

feeble resistance to tension, the spans that could be adopted were much restricted; 40 feet being commonly considered the maximum length to which single cast iron girders can be safely applied in railroad structures.

COMPOUND GIRDER BRIDGES.

The limitation of span above referred to, led the English engineers to attempt to combine wrought iron with the cast metal, with a view to obtain tensile resistance in the compound structure, and many bridges were constructed on this principle. It was soon discovered, however, that in the plans adopted it was impossible to make the two kinds of iron act fully together in bearing the load, and after several failures, attention was more directed to perfecting and bringing into use girders composed wholly of wrought iron.

Meanwhile, in the United States, numerous plans were originated for compound structures in the form of trussed girders, which proved much more successful than the English combinations. Among these may be mentioned the plans of Whipple, Rider, Bolman and Fink, who, separating entirely the duty of the respective metals, putting compression only on cast iron and tension on wrought iron, succeeded in constructing effective bridges, which are still adopted in various parts of the country.

No structure, however, in which cast iron is used, can be relied on to the same extent as if made wholly of wrought iron. The brittle nature of cast iron, its unequal contraction in cooling, and the liability to flaws in the castings, which it is difficult to detect, make it liable to break, and without warning, on being subjected to sudden shocks. The only safety in using it in bridges, after taking every precaution in the manufacture and construction, is to subject it to only a small strain per sectional inch of metal.

WROUGHT IRON BRIDGES.

In 1824, Mr. George Smart proposed a combination of wrought iron bars arranged in a diagonal form, under the title of "The Mathematical Patent Iron Bridge." This design, which was published in the works of the period, appears to have been the parent of the extensive family now known as Lattice Bridges, which were early adopted in the United States, substituting however timber