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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Are Sewers Remunerative to Small Municipalities?

Analysis of the Costs and the Benefits—It Pays to Construct Sewerage Systems Even in Very Small Towns, Claims Paper Read at the Hamilton Convention of Medical Officers of Health

By FRED. ALFRED DALLYN, C.E.
Ontario Provincial Sanitary Engineer

SMALL towns in Ontario are, almost without exception, provided with waterworks systems, originally designed for fire protection, but to-day, through progressive development, available as water supplies and, indeed, generally used as such.

The characteristic persistence of rural tradition in the small towns of Ontario has, however, retarded the complete acceptance of this new convenience, and according to available figures, only from 80 to 90 per cent. of the population are connected to such systems. Wells continue to be used by the remainder, some wells persisting even in very congested districts; especially is this true if the water supply of the town is subject to suspicion. Local officers of health are, however, rapidly dealing with the situation and are effecting improvements through two measures, in both of which they have the full co-operation of the Provincial Board of Health. The first is the protection of municipal water supplies and their purification, borne if necessary by general rates. Second, the abolishing and closure of all wells within the area where urban conditions may be said to exist.

These measures, when properly carried out, invariably put the waterworks on a paying basis, eradicate water-borne disease and introduce relatively large amounts of water into the home which must later be disposed of. It is to the disposal of wastes that this paper directs attention.

The Way to Avoid Complaints

It is not within the province of this paper to dwell at length on the various methods available for the disposal of wastes, or to describe minutely the odors and stenches occasioned by the improper discharge of slops and filth from sanitary conveniences. Neither is it necessary to remind this audience of the complaints so commonly arising from the pollution of wells by cesspools and septic tank systems; complaints, by the way, only too frequently founded on fact. Nor is it required to touch the troublesome conscience that wakes up every time a medical officer of health gives countenance to the use of some artifice which, whilst removing some local nuisance, directly contravenes the Public Health Act which he has been appointed to uphold. It is enough for me to state that the proper way of protecting a town and of avoiding many causes of complaint is to induce the municipality to adopt a sewerage system.

This step is recommended, not solely for the sanitary improvement bound to accompany it, but in addition, for the economic advantages which are as truly evidenced in the inducement it offers to manufacturers to locate in such towns, as well as the actual saving in cost and ease of payment compared with other methods of sewage disposal.

The greatest obstacles to the improved sanitation of the small town are its rural tradition and the opposition of wealthy and established citizens whose tax rates are liable, from the peculiar nature of their holdings, to be disproportionately affected by local improvement rates.

Obstacles Fast Disappearing

The first of these obstacles is very fast disappearing, owing largely to the splendid organizing ability of our women. We have to thank also the excellence of the propaganda work of the extension services of the agricultural colleges and the women's institutes, and in no little measure the everlasting effort of the local medical officer of health.

The second obstacle is more difficult to handle, but can readily be counterbalanced by publicity, and as a final resort the mandatory powers of the provincial Board of Health may be evolved. My own experience is that almost invariably when a systematic effort is made to ensure the passing of a public health measure involving a money vote, the citizens respond with substantial majorities.

There is one other obstacle which is worth mentioning. I have reference to old property held in downtown districts for which the taxes far exceed the rental values. To properly appreciate the difficulties of effecting improvement of such property, one must look to the experience of the larger cities. There one meets but one answer, "coercion." In order to meet the distress that arises in some instances through requiring the installation of sanitary conveniences, the Public Health Act provides that a local board of health in any city may direct that the cost, including interest at 6 per cent. on the deferred payments, be paid by the owner in equal successive annual payments extending over a period not exceeding five years, and that such annual payments be added by the clerk of the municipality to the collecters' rolls and collected in like manner as municipal taxes. The installation in such cases is directed by the city.

Engineers to-day should not attempt to lay out new towns for industrial purposes without providing sewers and water mains. This is true also in the temporary military encampments. The more obvious reasons are:—

The skilled and essential portion of the industrial class is accustomed to city dwelling and both expects and demands the convenience of a water supply in the house.

Town sites which are not sewered or drained present, during the spring, intolerable conditions.

Engineers as a class think logically and appreciate the difficulties connected with and the complaints apt to arise from local disposal of water in congested areas, and from the nature of the problem can recognize the economic advantages of a general system,—advantages mainly of a town-planning nature; that is, advantages not capable of full realization to-day but which appear more markedly as the town grows and congestion increases.

Substantial Return in Health Insurance

The most potent appeal, however, comes from the fact that investments promoting improved sanitation offer a substantial return in health insurance. This, of course, is not so apparent in towns hitherto blessed in having a general absence of disease, but is most assuredly so in all communities in which avenues for the approach of disease, hitherto wide open, are forever closed.

Of all classes benefiting by the sanitary improvement brought about by the extension of water and sewerage systems, the poorer industrial class benefit the most; and of all age groups showing improvement in mortality statistics, the group under one year, or our infant death rate, shows the greatest.

The connection between the living conditions of the laboring, or industrial classes and infant mortality is very great. Those of you who have been following the infant mortality statistics of recently published reports in the United States must have been struck with the fact that the highest infant mortality was invariably associated with the lowest incomes. Unfortunately, in our industrial towns, housing is expensive and the families with small incomes must accept very inferior accommodation. Frequently they must inhabit property which the landlord will not improve except when coerced.

The medical officer of health who is remiss in his duty and does not pursue such landlords and insist on destruction or improvement, must accept full responsibility for a portion of our infant mortality; often (so far as can be gathered from the meagre statistics as yet available) not less than three per cent. of the total births in the communities which he serves. So far as the workmen's cost of living is concerned, the increased rent chargeable to the installation of sanitary conveniences, and a connection to the sewer, never need exceed $17 per annum, $3 of which is for local improvements, $2 for sewage disposal, and the interest on $200 at 6 per cent., or $12 per annum. In terms of monthly rent this equals $1.45; or at an average figure, an increase from $15 per month to $16.50.

Seventy-Seven Cents Per Capita

The other economic aspects of the question are fairly summed up in a statement appearing in the financial statistics of the United States Bureau, to the effect that the combined annual cost of sewerage and waterworks operation in American cities of between 20,000 and 30,000 population was $3.65 per capita, and in a further statement in a report of the consulting sanitary engineer of the International Joint Commission, to the effect that for border towns an average annual per capita charge of 77 cents represents the cost of constructing interceptors and sewage treatment satisfactory for the protection of the purity of the boundary waters.

Available figures in Ontario are not greatly different, and it can be shown that $16.20 represents the per capita cost of installing a sewerage system in the average town. Interest and sinking fund retirements amount to $1.40 per capita per annum, to which must be added a small maintenance charge (at an outside estimate I would say $1), totalling $2.40 per capita per annum.

Should Study Town Planning

Both the Canadian Public Health Congress and the Medical Officer of Health Association might derive great profit from closer studies of town-planning movements. A little over a year ago I had the privilege of inspecting a great deal of the new housing and town planning work in England and Scotland. Unless we in this country exercise greater care than we are doing to-day, we are going to perpetrate conditions akin to those from which they are endeavoring so hard to escape. The fault lies not with our legislature, which has shown itself only too ready to advance municipal betterment, but in ourselves, —in our calm indifference to social wrongs, the growth of which to-day might well promote a stench in our nostrils.

Private philanthropy has at no time solved the housing problem, and in England even in those industrial centres where the greatest amount of money has been spent, such as at Port Sunlight by Messrs. Lever Brothers, the working class housed in the model village is less than 30 per cent. of the total persons employed. Industrial expansion, whether it takes place with high wages or with low, has in the past shown itself alike indifferent to the housing of the working man. The laborer cannot afford to pay the exorbitant profits on housing such as is asked by our real estate exploiters who at present control the flow of money to housing enterprises. This is well evidenced in Canada also, for we find that practically no advantage has been taken of the Ontario act to encourage housing accommodation in cities and towns, in which it is provided that a company incorporated under the Ontario Companies Act with a share capital, whose main purposes of incorporation are the acquisition of land in or near a city or town in Ontario and the building thereon of dwelling houses of moderate size and improvements and conveniences, to be rented at moderate rents, may petition the council of such city or town to guarantee its securities in order to enable or assist it to raise money to carry out such main purposes.

Six Per Cent. Insufficient

Section 12 of the Act is the obstacle. It reads: "No dividend upon the capital stock of the assisted company or other distribution of profits among the shareholders shall be declared or paid exceeding six per cent. per annum in any one year."

Why cannot some representative body, such as our bankers' associations, be requested to come forward frankly with a statement that for speculative purposes, to which we have relegated housing enterprises, six per cent. is not enough, and state what they deem is a proper percent. to attract the necessary money?

The first step in a forward move of this kind is to create a supervisor who will undertake the preliminary work, including compilation of statistics, much of which must be done by the municipalities themselves.

It is to be regretted that at the present time our municipal government, with the exception of one or two cities, is lamentably lacking in statistical information of any kind relating directly to the boards of health. No effort, even, is made to determine accurately the number of houses in the cities and towns in Ontario. A census is returned annually to the Department of Agriculture showing the assessment valuation of each town which, if properly prepared and analyzed, should yield information concerning

(Concluded on page 586)

THE NECESSITY OF ENGINEERING SUPERVISION IN THE CONSTRUCTION AND MAINTENANCE OF EARTH ROADS*

By H. Ross MacKenzie
Chief Field Engineer, Dept. of Highways, Saskatchewan

THE absolute necessity for engineer supervision in the construction of so-called "permanent" highways and large bridges is quite apparent to the average layman, but an erroneous idea is prevalent in Canada and particularly in Western Canada, to the effect that no special training or experience is required in order to supervise the construction of earth roads. This idea is one of the greatest obstacles in the way of securing better transportation facilities in the prairie provinces, and in the following brief treatise the writer shall endeavor to present a few of the many arguments in support of the contention that the construction of earth roads requires the supervision of competent engineers:—

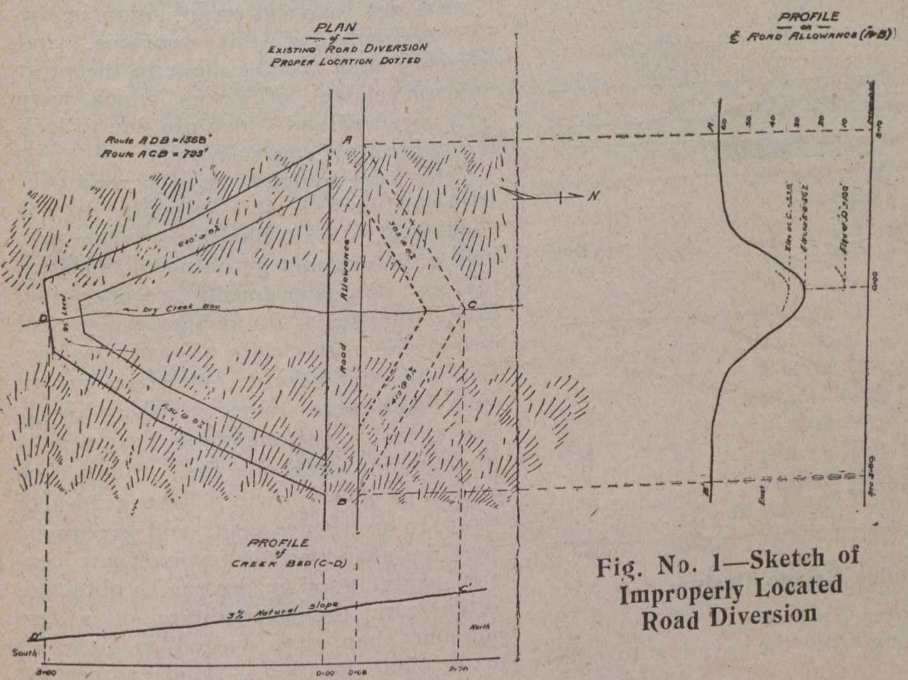

Fig. No. 1—Sketch of Improperly Located Road Diversion

The term "construction" as used in the heading of this article, refers not only to the grading of a road, but also to the location of required diversions, and to the installation or erection of the culverts and small bridges necessary to provide proper drainage facilities; and in view of the fact that Saskatchewan has not a single mile of "permanent" highway constructed in its rural area, this article applies generally to all road construction work in the province.

