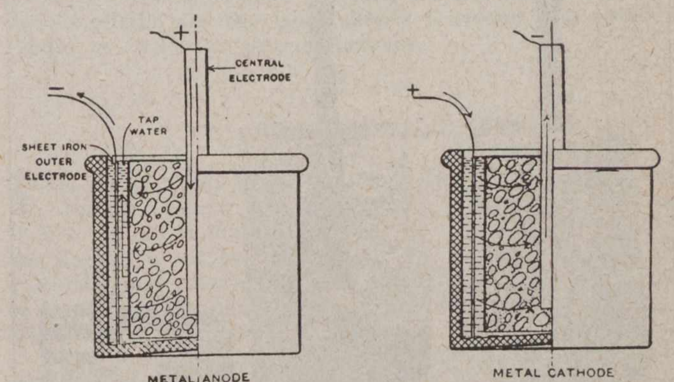


Fig. 2—Method of Making Connections to Specimens

Sources of Stray Currents

If there be electrodes embedded within the concrete, as in the case of reinforced concrete structures, the electrode effects may be expected provided the voltage is sufficient. The sources of potential differences in concrete structures may be classed under two heads, (1) those due to direct contact between the conductors of lighting or power circuits, and some part of the building and (2) those which have their origin in stray currents from railways or other grounded power lines. The former may happen in any building containing electric wires, through defective insulation. Ultimately, of course, any current that leaks off from the wire would pass out into the earth through the footings and foundations and through pipe systems entering the building. If the current be reversed, flowing to the building from outside, there would in time be some softening of the concrete in a thin layer under and around the steel structure terminating in the footing, but this would be under compression and not subjected to shear along the surface of contact between steel and concrete, so that failure here is extremely improbable. The only places where trouble is to be expected due to grounding of power wires directly on the concrete inside of a building is in the region close to the point of ground.

If, however, the power wire be grounded directly on a portion of the reinforcing material, the condition will be more serious and the extent of the danger will be greater if there is a large quantity of the reinforcing material in metallic contact with the electric circuit. If this comprises a large part of the total reinforcement of

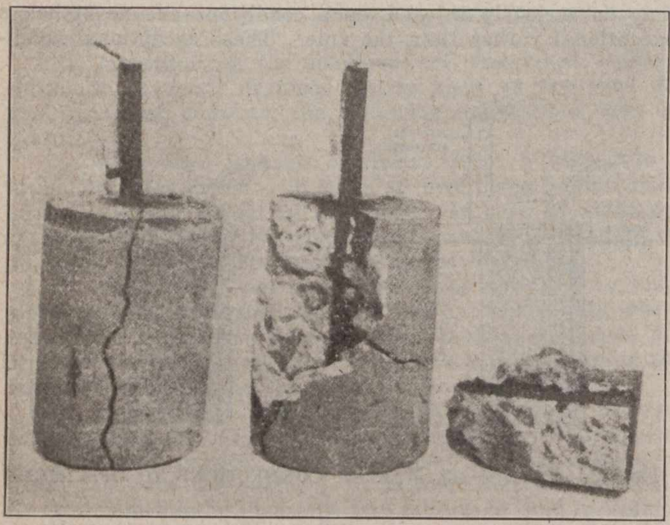


FIG. 3—HIGH VOLTAGE ANODE SPECIMENS

the building, the condition might be serious irrespective of whether the positive or negative side of the line is grounded. If the ground is on the positive side the potential gradient near the reinforcement may become high enough to cause rapid corrosion and consequent destruction of the reinforcing material. If, on the other hand, the reinforcing material be negative, there would develop a softened condition of the concrete near the surface of the iron which would practically destroy the bond, and this would probably be the more serious condition of the two, since the latter would not manifest itself by producing local cracks in the concrete, and might not become known until a large portion of the building has become weakened. However, while such a condition as this might occur, and if neglected become very serious, it is nevertheless a trouble that can be readily guarded against, as will be pointed out below.

Trouble from Ground Return of Railways

The other source of current that might possibly give rise to trouble under certain circumstances is the ground return of railways. The current may enter a building in two different ways. First, if the foundations under the two opposite sides of the building are at different potentials, there would be a tendency for a certain amount of current to flow up through the foundation on the one side, through the walls and floors of the building and out through the foundation on the other side. This condition may be said to exist to a very small extent in practically all concrete buildings, but it is not one that need cause any alarm.

