“INNOSEIS”

Title: **INNOSEIS – Valorization of innovative anti-seismic devices and systems**
Fund: Research Fund for Coal and Steel (RFSR-AM-2015-709434)
Partners: National Technical University of Athens (NTUA), Universitatea Politehnica Timisoara (UPT), Politecnico di Milano (POLIMI), Universita Degli Studi di Napoli Federico II (UNINA), Universita di Pisa (UNIPI), Rheinisch-Westfaelische Technische Hochschule Aachen (RWTH), Instituto Superior Tecnico (IST), Universitet po Architektura Stroitelstvo i Geodezija (UACEG), Universiteit Hasselt (UHasselt), Maurer Sohne Engineering GmbH & CO KG (MSE), Convention Europeenne de la Construction Metallique ASBL (ECCS)
Coordinator: Professor I. Vayas (NTUA Athens)
Research group: D. Vamvatsikos, P. Thanopoulos, P. Tsarpalis, K. Bakalis
Duration: 01/07/16 - 31/12/17
Budget: 995.660,35€

Fig. 1: 450 pages Volume with information documents

Summary

In the frame of the INNOSEIS project valorization actions for 12 innovative anti-seismic systems and devices were undertaken. Information documents combined into one 450 pages Volume were produced for dissemination to all partners of the construction sector. Criteria were set on which it may be decided which of the devices are subject to CE marking in accordance with EN 15129 and which may be considered as innovative systems that require a code approval in EN 1998-1. For the latter pre-normative design recommendations were drafted that allow them to receive the status of code-approved systems. A reliability based methodological procedure to define values of behavior factors (q-factors) for building structures was established. Case studies with application examples in which the devices are employed were worked out. The case studies refer to new single-story steel buildings, new multi-story steel buildings and to interventions for seismic upgrading of existing buildings. Seminars and Workshops were organized in large parts of Europe and in non-European Mediterranean high seismicity countries to promote technologies and codes developed in Europe. A web site (http://innoseis.ntua.gr/) with free access to the users was created and promoted to practice.

Publications

Conferences:

1. Tsarpalis P., Vayas I., Thanopoulos P. (2017). FUSEIS pin links: Information brochures and design of case study. Proceedings of the COMPDYN2017 Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
2. Bakalis K., Vamvatsikos D., Pyrza S. (2017). Q-factor verification of a 3-storey concentrically braced frame via the INNOSEIS risk-based approach. Proceedings of the 9th Hellenic National Conference on Steel Structures, Larisa, Greece.
3. Vamvatsikos D., Bakalis K., Pyrza S. (2017). Q-factor verification of a 6-storey concentrically braced frame via the INNOSEIS risk-based approach. Proceedings of the COMPDYN2017 Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
4. Vamvatsikos D., Bakalis K., Vayas I., Castiglioni C., Kanyilmaz A., Morelli F., Stratan A., D' Aniello M., Calado L., Proenca J.M., Degee H., Hoffmeister B., Pinkawa M. (2017). The INNOSEIS approach on determining EN1998-compatible behavior factors for introducing new steel lateral load resisting systems. Proceedings of the 9th Hellenic National Conference on Steel Structures, Larisa, Greece.
5. Vamvatsikos D., Castiglioni C., Bakalis K., Calado L., D' Aniello M., Degee H., Hoffmeister B., Pinkawa M., Proenca J.M., Kanyilmaz A., Morelli F., Stratan A., Vayas I. (2017). A risk-consistent approach to determine behavior factors for innovative steel lateral load resisting systems. Proceedings of the EUROSTEEL 2017 Conference, Copenhagen, Denmark.
6. Vayas I., Vamvatsikos D., Thanopoulos P. (2017). Innovative systems for seismic resistance: The INNOSEIS project. Proceedings of the EUROSTEEL 2017 Conference, Copenhagen, Denmark.