General Principles and Expert Opinions

Road building is divided into two parts, the theoretical and the practical, the one pertaining to the engineer, the other to the foreman or contractor. The engineer's duty is to design the road, having regard to cross-sections, gradients, alignment and drainage, whereas the duty of the foreman or contractor involves the direction of labor in an efficient manner.

We are still largely dominated in Canada by the belief that any ordinary capable man, possessing the necessary energy and ambition can do the work which should be done by a trained scientist. This belief is the direct result of rapid immigration to a country whose resources are abundant and where the absence of competition has enabled men lacking in scientific education to succeed in spite of crude and wasteful methods. This stage in the development of the prairie provinces is now passing; specialists in the various trades and professions are coming into prominence, and the public are beginning to realize that in road building, as in other construction work, the skill of the specialist is required. This awakening is largely due to the fact that although considerable sums are annually expended on road improvements, the ratepayers of the various municipalities find that the roads leading to their market centres are still in unsatisfactory condition.

The economic necessity of properly supervising the expenditure of funds for road construction, is well emphasized in a paper written by Adolph Edwards, who has had fifteen years' experience on road improvement work in the State of Florida. Mr. Edwards states that of the $300,000,000 spent on road improvement work in the United States during the year 1916, one-third was wasted. He adds that "this condition is the fault of the taxpayers primarily; they have not called for business-like administration and they have not received it.

"The pressing road problem of the country to-day is not so much to provide money for our highways and byways as it is to awaken the average taxpayer to a knowledge of the business side of the work for which he is contributing so liberally; that he may enlist the help of the ablest business men and the services of competent engineers in carrying it on. There is no question as to the correctness of this statement; the expenditure of road funds and the direction of road work by men of special training for the work is very often the exception, rather than the rule. Many a country has spent enough money to have good roads, but have poor roads because that money has not been judiciously expended. It is not a question of dishonesty in most cases, but of incompetency."

The startling statement made by Mr. Edwards regarding the waste of public funds on road improvement work in the United States, as a result of the lack of business-like administration and engineering supervision, is confirmed by Mr. Paul D. Sargent, who held the position of assistant director, U.S. Office of Public Roads, at the time when he made a statement to the Third International Road Congress held in London, England, in 1913, to the effect that during the period 1904 to 1913, practically $1,000,000,000 of local revenue was expended through the agency of 2,900 county officials and 19,000 township officials, with little, if any, permanent improvements resulting. We are safe in assuming that municipal officials in Canada are no better fitted to supervise road construction work than are the local municipal officials of the republic to the south of us, and any person familiar with road construction problems, travelling through our provinces can see instances on every hand where considerable funds have been expended without obtaining tangible results.

*Abstracted from paper before the Regina Branch of the Canadian Society of Civil Engineers.

Reference has already been made to the very definite manner in which individual men of broad experience in road construction work, have recognized the necessity of having such work supervised by competent engineers. We shall not examine the attitude of some of our Canadian provinces towards this matter, as expressed in the organization of their respective highway departments. In the neighboring province of Manitoba, the policy of road supervision is well outlined in the following extract from the 1916 Annual Report of the Good Roads Board:—

"All road construction is under the supervision of one of the good-roads engineers. Where the work justifies it an engineer is kept steadily in the district. Where the work is not sufficient to keep him employed all the time, the engineer stakes out the work and visits it from time to time to see that it is being properly carried out.

"No matter how small the amount of work performed in a municipality, a considerable expense is necessarily incurred for engineering purposes. Upon the engineering services and upon the inspection given to the work, depends largely the success and benefits resulting from the expenditure made."

In the province of Ontario the management of all road improvements under the Highway Improvement act, is centralized in a capable road superintendent or engineer, appointed by and acting under the direction of the county council. In an annual report on "Highway Improvements in Ontario," "supervision" is said to be the foundation stone on which road-building reform in Ontario must be based. County road systems with provincial aid are recognized as being very beneficial, but it is admitted that the greatest good will result from an awakening of the ratepayers, which will lead to all expenditure in the rural districts being supervised by men capable of applying scientific principles to the design and construction of a road.

In 1913 "an act to provide for the betterment of highways," was passed in the legislative assembly of the province of Nova Scotia. The first regulation for carrying out the provisions of this act reads as follows:—

"No work shall be commenced under this act, until a survey, report and estimate by a properly qualified engineer, have first been submitted to and approved by the commissioner of public works and mines."

The above reference to the attitude of other Canadian provinces in the matter of scientific supervision of road construction is sufficient for the purposes of this article, in view of the fact that the provinces mentioned are among the foremost supporters of the good roads movement in Canada. In the American republic, where earth roads comprise 90 per cent. of the total mileage we find that twenty-six states have divisional engineers, who supervise the construction and maintenance of all "State" and "State-aid" roads; many of the remaining states have a sufficient number of highway engineers in their employ to supervise the construction of all main highways.

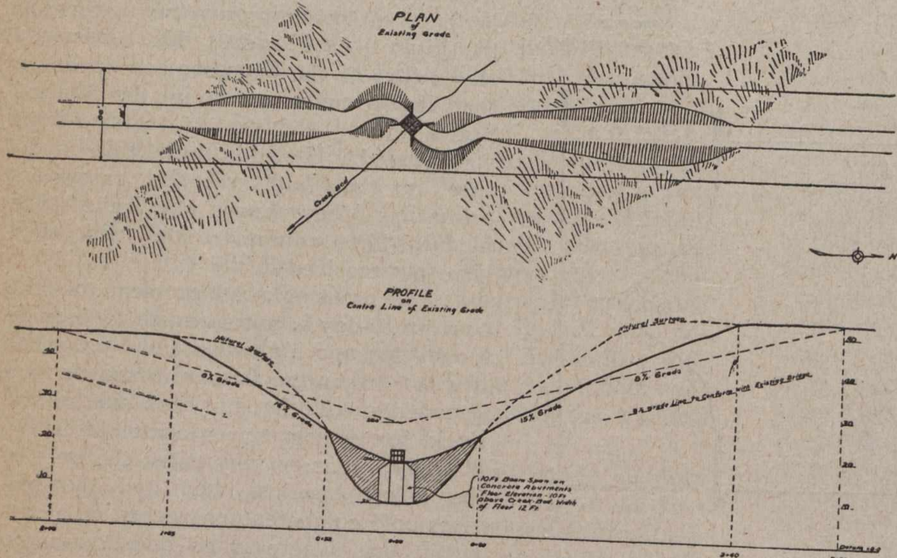

Fig. No. 2—Inadaptable and Unstable Bridge Design

Classification of Errors

The attitude of experienced individuals and progressive governments regarding the necessity of engineering supervision of road construction, is the direct result of the many concrete examples of poor location, faulty design and wasted effort, which are to be found on the roads in our rural districts. During the six years that the writer has been connected with highway improvement work, he has had the privilege of examining a great deal of road construction in the various parts of this province, and reference shall now be made to the most common classes of errors which have been observed and which are due to lack of engineering supervision.

The most frequent error in road construction work in this province is the adherence to road allowances when suitable grades cannot be obtained or where the cost of improvements are excessive. Many thousands of dollars are wasted every year in this class of road construction and in addition to the actual cost of such work there are accumulating losses, due to restricted tonnage and excessively high maintenance charges. Many such roads in this province have grades of from 10 to 18 per cent. and eventually they are abandoned in favor of new locations where good grades can be obtained, often with the expenditure of a less amount than was wasted in attempting to adhere to original location. Had engineering advice been obtained before construction was undertaken a profile of original road allowance would have shown that suitable grades were not obtainable.

When it has been decided to abandon the regular road allowance at some particular point, unskilled road builders often make grave errors in locating diversions. These errors are largely due to disregard of natural topographical features, and a concrete example of an improperly located road diversion is shown in Fig. 1. At this point a ravine 37 feet in depth, and roughly 400 feet in width, and having a natural fall southward of 3%, traversed an east and west road allowance at right angles. With total disregard of the natural fall of the ravine bottom, the diversion was constructed on the south side of the road allowance, as shown on solid lines on plan. The total length of the diversion A D B is 1,368 feet, whereas if the diversion had been located as shown on dotted line, the same per cent. grade would have been obtained with a total distance A C B of 795 feet, *i.e.*, by taking advantage of the natural topographical features, we would secure an unusually good grade with a saving in distance of 373 feet and corresponding savings in initial cost and maintenance of road. The fact that the point C is 23.8 feet higher than the point D would mean a saving in energy which would appreciably affect the cost of transporting produce over this road.

Defective Culverts and Bridges

The construction of culverts and bridges of insecure design, unsuitable type or insufficient capacity, constitutes one of the most serious errors in road construction work, performed under the supervision of men lacking technical education. Errors of this nature, apart from being a waste of public funds, sometimes result in serious accidents. Numerous motor cars have been wrecked and many valuable horses killed as a result of defective culvert and bridge construction.

The designer of culverts and small bridges, not only requires a knowledge of the strength of materials, but should be able to calculate the maximum run-off from a catchment basin in cubic feet per second in order to determine intelligently the drainage capacity required. The installation of culverts and bridges of insufficient capacity not only results in the loss of the structures themselves, but invariably means considerable loss of embankment and serious inconvenience to the travelling public. The determination of the most suitable type of culvert or small bridge requires considerable engineering experience. We find frame-bent bridges on marshy ground and over swift-flowing streams, concrete bridges without the necessary foundation to prevent heaving, and deck spans where the height of embankment requires a concrete or corrugated iron culvert. Grave errors in location of culverts and bridges are also prevalent.

