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A 3D Computational Model of RC Beam Using Lower Order Elements with Enhanced Strain Approach in the Elastic Range

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Summary

A procedure has been described to carry out three-dimensional elastic analysis of reinforced concrete beam employing finite element technique, which uses lower order elements. Attempts were made to improve performance of 2D isoparametric element based formulation using reduced and selective integration schemes, B-bar method, additional incompatible modes, but to a few specific problems and also under certain conditions of mixed formulation. All these attempts were made aiming at removing inherent difficulties (locking etc.) particularly in thin structures. Even these methods can only analyze certain specific problems where it is possible to study the behaviour of the structure with necessary simplification by adopting the assumptions of 2D analysis. On the other hand, one may opt for 3D modeling to avoid the shortcomings of 2D modeling in order to achieve most realistic analysis and to arrive at an optimal solution. The proposed procedure utilizes 8-noded isometric solid/hexahedral elements HCiS18 with enhanced assumed strain (EAS) formulation, recently developed in the literature, to predict load-deformation and internal stresses produced in case of a simply supported RC beams in the elastic regime. RC structures are highly non-homogeneous medium due to discrete presence of the reinforcements. Till date hardly a few literatures are reported, where due attention has been paid to model concrete and the reinforcing steel with different physical and mechanical properties, which needs to be combined together through an interaction model to represent its composite behaviour. It models the composite behaviour of concrete and reinforcements in rigid/perfect bond situation and their mutual interaction in bond-slip condition considering continuous interface elements at the material level. Although, bond-slip relation are very much non-linear in behaviour even at the beginning of the loading condition, predictions from the proposed model /procedure are found to be very close to the experimental observations as far as accuracy is concerned in the elastic range. The sole purpose of this paper is to demonstrate the general applicability and to explore the potentiality of using lower order solid elements in the 3D finite element analysis with an aim of developing a general analytical method for the study of reinforced concrete beam in the elastic range.

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