TALAT Training in Aluminium Application Technologies

TALAT Lectures 2704

Member with Requirements to Fire Resistance

8 pages, 6 figures

Basic Level

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Objectives:

- to give an example calculation of the fire resistance of a thermally insulated aluminium I-beam loaded in bending on the basis of a simplified calculation method and of a computer analysis

Prerequisites:

- basic knowledge of structural engineering
- TALAT Lectures no. 2501 - 2504

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2704 Member with Requirement to Fire Resistance

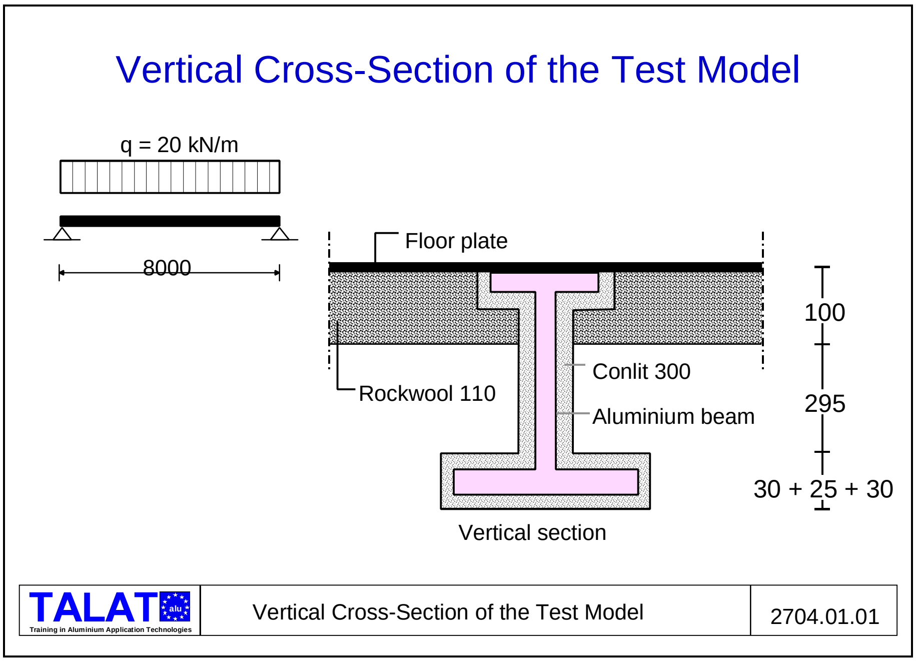
Contents

2704.01 Description of the Problem

In this example the method described in **TALAT Lecture 2503** ("Design of Aluminium Alloy Structures Exposed to Fire") shall be used together with a more exact computer analysis for comparing the results of the problem: will the beam shown in **Figure 2704.01.01** have a fire resistance of 60 minutes?

The floor beam has a span of 8000 mm and a load of 20 kN/m. The floor itself is insulated with 100 mm Rockwool 110. The beam is insulated with 30 mm Rockwool with density 300 kg/m³ (Conlit 300). The beam is an I 450 x 200 x 10 x 25, the alloy is 6082-T6.

the moment of inertia	I	=	$515{,}8 \times 10^6$	mm^4
the elastic section modulus	W	=	$2{,}29 \times 10^6$	mm^4
the yield strength	$\sigma_{0,2}$	=	250	Mpa



2704.02 Simplified Method

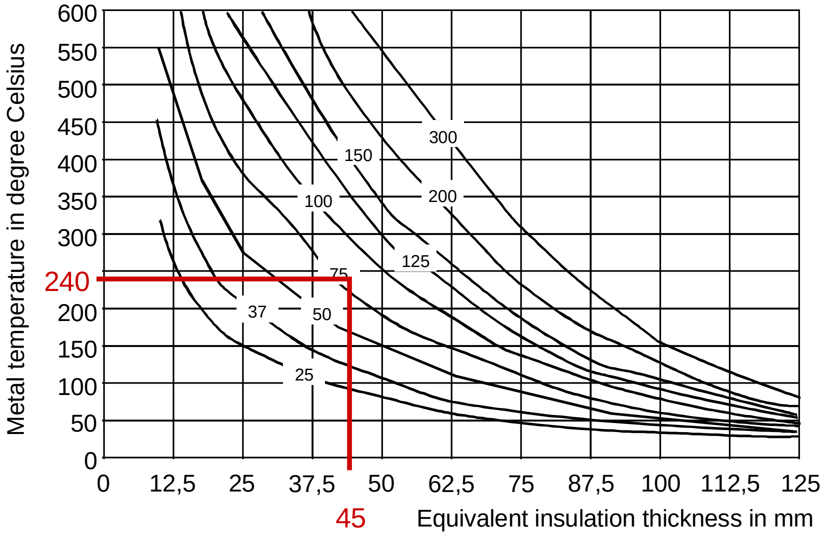
Finding the metal temperature of the beam:

