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DEPT. OF CIVIL ENGINEERING - DIVISION OF STRUCTURAL ENGINEERING
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To the attention of all members of the EAEE Ex. Committee

Subject:

**Report of activities of EAEE TG11 Seismic Design, Assessment, and Retrofit of Bridges
(for the period 2007 – 2010)**

The Task Group was launched in January 2007, following the approval by the EAEE ExCom of a proposal submitted in October 2006 by the Coordinator of the TG (Kappos); the current **membership** of the TG includes the following people:

Full members

1. Kappos, Andreas <ajkap@civil.auth.gr> (University of Thessaloniki, Greece), TG *coordinator*
2. Aydinoglu, Nuray <aydinogn@boun.edu.tr> (University of Bosphorus, Turkey)
3. Crewe, Adam <A.J.Crewe@bristol.ac.uk> (University of Bristol, UK)
4. Delgado, Raimundo <pdelgado@fe.up.pt> (University of Porto, Portugal)
5. Dolce, Mauro <dolcerom@libero.it> (University of Basilicata, Italy)
6. Fischinger, Matej <mfischin@ikpir.fgg.uni-lj.si> (University of Ljubljana, Slovenia)
7. Fleisch, Rainer <rainer.fleisch@arsenal.ac.at> (Arsenal research, Austria)
8. Karakostas, Christos <christos@itsak.gr> (ITSAK, Greece)
9. Mylonakis, George <christos@itsak.gr> (University of Patras, Greece)
10. Nuti, Camillo <c.nuti@uniroma3.it> (University of Rome III, Italy)
11. Pantazopoulou, Stavroula <pantaz@civil.duth.gr> (University of Thrace, Greece)
12. Papadimitriou, Costas <costasp@mie.uth.gr> (University of Thessaly, Greece)
13. Pinho, Rui <rui.pinho@unipv.it> (EUCENTRE & Rose School, Italy)
14. Pinto, Artur <artur.pinto@jrc.it> (JRC, Ispra, Italy)
15. Saiidi, Mehdi (Saiid) <saiidi@unr.edu> (University of Nevada Reno, USA)
16. Uzdin, Alexander <uzdin@mail.ru> (University of Petersburg, Russia)

Corresponding members

1. Deodatis, George <deodatis@civil.columbia.edu> (Columbia University, USA)
2. Gazetas, George <gazetas@ath.forthnet.gr> (National Technical University, Greece)
3. Karamanos, Spyros <skara@mie.uth.gr> (University of Thessaly, Greece)
4. Pecker, Alain <alain.pecker@geodynamique.com> (Geodynamique et Structures, France)

5. Stojadinovic, Bozidar <boza@ce.berkeley.edu> (University of California, Berkeley, USA)

During the **reported period (Jan. 2007 – Aug. 2010)** the following **activities** were pursued by the Group:

1. Creation and maintenance of **website**: Since spring 2007 the TG website has been set up (<http://nisida.civil.auth.gr/tg11/>); to the Group's best knowledge this is the only TG website within the EAEE. Currently it includes the following main items:
 - a. Background, scope, and foreseen activities of TG11.
 - b. Details of TG members.
 - c. Details of TG activities (Meetings-workshops, TG documents, publications).
 - d. Bridge research documents (papers, reports), that can be downloaded directly from the site, and links to a number of research projects dealing with seismic aspects of bridges.
 - e. Bridge design and assessment documents (codes, guidelines, handbooks), that can be downloaded directly from the site.
 - f. Links to a number of websites closely related to the issues tackled by TG11.
 - g. A secured 'Members Area', wherein exchange of documents (at the draft stage) can take place, solely among the TG members.

The site is also accessible via a link on the Task Group page of the EAEE website (<http://www.eaee.boun.edu.tr/tgwg/TGS.HTM>)

2. **Meetings – workshops**: The TG organised a number of meetings, all of them within the framework of Conferences related to Earthquake Engineering and all of them open to the public, so that exchange of ideas was maximised and visibility of the group increased. All scientific presentations made at the Meetings-Workshops can be found on the TG11 website (<http://nisida.civil.auth.gr/tg11/Meetings.htm>).