The second way in which stray currents may enter a building is through water or gas pipes, lead cable sheaths, and similar, structures. The low differences of potential that these usually bring about, would cause damage very slowly, however, but where differences of five to fifteen volts exist between the reinforcing material and the earth, it should be regarded as a dangerous condition, and "should be remedied at once."

The above statements in regard to the liability of damage under low or moderate differences of potential are intended to apply only to concrete which contains no appreciable quantities of salt. The data show that if a small quantity of sodium chloride (salt) or calcium chloride be added to the concrete the rate of deterioration proceeds many times faster, and under such circumstances much lower voltages should be regarded as dangerous.

Specific Cases of Trouble

In the course of the investigations a considerable number of cases were examined in which damage to concrete structures has been attributed to electric currents. Some of these have been reinforced structures and some have been without reinforcement. Among these not any non-reinforced structures were found in which the conditions indicated that electric currents could in any way be responsible for the damage. Among the reinforced structures there are some in which electrolysis has been at least a contributing cause of the damage. The investigators, however, have seen no case in which serious damage has occurred in which there was not also present a considerable quantity of salt in the concrete, either from having been put there during construction or from contact with salt water in service.

Protective Measures

Recommended protective measures mentioned are briefly, (1) the exclusion of salt (an addition of even a fraction of 1% of chlorine is sufficient to increase the rate of damage a hundredfold), (2) waterproofing below grade, (3) proper selection of materials for the foundations (of secondary importance however), (4) inclosure of electric wiring in continuous metal conduit, (5) introduction of insulating joints into pipes and leadl cable sheaths before they enter the building, (6) improvement in the negative return of railways, (7) the abolishment of the practice of grounding metallic conduits in contact with concrete. Waterproofing

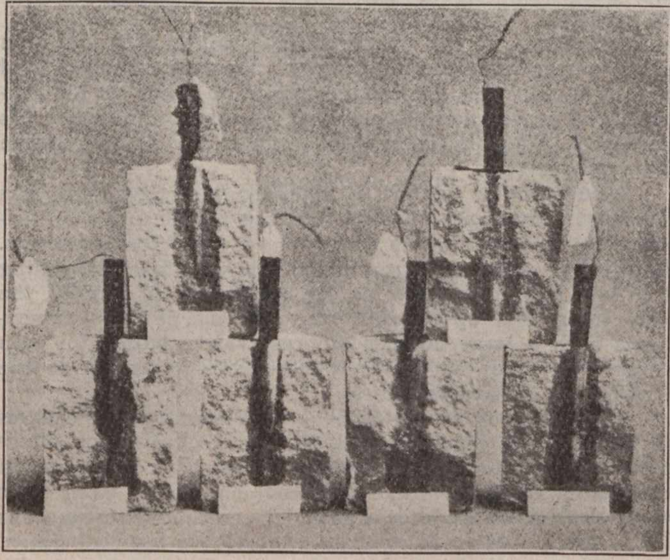


FIG. 4—CATHODE SPECIMENS SHOWING DISINTEGRATED MORTAR ABOUT ELECTRODE

compounds, and the making of reinforcing material negative by means of a low-voltage generator are of little value and are not recommended.

Copper-clad steel or aluminum for reinforcing material is impracticable, since the copper coating is readily destroyed and aluminum is attacked by alkali in the concrete.

In connection with the Calgary house building plan it is likely that the cement gum method of construction will be used.

The following is a list of Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, Toronto: Henry C. Mimms, testing device for the ignition systems of internal combustion motors; Fred. D. S. Robertson, process of extracting potassium from its insoluble compounds; Alfred T. Kwajel, magneto-electric machines for engine ignition purposes; Philip T. Jackson, fluid control apparatus.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND
Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

COST KEEPING IN ENGINEERING AND CONTRACTING

IN modern engineering construction the question of how much a dollar will do is one of vital importance. The necessity of cost keeping enters as largely into general engineering and contracting as into industrial business. Shrewd judgment, rule of thumb or "coming out on the right side" are not the factors in success that they may have been in the past, because costs are as important to the engineer as to the manufacturer.

No one cost system can be designed that will be found universally applicable—each job has its own individual peculiarities, and demands an independent treatment. The success of any system depends very largely upon the executive whose administrative ability must plan and put it into execution. The cost records are merely a guide post to him. In the installation of any new method, time and persistence are important elements, while its successful operation calls for loyal co-operation from all subordinates.