Insulation: 30 mm Rockwool 300 kg/m³
Insulation correction factor: C = 1,5
Equivalent insulation thickness: $t_{equ} = 1,5 \cdot 30\ \text{mm} = 45\ \text{mm}$
Section factor Fi/V:

$$Fi/V = \frac{0,35 \times 2 + 0,2 \times 2 - 0,01}{0,2 \times 0,025 \times 2 + 0,4 \times 0,01} = 78$$

With this Fi/V value the metal temperature is found from **Figure 2704.02.01.**

Equivalent Insulation Thickness Versus Metal Temperature for 60 Min Fire Resistance



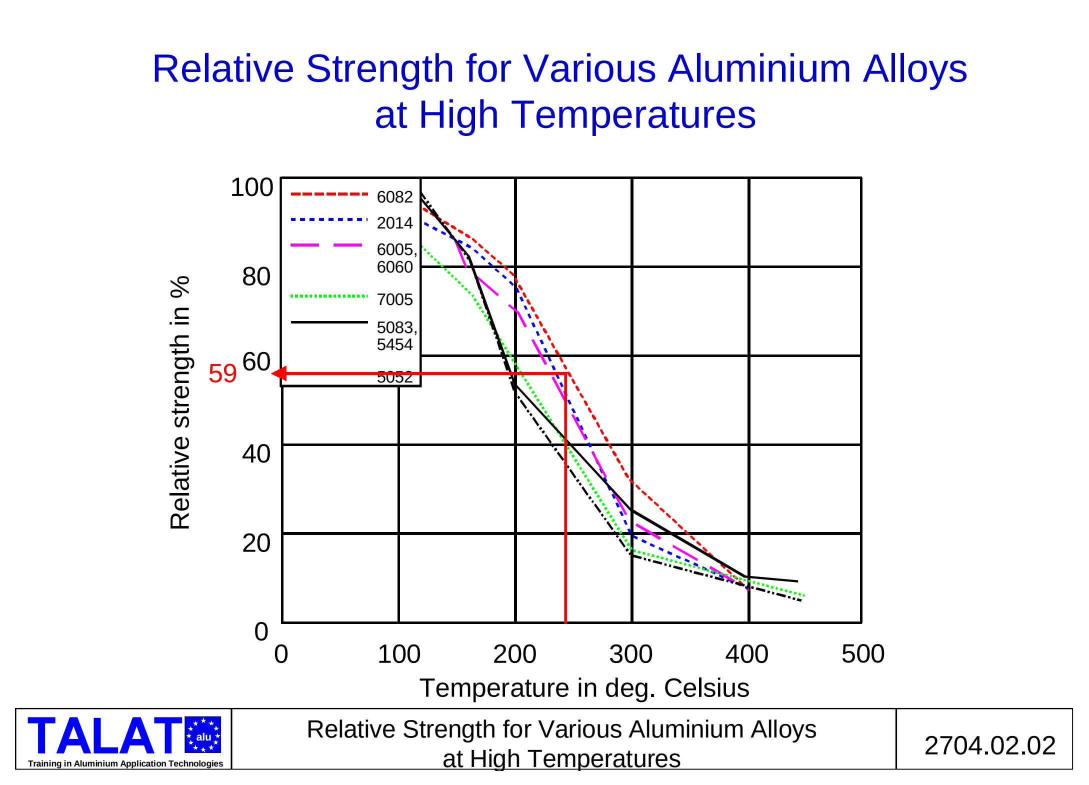
TALAT alu Training in Aluminium Application Technologies	Equivalent Insulation Thickness Versus Metal Temperature for 60 Min Fire Resistance	2704.02.01

The relative strength is obtained from **Figure 2704.02.02.**

The strength after 60 minutes of exposure to a standard fire is

$$\sigma_f = 0{,}59 \times \sigma_{0,2} = 0{,}59 \times 250 \text{ MPa} = 148 \text{ MPa}$$

Fire is an accidental loadcase. In most design codes both the material factors and the load factors are equal to 1,0 for this loadcase.



The bending stress in the beam is

$$\sigma_b = \frac{M}{W} = \frac{1/8 \times 20 \text{ N/mm} \times (8000 \text{ mm})^2}{2{,}29 \times 10^6 \text{ mm}^3} = 70 \text{ Mpa}$$

Conclusion: The beam has a fire resistance of at least 60 minutes which was required. (σ_f = 148 Mpa > σ_b = 70 Mpa).

