MOMENT REDISTRIBUTION IN PRESTRESSED CONCRETE BEAMS AND FRAMES

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Abstract

In this report a series of tests on statically indeterminate prestressed concrete structures are described, which were aimed at resolving the conflicting results of other investigations into the behaviour of such structures near maximum load. The testing equipment, the experimental procedure and the types of structures, are described in some detail.

The results are analysed and typical curves are given to show how the bending moment distributions in the structures change as the maximum loads are approached. The effects of various factors on these curves are discussed. The deformations of the structures are also considered briefly and are shown to be very unpredictable in the final stages of the tests.

For theoretical analysis, formulae are first derived for the limiting conditions of a prestressed concrete section under a combination of bending moment and axial load. It is then shown that the actual maximum loads on the structures are in general less than the theoretical fully plastic load, but only slightly so. Elastic theory invariably under – estimates the maximum load completely.

Theoretical formulae for calculating curvatures are also obtained. A rather unusual approach to the stress-strain curve of concrete is advanced and its influence on especially the curvature at maximum moment is shown. From this it is certain that concrete structures do not disintegrate when the maximum load is reached, but that there are falling branches to the moment – curvature curves of the critical sections and to the load – deflection curve of the structure as a whole. Thus the actual maximum load is less that the fully plastic load, not because of insufficient rotation capacity of any hinge, but because “over – redistribution of moments” sets in before full redistribution occurs.

It is finally suggested that this removes the need for complicated and doubtful calculation of deformations at maximum load and a simple method is proposed for calculating this load and thus for designing prestressed concrete structures.