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VULNERABILITY AND PROTECTION OF CULTURAL HERITAGE IN EARTHQUAKE ZONES

The Scientific Coordinating Committee of the European Centre for the Protection of Ancient Built Heritage in Earthquake -Risk Areas decided that the study of vulnerability would be the focus of the Centre's work in 1988-89. As L. Mendes Victor put it "*Vulnerability is already a whole research topic in itself. We know very little of the earthquake control rules observed in bygone times.*"

An examination of vulnerability might begin with the definition given by construction experts: "the vulnerability (V) of a building (or group of buildings) is the cost of the damage caused (or predictable with reference to a scale of damage which is itself a function of the intensity), expressed as a percentage of the total construction cost. At a macroseismic intensity of I to VIII, V = 0 and at an intensity of IX to XII V = 100%. V is reduced when generalised earthquake control rules are applied."

This kind of formula is extremely simplistic when it comes to defining the vulnerability of old buildings. The European workshop on historic architecture held at the CUEBC in December 1987, which marked the start of the work of PACT Network No 13 (Experts on the Protection of Ancient built heritage in -Risk Areas), conducted an in-depth analysis of this point.

Present-day global consideration of how to protect old buildings which are part of our cultural heritage in earthquake zones must necessarily start with the human community exposed to the earthquake risk. It is well known that in areas of traditional seismicity earthquakes have always been seen as events which one can neither prevent nor resist. The community affected had only one option: to rebuild what had been destroyed. Recurring diasters were thus the only available way of testing earthquake-resistant building methods and also provided an opportunity for renovating and improving buildings and the living environment.

Present-day thinking, however, is that whilst earthquakes cannot be prevented, we can protect ourselves against them and limit the damage. But that can only be done if we can predict their effects.

This change in the approach to earthquakes necessarily puts the emphasis on prevention but also, paradoxically, makes it harder to define effective methods of protection.

For example, refinement of these techniques is closely linked to an understanding of how buildings behave during a seismic shock, and that understanding can only be gained from modelling simulations. But the availability of simulation techniques - widely proven and used today - solves only some of the problems.

It is not always possible to construct a credible model of the object to be strengthened. Specifically it has been found that the difficulty increases depending on whether one is dealing with a simple archaeological structure, a single building, a large-scale structure or the entire architectural fabric of historic centres (cf. page 47). Not only because the structural complexity increases, but also because it becomes even harder, given the difficulty of reconstructing the origin and history of buildings, to know their structural anomalies and allow for these in the model.

At the same time we have the difficulty that we are using modern aids to knowledge but are progressively losing empirical knowledge, so that the measures we take may be less appropriate than traditional measures would have been.

The vulnerability of a building depends, then, not only on its *ability to resist* but also - or primarily - on the *behaviour of the community* which uses it before, during and after the earthquake. It is unanimously acknowledged that irrespective of the specific features of the local system (available resources, techniques used, procedures adopted, etc.) the best way of protecting cultural heritage in earthquake zones is always to maintain it properly, that is to say to work on it regularly, at the same time respecting its architectural characteristics.

An understanding of buildings and analysis of the way in which communities behave have become the two pillars of research done by experts on the protection of cultural heritage. A process of dialogue has arisen amongst historians, archaeol-ogists, administrators and architects, to deepen our understanding of old buildings (and at the same time analyse how the community behaves), with a view to reducing its vulnerability, especially in earthquake zones. A rapid review reveals that this body of knowledge concerning the "global" behaviour of the system is still at the embryonic and empirical stage, though numerous multidisciplinary initiatives have already been seen.

Experiments conducted between 1983 and 1986 as part of the work of the European Networks of scientific cooperation showed that measures to protect old buildings in earthquake zones can be made considerably more effective by:

- research on "buildings as a living fabric" conducted on a regional scale;
- multispatial, multitemporal analysis of the different types of architecture found in earthquake zones;

- analysis of the behaviour patterns of communities which built, modified and still use old buildings today.

Consequently it was deemed appropriate to base the work of the first seminar (the "theoretical" seminar held to devise procedural instruments) on a synthesis of views and findings to date.

Buildings - a living fabric

The idea of "architectural cultural heritage" has widened considerably over the last decade as a result of the heightened interest shown in old buildings.

Nowadays *architectural heritage* is no longer confined to prestige buildings (cathedrals, mansions, etc.). It also covers vernacular architecture, industrial buildings and smaller-scale craft premises dating from the late 19th and early 20th centuries, shops, mills, typical industries which emerge gradually as objects of attention, and then as objects worthy of protection, but above all as a living witness to the local culture.

