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ANALYTICAL TOOL FOR STEEL-CONCRETE COMPOSITE FRAMES

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In its simplest form, composite frames of the sort considered in the present research work comprise a bare-steel frame of H-section columns supporting I-section beams laid out in the typical primary and the secondary manner, supporting an overlaid composite floor deck. The overall structural behaviour of the composite floor deck system divides naturally into two phases. During the first phase called 'construction stage' the profiled steel sheeting alone carries the weight of wet concrete, workmen and tools. The second stage of behaviour may be identified when the concrete slab interacts with the supporting beam and develops the composite action in the transverse direction with respect to the spanning direction of the profiled steel deck..

This paper describes the mathematical formulation of the two-staged computer program, which has been developed by the first author based of the Finite Element Method of analysis. The program is capable of taking into account both geometric and material non-linearity, and can simulate the response the structure during the entire history of loading. The first module deals with the construction stage behaviour, using two different types of finite elements, namely the steel only beam-column element and the steel-to-steel semi-rigid connection element. The stains and rotations undergone by the bare-steel frame during construction is incorporated into the second stage of the analysis by programming the second module to read the output of the first module. The module to simulate the composite beam behaviour essentially consists of two additional finite elements, namely the composite beam element and the composite beam-to-steel column connection element. The former is capable of modeling the inherent but often neglected partial-interaction between the steel beam and the composite floor slab, by superposing the effects of curvature of cross-sections due to bending into the difference between the horizontal displacements of the centroids of steel and concrete sections. Further, it is capable of modeling the orientation of the metal deck and also the effect of continuation of reinforcements over column supports. Considering the fact that the joint and frame behaviour are more interdependent in composite than in bare steel construction, the composite beam to steel column connection is modeled as a 'macro-element' by integrating four different finite elements. Those elements were to take into account the steelwork connection flexibility, column web shear deformation flexibility, flexibility of the reinforced concrete slab zone and the flexibility of shear connectors between the steel beam and the concrete slab.

The validation carried out clearly indicates that the results produced from the computer program are generally in good agreement with corresponding test results. This is applicable for the full loading history, including construction and composite stages. In particular the comparisons made against the test NR3 indicate very good agreement not only in terms of load-deflection but also on load rotation and load-bar strains. Some comparisons made with the initial static test results from the eight storied full scale testing building at BRE test facility at Cardington are also included.