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Autor: Pasternak, Hartmut / Horváth, László / Iványi, Miklós
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Thermovision - An Efficient Tool for Monitoring of Steel Members

Hartmut PASTERNAK
Professor of Steel Structures
Brandenburg Techn. Univ.
Cottbus, Germany

László HORVÁTH
Assistant Professor
Techn. Univ. of Budapest,
Budapest, Hungary

Miklós IVÁNYI
Professor, DSc
Techn. Univ. of Budapest,
Budapest, Hungary

Summary

The monitoring of structures involves the measuring of aspects of their performance. For the prediction of future damages (cracks) the detection of high stress concentration areas is essential. The thermographic stress analysis with thermovision is a full-field experimental technique, which can be applied for this task. The method allows a fast overview about the principal stresses in a cyclically loaded steel member, the detection of dangerous stress concentration areas and the monitoring of the carrying behaviour of the member. The paper reports experience from 4 tests carried out at the Brandenburg Technical University, Cottbus (tension bar with opening, necked hot-rolled beam, plate girder with slender web, rosette press joint).

Keywords: monitoring, experimental stress analysis, thermovision, infrared detection.

1. Introduction

For controlling the performance of a structural element, a full-field stress pattern is an efficient tool, because the difference with respect to the predicted stress distribution can be observed rapidly. The conventional methods of experimental stress analysis (e.g. strain gauges, photoelasticity, etc.) require complex preparation, and are not always effective for complex surfaces. For this reason a contactless technique was chosen, a thermal emission method with conventional thermocamera. The possible applications of this method to monitoring purposes were tested and the results were compared with data from strain gauges and FEM calculations.

2. Experimental procedure

The emitted thermal radiation of the surface of the loaded specimen is detected by sensitive infrared detectors or cameras. For our experiments the AGEMA Thermovision System 900 was used. The analysis was based on the thermal difference image between the fully loaded and unloaded state of the specimen in one load cycle. The calculation of stresses was done according the classical equation of the thermoelasticity.

3. Applications

The four test represent some possible applications of the method. The tested specimens are shown in *Fig. 1*. (*a*) On the conventional tension plate with central circular hole the stress sensitivity of the system was compared with stresses measured by strain gauges. (*b*) The welded girder with necking was used to compare the geometrical resolution of the thermocamera with FEM calculations through full-field stress maps. (*c*) The ultimate behaviour of the loaded plate girder with slender web was followed and observed with the thermocamera.

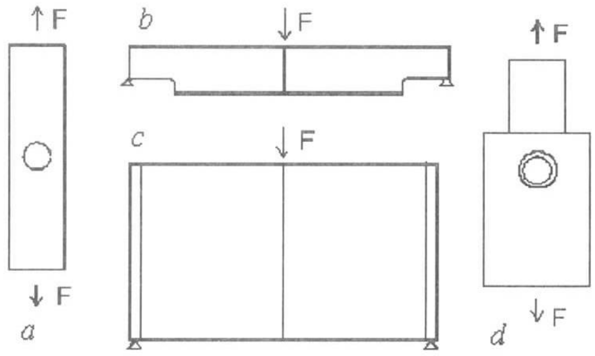

Fig. 1 Tested specimens

(*d*) The investigations on a complicated structural detail confirmed the usability of the thermographic method for complex surfaces. The stresses resulted from thermovision and calculated by FEM are shown in *Fig. 2*. The failure of the specimen was demonstrated in coloured thermal pictures.

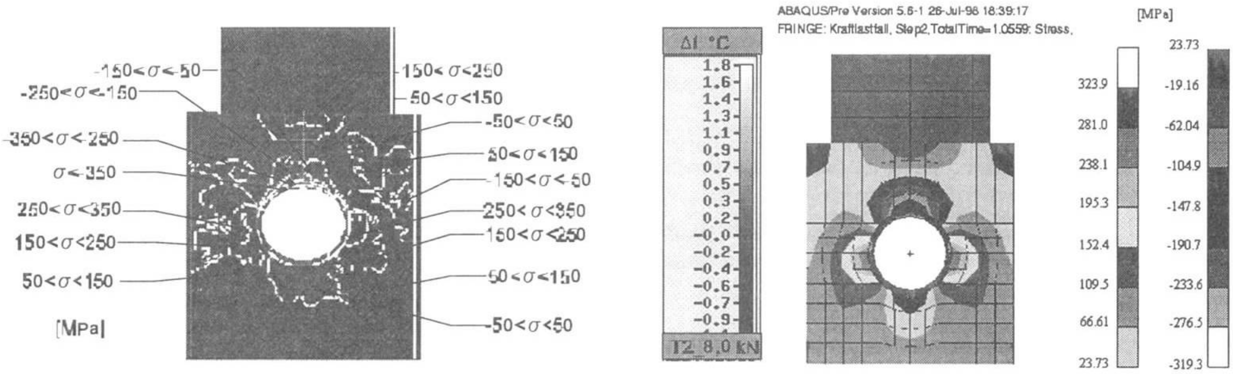

Fig. 2 Stresses from thermocamera and FEM in a rosette joint (Fig.1d) at a load level of 8,00 kN

4. Conclusion

The advantages and disadvantages of the thermographic method according to our experience has been briefly summarised. The thermographic stress analysis with conventional thermocamera can be an efficient tool for the monitoring of steel members. The experimental analysis of structures and details can be performed rapidly. The structural elements can be analysed in full-scale and in their operational environment, no modelling and only small surface preparation is needed. The sensitivity of a conventional thermocamera is sufficient to obtain good qualitative results from the whole structure, and acceptable quantitative results from smaller areas. For the refinement of the method further investigations are necessary (random loading, on-site effects, plastic behaviour).