High-rise building analysis considering construction stages: floor structure stiffness influence over vertical element axial shortening

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Abstract

The studies of building structures accounting construction stages considered the optimization of embedded materials both at the design stage and at the construction stage. Axial shortening of the vertical load-bearing elements under the effect of gravitational loads and due to the characteristics of the building materials is an important point of structural analysis of tall buildings that should be considered. The present study analyzes the influence of the floor structure stiffness and the vertical load-bearing element / floor structure connection over the axial shortening of walls and columns which affects the distribution of normal forces in them. A computational model of a building structure with simplified geometry and loads is considered to emphasize the impact of the stiffness of the floor structure. The results of the solution of several variants of calculation models are compared. Generalized conclusions are given in the end.

Keywords: construction stages; tall buildings; axial shortening; storey (floor) stiffness.

1 Introduction

The design and the construction of high-rise building is a trend in cities development which is motivated by economic, urbanistic, and social factors associated with present-day lifestyle and culture. The period of implementation of such buildings is protracted and involves significant tangible, time, and human resource. The time for the execution of the construction work is a non-negligible circumstance which affects the behavior of building structures.

Each building's construction is carried out in separate stages. At each stage of the construction, the structure is deformed under its own weight. The loads from the next phases of the construction are applied on a part of the structure, in which certain displacements, internal forces and stresses have already taken place. Taking the nonlinear behavior of the studied structures into account leads to deformations that are different in magnitude and sometimes as type. This affects the magnitude and distribution of stresses in the structural elements [1].

The nonlinear behavior of a structure is influenced by the technology and speed of execution, the type and geometry of the structure and structural elements, including the location and number of columns and walls in plan, the ratio in the cross-sections between columns and walls, the stiffness of the story structures, number of storeys, accounting of shrinkage and creep, the properties of the materials and the effect of the environment.

For tall buildings, the longitudinal deformations, and the distribution of normal forces in the vertical structural elements due to gravitational loads are of main importance. A difference in the length of vertical elements is obtained due to the longitudinal deformations, which leads to

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