D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures

<table>
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<tr>
<th>Work package</th>
<th>WP6 (NA4: Networking experimental seismic engineering databases (SERIES))</th>
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<tr>
<td>Lead</td>
<td>Joint Research Centre (JRC)</td>
</tr>
<tr>
<td>Authors</td>
<td>Alessio CAVERZAN (JRC)</td>
</tr>
<tr>
<td></td>
<td>Christos SINTORIS (UPAT)</td>
</tr>
<tr>
<td></td>
<td>Georgios TSIONIS (JRC)</td>
</tr>
<tr>
<td></td>
<td>Pierre PEGON (JRC)</td>
</tr>
<tr>
<td></td>
<td>Stathis BOUSIAS (UPAT)</td>
</tr>
<tr>
<td></td>
<td>Kuvvet ATAKAN (UiB)</td>
</tr>
<tr>
<td></td>
<td>Nikolaos AVOURIS (UPAT)</td>
</tr>
<tr>
<td></td>
<td>Adamantia ATHANASPOULO (JRC)</td>
</tr>
<tr>
<td></td>
<td>Javier Francisco MOLINA (JRC)</td>
</tr>
<tr>
<td></td>
<td>Anastasios NTOURMAS (UPAT)</td>
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Summary

This deliverable is written within the framework of the project “Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe – SERA” (Project no: 730900), funded by the Horison2020, INFRAIA-01-2016-2017 Programme. Main objective of this deliverable is to identify a roadmap for integrating the SERIES databases in the existing EPOS service as a new Thematic Core Service (TCS) and exploring possible interoperability with other TCSs (e.g. Seismology) and with international partners.
1 Integrated data banks and services for seismic risk reduction

A number of European research projects (NERA (Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation), SERIES1 (Seismic Engineering Research Infrastructures for European Synergies), SHARE2 (Seismic Hazard Harmonization in Europe), SYNER-G (Systemic Seismic Vulnerability and Risk Analysis and Risk Analysis for Buildings, Lifeline Networks and and for Buildings, Lifeline Networks and Infrastructures Safety Gain), etc.) in the fields of seismology and earthquake engineering have produced large amounts of data and related services with the scope of developing new approaches for seismic risk reduction. The SERIES project represents the most significant effort in Europe towards the interoperability of earthquake engineering experimental data (Lamata Martinez I. , Ioannidis, Pegon, Williams, & Blakeborough, 2014) (Lamata Martinez I. , Ioannidis, Fidas, Williams, & Pegon, 2015), while two European organisations, namely ORFEUS3 (Observatories and Research Facilities for European Seismology) and EMSC4 (European Mediterranean Seismological Centre), have been collecting and sharing seismological data. In the field of solid Earth science, the ambition of EPOS (European Plate Observing System) is to set up a virtual environment, which federates the handling of research data and services by existing scientific data infrastructures and provides a one-stop-shop for seamless access to services supporting the research community along the data life cycle. This objective is in line with the European Open Science Cloud (EOSC)5 which reflects the willingness to “embrace change, try new things and be willing to take risks to keep European research and innovation at the forefront of modernity and economic growth” (Schouppe & Burgelman, 2018).

Nevertheless, the two adjacent scientific disciplines of earthquake engineering and seismology have not yet interfaced their data structures, lacking an interoperable data-sharing structure. The SERA project (Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe) aims at creating a roadmap for integrating the most important databanks and related informatics services of the two research communities in Europe, i.e. SERIES and EPOS, so as to promote multi-disciplinary science, facilitate innovation and ultimately reduce the risk posed by natural and anthropogenic earthquakes (Freda, Cocco, Saleh, & Giardini, 2018).

Considering the large number of disciplines involved (seismology, earthquake engineering, near-fault observation, geotechnical engineering, etc.), a large amount of heterogeneous data was produced in the past and is going to be produced for better understating the various phenomena. Different data management practices and access policies applied by the data providers generate complex ecosystems of poorly interoperable data infrastructures. Resulting data silos slow down the circulation of knowledge and prevent cross-fertilisation of interdisciplinary research which is essential for increasing the interaction within adjacent scientific disciplines.

The EPOS and SERIES projects, in particular, have several similarities and some differences (Atakan, et al., 2018). The most important similarity is their principal mission, i.e. the development of interoperable data-sharing structures for the respective scientific communities and the provision of a single tool to make integrated use of data and data products provided by different European research infrastructures. However, the nature of the two projects is different. EPOS targets an integration of heterogeneous data coming from several communities in solid Earth science into a single and distributed infrastructure and facilitating access through a single online environment. On the

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1 http://www.series.upatras.gr/
2 http://www.share-eu.org/
3 https://www.orfeus-eu.org/
4 https://www.emsc-csem.org/#2
5 https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud

D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures
contrary, SERIES is a domain-specific infrastructure (representing the earthquake engineering experimental research community) that stores data in independent, distributed sources and provides a single uniform user interface to access them.

In both platforms’ architecture, data are received from external data providers/centres, as shown in Figure 1. The external data centres share existing data with the corresponding central access point. In the case of EPOS, the external data centres are the national research infrastructures and data centres. In the SERIES platform, the data providers are the partner research infrastructures which send their data to update the SERIES central database.

A notable difference though, stemming from the wide range of scientific domains that relate to the EPOS project (e.g. seismology, multi-scale laboratories, near-fault observatories, etc.), is that an intermediate layer exists between the data providers and the central database, namely the Thematic Core Services (Atakan, Michalek, Tellefsen, & WP6&7 Team, 2017). In this regard, SERIES being a thematic community service (i.e. the earthquake engineering community) can be compared to a TCS where the relevant data and products are already integrated and made available through a data gateway (the SERIES Data Access Portal). Similar TCS-level data gateways exist in EPOS, such as ORFEUS and EMSC in the TCS Seismology. Moreover, both systems are based on a Service-Oriented Architecture. While EPOS requires that DDSS (Data, Data products, Services and Software) provided by the national research infrastructures in each scientific community is exposed through a web service in the TCS layer, in SERIES each partner exposes their data through a web service towards the Central Site.

Figure 1: Architecture of the EPOS (a) and SERIES (b) platform
With regards to the data models, a direct comparison is not straightforward due to the differences and specificities in the nature and architecture of each platform. The EPOS metadata model (EPOS-DCAT-AP) follows a different approach that the SERIES Exchange Data Format (EDF). The SERIES EDF follows a hierarchical organization with four level entities: Project, Specimen, Experiment & Computation and Signal. On the other hand, EPOS is a “hyper-data” provider for multi-disciplinary data. The data provided are “heterogeneous”, having one format per thematic domain (i.e. per TCS). In the EPOS-TCS data model, the entities are Person, Organization, Research Infrastructures (RIs), DDSS, Instrument, Authentication, Authorisation, Accounting, Infrastructure (AAAI), Other.

There is no single roadmap for the integration of databanks and access services from the EPOS and SERIES platforms, but the most immediate approach is to consider the SERIES database as the first service of a new Earthquake Engineering Thematic Core Service within the EPOS architecture. In order to define the roadmap for integration, an extensive consultation with scientific, institutional and other possible end-users of earthquake engineering and seismological data in Europe and abroad was undertaken in 2018 and 2019.

In Section 2, cross-discipline needs in earthquake engineering and seismology are described, based on the information on requirements and use cases that was collected through a questionnaire addressed to end-users of data. The EPOS and SERIES metadata are discussed in Section 3, while Section 4 is devoted to IT related issues such as the strategy for converting metadata and the developments needed to implement the integration of the two platforms. Lastly, a timeline and associated tasks towards the creation in EPOS of a new Earthquake Engineering Thematic Core Service are proposed in Section 5.

### 2 Cross-discipline needs in earthquake engineering and seismology data and services

As highlighted above there is an urgent need to breaking the silos of the two adjacent scientific disciplines, the earthquake engineering and the seismology. A possibility to improve access to data, services and research infrastructures in order to accelerate the cross-fertilization of the two disciplines is given by the integration of the platform, or better, the SERIES database within the EPOS environment. In fact, the scientific and research community currently working in the field of seismology is developing its own TCS exploiting the potentiality of EPOS. In order to make the integration as effective as possible, however, it is first of all necessary to identify the needs and priorities that the two scientific communities have. To this end, an appropriately designed questionnaire was given to users and stakeholders operating in the field of earthquake engineering and/or seismology. In this section the questionnaire used and the results obtained in terms of requirements and use cases will be described.

#### 2.1 Requirement and Use Cases (RUC) collection process

In the second semester of 2018, a questionnaire was defined within WP6 "Networking experimental seismic engineering databases" of the SERA project. The questionnaire aimed to collect information on requirements and use cases for earthquake engineering and seismological data that will feed into the roadmap for integration of SERIES and EPOS databanks. It was composed of three parts. In the general part, after a brief introduction to the SERA, SERIES and EPOS projects and the scope of the survey, the users were asked to indicate their expertise and/or field of interest and provide some

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6 [https://ec.europa.eu/eusurvey/runner/SERA_Survey_RUCs](https://ec.europa.eu/eusurvey/runner/SERA_Survey_RUCs) (still open)
general information. In the quantitative part the users were asked to evaluate 13 different requirements for the databanks. The analysis of the replies to this part is reported in sub-section 2.2. The qualitative part was set in order to obtain, through open-ended questions, more extensive information regarding use cases, priorities, expectations and objectives to achieve through the database integration. The use cases and specific examples are reported in sub-section 2.3.

The questionnaire was sent to a targeted audience of about 250 users operating in the field of earthquake engineering and seismology. The users have different profiles and roles like academic positions, researchers, laboratory managers and technical staff, practitioners, etc. Thirty-two users from sixteen countries (see Figure 2) completed the questionnaire. The users’ expertise and fields of interest covered a broad spectrum: most of the responders work in the experimental testing, numerical modelling and teaching fields, as shown in Figure 3. The majority of the users (22 people) indicated three or more fields of expertise, as it could be expected considering the nature of the targeted audience, and only five users selected one field of expertise.
2.2 Requirements of users

In the quantitative part of the questionnaire, users evaluated different requirements (1 least important, 5 most important) for the data banks as shown in Figure 4. Thirteen different requirements were indicated: simple search, advanced search, access to search interface at local database, search for data in different formats, contact information at local database, contact information for individual project, data visualisation tools, tools to elaborate data, access to test reports and specific publications, description of the project, description of the specimen, description of the experimental setup, possibility to share my own DDSS.

![Figure 4: Requirements for databanks](image)

Starting from the collected data it was possible to rank the requirements in order of importance attributed by the users. In Figure 5, the requirements are listed from the most to the least important. Each value associated to the requirements is computed considering a weighted average of the values expressed by the users. The three most important requirements for the users were: access to test reports and publications, description of specimen and description of experimental setup. The users expressed a clear need for access to data that are essential for numerical simulations and reliability checks. Users suggested additional requirements that can be mainly summarize in: the possibility to share information with other researchers and access to quality plans of experiments (including calibration procedures, reliability data check).
In order to have a complete overview of requirements for databanks, users were asked to describe data, data products, software and services (DDSS) that they would like to access through data portal. The following data and data products were indicated:

- Raw data;
- Post-processed data;
- Data products customised for teaching and demonstration purposes;
- Drawings of test setup, specimen;
- Images and videos with detailed meta-data useful for identifying the structural part observed;
- Benchmark case studies for teaching at University;
- Code and standard development.

In addition, access to the following software and services was requested:

- Data visualisation tools;
- Data analysis tools;
- Data manipulation tools;
- Simulation tools;
- Learning tools;
- Validation of models;
- Comparison of experimental results from the SERIES partners with other results in literature;
- Comparison of performance of different structural types;
- Near-real-time damage assessment and early warning, e.g. at schools;
- Risk assessment.

The complete analysis of the replies to the quantitative part of the questionnaire and all the responses on requirements and DDSS are reported in Appendices 2 and 3.
2.3 Collection of use cases

2.3.1 Simple and complex use cases described by users

A simple use case describes a basic and elementary functionality, i.e. search for data, simple visualisation and download. The simple use cases described by the users may be grouped in the three cases reported in Table 1. There are several data and data products already in the SERIES database that can be downloaded and visualised according to the three use cases. Examples of such data include the displacement, force and acceleration time-histories, photos and drawings of specimen and experimental setup, videos of experimental tests, description of equipment and instrumentation, calibration data, and acquisition configuration. Moreover, some services like combined search criteria and researching for structural response for a given earthquake are already implemented in SERIES.

Table 1: Simple use cases for earthquake engineering and seismological data

<table>
<thead>
<tr>
<th>Step</th>
<th>Use case 1</th>
<th>Use case 2</th>
<th>Use case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Search</td>
<td>Search</td>
<td>Search a project</td>
</tr>
<tr>
<td>2</td>
<td>Filter/sort</td>
<td>Select</td>
<td>Select a specimen</td>
</tr>
<tr>
<td>3</td>
<td>Select</td>
<td>Visualise data</td>
<td>Select an instrument</td>
</tr>
<tr>
<td>4</td>
<td>Download</td>
<td>Download accompanying documentation</td>
<td>Visualise data</td>
</tr>
</tbody>
</table>

A complex use case will search for datasets from various sources / local databases, visualise them and possibly perform an analysis or processing. The complex use cases described by the users may be summarised in the three cases given in Table 2. These complex use cases require several interactions of the users with the web interface and a complex system workflow to process the query. Moreover, some particular data and features have not been implemented yet in the SERIES database (e.g. visualisation tools).

Table 2: Complex use cases for earthquake engineering and seismological data

<table>
<thead>
<tr>
<th>Step</th>
<th>Use case 1</th>
<th>Use case 2</th>
<th>Use case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Search a structural typology (e.g. RC frame, steel frame, two storeys, etc.)</td>
<td>Search for a type of structural element (e.g. column, beam, joint, etc.)</td>
<td>Search for a specific input action</td>
</tr>
<tr>
<td>2</td>
<td>Select a point of a post-processed data series (e.g. moment, shear, etc.)</td>
<td>Select two elements of this type (e.g. different geometry or material)</td>
<td>Filter to specific structural typology (e.g. RC frame, steel frame, two storeys, etc.)</td>
</tr>
<tr>
<td>3</td>
<td>Combine data series A with other post-processed data series (e.g. rotation, displacement, etc.)</td>
<td>Select two series of post-processed data for each element (e.g. moment-rotation)</td>
<td>Select two specimens tested by means of different setup and/or methodology (e.g. pseudo-dynamic or shaking table tests)</td>
</tr>
<tr>
<td>4</td>
<td>Visualise data</td>
<td>Visualise comparison of selected post-processed data for selected elements</td>
<td>Visualise data and share with others</td>
</tr>
<tr>
<td>5</td>
<td>Download data</td>
<td>Download data</td>
<td>Download data</td>
</tr>
</tbody>
</table>
2.3.2 Use cases for pre-operational access service

A simple use case to be implemented for pre-operational access service to the SERIES database is described in Table 3. Priority is the implementation priority, pre-conditions are the conditions needed for performing the use case, user and system view are the schematic description of the events from a point of view of the user and of the system respectively, post-conditions are the conditions applied at the end of the workflow related to the use case and other requirements are possible prescriptions or obligation to be fulfilled. The goal of the use case is to allow the user (a researcher / designer in the field of earthquake engineering) to select a specific specimen of a reinforced concrete (RC) building tested within a project and download the shear force – inter-storey drift curves for a test performed on the selected specimen. The objective is to calibrate an analytical tool and confirm its reliability.

