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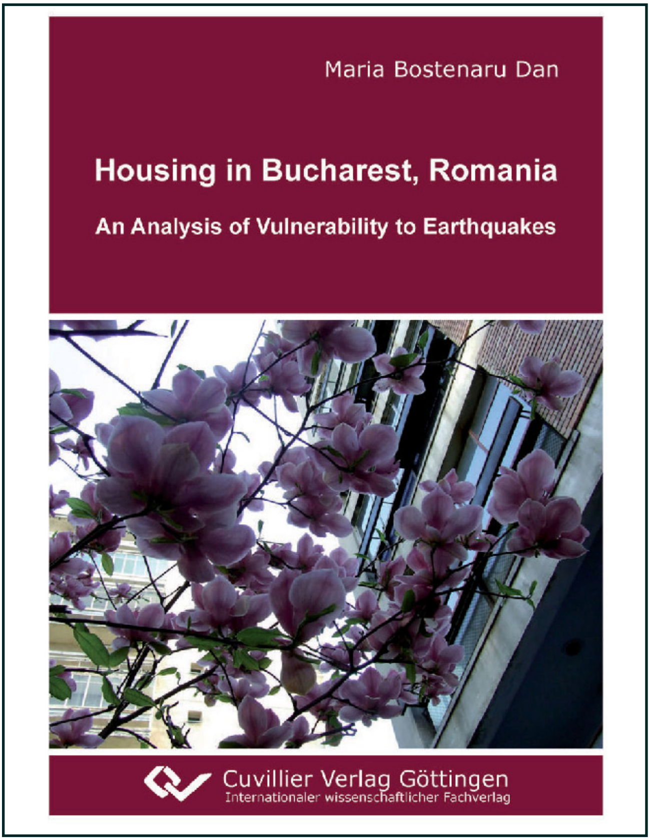
Housing in Bucharest, Romania

An Analysis of Vulnerability to Earthquakes



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Introduction: The built substance of Bucharest

The informational aspect in case of seismic design covers basically three aspects: inventarisation, evaluation and classification. The evaluation is a technical action, the most difficult step in this series. For a successful evaluation one must describe the effects of an earthquake on existing and future buildings, evaluate the state of buildings affected or not by previous strong motions and set the necessary seismic assurance level. Furthermore retrofit methodologies and technologies have to be defined, and an activity has to be organised in this direction. To fulfil all these requirements the evaluation takes place in successive phases, more and more detailed: qualitative evaluation in situ, approximate analytic evaluation and detailed analytic evaluation for special constructions or constructions with huge risk factor. Eventually a fourth stage can be introduced and on this intermediary step between qualitative and approximate analytic evaluation does this paper concentrate. After a selection buildings within one category are classified. Both inventarisation and classification are influenced by decisional aspects.

From a strategical point of view measures on existing buildings have to be justified. To support a decision data regarding the expected behaviour of constructions in case of an earthquake including the effects (victims, costs) as function of intensity, the periodicity of earthquakes of certain intensity, the use and expected lifetime of buildings and the duration and costs of retrofit interventions are needed. Taking in consideration these factors recommendations for building categories after criteria like use, age, structural type, can be erected, priorities within one category using an evaluation method can be set, these priorities correlated with a succession of time intervals leading to an action like retrofit or replace demolition or no action (the zero option).

A considerable amount of questionnaires was developed until now for different types of surveys, however, it is recommended to develop a special one at least for each country reviews are taking place in, to accommodate to the cultural differences reflected in the way of building. For example the division of building age will look completely different in Bucharest and Rome, as there are only few buildings built before 1850 in Bucharest but the buildings after 1940 must be classified into more categories than usually. The core elements of the check list must be built around determining the age, bearing structure and state of the building.

Each town has its own historic development and there is always a certain period which was decisive in conferring today’s face. Buildings of different ages are present in variable amounts and thus some periods didn’t let a statistically important quantity to be analysed. Table 2 shows the main periods in architecture history which let a significant number of buildings still in use in the city of Bucharest, Romania. It also shows the periodicity of earthquakes affecting them. As it can be seen, in 100 years of lifetime a building can be affected by two or even four major earthquakes. The engineering characteristics in table 3 and 4. Table 5 shows how identifying the age and structural type of a building or even only of its elements leads to an easier assessment of earthquake risk as the behaviour of buildings of the same kind have been observed and analysed in past earthquakes, which have in Romania similar characteristics.