The following meetings were organised

- a. **First** meeting on 16-6-2007, held in the form of a half-day workshop in **Rethymno**, Crete; the venue was kindly made available by the organisers of the COMPDYN Conference. The EAEE Secretary General was present at Workshop and spoke on recent activities of the Association. The day before the TG workshop, a **special session**, titled “**Analysis and Assessment of Bridges Subjected to Seismic Actions**”, was organised within COMPDYN; most of the papers presented at the sp. session were authored by TG members and their groups. The minutes of the meeting are given in Appendix 1.
- b. **2nd meeting**, held on 14-10-2008 in **Beijing**, during the 14WCEE; it included a presentation of Activities report (by the Coordinator), and a brief discussion of future TG11 activities, while most of the meeting was devoted to the discussion of the document “**Inelastic methods for seismic design and assessment of bridges**” (see Activity 4), which is expected to appear first as a report and subsequently,

depending on the quality of the final outcome, as a book to be published by Springer. The minutes of the meeting are given in Appendix 2.

- c. **3rd meeting**, held on 24-7-2009 in **Rhodes**, Greece, during the COMPDYN 2009 Conference. Again, it included a presentation of Activities report and a brief discussion of future TG11 activities, while most of the meeting was devoted to the discussion of the document “**Inelastic methods for seismic design and assessment of bridges**”, which was at a relatively mature stage. The day before the TG workshop, a **special session**, titled “**Analysis and Assessment of Bridges Subjected to Seismic Actions**”, was organised within COMPDYN; most of the papers presented at the sp. session were authored by TG members and their groups. The minutes of the meeting are given in Appendix 3.
 - d. **4th meeting**, held on 14-10-2008 in Toronto, Canada, during the 9USN & 10CCEE. After a presentation of the Activities report and a brief discussion of future TG11 activities, most of the meeting was devoted to the discussion of the document “**Inelastic methods for seismic design and assessment of bridges**” which was then at its final stage (see also Activity 4). The minutes of the meeting are given in Appendix 4.
3. Production of the **special issue of the BEE** “Earthquake Protection of Bridges” (Guest Editor: A. J. Kappos), published as no. 2 of Volume 7 (2009) that included a total 11 papers plus an editorial, most of them contributed by TG members and their co-workers. The papers are listed in the following table.

Table 1. Contents of BEE Sp. Issue ‘Earthquake Protection of Bridges’

	Authors	Title
BEEE121	A.N. Kotsoglou & S. J. Pantazopoulou	Modeling the seismic response of integral bridges by consideration of embankment participation - Performance-based earthquake design
BEEE123	T.B. Panagiotakos, C.P. Katsaras, B. Koliass	Effect of torsional stiffness of prestressed concrete box girders and uplift of abutment bearings on seismic performance of bridges
BEEE126	R. Delgado, P. Delgado, N. Vila Pouca, A. et al.	Shear effects on hollow piers under seismic actions. Experimental and numerical analysis.
BEEE127	D. Cardone, M. Dolce, G. Palermo	Direct Displacement-Based Design of Seismically Isolated Bridges
BEEE129	D. Timosidis & S. J. Pantazopoulou	Experimental and analytical modelling of monolithic joints in concrete bridges
BEEE131	I. Moschonas, A.J Kappos, P. Panetsos, V. et al.	Seismic fragility curves for greek bridges - Methodology and case studies
BEEE132	E.Ntotsios, C. Papadimitriou, P. et al.	Bridge Health Monitoring System Based on Vibration Measurements
BEEE133	E. Ntotsios,	Structural Identification of Egnatia Odos Bridges Based on

	C.Karakostas, V.Lekidis, P. et al.	Ambient and Earthquake Induced Vibrations
BEEE134	N. Johnson, M. Saiid Saiidi, D. Sanders	System vs. Component Bent Response of a Two-Span Bridge System
BEEE136	A. Sextos, A. Kappos	Evaluation of the new Eurocode 8 - Part 2 provisions regarding multiple support excitation of bridges
BEEE210	N. Gerolymos, V. Drosos, G. Gazetas	Seismic Response of Yielding Pile–Columns in Nonlinear Soil