Table 3: Simple use case for pre-operational access service

<table>
<thead>
<tr>
<th>USE CASE NAME/TOPIC</th>
<th>Select and download force and displacement experimental data for a RC frame building</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE CASE DOMAIN</td>
<td>This use case is related to a single discipline: earthquake engineering.</td>
</tr>
</tbody>
</table>
| ACTORS INVOLVED IN THE USE CASE | Civil/building engineer user  
Earthquake engineering researcher user |
| PRIORITY             | High                                                                              |
| PRE-CONDITIONS       | User must have logged in                                                          |
| FLOW OF EVENTS – USER VIEW | 1. Select:  
   a. project: SPEAR  
   b. specimen: Original. |
|                      | 2. View the tests performed on the Original specimen and select the test of interest.  |
|                      | 3. View the different data, select the shear force – inter-storey drift data of interest and visualise the graph.  |
|                      | 4. Download the images of interest.                                                |
| SYSTEM WORKFLOW – SYSTEM VIEW | 1. It activates one task connecting to the specific SERIES database  
2. The task connects to the database and performs a query for selecting the project and enters in its “subspace”  
3. The task opens a temporary VIEW in the database storing the results of the specific query, in our case the different specimen  
4. The task selects the specimen of interest and imports it in its “subspace”  
5. The task opens a temporary VIEW in the database storing the results of the specific query, in our case the different tests performed  
6. The task selects the test of interest and enter sin its “subspace”  
7. The task opens a temporary VIEW in the database storing the results of the specific query, the user can select and view the data of interest (i.e. image of Shear Load / Inter-story Drift)  
8. The data contained in the VIEW are also stored in a downloadable format |
| POST-CONDITIONS       | The VIEW is kept in the database as long as the user session is active or until the session timeout is reached. |
| OTHER REQUIREMENTS    | Acceptance of SERIES Terms of Service (ToS)                                       |
A complex use case to be implemented for pre-operational access service to the SERIES database is described in Table 4. The goal is to allow the user (a researcher in the field of earthquake engineering) to download experimental data and information about the test setup for a type of reinforced concrete structure tested with different experimental methods (pseudo-dynamic method and shaking table) for a selected acceleration time history input. The objective of the user is to numerically simulate the tests and validate a new 3D flexure-shear fibre model for reinforced concrete frame elements.

Table 4: Complex use case for pre-operational access service

<table>
<thead>
<tr>
<th>USE CASE NAME/TOPIC</th>
<th>Download experimental data and test set-up of RC frame specimen tested by means of shaking table and pseudo-dynamic technique for a defined seismic input</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE CASE DOMAIN</td>
<td>This use case is related to one single discipline: earthquake engineering.</td>
</tr>
<tr>
<td>ACTORS INVOLVED IN THE USE CASE</td>
<td>Earthquake engineering researcher User</td>
</tr>
<tr>
<td>PRIORITY</td>
<td>Medium</td>
</tr>
<tr>
<td>PRE-CONDITIONS</td>
<td>User must have logged in</td>
</tr>
</tbody>
</table>

FLOW OF EVENTS – USER VIEW

1. Select:
   a. input signal: Accelerogram A
   b. specimen typology: reinforced concrete frame
   c. experimental method: pseudo-dynamic and shaking table.
2. View the different tests performed on the specimen and select the test of interest.
3. View the different data and select the data of interest.
4. Download the data of interest.
5. Repeat steps 2, 3 and 4 for all the tests needed.

SYSTEM WORKFLOW – SYSTEM VIEW

1. It activates a task connecting to the specific SERIES database
2. The task connects to the database and performs a query for selecting the loading source [accelerogram A], the structural typology [RC Frame] and experimental techniques [PSD and Shaking Table]
3. The task opens a temporary VIEW in the DB storing the results of the specific query, in our case the different tests
4. The task select the test of interest and enter in its “subspace”
5. The task opens a temporary VIEW in the DB storing the results of the specific query, the user can select and view the data of interest (i.e. set-up drawing, position of the instruments, raw data of the results, post-processed data, etc)
6. The data contained in the VIEW are also stored in a downloadable format
7. The user can perform task 3,4 and 5 for different tests

POST - CONDITIONS

The VIEW is kept in the database as long as the user session is active or until the session timeout is reached.

OTHER REQUIREMENTS

Acceptance of SERIES Terms of Service (ToS)
2.3.3 Advanced use case

Finally, an advanced use case is reported in Table 5, starting from a use case proposed in the questionnaire. The use case is considered advanced due to its particular workflow and requirements. In fact, some data (e.g. vertical reinforcement ratio) and features (e.g. data visualisation and manipulation tools) are not implemented yet in the SERIES database and will not implemented in the pre-operational service activities within the SERA project. However, this use case can be considered for future mid- or long-term development of the database.

The goal of the advanced use case is to allow the user to visualise experimental force-displacement curves for a shear wall specimen with given geometric and material properties (shear span, axial load ratio, vertical reinforcement ratio, steel and concrete strength) and subjected to a specified loading history (cyclic loading with at least two cycles after yielding), identify on the curve the point corresponding to a given value of displacement ductility and download pictures of the tested specimen at that specific point. The objective of the user is to confirm the performance of a similar element he/she has designed. It has to be noted that the procedure described to implement the advanced use case can be simplified if the ductility displacement ratio is part of the metadata used to describe the test.

Table 5: Advanced use case

<table>
<thead>
<tr>
<th>USE CASE NAME/TOPIC</th>
<th>Visualise experimental force-displacement curves for shear wall specimens with a set of selected characteristics and download pictures of the specimen corresponding to specific points of the curves</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE CASE DOMAIN</td>
<td>This use case is related to one single discipline: earthquake engineering.</td>
</tr>
<tr>
<td>ACTORS INVOLVED IN THE USE CASE</td>
<td>User: Earthquake Engineering Researcher</td>
</tr>
<tr>
<td>PRIORITY</td>
<td>Low</td>
</tr>
<tr>
<td>PRE-CONDITIONS</td>
<td>User must have logged in</td>
</tr>
</tbody>
</table>

FLOW OF EVENTS – USER VIEW

1. Select:
   a. specimen typology: shear wall
   b. specimen characteristic: shear span < 1; vertical reinforcement ratio < 1.0%
   c. materials: $f_{ck} = 45 \text{ MPa}$ and $f_{yk} = 500 \text{ MPa}$
   d. axial load ratio > 0.1
   e. loading protocol: cycling test with at least 2 cycles after yielding.

2. View all tests according to these criteria and select the one of interest.
3. View the different data and select the data of interest.
4. Drag and drop the data series in the visualisation tool to plot the force-displacement diagram.
5. Identify the yielding and ultimate displacement point by pointing the cursor on them.
6. Compute ductility displacement ratio.
7. Researcher user download the picture of the sample if the ductility displacement ratio is larger than 2.
8. Repeat steps 2-7 for all the tests needed.

SYSTEM WORKFLOW – SYSTEM VIEW

1. It activates one task connecting to the specific SERIES database
2. The task connects to the database and performs a query for selecting:
- the specimen typology [the use case is focused on Shear Wall]
- specimen characteristic [the use case is focused on span<1; vertical reinforcement ratio < 1.0%]
- the materials used [the use case is focused on concrete (fck) and steel fyk]
- the protocol test performed [the use case is focused on cycling test with at least 2 cycle after the yielding point with and an axial load ratio larger than 0.1]

3. The task opens a temporary VIEW in the DB storing the results of the specific query, in our case the different tests
4. The task selects the test of interest and enters in its “subspace”
5. The task opens a temporary VIEW in the DB storing the results of the specific query, the user can select and view the data of interest (raw data of the results, post-processed data, pictures, etc.)
6. the data contained in the VIEW can be dragged and dropped the visualization tool area
7. in the visualization area it is possible to point with a mouse in order to visualise the X-Y values (useful to perform simple operation)
8. The data contained in the VIEW are also stored in a downloadable format (i.e. picture of the sample if needed)
9. The user can perform task 3,4 and 5 for different tests

<table>
<thead>
<tr>
<th>POST - CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The VIEW is kept in the DB as long as the user session is active or until the session timeout is reached.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance of SERIES Terms of Service (ToS)</td>
</tr>
</tbody>
</table>

### 2.4 Other anticipated needs and synergies

The questionnaire served to collect proposals on possible ways to better integrate data and services from the two adjacent scientific disciplines of earthquake engineering and seismology. The improved access to cross-discipline data, services and research infrastructures can help reduce the risk posed by natural and anthropogenic earthquakes, which is the main objective of the SERA project. A specific expectation is improving the regional loss assessment through integrating hazard and vulnerability assessment.

Different strategies can be followed to promote synergies between the earthquake engineering and seismology data providers and users. Considering the TCSs implemented in the EPOS platform, a simple way is to map data and establish a link when the same or related data exist in the SERIES database. Examples of such data that are already available through the TCS Seismology and the SERIES database are given in Table 6. For example when a user is searching and selecting a well-defined input accelerogram in the earthquake engineering TCS, a link to a service able to provide spectrum-compatible signals in the seismology TCS could be highlighted. Alternatively, in the seismology TCS when a user is looking for a particular building typology in an exposure database, a link to the SERIES data related to the test performed on the same building typology could be highlighted.

Table 6: Examples of links between data in the SERIES database and the EPOS TCS Seismology

<table>
<thead>
<tr>
<th>SERIES database</th>
<th>EPOS TCS Seismology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input accelerogram (Friuli, El Centro, etc.)</td>
<td>→ Seismological data related to the signal</td>
</tr>
<tr>
<td>Input accelerogram</td>
<td>→ Spectrum-compatible signals</td>
</tr>
</tbody>
</table>
Moreover, considering the DDSS provided by the TCS Seismology, it is possible to draft a cross-disciplinary use case and highlight the added value of a future integration of earthquake engineering and seismology data and services. The goal of the use case described in Table 7 is to obtain hazard, exposure and fragility input for the building stock in a specified city in Europe, perform seismic risk analysis, produce fragility curves for different retrofit scenarios and estimate the risk reduction resulting from each scenario. The objective of the users (earthquake engineering expert, seismology expert and advisor to municipal authority) is to evaluate and compare the effectiveness of different retrofit strategies on the reduction of the vulnerability of public and private buildings and the expected losses in a city.

Table 7: Cross-disciplinary use case

<table>
<thead>
<tr>
<th>USE CASE NAME/TEAM</th>
<th>Evaluate the impact of different retrofitting strategies on the physical vulnerability and seismic risk of the building stock of a city</th>
</tr>
</thead>
<tbody>
<tr>
<td>USE CASE DOMAIN</td>
<td>This use case is related to two disciplines: earthquake engineering and seismology.</td>
</tr>
</tbody>
</table>
| ACTORS INVOLVED IN THE USE CASE | User: earthquake engineering expert  
User: seismology expert  
User: advisor |
| PRIORITY           | Low                                                                                                                            |
| PRE-CONDITIONS     | User must have logged in                                                                                                                                                                    |
2. Expert selects the city.  
3. Expert views and/or downloads the building stock inventory of the city (Exposure).  
4. Expert performs analysis with the OpenQuake engine to evaluate seismic vulnerability and risk of the building stock. |
| FLOW OF EVENTS – USER VIEW | 5. Expert selects a retrofitting scenario (for each building typology present in the city).  
6. Expert uses earthquake engineering data and tools to obtain fragility curves for the retrofitted buildings.  
7. Expert performs new analysis with OpenQuake to evaluate vulnerability and risk for the retrofitted building stock.  
8. Researcher saves the results.  
9. Expert repeats steps 5-8 for all the retrofitting scenarios. |
| SYSTEM WORKFLOW – SYSTEM VIEW | 1. It activates one task connecting to the specific DDSS in the Seismology TCS (European Seismic Risk Service)  
2. The task connects to the Open Quake- Engine and performs a query for:  
- selecting the city location [the use case is focused on Patras]  
3. The task opens a temporary VIEW in the DB storing the information related to the building stock of the city (Exposure)  
4. The data contained in the VIEW are also stored in a downloadable format  
5. The task performs an analysis with OpenQuake-engine for evaluating present seismic vulnerability and risk  
6. The task performs an new analysis with OpenQuake-engine for evaluating |
seismic vulnerability and risk with a retrofitting scenario

7. When the vulnerability model routine is open in OpenQuake-engine a direct connections with TCS/EENG is established for selecting new fragility curves related to different building typologies and retrofitting approaches.

7. The task complete the analysis with OpenQuake-engine for evaluating the influence of the retrofitting scenario selected

8. At the end of the analysis the data contained in the VIEW are stored in a downloadable format

9. The user can perform task 6, 7 and 8 for different retrofitting strategies

**POST - CONDITIONS**

The VIEW is kept in the DB until user session is active or until the session timeout is passed

**OTHER REQUIREMENTS**

Acceptance of SERIES Terms of Service (ToS)

The cross-disciplinary use case described above involves the interaction between the proposed Earthquake Engineering TCS and the OpenQuake software available within the Seismology TCS. An interface shall allow the proposed Earthquake Engineering TCS to provide the “Vulnerability Model” module with fragility curves for each building class and for different retrofitting techniques. While new tools need to be developed to produce the fragility curves from the experimental data that are available in the SERIES database, as shown in Figure 6, this advanced cross-disciplinary use case highlights the potential of the proposed Earthquake Engineering TCS to provide new data products and integrate them with software available on the platform.

![Figure 6: Interaction between the proposed Earthquake Engineering and the Seismology TCSs](https://simcenter.designsafe-ci.org)

The SimCenter simulation tools are an excellent example in this respect. They provide a computational ecosystem that enables the NHERI research community to achieve unprecedented capabilities to conduct end-to-end simulations. By employing an open-source framework, the ecosystem allows researchers to contribute to some or all aspects of the simulation capabilities such as uncertainty quantification, model calibration, optimization and sensitivity analyses, finite element

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7 https://simcenter.designsafe-ci.org
modelling, etc. In the SimCenter framework a researcher can describe the assets and a possible event at the site, estimate asset response to the event and also estimate asset damage and its consequences.

2.5 Workshop outcomes

A meeting with the WP6 partners and representatives of EPOS and other SERA WPs to discuss the roadmap for integration of earthquake engineering and seismological data and present the developments on the SERIES database was organized in May 2009, before the second SERA annual meeting. Some feedback for improving data, data products services and software was received and is listed below:

- provide DOI for data;
- add a report that describes the data;
- improve ease of data uploading;
- use GEM building taxonomy to describe building specimens;
- use different flexible tools.

Moreover, participants suggested to consider the use of artificial intelligence and machine learning, e.g. to understand the use cases and search for the relevant data. These features can be extremely useful for the Earthquake Engineering TCS especially considering the future development of “Smart Cities” where an extensive use of sensors will collect an enormous quantity of data relevant for buildings and infrastructures.

Other sources of big data could come from the field of structural health monitoring. Data, data products, service and software developed in the field of structural health monitoring could be integrated in the Earthquake engineering and this opportunity will be investigated in the future steps of the Earthquake Engineering TCS integration in EPOS.

Issues related to the E/ENG TCS governance were also highlighted during the workshop, where the governance that is being developed for the European Facilities for Earthquake Hazard and Risk (EFEHR), one of the three EPOS Seismology TCS pillars, was discussed. The creation of a separate E/ENG TCS is preferable over including E/ENG as a service or pillar of an existing TCS, due to the complexity and variety of the Earthquake Engineering TCS areas and partners.