The second stage was the gradual acceptance of *privately owned cultural assets* as an integral part of the national heritage. But this acceptance is not without its difficulties, because there are so many historic buildings that if they were all transferred to the public domain, the state could not cope. The burden thus has to be shared with their owners, in exchange for certain grants and above all tax concessions.

This is all the more desirable since people visiting these buildings care not about their legal status as a historic house but how well they are maintained and presented and the fact that because they are lived in (whether by their owners or someone else), they are still residences and not museum-pieces.

A third aspect of the cultural change we are witnessing is that architectural heritage is no longer seen merely as providing *aesthetic pleasure*; increasingly it is seen as having an *economic and social function*. This means that it has moved from the strictly cultural sphere into the domain of economic development, social advancement, etc. The policy of protection has become a privileged dialectical interface between matters cultural, economic and social (conclusions of the Report on the conservation of cultural heritage, by M. B. Fajardie - Council of Europe document, 1987).

Officially the term "architectural heritage" embraces:

Monuments: any building noteworthy by reason of its historical, archaeological, scientific, artistic, social and technical interest, including any accessory or decorative features forming an integral part of it;

Group of buildings: homogeneous groups of urban or rural buildings which are noteworthy by reason of their historical, archaeological, artistic, social or technical interest and sufficiently coherent to form topographically definable unity;

Sites: the combined works of man and nature, being areas which are partially built upon and sufficiently distinctive and homogeneous to be topographically definable, and noteworthy by reason of their archaeological, artistic, scientific, social or technical interest ("Cultural heritage and seismic risk", by J.P. Massué, Council of Europe document, 1987).

The large international organisations, national and local governments, all help to protect sites, historic centres and monuments which make up the cultural heritage of the world or individual nations. Considerable work has been done on conservation, research, analysis and documentation. The same is not always true of old buildings in private ownership.

Where this is the case all manner of difficulties are encountered, as we shall see later. Such buildings are after all regarded as an essential part of our heritage: they are the living tissue of historic centres, cities, towns and villages throughout Europe and the world. But measures taken in respect of these buildings are invariably either general legislative measures, or they address limited specific issues and are not coordinated. The laws of the various countries vary in numerous respects here and contain many gaps when it comes to analysing buildings and understanding older construction techniques. For this reason, and to ensure a minimum of coherence amongst research projects, the most reliable level of analysis would seem to be the regional scale.

Multispatial and multitemporal analysis

Recent earthquakes led researchers and specialists in old buildings to notice similarities between the regional variants of various types of old building (timber frame, earthen, poorly bonded masonry, etc.). These appear to correlate with the conditions in which the various types of materials were used, independently of region or time, but influenced by one common factor: seismic risk. In other words, in all regions where there is a major risk of earthquakes, an understanding of this risk by the population - even empirically gained - seems to mean that for any given material the architectural solutions employed will be very similar (or even identical), and the same building methods will be used.
Another feature of the earthquake risk, the fact that it recurs over time, prompts us to examine not only the geographical but also the historical aspects of this.
Buildings may be regarded as structures which are born out of the response of the population and which:

- are influenced by an ever-present physical phenomenon;
- use local materials;
- reflect a well defined pattern of social and cultural behaviour.

Research on old buildings in earthquake zones must thus span more than one region and period of time and must seek to:

- understand both the physical reality of the phenomenon (drawing on seismology, geology and other sciences dealing with different aspects of seismicity) and its temporal reality (seismic history) on both a regional and local scale;
- understand the resources available (materials and building methods) in terms of their physical reality and their use over the centuries (materials science, architecture, archaeology);
- identify the behaviour patterns of the community.
  This last point, seriously underestimated hitherto, warrants closer consideration.

Behaviour of communities which built and which use buildings

Researchers and government authorities are increasingly aware of the importance of understanding how communities traditionally behave with regard to the construction and use of old buildings in earthquake zones.
Clearly, the methods chosen by a community over the centuries depend not only on the resources available but also on the cultural capacities of that community, on how forcefully the authorities insisted on those methods, etc., on the overall level of affluence (the best methods are often the most expensive ones), but above all on the proportion of resources spent on regular maintenance, something determined by the degree to which such measures are perceived as useful.

For this reason it is of paramount importance that methods of earthquake protection which are tailored to the specific characteristics of the local architecture should be revived, developed and their use encouraged. A population which properly understands the buildings it uses and knows how these have reacted or might react in future to earthquakes, which successfully revitalises traditional methods of reinforcement, repair and conversion, will be better equipped to safeguard its cultural heritage. And its organisational capacities - before, during and after the earthquake - are bound to be better as a result.