

COST ACTION TU0601 Robustness of Structures

Minutes of the Working Group 3 (WG3) Meeting Ljubljana, 21/22 September 2009

Attendance

Marios Chryssanthopoulos	UK
Luis Canhoto Neves	PT
Selcuk Toprak	TR
Daniel Honfi	SE
Victoria Janssens	EI
Fulop Ludovic	FL
Eduardo Cavaco	PT
Petros Christou	CY
Christos Bisbos	GR
Harikrishna Narasimhan	CH

Documents prepared and/or updated since last meeting

- D. Diamantidis, “Robustness of structures in codes of practice”
- M Inel, “Concrete buildings subjected to earthquakes in Turkey”

Presentations at the Ljubljana meeting

The following presentations, related to WG3, were given:

- D Diamantidis, “Robustness requirements/ criteria in codes regulations and best practice guides”
- Harikrishna Narasimhan and Michael Faber, “Categorisation and assessment of robustness related provisions in European standards”
- S Toprak / M Inel, “Analysis of damage/collapse statistics from concrete buildings under seismic loads”
- In addition, several other presentations made in the spirit of the joint meeting with COST E55, were linked to the scope of work of WG3.

Activity 6 – Safety measures

a. *Classification of importance classes*

The presentation by Diamantidis is linked to a draft factsheet. It was agreed that this can be presented as part of the output from WG3, and will form part of the outcome report from the joint E55/TU601 meeting. The factsheet is hereby distributed to members with a request to provide feedback to Diamantidis who will submit the final version within four weeks. In particular, any additional guidelines that members are aware of should be brought to the attention of Diamantidis.

b. *Classification of safety measures*

A possible classification according to RAPS (Resist – Avoid – Protect – Sacrifice) has been discussed in earlier meetings. Also, a distinction between structural measures, functional measures and organizational measures (affecting human errors) has been considered. Narasimhan made a presentation in which this concept has been extended further with respect to categorization of various measures. This will be further developed by Narasimhan as a working paper – to become a factsheet at a later stage.

Chryssanthopoulos informed the group that the UK Institution of Structural Engineers is in the final stages of producing a document entitled “Practical Guide to Structural Robustness and Disproportionate Collapse in Buildings”. The document attempts to capture the range of features that can be introduced in different structural forms/materials to promote robustness at element and system level. It would be helpful in relation to the above activity, and could also form the basis of a presentation at the next meeting (possible invitation to the Chairman of the Working Group).

c. *Effect of monitoring/smart technologies*

Robustness can be enhanced through state-of-the-art technologies, including monitoring, smart structures, self-healing materials etc. Since WG3 is focused on possible improvements of robustness, it is felt important to consider this topic through an increased awareness of what is being proposed in US and elsewhere. S Casciati and L Faravelli were unable to attend the meeting but the aim is to produce a factsheet which can be included as an outcome of this meeting (Sara Casciati has prepared an associated presentation, which will be included in the programme of a future meeting).

Activity 7 – Consequence analysis

The different factors affecting consequence analysis (system definition, timeframe, etc.) have been pointed out during the discussions. Special emphasis has been given in distinguishing between direct and indirect consequences. Toprak (on behalf of Inel) presented an update of the earlier work on damages recorded in Turkey after recent earthquakes. Emphasis (as previously agreed) was given to public buildings (schools, government buildings). The information is now summarized in the attached working paper. It is requested to extend this compilation by attempting to include direct economic consequences - possibly as a percentage of the building replacement cost. This piece of work lies at the interface between TU601 and C26 and could form the basis of a factsheet presented at a later date.

Work on quantifying bridge failure consequences is progressing slower than anticipated. The intention is still to produce two working papers, as detailed in the minutes of the Coimbra meeting.

Janssens will look into the literature for material on direct consequences from building failures. The aim is to table a working paper summarizing information available on this topic.

Members discussed the possibility of inviting an expert on consequence modelling, perhaps from the insurance industry, to make a presentation at a future meeting of TU601. It is felt that this is an area where the expertise within the group might be somewhat limited, especially in relation to indirect consequences. Discussion of the studies related to the collapse of I35W was pertinent in this respect, where these contributions were found to be stemming from economists and transportation analysts.

Activity 8 – Case studies

Further to the proposal made at the Coimbra meeting, Honfi intends to pursue the study on long-span single-storey buildings. A working paper is expected by the next meeting.

Discussion on a demonstrator study was initiated. This has to be co-ordinated with WG2 efforts but the feeling in WG3 is to focus on 3D analysis of a not overly complex building, through commercially available software (SAP, Seismostruct, etc). As a first step, column removal scenarios could be evaluated deterministically – e.g. robustness indicator as a ratio of intact to damaged capacity. Chryssanthopoulos was tasked with discussing this with Vrouwenvelder and presenting ‘concrete’ ideas to the group.

Themes of work for next meeting:

- Robustness requirements/criteria in codes, regulations and best-practice guides - **update** [Diamantidis]
- Improvement of robustness through monitoring and smart materials/devices - **presentation of factsheet** [S Casciati, Faravelli]
- Categorisation of robustness measures – **new working paper** [Narasimhan]
- Consequence modelling:
 - Analysis of consequences in selected mid-rise buildings through EQ databases -**update** [Inel]
 - Building failure consequences: collection of available material – **new working paper** [Janssens]
 - Failure consequences in long-span buildings - **new working paper** [Honfi]
 - Consequence analysis from bridge failure data – **new working paper** [Imam, Chryssanthopoulos]
 - Consequence analysis: bridge network modelling – **new working paper** [Neves]

- Contribution to the progressive collapse / robustness analysis of a selected frame building (in collaboration with WG2 – scope to be defined) [All]

WG3 members are kindly asked to send their deliverables to the working group leader (Chryssanthopoulos) at least one week before the next meeting.