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Nonlinear interaction analysis of infilled frame-foundation beam-homogeneous soil system

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Abstract. A proper physical modeling of infilled building frame-foundation beam-soil mass interaction system is needed to predict more realistic and accurate structural behavior under static vertical loading. This is achieved via finite element method considering the superstructure, foundation and soil mass as a single integral compatible structural unit. The physical modelling is achieved via use of finite element method, which requires the use of variety of isoparametric elements with different degrees of freedom. The unbounded domain of the soil mass has been discretized with coupled finite-infinite elements to achieve computational economy. The nonlinearity of soil mass plays an important role in the redistribution of forces in the superstructure. The nonlinear behaviour of the soil mass is modeled using hyperbolic model. The incremental-iterative nonlinear solution algorithm has been adopted for carrying out the nonlinear elastic interaction analysis of a two-bay two-storey infilled building frame. The frame and the infill have been considered to behave in linear elastic manner, whereas the subsoil in nonlinear elastic manner. In this paper, the computational methodology adopted for nonlinear soil-structure interaction analysis of infilled frame-foundation-soil system has been presented.

Keywords: conventional analysis; nonlinear analysis; constitutive law; differential settlement; exponential decay; infinite elements; interaction analysis; truncation boundary

1. Introduction

In the conventional method of design, a structure is designed assuming the fixity at the base. Such analysis does not provide the realistic structural behaviour because interaction takes place between the superstructure, foundation and soil mass. The forces in the frame members get significantly altered due to differential settlement of the soil mass. Thus, it is essential to consider the superstructure, foundation and the soil mass as a single integral compatible unit for more realistic and accurate structural analysis.

2. Literature review

Several investigators studied the influence of the phenomenon of soil-structure interaction in framed structures and investigated that the forces change significantly due to interaction effect.

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