Efficiency in engineering construction may be defined as the performance of a given task in the most expeditions, most economical and most substantial manner possible. This does not mean that the cheapest practical structure is sought. A dam may be designed with such emphasis on security and such large factors of safety as to make its cost unnecessarily high, but the dam, once designed, is built with the effort to secure by means of efficient methods of construction the maximum return for each dollar expended. Efficiency is no new invention; but modern industrial conditions have made efficient methods well nigh a requisite for success.

A good cost system should place in the producers' hands a tool far more valuable than any rule of thumb method, for it replaces all guesses, points out leakages and wastes, supplies standards for comparison and provides for accurate estimates being made.

A good system of cost keeping should have three requisites: first, it should be reliable; second, it should be simple; third, immediate. Reliability is unquestionably the first essential and if it is not fulfilled the records may be misleading, in which case they are worse than useless.

The system should also be simple and free from complications. Then, too, the clerical work attendant upon a laborious system of cost keeping must be considered and the best methods adopted for its reduction.

In order to be of practical value the records must be available before the information they portray is cold. It will be of little use at the end of a season to discover a leak that should have been discovered away back in midsummer. Yesterday's mistakes should be found out in time to plan to-morrow's work. Here appears an additional argument for simplicity, for the more simple a system, the easier it should be to obtain prompt returns.

"NO TIME TO TENDER"

THE construction season will soon be upon us and already the indications are that it will be a very active one. It is to be hoped that the phrase "no time to tender" which has become a rather too familiar one among Canadian engineering and contracting and manufacturing concerns will be heard less frequently than in previous years. Firms are often barred from tendering because of the time element.

There may be, and possibly are times when towns and cities require material or machinery in a hurry, but in most cases the time allowed bidders to secure specifications and arrange for bids could be extended a fortnight or a month without any detriment to municipalities.

It too frequently happens that a council decides at a meeting to call for tenders and instructs the clerk to have tenders in hand by the next council meeting. We have in mind a Canadian municipality that only allowed two weeks for tenders for an engine and then calmly waited eighteen months for its delivery; another municipality left less than two months for the placing of bids on a job amounting to considerably over a million dollars and then took over ten weeks to decide which of two bidders should be awarded the contract. If a little more consideration were shown in this matter it would be found to work to the advantage of both buyers and sellers.

CONSERVATION OF WATER POWER

EVERY ton of coal used is forever lost as a source of energy. On the other hand, the non-use of any quantity of water power, the development of which is commercially feasible, means a waste of energy that can never be recouped.

The question of conservation has to do with the policy of not only governments, but also the people at large with regard to those natural resources, useful to man, which are supplied by nature in a form easily adaptable to immediate utilization, and particularly with regard to those natural resources, not uniformly distributed, which are limited in extent or in quantity. Among such natural resources are the minerals of the earth, forests upon the earth and waters over the earth. Whether applied to any or all of these, a policy of conservation should manifestly be directed neither to a locking up or withdrawal from use, on the one hand, nor to an indiscriminate or wasteful utilization upon the other hand. Economy, in its best sense, should prevail, but an economy which has regard for both the present and the coming generations.

The two great, natural sources of energy available are coal deposits and water powers. Enough has been written regarding the matter of coal supply to say that, assuming that the present rate of consumption continues, is in fact limited as its cost to the consumer gradually increases as the supply diminishes. While the cost of developing water power is considerable, the development of electrical transmission of energy has made water power development feasible as a business proposition, as against the cost of steam power, to the extent that the amount of water power which is yet undeveloped amounts to millions of horse-power. Herein lies the peculiar adaptability of the policy of conservation as applied to the use of water for hydro-electric power purposes: the utilization without loss of one natural resource and the saving from loss of another.

Because it is inexhaustible, and because its use replaces that of another and exhaustible natural source of energy, water power is the most potent of all natural resources as a subject and agency of conservation. In the case of a limited, exhaustible and rapidly diminishing supply of a natural resource, such as that of coal, the forces of conservation should be directed to the prevention of use, as far as consistently possible. But the correct view of conservation inevitably leads to the demand that, in the case of water powers, there shall be encouraged and promoted the greatest and most immediate use possible.

