



VULNERABILITY ASSESSMENT OF HISTORICAL CENTERS OR TOWNS AND SAFE EVACUATION IN CASE OF AN EARTHQUAKE

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REPORT ON THE RESULTS OBTAINED WITHIN THE COORDINATED PROJECTS FOR 2015

ECPFE

Creation of a Digital Data Base for the Assessment of the Seismic Risk in Monuments

The aim of creating the ECPFE database is to enable the assessment of the vulnerability of monuments in view of seismic and other risks.

The first step for the creation of this database has been the choice of most appropriate data that can provide a **unique recognizable identity** for each monument. It was also decided that the main data elements (to be included at the ECPFE database) should be common or compatible with those of the database (Archaeological Cadastre) created by the Hellenic Ministry of Culture, in order to be directly retrieved as well as to be able to provide a common ground and communication (feed back) between the two databases.

To this purpose, meetings were held and collaboration with the Directorate of the Monuments National Archive was established, in order to obtain information concerning the structure of the Archaeological Cadastre database and examine the possibility of having access to necessary information about monuments already included there.

Subsequently, the following data units were chosen to be included at the ECPFE database as well:

- Name of the monument (and eventually other known names)
- Monument type
- Location (geographical data, cadaster code etc.)
- Historic & archaeological documentation
- Owner – User
- Legal Protection framework
- Existing documentation (photographs, studies, plans, references etc.)

Annex 1 contains the chapters of the Archaeological Cadastre database corresponding to the above units that can become gradually common. Since the Archaeological Cadastre is also under construction and trial, we hope for a further collaboration in the future, that will enable compatibility between the two data bases.

The second step of this research has focused on the pertinent categorization of monumental structures, in order to meet the aims of the specific research undertaken by ECPFE. The first approach was focused on the definition and categorization of monuments according to the architectural and archaeological data about their construction, and included the construction period, their function and the architectural typology as described in the relevant archaeological and architectural literature. This categorization is included in Annexes 2 and 3, and concerns, on the one hand, the monuments of Antiquity (Prehistoric, Classical, Hellenistic, Roman as well as the various archaeological sites) (Annex 2), and, on the other hand, Byzantine, Post-Byzantine and Recent (Modern) Monuments (Annex 3).

During this research, it was noted that the aforementioned categorization, which is based on morphological, historic and functional characteristics, is neither sufficient for the assessment of the monuments' risk, nor representative of (or, capable to describe) the behaviour of their bearing structures, which is the most critical factor regarding the earthquake risk. On the basis of this conclusion, it has been decided to emphasize on the fundamental geometrical features of the bearing structure, the construction system and the building materials. This type of information, however, is only scarcely included at the Archaeological Cadastre database.

As a conclusion, it was estimated necessary to include and categorize this type of data elements at the ECPFE database and further work was done in order to develop and organize them in detail.

To this purpose, two main sets of mandatory data were defined:

The first set of mandatory data, which was given the name "**Structural Categories**", concerns the categorization of the monumental structures in various groups, on the basis of the geometrical characteristics of their bearing system, and are therefore directly related to a specific structural behaviour (e.g. against earthquakes) as well as to different analytical and/or numerical modelization approaches and different damage treatments. The definition of these Structural Categories took initially into account the seven (7) classes (named from A to G) in which the monumental structures were grouped, following the recommendations developed within the EU-funded PERPERUATE programme by S.Lagomarsino (Univ. of Genova, Italy) and his collaborators. In the course of the current research, it was felt that those classes could not describe the totality of monumental structures encountered, and therefore these classes have been reworked and broadened to ten (10) in order to include some more types of monuments as well. Annex 4 contains a detailed description of the 10 proposed Structural Categories (named from A to I). To facilitate the database-user, the architectural types (as described in Annexes 2 and 3) have also been grouped within the proposed Structural Categories. These results are also included in Annex 4.

The second set of mandatory data was given the name "**Structural System**". This part of the database is expected to contain the largest part of the documentation data about a monument. Those data can be directly derived from in situ observation and are considered pertinent for the description of the bearing system and its condition. In a future work, those data can be calibrated, and may therefore be able to produce a quite sufficient, as well as, realistic assessment of the monument's structural condition and vulnerability against seismic and other environmental actions.