3 Data, Data products, Services and Software (DDSS) Elements

EPOS Integrated Core Services-Central (EPOS ICS-C) is the essential component of EPOS that provides end-users with a view of what EPOS has to offer and it allows the Thematic Core Services (TCS) to expose their assets for use by end-users. The EPOS ICS provides the central hub (ICS-C) of the EPOS infrastructure and ensures interoperability between the data and services provided by each of the TCSs and the National Research Infrastructures (NRIs). The ICS system architecture has been designed to provide the tools to facilitate the discovery of data, data products, software and services (DDSS) and the integration of these resources to fulfil users’ requests across the EPOS community. The system architecture of the ICS is composed of several modular components.
As discussed in Section 1, the most immediate approach to achieve integration between SERIES and EPOS, is to consider SERIES from the point of view of the EPOS architecture. That means integrating the Earthquake Engineering Community (SERIES) as a new EPOS Thematic Core Service.

The EPOS-ICS-C (Integrated Core Services-Central) harvests metadata from the Thematic Core Services (TCS) and performs other functions which are not necessary to explain in this section. The EPOS-ICS represents metadata using the CERIF format (Common European Research Information Format: an EU Recommendation to Member States). Since CERIF is a superset of commonly used metadata formats including DC (Dublin Core), DCAT (Data Catalog Vocabulary), ISO19115/INSPIRE (an OGC and ISO standard for geospatial data) and others, this means that metadata in these formats can be mapped to CERIF so they all appear in the same format for the ICS user. At the community level (TCS), users are free to use any standards as long as the data is accessible and discoverable by the ICS.

The process of converting metadata acquired from the EPOS TCSs to CERIF is twofold. First, each TCS is required to map its metadata into the EPOS baseline format. The mapping occurs between two metadata standards (source: TCS format; destination: EPOS baseline format). The EPOS baseline, which serves as an abstraction layer, has been implemented by extending the Data Catalogue Vocabulary Application Profile (DCAT-AP). Second, EPOS ICS is responsible of ingesting the EPOS baseline format (EPOS-DCAT-AP) into CERIF. This has been achieved through custom converters made by ICS.

In the next sections the metadata structures of EPOS and SERIES will be discussed.

### 3.1 The metadata structure in EPOS

#### 3.1.1 EPOS Data Catalogue Vocabulary Application Profile (EPOS-DCAT-AP)

The EPOS ICS team has provided a standard template for serialisation of the EPOS metadata reference model, so as to make feasible the conversion from domain-specific metadata formats to a format that is ingestible by EPOS. The template is built upon the existing standard vocabularies, Data Catalogue Vocabulary Application Profile (DCAT-AP). DCAT-AP is used to ingest the metadata from TCS and present data in a standardised way to machine agents willing to get information from the EPOS-ICS system. Extensions have been applied to accommodate for the EPOS specific needs of entities, attributes and relationships.

Interactions with TCSs have been crucial in understanding their metadata capacities and to provide the appropriate template for their conversion. In order to facilitate the process of metadata mapping, ICS has provided a UML diagram representing the EPOS-DCAT-AP (DCAT extension), along with a schema definition and an XML example for indicating expected values. A GitHub environment was established for providing them with the proper documentation.

It was also expected that each TCS contributes to the GitHub project by uploading their converted XML files into a dedicated folder on GitHub. Thus, ICS and TCS could easily interact and solve mutual issues encountered within each conversion.
The following tables list the entities that are described in the classes of the EPOS-DCAT application profile. For a more complete list, including a description of the properties that each class contains, please consult the most recent version of “EPOS-DCAT-AP: an extension of the DCAT Application Profile for Research Infrastructures in the solid-Earth domain” (Paciello, Trani, & Bailo, 18 January 2019). The first three Tables list the entity classes that are described in the DCAT-AP, while Table 11 and Table 12 list the classes that are introduced by the EPOS-DCAT-AP. Finally, the properties of two of those classes, Person and Dataset, are listed in Table 13 and Table 14 respectively, in order to facilitate the discussion in the next sections.

**Table 8. Mandatory Classes for DCAT-AP**

<table>
<thead>
<tr>
<th>Class name</th>
<th>Usage note</th>
<th>URI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent</td>
<td>An entity that is associated with Catalogues and/or Datasets. If the Agent is an organization, the use of the Organization Ontology is recommended.</td>
<td>foaf:Agent</td>
</tr>
<tr>
<td>Catalogue</td>
<td>A catalogue or repository that hosts the Datasets being described.</td>
<td>dcat:Catalog</td>
</tr>
<tr>
<td>Dataset</td>
<td>A conceptual entity that represents the information published.</td>
<td>dcat:Dataset</td>
</tr>
<tr>
<td>Literal</td>
<td>A literal value such as a string or integer; Literals may be typed, e.g. as a date according to xsd:date. Literals that contain human-readable text have an optional language tag as defined by BCP 47.</td>
<td>rdfs:Literal</td>
</tr>
</tbody>
</table>

**Table 9. Recommended Classes for DCAT-AP**

<table>
<thead>
<tr>
<th>Class name</th>
<th>Usage note</th>
<th>URI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>A subject of a Dataset.</td>
<td>skos:Concept</td>
</tr>
</tbody>
</table>
## Category scheme
A concept collection (e.g. controlled vocabulary) in which the Category is defined.

<table>
<thead>
<tr>
<th>Category scheme</th>
<th>Usage note</th>
<th>URI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>A physical embodiment of the Dataset in a particular format.</td>
<td>dcat:Distribution</td>
</tr>
<tr>
<td>Licence document</td>
<td>A legal document giving official permission to do something with a resource.</td>
<td>dct:LicenseDocument</td>
</tr>
</tbody>
</table>

## Table 10. Optional Classes for DCAT-AP

<table>
<thead>
<tr>
<th>Class name</th>
<th>Usage note</th>
<th>URI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalogue Record</td>
<td>A description of a Dataset’s entry in the Catalogue.</td>
<td>dcat:CatalogRecord</td>
</tr>
<tr>
<td>Checksum</td>
<td>A value that allows the contents of a file to be authenticated. This class allows the results of a variety of checksum and cryptographic message digest algorithms to be represented.</td>
<td>spdx:Checksum</td>
</tr>
<tr>
<td>Document</td>
<td>A textual resource intended for human consumption that contains information, e.g. a web page about a Dataset.</td>
<td>foaf:Document</td>
</tr>
<tr>
<td>Frequency</td>
<td>A rate at which something recurs, e.g. the publication of a Dataset.</td>
<td>dct:Frequency</td>
</tr>
<tr>
<td>Identifier</td>
<td>An identifier in a particular context, consisting of the string that is the identifier; an optional identifier for the identifier scheme; an optional identifier for the version of the identifier scheme; an optional identifier for the agency that manages the identifier scheme</td>
<td>adms:Identifier</td>
</tr>
<tr>
<td>Kind</td>
<td>A description following the vCard specification, e.g. to provide telephone number and e-mail address for a contact point. Note that the class Kind is the parent class for the four explicit types of vCards (Individual, Organization, Location, Group).</td>
<td>vcard:Kind</td>
</tr>
<tr>
<td>Linguistic system</td>
<td>A system of signs, symbols, sounds, gestures, or rules used in communication, e.g. a language</td>
<td>dct:LinguisticSystem</td>
</tr>
<tr>
<td>Location</td>
<td>A spatial region or named place. It can be represented using a controlled vocabulary or with geographic coordinates. In the latter case, the use of the Core Location Vocabulary is recommended, following the approach described in the GeoDCAT-AP specification.</td>
<td>dct:Location</td>
</tr>
<tr>
<td>Media type or extent</td>
<td>A media type or extent, e.g. the format of a computer file</td>
<td>dct:MediaTypeOrExtent</td>
</tr>
<tr>
<td>Period of time</td>
<td>An interval of time that is named or defined by its start and end dates.</td>
<td>dct:PeriodOfTime</td>
</tr>
<tr>
<td>Publisher type</td>
<td>A type of organisation that acts as a publisher</td>
<td>skos:Concept</td>
</tr>
<tr>
<td>Rights statement</td>
<td>A statement about the intellectual property rights (IPR) held in or over a resource, a legal document giving official permission to do something with a resource, or a statement about access rights.</td>
<td>dct:RightsStatement</td>
</tr>
<tr>
<td>Standard</td>
<td>A standard or other specification to which a Dataset or Distribution conforms</td>
<td>dct:Standard</td>
</tr>
</tbody>
</table>
Table 11. Additional Classes for EPOS-DCAT-AP

<table>
<thead>
<tr>
<th>Class name</th>
<th>Usage note</th>
<th>URI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annotation</td>
<td>A statement providing explanatory information about a resource or agent.</td>
<td>oa:Annotation</td>
</tr>
<tr>
<td>Equipment</td>
<td>Device</td>
<td>epos:Equipment</td>
</tr>
<tr>
<td>Facility</td>
<td>This refers to facilities with resources and related services used by the</td>
<td>epos:Facility</td>
</tr>
<tr>
<td></td>
<td>scientific community to conduct top-level research in their respective</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fields, ranging from social sciences to astronomy, genomics to nanotechnologies. Examples include laboratories, special habitats, libraries, databases, biological archives, etc. A type of facility could be a research infrastructure a higher aggregated entity.</td>
<td></td>
</tr>
<tr>
<td>Software Application</td>
<td>This represents software packages, applications and programs.</td>
<td>schema:SoftwareApplication</td>
</tr>
<tr>
<td>Publication</td>
<td>a text publication is a resource relating to a dataset, data product or other.</td>
<td>epos:Publication</td>
</tr>
<tr>
<td>WebService</td>
<td>Online interfaces (APIs) enabling a user or a machine to programmatically access the given resource.</td>
<td>epos:WebService</td>
</tr>
<tr>
<td>Service</td>
<td>Describes an offer of an RI to the community. It could be free or ask for something in return (money, publication of the datasets, etc.).</td>
<td>schema:Service</td>
</tr>
<tr>
<td>Project</td>
<td>This refers to associated projects for an organization.</td>
<td>foaf:Project</td>
</tr>
<tr>
<td>Operation</td>
<td>A description of a web service operation.</td>
<td>hydra:Operation</td>
</tr>
<tr>
<td>Iri Template</td>
<td>An IriTemplate consists of a template literal and a set of mappings.</td>
<td>hydra:IriTemplate</td>
</tr>
<tr>
<td>Iri Template Mapping</td>
<td>This maps a variable used in the template to a property and may optionally specify whether that variable is required or not. The syntax of the template literal is specified by its datatype and defaults to the [RFC6570] URI Template syntax, which can be explicitly indicated by hydra:Rfc6570Template.</td>
<td>hydra:IriTemplateMapping</td>
</tr>
</tbody>
</table>

Table 12. Equivalent Classes for EPOS-DCAT-AP

<table>
<thead>
<tr>
<th>Class name</th>
<th>URI</th>
<th>mapping property</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContactPoint</td>
<td>schema:ContactPoint</td>
<td>owl:equivalentClass</td>
</tr>
<tr>
<td>Organization</td>
<td>schema:Organization</td>
<td>owl:equivalentClass</td>
</tr>
<tr>
<td>Person</td>
<td>schema:Person</td>
<td>owl:equivalentClass</td>
</tr>
</tbody>
</table>

For some of the above classes, a list of properties is provided next, in order to facilitate the discussion in the next sections.

Table 13. List of properties of the Person class.

<table>
<thead>
<tr>
<th>URI</th>
<th>Range</th>
<th>Usage note</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>schema:identifier</td>
<td>rdfs:Literal</td>
<td>This property contains the main identifier</td>
<td>1..n</td>
</tr>
</tbody>
</table>
Table 14. Partial list of properties of the Dataset class. For the complete list see (Paciello, Trani, & Bailo, 18 January 2019).

<table>
<thead>
<tr>
<th>URI</th>
<th>Range</th>
<th>Usage note</th>
<th>Card.</th>
</tr>
</thead>
<tbody>
<tr>
<td>dct: description</td>
<td>rdfs:Literal</td>
<td>This property contains a free-text account of the Dataset. This property can be repeated for parallel language versions of the description.</td>
<td>1..n</td>
</tr>
<tr>
<td>dct: title</td>
<td>rdfs:Literal</td>
<td>This property contains a name given to the Dataset. This property can be repeated for parallel language versions of the name.</td>
<td>1..n</td>
</tr>
<tr>
<td>dcat: contactPoint</td>
<td>vcard:Kind</td>
<td>This property contains contact information that can be used for sending comments about the Dataset.</td>
<td>0..n</td>
</tr>
<tr>
<td>dcat: distribution</td>
<td>dcat:Distribution</td>
<td>This property links the Dataset to an available Distribution.</td>
<td>0..n</td>
</tr>
<tr>
<td>dcat: keyword</td>
<td>rdfs:Literal</td>
<td>This property contains a keyword or tag describing the Dataset.</td>
<td>0..n</td>
</tr>
<tr>
<td>dct: publisher</td>
<td>foaf:Agent</td>
<td>This property refers to an entity (organisation) responsible for making the Dataset available.</td>
<td>0..1</td>
</tr>
<tr>
<td>dct: source</td>
<td>dcat:Dataset</td>
<td>This property refers to a related Dataset from which the described Dataset is derived.</td>
<td>0..n</td>
</tr>
<tr>
<td>dct: isPartOf</td>
<td>dcat:Dataset</td>
<td>This property refers to a related Dataset in which the described Dataset is physically or logically included.</td>
<td>0..n</td>
</tr>
</tbody>
</table>
3.2 The metadata structure in SERIES

Figure 8. The entities of the SERIES Exchange Data Format hierarchy and their main properties. Arrows denote a hierarchical relationship.

In SERIES, the metadata format is the Exchange Data Format (EDF). In the scope of SERIES, the EDF assumes a twofold role:

- For the laboratories that already have databases with experimental data that they wish to share, it is the format in which their data and information is made public, i.e. published through the SERIES Data Access Portal (DAP). Therefore, Earthquake Engineering Laboratories that maintained infrastructure for storing experimental data prior to joining SERIES, will not
have to change their databases, as long as they can provide the requested data in the form prescribed by the EDF.

- Earthquake Engineering Laboratories that do not have such infrastructure can implement a database that conforms to the EDF data format.

In the SERIES Exchange Data Format, a hierarchy was implemented for the creation of the prototype database. The reason of this hierarchy was to provide a general naming scheme to simplify central site searches. The hierarchy is presented in Figure 8. The following sections describe the entities that are defined in the Exchange Data Format. The sections are organized in accordance to the hierarchical organization proposed by the EDF.

In the next tables, private attributes contain data that are hosted in the remote nodes, uploaded attributes are stored in the SERIES Central Database and searchable attributes are available for search to the end-users.

### 3.2.1 Project Level

**Table 15. List of attributes in the Project Level of SERIES EDF**

<table>
<thead>
<tr>
<th></th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project name</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expanded name, acronym and sponsor of the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project title</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acronym</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sponsor</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Principal investigator(s)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The coordinator(s) of the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual forename</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family name</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institution(^1)</td>
<td>string</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) *Institution name is specified by the institutions themselves. In case of institutions that are not SERA partners, the value is “other”.*

<table>
<thead>
<tr>
<th></th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local co-investigator(s)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The corresponding responsible(s) in the facility (local co-investigator)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual forename</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family name</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institution(^1)</td>
<td>string</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) *Institution name is specified by the institutions themselves. In case of institutions that are not SERA partners, the value is “other”.*

<table>
<thead>
<tr>
<th></th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Where</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The name &amp; place of the infrastructure and the facilities used during the tests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name and place(^1)</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name of facility</td>
<td>string</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) *Fixed in the database*

<table>
<thead>
<tr>
<th></th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starting date, and the ending date in case of closed projects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project starting date(^1)</td>
<td>date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project ending date(^2)</td>
<td>date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>status(^3)</td>
<td>string</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^2\) *Institution name is specified by the institutions themselves. In case of institutions that are not SERA partners, the value is “other”.*

\(^3\) *Fixed in the database*
1. **YYYY/MM/DD**

2. In the case of closed projects. **YYYY/MM/DD**

3. Can be finished, on-going, foreseen

### Main focus research area
Contains the results of all the experiments performed on a specimen

Main focus research area 1

<table>
<thead>
<tr>
<th>string</th>
</tr>
</thead>
</table>

1. For example: **Structural performance**, **Structural Performance-Deficient Structures**, **Retrofit techniques**, **Code checking**, **Experimental technique**, **Model calibration**, etc.

