THE STRENGTH OF CONCRETE BOX GIRDER BRIDGE DECKS OF DEFORMABLE CROSS SECTION

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Abstract

Thirteen model tests on single cell concrete box-girders of deformable cross-section are described. The models were simply supported and loaded either by means of a single point load over one web or by a pair of point loads acting upwards and downwards on opposite webs. A detailed account is given of the behaviour of these beams as the load was increased to failure. It was observed that at failure the beams fell into two categories according to the magnitude of the distortional component of the load.

By postulating alternative mechanism of collapse and making plastic assumptions about material behaviour, an upper-bound collapse locus is derived for general combinations of symmetrical and distortional loading applied to box-girders of the type tested. The behaviour of the tested beams is shown to be reasonably in agreement with this upper-bound theory, but the observed collapse loads are somewhat lower than predicted. By examining the forces required to maintain equilibrium at the junction between the walls of the box-girder and at mid-span, an approximate lower-bound collapse locus us deduced; the lower-bound equations bear a marked resemblance to the upper-bound equations, but predict collapse loads which are much lower that those observed. A design collapse locus is proposed, which is reasonable in theory, simple to apply, and safe in relation to the experimental results. An upper-bound approach is then used to examine box-girder structures with features difference from the tested beams.

By using an equilibrium method based on the lower-bound analysis it is then shown that it is possible to calculate a “transmission length” for a single-cell box-girder subjected to a distortional pair of point loads. Over this transmission length the web shears due to the applied load can be converted through transverse bending into a purely torsional set of shear forces in the webs and flanges. It is suggested that the transmission length concept may be of value in the design of the box-girder bridge structures.