

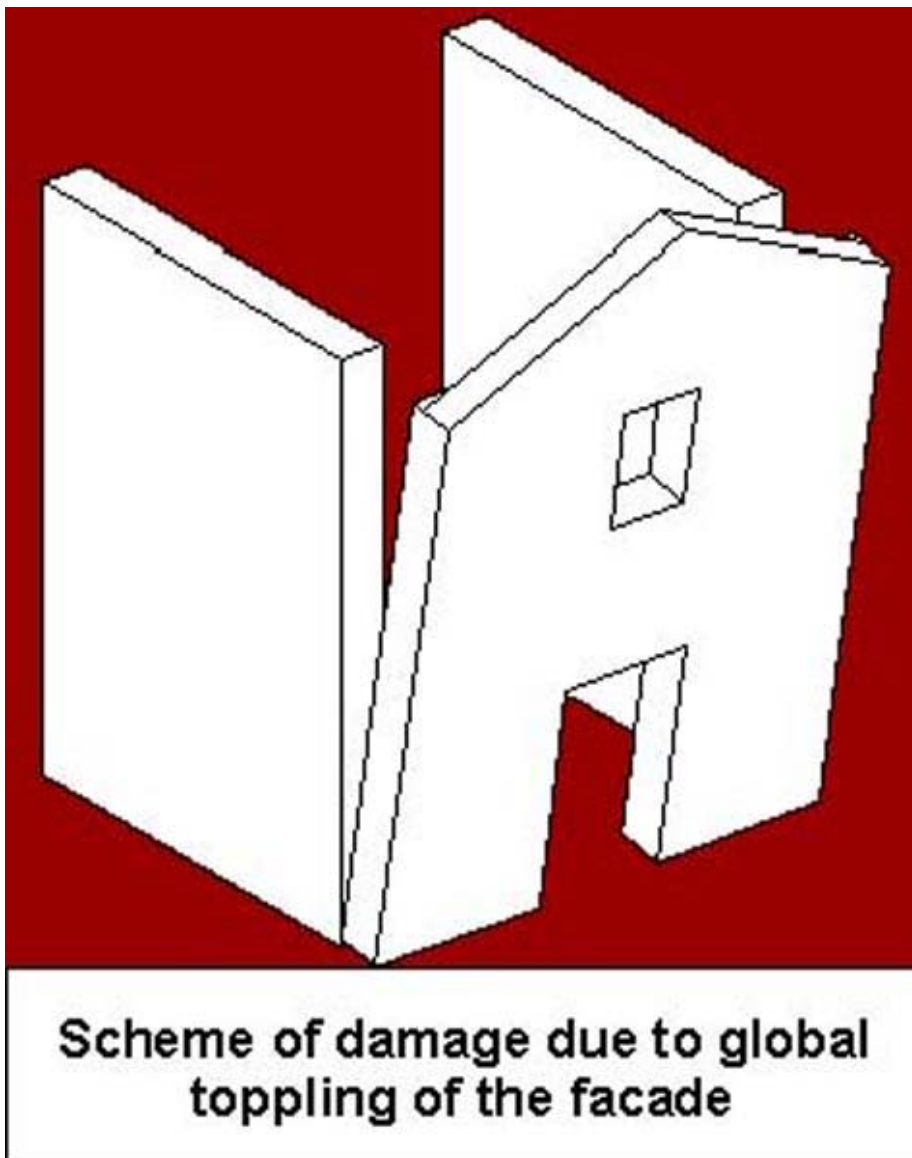
**Vulnerability of monumental buildings.**