### Keywords
The key actions performed in the test campaign

Keywords 1

<table>
<thead>
<tr>
<th>string</th>
</tr>
</thead>
</table>

1. For example: experiment, computation, in situ, in lab, with substructuring, without substructuring, distributed, static, quasi-static, PsD, shaking table, centrifuge, bearing tester, damper tester, hammer, shaker, monitoring, linear time history, non-linear time history, single-mode push-over, multi-mode push-over, non-linear static, equivalent static, modal analysis, etc.

### Summary
Executive summary (max 500 words) that describes the project, its objectives and methodologies.

Summary 1

<table>
<thead>
<tr>
<th>string</th>
</tr>
</thead>
</table>

1. It is intended that a dynamic search at the SERIES Central site will allow retrieving a project from the text of its summary

### Project report
Reports should describe objectively the test campaigns; interpretations of the obtained

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Author(s)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Date 1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Status 1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Link to pdf</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Link to original</th>
</tr>
</thead>
</table>

1. **YYYY/MM/DD**

2. Status can be preliminary, on-going or final.

### Journal articles & conference papers
Reports should describe objectively the test campaigns; interpretations of the obtained

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Author(s)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Journal/Conference</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Link to website</th>
</tr>
</thead>
</table>

### Specimen type
The specimens tested within the context of the project, specifying their main element(s) and material(s)

<table>
<thead>
<tr>
<th>Specimen name</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Specimen link</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Structural system(s)/elements(s) 1</th>
</tr>
</thead>
</table>

1. **YYYY/MM/DD**
Material(s)\(^2\)

<table>
<thead>
<tr>
<th></th>
<th>string</th>
</tr>
</thead>
</table>


2. Examples: solid brick masonry, concrete c25/30, steel FeB44k, carbon fibre composite, elastomeric, visco-elastic devices, FeB44k

3.2.2 Specimen Level

Table 16. List of attributes in the Specimen Level of SERIES EDF

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max length (m)</td>
<td>string</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Max width (m)</td>
<td>string</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Max height (m)</td>
<td>string</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Specimen mass (kg)(^1)</td>
<td>string</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Additional documentation</td>
<td>pdf</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

1. Only the physical weight of the specimen is here specified. Mass belonging to the other categories: (ii) mass used to simulate concentrated and distributed loads on the specimen, (iii) added (artificial mass) for shake table experiments that is calculated by similitude requirements, (iv) mass used in the PsD algorithm can be presented and justified in the accompanying reports.

For the case of PsD tests on multiple-degree-of-freedom specimens, it may be useful to present the mass as mass per floor (when referring to multi-floor structures).

For quasi-static experiments, the mass is just the physical mass of the specimen. For centrifuge experiments, the mass includes the soil sample plus any structural elements within it. The same is valid for laminar box experiments.

Nominal material properties

Materials are fully characterized by indicating their mechanical parameters: nominal values and, when they are determined, actual values.

| Material | string | Y | Y |
| Material properties | string | Y |
| Material properties value | string | Y |
| Material properties unit | string | Y |
| Material curve\(^1\) | pdf | Y |
| Additional documentation | pdf | Y |

1. Material curve column is for cases in which material properties cannot be expressed by a value, but with a curve (as for soil). It may also be expressed as a link to a signal.

Actual material properties

This field collects all the information that characterizes the experiment, as for example direction, effective input files, etc.

| Material | string | Y | Y |
Actual mean properties | string | Y
Number of samples | string
Actual mean properties value | string | Y
Actual properties unit | string | Y
Material curve | pdf | Y
Additional documentation | pdf | Y

Observations
² Material curve column is for cases in which material properties cannot be expressed by a value, but with a curve (as for soil). It may also be expressed as a link to a signal.

Scaling table
A large number of experiments are performed on scaled specimens. Although scaling the geometry of a structure implies also the scaling of other quantities such as density, loads, time, etc., only the primary scaling ratios need to be defined in the scaling table. The other quantities are then derived according to some fundamental equations (dynamic equation, Darcy’s law, etc.). These dimensional similitude laws can be fully expressed in a document uploaded in the Additional documentation field.

Fixed string | string | Y | Y
Prototype-Model ratio | string | Y
Additional documentation | pdf | Y

¹ The dimension that is scaled. Can be length, mod. elasticity, specific mass, area, volume, mass, displacement, velocity, acceleration, weight, force, moment, stress, strain, time, frequency

Construction, transport & demolition
Construction, transport and demolition of the specimen are usually documented by means of photos and short documentation.

Document name | string | Y
Date | date | Y
Status | String | Y
Link | link | Y

¹ YYYY-MM-DD for documents, [YYYY]-[MM]-[DD][hh]:[mm] for pictures

Specimen report
Contains the results of all the experiments performed on a specimen

Title | string | Y | Y
Author(s) | string | Y | Y
Abstract | string | Y | Y
Date | YYYY-MM-DD | Y | Y
Status | string | Y | Y
Link to pdf | link | Y
Link to original | link

¹ preliminary, on-going, final

Experiment/Computation log
Collects the list of experiments and/or computations performed. The date, type, and input of the test are specified. Detailed information is then given at the linked EXPERIMENT/COMPUTATION levels

Timestamp | string | Y | Y
Experiment/Computation type | string | Y | Y
Experiment/Computation name | string | Y
Repetition | number | Y
### Nominal loading name
- **Type**: string
- **Required**: Y

### Loading coefficient
- **Type**: number
- **Required**: Y

### Peak excitation
- **Type**: string
- **Required**: Y

### Experiment/Computation
- **Type**: link

### Observations
- **Type**: link

1. **[YYYY]-[MM]-[DD][hh]:[mm]**

2. Examples may be: quasi-static, PSD, shaking table, centrifuge, distributed, bearing tester, damper tester, hammer, shaker, monitoring, etc. (For each facility a list of possible experiments should be produced). Please note that the same type of experiment can then be repeated.

3. Linear time-history, non-linear time-history, single-mode push-over, multi-mode push-over, non-linear static, equivalent static, modal analysis, etc.

4. If two or more experiments have the same Nominal Loading Name and Loading Coefficient, they are not necessarily a repetition. Repetition captures this case.

5. The name of a loading input (defined further at the experiment level, e.g. “Earthquake1”)

6. Percentage of nominal loading that is applied to the structure

7. The effective magnitude of the loading that is applied to the structure

### 3.2.3 Experiment Level

Table 17. List of attributes in the Experiment Level of SERIES EDF

<table>
<thead>
<tr>
<th><strong>Experiment agent</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The personnel performing the listed experiment.</strong></td>
<td></td>
</tr>
<tr>
<td>Usual forename</td>
<td>string</td>
</tr>
<tr>
<td>Family name</td>
<td>string</td>
</tr>
<tr>
<td>Email</td>
<td>string</td>
</tr>
<tr>
<td>Institution</td>
<td>string</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Original loading signals</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The original time-histories and the information on the inputs used on the different experiments are collected</strong></td>
<td></td>
</tr>
<tr>
<td>Original loading name</td>
<td>string</td>
</tr>
<tr>
<td>Nature</td>
<td>string</td>
</tr>
<tr>
<td>Source</td>
<td>string</td>
</tr>
<tr>
<td>Peak excitation</td>
<td>string</td>
</tr>
<tr>
<td>Original loading signal</td>
<td>link to signal</td>
</tr>
</tbody>
</table>

| **Additional documentation** | pdf |

2. Possible values are: natural (accelerogram), natural-normalized (natural accelerogram normalized in the intensity), natural-modified (natural accelerogram modified according to Eurocode, for example), or generated/generated normalized (for accelerogram generated according to Eurocode or as for cyclic tests, often performed in the preparatory phase).

2. Peak Excitation is the maximum value of the loading signal, which may be an acceleration, for the case of seismic input, or a displacement (or other measures), for the case of inputs of different nature, such as in cyclic tests or snap-back tests.

<table>
<thead>
<tr>
<th><strong>Detailed loading characteristics</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>This field collects all the information that characterizes the experiment, as for example direction, effective input files, etc.</strong></td>
<td></td>
</tr>
<tr>
<td>Nominal loading name</td>
<td>string</td>
</tr>
<tr>
<td>Original loading</td>
<td>link</td>
</tr>
</tbody>
</table>
### Direction

<table>
<thead>
<tr>
<th>String</th>
</tr>
</thead>
</table>

### Loading coefficient (%)

<table>
<thead>
<tr>
<th>Number</th>
</tr>
</thead>
</table>

### Effective input file

<table>
<thead>
<tr>
<th>Link</th>
</tr>
</thead>
</table>

### Additional parameter

<table>
<thead>
<tr>
<th>String</th>
</tr>
</thead>
</table>

### Notes

<table>
<thead>
<tr>
<th>String</th>
</tr>
</thead>
</table>

---

**Boundary conditions**

*How the boundaries of the structure are connected to the testing facility (as on the shaking table), and, in the case of pseudo-dynamic experiments, the location of the actuators. Drawings, photos or reports may be available.*

<table>
<thead>
<tr>
<th>Document Name</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link to .pdf</td>
<td>Link</td>
</tr>
<tr>
<td>Link to original</td>
<td>Link</td>
</tr>
</tbody>
</table>

---

**Testing equipment devices**

*Devices and their characteristics*

<table>
<thead>
<tr>
<th>Device Type</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Subtype</td>
<td>String</td>
</tr>
<tr>
<td>Device Producer Name</td>
<td>String</td>
</tr>
<tr>
<td>Device Label</td>
<td>String</td>
</tr>
<tr>
<td>Capacity</td>
<td>Number</td>
</tr>
<tr>
<td>Unit</td>
<td>String</td>
</tr>
<tr>
<td>Calibration</td>
<td>String</td>
</tr>
<tr>
<td>Related device(s)</td>
<td>String</td>
</tr>
<tr>
<td>Inventory link</td>
<td>Link</td>
</tr>
</tbody>
</table>

---

**Sensors**

*Collecting the output of tests: sensors (that record the signals), the raw data and the treatment programs from which signals are derived. Photos, videos, etc., can as well be considered as generated by sensors.*

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>SubType</td>
<td>String</td>
</tr>
<tr>
<td>Product name</td>
<td>String</td>
</tr>
<tr>
<td>Label</td>
<td>String</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Number</td>
</tr>
<tr>
<td>Accuracy unit</td>
<td>String</td>
</tr>
<tr>
<td>Range</td>
<td>Number</td>
</tr>
<tr>
<td>Range unit</td>
<td>String</td>
</tr>
<tr>
<td>Calibration</td>
<td>String</td>
</tr>
<tr>
<td>Location¹</td>
<td>String</td>
</tr>
<tr>
<td>Direction</td>
<td>String</td>
</tr>
<tr>
<td>Coord²</td>
<td>String</td>
</tr>
<tr>
<td>Notes³</td>
<td>String</td>
</tr>
<tr>
<td>Inventory link</td>
<td>Link</td>
</tr>
<tr>
<td>Position⁴</td>
<td>String</td>
</tr>
</tbody>
</table>

¹ *Location is a physical descriptor of where the sensor is actually located in the specimen (e.g, first floor left bay, second floor central bay), and provides an immediate way of locating the sensor in the specimen.*

² *Coordinates of the sensor provide useful information when used in the context of a numerical model or a drawing produced by a CAD software.*
3 Reporting problems or observations on the performance of the sensors during the experiment; for example in case the sensor stops working and is replaced by another

4 A drawing may be uploaded providing a sketch of the specimen and the position of the sensors

**Signals**

Signals are the product of sensors during an experiment. They are defined by two variables: experiment and sensors

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal label</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Attribute¹</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Physical quantity</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Type²</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Location³</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Sensorlink</td>
<td>link</td>
<td></td>
</tr>
<tr>
<td>Additional parameter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Attribute describes the signal (e.g. accelerogram, laboratory, relative, target, drift, restoring)

² Type specifies if the signal is measured or computed (e.g., generated after processing or by the controller algorithm)

³ Location can be expressed by coordinates or by descriptive strings (1st floor, east-side, ...)

**Observations**

Multi-media resources preserving all the information reported about a test

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation file name</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Link to</td>
<td>link</td>
<td></td>
</tr>
</tbody>
</table>

**Graphics**

Multi-media resources summarising the results of the test in graphical form

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic name</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Link to</td>
<td>link</td>
<td></td>
</tr>
</tbody>
</table>

**Photos**

Resource name | string

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource name</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Time stamp¹</td>
<td>timestamp</td>
<td></td>
</tr>
<tr>
<td>Link to</td>
<td>link</td>
<td></td>
</tr>
</tbody>
</table>

¹ YYYY-MM-DDTHH:mm:ss[.ffffff]

**Videos**

Video name | string

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video name</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Link to</td>
<td>link</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2.4 Computation Level

Table 18. List of attributes in the Computation Level of SERIES EDF

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Searchable</th>
<th>Private</th>
<th>Uploaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational agent</td>
<td>The personnel performing the listed computations.</td>
<td>string</td>
<td>string</td>
</tr>
<tr>
<td>Usual forename</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family name</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td>string</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institution</td>
<td>string</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Original loading signals

*The original time-histories and the information on the inputs used on the different experiments are collected*

<table>
<thead>
<tr>
<th>Original loading name</th>
<th>string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature(^1)</td>
<td>string</td>
</tr>
<tr>
<td>Source</td>
<td>string</td>
</tr>
<tr>
<td>Peak excitation(^2)</td>
<td>string</td>
</tr>
<tr>
<td>Original loading signal</td>
<td>link to signal</td>
</tr>
<tr>
<td>Additional documentation</td>
<td>pdf</td>
</tr>
</tbody>
</table>

\(^1\) Possible values are: natural (accelerogram), natural-normalized (natural accelerogram normalized in the intensity), natural-modified (natural accelerogram modified according to Eurocode, for example), or generated/generated normalized (for accelerogram generated according to Eurocode or as for cyclic tests, often performed in the preparatory phase).

\(^2\) Peak Excitation is the maximum value of the loading signal, which may be an acceleration, for the case of seismic input, or a displacement (or other measures), for the case of inputs of different nature, such as in cyclic tests or snap-back tests.

### Detailed loading characteristics

*This field collects all the information that characterizes the experiment, as for example direction, effective input files, etc.*

<table>
<thead>
<tr>
<th>Nominal loading name</th>
<th>string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original loading</td>
<td>link</td>
</tr>
<tr>
<td>Direction</td>
<td>string</td>
</tr>
<tr>
<td>Loading coefficient (%)</td>
<td>number</td>
</tr>
<tr>
<td>Effective input file</td>
<td>link</td>
</tr>
<tr>
<td>Additional parameter</td>
<td>string</td>
</tr>
<tr>
<td>Notes</td>
<td>string</td>
</tr>
</tbody>
</table>

### Mesh & model

*The assumptions made on the numerical model concerning the elements modelled (beam, column, etc.) and the type of loading (nodal, uniform, excitation, etc.)*

<table>
<thead>
<tr>
<th>Undeformed shape picture(^3)</th>
<th>link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material(^2)</td>
<td>string</td>
</tr>
<tr>
<td>Material symmetry type(^4)</td>
<td>string</td>
</tr>
<tr>
<td>Material nonlinearity(^4)</td>
<td>string</td>
</tr>
<tr>
<td>Additional information(^5)</td>
<td>pdf</td>
</tr>
</tbody>
</table>

\(^1\) stores a picture of the original model

\(^2\) concrete, steel, rebar, tendon, masonry, FRP, aluminum, soil, etc.

