Eidgenössische Technische Hochschule Zürich
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Autumn Semester 2023

Advanced Structural Concrete – Exercise 3

(101-0127-00L)

Topics: Long term effects **Constructing in stages**

Hand out: 30. November 2023, HIL E7

1 Dimensioning bases of the exercise

1.1 Introduction

This exercise examines the redistribution of internal forces due to creep in the case of staged construction of a three-span beam.

1.2 Geometry

The dimensions can be taken from the figure in Appendix A. The span is l = 10 m, and the cross-section has an effective height of 600 mm. The bending stiffness of the cross-section can be assumed constant over the length of the beam.

1.3 Material

For the construction of the beam, concrete C35/45 (normal hardening cement) and construction steel B500B are used.

1.4 Exposure classes

The average relative humidity during the construction is 70%, whereas the average air temperature is 20°C.

1.5 Loads

The dead weight and the non-structural dead weight sum up to a total of g_d = 10 kN/m.

1.6 Building stages

In the table below the concrete age and the loading of each stage can be seen (also see the general overview in Appendix A).

Construction start	0	days
Finishing Stage 1	30	days
Finishing Stage 2	60	days
Finishing Stage 3	90	days

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2 Tasks

a) Determine the creep coefficient of each stage for the point in time t_{120} = 120 days and t_{5y} = 5 years after the start of construction, respectively. Assume, that the structure is only loaded after the completion of each stage (dead weight and non-structural dead weight are carried by the formwork). The influence of the level of loading on creep can be neglected (i.e. the factor according to SIA 262 [1], 3.1.2.6.3, can be set as $\beta_{\sigma c} = 1$).

b) Determine the bending moment distribution along the beam at the end of each construction stage (through superposing of the bending moment curves of all previous stages) as well as the bending moment distribution of the corresponding, monolithically constructed structure.

c) Superimpose 20% of the bending moments from the construction stages with 80% of the bending moments from the monolithically constructed structure, which were calculated in Task b), and thus approximate the final state of the bending moment distribution, taking into account the long-term effects of the staged construction ($t \rightarrow \infty$).

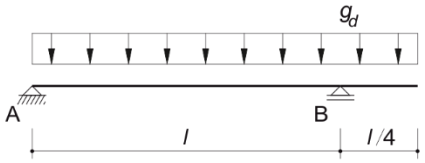
d) Additional task: Determine the bending moment distribution with the help of the Trost method, considering creep effects at the points in time t_{120} = 120 and t_{5y} = 5 years. The ageing factor can be assumed constant with $\mu = 0.8$.

3 Literature

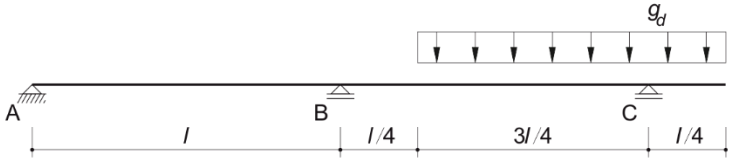
[1] Swiss society of engineers and architects (SIA), standards: SIA 262 Concrete Structures, 2013

Appendix A – General overview

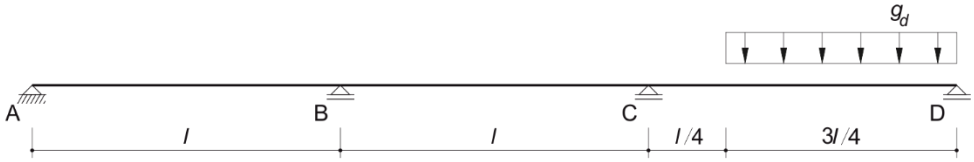
Stage 1 with loading



Stage 2 with additional loading



Stage 3 with additional loading



Final state with loading