4. Preparation of a state-of-the-art document titled “**Inelastic methods for seismic design and assessment of bridges**”, including: modelling of bridges for inelastic analysis, presentation of available methods (pushover and time-history analysis methods), examples – case studies of application of specific methods and comparisons of alternative methods, and finally conclusions on the range of applicability of (pushover) methods and criteria for selecting appropriate methods. Main drafters of the individual chapters of the document were M. Saiidi, N. Aydinoglu, M. Fischinger, T. Isakovic, and A. Kappos, while several other TG members also contributed sections to the document.

The document is currently (Aug. 2010) at the stage of a final draft and will be presented at the TG11 meeting to be held in Ohrid during the 14ECEE. The list of contents of the document is given in Table 2.

Table 2. **Contents of the document
‘Inelastic methods for seismic design and assessment of bridges’**

Sections	Principal drafter of the chapter	Other authors
1. Introduction	Kappos	
List of symbols and key terms	Kappos	Fischinger, Mylonakis
2. Modelling of bridges for inelastic analysis	Saiidi	
a. deck		Pantazopoulou
b. bearings and shear keys		Saiidi
c. isolation and energy dissipation devices		Dolce-Cardone
d. piers		Delgado-Vila Pouca, Pinho, Fischinger
e. abutments, foundations, and SSI		Pantazopoulou, Sextos, Mylonakis
3. Presentation of available methods (pushover and time-history analysis methods)	Aydinoglu	
a. code methods		Fischinger
b. research proposals		Aydinoglu, Pinho, Kappos
4. Examples – case studies of application of specific methods – Comparisons of alternative methods	Fischinger, Isakovic	Aydinoglu, Dolce -Cardone, Flesch-Benko, Kappos-Sextos, Pinho, Isakovic, Delgado-Vila Pouca, Nuti
5. Conclusions – Range of applicability of (pushover) methods – criteria	Kappos	

5. **Future activities** and a new Action Plan for TG11 will be presented by the Coordinator during the first meeting of the TG after the ECEE, provided its mandate will be renewed by the EAEE Ex. Committee (as anticipated)

A handwritten signature in black ink, appearing to be 'A. Kappos', written in a cursive style.

Andreas Kappos

Coordinator of TG11

Appendix 1

Minutes of TG11 meeting in Rethymno (16-6-07)

- **Participation:** Nuray Aydinoglu, Pedro Delgado, Matej Fischinger, Christos Karakostas, Andreas Kappos, George Mylonakis, Stavroula Pantazopoulou, Costas Papadimitriou, Mehdi Saiidi, Bozidar Stojadinovic, Donatello Cardone (representing Mauro Dolce), Tomaso Albanesi (representing Camillo Nuti), Chiara Casarotti (representing Rui Pinho), Anastasios Sextos, and a number of observers.
- The TG coordinator (Kappos) welcomed the participants and introduced the Agenda.
- The EAEE Secretary General, Prof. A. Ansal, addressed the meeting and spoke on recent activities of the Association.
- The TG members presented recent and current research carried out by their groups on analysis, testing, and design of bridges. The following presentations were made: M. Saiidi (University of Nevada Reno), D. Cardone (University of Basilicata), C. Karakostas (ITSAK), C. Papadimitriou (University of Thessaly), M. Fischinger (University of Ljubljana, Slovenia), N. Aydinoglu (University of Bosphorus, Turkey), G. Mylonakis (University of Patras, Greece), P. Delgado (University of Porto, Portugal), A. J. Kappos and A. Sextos (University of Thessaloniki).
- On the issue of “*Dissemination of research results through the TG web site and other means*”, the current version of the website (www.civilengineering.gr/tg11) was presented by Kappos and Sextos, and suggestions were made by the TG members for further improvements of the website (a new page will be added on ‘Meetings’, which will contain information on the TG meetings, including pdf files of the presentations made). The coordinator asked the members to send documents (not protected by strict copyright laws) and links to websites relevant to seismic aspects of bridges, to be included in the website.
- On the issue of “*Compilation of state of the art reports on topics falling within the scope of the TG, and the production of design-oriented documents*”, an extensive discussion took place and the following potential titles of documents were identified:
 - (1) Eurocode 8 - Part 2 Design Guide (with examples)
 - (2) Case studies of evaluation of seismic performance of bridges
 - (3) Background and calibration studies of bridges and their relevance to Eurocode 8 – 2
 - (4) Inelastic methods for seismic design and assessment of bridges (including evaluation of Eurocode 8 procedures)
 - (5) The TG members felt that the 4th document is both interesting and relevant to the scope of TG work, but also feasible in the sense that there is significant expertise within the group relating to this topical issue. After a preliminary discussion on the possible contents of the document, the following sections were tentatively suggested:
 6. Introduction
 7. Modelling of bridges for inelastic analysis
 - a. deck

