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ST. PAUL STREET BRIDGE, ST. CATHARINES

NOTES ON THE DESIGN OF FOUNDATIONS AND SUPERSTRUCTURE OF THE PROPOSED STEEL HIGH LEVEL VIADUCT FOR WHICH CONTRACTS ARE NOW BEING LET.

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THE substructure is under way and tenders have been called for the superstructure of a steel viaduct 1,236 ft. 3½ inches in length to provide a better means of communication between the business centre of the city of St. Catharines and the section known as the Western Hill. The only steam railway entering the city is the Grand Trunk, and its station and freight sheds are also situated on Western Hill. A deep valley intervenes, through which extends the old Welland Canal.

The need of a high level bridge has been a subject of controversy for a quarter of a century, and several campaigns were started at different times by private enterprise to provide funds for its construction. No definite action was taken by the city itself, however, until shortly after the outbreak of European hostilities, when, in the face of an indefinite period of monetary stringency, a by-law was passed by the ratepayers authorizing its immediate construction.

Of the several possible routes the St. Paul St. extension was finally chosen as being in the best interests of the city. A very slight deviation of the street alignment was necessary, and the structure at the same street level, as proposed, is made to provide for the elimination of 80 ft. of heavy grades with which the present roundabout road to the station is handicapped.

Several designs for the contemplated structure were submitted by Messrs. Sprague and Reppert, consulting civil engineers, Pittsburgh, Pa. Fig. 1 shows the type selected. In the test borings on the site no rock was found nearer the surface than 85 ft. There was also a matter of $40,000 difference between this design and an alternative one of concrete construction. Both factors figured materially in the selection of a steel structure. The cost of the bridge is estimated at $165,000, while the right-of-way has been purchased by the city for $55,000. Against this there are two grants, one from the Dominion Government amounting to $50,000 and one from the Grand Trunk Railway to the amount of $20,000; making a net cost to the city of $150,000. Preliminary work has included, in addition to the above, the cost of removing four stores and three large houses from the site of the north approach to the bridge. A new street will be made, and, when the structure is completed, there will be two

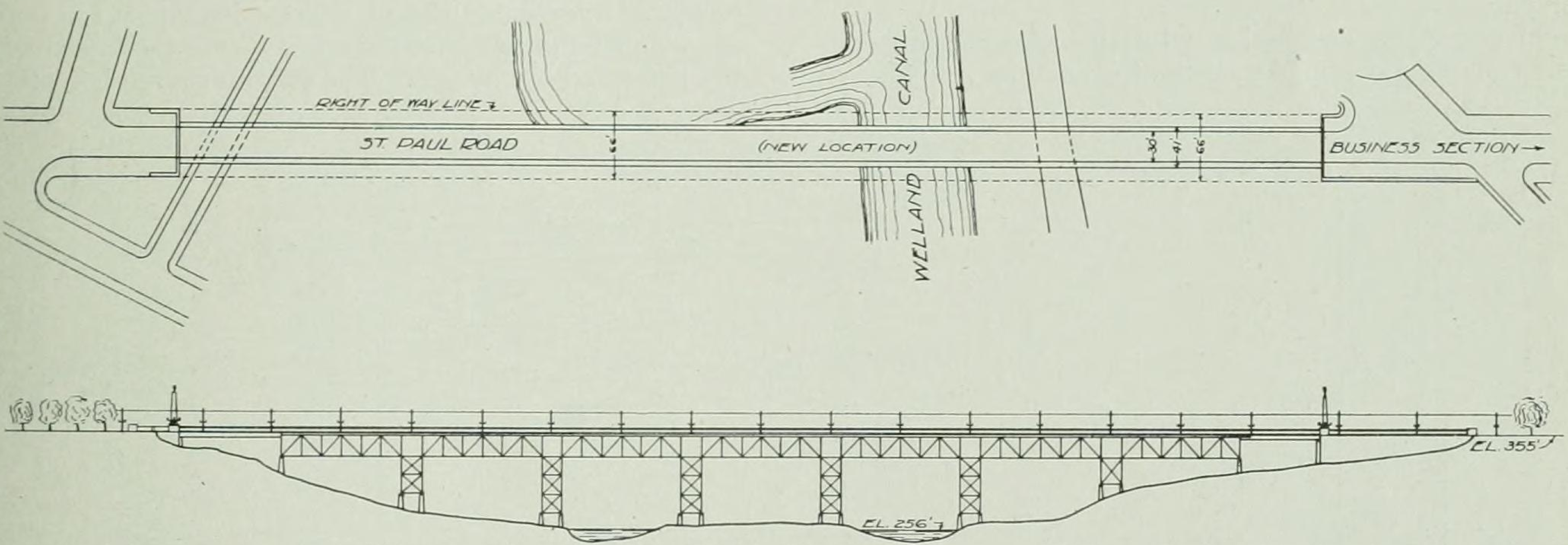

Fig. 1.—General Plan and Elevation of the Proposed Bridge.

