Spot monitoring and numerical analysis of high rising building

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Summary

The expanding of construction scale and the complexity of structure system bring out the complexity and safety problem in the construction process, which can result in that the construction procedures have great effect on the final state of structures. Based on the time-dependent model of reinforced concrete in CEB-FIP MD90, the numerical simulation of the construction process of CFST structures are provided in this paper. The spot timely monitoring test with vibrating strain gauge was conducted during the construction of Tongji multifunctional building, the comparison of the test results and the numerical simulation results demonstrated that the method in this paper could precisely simulate the time-dependent force and deformation of structures during the construction process, and the numerical simulation results showed that the deformation of the structure resulted from the shrinkage and creep of concrete during construction can not be ignored in the design.

Keywords: High rising building; Construction analysis; Time dependent model; Spot monitoring

1. Introduction

The expanding of construction scale and the complexity of structure system bring out the complexity and safety problem in the construction process, which can result in that the construction procedures have great effect on the final state of structures. Especially the effect of creep, shrinkage, strength and other factors lead to the complexity of construction analysis for composite structures, because the above factors changing continuously not only in the construction process but also in the service period will cause the redistribution of inner force in the structures.

2 .Time dependent nonlinear theory of concrete filled steel tube

In this paper, the time dependent model in CEB-FIP MD90[9] was used in the analysis of high rising buildings.

2.1 Time dependent model of concrete strength

The time dependent model of concrete strength in CEB-FIP MD90 was[9]：

$$f_{cm}(t) = \eta(t) f_{cm}, \quad \eta(t) = \exp[s[(1 - \sqrt{28/t})]] \tag{1}$$

2.2 Time dependent model of concrete elastic module
According to the elastic module of concrete, the relationship between the elastic module of concrete of 28 ages and the ultimate compress strength could be regressed as :

$$E_{c,28} = \frac{10^5}{2.2 + 31.5 / f_{cu}}$$ (2)

Time dependent model of elastic modulus in CEB-FIP MD90 [10] was described as:

$$E_c(t) = E_{c,28} \sqrt{\eta(t)}$$ (3)

2.3 Shrinkage and creep model of concrete
2.3.1 Shrinkage strain

The shrinkage strain of concrete was usually described as the product of ultimate shrinkage strain value and the time function of shrinkage strain, i.e. :

$$\varepsilon_s(t, \tau) = \varepsilon_s(\infty, 0)\varphi_s(t - \tau)$$ (4)

2.3.2 Creep strain

The creep strain of concrete was usually described with the time function of creep coefficient. that is:

$$\varepsilon_c(t, \tau) = \frac{\sigma(\tau)}{E_{c,28}}\varphi_c(\infty, 0)\varphi_c(t - \tau)$$ (5)

3 .Engineering example

3.1 Introduction
Tongji multi-functional building with 21stories is located in the northeast of Tongji University campus. So, in order to guarantee the safety of the structure during the construction, the spot monitoring test was conducted and got the stress of the column during construction, and the test results were compared with the numerical analysis results. The vibrating strain gauge was employed to monitor the stress in the column during construction.

3.2 Numerical model
The beam element was used to simulate the members of the structures in the finite element model of the structure. And the steel was Q345 and the design strength of concrete was C40. The concrete in the first type of section was common concrete and the concrete in the followed two types of section was self close-grained concrete. The time dependent model of concrete was CEB-FIP MD90 model.

4. Conclusions

Based on the time dependent model of concrete in CEB-FIP MD90, spot monitoring test and numerical analysis was conducted for a high rising building, and the comparison between test results and numerical results showed that the regularity of the results was similar, but the values had some difference for some reasons. If the effect of the objective reason was decreased, the numerical analysis could simulate the construction process accurately, which could provide reference for the construction.