Proposal for EAEE WG 14
Open Research Data in Seismic Engineering

1 Introduction

The safety of European citizens in the event of an earthquake depends on the continuous improvement of design codes, the quality of the training of engineers and innovations in the construction sector. Laboratory and field data provide key evidence on the seismic performance of systems. Our objective is to better preserve, document and share experimental data in order to maximize its impact to the better of the society. The objective of this WG 14 is to put forward initiatives that support the transition to open experimental research data (OERD) in seismic engineering within Europe. This concerns in particular two aspects:

- Goal 1: The continuous development of a platform for OERD in seismic engineering for Europe including services and tools for data providers, for the continuous development of design and assessment codes, for the professional community and for city science projects.
- Goals 2: Implement actions that promote and support the adoption of an OERD culture within the seismic engineering community in Europe.

2 Preparatory work

To prepare this WG, one preliminary meeting was held and a white paper prepared:

1) Meeting in Rome, November 26 2019 “EAEE Explorative Workshop on Open Experimental Data”

The objective of this workshop was to unite key actors related to seismic engineering testing within Europe. In addition, Ellen Rathje attended parts of the meeting remotely, who leads the US platform DesignSafe. The minutes of this meeting are attached to this proposal [1].

2) White paper “A European Vision for Open Experimental Research Data in Earthquake Engineering”

The objective of this white paper is to introduce a vision for a European platform for ORD in seismic engineering. The white paper is attached to this proposal [2].

3 Tasks of WG 14

3.1 Goal 1: The continuous development of a platform for OERD in seismic engineering for Europe

3.1.1 Actions related to Goal 1 are the following:

- Support the president of the EAEE in fund raising activities for this goal.
- Develop actions compatible that are compatible with the financial support obtained and pursue the goals outlined in the white paper.

3.1.2 Status quo of OERD in earthquake engineering in Europe and lessons learnt from past initiatives

Laboratory and field data on the performance of structural and geotechnical systems is scarce. Large-scale experiments are expensive and require significant expertise. Field data has not been systematically recorded and archived in the past and only few buildings have been instrumented. In Europe, a group of universities and research institutions with advanced research facilities has been supported through a number of EU Framework Programmes for Research and Innovation (recent examples are SERIES[1] as part of FP7, SERA[2] as part of Horizon 2020) to develop networking, research and transnational access activities of the European research infrastructures in earthquake engineering. In addition, several of Europe's leading universities have large-scale laboratories that perform high-quality experimental programs that are also supported by national funding agencies. Together, these facilities have produced a wealth of experimental data that is not yet fully exploited.

Within the scope of SERIES and SERA, a data portal was developed and updated for sharing the experimental data produced within these programs. While there is a unique access portal, the data is stored locally on servers of the research facilities that produced the data. Italy, as part of its national research program RELUIS, developed a national portal for data storage and sharing. Individual labs are sharing their data through general-purpose portals such as Zenodo[3], which was developed as part of the European OpenAIRE project.

From these past and ongoing initiatives as well as the experience of our colleagues in the US we have identified the following lessons and reasons for a future initiative:

3.1.3 Architecture of the data storage

- The long-term availability of data sets its key. While the distributed architecture of the data storage might be advantageous from a political point of view and for reasons of data ownership, it is difficult to maintain in the long run. For example several of the servers installed during the SERIES project were shut down after the end of the SERIES project. The data sets stored on these servers could therefore no longer be accessed.
- The technical solutions that are available today have advanced significantly during the last 10 years, in particular thanks to the development of cloud services. It seems therefore not advisable to continue building on a system that was designed with the technical constraints that existed ten years ago (the development of the SERIES system started in 2009 in the SERA project, the SERIES system was significantly improved).
- The architecture of the data storage system should be such that it is very easy for a data provider to upload data. The data storage system ideally should be open to all data providers, and not only to those funded within a specific European research program. Past initiatives were not always successful because it was difficult or cumbersome to upload data and because usage was effectively limited to data providers of a specific European research program (SERIES, SERA). As a result, only few data sets were shared through the portal and the usage of the portal was minimum and far below the expectations. A data portal is considered successful if it is openly accessible to everyone (respecting certain rules) and has a large data user group. It is

[1] http://www.series.upatras.gr/
[2] http://www.sera-eu.org, https://sera-ta.eucentre.it/
[3] https://zenodo.org/

assumed that this can be achieved if also the data provider group is large, i.e., if many research groups share their data through the portal.