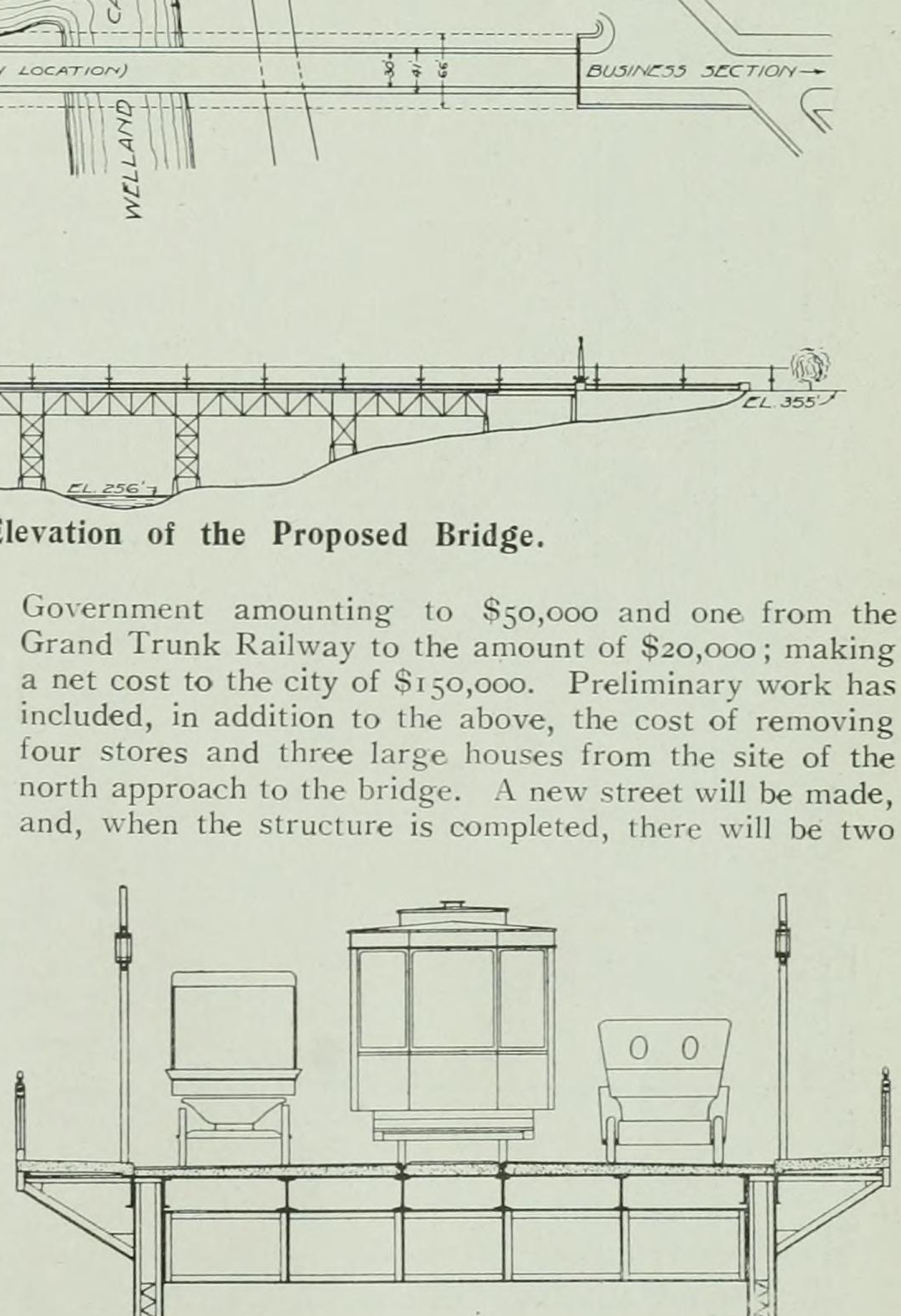

Fig. 2.—Section of Roadway.

streets leading directly to the bridge at the north end, thus allowing for future extension of traffic.

Contracts are being let in three sections. The substructure has already been let by contract to Campbell &

