Zukunft Bau

Outline short report

Titele

Development of a calculation method for the fire load applying considerations about combustion efficiency and time-dependent temperature rise inside a component

Motivation

According to German Standard DIN 18230 the fire load is calculated using combustion factor m (Abbrandfaktor). At the moment a testing facility which can be used for the determination of the combustion factor does not exist anymore. Regarding future applications, a new experimental set up does not seem to work. Thus the current research focusses on developing an alternative method using numerical simulations.

Research subject

According to DIN 18230 the fire load is calculated using the combustion factor m. The combustion factor is dimensionless and assesses the fire load of storage goods possibly consisting of one single material or a composition. There for the specific burning behavior as well as the time-depend temperature contribution inside a steel component is taken into account. The only facility which was used to determine the combustion factor experimentally does not exist anymore.
This research project aims to develop a method which can be used equivalent to the one from DIN 18230-2. This new method relies on the combustion efficiency and additionally takes the temperature rise inside a component into account. Another major aim is to introduce the combustion efficiency as a part of fire load calculations into DIN 18230-1. The combustion efficiency describes the reduced energy conversion of a material due to uncompleted combustion. The presented method investigates the time-dependent temperature behavior caused by a fire whose combustion reactions are assessed by the combustion efficiency.
The investigations were carried out by modelling the combustion factor oven (8 m^3 oven) and calculating the time-dependent temperature rise inside the component. The heat release rate is a key boundary condition of the numerical model and is determined using open calorimetry. The calculated thermal impact on the component caused by different materials was investigated to define a material specific factor. That factor assesses the burning behavior of the storage goods and can be used to calculate the material specific fire load.

Conclusion

A method for the determination of test factor m* is presented which is based on the approach of DIN 18230-2. The test factor m* is determined by the maximum temperature rise inside the component which is calculated with a CFD model. The heat release rate is described by a design fire. Considerations about unburnt material and time-dependent burning behavior showed that values of m* modelling spruce wood nearly match the value of 1.0, given in DIN 18230-3 as the combustion factor of the reference material spruce wood. The presented method is capable of estimating the value of the combustion factor using the CFD model. Thus the decision making according to the combustion factor can be supported.

Key data

Brief title: Calculation of fire load considering the time-dependent temperature rise

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Total costs: 184.871,00 €.

Federal part: 93.961,00 €

Term of project: 01.12.2013 bis 01.06.2015

Figures:

Figure 1: ABB_1_Temperatur_Brandraum_FDS_CFAST.png

Caption: Results of the temperature inside the room of fire calculated with FDS and CFAST using a heat release rate taken from experiment mf6

Figure 2: ABB_2_Waermefreisetzungen.png

Caption: Time-dependent heat release rate

Figure 3: ABB_3_Temperatur_Brandraum_FDS_CFAST.png

Caption: Numerical determined temperature in the furnace

Figure 4: ABB_4_Temperatur_im_Bauteil.png

Caption: Numerical determined temperature in the component

Bild 5: ABB_5_ Rechenmodell des Abbrandfaktor-Ofens.png

Caption: Computational model of the furnance