Types.—The various types of plate girder bridges which are in general use at present are represented in Figs. 1, 2 and 3, the deck girder being the cheapest and simplest form and therefore used wherever conditions of clearance will permit. Where the allowable depth for clearance is reduced to the limit where a deck span would not suit, it is necessary to adopt the half deck girder, as shown in Fig. 2, or the through plate girder type, as shown in Fig. 3. The half deck girder span is very little heavier than the deck span and is frequently used where the top flange is not more than three feet above the base of rail, the main girders being spaced 13 feet between centres. There have been bridges built where the shelf angles have been lower than this, and in some structures the ties have been made to rest directly on the bottom flange. This is not good practice, as it is necessary to space the girders further apart to suit the recognized requirements of clearance, and this would demand longer and

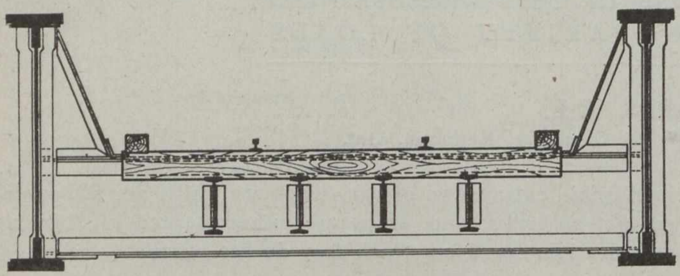

Fig. 3.—Through Plate Girder.

heavier ties and, moreover, the cross brace frames become so shallow that it is not possible to properly stay the top flanges of the main girders. The greatest objection to the half deck girder is that the ties resting on shelf angles must produce eccentric loading on the main girders, and this is not easily taken care of. The half deck span also requires extra heavy ties with an odd length, and these ties demand the most rigid inspection on account of the severe strain they undergo, and when it is necessary to replace them the procedure is much more difficult than in the case of the other types of girders because the ends of the ties butt into the webs of the girders.

The through plate girder span with stringers and floor beams, is undoubtedly the most desirable construction, where the depth of clearance is limited. Fig. 3 is an example of this form of bridge and shows four lines of stringers per track, which arrangement is considered to be better suited to support derailed trains, and which requires only a very light tie. But it is a cheaper construction, and quite as satisfactory, to use two lines of stringers per track.

In the case of railway bridges passing over streets in cities, where very shallow construction is an advantage, and where protection is needed for the street traffic, a solid floor is used. This may be accomplished by I-beams with a continuous cover plate, or by trough floor construction covered with a waterproofed concrete slab and ballast. The best type of trough floor is shown in Fig. 4. It is an expensive bridge and is not in very common use in Canada, but as railroads multiply in the larger cities it will be more necessary. The trough floor can be made shallower than any other type of floor for heavy loads, and is free from the noise of passing trains, which is an objection in more open construction.

Another type of solid floor, which is illustrated in Fig. 5, is being used in Canada by several railroads, even on bridges where protection below is not needed. It consists of regular track ties in ballast supported on concrete, which covers and fills in between the cross I-beams over the main girders. This construction is being used because of the scarcity of good large bridge ties, and the expense which is frequently required to replace these ties. Any construction which decreases the demand for timber is to be recommended, and there is a probability that bridge design may be considerably changed to suit the increasing scarcity of bridge ties.

There are some tube bridges still in existence, but they are not recommended in modern construction; nor is any form of box girder desirable where the inner surface is not accessible for painting. Wherever a box girder is used, it should be properly braced with diaphragms, so that it will not change its rectangular shape.

Dimensions.—In single spans the effective length of girders is dependent on the adopted clear opening between the abutments, as the edge of the masonry bearing plate should be six inches back from the face of masonry under coping. The length of the bearing plate can then be decided by an approximate calculation of the maximum end reaction. If the final calculations should give a slightly different required area of bearing plate, the difference can usually be taken care of in its width. The effective length of girders is the distance between the centres of these end bearing plates.

In bridges consisting of a number of spans resting on masonry piers, spaced at the most economical distance, the clear space between the ends of main girders should not be less than four inches, and the effective length of the girders is dependent upon this. In steel trestles where the girders rest on towers, the ends of adjoining girders should be placed as close together as the possible expansion will permit, and the effective length will depend on the adopted detail of seat, resting on the cap of the tower posts. In this construction, where the adjoining spans are of different lengths, the different end reactions will produce eccentric loads in the posts, which should not be neglected in the design.

The effective depth of main girders, which is the distance between the centres of gravity of flanges, is usually made to vary from 1/8 of length of span, for short spans, to 1/12 of length for long spans. If, for reasons of clearance, it is necessary to make the depth less than 1/12 of span, additional metal should be inserted so that the deflection will not be more than it would be with the above-mentioned depths. In bridges designed for very light traffic, it is more economical to use shallower girders.

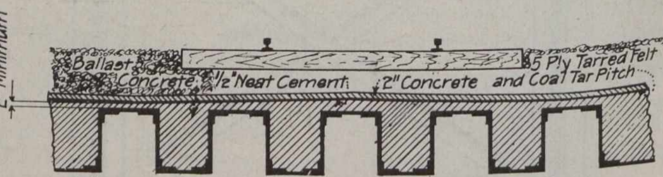

Fig. 4.—Cross Section Through Trough Floor.

There is a diversity of opinion among railroad engineers regarding the best spacing centre to centre of deck girders. This spacing consequently varies from 6½ feet for short spans to 10 feet for longer ones. Where the track is on a curve this spacing should be increased to accommodate the deviation of the track and to give additional stiffness to resist the centrifugal force of the trains.

Through girders are spaced as close together as the government clearance requirements will permit, and when the track is on a curve, this spacing is increased in proportion to the degree of curvature. A simple method of determining this required clearance is indicated in Fig. 6 and its accompanying explanatory note.

Skew in bridges should be avoided wherever possible, but it is sometimes necessary. It is less objectionable in girder spans than in trusses. Even though skew in the face of abutments is necessary, the ends of the girders should be