6. SURVEY OF OLD CHURCHES

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6.1 Introduction

Among monumental buildings churches are probably the most vulnerable type, even for earthquakes of low intensity. Observation of damage, due to the most recent earthquakes in Italy, and subsequent research have produced a broad and consolidated basis of knowledge of the most frequent damage mechanisms in these buildings (Doglioni et al. 1994, Guccione et al. 1998). Considering also that churches are quite numerous, especially in a country such as Italy, the need to have models of vulnerability assessment available appears evident. These should be not detailed models, such as would be required in a restoration project, but of simplified type, that is applicable on a land scale level for a large sample of buildings, both in the field of preventive risk analysis and for management of post-earthquake emergency. When considering a monumental building, and in particular churches, the methods that may be used on a land scale operate a statistical estimate of the vulnerability of the different parts of the church concerning individual collapse mechanisms (Lagomarsino and Podestà, 1999). However, the necessity to develop a specific methodology for the vulnerability analysis of the churches of Catania arose, since the original architectural shapes and technological and structural solutions of these buildings make an assessment based on the analogy with the churches of Friuli and Umbria impossible. Furthermore, having to operate on the urban level, a prompt assessment is required, even if approximate, of every individual item.

Therefore a census of the churches was carried out by the architects Caputo and Celeschi, *Socially Useful Workers*, with the co-ordination of Alberto Cherubini; they used a special form that required the filling in of certain information of a general nature, identification of the building with a cadastre map and the drawing of descriptive sketches of the planimetric and height development; in many cases graphic documentation was collected, taken from books or from findings available at the *Soprintendenza* (Monuments and Fine Arts Office*)* or the *Genio Civile*. A large number of photographs were also collected. This survey led to the acquisition of information about 70 churches, only in the historic centre of Catania.

On the basis of the collected data, a type analysis of the churches was carried out, with reference to their layout, and the *macroelements*, that are the characteristic architectural elements of churches that are characterised by a seismic response that is autonomous from the rest of the building, were identified (Lagomarsino 1998). The structural considerations on the characteristics of the macroelements present in the churches of Catania, together with observation of the slight damage due to earthquakes of low intensity, allowed for the identification of the facade as the element characterised by the greatest vulnerability; for this reason a specific type analysis was carried out, in function of the layout profile and the elevation.

6.2 The churches of Catania

The churches of Catania make up a unique episode in the architectural scenario of our country; mainly built or rebuilt after the earthquake of 1693, in Catanese Late-Baroque style, they show architectural and structural characteristics that can be found in other parts of Italy with great difficulty. The development in plan is often rather articulated, a typical feature of the eighteenth century both for the search for a formal originality (churches with a central layout) and because the buildings had to fit in with a town that was already heavily urbanised. Almost always the churches are close to other buildings and in many cases they are completely incorporated in the other buildings, being recognisable only for their facades that look out onto the public spaces; this is, for instance, the case of the churches that are part of the monasteries and convents which are very numerous in the town.

Therefore, it is necessary to find an alternative way, appropriate to the characteristics of the buildings concerned and the objectives of the risk analysis carried out with the *Progetto Catania* (Project Catania). Firstly, it is necessary to identify the elements of greatest vulnerability in these buildings: reading the seismic history and the consequent damage is necessarily the starting point. The most important earthquakes after that of 1693, that is after the reconstruction of Catania, are those of 1818 and 1848, while the recent earthquake of 13th December 1990 (earthquake of S. Lucia) only marginally affected the town. Reading today the seismic damage to a building going back more than 150 years is practically impossible, especially in an analysis of rapid type and on churches that are mostly subject to maintenance. Reading of historical documents in archives highlights how, also for the town of Catania, churches represent the most vulnerable typology (Azzaro et al. 1999); following the earthquake of 1818 citations of damage to many churches are found, while after the one in 1848 it was said: *"Almost all the churches (Collegiate, Cathedral, San Benedetto, ...) suffered damage"*. It is also possible to obtain certain information on individual churches but the documents rarely supply indications of the structural element that underwent the most important damage. For instance, in the case of the church of *S. Michele Arcangelo ai Minoriti* it is said, following the earthquake of 1818, that *"the cupola of the church and the major arches that support it are badly cracked; they cannot stand up without the due repairs";* it is not known whether interventions were carried out but, after the earthquake of 1848, it is written *"the cupola of the Minoriti church is completely cracked"* and still today the damage is clearly visible, perhaps due to the effects of the event of 1990.