Workshops and seminars

Country	Place	Event	Website
Greece	Larissa	9th Conference of Steel Structures	eeme.ntua.gr/9HNCSS/en/index.html
Belgium	Luxemburg	Journée Construction Acier 2017	www.infosteel.be/fr/events/journee-construction-acier/3165-journee-construction-acier-2017.html
Bulgaria	Sofia	75th Jubilee of UACEG	conference2017.uacg.bg/en/
Germany	Aachen	Symposium "Auslegung von Stahlbauten in Erdbebengebieten"	www.xing.com/events/auslegung-stahlbauten-erdbebengebieten-1880600
Italy	Pistoia	XVII ANIDIS Conference	http://convegno.anidis.it/index.php/anidis/2017
Romania	Iasi	15th National conference of Steel Structures	www.conmet15.ci.tuiasi.ro/en/
Portugal	Lisbon	PROHITECH Conference	www.prohitech2017.com/

Workshops and seminars

Country	Place	Event	Website
Cyprus	Nicosia		
Denmark	Copenhagen	EUROSTEEL 2017	www.eurosteel2017.dk/
Turkey	Istanbul		
Moldavia	Chisinau		
Greece	Rhodes	COMPDYN 2017	2017.compdyn.org/

List of innovative anti-seismic systems and devices

In total 12 innovative systems and devices were examined. The main characteristic of these systems is that when the design earthquake occurs only some small parts of the systems will enter the plastic zone, while the rest of the structure will remain elastic. These innovative systems and devices are listed below:

1. INERD pin connection
2. INERD U connection
3. FUSEIS beam link
4. FUSEIS pin link
5. FUSEIS bolted beam splice
6. FUSEIS welded beam splice
7. DUAREM replaceable bolted link
8. DUAREM replaceable shear panel
9. CBF with modified braces
10. SSCD Steel self-centring device
11. TRSH Triangle steel hysteretic device
12. MSSH Moon-shaped steel hysteretic device

Analytical investigations - Objectives

- Production of informative design-oriented documents (in the form of one single Volume) in several languages and dissemination of the material, printed or electronic, to Architects, Engineers, construction companies, students and other partners of the construction sector.
- Development of a reliability-based methodological procedure to define values of behaviour factors “q”.
- Borders of application between two important European Codes, EN 1998 “Design of structures for earthquake resistance” and EN 15129 “Anti-seismic devices”.
- Preparation of case studies with application examples for buildings.
- Organization of 12 workshops and seminars within and outside Europe.
- The creation of a website where all information regarding the project as well as the documents produced are available for everyone.

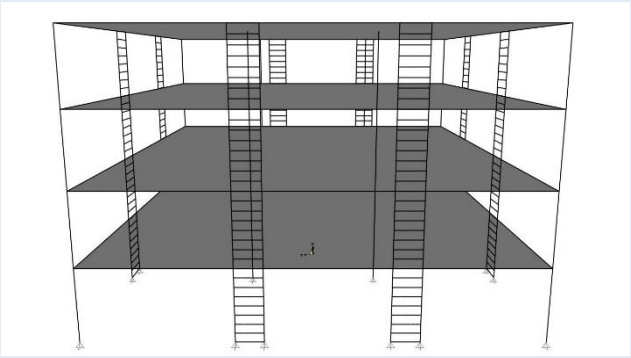


Fig. 2: Case studies with application examples on new steel buildings

- λ(LS) < **10%**/50years → q-factor ✓
- λ(GC) < **1%** - **2%**/50years → q-factor ✓

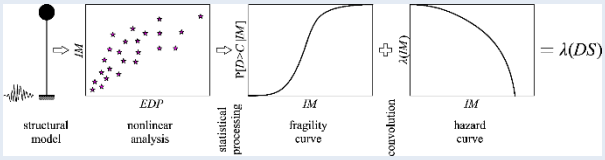
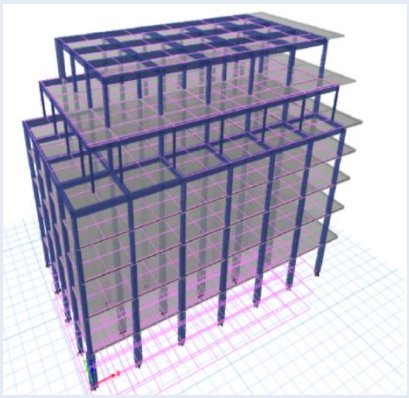