Without going into further details of the many errors made in culvert and bridge construction, we shall refer to Fig. 2, which is an actual example of bridge construction combining inadaptability with unstable design and faulty workmanship. At this location a ravine of 40 feet in depth crossed the road allowance at an angle of 45 degrees. Two concrete abutments 10 ft. in height and with 10 feet between face walls, were constructed parallel to the creek bed. These abutments supported a timber deck 12 feet in width and with the usual guard-rails, leaving a clear roadway of slightly over 11 ft. The lack of stability was due to the absence of footings, or any kind of foundation for the abutments. The concrete was of very poor quality as a result of using sand containing a large percentage of loam, and when the back-filling was in progress the wing-walls collapsed. This type of bridge, even if properly designed and well constructed, would not be adapted to this location, in view of the fact that a 19-ft. fill was required to provide a serviceable grade. To construct 19-ft. concrete abutments for a 10-ft. span would be obviously ridiculous. The method adopted by the writer to improve this crossing was to remove the flooring of span, place a 6-ft. corrugated iron culvert 60 ft. in length between the abutments and raise the fill 9 ft. above floor level of old span. By this method the road was straightened, the grade reduced from 15% to 8%, and the mistakes of a man who is a successful farmer but an amateur road builder, were disposed of, after the manner sometimes attributed to the medical practitioner.

Profiles are Important

The lack of continuous fall in side ditches is a serious error in road construction work. Often the ditches are dug deeper at the lower points because more material is required to make the fill. The resulting pools saturate the foundation of the road and heavy traffic will then cause the road surface to become badly rutted. Profiles of all ditches should be prepared in order to secure continuous flow to the point of outlet whenever possible.

Another error due to the absence of profiles for the guidance of road foremen, is the improper determinations of the point at which the assumed grade line intersects the natural surface of the hill, in order to give an economic balance between cut and fill. The writer has observed many instances where excavation was commenced at a point too near the foot of a hill, with the result that when the road was properly improved part of the original excavation had to be refilled. The construction of grades of uniform height across periodically flooded areas assumed to be level, but which in reality present difference of elevation of two or more feet and vice versâ, the construction of grades of varying height across low areas of almost uniform elevation, are further evidences of the necessity of cross-sectioning road construction work, in order to prevent waste of material and unsatisfactory results.

Side-Borrowing vs. End-Haul

One of the principal errors of an economic nature is "side borrowing" in cases where "end-haul" would be cheaper when the general improvement of the road is considered, and vice versâ, the construction of a fill by "end-haul" when "side-borrowing" would be more economical. The writer once observed a road foreman who had several years' experience in railway construction work undertake the building of a fill across a U-shaped ravine by side-borrowing in the bottom of the ravine. When the fill got so high that he was unable to continue this method, he resorted to the proper method of excavating on each bank, and depositing the material in the fill. Before the fill attained the required height the side slopes extended so as to completely fill the borrow-pits. The lack of economy in making an excavation for the purpose of refilling it, is apparent. This foreman had been accustomed to following the grade stakes set by an engineer, but when thrown upon his own resources he was entirely incapable of constructing a road in an economical manner; and although the case referred to may be a particularly striking example of this class of error, still, numerous cases exist where an unusually great waste of funds resulted from the adoption of the wrong method in the construction of a fill.

Six Outstanding Errors

Numerous examples of other classes of errors might be given, but it is not the purpose of this article to exhaust the subject nor to deal to any extent with the features which refer more to the execution of the work than to the design. The classes of errors already referred to embrace the most prevalent and outstanding examples of faulty road construction in Saskatchewan, due to the lack of engineering supervision, and these errors can be briefly classified as follows:—

(1) Too rigid adherence to road allowances.
(2) Disregard of topography in relocation.
(3) Improper location and construction of culverts and small bridges.
(4) Ill-designed ditches.
(5) Naked-eye levelling of heavy cuts and fills.
(6) Improper use of "side-borrow" and "end-haul."

Qualifications of Road Supervisors

Having enumerated the principal classes of errors in road construction, we can now summarize many of the required qualifications of road supervisors, as to the ability to eliminate these errors. The road supervisor should not only be able to determine the best possible

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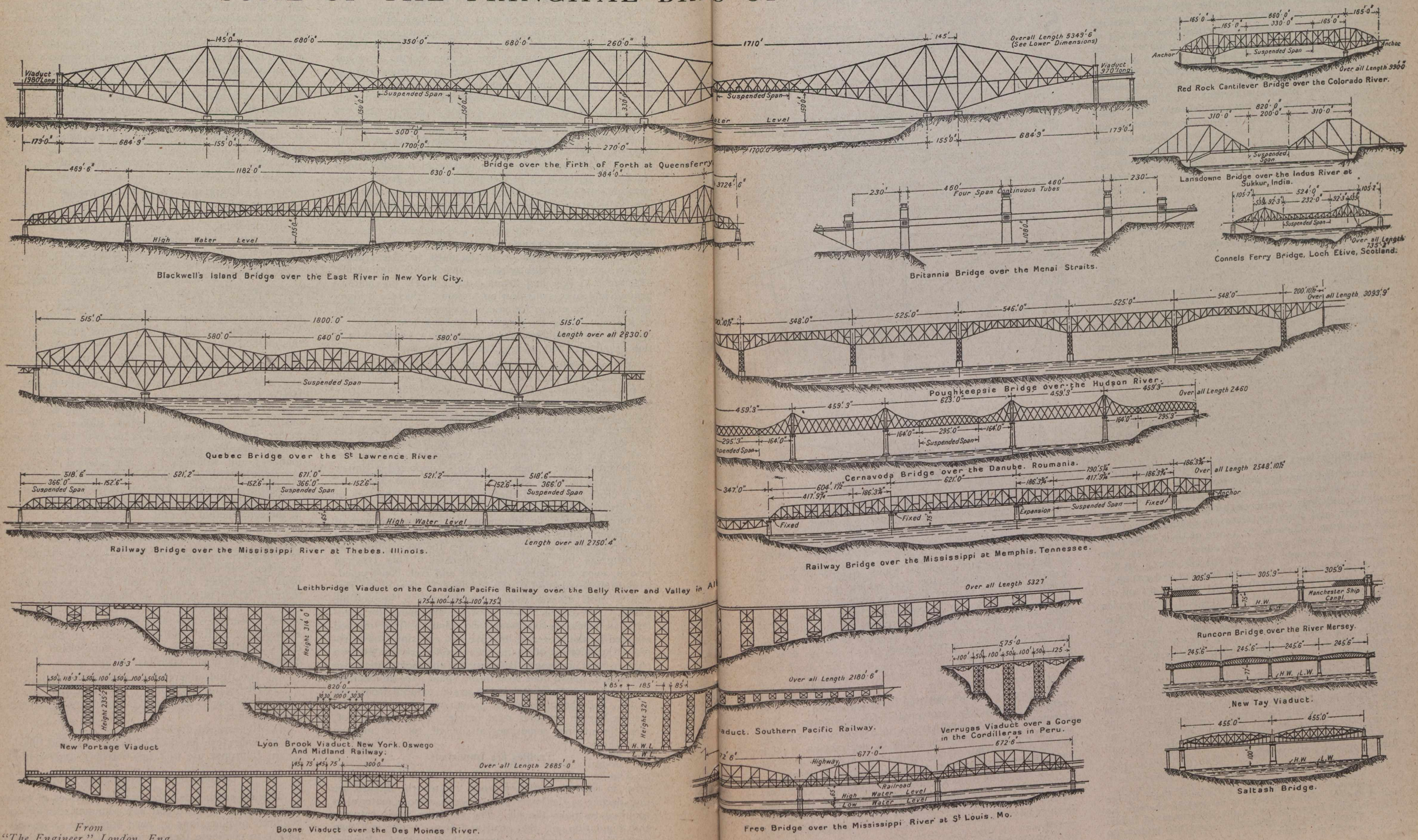
SOME OF THE PRINCIPAL BRI S OF THE WORLD COMPARED



From "The Engineer," London, Eng.

NECESSITY OF ENGINEERING SUPERVISION

(Continued from page 573)

location of a road and to design and construct the necessary culverts and bridges, but he should have such scientific knowledge as would enable him to maintain it in the most economical manner. This means a thorough technical training and years of practical experience.

Road construction and maintenance require of the engineer qualifications of just as high order as would be demanded in the case of an engineer required to supervise the construction of railways and canals, for the problems to be solved are exactly analogous. Thomas Adams, of the Commission of Conservation, states that "road planning and engineering is a highly skilled profession and millions of dollars are wasted in the attempt to save money that should be used to employ good men to design the location and construction of roads." Scientific determination of the proper location of a road involves a knowledge of the road-building value of various kinds of soils, and the design of sub-drainage requires familiarity with certain geological features, hence it is evident that the road supervisor requires a very liberal education.

Permanent Road Supervisors Needed

During the past year several municipalities in Saskatchewan for the first time employed engineers to supervise their road construction. Sherwood municipality has led the way in appointing a road supervisor at an annual salary, and the writer is confident that in the near future the ratepayers of the various municipalities will realize that so long as municipal councillors rotate in office from year to year, their services as road supervisors consist of a series of experiments by which they gain their experience at the expense of the people. If there is need for a permanent secretary-treasurer, there is still greater need for a permanent road supervisor, possessing the necessary technical training to enable him to locate, construct and maintain public highways in an efficient manner.

Road Supervisors Should Be Trained Engineers

It is true that there are many good road builders who have not graduated from technical schools, but these are exceptional and their experience is restricted to a narrow line of work, and their usefulness is curtailed by their limited education. Outside the range of their experience they have to depend on analogy and in so far as their education is incomplete they lack in efficiency. In the opinion of the writer, a thorough technical education is primarily necessary to properly equip a man as a road designer and builder. A general knowledge of the principles of engineering practice can be obtained by field experience, but an education obtained in this manner has certain restrictions to which reference has already been made. Having received a technical education preferably by a systematic course of training in an engineering school, years of practical experience on highway work is desirable, if not essential, to produce the proper balance between theory and practice. The personal characteristics of the individual largely determine his prominence in this as in any other profession, but generally speaking, it may be said that road supervisors should be engineers first and highway engineers afterwards.

If repairs are to be made to the Gatineau Point Bridge at Hull, P.Q., the work will have to be done by the city, as the city clerk has been notified by the Department of Public Works of Canada that the department does not propose to contribute toward its repair.

REINFORCED CONCRETE FOR SHIP CONSTRUCTION*

By Major Maurice Denny, A.M.I.N.A.

SO long as the efficiency of a mercantile marine is judged by its dividend-earning capacity in free competition, so long will the choice of material for the construction of its units depend on economic considerations.

Up to the present, for the general trader, steel has proved to be the material which gives the greatest return for capital invested, and no material inferior in this respect will permanently displace steel from this position.

In the abnormal circumstances now prevailing, however, when free commercial competition is suspended, it is not necessary to examine the suitability of a material solely from the monetary point of view, and any substance which swells the volume of tonnage by drawing on fresh sources of labor and material has a chance to prove its

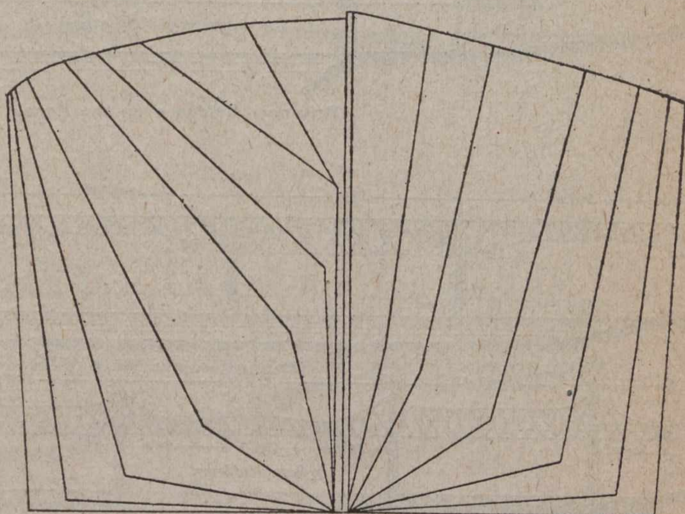


Fig. No. 1

merit on technical grounds alone. Reinforced concrete at once suggests itself as an alternative to steel, its suitability for general structural purposes being everywhere evident on land, and its application to floating structures being no longer entirely novel.

