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Optimization of tubular trusses using intumescent cover in fire

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## Abstract

There exist at least two ways to design the structures in fire conditions: 1) Design the structures without taking into account the fire and define the fire protection to this structure; 2) Design the structure by taking into account simultaneously the requirements for fire. The first approach is considered in this study as a "traditional engineering" and the second approach is considered as an "advanced engineering". The advanced engineering is possible due to the optimization methods which are available for designers, nowadays. However, in many cases the traditional engineering is still used. In this study a tubular welded one-span roof truss is considered in R30 and R60 using both approaches. The fire protection is completed using ETA-approved intumescent cover. In the traditional engineering the cost of the truss is optimized (sizing) without fire protection. After that the fire protection is defined so that the fire resistance is guaranteed. In the advanced engineering the cost of the truss is optimized by taking into account the fire resistance. The costs in both approaches include material cost (1 €/kg for S420 steel), fire protection cost (40 €/m<sup>2</sup>/1mm) and other fabrication costs (welding, cutting, real estate etc) based on the feature based cost function, which is public and available for this kind of study. The constraints include all rules of Eurocode 3 including resistance checks of members and joints. The optimization is performed using the particle swarm optimization (PSO).

The results indicate considerable savings in costs using the advanced engineering compared to the traditional engineering. So, the advanced engineering is highly recommended to be used when considering tubular structures in fire. The cases were analysed using old Finnish regulations for the same the intumescent cover. It is shown, that new ETA-approved rules indicate much more costs to tubular structures for R60. For R30 the results were vice versa.