- b. bearings and shear keys
 - c. piers
 - d. abutments, foundations, and SSI
8. Presentation of available methods (pushover and time-history analysis methods)
- a. code methods
 - b. research proposals
9. Examples – case studies of application of specific methods – Comparisons of alternative methods
10. Conclusions – Range of applicability of (pushover) methods – criteria

The TG members will be asked to indicate their availability on (co-)authoring specific sections of the document, which could appear as a special issue of the Bulletin of Earthquake Engineering (the official journal of the EAEE, now included in the ISI Citation Index) and/or in book form (to be published by Springer).

- On the issue of “*organization of scientific meetings*”, a brief discussion took place and the idea of a workshop on the application of Eurocode 8 – Part 2 (Seismic Design of Bridges) was put forward. The content of this workshop could include both lectures on practical application aspects of the code (preferably to specific actual bridges), and lectures on reasearch related to verification and calibration of the EC8-2 procedures.
- Regarding the next meeting, it was decided to have it in 2008 (one meeting per year was deemed appropriate, the rest of the communication among the group taking place through the website and e-mail); two places were suggested Beijing (China) during the 14th WCEE (October 2008), which a number of the TG members will attend, and Thessaloniki (Greece) where the coordinator can arrange for a proper venue in the period late May – early June 2008. The members of the group are kindly requested to indicate their preference by e-mail to the coordinator before the end of next month.

Appendix 2

Minutes of the TG11 2nd meeting in Beijing (14-10-2008)

List of Attendees:

TG members: N. Aydinoglu, P. Delgado, M. Dolce, M. Fischinger, A. Kappos, G. Mylonakis, C. Nuti, D. Syntzirma (representing S. Pantazopoulou); A. Crew and B. Stojadinovic (2nd half of the meeting)

Observers: A. Sextos, D. Cardone, T. Isakovic, N. Vila-Pouca, T. Albanesi.

Activities report: The activities report (based on the document: *Report of activities of EAEE TG11 Seismic Design, Assessment, and Retrofit of Bridges*, submitted in Aug. 2008 to the EAEE) was presented by the TG coordinator A. Kappos, who noted that several EAEE Ex. Committee members have expressed their full approval of the TG11 activities; the TG is currently one of the most active within the EAEE.

Discussion on the document “Inelastic methods for seismic design and assessment of bridges”: Most of the meeting was devoted to the discussion of this document, which is expected to appear first as a report and subsequently, depending on the quality of the final outcome, as a book to be published by Springer.

The main decisions made with regard to the content of the document are the following:

General aspects

- A list of terms and symbols will be included, whose main purpose will be to contribute towards establishing an appropriate terminology pertinent to the application of inelastic analysis methods to bridges. The notation adopted by the Eurocodes (EC8 in particular) will be used as a basis, but additional symbols and terms will be needed.
- Even at this early stage, an effort will be made to include a detailed publications list in each chapter, covering all pertinent studies by the TG members as well as by other researchers.
- It was emphasised that it is not sufficient for TG members and their co-workers to send journal or conference papers (or, indeed, research reports) to the chapter drafters; instead, they should send complete drafts of the intended contributions, and chapter drafters will be responsible only for homogenizing the contributions and possibly reducing them if they exceed the agreed length, as well as for writing the general sections of the relevant chapters.