For all structures such as beams, reinforced concrete is particularly suitable, the steel taking tension and the concrete bearing compression. As almost every part of a ship's structure may be considered to be a beam under load, reinforced concrete is therefore not fundamentally unsuited to ship construction. When it is added that the use of reinforced concrete makes practically no demand on the class of labor and material used for steel shipbuilding, the justification for its trial is sufficient, and, in these times, overwhelming.

Experience has proved that steel embedded in concrete is completely protected from corrosion. The principal source of deterioration in a steel ship is consequently removed, and the saving of steel shown in comparing a reinforced concrete vessel with a steel ship of the same dimensions must be partly credited to this fact.

The repairing of local damage in a reinforced concrete ship would seem to be a relatively simple matter. So soon as sufficient concrete and steel in way of the damage has been removed to allow of an adequate "scarph" between

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*Abstracted from a paper read before the Spring Meeting of the Institution of Naval Architects, 1918.

old undamaged and new reinforcement, fresh concrete can be poured into place. Since concrete sets under water it is not necessary to retain the vessel in dry dock during the initial stages of hardening. The actual time required for weathering will depend on the structural importance and extent of the damaged portion, and unless this is considerable, the vessel can return to service after a much shorter lapse of time than was necessary between launching and delivery.

Methods of Waterproofing

Watertightness is one of the points which the naval architect will most critically examine when the question arises of replacing steel by reinforced concrete. Fortunately, experience of large tanks in land work is by no means limited, and it is possible to draw certain inferences from the behavior of these structures. Apart from the water-resisting ability of simple concrete there are various methods of treating the material which fall generally into two categories: (1) The addition to the concrete during mixing of a waterproofing compound; (2) The treatment of the finished surface with a suitable non-porous material. The first of these is generally believed to reduce the strength, and in the present position of the industry the naval architect will be chary of adopting it. The second comprises the treatment of the surface with a cement mortar well rubbed into the pores, coating with a special mixture, and painting as in a steel ship. It is interesting to note that, even in this early stage of development, reinforced concrete vessels are being built to carry fuel oil in bulk, experience with land storage tanks and experiments recently made indicating that mineral oil has little or no destructive effect on the material.

The ability of reinforced concrete to stand vibration, whether from propelling or deck machinery, may be called in question. The experience afforded by railway bridges and factory floors shows that little trouble need be feared from this cause, provided that the concrete is not allowed to fail progressively by unsuitable distribution of attachments.

Concrete when being worked in a plastic material; the processes of construction partake more of the foundry than of the shipyard, and the moulds required in a foundry equally have their place in the reinforced concrete shipyard. It is evident that the quantity of material required for the moulds is great, and the labor required for their erection will bear a considerable proportion to the total labor required for the ship. It is therefore an obvious economy to arrange that several vessels shall be cast from the same moulds. This has a marked effect on standardization of type. Where wood is used for the moulds it will probably be found that from five to eight vessels can be built from one lot of shuttering, though considerable repairs and renewals to the woodwork will only be avoided by skilful design and care in erection and dismantling.

To Avoid Intricate Forms

It seems evident that if the usual ship form be adopted, in which there is curvature in two directions, the amount of work entailed in shaping the shuttering will be at its maximum. The minimum amount of shaping will be given by a rectangular box; but as such a form is usually inadmissible a compromise must be effected. The best result from the point of view both of the naval architect and the reinforced concrete engineer must be sought among the class of "straight frame" forms, which yields at once reasonable figures for resistance in association with curvature in one direction only. Two suggested compromises are shown in Figs. Nos. 1 and 2, the "batter" of the sides in Fig. No. 1 being given in order to reduce the chances of possible damage at the sharp bilge when lying alongside quay walls, and in the case of Fig. No. 2 to secure "flare" at the bows.

The inspection of a reinforced concrete vessel just prior to the commencement of pouring is apt to produce in the mind of the naval architect an impression other than favorable. The unfamiliar network of rods scarcely suggests serious shipbuilding, and the idea that these should be replaced by the more usual and substantial sectional material at once presents itself. In the case of the frames, for instance, two angle bars connected by light bracing would appear to possess the same strength as the rods, in combination with greater ease of erection and immobility during pouring. This system, however, would relegate the concrete to the inferior position of a mere cover for, and support to, a complete steel structure, and would be a return to a method long discarded by reinforced concrete engineers. It would seem a fundamental error to cling to methods of construction found suitable in one material when dealing with another material of a totally different character.

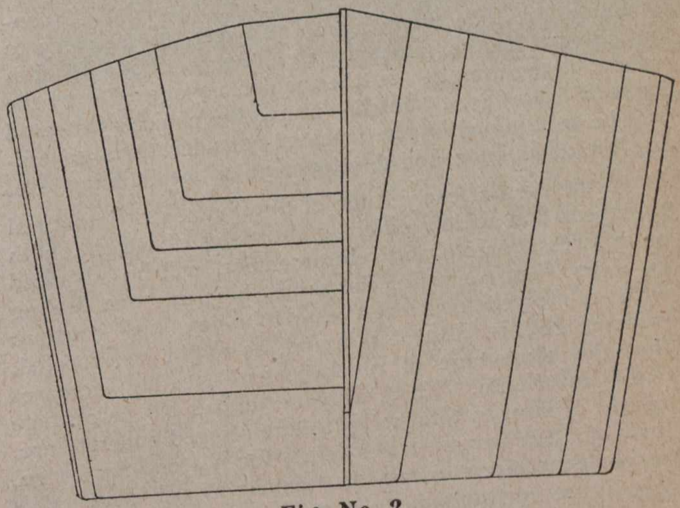

Fig. No. 2

The majority of present-day reinforced concrete designs are based on the production of a vessel which should be cast in one operation, the "monolithic" method, and the foregoing remarks on construction primarily have reference to a monolithic ship. The alternative method is to cast the integral parts separately and assemble them at the slip—the "sectional" method.

In the "sectional" method, portions of the structure more or less extensive are cast from moulds which should be capable of being used a large number of times. A vessel whose sides have irregular curvature, or one in which there is no great extent of parallel middle body, is evidently ill-suited to this form of construction. The sections are assembled in place, and in addition to grouting, steps must be taken to provide for continuity of the local reinforcing material. As it is impossible to allow the general longitudinal reinforcement to be broken abruptly, it is obvious that it cannot form part of the sections, and must therefore be placed in position separately from them. After the sections are assembled, the longitudinal reinforcement at gunwale, bilge, etc., would be placed and the concrete poured round it.

The launching of a vessel subjects the structure to local stresses which may be of considerable magnitude. By constructing the vessel in such a situation that she may be waterborne without subjecting her to stresses as severe as those imposed by launching, the necessary period of delay between the completion of pouring and floating is reduced. The advantages of floating from a dock, however simple or elaborate it may be, as distinct from launching are:—

Launching vs. Floating

(1) The possibilities of failure of the structure during removal from the building berth are much reduced.

(2) The number of berths required to execute in a given time any programme is reduced owing to the fact that the number of ships lying "weathering" on dry land is less.

(3) The ground can be permanently levelled and prepared so as to form the exterior surface of the bottom shuttering, whereas bottom shuttering is always required (at least in a monolithic vessel) where launching is contemplated.

It should be noted that given equal speeds of construction the time from laying of keel to delivery to owners will be the same under either method, if, as is essential, the strength on the maiden voyage is to be the same in both cases. In the future, the choice of method will be determined by the financial considerations governing the acquisition and development of the building site.

In the present early stage of development it is natural to expect that widely differing estimates of weight, both as regards concrete and reinforcement, will be advanced by various engineers for the same ship; any one dealing with reinforced concrete vessels to-day has constant evidence of this. But it is found, as might be expected, that the percentage of reinforcement steadily increases with size of ship. Thus, average figures for percentage weight of steel to total weight of reinforced concrete are, for a 500-ton barge 11 per cent., for a 1,000-ton barge, 14 per cent., for a 6,000-ton steamer 22 per cent. This last figure corresponds to a percentage area of steel to reinforced concrete of about 7 per cent., and when it is recalled that an average figure in land work is about 1 per cent., the much more onerous requirements of marine construction are again emphasized.

Deadweight and Internal Volume

The shipowner is chiefly interested in the loss in deadweight-carrying ability. If a vessel of the same dimensions as the 1,000-ton concrete barge noted above had been built in steel, she would have carried somewhere between 35 and 40 per cent. more deadweight.

The quantity of steel required in this reinforced concrete vessel is less than one-third that used in the steel ship, but the finished hull weight is nearly twice that of the latter, even when allowances have been made for the omission of cement and paint in the heavier ship. Where internal volume is the measure of the carrying capacity of a vessel, this increase of weight, though not without its drawbacks, is not vital, but where deadweight is the governing factor, the advantages are heavily in favor of the steel structure.

A detailed comparison of the technical particulars of the 6,000-ton deadweight steamer mentioned above will be of interest. It is observed, however, that while the figures quoted for the steel ship are probably accurate, the weight of the reinforced concrete hull is purely estimated, represents a much larger vessel than has yet been attempted in the new material, and lacks the confirmation of practice.

	STEEL.	REINFORCED CONCRETE.	
Length	375 ft.	375 ft.	
Displacement	9,900 tons	9,900 tons	
Steel	1,920 tons	680	3,150 tons
Concrete	—	2,470	
Wood and outfit	400 tons	350 tons	
Machinery	570 tons	570 tons	
Lightweight	2,890 tons	4,070 tons	
Deadweight	7,010 tons	5,830 tons	

From the above it will be noted that 1,180 tons of deadweight is lost, or 17 per cent. of that carried in the steel ship; that the bare hull of the concrete ship is 65 per cent. heavier than that of the steel ship, and that the lightweight of the concrete ship is 40 per cent. greater than that of the steel ship.

It is impossible to state exactly to what extent the loss in deadweight will restrict the application of reinforced concrete to the construction of cargo carriers, since the cost of construction in reinforced concrete is still somewhat conjectural, but it can be stated with fair certainty that reinforced concrete will not replace steel for the ordinary cargo carrier unless the hull can be built for considerably less than half the cost of building the same hull in steel.

The Future for Concrete Ships

In spite of this there appears to be a class of floating structures in which reinforced concrete may well replace steel. Where the additional weight is more than counterbalanced by the durability and reduced prime cost of the new material, there is reason to expect that its adoption will naturally follow.

