known. The weight of the steel must be assumed either by approximate methods or from records of weights of other spans, and when the design is completed a check should be made to make sure that these assumptions agree with final results.

The live loads adopted by various railroads are usually standard types of consolidated engines followed by a uniform train load and an alternate heavy concentrated load, and the different classes of loading are provided for by varying the loads in the same proportion throughout the whole train. In this way the calculations of stresses are simplified and the results are quite satisfactory, as it is impossible to foresee in every case the exact wheel loads which may be carried by the bridge. Moreover, by the adoption of this standard loading, tables of shears and moments for deck spans of various lengths can be made, which save time and labor in actual practice. In through bridges it is always necessary to calculate each bridge by applying the actual wheel loads.

Impact stresses should always be added to provide for the momentum of the live load caused by deflection of the bridge, the unevenness of the track, vibrations, and various other conditions, but the amount of this impact is always a stumbling block to bridge engineers, as shown by the number

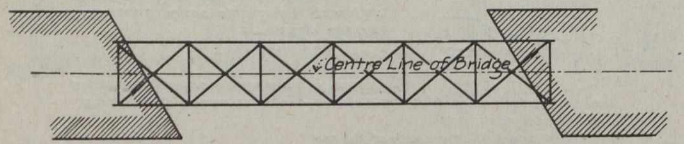

Fig. 7.—Right-Handed Skew, Showing Bridge With Ends Square.

of different formulae in use. The intensity of this impact depends on the length of span under load, the proportion of dead and live loads, the elasticity of material and other causes which are unknown, and it is imperative that practical experiments be made on all types of bridges to determine a formula for impact which will be reasonable and satisfactory. However, all formulae used at present are doubtless on the safe side.

The wind stresses in an ordinary plate girder span do not affect the sections of the main girders at all, because they are usually not considered unless they exceed 25% of the other loads combined. In plate girder bridges a moving load of 600 pounds per lineal foot of span is ample to provide for the wind on a moving train, for the oscillation of the train and for the wind on the bridge itself. This force will determine the wind stresses in the lateral system.

The centrifugal force of a train, when the bridge is on a curve, is not so important as the preceding stresses, but it cannot be neglected and should be considered, both in the laterals and in the main members. The equation $F = \dfrac{W V^2 D}{85700}$ gives the centrifugal force for a load W on a curvature of D degrees with a velocity of V miles per hour. It is considered to act in a horizontal direction, five feet above the base of rail and at right angles to the line of bridge. All engineers agree that the force F must be resisted by the lateral bracing in the same manner as the wind stresses, but they do not all have the same opinions of the stresses produced in the main girders. The best arrangement of a curved track on a bridge, is to place the axis of the bridge parallel to the chord of the curve, and to make the centre line of the bridge bisect the middle ordinate of the curve at the centre of the span. In other words, the deviation of the track from the centre line of the bridge is the same at the middle as at the ends of the span, and this is an advantage in the event of train derailment. Some bridge engineers are satisfied to consider that, with this position of the track, there will be practically the same load on both girders, and they only add centrifugal force stresses to the lateral system, and use the same girders for a track on a curve as for a track on a tangent.

A more general practice is to assume that there is an overturning action, and that in addition to one-half the live load, there is a load on the outer girder equal to $\dfrac{F h}{b}$, where F is the centrifugal force, h is the height at which F acts above the lateral system, and b is the spacing centre to centre of girders.

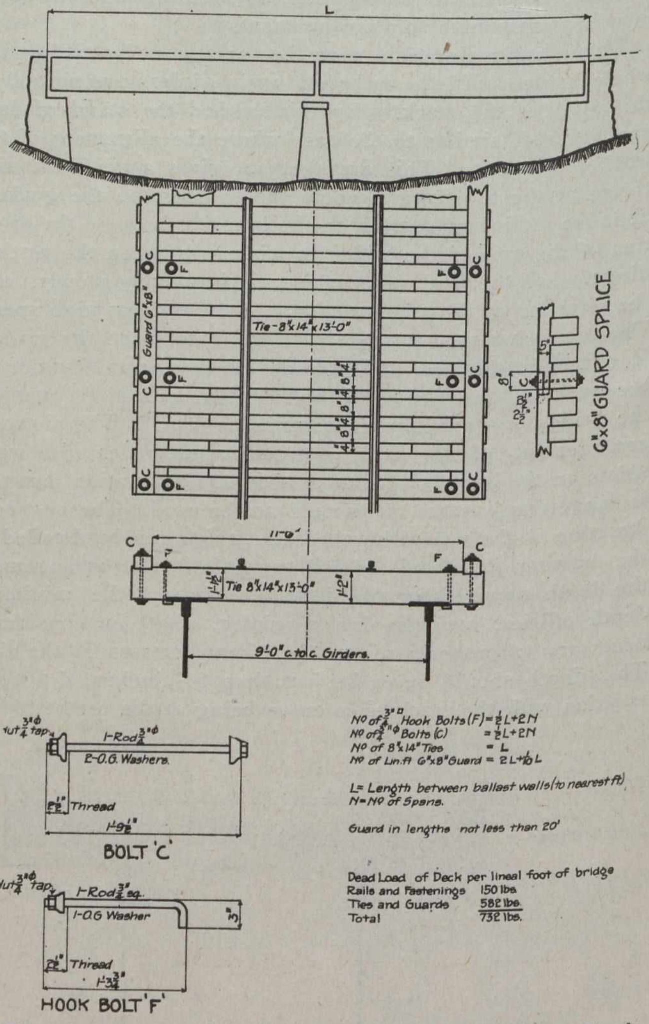

Fig. 8.—Standard Floor for Deck Bridges—Without Steel Floor Beams and Stringers.

Another practice is to consider that the eccentricity of the track at the centre of the span is constant over the entire length of the bridge. Then the proportion of the live load to be added to each girder is given by the formulae $W\left(\dfrac{M + b}{2 b}\right)$

Where W equals the live load, M is the centre ordinate to the curve, and b is the distance centre to centre of main girders. A thorough treatment of this subject is given in Fig. 9 and the data accompanying it. The theory applied in this example was advanced by Ward Baldwin, who is a college professor and a practical man, and perhaps the best authority on this subject in the United States. He was consulting engineer on a large viaduct in Cincinnati, which the writer designed. In this example the track is super-elevated to suit only a medium speed of train. On account of this arrange-