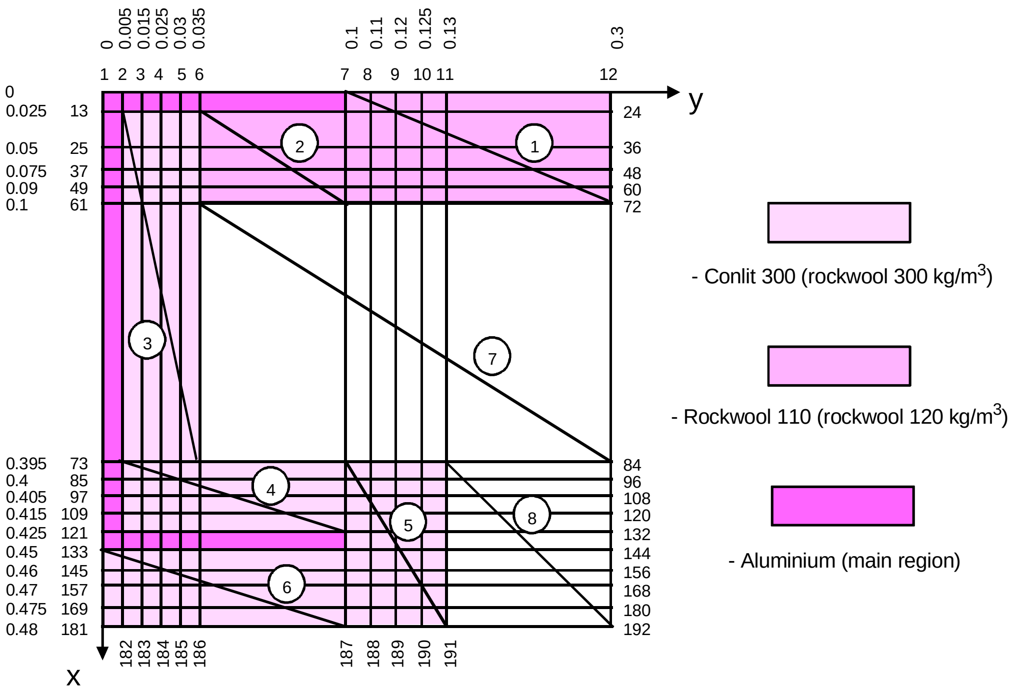
2704.03 Computer Analysis

To determine the metal temperature of the beam with the aid of a computer programme called TASEF v.3.0 PC, the following procedure was followed:

The cross section of the beam has to be modelled for the analysis (see **Figure 2704.03.01)**:

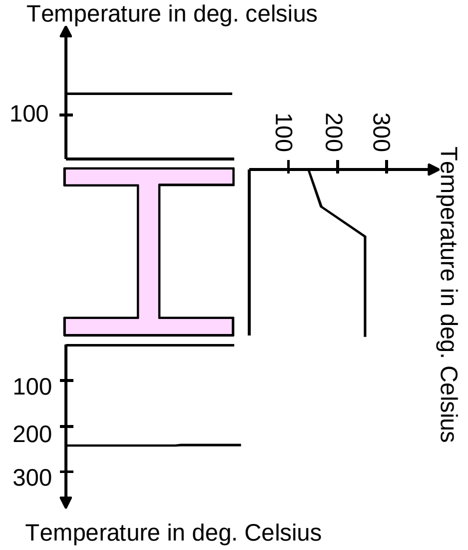
After one hour of exposure the obtained temperature distribution over the cross-section is shown in **Figure 2704.03.02**. The average temperature of the lower flange is 240 °C which will be the critical part of the member (maximum bending stress).

The average temperature rise in the lower flange during the one hour fire exposure is shown in **Figure 2704.03.03**.



TALAT Training in Aluminium Application Technologies | Model of the Beam for a Computer Analysis | 2704.03.01

Temperature Distribution after One Hour of Exposure



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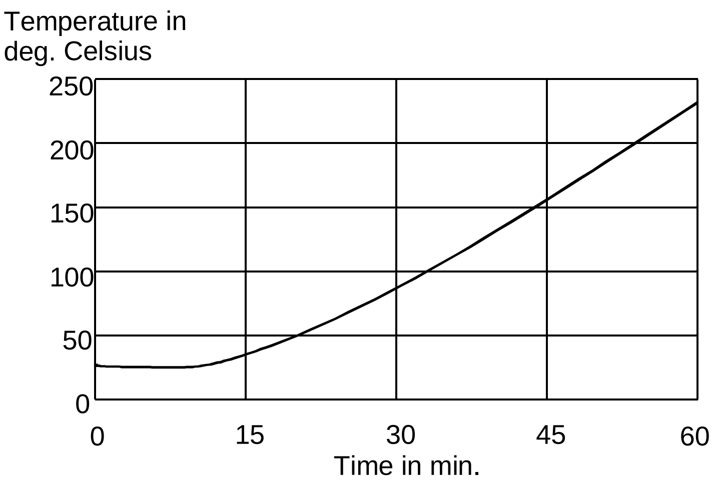
Temperature Rise during the Exposure to Fire



TALAT Training in Aluminium Application Technologies	Temperature Rise during the Exposure to Fire	2704.03.03

Conclusion:

Compared to the simplified method, the computer analysis gave exactly the same average temperature in the lower flange of the beam. The rest of this calculation will be the same as for the simplified method.

The output file of this computer run is called TASEF U02. The computer listing is available on request.

Reference:

[1] TALAT Lectures 2501 to 2504

[2] Ulf Wickström, TASEF (Temperature Analysis of Structures Exposed to Fire), V. 3.0 PC, Computer Programme for the determination of fire resistance of structural elements with or without insulation. Swedish National Testing Institute

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