There would, therefore, seem to be a future for reinforced concrete in such structures as lightships, floating docks, landing stages, hulks, depot ships and similar craft, and it may confidently be expected that even when the artificial stimulus to reinforced concrete construction provided by present-day conditions is removed, the industry will still persist on the sound footing of commercial and technical suitability.

HAMILTON ENGINEERS ORGANIZE

At the organization meeting of the Hamilton Branch of the Engineering Institute of Canada, J. L. Weller, formerly chief engineer of the Welland Canal, presided. The meeting was held in the Connaught Hotel and was attended by about forty engineers, including some from St. Catharines and Niagara Falls. The latter attended to protest against the formation of the branch, being under the impression that all members within fifty miles would be forced to join the new branch, whereas they preferred to retain their non-resident membership in the Toronto Branch. They found, however, that the by-laws of the institute do not require members residing further than twenty-five miles from any branch to belong to that branch.

It was definitely decided to organize, and a formal petition was signed to be forwarded to the council of the institute at Montreal. E. R. Gray, city engineer, was appointed temporary chairman, and E. H. Darling, consulting engineer, was elected temporary secretary.

It was suggested by John H. Jackson, engineer of the Niagara Falls Victoria Park Commission, that another branch might be formed at Niagara Falls, Ont.

REINFORCED-CONCRETE FLAT-SLAB RAILWAY BRIDGES*

By A. B. Cohen
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THE art of reinforced concrete had its inception in Europe and flourished there for a number of years before taking root in this country. Although the development here has been of the highest order, there are foreign precedents for a major portion of the various uses for which we have structurally combined steel and concrete. The style of our American design has differed from that of the European to meet the widely different economic conditions of labor and of materials. With limited labor and abundant resources—the reverse has been true in Europe—our efforts have been concentrated, in a general way, toward the simplification in design and expedient methods in erection. The results are exemplified in no greater instance than in the development of the girderless floor, better known as flat-slab construction, where the simplicity has been so perfected as to produce the extreme European effort in conservation of materials without the excessive expenditure of time and labor incident thereto.

One has only to mention the recent astonishing record, seemingly incredible, made by the use of the flat slab in the erection of the Brooklyn Naval Storehouse, to prove conclusively its remarkable utility. This eleven-story building frame covering a ground area of 180 x 260 ft., or 1½ acres, was completed in 14 weeks by 500 men working one shift a day. The building, entirely fireproof, is capable of holding 70,000 tons of supplies.

Other building achievements could be mentioned to show the extraordinary development and utility of the flat-slab system for light building loads. It is the object of this paper, however, to show that the flat slab can be utilized, with equal effectiveness and added advantages, in carrying heavy railway loadings in the construction of viaducts and especially bridges of lesser magnitude where the required span length is not prohibitive. All forms of concrete construction have this limitation.

The principal advantages of the flat slab compared with all other forms of reinforced concrete and other fireproof construction are embodied in the simplicity of both

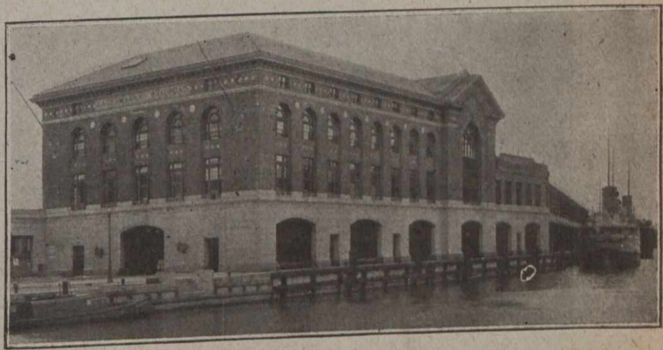

Fig. No. 1—Lackawanna Railroad's Buffalo Terminal

the formwork and arrangement of the reinforcing steel. The first cost of construction has been so reduced thereby as to put structural steel, in competition with the flat slab within its limitations, substantially out of consideration; furthermore, with the concrete construction lower maintenance charges prevail and greater permanency is obtained. The simple arrangement of the reinforcing steel, laid over a practically unbroken flat surface, insures a more positive placement of the reinforcing bars than the general beam and slab design in concrete.

In addition to these general advantages of the flat-slab construction, the salient advantages resulting from its

*Paper read at convention of American Concrete Institute, June 27th-29th, 1918.

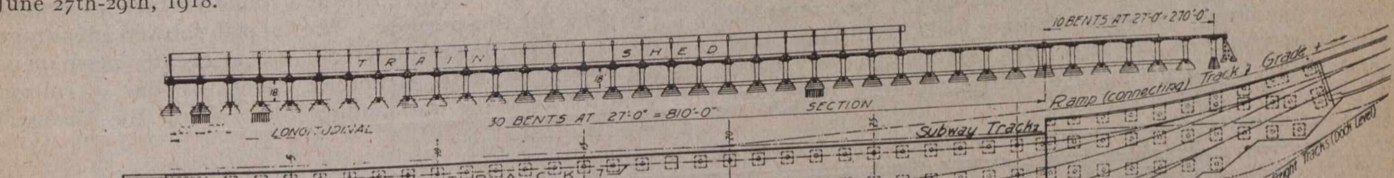

Fig. No. 2—Details of Reinforced-Concrete Flat-Slab Trainshed of Lackawanna's Buffalo Terminal adaptation to railway structures will be brought out in subsequent description and illustrations of actual examples. There is, however, one outstanding feature of the flat-slab system which in the writer's opinion is of most vital importance in reinforced-concrete construction. By reason of its uniform cross-section and continuity of the reinforcement, there is no other type of reinforced concrete that is better proportioned to resist shrinkage and thermal changes. Structures of the flat slab have been built in surprisingly great lengths without the incorporation of a single expansion joint and have successfully resisted the very severe strains of these stresses. By the insertion of an additional amount of reinforcing steel across construction joints, a constant tensile resistance can be maintained which has the effect of preventing cumulative action of the stresses at any particular section; the strain is distributed uniformly throughout, resulting in an infinite number of minute cracks that do not impair the strength of the structure.

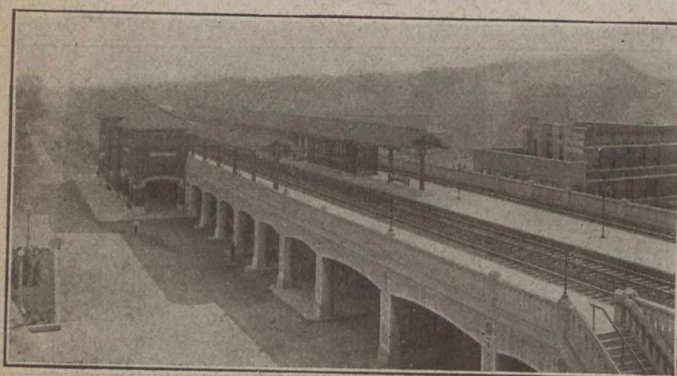

Fig. No. 3—Flat-Slab Bridge Carrying Lackawanna at South Orange Station

Our experience does not extend over a sufficient length of time to ascertain definitely what effect the repeated action due to temperature changes will eventually have on the strength of the structures. However, very close observation of existing flat-slab structures, in service from three to six years, have disclosed no deleterious effect due to these causes. The minute cracks found were of no greater concern than those developing on the tension side of a beam long before the steel has reached full working stress

By way of comparison in this regard, to show the difficulties encountered in other types of concrete construction, consider the special arrangements in the manner of expansion and sliding joints that are necessary and not always efficacious in large concrete-arch viaducts or in viaducts of the column, beam and slab design. In the viaducts consisting of a series of large main arches surmounted by transverse spandrel walls supporting a floor system, the vertical movement of the heavy arch ring, for a rise and fall of temperature, is transferred to the floor system. This very appreciable vertical movement must be resisted by the comparatively light floor in addition to its own changes in a horizontal plane. In the case of the beam and slab design the constituent members have different sections and therefore offer varying degrees of tensile resistance. There arises the difficulty of transferring the movement from the larger through the smaller members, as from the deep beams through the thin slab, which is not always satisfactorily controlled.

Soo Line Terminal at Chicago

In 1912-13 the first and so far the most extensive application of the flat-slab system for carrying railway loadings was made in Chicago with the erection of the Soo Line Freight Terminal.

The yard area required for this improvement amounted to 18½ acres, comprising eleven city blocks located near the business and manufacturing centres. This entire layout for handling freight is carried on an elevated structure to meet the municipal requirements that no grade crossings should exist. Deck construction gave the greatest possibilities of storage development, making available 520,000 sq. ft. on the ground surface underneath the deck for this purpose. The flat slab showed advantages of lower cost, lower maintenance and greater permanence as compared with structural steel. From a railroad point of view the outstanding feature of the design is

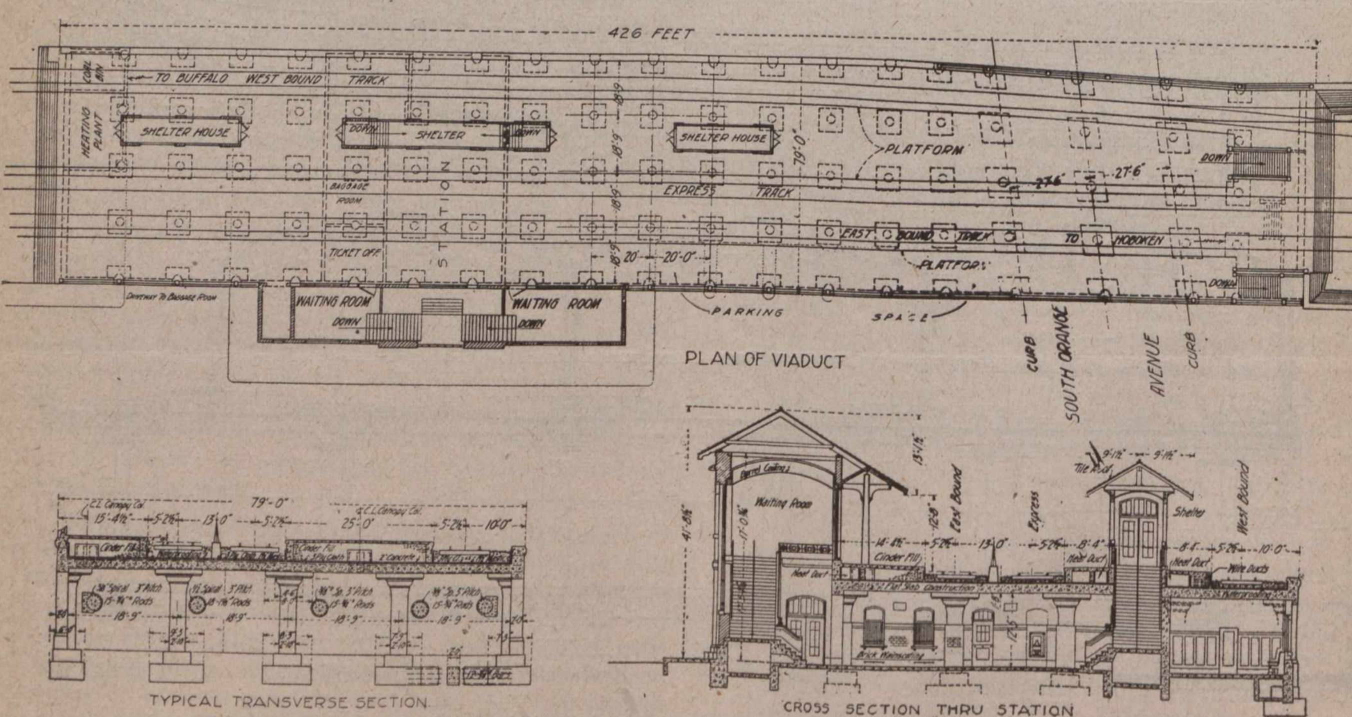

Fig. No. 4—Details of the South Orange Structure

the possible flexibility in the track layout since the structure is designed to carry any arrangement of tracks on 12-ft. centres. This was obtained with very little additional cost over a fixed position of tracks and driveways. It was in this structure that those responsible for the design decided that no expansion joints were necessary and their judgment seems to have been justified.

