COST ACTION TU0601
Robustness of Structures

Working Group 2 (WG 2), Coimbra Meeting, 2 and 3 March 2009

Attending:

Carmen Bucur (RO)
Geoffrey Decan (BE)
Bassam Izzuddin (UK)
Marian Gizejowski (PL)
Ulrike Kuhlmann (DE)
Leslaw Kwasniewski (PL)
Bernt Leira (NO)
Jana Markova (CZ)
Lars Rölle (DE)
Uwe Starossek (DE) – invited expert
Miroslav Sykora (CZ)
Ton Vrouwenvelder (NL)
Leonard Ziemianski (PL)

1. Opening / approval of agenda

No changes envisaged.

2. Minutes of the Timisoara meeting

No comments were made.

3. Progress in activity 4, Exposure conditions

3.1 Present status

A basic note on the probabilistic modelling of exposure conditions has been written by Ton Vrouwenvelder and discussed the previous meeting. Afterwards some comments were received. A second draft is available and will be distributed together with the rest of the Activity 4 results in the coming period.

For quite a number of exposures it turns out that use can be made by the models within the JCSS model code. However, in particular for two important exposures this document does not give sufficient information, that is:

1) The modelling of human errors and human actions
2) The modelling of explosions

Some drafts for these topics already have been made and a list of references with valuable models and data have been gathered.

3.2 Human error

There is, also on request of the Project Chair, an intensive discussion on the modelling of the human error. In the basic note in this Activity 4, based on a scheme by one of the former JCSS president Joerg Schneider, the following subdivision was made:

- unforeseeable/unknown actions
- known actions, but not recognized or ignored
- known actions, but incorrectly modelled or calculated

The main point is whether unforeseeable actions can be dealt with in the design. On the one hand it seems impossible. On the other hand, we may be quite sure that every now and then some kind of unforeseeable action will happen and may thread the integrity of the structure. The designer and also the code requires that in those circumstances a small or local damage should not lead to a major collapse.

In a formal risk analysis it may be helpful to have at least a notional number for these type of events. The idea is that we then have a basis for a consistent decision making. We may for instance find the structure that has the least sensitivity for a given construction cost.

In order to find such a notional number, it seems that no specific information is available for unforeseeable, unrecognised and ignored and actions. Nevertheless, when making an inventory of failed structures from the past, one could categorize the cause of collapse as unforeseen or unforeseeable at that time. The flutter mechanism of the Tacoma Narrow Bridge, for instance, could be considered as unforeseeable at that time. So, in principle, although difficult and debatable, it is possible to find for past failure frequencies of unforeseeable and unforeseen failures. It is doubtful, of course, how much these numbers have a meaning for future structures yet to be built. However, as an indicative number this may be helpful.

Another outcome of the discussion was that the distinction between unforeseeable on the one hand and foreseeable gut not recognised on the other is not helpful. It is close to semantics and subjective interpretation. It is decided to consider these issues as one category.

3.3 Deliberate destructive Human Actions

Deliberate destructive human actions like vandalism and terrorist actions are probably the most difficult actions to tackle. The person in question may always seek for loads and scenarios that will counteract the measures of the designer. If he knows that the building was designed for one missing column he might focus his attention on attacking two columns. Probably this is more the field of non-structural security type measures than structural measures. On the other hand it still makes sense to built robust structure that cannot be destroyed too easily. In this respect the design should start with an identification of the buildings where these deliberate destructive actions may be expected.

In case there is an enhanced danger for these types of actions both stronger elements and more robustness are justified.

3.4. Final Report Activity 4

According to the time schedule, the work of Activity 4 will end next meeting. It is decided to produce a draft report before the summer, discuss it by mail and finalize it at the next meeting. The envisaged table of contents is given as:

	Introduction	Vrouwenvelder
	Probabilistic modelling of exposure conditions	Vrouwenvelder
	Modelling of human errors ()	Vrouwenvelder and Sykora
	3.1 Models	
	3,2 Data	
	3.3 Deliberate actions	
	Modelling of explosions	Vrouwenvelder + Leira
	4.1 Models for internal explosion	
	4.3 Models for external explosion	
	4.4 Data	
	Recommendations	Vrouwenvelder

It is envisaged that during the remaining part of the project and the use of the model adjustments might prove to be necessary.

4. Progress in activity 5, Structural behaviour models

4.1 Present status

At present the following documents are available:

-Cover note (draft)
-Note on steel structures (Kuhlman/Rölle)
-Note on concrete slabs (Taerwe/Decan)
-Sheets on timber (Thelandersson)
-Note on composite structures (Kwasniewski)
-Note on existing (timber) structures (Markova)

As well as the following papers from the Zurich Workshop:
-Izzuddin (sudden column failure)
-Byfield (requirement on joint ductility)
-Kuhlman (joint ductility steel structures)
-Cichocki (concrete damage models / blast loading)
-Gizejowski/Kwasniewski (joints in comp structures)
-Taerwe (catenary action in slabs)

The notes discuss the properties for normal conditions and the behaviour under extreme loading conditions (dynamic response, large deformations, hysteresis, joint characteristics) and sometimes specific strategies.

A paper on Historical structures was promised by Eduardo Julio, but has become impossible because of skipping of a project.

4.2 Discussion

During discussion it becomes apparent that some parts of the papers have a more general nature. These concern mainly items like material models, geometrical nonlinearities, dynamic properties, 2D versus 3D schematisations, Finite Element modelling, Solvers, Dynamic integration schemes etc. It is decided that it is to be preferred to includes this material in one generic chapter.

For the timber paper Vrouwenvelder will contact Sven Thelandersson and ask him to elaborate a bit more on the robustness strategy of timber in the case of big halls.

The paper on existing structures is considered to be an interesting example, but first a more general chapter including inspection and maintenance aspects is necessary.

4.3 Proposed Table of Contents

Based on the foregoing discussion the following table of content is proposed:

	Introduction	Vrouwenvelder
	Modelling and analysis	Kwasniewski +Izzuddin
	Sections per material	
	-steel	Kuhlmann and Rölle
	-concrete	Taerwe +Decan + Julio
	-composite	Kuhlmann
	-timber	Thelandersson
	Existing structures	
	-general	Markova+Sykora
	-inspection/testing and maintenance	
	-examples	Markova+Sykora
	Closure	

The names indicate the persons responsible for the next draft.

5. Case proposal

Ton Vrouwenvelder has written a proposal to produce a case where we can demonstrate the working of the deterministic structural models for extreme conditions, the extension to sensitivity and probabilistic calculations in order to evaluate the risk according to the MuO. Cooperation with WG 1 and 3 is essential and need discussion between the WG-leaders in the next half year. Based on the results we may also make links to robustness measures proposed in Eurocode EN1991-1-7 (Accidental Actions) Many countries have difficulties in how to deal in particular with Annex A of this document (tying rules etc).

6 AOB

Kuhlmann states that at the Spring meeting next year we should have one comprehensive presentation and not a number of separate ones. Next meeting in Ljubljana this needs to get attention. Everybody agrees.

7. Closure