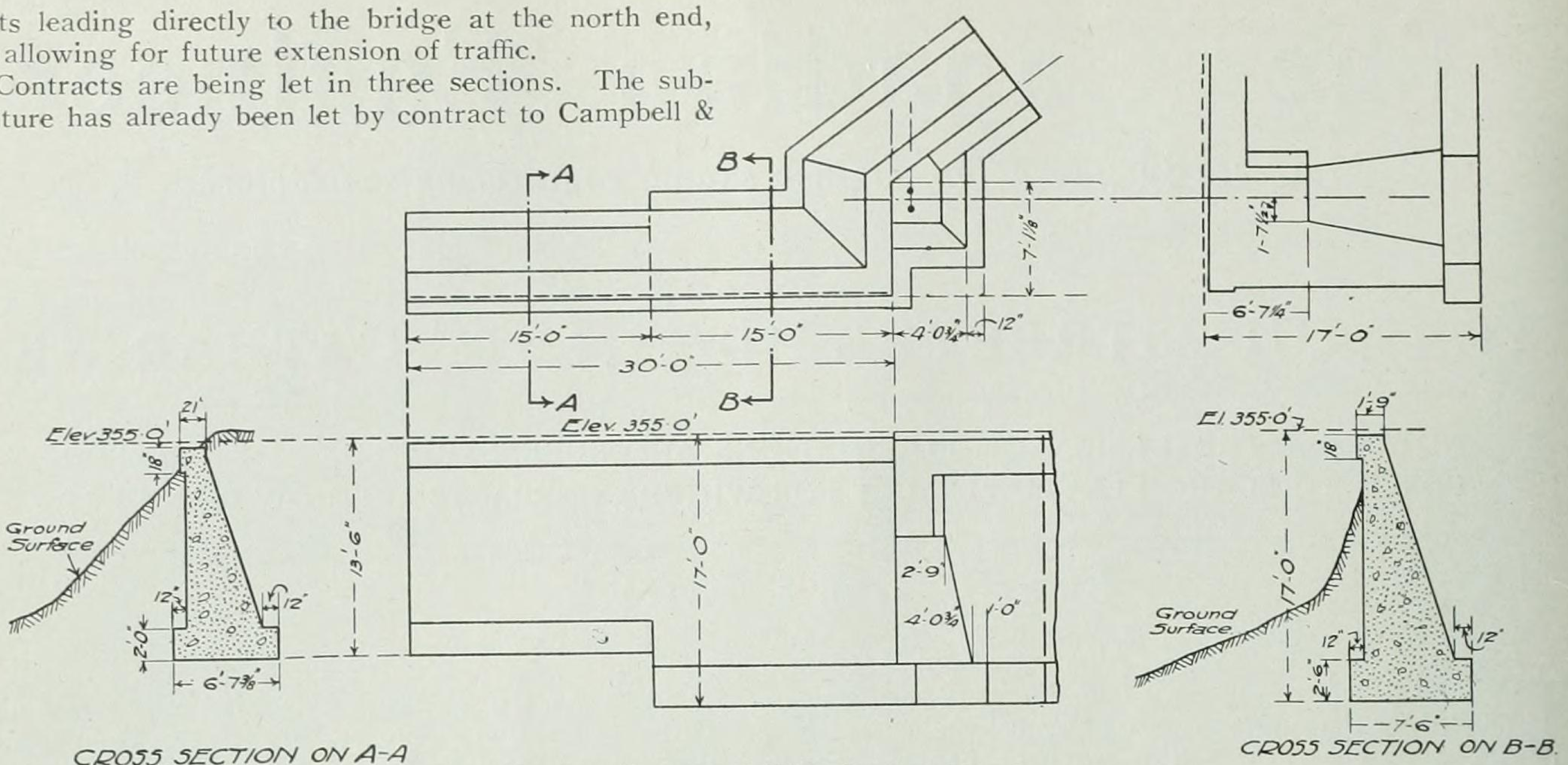

Fig. 3.—Details of Wall Section No. 1.

Lattimore, Toronto. Tenders for the steel superstructure close on December 8th. The contract for paving, which will probably be of creosoted wood block, will be let at a later date.

The work in connection with the substructure consists of about 3,000 cubic yards of excavation, and 1,850 cubic yards of concrete in piers and abutments. There will also be considerable concreting in copings and parapet wall. About 10,240 lineal ft. of timber is being used in piling. Other quantities of interest include 7,250 pounds of anchor bolts and 3,000 pounds of reinforcing steel for the piers and abutments. The contract for this work has