\(^3\) isotropic, orthotropic, anisotropic, uniaxial, etc.

\(^4\) elastic, plastic, viscoelastic, hyper-elastic, cracking, geotechnical, etc.

\(^5\) can be given through a pdf document

### Boundary conditions

*How the boundaries of the structure are connected to the testing facility (as on the shaking table), and, in the case of pseudo-dynamic experiments, the location of the actuators. Drawings, photos or reports may be available.*

<table>
<thead>
<tr>
<th>Document Name</th>
<th>string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link to .pdf</td>
<td>link</td>
</tr>
<tr>
<td>Link to original</td>
<td>link</td>
</tr>
</tbody>
</table>
**Computer system**

Specifies the computer system, the software used and the corresponding version number.

<table>
<thead>
<tr>
<th>Computer</th>
<th>string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>string</td>
</tr>
<tr>
<td>Version number</td>
<td>string</td>
</tr>
</tbody>
</table>

**Signals**

Signals are the product of sensors during an experiment. They are defined by two variables: experiment and sensors.

*Note: Type can be omitted, since all signals are computed*

<table>
<thead>
<tr>
<th>Signal label</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Attribute ¹</td>
<td>string</td>
</tr>
<tr>
<td>Physical quantity</td>
<td>string</td>
</tr>
<tr>
<td>Type ²</td>
<td>string</td>
</tr>
<tr>
<td>Unit</td>
<td>string</td>
</tr>
<tr>
<td>Location ³</td>
<td>string</td>
</tr>
<tr>
<td>Sensor link</td>
<td>link</td>
</tr>
<tr>
<td>Additional parameter</td>
<td></td>
</tr>
<tr>
<td>Signal</td>
<td>link to SIGNAL</td>
</tr>
</tbody>
</table>

¹ Attribute describes the signal (e.g. accelerogram, laboratory, relative, target, drift, restoring)

² Type can be omitted, since all signals are computed. It may be included for finite element programs in which it is possible to position sensors on the mesh.

³ Location can be expressed by coordinates or by descriptive strings (1st floor, east-side, ...)

**Observations**

Multi-media resources preserving all the information reported about a test

<table>
<thead>
<tr>
<th>Observation file name</th>
<th>string</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link to</td>
<td>link</td>
</tr>
</tbody>
</table>

**Graphics**

Multi-media resources summarizing the results of the test in graphical form

<table>
<thead>
<tr>
<th>Graphic name</th>
<th>string</th>
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<tbody>
<tr>
<td>Link to</td>
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</table>

**3D-Plot**

<table>
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<th>3D-plot name</th>
<th>string</th>
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<tbody>
<tr>
<td>Link to</td>
<td>link</td>
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</table>

**Animation**

<table>
<thead>
<tr>
<th>Animation name</th>
<th>string</th>
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<tbody>
<tr>
<td>Link to</td>
<td>link</td>
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</tbody>
</table>
3.3 Gap analysis and Metadata catalogues development for TCS/EENG

The SERIES EDF and the EPOS-DCAT metadata formats, when compared, reflect the differences of scope and domain of the projects that produced them. SERIES EDF is targeted at the specific needs of the Earthquake Engineering community, as they were reflected in the past decade, when the metadata format was first designed and then used in the actual implementation of the SERIES Data Access Portal. EPOS-DCAT-AP on the other hand, has been designed with the explicit aim of allowing different scientific domains that relate to the sciences of solid earth, to consolidate their data. These communities have varying needs and requirements to describe their data and EPOS-DCAT-AP has succeeded in integrating these communities as part of its Thematic Core Services.

The similarities of the Earthquake Engineering community to those domains make some aspects of the EDF easy to map into EPOS-DCAT format. These similarities concern entities such as Person, Organization, etc., which can be used to map the EDF entities Project coordinator, or Investigator (Table 15). SERIES EDF format lacks a property that can act as a global identifier for persons. In SERIES, Persons are identifiable only through internal ids which have scope only in the context of SERIES. EPOS-DCAT-AP on the other hand requires that Persons are identifiable via identifiers such as ScopusID, ORCID, or similar (Table 13) which allow a global identification, outside of the context of a given TCS. To bridge this discrepancy, an upgrade of the SERIES EDF may be necessary to include global identifiers for Persons that have a role in SERIES metadata. The retrospective acquisition of such metadata for projects that have been concluded for many years may be problematic, and a strategy may need to be defined to address this issue. A similar issue concerns the Organization entity in EPOS-DCAT-AP, where an identifier such as PIC, or ISNI is required. Given that the participating organizations are limited in number, such information is easier to be included in SERIES retrospectively. SERIES EDF needs to be updated though for both cases, in order to be able to harvest these metadata in the future. This update of the SERIES EDF specification would entail updates on existing implementations of partner databases, to host the required data, and updates in the existing SERIES software stack that is responsible for harvesting the metadata from the remote notes.

The mapping of the EDF hierarchical structure (Figure 8) into EPOS-DCAT format seems less straightforward. Figure 10 depicts how the relationship between the TCS domain of Earthquake Engineering (E/ENG) and the EDF metadata structure is proposed to be established. All metadata that are shared via the SERIES Central Site, are exposed to machine-readable format via a single web service. The metadata are categorized in accordance to eight DDSS definitions. For each of those DDSSs, an operation is provided via the webservice to retrieve the metadata.
Figure 9. Proposed structure of the metadata retrieval webservice of the TCS Earthquake Engineering. A single webservice provides retrieval operations for DDSSs that follow the SERIES metadata structure.

The hierarchical structure of the SERIES EDF format is proposed to be implemented in EPOS-DCAT-AP via the mechanism of Datasets (Table 8. Mandatory Classes for DCAT-AP). Datasets, as specified in EPOS-DCAT-AP, can relate to other Datasets. Using this mechanism, hierarchies of Datasets can be specified, reflecting the hierarchical relationship between the SERIES EDF Levels. The Dataset entity provides three properties that allow such an implementation (Table 14):

- **isPartOf**, which denotes that a Dataset is physically or logically included in another Dataset,
- **hasPart**, which relates the current Dataset to a Dataset that is part of the current one,
- **source**, which refers to a related Dataset from which the described Dataset is derived.

Appendix 12 contains a sample TTL that describes the TCS metadata retrieval webservice.
4 IT-related needs for further steps

Current SERIES architecture is comprised of two conceptual parts, the Central Site and the Remote nodes (see Figure 1b). The remote nodes act as distributed data storages and are controlled by SERIES partners. The Central Site provides data discovery and publication services. To achieve this, the Central Site harvests metadata from the remote nodes and allows end-users to search these metadata data and download data from the remote nodes via the Central Site interface. Currently, SERIES harvests and hosts the metadata from remote nodes (Earthquake Engineering community laboratories) while actual data are hosted by the nodes themselves.

In order to integrate the SERIES metadata into EPOS, flow of data in two directions has to be established.

In the upstream direction, metadata from SERIES need to be exposed to EPOS through the TCS E/ENG (Earthquake Engineering). This will be facilitated through the “TCS metadata retrieval web service”. The TCS metadata retrieval web service acts as the single point of access for automated metadata exchange of the underlying E/ENG data in the EPOS-DCAT-AP format, as described in the previous section.

In the downstream direction, requests for data that are submitted by end-users via the EPOS GUI (or similar end-user interfaces) are served via the TCS data publication web service (Figure 10). The current model through which access of actual data is provided to end-users of the SERIES Data Access

Figure 10. SERIES as an EPOS-TCS. Two web services are provided. Metadata retrieval web service facilitates upstream flow of metadata information to enable data search and discovery by end-users via the EPOS ICS. The data publication web service handles user requests for actual data that are hosted in the data storage facilities of the SERIES remote nodes.
Portal, presumes an implicit trust in the infrastructure, in which data requests are handled in the following manner: (a) end-users issue download requests in the SERIES DAP, (b) SERIES displays a terms of service (ToS) message that the user has to accept in order to continue, (c) each request is transparently forwarded to SERIES remote node that actually hosts the data, (d) the remote node answers the user request based on an automatic exchange of certificates between the SERIES DAP and the remote node. Such a chain of trust can be expanded to include the TCS data publication service. An issue that needs to be resolved is the acceptance of the ToS by end-users at the level and EPOS-ICS end-user.

The EPOS-DCAT-AP model demands that web services be described via Turtle files (.ttl). A first draft of such a file is included in Appendix 12. This initial version was established via the web editor that is provided by EPOS (EPOS metadata editor). Unfortunately, the current version of the metadata editor is not sufficiently stable and the editing of the turtle file has to be performed manually.

5  The way ahead

5.1  Objective of the integration

The work conducted in SERIES enabled the automated integration of experimental results within a number of European laboratories and brought a source for experimental data so that the earthquake engineering community can access data from any SERIES partner by using a single, unified web interface. SERIES also supported the creation of an infrastructure that filled the technological gap between partners. On the other hand, EPOS integrates the key research infrastructures in seismology, volcanology, geodesy, geology, geomagnetism, anthropogenic hazards and geoenergy applications. Each thematic community develops specific services that are validated and introduced in EPOS for sustainable operation.

The main objectives of the integration of databanks and services from SERIES and EPOS are to improve access to earthquake engineering and seismology data and services and facilitate cross-discipline collaboration. This integration will strengthen the SERA advanced community of earthquake engineering and seismology and more in general the community of earthquake hazard and risk mitigation. This effort will serve the needs of the individual communities and, more important, improve the interoperability of the data exchange services aiming at smarter access, integrated data and knowledge that is needed to develop innovative technologies for the reduction of the vulnerability of the built environment to earthquakes and the mitigation of seismic risk.

The most immediate approach to effect the integration is to consider the SERIES database as the first service of a new Earthquake Engineering Thematic Core Service (E/ENG TCS) within the EPOS architecture. By following this approach, SERIES will initially provide, through EPOS, integrated access to key data and experimental measures produced at some of the best facilities for earthquake engineering worldwide. In its mature phase, the integration process will provide an advanced interoperability within the earthquake engineering community itself, with the sibling TCS seismology and other TCSs, and with international partners. This objective will be guaranteed by means of the implementation of new services and tools for improving user accessibility and experience.
5.2 Pre-operational service activities

The planned integration of SERA data in EPOS, as laid out in the previous sections, can be analyzed in the following tasks.

- Identification of specific datasets to be selected for the validation of EPOS-SERA interoperability. The identified datasets should be such that cover the range of datasets that are desirable or meaningful to be shared with EPOS. Furthermore, targeted modifications need to be applied to the selected datasets to overcome the discrepancies identified in section 3.3, such as lack of global identifiers for Persons or Organizations in the SERA EDF. Should such modifications be deemed to be necessary for further integration, the process by which they should be applied needs to be established.

- Development, deployment and evaluation of the TCS metadata retrieval web service (see Figure 10). The pilot version of the metadata retrieval web service will be developed and hosted in the SERIES Central Site and be part of the EPOS TCS E/ENG. Development of the web service will be based on the API standards used in the SERIES-internal web services that are used to harvest metadata from the SERIES remote nodes.

- Production of the ttl-description (Turtle files) for the TCS metadata retrieval web service. Initial work is underway for constructing ttl-descriptions, based on the assumptions that the final TCS metadata retrieval web service will offer a similar API as the available SERIES web services. Appendix 12 shows such a ttl-description.

- Development, deployment and evaluation of the TCS data publication service. The web service should receive requests for datasets from EPOS-ICS and return URIs that point to the actual datasets. In this request and response process, a step for acknowledging SERIES’ Terms of Service (ToS) agreement may be necessary to be inserted: a) the web service receives a request and responds with, b) after the ToS have been acknowledged, a URI is given that points to the dataset, c) dataset can be retrieved by following the URI. By the end of the pre-operational phase, the precise formulation of the process of acknowledging the ToS should have been established.

5.3 Tasks and timeline

The roadmap puts forward a strategy for integrating the databanks and services of SERIES in the EPOS framework. However, the different tasks introduced in the roadmap cannot be performed integrally in the time frame of the SERA project. For such reason, a timeline divided in three steps (short-, mid- and long-term) is proposed in Figure 11.

In the short-term, by the end of the SERA project, a pre-operational access service will be provided to selected SERIES datasets in order to allow validation of identified access technologies and involvement of the user community, for further implementation in EPOS. In the activities planned for the short-term, the involvement of the SERA partners and other users (e.g. researchers and operators of research infrastructures who replied to the questionnaire), through beta-tester activities and feedback on requirements and services to be implemented, would be beneficial in order to collect suggestions for the further improvement of the access services. At the end of the short-term period, a simple use case will be implemented and validated. Moreover, DDSS such as list of experimental campaigns with short information, first-glance report and identification of as-built and retrofitted buildings should be implemented. The pre-operational phase will be important for disseminating the approaches and innovations developed in SERIES and SERA to adjacent scientific communities, e.g.
structural monitoring, structural engineering, etc., in order to increase the Earthquake Engineering TCS partners and introduce new relevant expertise and areas different from the purely experimental one.

The activities performed in the mid-term will include a review of how the newly developed services and products will be fully compatible with the requirements of EPOS, at the technical, legal, governance and financial levels. The mid-term activities will also aim at expanding the access to and collection of data and at performing an in-depth study of the full range of data to characterise the level of maturity of the DDSS elements and prepare for moving to the next stage, i.e. full data integration. Moreover, new tools and services (data visualization and manipulation tools, learning and teaching services, etc.) will be designed to offer more complex services in the earthquake engineering and seismology TCS, and to facilitate networking of new classes of infrastructures and data for future services in EPOS. These tools will be implemented in a pre-operational service activity for validation by EPOS. In this phase, a close interaction between users and partners of different TCSs will foster the cross-fertilization of the communities. At the end of the mid-term period, a complex use case will be implemented and validated. Moreover DDSS, such as data processing and visualisation on the platform without the need to download, images and videos with metadata, data where pi-delta effect is removed, data for structural types present in a specified area, tests performed with accelerogram 'similar' to a given one and a coverage expansion to wider range of earthquake engineering research infrastructures – also outside Europe should be implemented.

In the long-term perspective it is foreseen to provide a critical contribution to the successful construction and validation of EPOS, by developing major building blocks for the provision of key advanced services in earthquake engineering and seismology. Moreover, by including access to research infrastructures, laboratories and data centres established outside Europe, it will be possible to improve the international dimension of EPOS and increase its overall impact. At the end of the long-term period, the services developed by the earthquake engineering community will be mature to constitute a fully-integrated Thematic Core Service (TCS) in EPOS. This new TCS will be a new important pillar of EPOS that will provide access to data, services and infrastructures that are
important for other TCSs and the society at large. At the end of the long-term period, an advanced and/or cross-disciplinary use case will be implemented and validated, moreover DDSS such as interface with simulation tools, correlation of intensity measures (PGA, etc.) with damage of specimens, development of fragility functions and automated damage assessment according to codified procedure, e.g. FEMA P58 should be implemented.

The technical aspects and procedures proposed in the roadmap describe a possible path to follow for the complete and effective integration of the SERIES databanks and services into EPOS. However, it has to be noted that an effective and complete integration needs a deep analysis of the technical, legal, governance and financial aspects to be conducted by the scientific advisory body of the EPOS Board of Governmental Representatives with the support of an External Evaluation Panel and by the SERA partners and other interested infrastructures that offer access to earthquake engineering DDSS.

6 References


7 Appendix 1 – Questionnaire

Requirements and use cases for earthquake engineering and seismological data

Fields marked with * are mandatory.

The Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe (SEPA) is a Horizon 2020 project aiming at reducing the risk posed by natural and anthropogenic earthquakes, based on innovative research and development projects. SEPA also targets at providing improved access to data, services and research infrastructures for scientists and other professionals. Among the objectives of SEPA is to design a roadmap for integration of earthquake engineering and seismological data banks and informatics services to serve the needs of the research communities involved and beyond.

The work conducted in the project SERIES (Seismic Engineering Research Infrastructures for European Synergies) enabled the integration of experimental results within a number of European laboratories so that users can access data by using a centralized gateway, the Data Access Portal. The European Plate Observing System (EPOS) is a long-term plan to facilitate integrated access/use of data, data products, software and services provided by heterogeneous infrastructures on solid Earth science in Europe.

This questionnaire is addressed to all end-users of earthquake engineering and seismological data and aims to collect information on requirements and use cases that will feed into the roadmap for integration of SERIES and EPOS data banks.

*Your name

*Your surname

*Organization

*Country

*e-mail

22 https://ec.europa.eu/eusurvey/runner/SERA_Survey_RUCs (still open)
What is your expertise / field of interest?

- experimental testing
- numerical modelling
- teaching
- software for structural analysis

Please specify
100 character(s) maximum

Please describe data, data products, software and services (DDSS) that you would like to access through the data portal.
1200 character(s) maximum

How important are the following requirements for the data banks?
1 = least important, 5 = most important

<table>
<thead>
<tr>
<th>Requirement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple search</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Advanced search</td>
<td></td>
<td></td>
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<tr>
<td>Access to search interface at local database</td>
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<tr>
<td>Search for data in different formats (e.g. text, image, video)</td>
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<tr>
<td>Contact information at local database</td>
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<tr>
<td>Contact information for individual project</td>
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<tr>
<td>Data visualisation tools</td>
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<tr>
<td>Tools to elaborate data</td>
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<tr>
<td>Access to test reports and scientific publications</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of specimen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of experimental setup</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Possibility to share my own DDSS</td>
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</tbody>
</table>

Please describe other important requirements that were not included in the previous question.
1200 character(s) maximum
Please describe simple use cases. List use cases from the one with highest priority for implementation to the one with lowest priority.

2000 character(s) maximum

A simple use case is describing a basic and elementary functionality, i.e. search for data, simple visualisation and download. Example: As a researcher I want to download data from experiments on RC columns so that I can validate a new model.

Please describe complex use cases. List use cases from the one with highest priority for implementation to the one with lowest priority.

2000 character(s) maximum

A complex use case will search for datasets from various sources/local database, visualise them and possibly perform an analysis or processing. Example: As a university teacher I want to compare total base shear - top displacement curves of buildings designed with different codes so that I can explain to students their different performance.

Please describe use cases that require earthquake engineering and seismological data. List use cases from the one with highest priority to the one with lowest priority.

2000 character(s) maximum

The [Seismology Thematic Core Service](#) of EPOS provides services for waveform data, earthquake parametric data, hazard data and computational seismology. Example: As a municipality official I want to know the damage grade of old RC buildings for the peak ground acceleration corresponding to the maximum credible earthquake in my town so that I can estimate losses for this scenario.

What are your expectations and objectives to achieve through the integration of earthquake engineering and seismological data?

1200 character(s) maximum

Are you interested in obtaining access to research infrastructures for experimental, training, etc. activities?

Ten [high-class research infrastructures](#) offer transnational access within SERA.

- Yes  
- No

Please briefly describe the experimental, training, etc. activities you are interested in.

1200 character(s) maximum

Would you like to be informed of the developments in the roadmap for integration of earthquake engineering and seismological data?

- Yes  
- No
8 Appendix 2 – Importance of requirements

Simple search
- 1
- 2
- 3
- 4
- 5
- No Answer

Advanced search
- 1
- 2
- 3
- 4
- 5
- No Answer

Access to search interface at local database
- 1
- 2
- 3
- 4
- 5
- No Answer

Search for data in different formats (e.g. text, image, video)
- 1
- 2
- 3
- 4
- 5
- No Answer

Contact information at local database
- 1
- 2
- 3
- 4
- 5
- No Answer

Contact information for individual project
- 1
- 2
- 3
- 4
- 5
- No Answer
D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures

Data visualisation tools

- 3% 3% 13% 28% 25%

Tools to elaborate data

- 3% 13% 13% 25% 16%

Access to test reports and scientific publications

- 3% 0% 6% 9% 16% 66%

Description of project

- 3% 0% 6% 13% 38% 41%

Description of specimen

- 3% 3% 3% 13% 28% 50%

Description of experimental setup

- 3% 6% 3% 13% 22% 53%

Legend:

- 1: Very Poor
- 2: Poor
- 3: Good
- 4: Very Good
- 5: Excellent
- No Answer
Appendix 3 – User requirements and use cases collected through the questionnaire

Please describe data, data products, software and services (DDSS) that you would like to access through the data portal.

- I don’t really know what is the availability atm. Generally, any type of information would be of interest. Perhaps raw data more interesting for research purposes and data products interesting for teaching/demonstration purposes.
- Experimental results from subassembly, system level and component testing
- Raw and processed (filtered) data from experiments conducted. Supporting post-processed data for any paper published on the experimental work
- Flat slabs under seismic actions experimental data.
- Strong motion data (raw and corrected data), real accelerogram spectrum-compatible to a target acceleration or displacement response spectrum, tools for ground motion selection using conditional mean spectra
- Data on precast structures, precast connections, masonry infills
- Experimental development of seismic resistance solutions.
- Raw data of experimental results (i.e. a test database), whereby all information is needed to be able to numerically simulate the experimental test, i.e. characteristics and drawings of test setup (including tested specimen as well as surrounding setup, which may have an influence on results). Already a "first glance" report, diagrams and pictures with main conclusions. Service is not important for me, as I would post-process the data by myself - when needed.
- A list of experimental test campaign with a brief description. After selection of the test campaign, access to raw data and to a report that describes the test setup, instrumentation and test sequence. Ideally, it would be possible to visualize and analyze data directly on the website (time history, Response spectra, transfer function, filter). Finally, download data.
- Raw data, data products and data visualization
- Seismological data bank and benchmark of structural response
- Data products: Cleaned experimental data that can be used for the validation of numerical modelling tools, in particular results from hard-wired channels but also images and videos (should be taken in a systematic manner with sufficient meta-data to transfer which parts of the structure these images show)
- Jupyter notebooks are really handy for data manipulation and visualization. Python should be provided in the data portal as data manipulation software.
- Test results on masonry structures, dynamic testing, behavior of wall-to-wall connections
- Detailed data of experimental tests for calibration of behaviour models
- Seismological data sets, waveforms, experimental results, catalogues
- Experimental data and analysis report
- Replicate the functions of DesignSafe-CI. Then, implement a mechanism to peer-review the entry (there are many many empty entries in the SERIES database) before a DOI number is assigned and
the entry is made public: it is good to associate a so-called "data paper" with a database entry, as is done in Earthquake Spectra. Then, implement a data embargo and data access expiration functions to be consistent with the OpenAccess publication guidelines.

- Raw data from experiments, post-treatments of data as (time varying) equivalent frequency, modes and damping, visualization of force/displacement (or inter-storey shear/drift) curves
- TXT, MATLAB, ANSYS APDL, EXCEL, etc.
- Strong ground motion data, data from experimental tests and in situ tests, geotechnical data from different sites across Europe, Seismicity data of European Regions
- Use of Structural Labs
- Data concerning the behavior of specific structures (displacements, moments, accelerations, strains, rotations, cracks, Soil Structure Interaction), earthquake loading
- Simulation Tools, data on earthquake damage, data on experiments, learning tools and resources, data processing and visualisation, Outreach materials
- LabView, DIADEM

Please describe other important requirements that were not included in the previous question.

- My products are under development at the moment with two UK Universities
- Data reliability, data processing routines
- Completeness of metadata for strong motion recordings
- Post a comment, have a discussion with other users and/or with the project responsible
- An option to share information with other researchers
- Implies that data structures will be shared, too. The tools to instantiate these data structures then must be open source, not proprietary
- Access to Quality Plan for the experiment (including calibration procedure and results), possibility to download data (was it implicit?)
- Standards, acceptance criteria

Please describe simple use cases. List use cases from the one with highest priority for implementation to the one with lowest priority.

- As an academic I would like to have access to raw experimental and numerical results to give my students a benchmark model to start their research
- I would like to download data from system level tests to validate models that capture the force redistribution after damage initiation
- As a researcher I want to download data from experimental tests on flat slabs
- Download datasets and use them as a benchmark in numerical and experimental modeling, visualization purposes to well document one or more case study
- Database on seismic tests on reinforced concrete structural components and frame structures with the main focus on beam-column joints
Access to test data and test reports to investigate and validate new models

- Downloading data to be able to numerically simulate. Easy searching for data. Different formats of data, to be able to easily use it
- I would like to download data to get the structure characterization, the plastic behavior of the elements, the details of the experimental set-up in order to reproduce the tests and to compare with results in literature
- Download hard-wired data and digital images of experimental tests for numerical model validation
- As a user I would like to search with keywords the data, have a simple visualisation tool, search for the accompanying documentation and reports, and download the data, so that I can use it for numerical modeling
- As a researcher in tectonic and induced seismicity, I would like to download data from experiments on building types which are similar to edifices in my research area
- Downloading data from hybrid simulation and shaking table tests
- Look up force-deformation response data for a single specimen in a project
- Possibility to combine signals (linear combination) in visualization (can become a complex use case in case of different experiments/structures), search by dimension of specimen, use of tools (power spectrum, wavelet analysis, …)
- Natural strong motion data is used to generate records for the description of a given design Spectrum; experimental data are used for the validation / calibration of numerical models; case studies are used in teaching
- Validation of theoretical and numerical models that we develop
- Data from experiments for model evaluation, data from experiments for code and standard development, visualisation capability to search for tests from various sources under a common theme

Please describe complex use cases. List use cases from the one with highest priority for implementation to the one with lowest priority.

- As above perhaps the post processing of the results (e.g. excel files of the processed results) to compare our models (e.g. developed in a different version of the software) with the benchmark model. This is very important to accelerate research results
- I would like to use data on moment rotation of columns that the P-Delta effect has been removed from the deduced moment rotation diagram
- I want to have access to the experimental data on flat slabs under seismic and cyclic actions.
- Downloaded datasets and process them for additional or complementary numerical analyses for research; distribute datasets to students of a course to perform homework and/or projects with original or modified data
- Describing the seismic performance of reinforced concrete structures to students; educating students about the seismic behavior of different structural components; gathering information on the performance of retrofitted structures
• Comparison of influence of detailing in RC and precast structures for training, teaching and research purposes
• Searching for different peak floor accelerations of "shake table tested" buildings to assess the quality of current code approaches
• I am interested in the behavior of the nodes of the structures subject to test in order to compare them with results available in literature
• Extract similar information from various tests (which might have had different instrumentation) and compare, give a measure of the quality of the experimental data
• I would like to be able to perform data manipulation online inside the data portal, i.e. signal processing and visualisation, without downloading the data. For these reason, python, Matlab, R, and other similar software should be available for use inside the portal
• Comparison of data between hybrid simulation and shaking table tests
• Find all shear wall specimens with a shear span smaller than 1.0, axial load ratio larger than 0.1, vertical reinforcement ratio less than 1.0%, and specific steel and concrete strengths, tests cyclically using a loading protocol with a minimum of two repeated cycles after first yield. Extract only pictures of the specimens for displacement ductilities larger than 2
• Possibility to combine signals (linear combination) in visualization (can become a simple use case in case of same experiment/same structure), search for experiments having the base acceleration "closer" to a given accelerogram ("closer" can be based on Response Spectrum, Power spectrum, time/frequency representation of the signal)
• Definition of seismic risk based on historical and recorded seismicity in a region
• Validation of theoretical and numerical models that we develop (in terms of forces-displacements but also strains, and crack openings) and Soil Structure Interaction
• Access to data from experiments under a common them to develop guidelines and code proposals,

Please describe use cases that require earthquake engineering and seismological data. List use cases from the one with highest priority to the one with lowest priority.

• None that I can think of apart from the recorded responses of bridges for given earthquake motions. this would be helpful in conjunction with calibrated FEM models to start a research project (as opposed to starting from scratch
• Spatial correlation of PGA and mapping with damaged buildings
• To perform pushover analysis, capacity assessment and Seismic fragility analysis of concrete structures we need to have response spectra for different ground accelerations
• Simulation of deterministic scenarios of damage to structures and infrastructures using a mathematical-numerical model that includes both the seismic source (e.g. kinematic model of a fault) and the structure; Simulation of deterministic scenarios of environmentally-related co-seismic failures such as slope instability, soil liquefaction, ground failure, surface fault-rupture and foundation interaction
• Waveform data, hazard data
• see below: Linking damage of buildings to seismological events, e.g. what are the most detrimental earthquake characteristics causing for a specific kind of structures. Are some
characteristics more dangerous and so on. What are the differences between different buildings/events in terms of performance?

- As a civil protection agent, I would like to have an early warning system that will alert students in the municipality schools about the incoming earthquake, and at the same time I would like to have a vulnerability assessment of the structural damages and the risk that each school will exhibit so that I can manage the efforts of the civil protection teams after the earthquake.

- As a researcher in tectonic and induced seismicity, I would like to download data from experiments on building types which are similar to edifices in my research area.

- Behaviour and damage of old historical buildings.

- Simple: report all available squat shear wall fragility functions for near filed earthquake hazard. (1)Complicated: extract and scale earthquake ground motions for a specific location; find all steel moment frame buildings in the database designed for the that location (similar seismicity, soil, etc.); perform IDAs for these buildings and ground motions to compute the life-safety limit state fragility curves. Report these fragility curves. More complicated: estimate the risk exposure of an EC8 compliant reinforced concrete frame 5-story 2000 m² bank back-office building in Bucharest for a period between 2025 and 2100. Report the monetized expected annual losses due to business interruption and casualties separately (note: this can be done using FEMA P-58 PACT or SP3 today).

- The second use case can be combined with seismological data: search for experiments having the base acceleration "closer" to a given accelerogram just registered after an important event.

- Definition of seismic hazard and development of spectrum-compatible accelerogram for seismic design with transient analyses.

- Establishing risk associated with earthquakes for a transportation infrastructure network.

What are your expectations and objectives to achieve through the integration of earthquake engineering and seismological data?

- Explore different directions/options/open research areas/gaps in knowledge in earthquake engineering.

- Regional loss assessment.

- It will facilitate a better understanding of the response of the built environment to earthquake loading. It will help to better identify what particular features of ground motion are correlated to damage to structures and infrastructures. It will help to better identify what particular features of ground motion are correlated to environmentally-related failures such as landslides and ground failure. It will help improving the dialogue between seismologists and earthquake engineers.

- More reliable seismic hazard assessment around Europe.

- Linking damage of buildings to seismological events, e.g. what are the most detrimental earthquake characteristics causing for a specific kind of structures. Are some characteristics more dangerous and so on. What are the differences between different buildings/events in terms of performance?

- To integrate hazard calculation in vulnerability assessment of structures.