D., L. & W. R.R., Buffalo, N.Y., Terminal

The highly satisfactory results obtained with the flat-slab system at the Soo Line Terminal prompted its consideration and adoption by the Delaware, Lackawanna and Western Railroad in the recent construction of a viaduct approach to the station of the new terminal improvement at Buffalo, N.Y. (See Fig. 1.) The viaduct, 154 ft. in width and 1,070 ft. in length, supports a structural steel trainshed, platforms, and seven tracks on ballasted floor. This is shown in plan and cross-section (Fig. 2). For reasons analagous to those cited in the first example, deck construction was admirably adapted to the maximum development of full terminal facilities in a very limited area. This new layout is located alongside the Buffalo River. Docking facilities are for Great Lake steamers which can be unloaded directly under cover of the slab where storage and other shipping facilities, including the express companies, are available. Two tracks are located on the dock level which connect by means of the subway and ramp tracks, with the main line tracks on the upper level. Passenger traffic is discharged on the upper level precluding interference with other station appurtenances best located on the ground level.

The entire structure is supported on timber piles and gravity footings. A precautionary measure was taken to prevent possible movement of piles by connecting all the piers in both longitudinal and transverse direction with reinforced-concrete beam structs or ties, thus insuring lateral stability. Single drop panels connect corresponding columns of bents 1 and 2 to reinforce the end section

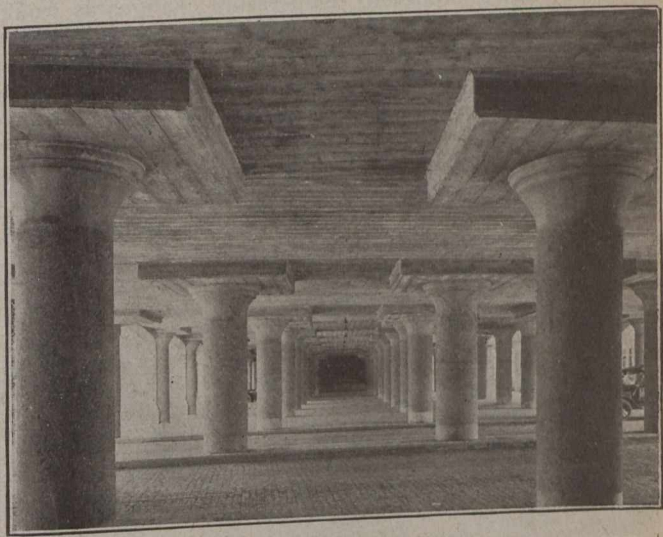

Fig. No. 5—Underside of Slab at South Orange

to take impact transferred from the bumping post which is anchored to the slab. The perfectly flat unobstructed floor simplified the waterproofing treatment which consists of a membrane composed of two layers of cotton cloth saturated and applied with hot asphalt and protected by a cover of asbestos paper and two ¾-in. layers of

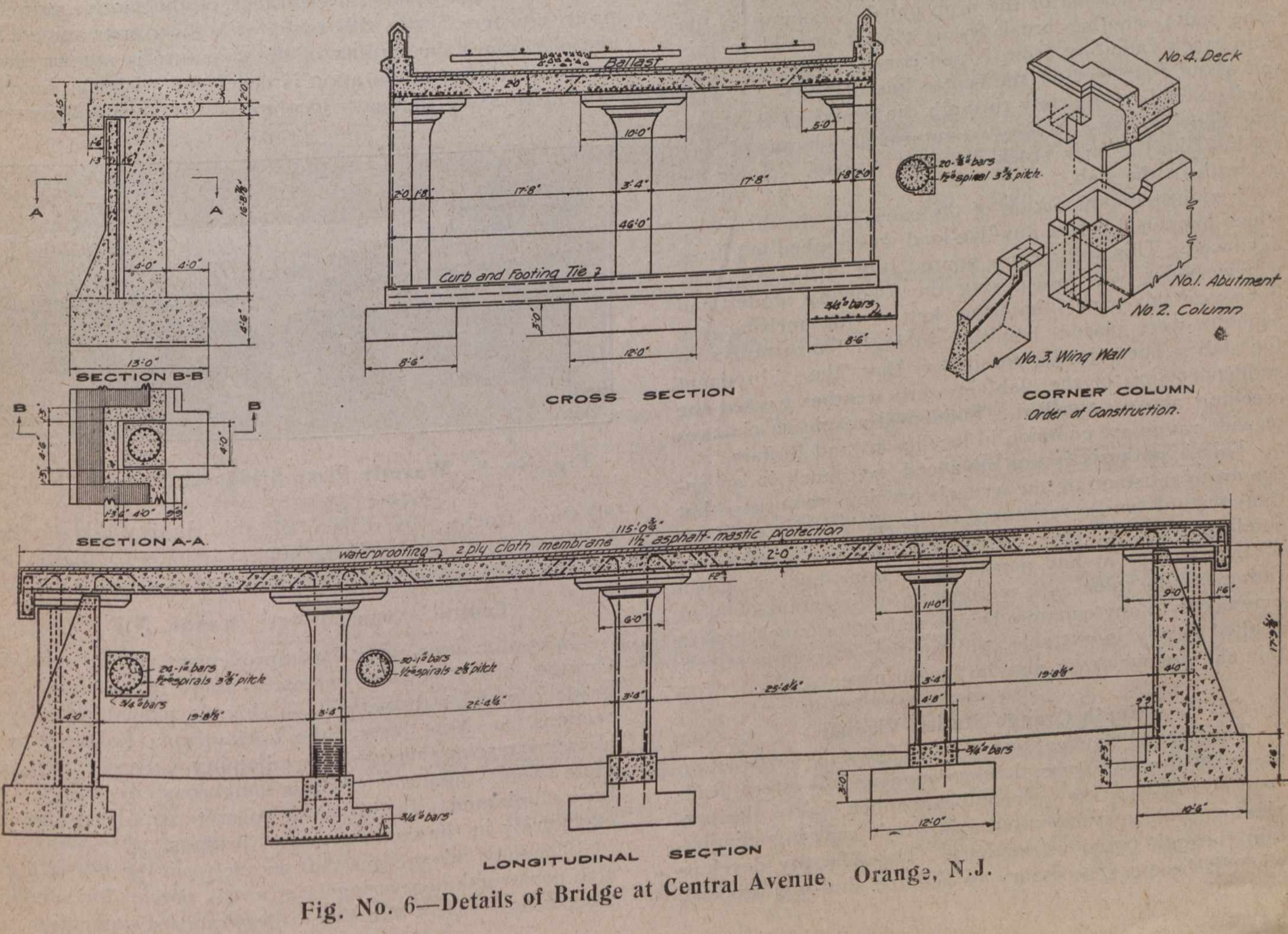

Fig. No. 6—Details of Bridge at Central Avenue, Orange, N.J.

asphalt mastic. Only one expansion joint was provided and this placed at bent 31 where the slab begins to narrow down from the seven-track to the two-track width at the easterly end. The joint was deemed necessary here for the reason that the narrow section would not offer the same tensile resistance to temperature changes as would the wider section. An accumulation of stress might reasonably be expected somewhere in the narrow section if no expansion joint were provided which might result in cracks of sufficient magnitude to impair the strength of the viaduct.

It might be noted here that the only cracks so far developed have occurred in the side panel under tracks 1 and

Fig. No. 7—View of the Central Avenue Bridge, Lackawanna R.R.

2 between bents 24 and 25. The principal crack starts at a point where the centre line of track 3 intersects the side of the drop panel of column in bent 24 and bows out slightly in the arc of a circle to about the third point of the panel, ending at the intersection of the centre line of track 1 with the side of the drop panel of column in the same bent; another break forms almost normal to this main crack radiating from it and continues parallel with and about four feet off the centre line of track 1. This crack extends completely through the centre of the large drop panel common to the two outermost columns of bent 25, but like the main crack does not seriously impair the strength of the slab.

A plausible explanation of the cause of the cracking which happened before any live-load was applied might be advanced. This section was poured July 14th, 1916. The waterproofing was laid during the following winter and it was on this panel that the kettles for melting the asphalts were placed, resulting in high temperatures in the slab. There is the possibility that the subsequent sudden cooling of the slab in zero weather caused the cracking above described. Sudden atmospheric changes of wide range are common in locality around Buffalo.

This hypothesis is not advanced so much in an endeavor to substantiate the writer's previous remarks—that the constant tensile resistance of the slab under ordinary conditions has the effect of preventing cumulative action of the stresses at any particular section—but is given rather for its value as a warning in anticipation of what may occur to any concrete bridge slab if too much heat is applied locally in extreme cold weather to comparatively thin slab for whatever may be the purpose.

South Orange Station Viaduct

The second application of the flat-slab construction made by the Delaware, Lackawanna and Western Railroad solved in a very acceptable manner one of the perplexing problems encountered in grade crossing elimination through populous sections. The difficulty develops when it becomes necessary to acquire abutting property for the expansion of tracks and station facilities, in which case the property is usually rated at an exorbitant value.

This condition prevailed in connection with track elevation work through South Orange, N.J., where the acquisition of more right-of-way would have been necessary for an additional third track and island platform together with a new station if the latter were to be built in the usual manner alongside. The necessity of purchase was obviated advantageously by the adoption of a flat slab viaduct, 79 ft. in width and 426 ft. in length, under which the station and all its appurtenances were built within the confines of the original right-of-way. (See Figs. 3, 4 and 5.)

The proximity of South Orange Avenue, a county highway, was an important consideration in favor of the slab construction since the easterly end of the viaduct is carried over this main thoroughfare. Included in the facilities provided under cover of the slab are a concourse connecting the station with the avenue and its trolley line, parking space for vehicles, a baggage platform and a heating plant apart from the station.

In addition to the three tracks, the viaduct carries an eastbound platform 14 ft. 4½ ins. in width and a 25-ft. island platform between the middle or express track and the westbound local. The 25-ft. width was fixed by clearance requirements on either side of the shelter houses built on the platform.