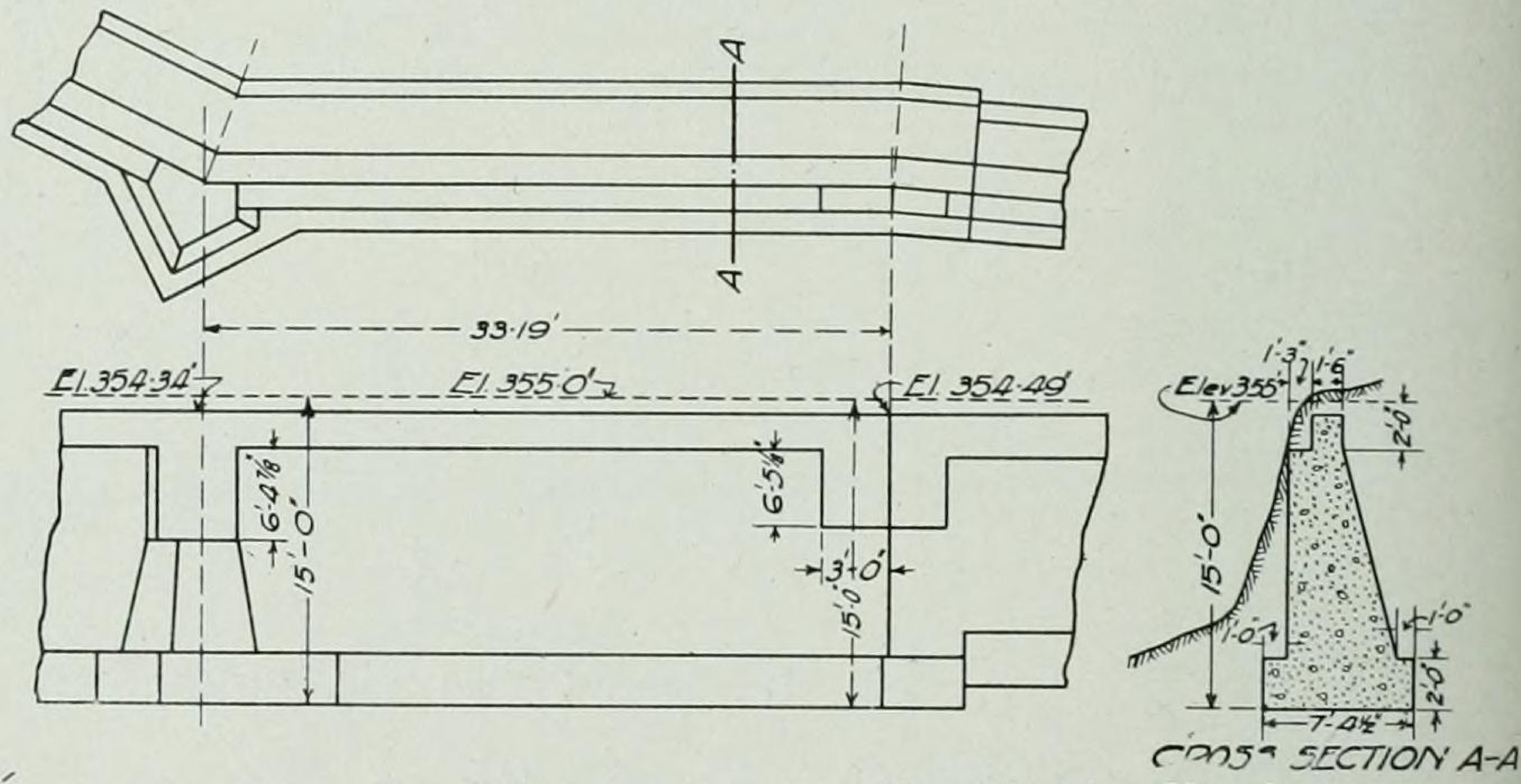

Fig. 4.—Detail of Wall Section No. 3.