Fig. 3: INNOSEIS methodology to define values of behaviour factors



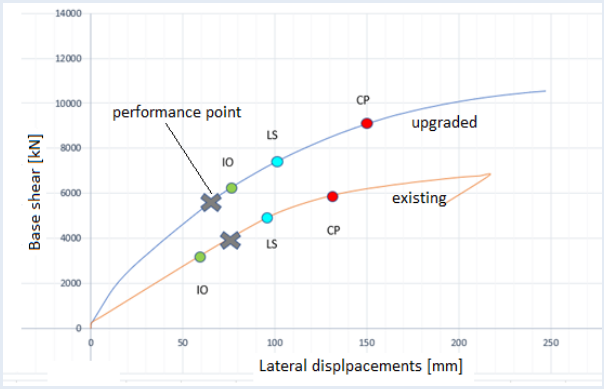
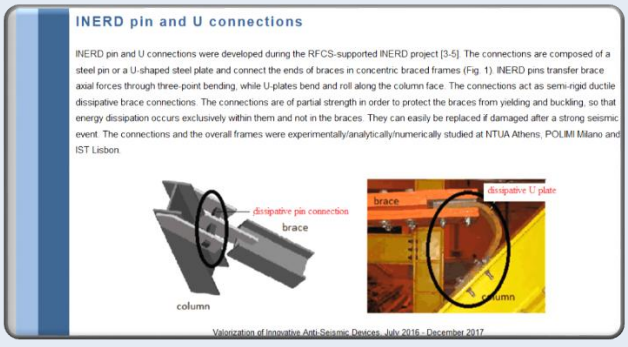


Fig. 4: Case studies with application examples on existing reinforced concrete buildings



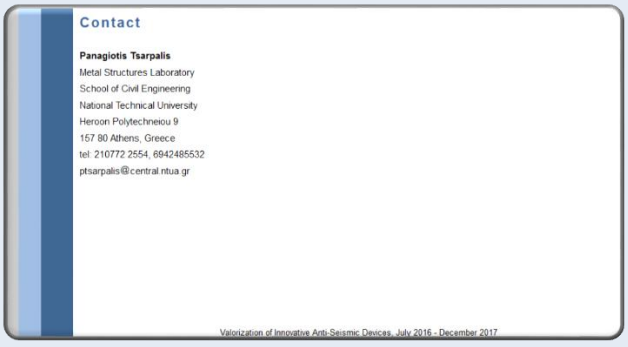


Fig. 5: Creation of a website with all information and documents available

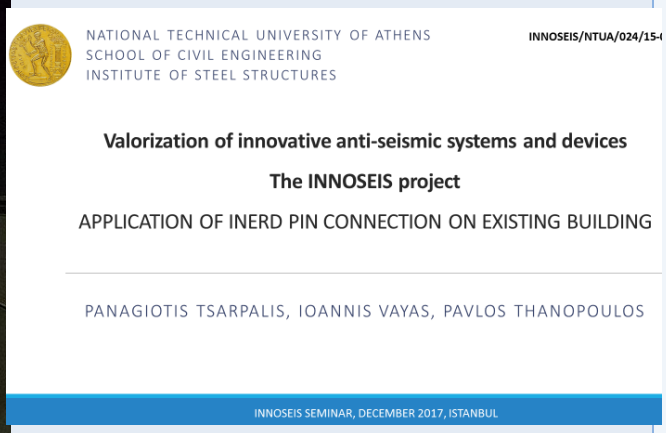


Fig. 6: Organization of 12 workshops and seminars within and outside Europe.