**Cult buildings damaged by the 2000 and 2003 earthquakes in Piedmont.**

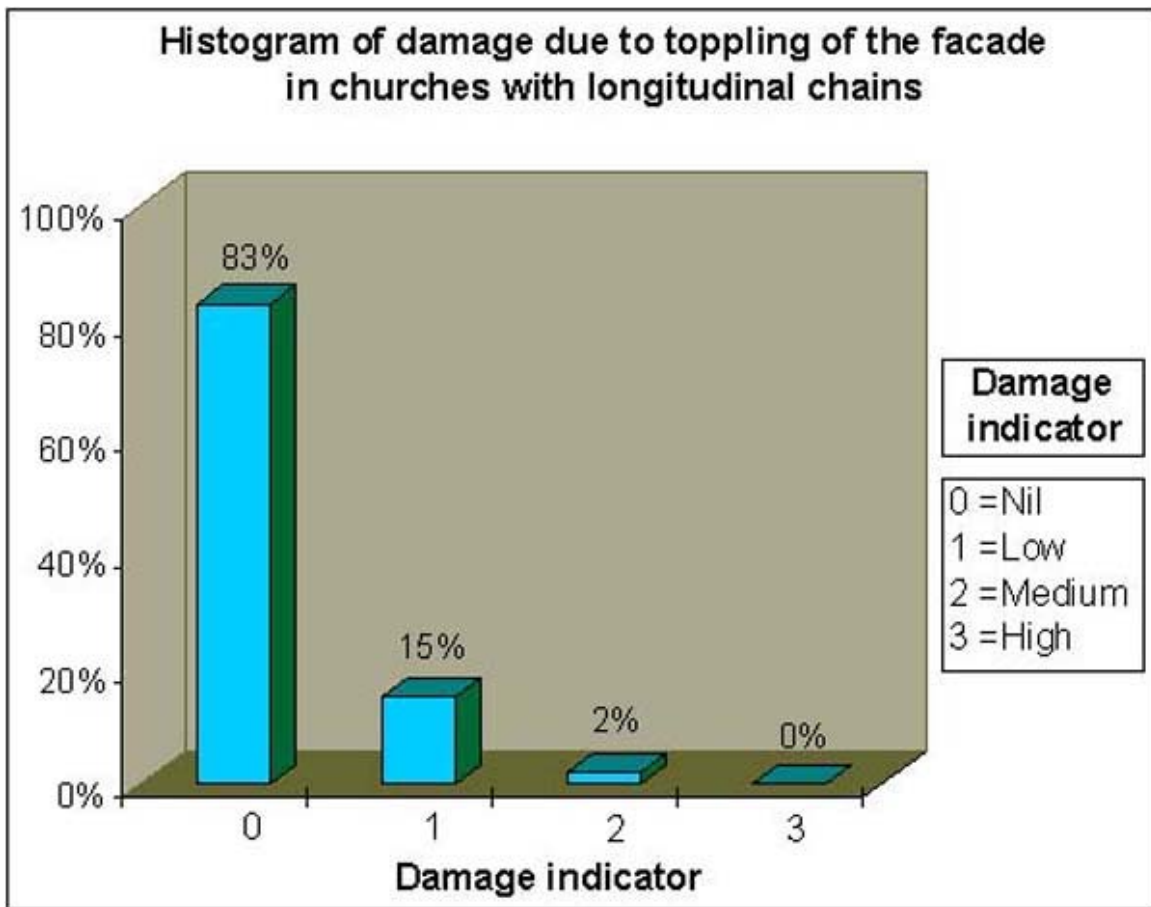
by Rotondaro Luigi

Tutors: Roberto Roccati, Stefano Podestà (Engineering University of Genoa)

This Dissertation addresses the need to define a procedure, for use on a regional scale, for the assessment of seismic improvement projects proposed for monumental church buildings damaged by an earthquake.

