SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: TU1403
STSM title: Thermo-mechanical numerical modelling of adaptive facade assemblies under high temperatures and fire
STSM start and end date: 08/04/2018 to 14/04/2018
Grantee name: Chiara Bedon

PURPOSE OF THE STSM:

(max.200 words)

The primary aim of this STSM consisted in the thermo-mechanical numerical modelling of adaptive facade assemblies under high temperatures and fire.
Careful consideration was spent especially for structural glass case studies of technical interest, based on the availability of experimental data.
The reason of the STSM goals has direct feedback in current design trends for facade assemblies.
Modern building envelopes are in fact high-tech components that must meet several requirements and constraints with regards to architecture/urban planning/aesthetics, energy efficiency, indoor environmental quality, buildability and value. Within the requirements an adaptive facade needs to provide, a fundamental role is assigned to the structural performance under ordinary and exceptional loads. Most of the systems representative of the next generation of facades in buildings, in this regard, generally involve advanced use of smart materials, kinematic mechanisms, etc. The current lack of standardized procedures to evaluate their mechanical performance by means of numerical models, however, certainly represents a barrier towards their optimal structural design. This is true especially in the case of facades of strategic buildings (governmental buildings, banks, terminal buildings, landmark structures) or any other types of buildings of which the facade could be exposed to exceptional loads or the building envelop has a significant contribution to the robustness of the entire structural system.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

The STSM activities were organized in accordance with the original Work Program, being part of the on-going activities of the Structural Task" sub-group (Working Group 2 "Component performance and characterization methods").
In this regard, the STSM outcomes allowed to further promote the COST Action TU1403, since most of the numerical results and comparisons discussed during the visit have been included in joint journal/conference publications that are going to submitted or in progress.

First, experimental samples were selected from RISE (Hosting Institution) documentation, to carry out the corresponding numerical studies. Careful consideration was spent for structural glass specimens under radiant heating and fire loading, in several loading and boundary conditions.

Furthermore, a literature review was carried out to properly describe the input properties of materials (glass and interlayers), as well as the expected boundary conditions. Finally, comparative studies and sensitivity analyses were carried out, so to explore the potential of numerical models and the reliability of the obtained predictions, with respect to the past experimental observations.

Major issues, for example, were found to derive from uncertainties in material properties definition, including the degradation with temperature of both the thermo-physical and mechanical material features, hence resulting as key influencing parameters for the numerical study. In any case, based on a critical assessment of the collected comparisons, some general recommendations of practical interest were derived, so to provide modelling guidelines for structural glass assemblies under high temperature and/or fire.

Additional work was hence carried out during the STSM visit,focusing on:

1) drafting of a common conference paper (abstract already accepted) for the 3rd International Electronic Conference on Materials Sciences (section Materials Characterization)
"Numerical modelling of structural glass elements under thermal exposure"
(paper submission deadline= 24/04)

2) drafting of two COST Final Conference papers (abstracts already accepted):

PAPER-ID 1013
"Structural performance of adaptive facades: classification, metrics, experimental testing, numerical modelling issues"

PAPER-ID 1014
"Thermal assessment of glass facade panels under radiant heating- Experimental and preliminary numerical studies"

3) preliminary drafting of a joint journal paper, to be possibly submitted to Composite Structures, inclusive of extended comparisons and parametric studies collected during and after the STSM in object

4) part of the STSM outcomes, in addition, will be used within few weeks for the preparation of Educational Pack slides to present during the Belgrade Training School (submission of updated slides will be finalized as soon as possible - before the end of May - according to FE simulations and outcomes that will be further elaborated in the weeks following the visit at RISE)

DESCRIPTION OF THE MAIN RESULTS OBTAINED

(max.500 words)

As a first outcome, the STSM numerical results and comparison to past experimental tests (RISE hosting Institution) have been properly collected and critically discussed.
Most of them are going to be used in the journal/conference papers in progress, to provide useful recommendations for the thermo-mechanical numerical modelling of adaptive facade assemblies, especially for structural glass systems.

More in detail, numerical modelling recommendations have been drafted and collected, based on comparative calculations carried out towards past experimental tests on structural glass specimens, including both monolithic and laminated glass samples under various loading/boundary conditions.
In this regard, several modelling techniques have been assessed, including simplified one-dimensional (1D) numerical models, as well as bi-dimensional shell models or full solid 3D models.
Careful consideration was also spent for some key aspects in the numerical modeling of structural glass systems under thermal loading and fire, including sensitivity studies related to numerical model assembly features, like for example:

- Mesh sensitivity
- Thermal loading exposure

- Thermo-physical and mechanical properties of involved materials (glass, interlayers, etc.), including their degradation with temperature increases
- Effect of local details, such as supports and restraints, on the actual thermo-mechanical response of he selected structural systems
- Size effects (small-scale specimens vs. large scale samples, etc.)
- Geometry of the examined specimens, including possible sensitivity to thermo-mechanical results to even small variations in real vs. nominal dimensions of the assembly components (thickness, etc.)

Most of the FE-to-experimental comparisons here recalled have been already included in the joint conference & journal papers that are going to be submitted / finalized in the weeks following the STSM.

FUTURE COLLABORATIONS (if applicable)

The STSM visit gave to both the Visitor and the Host the opportunity to establish and enforce the past research networking.
First of all, the major goals of the visit have been properly achieved, and most of the collected outcomes will be published in journal papers (submission is planned for summer) and/or orally presented during the COST Final Conference in Lucerne.

In any case, during the STSM further collaboration was also agreed between the involved researchers, in view of medium-term as well as long-term cooperation.
Such a networking will take several forms.
Part of the efforts will be spent for joined applications in European calls for research grants, based on common topics of interest for both the institutions the Visitor and the Host belong.
The first grant application the STSM researchers agreed and discussed is the NATO “Science for Peace and Security” opportunity.

Secondly, further collaboration will take favorable advantage from the key tasks the involved researchers join at their home institutions. From one side, the Visitor will provide numerical modelling support for structural systems under extreme loads. On the other side, the experience/involvement of the Host and RISE on experimental testing will facilitate long-term cooperation between the researchers.