3.1.4 Data sets

- Data sets must be assigned a digital object identifier (DOI). Data sets without digital object identifiers cannot be cited easily and cannot be the basis of data papers in scientific journals. This is a key point in order to credit the producers of OERD and recognise OERD as a valuable research output that is considered when evaluating the performance of a researcher according to the DORA convention[4]. The current data platforms by SERIES and SERA do not assign DOIs to the data sets.
- Many domain-specific repositories in seismic engineering (in particular NEEES hub but also SERIES) were not very successful because very restrictive data structures and naming conventions were prescribed for the data sets. This required considerable effort by the data providers, who eventually uploaded only the data required by the funding agency.
- The currently most advanced and most successful domain specific data hub in seismic engineering is the DesignSafeCI[5] portal, which leaves significant freedom to the data provider to structure the data set, to choose the naming convention, and to define other parameters such as embargo periods. This has the advantage that data sets do not need to be restructured if the data provider needs to also comply with another set of rules (e.g. institutional rules). Freedom to define embargo periods until the data set is freely available to other users reduces the aversion against data sharing and ensures that data providers can be the first to exploit the data set. This is considered important to protect in particular the interests of early career researchers that contributed to the OERD.
- The new repository should be in agreement with the rules for Open Access Repositories according to Plan S[6].

3.2 Goal 2: Creating a culture for OERD

To make OERD a widely adopted practice among researchers in Europe, a culture change should be initiated and supported through further actions and incentives. The EAEE could play a key role in this cultural change. Possible actions are the following:

- Share and advertise the European vision for OERD in the Bulletin of Earthquake Engineering (BEE) and through the EAEE to all National Earthquake Associations.
- Consider the explicit introduction of data papers in the BEE in the format of the data papers in Earthquake Spectra or the Data in Brief in Elsevier.
- Consider organizing regular blind-prediction competitions by the EAEE (e.g. once a year, changing topics between the years). These could be addressed to students, professionals and also the research community.
- Consider organizing special sessions on experimental data as part of the ECEE. Session topics could be:
    - Blind prediction competitions (several blind prediction competitions are carried out within Sera projects; the successful ones could be given a special platform within the next ECEE);
    - Session dedicated to best practices with regard to OERD: This could cover re-uses of data sets and testimonials of researchers who reused the data sets;

[4] https://sfdora.org/
[5] https://www.designsafe-ci.org/
[6] https://www.coalition-s.org/principles-and-implementation/

efforts invested in visualization of experimental data; studies on the impact of OERD, panel discussions, ….

4 References

[1] Beyer K, Pitilakis K (2019) Minutes of the "EAEE Explorative Workshop on Open Experimental Data" held on November 26, 2019, Rome, Italy.

[2] Beyer K et al. (2020) White paper "A European Vision for Open Experimental Research Data in Earthquake Engineering", Version May 19, 2020.

5 WG 14 members (not yet confirmed)

5.1 Members

1. Katrin Beyer, katrin.beyer@epfl.ch, EPFL, Switzerland, WG coordinator
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5.2 Corresponding members

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5.3 International advisor

1. Ellen Rathje, e.rathje@mail.utexas.edu, University of Texas, USA

EAEE Explorative Workshop on Open Experimental Data

Tuesday, November 26, 2019 in Rome
Venue: Premises of the National Council of Engineers, Room Musmeci (3rd floor).
Address: Via XX Settembre, 5, 00187 Roma, Italy
Time: 10:00-16:00

Attendance:

Kyriazis Pitilakis, Andrea Prota, Claudio Moroni, Mauro Dolce, Georgios Tsionis, Alberto Pavese, Zoran Rakicevic, Dimitris Pitilakis, Antonio Correia, Evelyne Foerster, Stathis Bousias, Katrin Beyer