- I expect for instance to get a quick overview on areas I'm working in, to see if there are chances for hazard and risk studies, and what would be missing to do a proper study of that kind.
• Make the complicated use case above possible with one click(1)
• Better identify and quantify pro and cons of preventive retrofitting (mostly on experiment) vs repair after an important event (mostly on real observation).
• As we are primarily studying assets in Europe, the objective is to have access to reliable and up-to-date earthquake engineering and seismological data from Europe
• Research and teaching
• Improved scenario and risk evaluation
• Promotion of our research facilities, access to research activities

Please briefly describe the experimental, training, etc. activities you are interested in.
• Interested to access the EUROSEISTEST and EUROPROMAS testing facility to examine multiple hazards effects on bridge behaviours
• Data management, instrumentation
• Experimental testing of concrete structures under combined gravity and horizontal cyclic (or dynamic) loading
• Centrifuge modelling of geotechnical earthquake engineering problems. Field trial tests to simulate earthquake-induced ground liquefaction. Laboratory tests on small-scale physical models (for example seepage through an embankment dam) for teaching purposes and to communicate science and engineering to the general public
• Seismic testing of RC structures (pushover, quasi-static cyclic, shake table)
• Shake table testing and cyclic testing, Monitoring data of real buildings gathered during seismic events
• I am interested in experimental activities to test some new materials under a seismic input
• SERIES / SERA is an excellent funding instrument and I hope it will be maintained
• Standardization of testing procedures, hybrid simulation
• SERA 3DRock project
• Training on centrifuge testing
• Seismic qualification of equipment and structures, training on numerical calculation methodologies, training on improvement of seismic resistance of structures
• Experimental investigation of the dynamic response of structural and geotechnical systems, Soil-structure interactions, Training and Innovation in Earthquake Engineering in Europe
• Experimental tests on structural systems for building structures and on innovative seismic devices
• Seismic tables, centrifuge facilities
• Payload projects on ongoing tests where I would evaluate new sensors, or theories
• Shake table tests, ambient vibration measurements, force vibrations, quasi static tests
Appendix 4 – Questionnaire: Requirements of TCS/EENG Laboratories and Transnational Access (TA) facilities

Requirements of TCS/EENG Laboratories and Transnational Access (TA) facilities

Fields marked with * are mandatory.

About SERA/EPOS
The Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe (SERA, www.sera-eu.org) is a Horizon 2020-supported program aiming at reducing the risk posed by natural and anthropogenic earthquakes, based on innovative research and development projects. SERA also targets at providing improved access to data, services and research infrastructures for scientists and other professionals.

The European Plate Observing System (EPOS, www.epos-ip.org - EPOS-IP refers to EPOS Implementation Phase), is a long-term plan to facilitate integrated access/usage of data, data products, software and services (ODSS) provided by heterogeneous infrastructures (Thematic Core Services, TCS) on solid Earth science in Europe. The metadata describing these DDSS for each TCS (which may follow established metadata profiles such as ISO 19115, DCAT, Dublin Core) are being mapped (via the EPOS data model) to a CERIF (Common European Research Information Format) metadata catalogue, in order to manage all the information needed to satisfy user requests related to the various DDSS.

The project SERIES (Seismic Engineering Research Infrastructures for European Synergies) addressed the fragmentation and sub-optimal use of European research infrastructures by bringing together Europe’s research infrastructures in earthquake engineering into a coherent and sustainable platform of cooperation. The work conducted in SERIES enabled the automated integration of experimental results within a number of European laboratories and brought a source for experimental data so that the earthquake engineering community can access data from an SERIES partner by using a single, unified centralized gateway, the Data Access Portal (www.datap.series.upatras.gr).

Building on the achievements in SERIES project and the developments in EPOS, one of SERA tasks targets to a roadmap for the integration of earthquake engineering and seismological data, databanks and informatics services to serve the needs of the research communities involved and beyond. The parallel activity in SERA and EPOS offers opportunities to benefit from each other, especially regarding advancements in the data and services offered in EPOS. In this respect, an important milestone for SERA will be to contribute to the enlargement of EPOS by adding new scientific thematic communities, i.e. TCS – the earthquake engineering community being a potential candidate (TCS/EENG). The first step in this direction entails the definition of the general requirements by TCS/EENG and a list of the DDSS it will provide to users; this step, along with use-case scenarios, will provide the technical details necessary for a feasibility study/roadmap in integrating the earthquake engineering community to EPOS and providing earthquake engineering DDSS to EPOS. The questionnaire that follows is intended to extract the required information.

*Your name

*Your surname

https://ec.europa.eu/eusurvey/runner/SERA_Survey_TCSEngineering (still open)
The following questionnaire is split in two parts, one of general nature (Part A, approximate 15-20 min to complete) and a more technical one (Part B, approximate 20-25 min to complete).

**Part A**

Please provide short info for your organization/institution (two sentences).

*400 character(s) maximum*

Which should be the scope of a Thematic Core Service in Earthquake Engineering (TCS/EEENG) in EPOS?

*1200 character(s) maximum*

Note: Within the EPOS IP, ten different communities were identified and organized in as many Thematic Core Services (TCS), taking into account the requirements of the different EPOS communities. The TCS are the community-specific integration (e.g., seismology, volcanology, geodesy, experimental laboratories, etc.) and represent transnational governance frameworks where data and services are provided to answer scientific questions. It is within the TCS where each community discusses their specific implementation, best practices, and sustainability strategies as well as legal and ethical issues.

Who would you envisage to be the main stakeholders of such TCS/EEENG in EPOS?

*200 character(s) maximum*
Would your institution/organization be willing to participate in developing parts or elements (data dissemination, provision of services, provision of software, etc.) in a TCS/EENG in EPOS?

- Yes
- No

Can you describe how is currently your data acquired, curated and made available to the users?

1200 character(s) maximum

Who are currently the users of your data within your institution/organization and outside?

1200 character(s) maximum

Does your institution/organization employ the Exchange Data Format (EDF), developed within the SERIES project, for managing your data locally? If not, what is the substitute system?

1200 character(s) maximum

Note: The external user connects to the SERIES Central Web site where various functionalities giving access to data are found. Some of these data will be stored locally to the Central Site, while some other data will be kept locally at the partner’s repository but would be accessible by means of Web Services. The external user obtains the data in a uniform manner, encapsulating values and context. These elements in SERIES are called the Exchange Data Format (EDF). The EDF solves the problem of partners storing their own data in their databases in an unstructured way.

Has your institution/organization implemented the SERIES Data Access Portal (SERIES-DAP) service?

Note: The SERIES Virtual Database can be accessed by an external user at the Data Access Portal (DAP) at http://www.sdap.series.unifr.ch/.

- Yes
- No

Does your institution/organization maintain and perform content update of the SERIES-DAP service?

- Yes
- No
Have you identified modifications to the data model of the SERIES-DAP service which should be accounted for in the DDSS metadata of a future TCS/EENG?

What functionalities are currently missing at SERIES-DAP that could be added to the EPOS-IP?

Would you consider an updated version of SERIES-DAP as a suitable/viable way of interoperation with EPOS?

What is the format(s) of the data/data products (if applicable) that could/would be made available by your Institution to EPOS, through the future TCS/EENG?

For each DDSS element that your institution/organization provides (or will provide), add information of:
- where it is located (web database, internal database, individual files, paper, tape, outdated type of media)
- how it is accessible (via web services, personal contact, downloaded from website and if yes which, etc.)
Does your organization/institution have a Data Management Plan (lifecycle of collected, processed and/or generated data)?
- Yes
- No

Does it comply to some standard? Which one?
1200 character(s) maximum

What is the data policy of your organization/institution: is the data open, restricted, or embargoed?
1200 character(s) maximum

How would you prefer access to the DOSS of the future TCS/EENG be better served:
- through a single e-infrastructure (centralized TCS/EENG)
- through the individual organization endpoints (distributed TCS/EENG)

Would you contribute to a "User Feedback Group" within the EPOS TCS/EENG?
- Yes
- No

End of Part A. You can continue with the more technical Part B (approximate 20-25min to complete). If you wish to submit Part A only, please scroll down to the end of the questionnaire and click on the "submit" button.

Part B

Can you provide a short list of the DDSS your organization/institution could/should make available through EPOS?
1200 character(s) maximum

Please specify the type of resource (Data, Data Software, Service or Service, DOSS) and its name. If you are describing a group of resources, then provide the name of each one.

Note: The list of Data, Data Products, Services and Software (DOSS) provided by individual institutions, consortia or organizations which are or will become part of the EPOS platform are currently collected in a document termed DOSS Master Table (a mechanism to update the requirements and use case information as well as a mechanism for accessing more detailed IT technical information and the integrated CORE Services). Each EPOS Thematic Core Service is collecting the DOSS related to the specific discipline. Each TCS declares a list of DOSS elements which are about to be implemented. The already prepared DOSS elements are of different maturity and some are declared by TCS groups to be ready for implementation; this means that the data are well described with metadata,
following the standards specific for their domain and, in the best case, with some services allowing their access already. The CDSS Master Table serves as an overview of the CDSS elements and includes most of the important information needed for further implementation and is continuously updated as the EPOS project evolves.

What is the metadata standard used by your institution/organization?

1200 character(s) maximum
Please provide information about the metadata used to describe the CDSS: for data (unique resource identifier, title, distribution format, etc.), for software (title, description, version, programming language, license, etc.), for services (name, type, description, contact, terms of use, web access, etc.). You may point to existing documentation, or any other kind of resource which provides a detailed and complete description of the metadata you used.

Does your organization/institution provide web service access (Application Programming Interface - APIs) to your CDSS?

1200 character(s) maximum
Please provide information about the APIs (web services) used to provide access to CDSS. In case it is an on-going process, please specify the status. You may point to existing documentation, or any other kind of resource which provides a detailed and complete description of the APIs.
If for the same CDSS you have two different APIs (one for discovery, the other for accessing / downloading) please provide details of both.
(Note: if you employ the SERIES-CAF, such web service is already implemented).

If your institution/organization does offer web access to your CDSS, for which of the CDSSs is this web access provided?

- to all your CDSS elements
- to only part of them

Please comment on the following points regarding the Authentication, Authorization, Accounting Infrastructure (AAA)

Note: Please provide as much detail as possible. You may point to available documentation. Please provide links to useful documents, with technical specifications, on how to integrate your AAA in the Integrated Core Services (ICS) framework.

- Do you intend to provide secure access to your CDSS or will it be openly available?

1200 character(s) maximum
- Do you have an AAAI in place or do you envisage having one?

1200 character(s) maximum

- Which technology are you using (e.g. eduGAIN, certificates, proprietary technology)?

1200 character(s) maximum

Does your organization/institution offer on-line access to software or other computational environment?

- Yes
- No

Please, describe briefly.

1200 character(s) maximum

Do you have non-commercial data to which you consider providing access for a fee?

Non-commercial data is data that has not been produced for commercial purposes, but might be useful to such.

- Yes
- No

Should the EPOS TCS/EENG platform have such capabilities?

200 character(s) maximum

What type of on-line service/processing tools the EPOS platform should offer to users regarding the future TCS/EENG DDSS made available?
Could you describe (in two sentences) one or more scenarios (use-cases) of use of the DDSS the future TCS/EEENG could provide to users? Please consider a simple and a more complicated one. For each case, please indicate:

How important (considering the degree of use: unavoidable, frequent, occasional, rare) you consider this use-case would be to the TCS/EEENG: High, Medium or Low ?

Does the use-case address a single or more disciplines? Which are the discipline(s) addressed by the use-case?

(Example of simple use-case: A researcher is searching for earthquakes in a specific area/bounding box and in specific time period. Once the earthquake catalogue (list of earthquakes with other specific parameters) is found, the researcher wants to do some filtering of earthquakes: select earthquakes only (i.e. not explosions), select events larger than a specific magnitude threshold (e.g. M=5), select only those earthquakes which have been recorded by at least 5 stations within 150 km distance (all stations must be within that range). For this selection the researcher wants to visualize the catalog in a map, save the map view as a figure for publication, download the complete earthquake catalogue (locations, phase readings, MT solutions, ...) in QuakeML format and download waveforms starting 2 minutes before origin time (time of earthquake) and ending 10 minutes after that time.)

- Scenario 1

- Scenario 2

- Scenario 3

- Additional scenarios
Could you describe (in few sentences) one or more scenarios of cross disciplinary use-cases i.e. a user inquiring DDSS from different EPOS TCSs and on which he/she needs to perform some type of on-line processing? How important do you consider these use-cases to be for the future TCS/EENG (considering the degree of use: unavoidable, frequent, occasional, rare): High, Medium or Low? Which disciplines is each of these use-cases addressing?

[Example of cross-disciplinary use case: A strong earthquake hits southern Italy near the Vesuvius volcano. A scientist is seeking different datasets, and wishes to display and compare them. He/she wants to select subset of data that shows some specific trend and perform analysis on that subset. Next, he/she wants to use the results in another context and prepare figures for publication or web presentation.]

- Scenario 1
1200 character(s) maximum

- Scenario 2
1200 character(s) maximum

- Scenario 3
1200 character(s) maximum

- Additional scenarios
1800 character(s) maximum

Is there a contact person responsible for each DDSS element available in your organization/institution (may be the same for all)? Please provide the respective contact information.
200 character(s) maximum
11 Appendix 5 – User requirements and use cases of TCS/EENG Laboratories and TA facilities collected through the questionnaire

Which should be the scope of a Thematic Core Service in Earthquake Engineering (TCS/EENG) in EPOS?

- To have data in a comprehensive and readily accessible manner.
- Resilience of Communities against Natural Hazards.
- Knowledge exchange, presentation of laboratories, experimental data exchange.

Who would you envisage to be the main stakeholders of such TCS/EENG in EPOS?

- The main stakeholders should have the capacity to maintain the depository.
- Earthquake Engineering Community, Social Scientists and Earth Scientists.
- Laboratories, educational institutions.

Can you describe how is currently your data acquired, curated and made available to the users?

- We use some proprietary software and the White Rose depository.
- There are several sources of data collection being used to acquire data. First and most important is from experimental testing and various facilities. Next, are data generated from computational simulations. These two are followed by data collected from post-event reconnaissance around the world and in the USA from earthquakes and windstorms. Lastly, are data contributed by partner organizations in the USA and abroad.
- Acquired through our acquisition system and shared internally in a cloud.

Who are currently the users of your data within your institution/organization and outside?

- Mainly other researchers.
- Researchers, practitioners and students focused on the mitigation of the impact from earthquakes, tsunamis, windstorms and coastal inundation from storm surge.
- The data are mainly used internally by the employees from the Laboratory for dynamic testing or shared with research institutions which are conducting experiments in our laboratory.

Does your institution/organization employ the Exchange Data Format (EDF), developed within the SERIES project, for managing your data locally? If not, what is the substitute system?

- The data are normally processed and stored in Microsoft and Google drive formats.
- No.
• Implemented but not used actively. We intend to share the data from the experiments which are planned through the SERA project.

Would you consider an updated version of SERIES-DAP as a suitable/viable way of interoperation with EPOS?
• Do not know.
• No.
• Yes.

What is the format(s) of the data / data products (if applicable) that could/would be made available by your Institution to EPOS, through the future TCS/EENG?
• Experimental data from material and structural tests.
• ASCII, database, images, pdf.
• Labview TDM format.

For each DDSS element that your institution/organization provides (or will provide), add information of:
- where is it located (web database, internal database, individual files, paper, tape, outdated type of media)
- how is it accessible (via web services, personal contact, downloaded from website and if yes which, etc.)
• www.designsafe-ci.org
• Experimental testing data from our laboratory are stored in individual files which could be imported in the database developed through the SERIES project and accessed through the SERIES-DAP service.

Does your organization/institution have a Data Management Plan (lifecycle of collected, processed and/or generated data) ? / Does it comply to some standard? Which one?
• Yes / I am not sure.
• Yes / Creative Commons.
• No.

What is the data policy of your organization/institution: is the data open, restricted, or embargoed?
• Aligned with EPSRC and EU policies. Open data as much as possible unless there is a reason to restrict or embargo.
• Open.
• Depending on the type of the research.