On the sample studied, consisting of 70 churches, a preliminary type analysis was conducted. Examination of the development of the layout of churches allowed identification of three types of church: a) single nave (51 churches); b) central nave with side aisles (7); c) central layout (12). Figure 6.1 shows separation into macroelements, highlighting the presence of recurrent elements for which an estimate of vulnerability was possible, based on the knowledge acquired from earthquakes in

other regions. The most important churches mostly belong to the last two types (average gross surface area - nave with side aisless: 1300 m^2, central layout: 400 m^2); they show shapes and proportions that are various and original, difficult to trace back to already known situations. The single-nave churches are smaller (average gross surface area: 300 m^2) and appear more easily comparable to churches present in other Italian regions, even though with certain peculiarities. For instance, the women's galleries, that are a system of corridors on the whole perimeter below the roof, represent a weakening; this element is typical of many convents and monasteries, which in most cases completely incorporate the church, with the exception of the facade that remains the only element clearly distinguishable. Another specific point is the frequent presence of an entrance hall (32 cases), which separates the room from the facade, in which a stairway is sometimes placed to overcome the difference in elevation caused by a nineteenth century restructuring of the traffic system of the town; this element often makes the facade appear to be an element that is completely separate from the rest of the church.

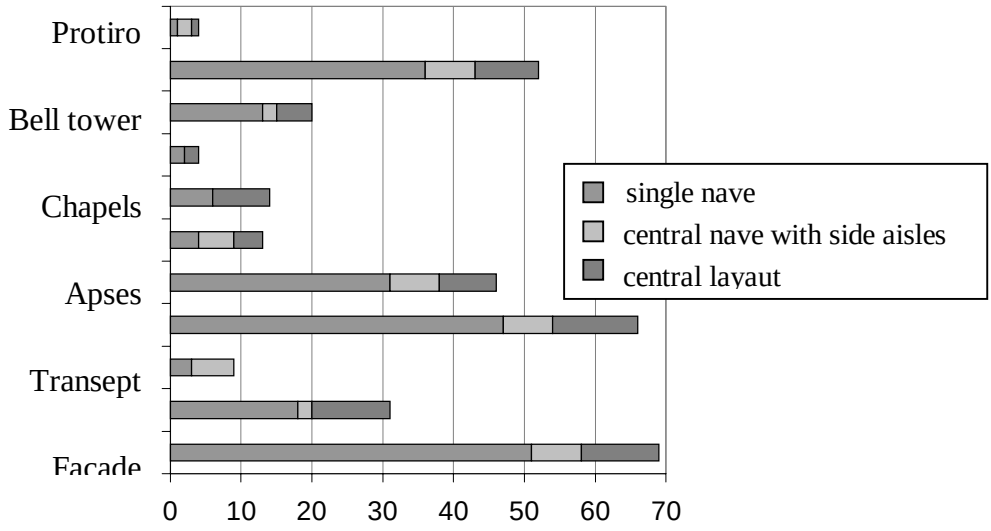


Figure 6.1 - Rate of the different macroelements in 70 churches of Catania.

The 70 churches were digitised and fed into the GIS elaborated for the *Progetto Catania* at the Polytechnic of Milan (Fig.6.2), linking to them, other than the data base containing the type classification and the presence of macroelements, some photographs (an external view and an internal one) and the graphic survey of the layout; this allows a complete and immediate view of the ecclesiastical patrimony of the town of Catania.

6.3 Typological analysis of the facades

As already said in the introduction, the facade represents one of the elements of greatest vulnerability of the churches of Catania; in order to devise a model for damage forecasting (§14) a typological analysis of the facades was carried out to

identify the main geometrical and construction elements. Considering the whole sample of the churches of Catania, both the elevation and the section at the base of the wall was analysed.