Per video conference: Anastasios Sextos, Ellen Rathje (partially)

Distribution of the minutes to: participants, Gopal Madabhushi, Andreas Kappos

Agenda:

10:00 Welcome and short introduction (see attached presentation)

10:15 Presentations on ongoing initiatives: Focus on lessons learnt and recommendations for EAEE initiative

- Georgios Tsionis: SERIES/SERA
- Stathis Bousias: SERIES/SERA
- Andrea Prota, Claudio Moroni: Reluis
- Ellen Rathje: DesignSafeCI (recorded)

11:30 Discussion on scope and challenges

13:00 Lunch

14:00 Discussion with Ellen Rathje

14:40 Discussion on whether/how to proceed + Conclusions

16:00 End

Summary of the results of the discussion:

The following conclusions are agreed upon:

- The participants of the EAEE exploratory workshop on open experimental data as assembled in Rome, representing major experimental large scale facilities in Europe, unanimously agreed that they will continue pursuing together the vision of a European portal for open experimental data in earthquake engineering.
- It was also agreed that to proceed it should be necessary to establish a proper common working environment and for this an adequate funding from EU is deemed the most appropriate process.

- The next steps should comprise two actions:
  - Drafting a vision document to be submitted to the European Commission (see below) aiming to convincingly argue on the necessity of the open portal and the quest for potential support and financing through appropriate European funding instruments;
  - Reflecting on how a culture towards Open Experimental Research Data can be fostered. An EAEE working group in this regard could be considered. All participants in the workshop agreed to support this activity.

Vision document for Brussels

It is agreed that 5 participants (Antonio Correia, Dimitrios Pitilakis, Georgios Tsionis, Anastasios Sextos, Katrin Beyer – lead) draft a 1-2 page vision conceptual document for a European multi purpose portal for open experimental data. The vision document should focus on the scope of portal and not on technicalities. It can be assumed that a technical implementation can be found, given in particular also the increase of cloud-based services, which are required when dealing with very large data sets. The aim of this vision document is to argue on the necessity of launching and funding this activity and portal to valorize and maximize the impact of the experimental data from various past and future research projects and activities at European and national level.

The pitch should be relatively wide, highlighting, among others, the following points

- the value of OERD to the research community;
- the value of reusing OERD for the professional community for continuing education and capacity building;
- the value of OERD for the continuous upgrade of the European codes
- the impact of OERD on reducing seismic risk and therefore its role in creating a resilient society;
- the need of different tools for different uses. In addition to tools for research purposes, the European portal should also have functionalities / services for the professional community. Also the larger public (outreach activities, citizen science) should be considered.
- Reference should also be made to the existing European Union Open Data Portal (EU ODP, https://data.europa.eu/euodp/en/home).

The draft of the vision document, which is envisaged to be drafted within a period of 2-3 weeks, should then be discussed by the entire working group (i.e. participants of the present workshop) and be finalized. In a next step, it should be considered how this document can be taken forward in order to lobby in Brussels for a corresponding call or other funding instruments. This step will be coordinated by Kyriazis Pitilakis.

Working towards an Open Experimental Research Data Culture in Europe

Adoption of an Open Experimental Research Data (OERD) Culture in Europe will depend on the corresponding services that are made available, the demonstration of what is possible through exemplary cases and a general awareness of the value of OERD.

While the exploratory work towards European portal for OERD is under way, it is already possible to start working with concrete actions on exemplary cases of OERD using the existing data portals of Series/Sera/Reluis, general purpose data portals such as Zenodo or for exploratory studies also DesignSafeCI. Participants in the workshop coordinating the

Series/Sera and Reluis portals agreed to actively contribute. In addition, actions should be designed that highlight the value of OERD to the research and professional community.