Chapter 2 (Modelling of bridges for inelastic analysis)

- A new section (2f) will be added, titled “Seismic input for bridges” which will focus on aspects of seismic input that are particularly relevant to bridge analysis (such as spatial variability of ground motion, kinematic effects, criteria for selection of earthquake records), rather than being a detailed and comprehensive treatment of the subject (which is available in a number of existing publications). G. Mylonakis and C. Nutti have volunteered to contribute this new section.
- In section 2d modelling of pounding effects and restrainers should be added (M. Saiidi is currently requested to take care of the addition).

- Damping in bridges (and related problems) have to be addressed; this could be included in section 2c.
- B. Stojadinovic volunteered to review chapter 2 and add comments and possibly selected parts from the recent PEER report “Guidelines for Nonlinear Analysis of Bridge Structures in California”. {*Post-meeting note by the Coordinator*: at a first glance, PEER 2008/03 appears to be an excellent document, focussing mainly on the implementation of nonlinear analysis procedures intended to estimate seismic *demand* on bridge components and systems. Nevertheless, it leaves ample room for additional work on a state of the art document, like that envisaged by our TG, especially with respect to current developments in the pushover procedures for bridges and other relevant developments outside the US}.

Chapter 3 (Presentation of available methods)

- The first draft, prepared by N. Aydinoglu, was recognised as an appropriate basis for the chapter; of course, a list of references should be added, even at this stage.
- It was confirmed that all published methods of inelastic analysis of bridges should be presented in a balanced way, but under a critical eye; generally the intent is to identify the scope, as well as the advantages and disadvantages, of each method.
- The treatment of each method should be extensive enough to enable the reader to grasp the basics of the method without having to go through all the related literature.

Chapter 4 (Examples – case studies)

- Case studies using one or more of the (inelastic) methods addressed in Chapter 3 will be accepted, whereas elastic methods are beyond the scope of the document.
- The issue of whether experimental assessment falls within the scope of this chapter was discussed. It was concluded that this should not be excluded beforehand, but final inclusion of one such example will depend on the scope and quality of the material that will be put forward by the interested TG member(s). The Portuguese team offered to contribute with data from the ISPRA bridge tests.
- M. Fischinger and T. Isakovic have suggested the idea of using the two-span two-column bent reinforced concrete bridge, tested by Saiddi et al. at the UNR as a ‘benchmark’ for (if possible) all inelastic methods. Several TG members expressed their willingness to test their methods on the particular structure, provided that sufficient data will be made available to them by Fischinger and/or Saiidi. In any case, additional case-studies (such as those summarised in the draft of Ch. 3 prepared by Fischinger) were also deemed appropriate for inclusion, provided they fulfil the criteria listed under the first item in this section.
- The format and length of the contributions was discussed. It was suggested that each contribution should be between 8 and 10 pages (including figures and tables), and should describe in adequate detail the structure studied, as well as the most pertinent results and conclusions. Contribution along these lines should be sent to Matej as soon as possible.

Future TG11 activities

- *Membership*: In line with established practice within the EAEE, the membership will stay as it currently stands until the next ECEE (Skopje, 2010). After the ECEE, members that are not active (these are very few) will be replaced by new ones.
- The idea of organizing a *workshop* (as, for instance, has long been done by EAEE TG8) was put forward; no decision was made at this stage.
- *Website*: The TG website will be updated soon with minutes (in the member's area) and photos from the Beijing meeting, further links to PEER reports (including the aforementioned one), and to more papers (for copyrighted material the link will be to the journal page with the abstract etc.), and the experimental data for the benchmark bridge (in the member's area). Members that have not sent yet their profiles were requested to send them immediately to A. Sextos (asextos@civil.auth.gr).

