CHAPTER VII.

REMARKS CONCERNING MAIN MEMBERS.

Top chords should nearly always be built of two channels, with a plate on top, and latticing or lacing below. It is never good practice to use a single I-beam for top chord or batter brace, because of the great variation in stiffness in its two principal rectangular planes and the difficulty in making neat details for the connections. When the span becomes so short that it appears to be economical to use such a section, it is short enough to employ plate girders which are far superior, both as regards strength and stiffness, to a bridge with I-beam chords.

The same objection applies to an I-beam post, a favorite design of inferior bridge companies. If one were to take the trouble, in passing over a few bridges where they are used, to cast his eye along the posts, he would generally see that they are bent to one side or the other, or to both; the latter being the case when there are employed what are termed out West "Giasticutus rods," or horizontal rods five-eighths or three-quarters of an inch in diameter, passing from the middle of one post to the middle of the next in the same truss. Such rods are a noticeable feature in arch bridges, a class of structure that ought to be universally condemned. The principal objections to these bridges are their lack of rigidity, and their inability to resist wind pressure, because of the absence of efficient lateral bracing. But another grave fault is, that, being as a rule built by companies of the lowest order, they are weak in section and detail, and the workmanship is poor. They are, without doubt, the cheapest kind of iron bridge that can be manufactured: hence their general adoption throughout the West, where short-sighted economy in building is the order of the day.
The I-beam is more often found in upper lateral struts, where its use is quite as objectionable. Even if strong enough, which it seldom is, it is by no means the best section for that place, owing to the difficulty in connecting to the top chord. Where it rests on the chord plate, and is riveted thereto, the lateral rods being attached to the chord pins, there is a great leverage afforded to the wind stresses to distort the chord; and, where connected to the pin by a jaw, the detail has to be either very clumsy or very weak. Another objection to I-beams for lateral struts is the little room which there is in the flanges for punching rivet holes. But the chief one is the small resistance that they offer to the bending effect of the wind pressure when there is no vertical sway bracing. What has been said of I-beams in lateral struts can be said with much more effect concerning I-beams in portal braces, for great stiffness and strength are there necessary in order to carry the wind pressure upon the upper half of the bridge to the foundations.

The proper function of an I-beam is to resist deflection in the plane of its web: consequently it should be used as a floor beam, in which place its depth should seldom be less than ten inches, never less than nine inches. When one is debating about using such small floor beams, he should figure them for a concentrated wheel load, as well as for a uniformly distributed load.

About the only places where a small I-beam can be legitimately employed are between the pedestals, as a lateral strut at the fixed end of a span, or at the free end if the bridge be narrow and the span very short, and in vertical sway bracing as an intermediate strut.

For upper lateral struts, iron gas-pipe was formerly often employed, and is so yet to a certain extent. Regarded as a section, nothing could be better or more economical; but the connections made with it are very weak. Then, again, there is the objection that it is a closed column, and consequently inaccessible to painting. Notwithstanding the fact that two of the leading bridge companies of the United States employ almost exclusively closed columns, such columns are not, by engineers in general, conceded to be so good as open ones, which are always accessible to the paint-brush.
ORDINARY IRON HIGHWAY-BRIDGES.

Some other common forms of upper lateral struts are the following: two tee-irons trussed, the upper resting on the chords, and riveted thereto, the lower abutting against the same, and attached by bent plates; two channels trussed and attached to the chords in the same manner; a combination of a channel and a plate, with trussing between; and two tee-irons laced or latticed, with a jaw plate at each end wider than their flanges, screwed up to the chords by nuts on the ends of the chord pins. Owing to their lack of both strength and rigidity, all these are poor contrivances, two channels laced or latticed being the best form of strut that can be designed for the upper lateral system.

As stated in the "General Specifications," in no highway bridge should the channels in chords, posts, or batter braces, be less than five inches in depth, nor in any other part of the structure less than four inches. One does hear occasionally of such a thing as a three-inch channel top chord with two-inch pins, for a sixty or seventy foot span. But, fortunately for the public safety, such structures are few and far between. The author once heard the senior representative of one of the most flourishing highway-bridge companies in America contend that two three-inch channels trussed make a very good centre post for short through-spans,—strong enough, because the area called for by the stress is less than three square inches. He must either have forgotten, or been ignorant of, the fact that stiffness is as important a factor in a bridge as simple strength. In reality, strength is dependent upon stiffness; for where vibration can occur, the stresses are increased, not only in the members where stiffness is wanting, but in adjoining members of the structure.

Light sections for compression members are more economical than heavy ones, and it is generally preferable to use them. But, if the situation be one where the members will be exposed to excessive moisture, the webs should be thickened.

The top plate for chords and batter braces should generally be from one-quarter to three-eighths of an inch thick. Any thing below the inferior limit would be liable to distortion when roughly handled, and to rust through too readily; and any thing above the superior limit would usually be inconsistent with the best distribution of area in the section.