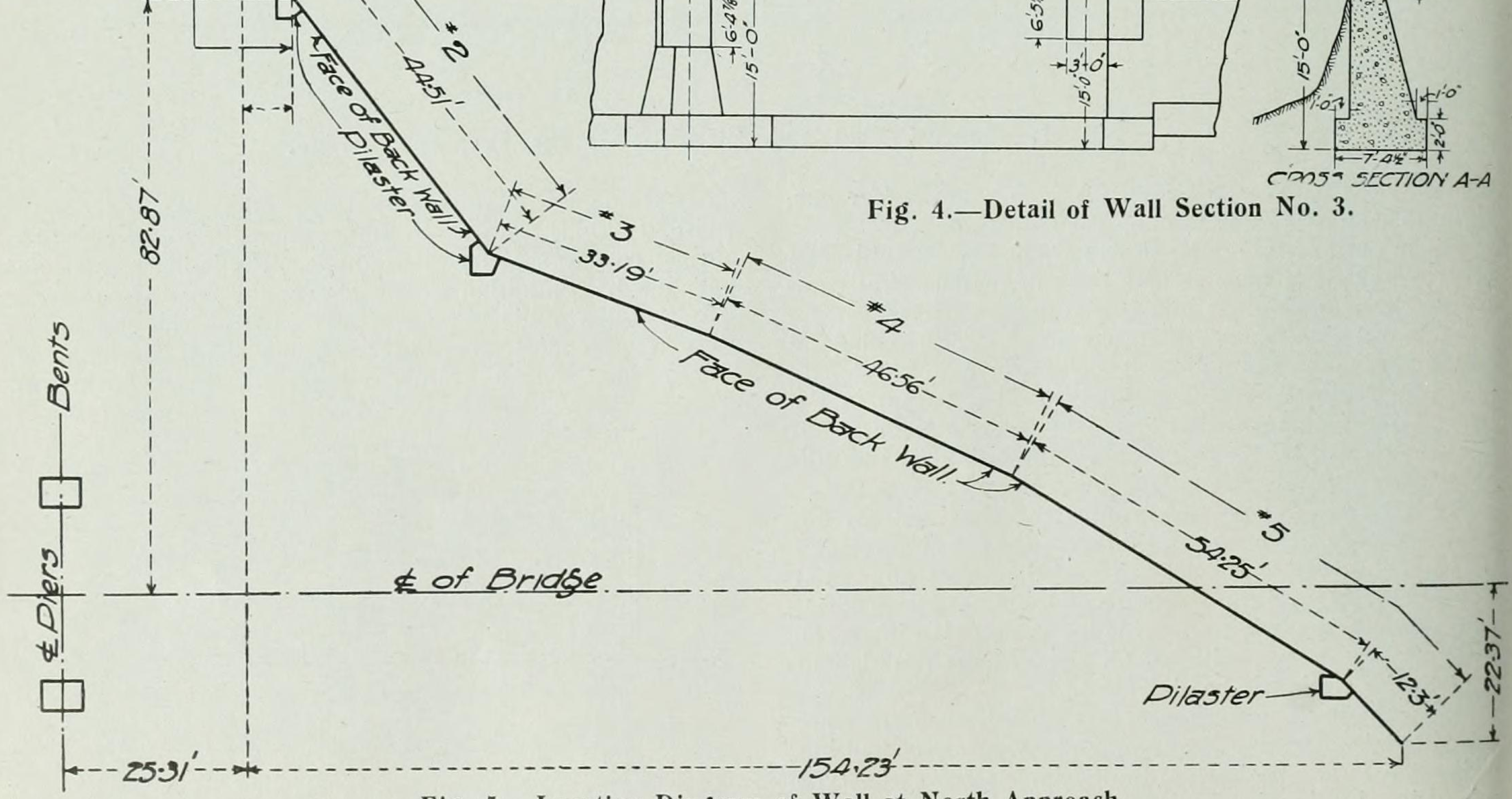

Fig. 5.—Location Diagram of Wall at North Approach.

been let at an amount about $10,000 under the engineer's estimate, the latter being based on normal conditions.

The design of the north abutment possesses some points of considerable interest. As shown in Fig. 5, the wall has been divided into sections with alignments at angles to the centre line of the bridge. Section 1, 30 ft. 46.56 ft. long, the height decreases owing to an elevation of 2 ft. of the base, while the thickness of the base of the retaining wall decreases with the height to 6 ft. 10½ in. Wall section No. 5, which is illustrated in Fig. 6, is 54.25 ft. long with a depression of the base to 15 ft. and a corresponding enlargement of the base to 7 ft. 4½ in. in

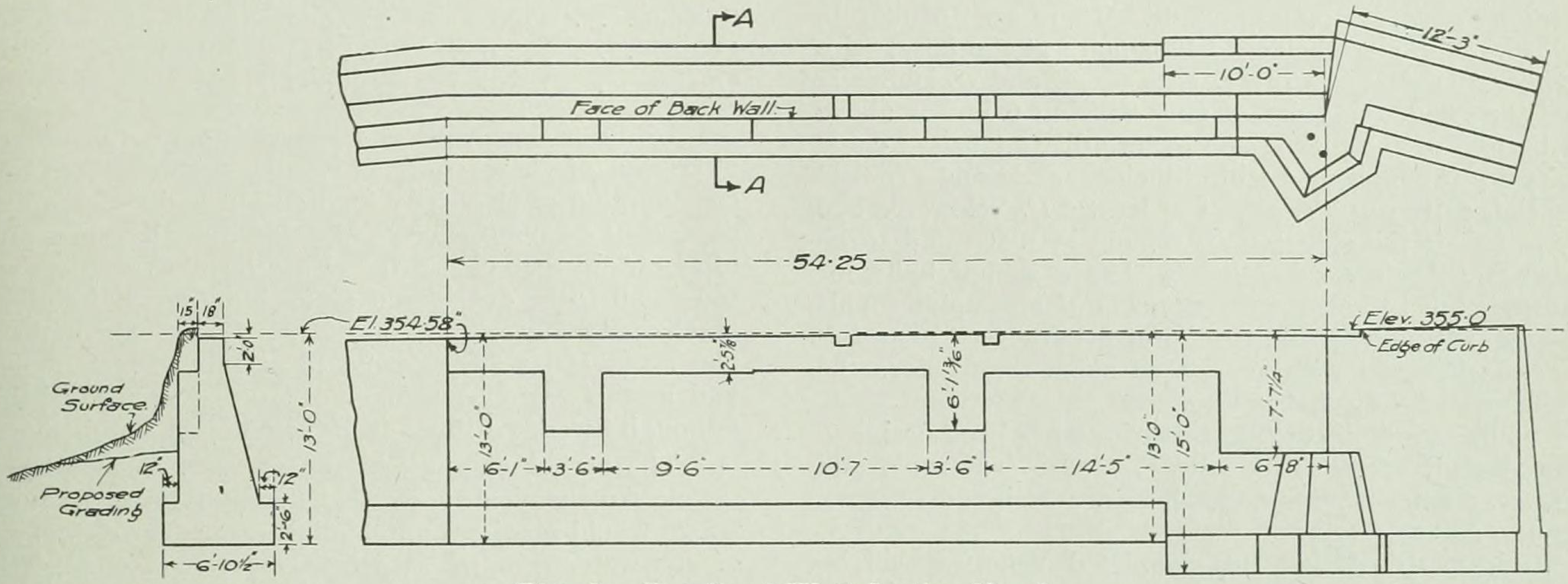

Fig. 6.—Details of Wall Section No. 5.

in length, marking the extreme end of the abutment along Yates St., is shown in detail in Fig. 3. It varies in height from 13½ ft. to 17 ft., and includes a pilaster at the intersection with wall section No. 2. Section No. 3, the details of which are shown in Fig. 4, which is 33.19 ft. in length, is uniform in depth, 15 ft., and its section corresponds to section BB' in dimensions. In section 4, width, as shown in Fig. 5. The centre line of the bridge is crossed by this wall section, and a pilaster, shown in Fig. 6, connects a sub-section 12 ft. 3 in. in length, which forms the extremity of the abutment wall.