Date and venue of the next meeting

- The proposal for the date and venue of the next meeting that appears to suit most TG members is to have it during the COMPDYN in Rhodes (22-24 June 2009). However, it was noted that Saiidi, Stojadinovic and Fischinger will have to attend a NEES meeting during the same dates. Hence, no decision will be made before these members have the chance to suggest another venue, and the TG members to express their final preference.

Appendix 3

Minutes of the EAEE TG11 3rd meeting in Rhodes, Greece (24-7-2009)

List of Attendees:

TG members: N. Aydinoglou, A. Kappos, P. Delgado, V. Pantazopoulou (2nd part of the meeting), G. Mylonakis (1st part of the meeting), T. Isakovic (on behalf of M. Fischinger), H. Friedl (on behalf of R. Flesch), N. Gerolymos (on behalf of G. Gazetas).

Observers: A. Arede, A. Sextos, I. Moschonas, Th. Paraskeva.

Item 1: Activities report and Membership

The activities report was presented by the TG coordinator A. Kappos; the following issues were reported and discussed:

- **TG Membership:** It was noted that the membership will be reviewed again in 2010, after the ECEE (in Ohrid), and provided that the mandate of the TG will be renewed (which is very likely, given that the TG is currently one of the most active within the EAEE). Idle members will be replaced by new ones that are already involved in the activities of the TG. Herbert Friedl (participating on behalf of TG member R. Flesch) has made a short presentation of the activities of their group (now named Austrian Institute of Technology <http://www.arsenal.ac.at/>).
- **Sp. issue of Bull. Earthquake Engineering:** This was a joint venture of the TG11 and the research programme 'Earthquake Protection of Bridges (ASPROGE)'. The issue appeared in time, as no. 2 of Vol. 7 of the Bulletin; it includes 11 papers plus an editorial, see: <http://springerlink.metapress.com/content/hh15u8tl6326/?p=876dfbb27efd40d6b818511910561280&pi=1>.
- **Website:** The 'Member's area was recently restructured, see: <http://nisida.civil.auth.gr/tg11/Members%20Area.htm>. The general structure of the website was deemed as appropriate and will remain the same, while new items will be included in all pages.

Item 2: Discussion on the document "Inelastic methods for seismic design and assessment of bridges":

Most of the meeting was devoted to the discussion of this document. The coordinator referred to the character of the document, which (as also discussed during the 2nd meeting) is expected to appear first as a report (possibly 'open-file') and subsequently, depending on the quality of the final outcome, as a book to be published by Springer. N. Aydinoglou presented an overview of Chapter 3 (Presentation of available methods), and T. Isakovic an overview of Chapter 4 (Examples – case studies); each presentation was followed by extensive discussion. Chapter 2 was discussed only very briefly, due to lack of time and pending its completion.

The main decisions made with regard to the content of the document are the following:

General aspects

- Profs. Pantazopoulou and Mylonakis noted that they will send their contributions as soon as possible.

- The deadline for producing the first form of the document (the report, ‘open-file’ or otherwise) is the next ECEE (Ohrid, 30 Aug. to 3 Sep. 2010). Hence exchange of e-mails between the chapter drafters, the contributors, and the coordinator will be needed.

Chapter 2 (Modelling of bridges for inelastic analysis)

- Regarding the section dealing with seismic input, it was clarified that the topic refers to both asynchronous excitation and the selection of earthquake ground motion. It was also pointed out that this specific section is currently missing and contributors to the chapter should take care of including it.