Can you provide a short list of the DDSS your organization/institution could/would make available through EPOS?
• Experimental Data, Educational Tool, Images, Reports.
• Experimental testing data.

What is the metadata standard used by your institution/organization?
• DOI for data.

Does your organization/institution provide web service access (Application Programming Interface - APIs) to your DDSS?
• www.designsafe-ci.org
• SERIES-DAP.

Does your organization/institution offer on-line access to software or other computational environment? Please, describe briefly.
• Yes / Tools needed for teaching and research.
• Yes / www.designsafe-ci.org
• No.

What type of on-line service/processing tools the EPOS platform should offer to users regarding the future TCS/EENG DDSS made available?
• As many education and research tools that are freely available.
• data visualization.

Could you describe (in two sentences) one or more scenarios (use-cases) of use of the DDSS the future TCS/EENG could provide to users? Please consider a simple and a more complicated one. For each case, please indicate:

How important (considering the degree of use: unavoidable, frequent, occasional, rare) you consider this use-case would be to the TCS/EENG: High, Medium or Low? Does the use-case address a single or more disciplines? Which are the discipline(s) addressed by the use-case?
• A researcher is searching for test data on RC elements. Once found, he/she wants to select a specific type of element, with specific type of detailing, of specific strength, of specific type of loading.
• A researcher is searching for experimental data on reinforced concrete shear walls under in-plane lateral loading both monotonic and under load reversals reinforced with Grade 60 and Grade 100 reinforcement with varying amount of confinement. Once the test database is assembled, the
engineer wants to do some filtering of the specimen with respect to grade of longitudinal reinforcement: select only those specimens which have Grade 100 or above. For this selection the researcher wants to visualize the sample with respect to maximum load, mode of failure and then save those results as a figure for a paper.

- The researcher in the above Scenario wants to drill in further on the experiments for the purpose of evaluating a proposed code change by comparing the results with calculated test capacities.

- Finally, model numerically a group of selected specimens compiled on the basis of mode of failure and test various models and proposed new modeling strategies.

Could you describe (in few sentences) one or more scenarios of cross disciplinary use-cases i.e. a user inquiring DDSS from different EPOS TCSs and on which he/she needs to perform some type of on-line processing? How important do you consider these use-cases to be for the future TCS/EENG (considering the degree of use: unavoidable, frequent, occasional, rare): High, Medium or Low? Which disciplines is each of these use-cases addressing?

- I respectfully submit that the platform should be kept grounded on providing basic commonly used tools. More advanced simulations and manipulations should be left to the researchers to develop. However, and important service would be to provide access to supercomputing resources to the users to test their advanced simulations for instance.
12 Appendix 6 – Sample TTL describe the TCS metadata retrieval

```ttl
@prefix adms: <http://www.w3.org/ns/adms#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix epos: <https://www.epos-eu.org/epos-dcat-ap#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix dct: <http://purl.org/dc/terms/> .
@prefix vcard: <http://www.w3.org/2006/vcard/ns#> .
@prefix hydra: <http://www.w3.org/ns/hydra/core#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix schema: <http://schema.org/> .
@prefix dcat: <http://www.w3.org/ns/dcat#> .
@prefix cnt: <http://www.w3.org/2011/content#> .
@prefix locn: <http://www.w3.org/ns/locn#> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix http: <http://www.w3.org/2006/http#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix gsp: <http://www.opengis.net/ont/geosparql#> .

<0000-0003-3560-988X> a schema:Person;
    schema:identifier [ a schema:PropertyValue;
        schema:propertyID "orcid";
        schema:value "0000-0003-3560-988X"; ];
    schema:familyName "Bousias";
    schema:givenName "Stathis";
    schema:address [ a schema:PostalAddress;
        schema:addressCountry "Greece"; ];
    schema:email "sbousias@upatras.gr";
    schema:telephone "+302610 996588";
    schema:url "http://orcid.org/0000-0003-3560-988X"^^xsd:anyURI;
    schema:qualifications "Senior Advisor";
    schema:affiliation <PIC:99985805>;
    schema:contactPoint <0000-0003-3560-988X/legalContact>;
    schema:contactPoint <0000-0003-3560-988X/contactPoint>;
.

<PIC:99985805> a schema:Organization;
    schema:identifier [ a schema:PropertyValue;
        schema:propertyID "PIC";
        schema:value "PIC:99985805"; ];
    schema:legalName "University of Patras";
    schema:address [ a schema:PostalAddress;
        schema:streetAddress "University of Patras campus";
        schema:addressLocality "Patras";
        schema:addressCountry "Greece"; ];
    schema:contactPoint <0000-0003-3560-988X/legalContact>;
.
<epos:SeismicEngineering> a skos:ConceptScheme;
    dct:title "Seismic Engineering";
    dct:description "The domain is Seismic engineering.";
.
<https://www.epos-sera.upatras.gr/resources/Dataset/001> a dcat:Dataset;
    dct:title "Laboratory metadata";
    dct:identifier "https://www.epos-sera.upatras.gr/resources/Dataset/001";
    adms:identifier [ a adms:Identifier;
        adms:schemaAgency "DDSS-ID";
        skos:notation "WP16-DDSS-002"; ];
    dct:description "Lab metadata";
    dct:type "http://purl.org/dc/dcmitype/Collection"^^xsd:anyURI;
    dcat:contactPoint <0000-0003-3560-988X/contactPoint>;
    dct:publisher <PIC:99985805>;
```
D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures
rdfs:label "Title of data publication";
hydra:required "false"^^xsd:boolean;
]

];
hydra:mapping[ a hydra:IriTemplateMapping;
hydra:variable "Description"^^xsd:string;
hydra:required "false"^^xsd:boolean;
]
];
hydra:mapping[ a hydra:IriTemplateMapping;
hydra:variable "DOI"^^xsd:string;
hydra:required "false"^^xsd:boolean;
]
];
hydra:mapping[ a hydra:IriTemplateMapping;
hydra:variable "Lab"^^xsd:string;
hydra:required "false"^^xsd:boolean;
]
];
hydra:mapping[ a hydra:IriTemplateMapping;
hydra:variable "Institution"^^xsd:string;
hydra:required "false"^^xsd:boolean;
]
];

]);

<https://www.epos-sera.upatras.gr/resources/Dataset/002> a dcat:Dataset;
dc:title "Project metadata";
dc:identifier "https://www.epos-sera.upatras.gr/resources/Dataset/002";
adms:identifier [ a adms:Identifier;
adms:schemaAgency "DDSS-ID";
skos:notation "WP16-DDSS-003";
];
dc:description "Projects of the SERIES database";
dct:keyword "Project";
dct:contactPoint <0000-0003-3560-988X/contactPoint>;
dct:publisher <PIC:PIC:99985805>;

dc:title "Distribution of project metadata";
dc:keyword "Distribution of projects";
dct:conformsTo <https://epos-msl.uu.nl/003>;
dcat:accessURL <https://epos-msl.uu.nl/003/api.php>;
dc:license "http://creativecommons.org/licenses/by/4.0/";

<https://www.epos-sera.upatras.gr/002> a epos:WebService;
schema:identifier [ a schema:PropertyValue;
schema:propertyID "DDSS-ID";
schema:value "";
]
schema:description "Web service for retrieving SERIES metadata";
schema:name "SERIES Metadata Catalogue Service";
6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures
D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures

rdfs:label "Institution(s) where data was collected";
hydra:required "false"^^xsd:boolean;
];
hydra:mapping[ a hydra:IriTemplateMapping;
hydra:variable "freeTextAllFields"^^xsd:string;
hydra:required "false"^^xsd:boolean;
];
]
];

<https://www.epos-sera.upatras.gr/resources/Dataset/003> a dcat:Dataset;
dct:title "Specimen Metadata";
dct:identifier "https://www.epos-sera.upatras.gr/resources/Dataset/003";
adms:identifier [ a adms:Identifier;
  adms:schemaAgency "DDSS-ID";
  skos:notation "WP16-DDSS-004";
];
dct:description "Specimen metadata at SERIES";
dct:type "http://purl.org/dc/dcmitype/Collection"^^xsd:anyURI;
dct:keyword "specimen";
dct:contactPoint <0000-0003-3568-988X/contactPoint>;
dct:publisher <PIC:PIC:99985805>;

<https://www.epos-sera.upatras.gr/resources/Dataset/003/Distribution/003> a dcat:Distribution;
dct:title "Distribution of specimen metadata";
dct:description "Distribution of specimen metadata";
dct:conformsTo <https://epos-msl.uu.nl/004>;
dct:accessURL <https://epos-msl.uu.nl/004/api.php>;
dct:license "http://creativecommons.org/licenses/by/4.0/";

<https://www.epos-sera.upatras.gr/003/api.php> a hydra:Operation;
hydra:method "GET"^^xsd:string;
hydra:returns "application/json";
hydra:property[ a hydra:IriTemplate;
  hydra:template "https://www.epos-sera.upatras.gr/webresources/api.php?Author, supplementTo, Publisher, publicationYear, Keywords, Title, Description, DOI, Lab, Institution, freeTextAllFields"^^xsd:string;
  hydra:mapping[ a hydra:IriTemplateMapping;
    hydra:variable "Author"^^xsd:string;
    rdfs:range "xsd:string";
    rdfs:label "Author";
    hydra:required "false"^^xsd:boolean;
  ];
  hydra:mapping[ a hydra:IriTemplateMapping;
    hydra:variable "supplementTo"^^xsd:string;
    rdfs:range "xsd:string";
    rdfs:label "Dataset is supplement to";
    hydra:required "false"^^xsd:boolean;
  ];
  hydra:mapping[ a hydra:IriTemplateMapping;
    hydra:variable "Publisher"^^xsd:string;
    rdfs:range "xsd:string";
    rdfs:label "Publisher";
    hydra:required "false"^^xsd:boolean;
  ];
  hydra:mapping[ a hydra:IriTemplateMapping;
    hydra:variable "publicationYear"^^xsd:string;
    rdfs:range "xsd:integer";
    rdfs:label "Year of (data) publication";
    hydra:required "false"^^xsd:boolean;
  ];
  hydra:mapping[ a hydra:IriTemplateMapping;
    hydra:variable "Keywords"^^xsd:string;
    rdfs:range "xsd:string";
    rdfs:label "Keyword(s)";
  ];
schema:defaultValue "analogue modelling results";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Title"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "Title of data publication";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Description"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "Description of data publication";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "DOI"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "DOI assigned to data publication or related articles";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Lab"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "Lab(s) where data was collected";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Institution"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "Institution(s) where data was collected";

hydra:required "false"^^xsd:boolean;

];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "freeTextAllFields"^^xsd:string;

rdfs:range "xsd:string";

rdfs:label "Search in all fields";

hydra:required "false"^^xsd:boolean;

];

];

<https://www.epos-sera.upatras.gr/resources/Dataset/004> a dcat:Dataset;

dct:title "Structural Element metadata";

dct:identifier "https://www.epos-sera.upatras.gr/resources/Dataset/004";

adms:identifier [ a adms:Identifier;

adms:schemaAgency "DDSS-ID";

skos:notation "WP16-DDSS-006";

];

dct:description "Structural elements of the SERIES database";

dct:type "http://purl.org/dc/dcmitype/Collection"^^xsd:anyURI;

dcat:keyword "Structural element";

dct:contactPoint <0000-0003-3560-988X/contactPoint>;

dct:publisher <PIC:PIC:99985805>;


<https://www.epos-sera.upatras.gr/resources/Dataset/004/Distribution/004> a dcat:Distribution;


dct:title "Distribution of structural elements";

dct:description "Distribution of structural elements";


dct:concept <https://epos-msl.uu.nl/006>;

dct:accessURL <https://epos-msl.uu.nl/006/api.php>;

dct:license "http://creativecommons.org/licenses/by/4.0/";


<https://www.epos-sera.upatras.gr/003> a epos:WebService;

schema:identifier "https://www.epos-sera.upatras.gr/003";

schema:identifier [ a schema:PropertyValue;
SERAS: Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe

D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures

#schema:propertyID "DDSS-ID";
#schema:value "";

schema:description "SERIES Metadata Catalogue Service";
schema:name "SERIES Metadata Catalogue Service";
schema:provider <PIC:PIC:99985805>;
schema:datePublished "2017-10-21"^^xsd:date;
hydra:supportedOperation <https://www.epos-sera.upatras.gr/003/api.php>;
schema:keywords "specimen";
dct:license "http://www.fsf.org/licensing/licenses/agpl-3.0.html"^^xsd:anyURI;
dcat:contactPoint <0000-0003-3560-988X/contactPoint>;

<https://www.epos-sera.upatras.gr/004> a epos:WebService;
schema:identifier "https://www.epos-sera.upatras.gr/004";
#schema:propertyID "DDSS-ID";
#schema:value "";

schema:description "Web service for retrieving SERIES metadata";
schema:name "Web service for retrieving SERIES metadata";
schema:provider <PIC:PIC:99985805>;
schema:datePublished "2017-09-21"^^xsd:date;
hydra:supportedOperation <https://www.epos-sera.upatras.gr/004/api.php>;
schema:keywords "laboratories";
dct:license "http://www.fsf.org/licensing/licenses/agpl-3.0.html"^^xsd:anyURI;
dcat:contactPoint <0000-0003-3560-988X/contactPoint>;

<https://www.epos-sera.upatras.gr/004/api.php> a hydra:Operation;
hydra:method GET^^xsd:string;
hydra:returns "application/json";
hydra:property[ a hydra:IriTemplate;
hydra:method "GET"^^xsd:string;
hydra:returns "application/json";
hydra:property[ a hydra:IriTemplate;
D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures

D6.5 Roadmap for the integration of data banks and access services from the earthquake engineering (SERIES) and seismology (EPOS) research infrastructures
schema:dateModified "2018-09-11"^^xsd:date;
schema:license "http://www.fsf.org/licensing/licenses/agpl-3.0.html"^^xsd:anyURI;
dct:contactPoint <0000-0003-3560-988X/contactPoint>;

<https://www.epos-sera.upatras.gr/005/api.php> a hydra:Operation;

hydra:method "GET"^^xsd:string;
hydra:returns "application/json";
hydra:property[ a hydra:IriTemplate;

hydra:template "https://www.epos-sera.upatras.gr/webresources/api.php?Author,
supplementTo, Publisher, publicationYear, Keywords, Title, Description, DOI, Lab, Institution,
freeTextAllFields"^^xsd:string;

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Author"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Author";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "supplementTo"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Dataset is supplement to";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Publisher"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Publisher";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "publicationYear"^^xsd:string;
rdfs:range "xsd:integer";
rdfs:label "Year of (data) publication";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Keywords"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Keyword(s)"

schema:defaultValue "magnetic susceptibility data";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Title"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Title of data publication";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Description"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Description of data publication";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "DOI"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "DOI assigned to data publication or related articles";

hydra:required "false"^^xsd:boolean;
]

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Lab"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Lab(s) where data was collected";
hydra:required "false"^^xsd:boolean;
];

hydra:mapping[ a hydra:IriTemplateMapping;

hydra:variable "Institution"^^xsd:string;
rdfs:range "xsd:string";
rdfs:label "Institution(s) where data was collected";
hydra:required "false"^^xsd:boolean;
]
Contact

Project lead ETH Zürich
Project coordinator Prof. Dr. Domenico Giardini
Project manager Dr. Kauzar Saleh
Project office ETH Department of Earth Sciences
Sonneggstrasse 5, NO H62, CH-8092 Zürich
sera_office@erdw.ethz.ch
+41 44 632 9690
Project website www.sera-eu.org

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