

Application of Structural Fire Engineering

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Czech Technical University in Prague, Faculty of Civil Engineering, Department of Steel and Timber Structures

CONNECTIONS OF TRAPEZOIDAL SHEET UNDER FIRE

Petra Kallerová, František Wald, Zdeněk Sokol

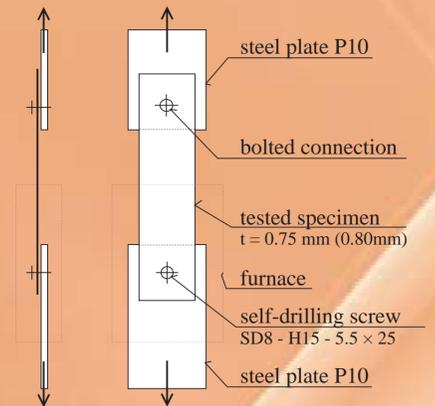
TENSILE TESTS OF SCREWED CONNECTIONS



The electric furnace with window

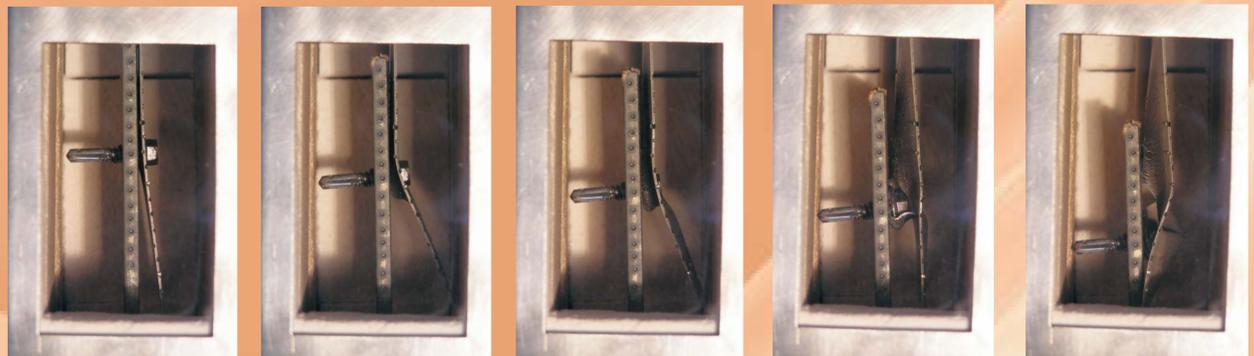
The experiments were focused on stiffness, resistance, deformation capacity and collapse mode of the connections during fire. The tested screwed connections were made by self-drilling screws from carbon steel with marking SD8-H15-5.5x25 and trapezoidal sheets with thickness 0.75 mm and 0.80 mm. The values of material properties of used trapezoidal sheet were obtained by material experiments.

In each sets of tests there were made experiments with two specimens for ambient temperature 20°C and for constant elevated temperatures 200°C, 400°C, 500°C, 600°C and 700°C. The steel sheets with thickness 10 mm simulated the bearing roof structure and they were anchored into grips of the testing machine. The tested screwed joints were situated in the middle of the electric furnace with one opening. During the fire tests there was the possibility to see the behaviour and the performance of the tested connections. In the course of the experiments the photo documentation in interval 5 seconds was provided.



The test scheme

For all specimens with the thickness of sheet 0.75 mm the failure in bearing was reached which occurred by tearing of trapezoidal sheet. Two modes of failure were observed for the sheet thickness 0.80 mm. For the temperatures from 20°C to 600°C the failure of sheet in bearing occurred, whereas for the temperature 700°C the mode of failure was the shear failure of the screw.