Chapter 3 (Presentation of available methods)

- The first complete draft, prepared by N. Aydinoglu, was recognised as an appropriate basis for the chapter.
- An effort shall be made to strike a balance between the description of response history and pushover analysis. It was proposed to expand the description of response history analysis by providing at least the fundamentals of the numerical methods commonly used. It was agreed that this task will be carried out by Aydinoglou, Pinho and Sextos, and that response history analysis should be described at the beginning of the chapter.
- It was agreed that the draft currently includes all nonlinear static analysis methods that are worth including in the document. Nevertheless, T. Isakovic will prepare a short description (1 or 2 pages) of the relevant proposal of Reinhorn and De Rue, to be included in this chapter.
- It was agreed that all inelastic static analysis methods should be treated in (practically) equal depth and that authors should first state clearly the assumptions and simplifications involved, and should also try to include short examples (including figures) of application of their methods.
- Kappos and Paraskeva will revise the description of their method, focussing on the final version of the method rather than its differences from previous versions. The contribution of Cardone to this chapter is not, strictly speaking, describing a method substantially different from those already presented in the previous sections; hence it should be merged with the contribution to Ch. 4 (and be moved there), removing material related to fragility analysis, which, albeit valuable in itself, is not directly relevant to this document.
- *Post-meeting note:* The TG coordinator has spoken (in Corfu, during the ACES workshop) with R. Pinho (member of TG11) and the latter has indicated that he is happy with the way his method is described in the current draft of the document.

Chapter 4 (Examples – case studies)

- The first complete draft, prepared by T. Isakovic and M. Fischinger, was recognised as an appropriate basis for the chapter.
- Although the contributions included so far are sufficient in number and interesting to potential readers, more effort should be spent in evaluating the various methods in the light of the presented case-studies. To this effect, contributors are asked to revise their sections by including quantitative evaluations of the discrepancies between the ‘exact’ results (those from response history analysis) and the predictions of the inelastic static methods used. This quantification should preferably be based on the indices proposed by

Isakovic et al. (Structures and Buildings / Volume SB156 / Issue 02, 2003) and by Pinho et al. (EESD, V. 36:1347–1362, 2007; also see eq. 2 and fig. 2 in the Pinho contribution to Ch. 4). Quantities to be evaluated should include displacements, plastic hinge rotations, and important forces (like pier shears).

- The feasibility was discussed again of using the two-span two-column bent reinforced concrete bridge, tested by Saiidi et al. at the UNR as a ‘benchmark’ for (if possible) all inelastic methods. Several TG members expressed their willingness to test their methods on the particular structure, provided that sufficient data will be made available to them (Isakovic will contact Saiidi to obtain his consent that she distributes the data).
- Time was spent on a proper definition of irregularity in bridges and its effect on the analysis method to be used. It appears that the majority of the group agrees that the most severe type of irregularity involves substantial change of the deformed shape of the bridge when it enters well into the inelastic range of its response, but higher mode effects and mode coupling are also sources of irregularity, especially when torsional sensitivity is present. A short section should be added (at the beginning) of chapter 4 on this important issue. It was also agreed that a table such as that proposed by T. Isakovic, should be added at the end of the chapter (and/or in Ch. 5), wherein the recommended methods (single-mode pushover, multi-mode pushover, or response history analysis) should be related to the degree of irregularity in the bridge.
- Finally, Delgado and Arede have raised the issue of including a case-study wherein different models will be used for response history analysis of an actual bridge (the Warth bridge), and the effect of model type and sophistication will be evaluated. No decision was made on this issue, but the coordinator felt that such work falls well within the scope of the document (Inelastic methods for seismic design and assessment of bridges) and encouraged them to submit a draft of this contribution to Fischinger and Isakovic, perhaps after liaising with Sextos who has analysed the same bridge, hence a joint contribution could be prepared.

Item 3. Future TG11 activities

- Due to lack of time no decision on new activities was made.

Item 4. Date and venue of the next meeting

- Two proposals for the date and venue of the next meeting were put forward: Either within the framework of the next European Conference on Earthquake Engineering in Ohrid (30/10-3/9 2010) or during the 9th US-10th Canadian National Conference on Earthquake Engineering in Toronto (25-29 July 2010). TG11 members are kindly requested to indicate (by e-mail to the coordinator) their preference.

Post-meeting note: Given that the aim is to have the document in the form of a report by Sep. 2010, the possibility of having two meetings next year is also an option, provided that (at least) the coordinator will be able to attend both conferences.

