

Besides this, it is economical in first cost as compared with other fireproof and permanent materials. In buildings concrete steel is used in beams, girders, columns, floors, partitions and even outside walls. It is usually cheaper than steel protected by fireproofing, and not much dearer than timber mill construction. The saving in insurance premiums alone will frequently off-set the extra cost.

To the bridge engineer reinforced concrete has proved of great value. In railroad work it is used very generally for culverts and arches under embankments, and other short spans. These designs are safer and more permanent than timber trestles or open bridges with steel beams and wooden ties. Their maintenance costs almost nothing.

For highway bridges, both of long and short span, the reinforced concrete arch has no equal for economy combined with aesthetic value.

In other structures, such as retaining walls, dams, etc., hitherto built of solid masonry, which depends entirely upon its weight for stability, the tensile strength of reinforced concrete has led to new and more economical designs, in which the stresses are more rationally distributed.

OBJECTIONS TO REINFORCED CONCRETE.—Although steel concrete is now so widely used, and its economy is generally admitted, there is still much discussion as to its permanence and reliability. It may, therefore, be of interest to mention some of the objections commonly made, and to discuss them briefly.

The points to be considered fall under these headings:—

The permanence of steel concrete, more especially the liability of the steel to corrosion in outdoor structures.

The uniformity and reliability of the concrete itself.

The proper designing of reinforced concrete structures and the calculation of stresses.

With regard to the *permanence* of steel concrete, I believe that most American engineers, at least, are now well satisfied that the metal is fully protected if the concrete covering is of sufficient thickness. Some eminent engineers, however, do not think that our experience in this respect is long enough to permit a definite conclusion to be reached. Sir Benjamin Baker, for instance, in a recent discussion before the Institution of Civil Engineers, expressed the opinion that a test extending over twenty years would be required to settle this question. Our experience with reinforced concrete hardly extends over twenty years, but a considerable amount of iron and steel has been in use embedded in cement mortar in various suspension and truss bridges and in buildings for fifty years or more. The subsequent demolition of some of these