FUNDAMENTAL RESEARCH ON THE STATICAL ANALYSIS OF RC BUILDINGS WITH HOLISTIC 3D CALCULATION MODELS

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Abstract

Nowadays, holistic 3D calculation models can be seen as a substantial part of structural engineering, especially in case of irregular, more complex and/or unconventional structures. The herewith presented research aims at an optimal use of such holistic 3D calculation models for the structural analysis of buildings. In detail, a representative high-rise building with flat slabs and a core for structural stability was modelled with a holistic 3D model taking into account the overall compatibility of the structural elements in the structure when loaded.

This contribution concentrates on the comparison of the calculation results from the 3D models with and without construction stage analysis (CSA) with those from commonly used extracted 2D subsystems. Furthermore, the effect of stress distribution due to differential creep and shrinkage in the individual concrete columns and the concrete core will be discussed.

Keywords: holistic 3D calculation model, construction stage analysis, creep and shrinkage

1. INTRODUCTION

Holistic 3D calculation models are often an indispensable part of structural design, especially for complex and/or unconventional structures [1]. In addition, the importance of holistic 3D calculation models is growing in context of "Building Information Modelling" (BIM) in order to integrate essential information about the building structure into the BIM model. Moreover, the consideration of the interaction between horizontal and vertical elements can lead to a quality jump regarding the prediction of the realistic structural behaviour of buildings.

2. HOLISTIC 3D CALCULATION MODEL

A current research project of the Institute of Structural Concrete at Graz University of Technology and FCP Fritsch, Chiari & Partner ZT GmbH investigates the effects of different modelling approaches on the holistic 3D model systematically. Therefore, a representative high-rise building with flat slabs and a core for structural stability was defined (see figure 1). The geometry and basic information of this simplified building can be found in [2]. Core walls, slabs and foundation plate are modelled as 2D shell elements and columns as 1D beam elements with rigid connections. The effect of present reinforcement was neglected at this stage. By now, this model is also enhanced with the consideration of the construction process including deformation compensation through construction stages, the soil-structure-interaction using a linear-elastic half-space and the time-dependent behaviour of concrete (creep and shrinkage).

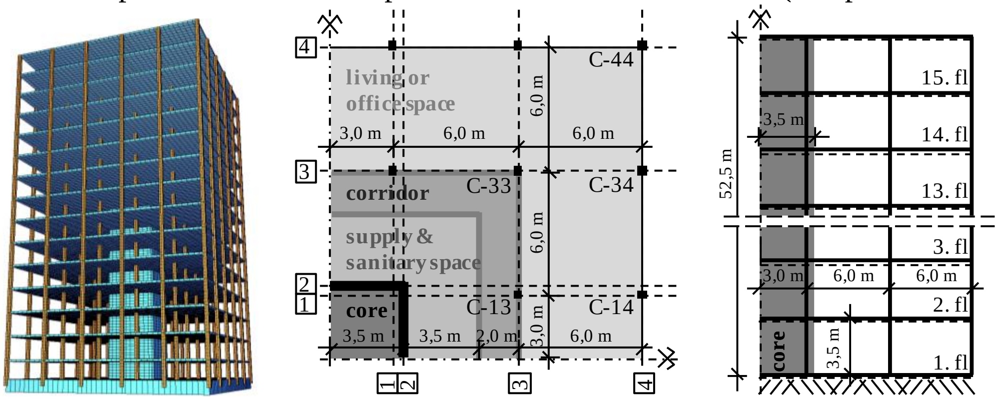

Figure 1: holistic 3D model (left); floor plan (center); vertical section (right)

Caused by a gradually increase of the frame stiffness, the CSA shows different column forces than the analysis with the final system (see figure 2, right). Moreover, it can be shown that time-dependent effects reduce the axial force of highly stressed columns at young age (figure 2, left).

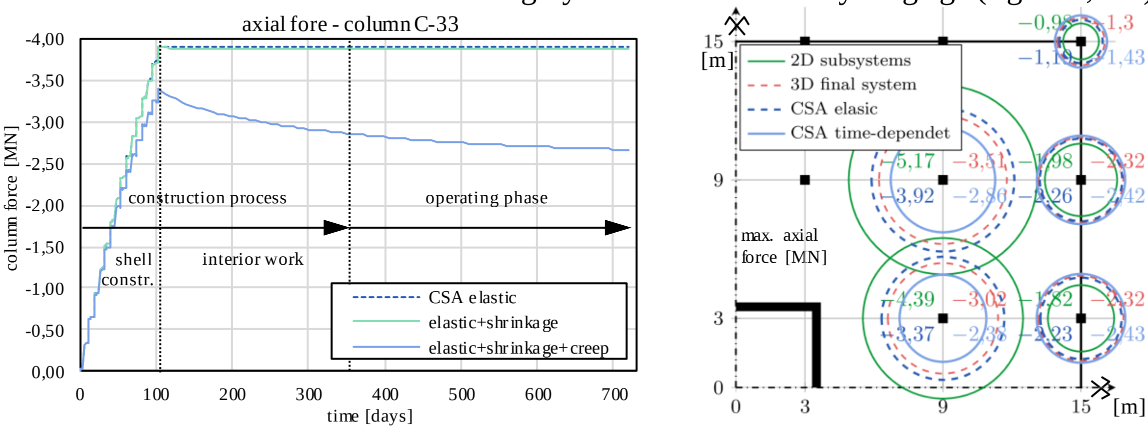

Figure 2: development of column force – C-33 (left); maximum column forces (right)

3. FINAL REMARKS

The analysis with holistic 3D models leads to a homogenization of maximum column forces. Furthermore, the consideration of the construction stages and time-dependent effects have a significant influence on the internal forces. In the next step, further effects like redistribution of stresses due to cracking as well as different reinforcement ratios will be investigated. It is expected that these effects will significantly reduce the homogenization of axial forces.

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