

COST-STSM-TU0904-14885 SCIENTIFIC REPORT

STSM Topic: Benchmarks for steel beams under fire

STSM Applicant: Paweł Krupa,
Warsaw University of Technology, Warsaw
pawelk4@hotmail.com

Host: Euripidis Mistakidis,
University of Thessaly, Volos
emistaki@gmail.com

Period: 21-08-2013 to 01-09-2013

1. PURPOSE OF THE STSM

My name is Paweł Krupa and I am an undergraduate student at Faculty of Civil Engineering at Warsaw University of Technology. I work on benchmark studies under the supervision of prof. Lesław Kwaśniewski. The purpose of the Short Term Scientific Mission was to create and test models of steel beams in elevated temperatures in ABAQUS software. The main objective was to design models that were simple enough to allow easy analysis in any FEM software. This would lead to verification and comparison of different software.

2. WORKS CARRIED OUT DURING STSM

The Short Term Scientific Mission I participated in took place from 21st August to 1st September at the University of Thessaly in Volos. After my arrival at the Department of Civil Engineering I met Daphne Pantousa, an employee of the university who was a very gracious and helpful host during my whole stay. She showed me the Laboratory of Structural Analysis and Design where she works and roughly explained to me what her studies are focused on. Later I met dr Konstantinos Tzaros who works at the Laboratory of Structural Analysis and Design as well. He was very kind and extremely helpful, because of his extensive knowledge and experience in work with steel structures models and simulations. His support and tips in the following days of my stay turned out very useful and provided an interesting insight into FEM software. He also described his work at the university and told me about his Ph.D. dissertation on unilateral contact buckling of beams. Moreover he explained his studies on composite slabs and some details of his Master's Thesis. I found it very interesting and inspiring.

With cooperation of prof. Lesław Kwaśniewski and Bartłomiej Sawicki from Warsaw University of Technology I continued their work on benchmark problems¹. We decided to use 5 different loading and boundary condition cases. Two types of beams were used: 1 meter long

¹ Sawicki B., Pełczyński J., Kwaśniewski L. „BENCHMARK EXAMPLE PROBLEMS FOR BEAMS At Elevated Temperatures”, APPLICATIONS OF STRUCTURAL FIRE ENGINEERING, CTU Publishing House, pp.29-35, Prague 2013.

beam with rectangular cross-section and 8 meters long I-beam of standard UB 406x178x67 cross-section. Material model was simplified (elastic perfectly plastic) and chosen in a way that it reflects steel properties at elevated temperature (800°C) i.e. Young's modulus equal to 40 GPa and yield stress equal to 40 MPa². Another material (fully elastic) was also used for comparison. Those material models allowed for simple finite element analysis and easier identification of error sources. In the case of rectangular cross-section models with three element types were created (solid, shell and beam elements). For I-beam only shell and beam elements were used. For each case models with 3 different mesh densities were developed and analysed. Solution for the problem I had with boundary conditions for the fixed beam (rotation constrained at both ends) was suggested by dr Konstantinos Tzaros. Thanks to his experience in FEM modeling, he recommended adding one-element, thin, stiff plates at the ends and applying boundary conditions to those plates. For me, still a beginner in FEM, his help was invaluable.

During my stay I learned that Daphne Pantousa is finishing her Doctoral Dissertation on steel structures under fire after earthquakes. She explained to me in more detail what she had been doing and showed me the model of a beam that she was using in her simulation in MARC software. In order to compare results I tried creating the same model in ABAQUS but unfortunately due to my lack of experience I was not able to reflect the same conditions. I will put more effort into working on similar problems in the future and I will try to increase my knowledge in the subject.

3. RESULTS

Throughout the whole Short Term Scientific Mission I gained a lot of experience in FEM modeling and an insight into immense possibilities that FEA offers. I received a better understanding of behavior of steel structures in fire conditions. I would like to further my knowledge in this subject and continue to work on similar problems.

The direct result of the STSM is a paper on elastic-plastic bending of beams by prof. Lesław Kwaśniewski, prof. Ian Burgess, Bartłomiej Sawicki and Paweł Krupa that will be published as a part of COST action. Detailed results and descriptions of the problems that were carried out during the STSM are presented in the paper.

Unluckily I came to the University of Thessaly right after the holiday break, so many people were not present and I could not see the university as fully operational. That is why, I have to thank even more to the people that made my stay as pleasant and informative as possible: Daphne Pantousa and dr Konstantinos Tzaros. I would like to thank them for devotion of their time to me. I look forward to further cooperation and I am grateful for the possibility of exchanging ideas with them. I would also like to thank COST framework for execution of this unique opportunity.

Paweł Krupa

² Gillie M., Analysis of heated structures: Nature and modelling benchmarks, Fire Safety Journal 44, pp. 673–680, 2009.