1min 10s

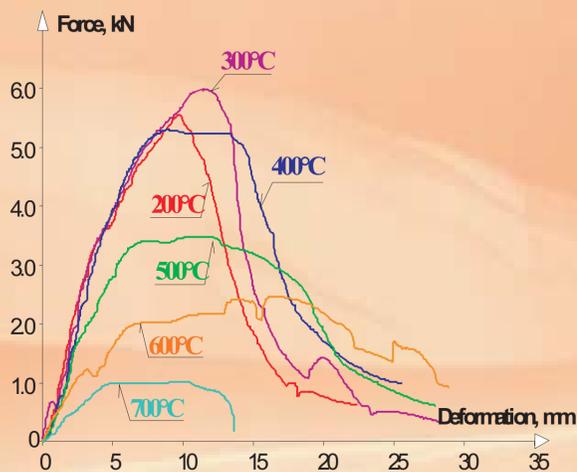
2min 15s

3min 10s

4min 15s

5min

Deformation of the connection



The force-deformation diagram of the connection

For the temperature 550°C is the bearing capacity of the connection reduced approximately to half of the bearing capacity under ambient temperature and for the temperature 700°C the bearing capacity is less than 20% from the bearing capacity under the ambient temperature. The reduction of 45% for temperature 500°C and 90% for 700°C is used for calculations of connections with bolts and nuts. The experiments confirm the higher reduction of the resistance of the self-drilling screws in bearing in the initial phase of heating (up to temperature 550°C) and smaller reduction for higher temperatures.

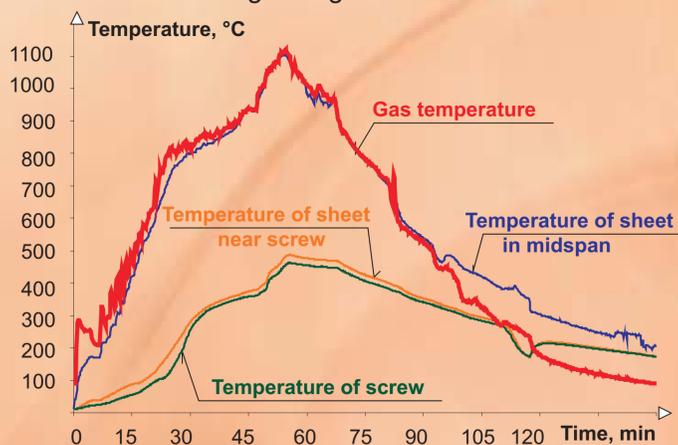


The collapse modes of the connection at specific temperatures

THE EXPERIMENT OF THE TRAPEZOIDAL SHEET AND ITS CATENARY ACTION

The aim of this fire test was to reach the membrane effect for corrugated sheet which was supported as a simple beam. The specimen was from the trapezoidal sheet with sheet thickness 0.75 mm and it was fastened by self-drilling screws SD8-H15-5.5x25 to the bearing steel frame. In each lower wave of trapezoidal sheet two self-drilling screws were used. The frame was protected by the thermal insulation against the effect of the high temperatures. The total load on the tested specimen was 240 kg which corresponds to 1 kN/m².

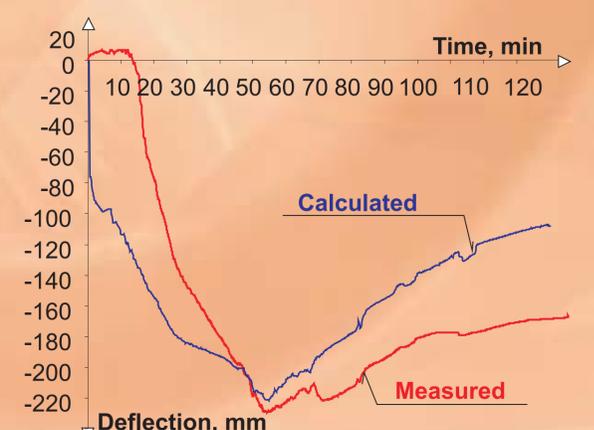
The maximum measured temperature of the trapezoidal sheet in the midspan was 1084°C in the 55min. The temperature of the sheet above the support was 447°C, this temperature is about 58% lower than the temperature in the midspan. The comparison of maximum deflections and the times where the deflection are obtained are in a good agreement. The maximum measured deflection of trapezoidal sheet was 229 mm, the calculated vertical deformation was 222 mm.



The temperatures of the sheet and of the screw during the fire test



The catenary action of trapezoidal sheet during the fire test



Comparison of measured and calculated deflection