

**The damage of churches of Piemonte struck by an earthquake on august 2000.
F.E.M. for a case of study**

by Marialaura Roselli

Tutor: Roberto Roccati

Co-tutor: Mauro Picotto (Ufficio Sismico di Pinerolo)

A moderate earthquake shock (VII MCS) struck Centre – South Piemonte on August 2000. The most hit area corresponded to some communes of Asti and Alessandria. Damages were generally moderate.

A plan of urgent interventions was elaborated. It was the result of the collaboration between “Soprintendenza”, Structural Engineering Department of “Politecnico di Torino” and Administrative Offices of Technical Services of Prevention.

The CNR – GNDT card was compiled for each damaged church. In the CNR – GNDT card a church is considered as made up of recognizable and complete parts that act unitarily in case of seismic event. For each part of the church the card points out vulnerabilities and mechanisms of collapse.

In Asti and Alessandria 166 churches were significantly damaged. Their indexes of damage (id) and vulnerability (iv) were calculated. These indexes vary from 0 to 1. Two maps were made.



picture 1: map of indexes of damage

By elaborating data it has been possible to have a global vision of the upkeep and the vulnerability of churches. 57% of churches suffered slight damages ($0 < id < 0.1$). In most

cases (65%) index of damage was inferior to index of vulnerability. Slight damages were due to the moderate earthquake shock and to the general good upkeep of churches.

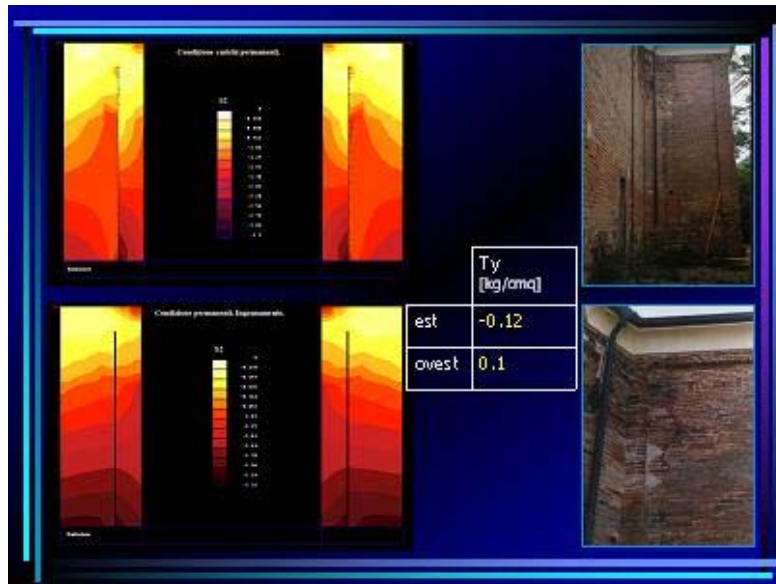
Afterwards a damage church was analysed by using a computer program based on F.E.M. in order to obtain the static behaviour and the dynamic reply of the church in case of future seismic events



picture 2: geometry of the church and view of solid dimension of brick walls and arches

The vulnerabilities of the church, such as fissures due to seismic shocks, building discontinuations, static historical damages, were considered during the elaboration of the model. DOLMEN WIN of CDM of Turin was used.

In order to obtain simulations of the behaviour during an earthquake shock, the church was subjected to Equivalent Static Analysis; seismic event was represented by two horizontal and perpendicular between them forces which don't act contemporarily. At first, the church was subjected to Equivalent Static Analysis without the fissures formed during the seismic shock of august 2000 in order to justify their location and geometry, then all vulnerabilities were considered. Fissures were shaped with and without seizure between bricks



picture 3: moulding of fissures, principal tensions of compression, on the left absence and presence of seizure

In case of absence of seizure a damage wall act as if made up of independent parts, tensions of which are due to the loads on each part. Highest tractions concentrate near the ends of fissures. An effect of intaglio has fissures continued. In case of presence of seizure the effect of intaglio and values of principal tensions are minor. It was possible to calculate values of seizure in static and dynamic conditions: highest values vary from 1 to 1.5 kg/cm².

For further information: roselliml@libero.it