Below are given a few figures for the comparison of a 170 ft. double-track span of the above type, and a double-track span of the same length, with the usual open floor construction, in which the floor beam and stringer sections are determined by the economical depth.

	Shallow trough floor type.	Deep floor type.
Depth of floor	1 ft. 11 in.	4 ft. 9 in.
Weight of floor system per lineal foot of bridge	5,000 lb.	1,700 lb.
Weight of trusses and bracing, per lineal foot of bridge	3,400 lb.	3,250 lb.
Weight of 170-ft. span, complete	1,496,000 lb.	900,000 lb.
Total cost of span, f.o.b. cars at bridge company's plant, at $0.025 per lb.	$37,400.00	$22,500.00

Difference, $14,900.00 = 66.2 per cent. of deep floor type.

As the depth of floor is increased, the weight diminishes rapidly. At 2 ft. 4¼ in. depth, the weight is 4,100-lb. per lineal foot of bridge. Further increase of depth would show a corresponding decrease in weight until the minimum thickness of material in sections is reached.

Unit prices in bids submitted by bridge companies for the fabrication of material for the shallow trough floor type have been found to run about the same as those submitted at the same time for open floor truss bridges. On this basis, a comparison of the two types of the span selected shows that the shallow floor type would cost, f.o.b. cars at bridge company's plant, about 66 per cent. more than the deep floor type. The cost per ton for erecting would be about the same for both types. The number of field rivets per ton is somewhat less in the shallow floor type than in the other type; but an allowance, for which no figures are at present available, must be made for the order of procedure in riveting, which requires that part of the riveting be done before all the material in the bridge is assembled, and for the additional falsework and blocking that are necessary under the floor system to provide for the uninterrupted movement of the trains.

The comparison of costs of the two types erected would show about the same relation as that of the costs of fabrication.

The range of application of floors of this type in double-track truss bridges would cover depths of floor of about 3 ft. and under, if the panel lengths do not exceed 15 ft. With a depth of floor over 3 ft. an open floor bridge is practicable and would be more economical.

For double-track through girder bridges, where panel lengths can be varied as desired, the application would be limited to about 2 ft. 6 in. depth of floor.

The Shallow Open Floor Bridge.—A design of open floor, double-track bridge, with 1 ft. 6 in. depth of floor is shown in Fig. 2. This is the plan of a bridge erected near Mapleton, Wis., on the new line of the M. S. & N. W. The design shown is for a double-track bridge, but the type is applicable to crossings with any number of tracks at the standard distance of 13 ft. centres. The limitation of this type of bridge is in the direction of span lengths, being suitable only for spans of less than 40 ft.

The relation of the clearance diagram to the girders shows that in the longer spans the girders and not the floor beams or stringers determine the depth of floor. The section of the middle girder, which carries load from both tracks, is exceptionally heavy, while that of the floor beams have no shapes over ⅝ in. thick. In shorter spans, 20 to 25 ft., it would be possible to make a shallower girder and reduce the depth of the floor beam so that the depth of the floor would be about 1 ft. 3 in. At that depth the stringer would be so shallow that any further attempt to reduce the depth of floor would result in stringers so shallow and short, and floor beams so close together, that the floor would consist of floor beams connected by diaphragms acting as stringers. It would be approximating the type described above under the name of shallow trough floor bridges.

In spans of 15 ft. or less, the girders can be brought under the third offset of the clearance diagram, making the floor beams shorter and lighter. At this point the depth of floor would probably be determined by the stringer, and the floor beam would be designed in accordance with that depth.

The Rail Girder.—Fig. 3 is the plan of a girder designed to carry a track over a 4 ft. 6 in. clear span in places where there is not sufficient space for stringers and ties below the rail. Conditions requiring such designs are not uncommon in railway yards and in city streets, where pipes and conduits are laid close to the grade of the track.

This design consists essentially of an independent girder for each rail, built up of Z shapes and bars. Section E-E is a transverse section of the girder, showing the rail held in place by cast iron clips bolted to the webs of the Z's. The depth of floor is 3 in., using the term in the same sense as in the discussion of the previous types.

In the design of the girder it is assumed that both rail and girder will be effective in resisting the bending under load. They will act as separate units, however. Both rail

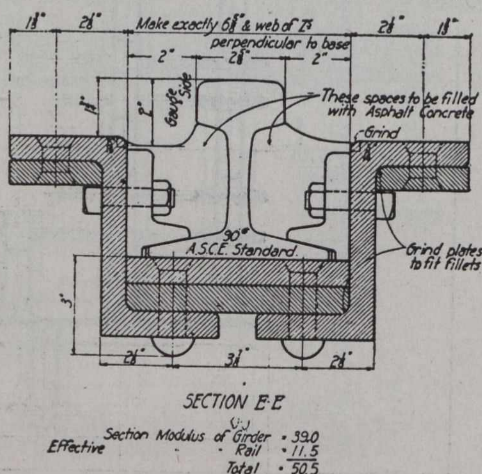

Fig. 3.—Details of Rail Girder for Shallow Bridge Floors.

and girder will be deflected the some amount, but as they are of different sections, the stresses in the extreme fibres will not be the same, but will be proportionate to the distance of the extreme fibre from the neutral axis in each case. This distance in the girder is 3 in. In the rail shown it is 2⅞ in., or 0.96 of that of the girder.

The section modulus of the girder given below, Section E-E, is the actual section modulus of the net section of the girder. The "effective" section modulus given for the rail is 0.96 of the actual section modulus of the rail. The sum is the effective section modulus of girder and rail acting as separate units, and deflected the same amount.

Section E-E shows a 90-lb. A. S. C. E. rail section, on the girder. Any type of rail can be used with the girder by varying the details of the cast iron clips to conform to the section of the rail to be used. The space in the girder on each side of the rail is filled with asphalt mastic, to protect the steel and provide a run off for drainage.

The weight of a pair of girders of the section shown in section E-E is about 1,500 lb. The weight of a pair of the special section is practically the same as that of the standard section.