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ANALYSIS OF DEFLECTION OF REINFORCED CONCRETE ELEMENTS AFTER DEMOULDING

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Abstract: *The content of this article is strut-and-tie modelling including the behaviour of early age concrete and analysis of deflections of reinforced concrete elements after demoulding. Good knowledge of the behaviour of concrete at early age plays an important role in setting the deadline for removal of formwork and props. Material parameters and time-dependent deformation such as creep and shrinkage were in this work determined based on measurements and by using the microstructure development function. The results are deflections depending on the time of demoulding and the influence of support by props. The results are compared with the limit values. The proposed analysis of the instant of demoulding may be of practical use and can lead to proper intervals or technological breaks and can reduce the amount of formwork required for construction.*

Keywords: ***Early-age concrete, formwork stripping, strut-and-tie model.***

1. Introduction

In building construction process, fast formwork dismantling is a very significant issue. There is always a purpose to reuse the formwork or to apply a load to the structure from the adjacent elements. The technological break between concreting and formwork removal and the time when structure can be loaded represents the most important time period in construction of reinforced concrete elements. Because of this, it is important to study the properties of concrete not only in long term, but also in early age just after formwork removal. Other criteria besides the speed of construction are the price of construction affected by the price of formwork rent, etc. Reduction of time necessary for formwork rent and minimizing of time necessary for technological breaks leads to cost savings.

2. Application of material model for analysis of deflections

The element for application of assumptions is defined as a simply supported beam with the span of 6 metres and cross-section 0.3 x 0.6 m with lower reinforcement 6Ø20 and top reinforcement 2Ø12. Stirrups were for simplification assumed as two-legged Ø8 all over the length of the beam with the spacing of 200 mm. The calculation model was created using the 1D finite element method.

In the first case, the removal of formwork of whole element at the same time was assumed, see Figure 1. In Figure 2, deformations based on the removal of formwork at the time period 20 minutes are shown. If we assume the limit deflection L/250, construction complains the requirement at the time 9 hours after removal of formwork.

In the practice, the beams demoulded are step-by-step based on the type of the formwork system. Separate states will appear after formwork removal. In our case, it was opted for length of segment of 3 metres. It means two segments for the whole beam. Figure 3 expresses the largest deflections at individual time periods after demoulding. It is obvious that a big part of the deformation is caused directly by the last stage of demoulding. This is caused by higher stress in the struts that were not as big in the previous stages of demoulding. If additional possible loading was assumed, especially the period of the last stage would be very important and leaving the props on their positions would be decisive for the deflection.

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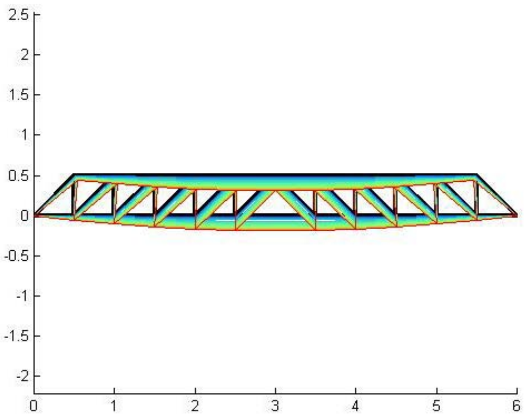

Fig. 1: Deflection after one-shot formwork removal (not in scale)

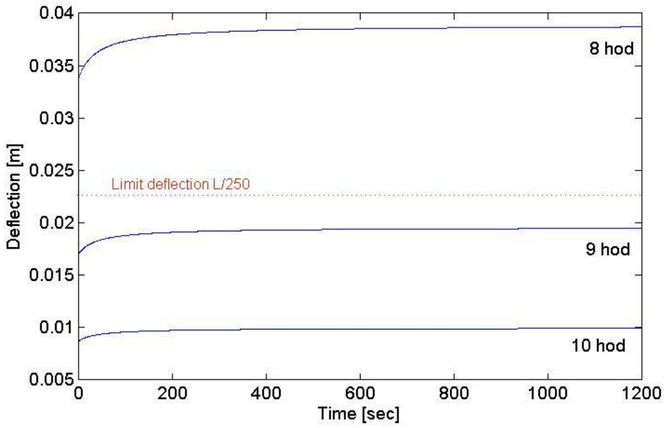

Fig. 2: Deflection after formwork removal

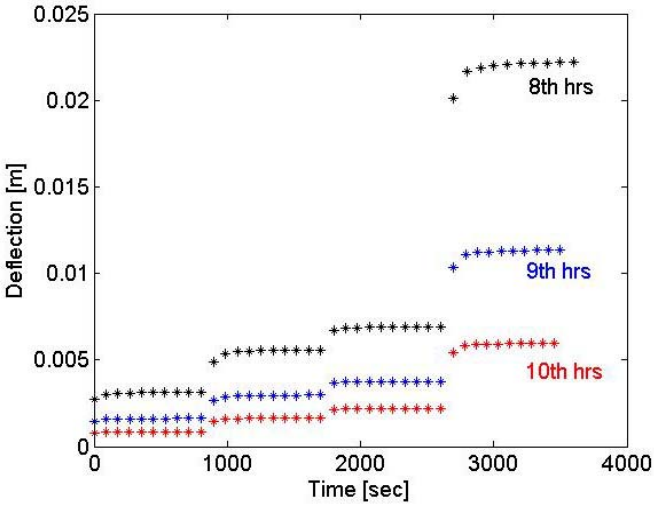

Fig. 3: Deflection based on the various time of demoulding

3. Conclusions

In this study, a method to predict the earliest instant for formwork stripping is presented. Considering the early-age concrete, most of the final strength will be achieved after a relatively short time, though some further strength gain can occur according to the type of cement and admixtures. Therefore, the function of evolution of microstructure was used to define the time-dependent gain of concrete stiffness.

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