ABSTRACT

Reinforced concrete deep beams are extensively used as various forms of structural elements and frequently favoured in the building and industrial constructions which require large column-free areas or used as a load bearing members. They have the additional features like capability of transferring the wind forces, column loads etc. down to the foundation.

Due to the predominant shearing forces and presence of normal forces associated with minimum bending forces, characteristic behaviour of deep beams is found to be comparatively complex and so an accurate analysis of such beams by using the classical method of bending is not possible. Moreover, due to certain experimental constraints, hindrance is encountered in taking up an extensive experimental investigation on the characteristic behaviour of such beams. A good many number of investigations on the characteristic behaviour of reinforced concrete rectangular deep beams at the ultimate stage was reported earlier; but very little information is available on the characteristic behaviour of such deep beams at the elastic stage. Moreover, very few studies on Tee deep beams are available in the literature.

The objective of the present study is to predict the characteristic behaviour of reinforced concrete rectangular and Tee deep beams both in the precracking stage till first cracking load and postcracking stage till collapse load. Furthermore, the effect of flanges of Tee deep beams is yet to be properly understood. With the above objective in view some experimental and theoretical studies have been performed during the present work. In the experimental program, altogether eighteen reinforced concrete deep beams (both rectangular and Tee sections) have been cast for testing on simple supports under two point static loading. The depth to span ratio and percentage of main reinforcement are the two variable parameters in all the specimens. The finite element method has been employed for the theoretical analysis (in the elastic range) using the 8-Node isoparametric elements for rectangular and the 20-Node

isoparametric brick elements for Tee deep beams both with and without steel reinforcements. It is to be noted that the rectangular deep beams are assumed to be under plane stress conditions while the Tee deep beams are analysed for three dimensional state of stresses.

The above study is also aimed at establishing the characteristic behaviour at postcracking stage in order to predict the collapse load and mode of failure of these structures. Moreover, both the elements are tested for rigid-body modes using standard eigenvalue subroutines. Furthermore, elastic analysis of deep beam problem made by earlier investigators is taken up for the present study and the author's results are found to be in good agreement with those of the earlier ones. The author also endeavours to make a study on the convergence of results for both types of deep beam problems taking various mesh sizes.

Finally, based on the Mohr-Coulomb failure criterion, formulae for ultimate and limit load carrying strengths valid for both types of deep beams are proposed. The results obtained from these equations are fairly comparable with those obtained from the experimental studies. Moreover, a number of fairly accurate design guidelines have been proposed for deep beams based on the comprehensive theoretical and experimental studies performed on the characteristic strength and deformation of such structures.

Key words: Deep beams, rectangular, Tee, reinforced concrete, cast, finite element, isoparametric, Node, static, rigid-body, eigenvalue, convergence