First ideas for actions that highlight the value of OERD were in a non-systematic way collected during the workshop. This work should be continued in a more systematic way, possibly through a sub-group of the working group that met in Rome, possibly adding further members who might be essential for the implementation of actions. First ideas that were mentioned in the workshop are the following

- Consider explicit introduction and advertisement of this activity (and vision) and the outmost importance of a European portal on Open Experimental Data in the Bulletin of Earthquake Engineering (BEE) and through EAEE to all National Earthquake Associations.
- Consider the explicit introduction of data papers in the BEE in the format of the data papers in Earthquake Spectra or the Data in Brief in Elsevier.
- Consider organizing regular blind-prediction competitions by the EAEE (e.g. once a year, changing topics between the years). These could be addressed to students, professionals and also the research community.
- Erasmus+ Knowledge Alliance: Deadline Feb 26, 2020. If someone is ready to champion such a proposal, it could be used to establish exemplary cases of OERD, share best practices and develop in particular tools of exploiting OERD such that it is useful for industry (e.g. for continuing education, validation of modelling approaches used by industry, …). https://eacea.ec.europa.eu/erasmus-plus/funding/knowledge-alliances-2020_en Note: Switzerland is not part of Erasmus+; KB can therefore not lead this proposal but is happy to support (Switzerland can join as partner country).
- Consider organizing special sessions on experimental data as part of the ECEE. Session topics could be:
    - Blind prediction competitions (several blind prediction competitions are carried out within Sera projects; the successful ones could be given a special platform within the next ECEE);
    - Session dedicated to best practices with regard to OERD: This could cover re-uses of data sets and testimonials of such the researchers who reused the data sets; efforts invested in visualization of experimental data; studies on the impact of OERD, panel discussions, ….

Thank you:

The participants thank Andrea Prota and Mauro Dolce for organizing the meeting venue, which was perfectly set up for the video conference, and for sponsoring the lunch.

A European Vision for Open Experimental Research Data in Earthquake Engineering

An initiative by the European Association of Earthquake Engineering

http://www.eaee.org/

The safety of European citizens in the event of an earthquake depends on the continuous improvement of design codes, the quality of the training of engineers and innovations in the construction sector. Laboratory and field data provide key evidence on the seismic performance of systems. In this white paper we outline the need for conservation and sharing of research data from large-scale laboratory experiments simulating the seismic performance of buildings, infrastructure, and their components as well as of data collected after earthquakes from the field and from instrumented buildings. We identify the value of open experimental research data (OERD) for the research community, the professional community and the society as a whole in the endeavour of striving towards a more resilient society and highlight the achievements of the programs FP7 SERIES and H2020 SERA.

We outline our vision for a continuous development of these endeavours in order to maximize their impact to the better of the society and to increase the knowhow and competitiveness of the European construction sector at the international level. This requires new initiatives with regard to homogenisation and long-term preservation of open experimental research data and accompanying services for data providers and data users from research and industry. It further aims at developing tools supporting the continuous development of design and assessment codes and information for the general public including space for citizen science projects.

Table of Contents:

May 19, 2020; Katrin Beyer

1 Why is OERD important?

OERD is important

… for the society as a whole. OERD is an important element in the scientific endeavour to increase the safety of citizens reduce the seismic risk and improve the seismic resilience of the society in the case of earthquakes and other natural hazards. Earthquakes affect large regions across Europe, claiming hundreds of victims and causing significant economic losses. Recorded damages due to the earthquake disasters for which the EU Solidarity Fund intervened in the last two decades reached almost 50.000 million Euros[1]. Open access to data and services tailored to the needs of national, regional and local operators, supports risk assessment and mitigation activities, and ultimately helps achieving the objectives of the Sendai Framework for disaster risk reduction, and the Sustainable Development Goal for safe and resilient cities. OERD also supports communication with the general public as it can illustrate the improvements achieved by engineering research and the continuous development of codes, as an example of a common European effort.

… for the research community. Researchers in civil engineering of any profile need high-quality experimental data: Researchers who carry out experimental research themselves require data by others to learn from past testing campaigns best practices and to complement their own experimental data. Researchers developing new numerical simulation tools need experimental data for the calibration and validation of their models. Hence, the quality of the research of the entire community stands and falls with experimental research data that is openly available to all.

