Eidgenössische Technische Hochschule Zürich
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Autumn Semester 2026

Advanced Structural Concrete – Exercise 3

(101-0127-00L)

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

Hand out: 24. November 2026, HIL E 3

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 girder. As a first approximation, a redistribution of 80% from the initial state towards the one-casting system occurs (task c). The result is compared to a more refined analysis using Trost's method (additional task, d).

1.2 Geometry

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

1.3 Material

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

1.4 Exposure classes

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

1.5 Loads

The dead load and the non-structural permanent load sum up to a total of g_k = 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, Starting Stage 2	30 days
Finishing Stage 2, Starting Stage 3	60 days
Finishing Stage 3	90 days

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2 Tasks

a) Determine the creep coefficient $\varphi(t, t_0)$ 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 girder is only loaded after the completion of each stage (dead load and non-structural permanent load are carried by the formwork) and that the concrete is poured at the starting of each stage. 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 girder (i) at the end of each construction stage (through superposing of the bending moment curves of all previous stages) as well as (ii) the bending moment distribution of the corresponding, monolithically built structure (one-casting system). Neglect any long term effects.

c) Superimpose 20% of the bending moments from the construction stages (i) with 80% of the bending moments from the monolithically built structure (ii), and thus approximate the final state of the bending moment distribution, taking into account the long-term effects of the staged construction ($t \rightarrow \infty$).

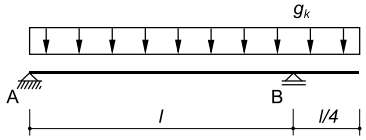
d) Additional task: Determine the bending moment distribution with the help of Trost's method, considering creep effects at the points in time t_{120} = 120 and t_{5y} = 5 years. The ageing factor can be assumed constant with μ = 0.8.

3 Literature

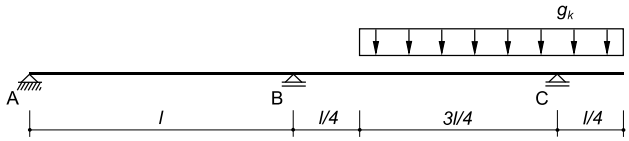
[1] Swiss society of engineers and architects (SIA), standards: SIA 262 Concrete Structures, 2013[1]

Appendix A – General overview

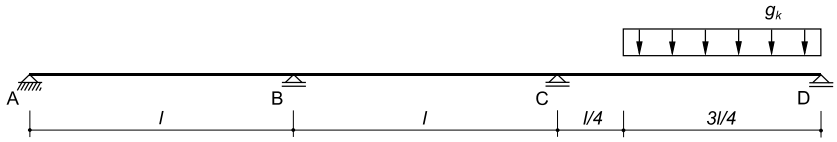
Stage 1 with loading



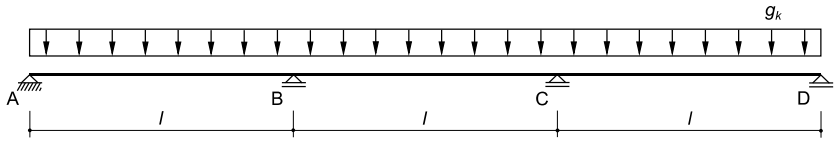
Stage 2 with additional loading



Stage 3 with additional loading



Final state with loading



[1] *Despite the latest version of SIA 262 dating from 2025, this exercise uses the version from 2013 (the solutions will be updated in accordance with the release of the second generation of Eurocode 2 in the near future).*