The south abutment, 24½ ft. in length, is shown in Fig. 7, which illustrates clearly the general features of its design and the proportioning of the supporting walls.

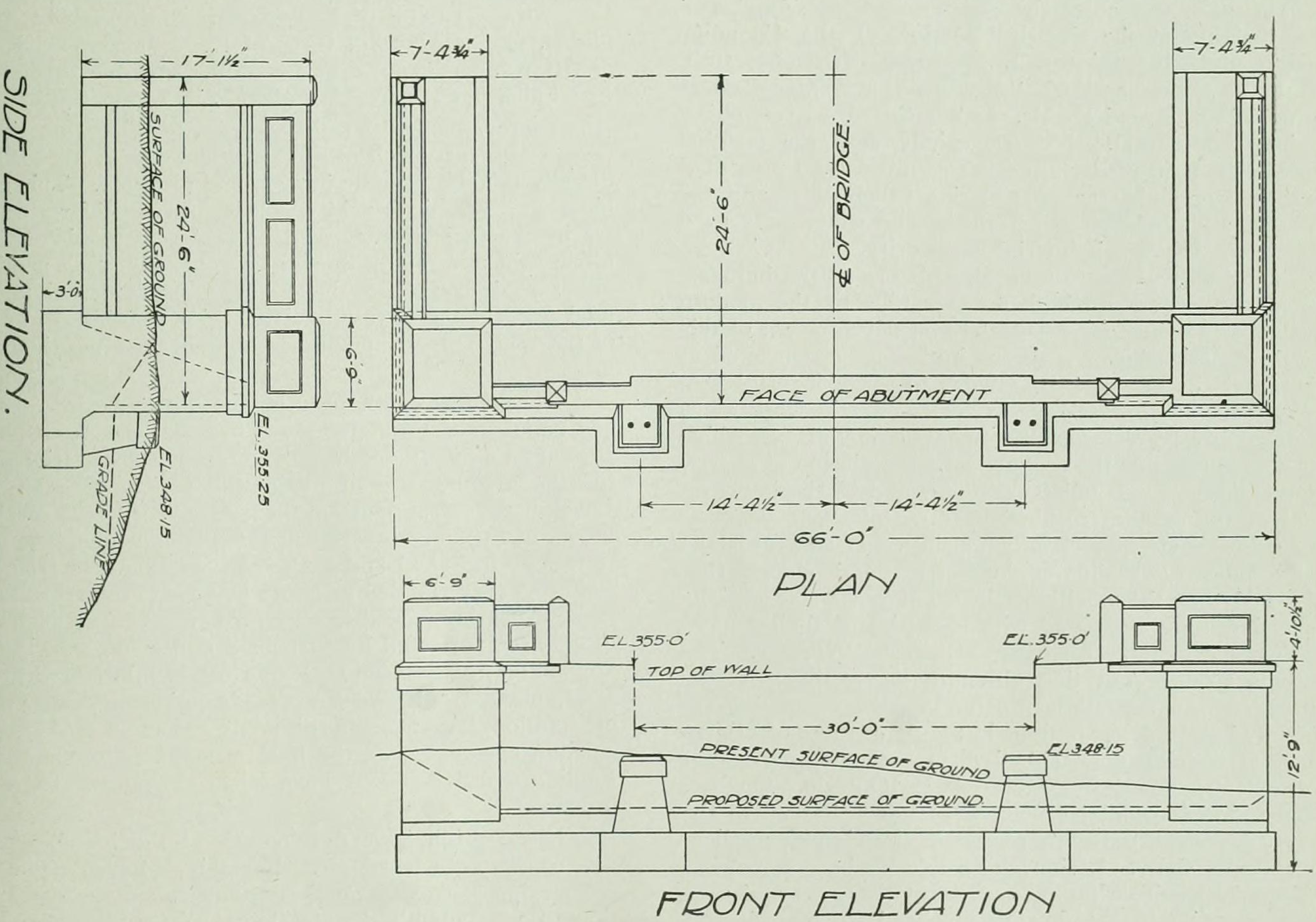

Fig. 7.—General Design of South Abutment.

There will be seven Warren truss spans, with plate girders at the ends extending to the concrete approaches. The steel is supported on 35 concrete piers, two for each of 17 bents, and a single pier at the south end. Five of these piers are reinforced. The 8 bents on the level portion of the valley rest on timber piles driven to a depth of about 40 ft., or to a point where each pile will sustain a load of at least 30,000 pounds. There are 16 piles to each pier, the piers being 12 ft. square at the base, with the piles spaced 3 ft. c. to c. both ways, and 18 inches in from the edge, the point of cut-off being 6 inches above the bottom of the pier. The bents adjacent to the canal banks are to be sheeted with 3-inch tongued and grooved material, driven to a depth of at least 6 ft. below the bed of the canal, the sheeting to remain in place and to be cut off 1 ft. below water level. The 4 anchor bolts for each pier are to be placed by means of a templet. This is a part of the work that requires accuracy and carefulness, as the steel will be ordered some time before the completion of the substructure.