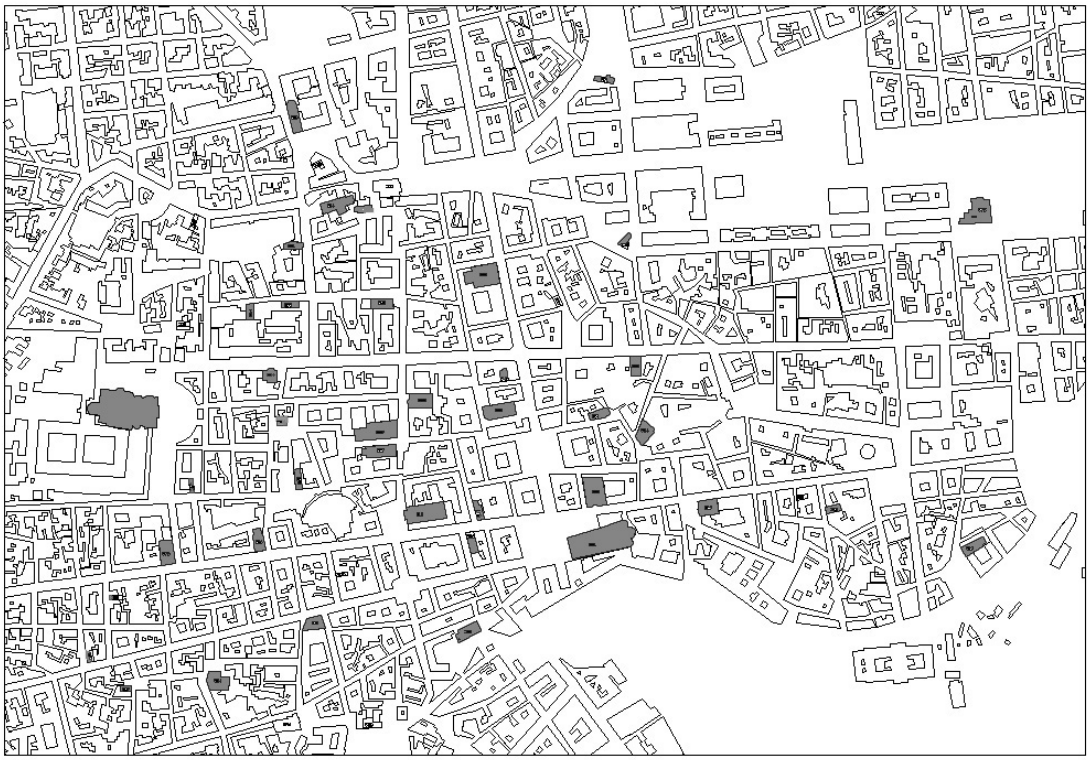
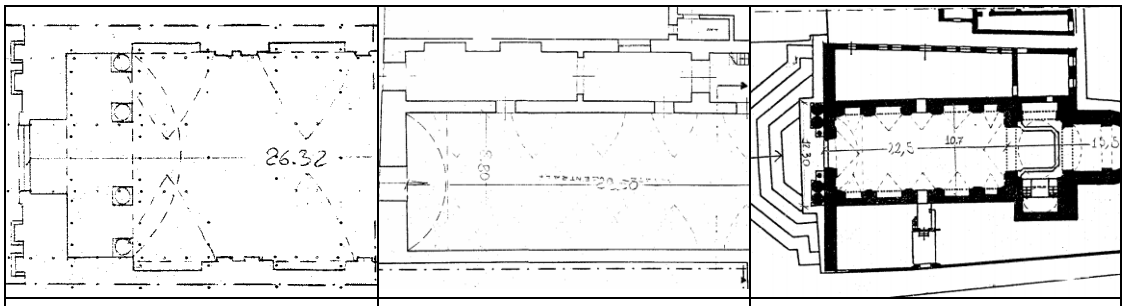


Figure 6.2 - Map of the historic centre of Catania, with 41 of the 70 churches surveyed.

With reference to the profile of the base section, the sample was divided into three types: A - rectilinear (58 churches), B - concave (5), C - convex (6); furthermore for the rectilinear ones another subdivision is foreseen, which considers the possible presence of stiffening: A1 - simple (13), A2 - with pilasters (34), A3 - with columns (8), A4 - with half-columns (3). Figure 6.3 shows an example for each type identified. Examination of the types suggests a consideration: the concave and convex profiles, on the one hand typical of the Baroque scenographic style, also take on a structural value in relation to overturning mechanisms; it appears intuitively evident that a facade with concave or convex profile offers greater stability compared to a straight facade; similarly the presence of columns, connected at the top by large trabeations, or of half-columns leaning against the facade, supply a certain contrast to rotation towards the outside.

The other element characteristic of the facade is the shape of the elevation, for which the following types have been identified: 1 - triangular, 2 - with salient, 3 - rectangular, 4 - rectangular with gable; figure 6.4 shows some examples which demonstrate how the types are almost independent in both layout and in elevation from one another.



A2-Rectilinear with pilaster (34)	*A1 - Rectilinear (9)*	*A3-Rectilinear with columns (8)*
A4 - Rect. with half-columns (3)	*B - Concave (5)*	*C - Convex (6)*

Figure 6.3 - Types of facade on the basis of the cross-section shape at the base.

1 - triangular	*2 - with salient*	*3 - rectangular*	*4 - rectang.with gable*

Figure 6.4 - Types of facade on the basis of the shape.

References

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