Appendix 4

Minutes of the EAEE TG11 3rd meeting in Toronto, Canada (27-7-2010)

List of Attendees:

TG members: M. Fischinger, A. Kappos, V. Pantazopoulou

Observers: T. Isakovic, A. Sextos, C. Yalcin, O.-S. Kwon, K. Rejec, A. Zerva

Item 1: Overview

A brief presentation of the TG11 activities (mainly for the sake of the observers not familiar with the TG11 activities) and an overview of the document under preparation were presented by the TG coordinator A. Kappos.

- **TG Membership:** It was noted that it is expected that the membership will be renewed in the ECEE (in Ohrid), given that the TG is currently one of the most active within the EAEE). Idle members will be replaced by new ones that are already involved in the activities of the TG and/or have indicated their interest to do so.

Item 2: Discussion of the document “Inelastic methods for seismic design and assessment of bridges”

Most of the meeting was devoted to the discussion of this document. The coordinator referred to the character of the document, and the possibility that it will appear as a book to be published by Springer. V. Pantazopoulou presented an overview of Chapter 2, A. Kappos an overview of Chapter 3, and T. Isakovic an overview of Chapter 4; each presentation was followed by extensive discussion, where valuable comments were received also by some of the observers to the meeting.

The main decisions made with regard to the content of the document are the following:

Chapter 2 (Modelling of bridges for inelastic analysis)

- ACI 341 Committee report dealing with Performance-Based design of Bridges is quite relevant to the TG11 report and as such, it should be taken into account or at least be cited appropriately; Pantazopoulou will circulate a copy of this document.
- It was decided to remove section 2f (initially planned to be prepared by G. Mylonakis and C. Nuti) because it is difficult to discuss this very broad subject in a few paragraphs. A. Sextos agreed to add a short reference at the beginning of section 2e related to SSI etc. noting the importance of ground motion and that extensive discussion on the issue is beyond the scope of this document.
- It was decided to change “time history” to “response history” throughout the document.
- It should be mentioned (section 2d) that in EC8-2 it is not required to consider cracked sections for the piers.
- T. Isakovic agreed to rephrase the statement that “high damping rubber bearings have constant damping” (p. 20) and send it to Saiidi and Cardone for their information.

Chapter 3 (Presentation of available methods)

- The only missing information is the part related to NLRHA.
Post-meeting note: A first complete draft of Section 3.2 has been sent by R. Pinho shortly after the Toronto meeting and will be circulated together with this memo for comments.
- The issue of the definition of the initial period of the bridge was extensively discussed. A. Kappos agreed to expand pages 4-5 with two comments related to the calculation of the initial period and the fact that the inelastic spectra have been derived for bi-linear behaviour whereas the bridge response is typically multi-linear.

Chapter 4 (Examples – case studies)

- T. Isakovic proposed some modifications related to the critical evaluation of the effectiveness of the various non-linear static methods to be made and sent to Rui Pinho.
Post-meeting note: action has now been completed; R. Pinho kindly agreed with the suggestion made during the meeting.

Following a proposal by the Coordinator, the TG decided to implement a peer reviewing system to the document before it becomes a book; several names of distinguished colleagues, not members of TG11, have been put forward in this respect (P. Fajfar, P. Pinto, A. Reinhorn), and will be contacted by Kappos in due course.

Item 3. Future TG11 activities

- Due to lack of time no decision on new activities was made. A new Action Plan for TG11 will be presented by the Coordinator during the first meeting of the TG after the ECEE, provided its mandate will be renewed by the EAEE Ex. Committee (as anticipated).

Item 4. Date and venue of the next meeting

- Next Task Group meeting was already arranged to take place during the forthcoming European Conference on Earthquake Engineering in Ohrid (30/10-3/9 2010); the meeting will take place on Tues. 31/9/2010 and will be mainly in the form of a sp. session (<http://www.14ecee.mk/#>), where the main chapters of the document will be presented by Saiidi, Isakovic, and Kappos.