… for universities and research centres. OERD increases the international visibility of universities and research centres as well as the impact of their research on the society. OERD helps the universities and research centres in preserving their research output and ensuring that research results are reproducible.

… for the construction sector. The construction sector depends on highly trained engineers and the know-how represented in design codes and design practices. In addition, open access to experimental data can facilitate and accelerate innovation in the construction practice and serve as catalyst for collaborations between researchers and industry. This might lead to new solutions for the construction practice that are safer, cheaper or have a smaller environmental footprint. Innovative companies of the construction sector might also want to share own experimental data to provide scientific support for their products.

… **for the continuous development of design standards in Europe**. OERD is a key element for the continuous and transparent development of the European design standards (EN standards for the design of structures[2]) that are among the most scientifically advanced in the world. It serves for benchmarking the performance of new design approaches and equations that are introduced in the code. OERD-based validation of European design will support the application of the European design standards within and beyond Europe.

… for the training of engineers. Up-to-date standards and highly-skilled professionals underpin the competitiveness of the European construction industry in the internal and global markets.

[1] https://ec.europa.eu/regional_policy/sources/thefunds/doc/interventions_since_2002.pdf
[2] https://eurocodes.jrc.ec.europa.eu

2 The EAEE initiative on OERD

Why now? For the following reasons, this initiative is put forward now:

1) There is a general movement towards Open Science in Europe (regarding for instance Findable, Accessible, Interoperable and Re-usable (FAIR) data, the European Open Science Cloud and the future of scholarly communication) and worldwide. Sharing of experimental data will become therefore the norm and not the exception.
2) Cloud and edge storage and computing services are more and more easily available. Such services have largely simplified the sharing and processing of experimental data
3) One testing campaign may serve many research groups and professional engineers. The increasingly extensive use of optical measurement techniques in structural engineering leads to very large data sets that can be exploited to answer a larger range of research questions than past tests and serve for the validation of many numerical modelling approaches.

Why the EAEE? The EAEE is the European organisation that brings together researchers, practitioners and national organisations that are committed to the advancement of earthquake engineering and the improvement of the seismic resilience of our society. Our members work in engineering practice, contribute to the development of national, European and international design and assessment codes and advise governments on strategies for reducing the seismic risk. EAEE, therefore, unites all of the stakeholders whose work relies on OERD in earthquake engineering. This white paper is the result of an in depth consultation process with operators of large European research infrastructure in the field of earthquake engineering.

3 Status quo of OERD in earthquake engineering in Europe and goals of future activities

The EU Framework Programmes for Research and Innovation provided significant support to European research infrastructures in the domain of earthquake engineering. With unique capabilities at world level, these highly specialised infrastructures have produced a wealth of data which, at the support of the FP7 SERIES project[3] succeeded in making openly accessible via a online platform[4]. This domain-specific database, along with a similar one in the US[5], offer freely-accessible earthquake engineering experimental data. In addition, several of Europe's leading universities have large-scale laboratories that perform high-quality experimental programs. Individual labs are sharing their data through general-purpose portals such as Zenodo[6], which was developed as part of the European OpenAIRE project.

The European domain-specific platform developed as part of the FP7 SERIES project was successively upgraded during the H2020 SERA project. The most important enhancements included its compatibility to the CERIF (Common European Research Information Format) metadata catalogue and the development and preliminary verification of its interoperability to EPOS (European Plate Observing System) platform[7].This activity is discontinued upon completion of the aforementioned projects, abolishing the availability and enrichment of this, unique at the European level, data platform and hampering its further exploitation. Maintenance, enrichment and long-term availability of the experimental data and services will

[3] http://www.series.upatras.gr
[4] www.dap.series.upatras.gr
[5] https://www.designsafe-ci.org/
[6] https://zenodo.org/
[7] http://www.epos-ip.org

be essential to attain a large impact in order to increase resilience in the built environment visibility of European research at world level and, finally, better use of the investment so far. To that end, a coordinated activity is needed, aiming at:

- Maintaining in the long term and expanding the open-experimental-data service provided by the European earthquake engineering research infrastructures, fulfilling the requirements for Open Access Repositories according to Plan S[8]..
- The OERD infrastructure should have a modern, open-source architecture, offer a long-term preservation service of the data for 30 years after the end of the project.
- The OERD infrastructure should be of use to a large range of stakeholders to maximise its impact: the research community, the professional and academic community, and for society as a whole. Support and tools should be provided to all user groups.
- The OERD infrastructure should guarantee open access of data.
- To make OERD a widely adopted practice among researchers, the culture change should be supported through further actions and incentives.