As illustrated in Fig. 2, the bridge has been designed for a single-track electric railway, a 30-ft. roadway, and two 5-ft. sidewalks. The members are designed to carry a 36-ton car.

It is expected that the completed structure will be open to traffic in the fall of 1915. Mr. W. P. Near is the city engineer.

FIELDS FOR THE INDUSTRIAL APPLICATION OF CANADIAN WATER POWERS.

SOME very potent arguments bearing upon Canadian water powers and the rate at which they are being made of service to the country were presented at a meeting of the electrical section of the Canadian Society of Civil Engineers in Montreal, November 16th, 1914. A paper entitled "Making Our Water Powers Valuable" was read by Mr. Arthur Surveyer, consulting engineer, Montreal. It dealt chiefly with the position Canada holds in respect to other countries and presented in their true light the possibilities which exist and the national asset which we have in our water falls as a guarantee of future industrial superiority.

The paper presents a concise history of the harnessing of the larger and higher water falls by the modern turbine, in various countries, the first development of this sort in America being a 15,000 h.p. plant constructed at Niagara Falls in 1893. It alludes to the wonderful progress made in the technics of hydro-electric work since that time, to the recent improvements in installation which have made possible the economical transmission of energy for distances of 200 miles and over, and to the improvement of the modern turbine whereby low head developments are now commercially feasible. It compares the water powers of different countries and shows that Canada is not the wealthiest in water powers, especially if provinces are compared with countries of similar area, for example France, Austria, Sweden and Norway. The truth is brought out that although the available horsepower per square mile is greater in some cases, we are woefully behind other nations in the percentage of utilization. The following table indicates the uses made of hydro-electric energy generated in Ontario, Quebec, France, Sweden and Norway, and shows that up to the present we have only progressed in the simpler applications of electricity. It shows also that we have somewhat neglected its utilization as an electrolytic agent and as a heat-generating agent in electro-chemistry and electrometallurgy.

Countries.	Developed hydro-electric power.	Subdivision of developed power. Electro-chemistry and electro-metallurgy.		Motive power, traction and lighting.	
	h.p.	h.p.	%	h.p.	%
France . . .	592,000	291,000	49.1	301,000	50.9
Norway . .	543,000	275,000	50.6	268,000	49.4
Sweden. . .	370,000	120,000	32.4	250,000	67.6
Ontario. . .	320,000	25,000	7.8	295,000	92.2
Quebec . . .	198,000	28,000	14.1	170,000	85.9

In discussing ways and means for the advantageous alteration of these conditions, the author refers to the consumption of electricity for lighting and for traction as dependent on population, and notes that the consumption of electricity per capita for either lighting or traction is too small to be considered as an inducement for the extensive development of our water falls. The pulp and paper industries are referred to as large users of power and in this instance Canada is not so very far behind, although Sweden utilizes over 120,000 h.p. in this manner.

The author emphasizes the value of closer attention to electro-chemical and electro-metallurgical industries which would require a notable increase in the development of our water powers. He briefly reviews some of these industries that either on account of the abundance of necessary raw materials or because of large neighboring markets, might be likely to prosper in this country.

Electro-chemical Industries.—The manufacture of calcium carbide is the oldest of these industries in Canada. Three plants are in operation at present, absorbing about 14,000 h.p. and producing about 12,000 tons annually, half of which is exported. (The world's production in 1913 amounted to 339,000 tons.) The Canadian Carbide Co., with a capital of $2,000,000, control these three plants, one at Thorold, Ont., of 1,000 tons capacity, one at Ottawa, producing over 4,000 tons, and one at Shawinigan Falls, Que., supplying about 7,000 tons, annually.

There are also the nitrogenized fertilizers all except one process of which utilize electrical energy to combine directly the atmospheric oxygen and nitrogen. This combination gives nitric acid which in presence of water and air in excess is transformed immediately to nitrous and nitric acid and finally into nitric acid only; this azotic is either sold as such or is led over limestone, giving as final product the nitrate of lime which is utilized in place of the Chili saltpetre or nitrate of soda for all agricultural uses.

"The story of the fixation of atmospheric nitrogen can be summed up as follows: In 1902, the Atmospheric Product Company erected in Niagara Falls a trial plant for the manufacture of nitric acid by the Bradley and Lovejoy process. During the same year, de Kowalsky began in Fribourg a series of researches which were continued by Moscicki and led to the erection of a trial station at Vevey, in Switzerland; in 1903, Professor Birkeland, of Christiania, discovered a new process which was afterwards perfected by Birkeland and Eyde, and is now applied on a very large scale at Notodden in Norway. In 1903, also, Frank and Caro made public a new method of fixation based on a different principle and giving calcium cyanamide as the final product. More recently, Pauling and Schonnherr have taken out patents for other processes."

Nitrate of lime has developed in production since 1909 to 110,000 tons last year. For this industry alone the Norwegian Nitrogen Co. have undertaken the construction of plants with the total capacity of 540,000 h.p Nitric acid is produced in quantities ranging from 200,000

STEEL PASSENGER CAR FRAME CONSTRUCTION.