There are many advantages in addition to that of economy to be gained by this type of construction. It permits of more effective architectural treatment; because of its shallow floor depth the track can be laid in ballast which is a very important consideration in track construction; there are no girders projecting above the deck to encroach upon the lateral clearance of the motive power or to interfere, as in this case, with the construction of the platforms; the rigidity of the structure is noteworthy since no noticeable vibration is developed with the simultaneous passing of heavy locomotives at high speeds on

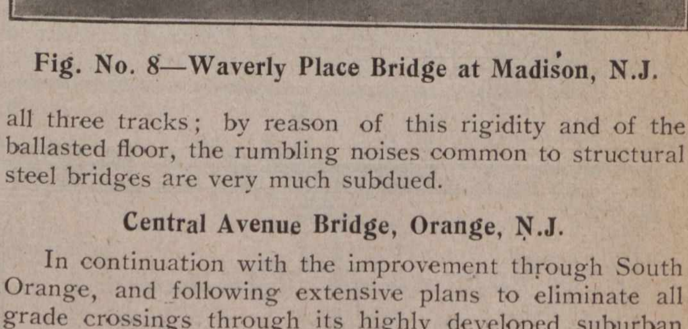

Fig. No. 8—Waverly Place Bridge at Madison, N.J.

all three tracks; by reason of this rigidity and of the ballasted floor, the rumbling noises common to structural steel bridges are very much subdued.

Central Avenue Bridge, Orange, N.J.

In continuation with the improvement through South Orange, and following extensive plans to eliminate all grade crossings through its highly developed suburban sections in New Jersey, the Lackawanna Railroad has elevated tracks through the adjoining City of Orange. Here twenty-three more or less dangerous crossings have been eliminated. In this work concrete was used almost exclusively in the construction of bridges.

The same advantages that accrue from the use of flat-slab construction covering large areas prevail for smaller structures. Fig. 5 and Fig. 6 illustrate its application to a small type three-track bridge built on the Orange Improvement over Central Avenue, 100 ft. in width. Columns on the curb and along the centre line of the driveway divide the deck into eight rectangular panels, two in the width and four in the length of the structure, with dimensions as shown in cross-sections of Fig. 6.

The simplicity of the structural details of the flat slab offers an opportunity to correct the troublesome conditions encountered in bridge abutment construction. The writer calls attention to the abutment development of the Central Avenue Bridge which resulted from the conception of maintaining throughout the deck the positive plate action attributable to the flat slab. This was to be effected by an end column support to replace the somewhat complex action in supporting the slab on the full width of the abutment. The columns are set in recesses built in the abutments as shown in sections A-A and B-B and also in the isometric drawing of the corner column, which shows the sequence of the construction. The slab is cantilevered beyond the abutment, and built integrally with the slab is the suspended beam or apron which is to prevent the back fill and drainage from percolating through the construction joints. The cantilever has a theoretical significance in giving greater balance in resistance to the negative moment over the columns. The abutment is in fact a retaining wall, since it takes no slab reaction, and it was possible to reduce its section for the reason that the suspended apron of the slab reduces to a considerable extent the live- and dead-load surcharge pressure against the back of the wall. The reduction in concrete is a saving over ordinary concrete bridge abutments and an appreciable saving over the massive abutments required in support of structural steel bridges, where the top width is fixed by wide bearing plates, or shoes, and a back wall. The wide bridge seat retains water, snow and ice, which are sources of much trouble resulting from their marked deteriorating action on the steel and concrete. Here again it is to be noted that the waterproofing details are reduced to the very simplest arrangement.

Relative to the comparison of the cost of structural steel with the flat slab for the small type railway bridge, it has been found in a number of estimates that a very appreciable difference existed in favor of the flat slab. The statement that the cost of structural steel in one case exceeded the cost of the flat slab by 200 per cent. may seem somewhat surprising. This result was obtained where deck construction would have been required on account of a yard layout involving crossovers on the bridge, and a shallow floor depth made necessary because of close vertical clearances. The estimate included the price of structural steel at its high-water mark. The appreciable saving augmented by the present high price of structural steel, which is likely to continue for some time, should give added impulse to the consideration of flat-slab construction.

From the standpoint of appearance and quantities involved a specific comparison of the flat-slab bridge can be made with a flat-top bridge, the deck of which is the common slab of rectangular cross-section reinforced in one direction for continuous action over a series of piers. Fig. 8 is an example of the latter type spanning Waverly Place in track elevation through Madison, N.J. The spans of this bridge are almost identical with the spans over Central Avenue, since here the street is also 100 ft. in width, but the slab reinforced in one direction is 12 ins. deeper than the four-way reinforced slab of Central Avenue Bridge, exclusive of the drop panel. If this type were used at Central Avenue at the same unit prices, its cost would exceed that of the present structure by 25 per cent. The noticeable advantage of the Central Avenue Bridge is the clearer vision beyond the bridge obtainable from all angles of approach.

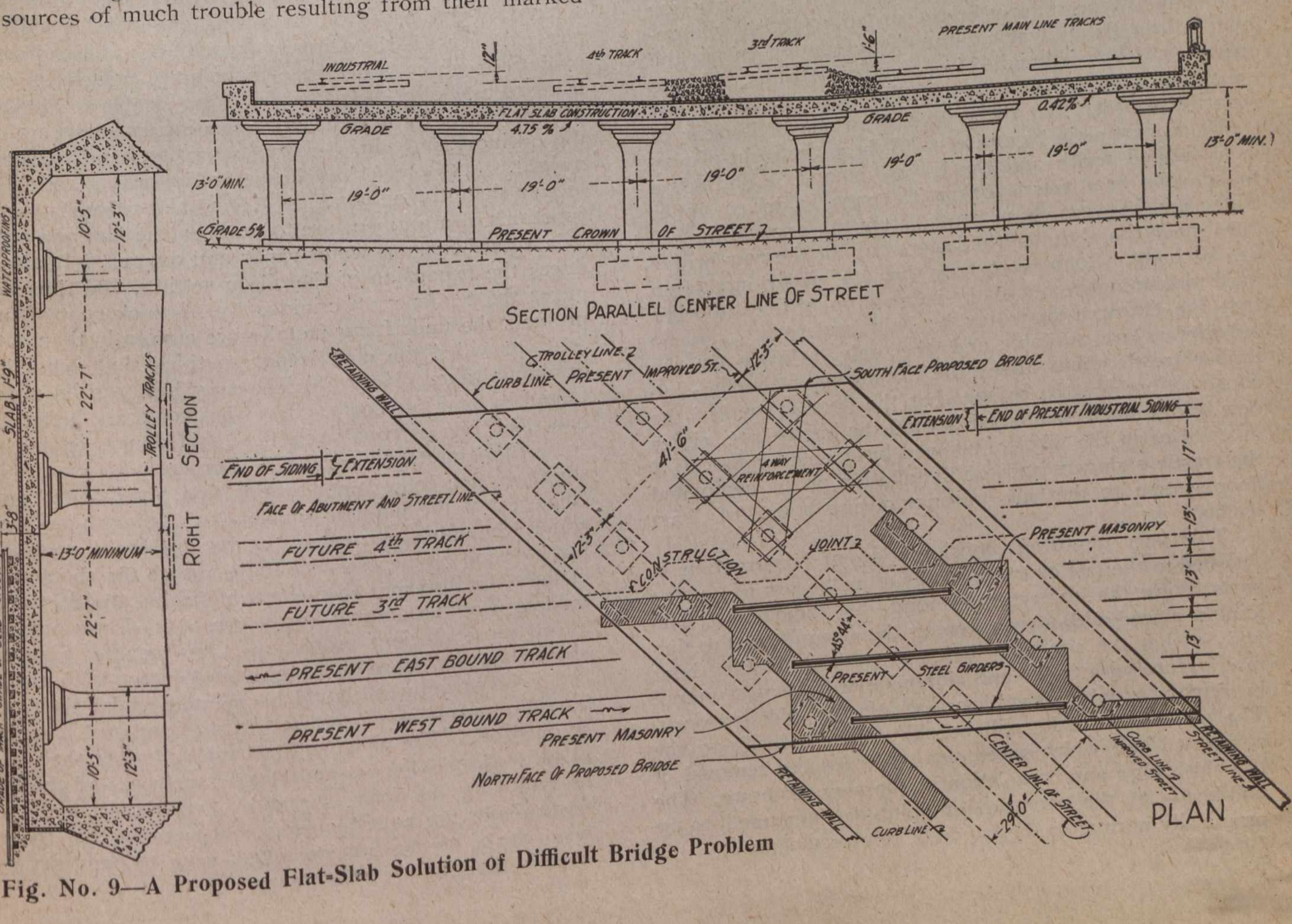

Fig. No. 9—A Proposed Flat-Slab Solution of Difficult Bridge Problem

D., L. & W. R.R. Bridge, No. 9.99

That the flat-slab system has flexible possibilities not obtainable by established bridge construction, a plan, (Fig. 9) of a study in the renewal and extension of the D., L. & W. R.R. Bridge, No. 9.99, is submitted for consideration.

It is here proposed to remove the present two-track steel bridge for the reason that the abutments, 29 ft. apart, encroach upon the 41-ft. 6 in. new driveway, which has been substantially paved with granite block on a concrete base. The bridge is to be extended for future track development on the southerly end, including the installation of an industrial track by extension of the present separate sidings which terminate close to the proposed bridge on either side.

Lateral street intersections fixed the 5 per cent. grade of the street on the southerly side to begin at the face of the present steel bridge, thereby materially encroaching upon the vertical clearance for future expansion of tracks at their present elevation. To overcome this difficulty the flat slab is here tilted in the transverse direction to be approximately parallel with the grade of the present crown of street, and in the longitudinal direction parallel with the grade of the tracks. This flexibleness and the thin slab have resulted in a very shallow floor depth street, and in the longitudinal direction parallel with the grade of effecting the preservation of the established well-ballasted main line tracks, and the extension across the bridge of the industrial siding to the right at its present elevation without resorting to the usual alternative of lowering the street, which in this case would be a very expensive operation. When the future third and fourth tracks are laid, they can easily be established at the elevation 1 ft. 6 ins. above the present tracks necessary to provide the proper amount of ballast.

The most important consideration in the construction of the small type railway bridge on an established alignment is to maintain traffic without interruption during the operation. This is handled in a number of ways. Where the topography will permit, the alignment is shifted temporarily in order that the bridge might be built clear of traffic, in part or in its entirety. Where the right-of-way is of limited width and the tracks cannot be shifted, a timber pile bent trestle of 12-ft. spans is driven under traffic and between these bents, after the excavation has been made the abutment and piers only of the new bridge can be built. Long temporary through girders are often used to span out to out of the new abutment lines in order that the entire bridge may be built underneath. If no old girders are available and the only solution is the timber trestle there arises the exclusion of the flat-slab construction, for the reason that the floor system of the new bridge must be erected beyond the bridge site, either in units or in the whole, followed by a quick removal of the trestle stringers and the installation of the completed floor system on the new masonry during hours of least traffic.

This very important consideration of construction is satisfied in the last example by dividing the work into two parts along the construction joint as indicated. This joint is placed without weakening the strength of the slab and so that the southerly half can be built first without interference with traffic and alongside of present structure by removing only a small portion of the old masonry. The main line tracks will be shifted temporarily to the completed half which gives clear field for the removal of the old bridge and completion of the new structure. The bulkheads of the construction joint are arranged to be practically normal to the bands of reinforcement.