In this part of the database, the structural system is systematically described. To this purpose, it was divided in elements (named "**Structural Elements**"), which were included in the following groups: vertical elements, horizontal elements, foundation, openings, piers/columns and arches/colonnades. The description is done separately for each floor level and refers to its building materials (stonework, brickwork, wooden or steel structure, reinforced concrete) and contains the following data:

- Morphology of the construction (refers mainly to the formation of the external facing of the walls)
- Method of construction (refers to the applied structural technique)
- Building Materials
- Main dimensions of elements
- Connections – reinforcements

- Later interventions
- Damages
- Specific annotations

The content (sub elements) of the aforementioned data is included, step by step, in detailed tables containing helpdesks with multiple choice options or a Yes-No choice, so as to facilitate the in situ observation and documentation. It is expected that this detailed and structured procedure will enable the person who is doing the monument assessment, either before or after an earthquake, to notice and describe accurately and objectively all the necessary structural details. In this way, the risk of a gross or inaccurate assessment is hoped to be greatly reduced.

The aforementioned description of the monument data is also supported by additional tables, which contain data concerning its immediate natural and built environment (named “**Environmental Factors**”) and are included in Annex 5.

The selected data were used for the development of the database. To check the database, care was taken to perform an internal (logical) control of the various elements included, so as to avoid double or cross references. Moreover, the performance of the database has been tested by means of pilot applications. Namely, two monuments, one ancient (Temple of Zeus in Nemea) and one post byzantine (Holy Church of Chryssospilotissa in Athens) have been selected and the corresponding data were introduced and used for the control of the database.

Web Interface

Web Interface (E-monuments) allows accessing the database remotely in an efficient way by first invoking a Web browser. Access is granted only to authorized users. Each user inside E-monuments can search the monuments that have been recorded in the database, update fields or insert a new record for a monument. The web interface is hosted temporarily in the following link: <http://oasp.codefactory.mobi/> and will shortly be transferred to a production node of EPPO/ECPFE.

ECRP

In accordance with the decision adopted during the meeting of directors of the centers of European and Mediterranean Major Hazards Agreement (EUR-OPA) of the Council of Europe that took place in 2014 in Strasbourg, France - European Centre for Risk Prevention, Sofia, Bulgaria participates in 2015 how support partner (without budget) in a project “Creation of digital data base for the assessment of the seismic risk in monuments” coordinated by European Centre on Prevention and Forecasting of Earthquakes (ECPFE), Athens, Greece.

After a discussion with experts from the Ministry of Culture was selected Bulgarian monuments (Short List protect by UNESCO and Extend List with monuments with National importance).

The following activities have been performed in 2015 by the European Centre for Risk Prevention (ECRP), Sofia within the implementation of the project “Creation of digital data base for the assessment of the seismic risk in monuments”, Coordinator – European Center ACPFE, Athens:

Of base Work Package sent by Coordinator:

- Development of list of monuments in Bulgaria and send it to Coordinator.

All activities planned for 2015 under this project have been performed.

LIST OF MONUMENTS IN BULGARIA

The World Heritage Convention

The most significant feature of the 1972 World Heritage Convention is that it links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.

Acceptance of the Convention in Bulgaria: Thursday, March 7, 1974.

Properties inscribed on the World Heritage List in Bulgaria:

Cultural:

- Ancient City of Nessebar (1983)
- Boyana Church (1979)
- Madara Rider (1979)
- Rila Monastery (1983)
- Rock-Hewn Churches of Ivanovo (1979)
- Thracian Tomb of Kazanlak (1979)
- Thracian Tomb of Sveshtari (1985)

Natural:

- Pirin National Park (1983)
- Srebarna Nature Reserve (1983)

Properties submitted on the Tentative List :

- Two neolithic dwellings with their interior and household furnishings and utensils completely preserved (1984)
- The Magoura cave with drawings from the bronze age (1984)

- The ancient town of Nicopolis ad Istrum (1984)
- The late ancient tomb of Silistra (1984)
- The Bachkovo Monastery (1984)
- The town of Melnik and the Rozhen Monastery (1984)
- The Roussensky Lom National Park (1984)
- The Ancient Plovdiv (2004)
- Thracian Tomb with Wall Paintings beside Alexandrovo village (2004)
- Vratsa Karst Nature Reserve (2011)
- Rocks of Belogradchik (2011)
- Central Balkan National Park (2011)
- Pobiti Kamani Natural Monument (2011)
- Extension to the Joint World Heritage Property “Primeval Beech forests of the Carpathians (Slovak Republic and Ukraine) and the Ancient Beech forests of Germany (Germany)” (2015)

The Intangible Cultural Heritage of Humanity (originally proclaimed in 2005):

- Bistritsa Babi, archaic polyphony, dances and rituals from the Shoplounk region (2008);
- Nestinarstvo, messages from the past: the Panagyur of Saints Constantine and Helena in the village of Bulgari (2009)