4 Our vision of a European Program for Open Experimental Research Data in Earthquake Engineering

Our vision is to continue developing the existing OERD infrastructure, adding to the data platform services and tools that promote OERD and make OERD in earthquake engineering available and useful to the researchers, practising engineers, construction industry and the general public. We aim to support the culture of OERD in the European research community of Earthquake Engineering through (i) continue building an infrastructure that enables sharing of OERD, (ii) operating services and offering tools that build on this infrastructure and through (iii) creating a culture of OERD within the Earthquake Engineering Community in Europe and internationally. These three components of our vision are described in the following.

4.1 Infrastructure

We aim to develop an infrastructure that allows

- **to store OERD**. The maximum allowable size of the data sets should consider that the extensive use of optical measurement systems leads to very large data sets (up to a few TB per test unit), which exceed the maximum allowable size of general purpose data sharing platforms such as Zenodo.
- **to curate OERD**. OERD in seismic engineering is often used over decades. The data needs therefore to be curated in the long term and the integrity and readability of files needs to be regularly checked and file formats translated to the latest file formats.
- **to visualise OERD**. To promote the reuse of data sets, in particular complex 4D data sets from optical measurements, tools for the visualisation of data sets that allow exploration of the data sets without large time investments by the potential users, should be developed and made available within the infrastructure.

[8] https://www.coalition-s.org/principles-and-implementation/

- **to combine OERD with cloud computing services**. Our vision is to design a system that follows the “code to data” maxime. A first set of more specific requirements and use cases were established through an online poll among potential users[9].

4.2 Services and tools for various user groups

Services and tools for data providers: The infrastructure should be accompanied by services which ensure a continuous availability of the infrastructure, sure long-term preservation of data and provide support to data providers and data users. All data sets that are uploaded should follow the FAIR data principles[10] and should be identified through DOIs.

Services and tools for the continuous development of design and assessment standards: To accelerate the improvement of seismic design and assessment codes, the data portal should contain a dedicated space with curated data sets that are continuously amended as more experimental data becomes available. These data sets serve as basis for the continuous development of European design standards.

Services and tools for the professional community: The portal space for the professional community could contain, for example, well-documented examples of tests on structural components and model buildings that are recommended for the validation of numerical simulation tools. These examples should be tests that have been successfully reproduced by the research community. The use of the platform could be extended beyond OERD and also serve as hub for sharing recorded lectures, e.g. lectures organized by the EAEE for the continuous professional development of structural engineers.

Services and tools for the larger public, including citizen science: The portal space for the larger public could contain, for example, videos explaining what researchers do to improve the seismic resilience of societies, videos explaining exemplary research projects as well as a space for citizen science projects such as space for uploading of photos after seismic events documenting the damage and construction practice in regions affected by earthquakes.

4.3 Creating a culture for OERD

To make OERD a widely adopted practice among researchers, a culture change should be initiated and supported through further actions and incentives. The EAEE could play a key role in this cultural change. Possible actions include the promotion of OERD through special sessions to the European Conference for Earthquake Engineering, which is one of the largest conferences in the field, and the organisation of blind-prediction competitions of up-coming large-scale tests for students, professional and the research community.

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[9] Caverzan, A; Sintoris, C; Tsionis, G; Pegon, P; Bousias, S; Atakan, K; Avouris, N; Athanasopoulou, A; Molina, J F; Ntourmas, A, *Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures*, EUR 29754 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-03971-6, doi: 10.2760/379157, JRC116612

[10] https://www.go-fair.org/fair-principles/