PERSONALS

Marcel Pequegnat, who was recently appointed superintendent and engineer of the water commission of Kitchener, Ont., was born in that city on April 27th, 1886. He was educated at Kitchener Collegiate, and received his technical training at the School of Practical Science, Toronto, from which he graduated in civil engineering in 1908. The following year he obtained his degree of B.A.Sc., and returned to the S.P.S. as a demonstrator, retaining this position until 1913. The summer vacations during his undergraduate association with the S.P.S. were spent in Kitchener as assistant to the city engineer, carrying out public improvements. In the summer of 1910, Mr. Pequegnat supervised the construction of pavements in Kitchener, and two years later, he filled the post of resident engineer for the Kitchener water commission. Obtaining his O.L.S. certificate in 1910, and the D.L.S. certificate the following year, Marcel Pequegnat occupied the summer of 1911 in carrying out a D.L.S. contract in Manitoba. He has retained close connection with Kitchener municipal works from 1913 to the present date. He held the position of assistant city engineer until 1917, then devoted part time to carrying out city surveys from 1917-1919, and was appointed to his present position at the beginning of this year.

Dr. Geo. H. Field has been reappointed medical health officer of Cobourg, Ont.

W. E. Crouse, of Toronto, has been appointed town engineer of Paris, Ont.

John Bingham has been elected chairman of the Ottawa Suburban Road Commission.

Henry V. Macksey has been elected president of the New England Water Works Association.

Sir Henry K. Egan has resigned as chairman and also as a member of the Ottawa Improvement Association.

William Kirk Thompson, of Toronto, has been appointed engineer clerk, Department of the Interior, Ottawa.

T. R. Deacon, of the Manitoba Bridge & Iron Works, has been elected vice-president of the Manitoba branch of the Deep Waterways Association.

W. R. Robertson, formerly superintendent of the Windsor and Walkerville Electric Railway, has been given charge of all Hydro radials by the Hydro-Electric Power Commission of Ontario.

A. T. McGill, formerly assistant superintendent of the Niagara, St. Catharines and Toronto Railway, has been appointed manager of the Windsor and Walkerville Electric Railway, recently taken over by the Hydro-Electric Power Commission of Ontario.

J. J. Traill, B.A.Sc., assistant professor in hydraulics of the University of Toronto, has resigned to take a position in the hydraulics department of the Hydro-Electric Power Commission. Prof. Traill has been on the staff of the Faculty of Applied Science for fourteen years, during which time, as a result of his constant readiness to do all in his power to help the students, his unfailing courtesy, coupled with his knowledge and experience in hydraulics, he has risen high in the esteem of his colleagues and his students.

OBITUARY

A. L. Hertzberg, who recently retired from the position of district engineer, Ontario district, Canadian Pacific Railway, whose retirement was announced in *The Canadian Engineer*, January 8th, died at his home 151 Evelyn Ave., Toronto, Ont., on Saturday, January 31st, 1920. Mr. Hertzberg was born 65 years ago in Horten, Norway, the son of Col. L. H. Hertzberg of the Norwegian Royal Engineers. Mr. Hertzberg was educated at Horten and at Gothenburg University, Sweden. He came to Canada in 1881 and joined the Credit Valley railroad as assistant engineer. Two years later that railroad was taken over by the C.P.R. and Mr. Hertzberg soon became division engineer at Toronto, and was later promoted to the rank of district engineer. He was vice-consul at Toronto for Norway and Sweden from 1894 until 1905. Mr. Hertzberg became a member of the Canadian Society of Civil Engineers in 1888. He has three sons all of whom are engineers: Col. H. F. H. Hertzberg, commandant of the Canadian Engineers at Halifax, N.S.; C. S. L. Hertzberg, consulting engineer, Toronto; and O. P. Hertzberg, resident engineer, C.P.R.

A few days ago John V. Gray, of the John V. Gray Construction Co., Ltd., was accorded a genuine surprise when members of the staff presented him with a gold watch, suitably inscribed. Mr. Gray was visibly affected by this expression of goodwill on the part of his staff and made a fitting reply. The presentation was made on behalf of the employees by Mr. Lister. Announcement of the removal of the offices of the company to larger and more suitable quarters will be found on another page of this issue.

Survey work on the international bridge across the Detroit river has been commenced by a private corporation. According to Charles Fowler, of New York, associate of Gustave Lindenthal, bridge engineer, the structure will be the longest and the heaviest of its kind in the world, and will take four years to construct. Present plans call for two railway tracks, two roadways and two sidewalks. Revenue will be derived by the corporation behind the venture from tolls levied on freight and passenger trains, vehicular and pedestrian traffic. The Canadian entrance to the bridge will be in Sandwich, where the Huron Line road meets the river, near Assumption College, while the American entrance will be between 22nd and 23rd Streets, Detroit.