The measure of the advantage in cost of the flat-slab railway bridge, compared with other types, varies considerably and is dependent upon the conditions at hand. There seems to be no question concerning the architectural and structural advantages, the latter results in less maintenance and greater permanence. Of immeasurable value is the simplicity of design and the expediency with which the construction can be carried on. These features are emphasized in the last example which, with its 45° 44′ angle of crossing coupled with the grades of the street and tracks, would considerably complicate the details of design and construction of established bridge practice. The flat-slab design will not require any special consideration on account of these complications. Its flexibility offers much opportunity in overcoming and simplifying other inherent complications of the small type railway bridge.

PROTECTING IRON FROM CORROSION

In a paper read before the Iron and Steel Institute, J. N. Friend summarized as follows the results of his researches on the usefulness of paint for protecting ironwork from atmospheric corrosion: (1) The practical value of acceleration tests is very small in the present state of our knowledge. Reliable results can only be obtained from tests carried out under conditions closely resembling those prevailing in practice. (2) Addition of pigment to oil increases the efficiency of the latter as a protective paint until a maximum is reached. After this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered. (3) Linseed oil on setting expands by some 3.3 per cent. This is the primary cause of crinkling. Further oxidation causes a decrease in volume, which in time leads to cracking. (4) Linoxyn is permeable to moisture. The permeability is reduced by heating in absence of air, the oil increasing in density, viscosity, and molecular weight. (5) Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle. (6) The functions of a pigment are to toughen the film and render it less permeable to water-vapor and oxygen. It also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle. (7) A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place. (8) The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight. (9) Thinners enable thin coats of paint to be applied. Turpentine leaves a very slight residue behind upon evaporation, but its effect on the efficiency of the paint is small. (10) Other things being equal, the most permanent paints are those containing black or red pigments, since these absorb the shorter rays of light, and prevent them from hastening the destructive oxidation of the linoxyn by the air. (11) Finer pigments afford more efficient protection than coarse pigments, since they are more thoroughly in contact with the oil. (12) Iron structures should be painted whilst their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved. (13) Experiments with rusty plates are not conclusive, but suggest that the rust need not be so carefully removed, prior to painting, as is usually thought to be necessary.

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Principal Contents of this Issue

MOBILIZATION OF LABOR

AGAIN the perennial problem of properly mobilizing the nation's labor power has been brought to the fore. The outbreak of war found Canada faced with a serious situation, in which unemployment and the closing down of industries brought the country to the verge of an economic crisis. The same situation arose in the United States, giving the utmost concern to the authorities everywhere. For a time attention was centered upon the problem of finding work for the unemployed; but the sudden expansion of war work reversed the whole situation and submerged the problem, for the time being, of how best to co-ordinate the labor and industry of the nation.

It is a problem, however, that will not down. It has been extremely difficult since the outbreak of war to find the labor essential for carrying on fundamental war work, both in manufacturing and in agriculture. In the latter, the most difficult phase of the situation is the securing of labor for seeding and harvest. Agriculture, no doubt, is the outstanding example of a seasonal occupation; but there are also many seasonal trades which cause a surplus of labor to emerge at more or less regular intervals. This labor, in the past, has been largely wasted; and there has been also an extravagant waste of labor energy through under-employment, over-employment and the failure, in general, to adequately co-ordinate the labor and industry of the nation.

While the several provinces of the Dominion, and the individual States of the Republic, have had labor bureaux of one sort or another for the providing of men with jobs, and jobs with men, nevertheless, these vital functions have been but poorly performed. Ontario has made a splendid beginning; but the other Canadian provinces lag far in the rear, in the solution of this problem. The truth seems to be that the efficient directing of the country's labor force can be accomplished only under federal authority. The United States has afforded sufficient example of the inefficiency of purely local administration of surplus labor.

A system of federal labor bureaux would effect many economies and cut down the expenses of administration, because directed by a single executive head. It is reasonable to expect that a superior personnel would be secured under the federal supervision of labor bureaux, since those employed therein could be brought under the scope of the Civil Service Act. Moreover, it is necessary to take the national view of the labor problem; to rise above local prejudices; to win the support of organized labor; and, above all, to swing the prestige of the federal government and parliament behind the whole scheme. But, whatever the best solution may be, it is of imperative importance that the problem be attacked now, to the end that our economic life shall not be dislocated at the close of the war.

RECONSTRUCTION IN UINTED KINGDOM

RECENTLY the British Labor Party gave to the world its programme of political and economic reconstruction after the war—a programme which, if carried into effect, is destined, according to the belief of Mr. Arthur Henderson and his confrères, to lay the foundations of a new social order. No doubt the labor parties and the Socialists of Europe expect peace to usher in full democratic control; but they are likely to be disappointed insofar as changes of a fundamental nature in diplomacy, politics and industry are to be accomplished overnight.

Specifically, the British Labor Party demands the enforcement of a minimum wage for all workers; the democratization of industry by giving labor a voice in its management; the shifting of taxes to large incomes and fortunes made during the war; and the appropriation of the surplus wealth of the nation for the common good. These are glittering phases. To what extent can they be translated from the realm of theory and speculation into the hard facts of everyday life?

At the conclusion of the war the United Kingdom will face a stupendous task in dealing with the demobilization of 8,000,000 workers, 5,000,000 of whom are at present engaged in military and naval service. To throw this vast labor force upon the country at a time when war orders have ceased, would effect economic paralysis. The British Labor Party has at least made one constructive proposal—that plans be immediately perfected for the carrying on of great national works, so that unemployment will not be permitted to develop, at least to any appreciable degree. The government of the United Kingdom has itself declared its intention of spending £300,000,000 sterling upon the building of cottages for the working class. Great power stations for the development and distribution of electrical energy may also be undertaken, as well as the extension of the nation's system of light railways and canals. It is obvious that, if national enterprises on a huge scale are started, the demand for materials from private industry will gradually result in the re-establishment of the normal trade and industry of peace.

We are not at all convinced that the war has demonstrated the superiority of State administration over private enterprise, or the capacity of uniformed masses of men to direct and control industry. As for a minimum wage, it is clear that labor cannot get more than it produces—and not even all that it produces; for otherwise capital would not be attracted to fields that prove unprofitable. Inordinate labor demands will kill industry, both domestic and foreign; for it is plain that a high level of wages, and excessive costs of production, diminish a nation's power to compete in the neutral markets of the world. The future of labor is to be found, not in short hours, inefficient work, and artificial wages, but in technical and trained efficiency and increased production. A just return to capital, commensurate with the risks of industry, and the loyal co-operation of trained and efficient labor will do more to safeguard the standard of living and advance true democracy than the vaporings of any Bolsheviki class, whether at home or abroad.

PERSONALS

R. S. Kelsch, consulting engineer of Montreal, has been elected vice-president of the American Institute of Electrical Engineers.

W. M. Punter, formerly Canadian manager of Saxby & Farmer, Limited, has been appointed signal engineer of the Canadian Northern eastern lines, with headquarters at Toronto.

Dr. Alfred Stansfield, of Montreal, has accepted a commission from Hon. Wm. Sloan, minister of mines for British Columbia, to make a full investigation into the commercial possibilities of the application of electrical smelting methods to the development of the iron ore resources of that province.

Walter Sidney Harvey has resigned from the Department of Works, city of Toronto, to accept a responsible position with the Leaside Munitions Co. Mr. Harvey has been in the sewer drafting section for several years, and for the past few years was in charge of that section. He was more or less responsible for the design of nearly all of the more important sewers constructed in Toronto within recent years. Mr. Harvey was formerly assistant engineer of Lethbridge, Alta.

George A. Johnson, of New York City, has closed his consulting engineering office temporarily, having been commissioned a major in the quartermaster corps of the United States Army. He will be attached to the Construction Division of the Maintenance and Repair Branch, with headquarters at Washington, D.C. Mr. Johnson has been very prominent for many years past in waterworks circles, having done much original filtration and chlorination research work. He has acted as consulting engineer to a number of Canadian municipalities.

OBITUARY

Lieut. John Turner Howard, of the Royal Engineers, a graduate in civil engineering at the University of Toronto, has died from wounds.

In a debate on railways in the Spanish Senate recently Senor Cambo said the government was occupied with a large scheme for the development of hydro-electric energy, and hinted at the existence of a plan for working thus the main railways of the country. As the industrial development of Spain is suffering for lack of communications and transport, and as transport at present depends on coal, the importance of this project is obvious, says the "Railway News." It is interesting to note also that practically all waterfall power plant in the country is run with German machinery, and Germans have been actively surveying and buying properties where this power could be developed on a large scale. There is said to be enough water power in Spain to do the whole work of the country.

ARE SEWERS REMUNERATIVE?

(Continued from page 570)

the housing and rentals. No attempt is made to analyze the over-crowding statistics, though a police census of population is required annually for the purpose of returns to the Departments of Agriculture and to the Ontario and Municipal Railway Board.

The engineering departments are almost as lamentably backward. No effort is made to tabulate the number of premises lacking connection to either the waterworks or the sewers, although in most instances accurate references are kept as to whether an individual premise is connected. And apparently no effort is being made by the boards of health to determine, in sewered municipalities, the number of connected premises; nor is there, with the exception of one or two instances, any well-directed and continuous effort towards compelling all premises to connect to water mains and sewers.

UNION OF CANADIAN MUNICIPALITIES

THE eighteenth annual convention of the Union of Canadian Municipalities will be held July 9th-11th, at Victoria, B.C. The session of Wednesday, July 10th, will be under the auspices of the Commission of Conservation and will be devoted to civic improvement work. At this session Thos. Adams, town-planning adviser of the Commission of Conservation, will present a paper on "National and Municipal Housing." During the convention delegates will visit the shipyards located in the vicinity.

CORRECTION

IN our issue of April 11th, 1918, appeared an article by W. W. Young on "Emergency Development at Niagara Falls." The heading given to the article would indicate that Mr. Young planned to put temporary penstocks on the crest of Luna Falls. We are advised by Mr. Young that while his article may have been somewhat ambiguous regarding this point, he did not intend actually to build penstocks on the crest of the falls. Mr. Young writes:—

"To simplify for the reader as a method in the very elementary illustration for Luna Falls, I plead guilty of putting penstocks on the crests for the moment, and, with the length of article I felt justified in dictating, did not go into head works details and used 'removable dam' in an after-the-war sense.

"The successive steps of emergency development would result in a continuous spillway weir, with provision for emergencies, well behind the crest of all the falls, to raise the elevation of the water and divert it at right angles into marginal or littoral canals or penstocks along the three shores of Prospect, Goat Island and Victoria Parks. On re-reading I see that I left the matter open to the construction placed on it in the caption, though the one on the map and note is also implied and intended."

United States government supervision of employment for technical men has been inaugurated by the United States Employment Service, through the establishment of a division of engineering, with A. H. Krom, of Chicago, as director. Mr. Krom is a graduate of Purdue University and was formerly secretary of the American Association of Engineers. Recently he was engineer-in-charge of the Chicago office of the State Public Utilities Commission of Illinois.