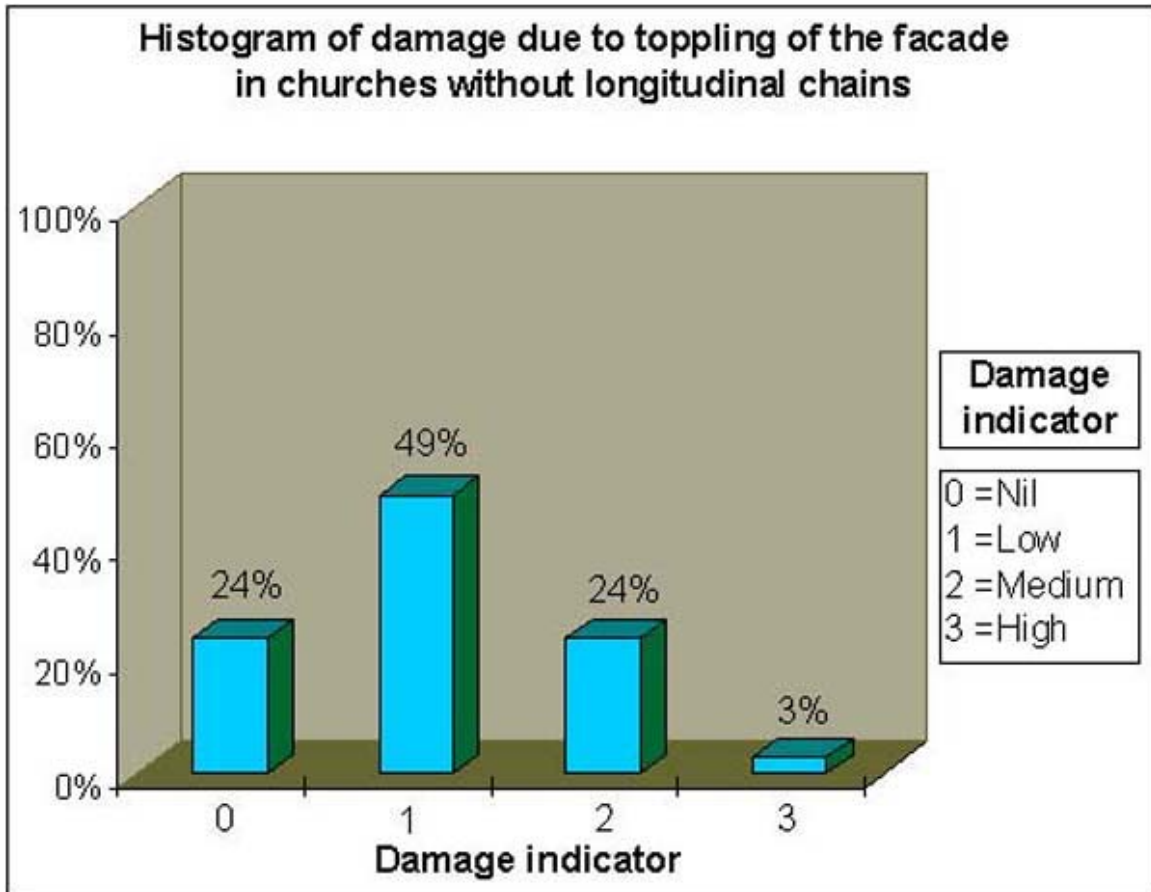


The applicable regulations (M.D. 16 January 1996) and a recent Ordinance, P.C.M. no. 3274 of 20 March 2003, specify that any seismic improvement intervention must be checked in terms of the conditions of a structure before and after the intervention, in order to determine the effectiveness of the works conceived for its seismic improvement. A detailed preliminary check can be conducted by using more or less complex design methods (Finite Element Models or Limit Equilibrium Analysis), but the computation costs associated with such methods are always very high in view of the complexity of monumental structures. Hence, it is impractical, or outright impossible, to use such methods to verify quickly enough all the projects submitted to the control authorities (Superintendence, Regional and Provincial Bodies, etc.) after a seismic event. Also in view of the great vulnerability of historical buildings, as borne out by the appreciable damage levels caused throughout the territory by low intensity seismic events (e.g., the earthquakes that hit Piedmont in 2000 and 2003), this Dissertation defines a project control procedure that makes it possible to formulate an initial assessment of the effectiveness of the proposed interventions (probabilistic method).



The proposed methodology takes into account the materials that the control bodies can use for checking the design solutions proposed by practising designers: project documents and the data sheets on damage and vulnerability compiled after the seismic event. The data sheets currently employed to assess seismic damage and the vulnerability of church buildings have been designed to formulate a judgement on suitability for use and cost estimates, but in view of their being organised in terms of damage mechanisms and macroelements, they can also be used for the assessment of the seismic improvement levels that can be achieved with the proposed interventions.

As mentioned above, the methodology does not consider the building as a whole, rather, it takes into account the individual constructive parts (macroelements) which are potentially vulnerable according to different “damage mechanisms”. According to this approach, the data sheets compiled by the technicians appointed by the census authorities can be recompiled by taking into account the seismic improvement interventions proposed by the designers; in this manner it proves possible to assess the reduction in anticipated damage: albeit in a probabilistic manner, this provides a quick tool to verify the effectiveness of the technical solutions envisaged.



Furthermore, starting from an analysis of a number of church buildings surveyed after the earthquake that hit the provinces of Alessandria and Asti in 2000, the results of a probabilistic assessment (i.e., based on forecast average damage as defined on the basis of vulnerability curves) were compared with the results of a mechanical evaluation of the proposed interventions (performed with the aid of a computation program based on Limit Equilibrium Analysis).

The results obtained with the two methods were seen to be in excellent agreement. This shows the feasibility of adopting the probabilistic method as an initial control tool for the seismic improvement projects proposed for church buildings.

For further information, e-mail: [luigi.rotondaro@libero.it](mailto:luigi.rotondaro@libero.it)