The seismic hazard for buildings in Bucharest, Romania, is represented by intermediate depth earthquakes with the epicentre in Vrancea. Bucharest is situated 150 km south of the epicentre, in the main direction of propagation of seismic waves, on the banks of the rivers Dâmbovita and Colentina on non-homogenous alluvial soil deposits. Strong earthquakes with the epicentre in Vrancea occur each 30-40 years. During the earthquake of 4 March 1977 (Richter magnitude 7.2), over 30 buildings collapsed in Bucharest, killing 1,424 people.

Inventories of the building stock for Bucharest were developed in the frame of different projects: the RISK-UE European project, a resilience planning approach, and HAZUS and the German SFB 461, an emergency planning approach. For HAZUS the related Rapid Visual Screening method is available. The experiences of the author were with the early stages of data collection for the SFB 461, however, they leaded for creating a typological review of the housing types, resulting into technical reports included in the World Housing Encyclopedia.

The RISK-UE project developed a modular methodology for earthquake scenario assessment through global impact analysis, accounting for the distinctive features of European cities with regard to current and historical buildings, as well as their functional and social organisation. The project was organised in work packages. A work package comprised either a methodologies, or the application to the participating cities: Barcelona, Bitola, Bucharest, Catania, Nice, Sofia, Thessalonica. In the work package ”Urban System Analysis” (Masure and Lutoff, 2006) through the ”Urban-System-Exposure” methodology system components and their functionality, then the “elements-at-risk‟, their indicator-quantified exposure, and the vulnerability factors were analysed, leading to the identification of problems and opportunities. After appropriation of the problems posed by seismic risk, "management-plans" and "plans-of-action" are proposed for strategic implementation by decision-makers through land-use decisions.

Emergency preparedness planning is useful for officials, not necessarily experts. The best known methodology for loss estimation and emergency preparedness planning is HAZUS (FEMA, 1999), a computer aided modular methodology. Parameters on the potential earthquake, the built substance, and the infrastructure are used to compute scenario physical damage and socio-economic losses. Area parameters (ex. land-use) are transformed into building parameters and individual data of buildings are mapped to areas. Obtained databases are loss estimates for zones, not for building classes. Fiedrich (2004) proposed the integrative model EQ-RESQUE to support the prioritisation of intervention zones and the efficient allocation of help-and-rescue resources with help of computer tools for post-earthquake disaster staff. Further developments include a "Disaster management tool" (Markus et al., 2004), for damage and casualty estimation and detection as well as communication and information support. This tool for pre-event training and post-event disaster management integrates a computer aided damage estimation tool (EQSIM) for which the survey of a test area in Bucharest was performed.

The historical constituted types of planning, including the two exemplified above were brought in connection in Bostenaru (2005).

A joint project of the Earthquake Engineering Research Institute and the International Association of Earthquake Engineering: an encyclopaedia of housing construction types around the world using the interactive possibilities of the internet (http://www.world-housing.net) is an example of co-operation, in virtual space. Contributions are compiled using a standard format, and constitute together a database, searchable according to criteria based on the aspects covered by the forms. Relevant aspects from architectural and structural features, to socio-economic aspects, construction process and materials, and insurance are included, either through completing check-lists or as a more detailed description. Text information is completed by photos and drawings. Strengthening technologies are less detailed presented and all relevant aspects are brought under one section.

Since the 1980s the image of planning changed in two regards. The image of planning is characterised by co-operative action (Selle, 1994) and the strategical planning was developed as a solution to the change in the understanding of planning. Today, instead of participation of citizens, communication is aimed for, which is, according to Selle (1994) a collective term for information, participation, co-ordination and cooperation activities. With cooperation the decision process is relocated to the exterior, through the acceptance of simultaneous decision processes in own action fields outside politics and administration. The 'ingredients' of a strategic plan for the reduction of seismic risk are action plans, goals, operative means, human resources, time and costs, oriented on the analysis, the evaluation, the setting of priorities and the communication (Bostenaru, 2004d).

In Bostenaru (2004d) the interdependencies and the phasing of urban management operations have been shown. The management module 'identifying problems and opportunities' covers the operation of transforming data to information, with the function of problem analysis. In a next operation, with the management