A PAPER presented at the December 3rd meeting of the Mechanical Section of the Canadian Society of Civil Engineers, by Mr. C. Brady, discussed in a very enlightening manner the differences existing in different types of frame construction designed for like loads and stresses. Mr. Brady emphasized the impossibility of drawing satisfactory conclusions as to the merit or weight of any particular type of framing when comparing cars built by different designers for different roads. This for the reason that variations in proportion and in size of plates and bars, together with different weights of other parts of the car and different general dimensions throughout, do not admit of close comparison. But the writer presents some interesting data respecting the four distinct types as they are actually built. These types are described as follows:

(1) Heavy centre sill construction, the centre sills acting as the main carrying member.

(2) Side carrying construction, the sides of the car acting as the main carrying member having their support at the bolster.

(3) Underframe construction, in which the load is carried by all the longitudinal members of the lower frame, the latter being interpreted to include the side girder below the windows.

(4) Combination construction, in which the side frames carry a part of the load, transferring it to the centre sills at points remote from the centre plates, so as to utilize the uniform centre sill area.

The writer does not submit particulars respecting the first type of construction, as it is quite unequal to the others in weight. Types 2, 3 and 4 are analyzed in detail with respect to the above considerations, and the reader is given a clear insight into what to look for in examining cars in service, or more especially, when the opportunity presents itself, to examine cars that have been in accident. The great importance of a minimum weight for a given standard strength is clearly emphasized. Ability to support its own weight and the usual maximum live load is brought out in the case of each, and each is proven entirely satisfactory in that regard. The same is said of end shocks in coupling and uncoupling, and in collisions, so long as the cars remain on the track in the same horizontal plane.

The condition that usually results in numerous injuries and loss of life is the telescoping of cars, as it is called, when the underframe of one car gets above the underframe of the next car and plows through the comparatively light superstructure. When this occurs it is impossible to express what happens in terms of a static load at a given location, but it has come to be generally accepted as inevitable that some damage must result to the vestibule and car end no matter what construction is used. The greatest protection to passengers is effected by making the end construction very strong, not necessarily to resist bending but rather to prevent tearing away at the fastenings. As a telescope contemplates conditions where the centre sills are not in line, some exponents of the comparatively light centre sill construction argue that the very large and powerful centre sills do not afford any additional protection but are actually objectionable because of the increased probability of their tearing away the end superstructure.

For resisting end shocks above the floor level, side swiping and bending, Type 2 is shown by the writer to be stronger than the others on account of the comparatively heavy top plate angle and the stronger post construction.

Advantages for the large heavy centre sills are not so easy to find, but there is one important condition where they would probably show up to advantage and that is in case of a collision where a locomotive strikes the car. A modern locomotive would not be at all likely to climb into the car, and if the speed was great even the heaviest car construction could not be expected to stand up against the massive castings and heavy steel plates used in locomotive construction; but it is quite reasonable to presume that the stronger the centre sill construction in the car the less the damage which would result.

From construction and operating standpoints the shallow centre sill car has the advantage of not interfering in any way with the locating of brake rigging and other equipment under the car, and it materially facilitates quick and thorough inspection in service.

ST. CATHARINES VIADUCT PLANS TO BE REVISED.

The proposed St. Paul Street bridge at St. Catharines, over the old Welland Canal, a description of which appeared in *The Canadian Engineer* for November 26th, 1914, is to undergo a slight change in plan to provide sufficient carrying capacity to accommodate the proposed Hydro-Electric railway between Windsor and the Niagara River. It has been decided to increase the strength of the bridge by approximately 20%, and the companies now tendering on the superstructure are being notified to that effect.

The bridge, as described in the article referred to, was designed to carry a 36-ton car, whereas, a 57-ton passenger car will probably be the requirement of the Hydro.

Although the Hydro-Electric Power Commission is probably not contemplating the early construction of this electric trunk railway line across the western peninsula, members of its engineering staff have conferred with the St. Catharines authorities in an advisory capacity with respect to the wisdom of providing for the future installation.

CANADIAN MANUFACTURE OF SHRAPNEL SHELLS.

As announced in these columns some weeks ago, the British War Office has awarded, through the Department of Militia at Ottawa, a number of contracts for the manufacture of shrapnel shells to different Canadian firms. It has just been announced that these contracts aggregate the sum of $2,500,000, and that practically all the material entering into their construction is being obtained in the Dominion. For instance, the Nova Scotia Coal and Steel Company supplies the steel, the Trail smelters in British Columbia supply the lead, and like materials come from various parts of the Dominion.

At present, about 200,000 shells have been contracted for, and they are being turned out at the rate of 30,000 a month. It is stated that there is capacity in Canada for the manufacture of 100,000 or more per month. The work is now going on at Montreal, Sherbrooke, New Glasgow, Amherst, St. John, Kingston, Toronto, Welland, St. Catharines, Hamilton, Dundas, Galt, Ingersoll, London, Lindsay and Smith's Falls.