

8. DAMAGE IN CATANIA ON THE OCCASION OF THE 1693 EARTHQUAKES

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8.1 Introduction

The seismic history of Catania has been analysed in detail by Azzaro et al. (1999). In the last 1000 years Catania was destroyed twice (1169 and 1693) and more or less severely damaged twelve times (e.g. 1542, 1818, 1848, etc.); destruction or heavy damage were mainly due to earthquakes occurring in the coastal sector of the Hyblean foreland, see Figure 1 in sub-sect. 1.1 (Azzaro and Barbano, 1999). Azzaro *et al.* (1999) also supply a site catalogue (Fig. 8.1) from which they assessed seismic hazard according to the method proposed by Magri et al. (1994), showing that the probability of occurrence of intensity 7 and 10 in Catania exceeds 99.9% for 150 and 500 years, respectively.

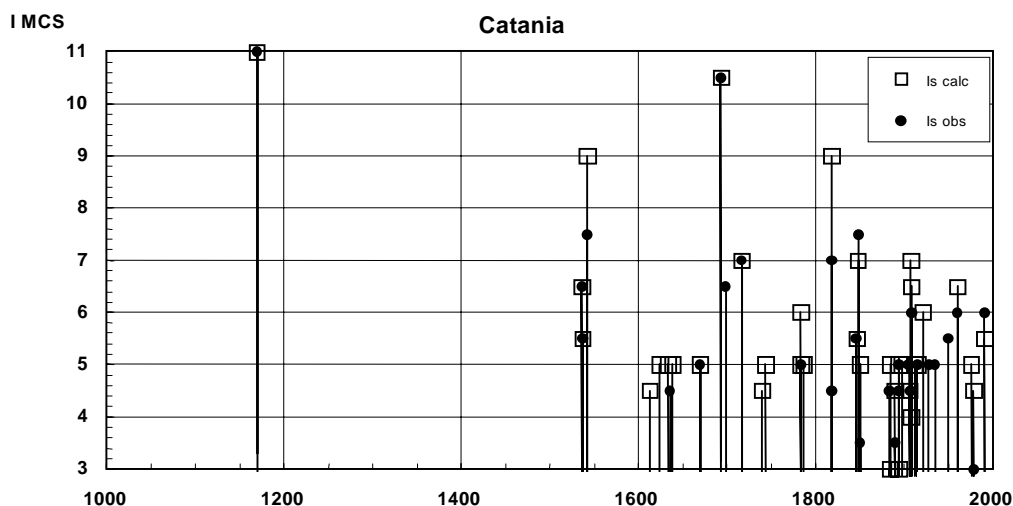


Figure 8.1 - Observed (I_s obs) and calculated (I_s calc) macroseismic intensities in Catania (from Azzaro et al., 1999).

This paper illustrates the results of ad-hoc historical investigation, accomplished with the purpose of mapping the damage at Catania after the earthquakes of 1693. Following the preliminary attempts by Moroni et al. (1997) and Azzaro et al. (1999), damage to monumental buildings is finally assessed here in terms of damage grades of the EM-98 intensity scale (Gruenthal, 1998).

8.2 Catania at the beginning of 1693

In 1693 Catania showed the typical characteristics of a medieval town, shaped on the pre-existing Roman settlement: narrow and short streets and just a main street

crossing the town from south to north. The town was surrounded by walls (except some convents and a few churches) that had been rebuilt in 1552, having a perimeter of about 4.7 km and with 8 bastions and 8 gates (Policastro, 1952). An anonymous map (Catania, 17th cent.), that Dufour and Raymond (1992) publish without information on its present location and date prior to 1693, shows the position and the names of more than one hundred monumental buildings before the 1669 eruption of the Mt. Etna volcano. This map can be used as a reliable reference for the pre-earthquake situation.

In 1681 the inhabitants were about 15,900 (Longhitano, 1988). The number of buildings and their typology in 1693 are unknown; however it seems that common houses were not particularly tall (Fichera, 1925). Religious buildings are quite well described: 14 seclusion monasteries; 19 cloisters and monasteries of different religious orders; 28 congregations, confraternities and companies each of them referring to a church; and lastly the Cathedral (e.g. Privitera, 1695).

As a general rule, the vulnerability of the monumental buildings cannot be easily assessed in terms of vulnerability classes of the EM-98 intensity scale (Gruenthal, 1998), as the classes are conceived with reference to ordinary buildings. In general, it is well known that complex buildings like churches can be very vulnerable. In the case of Catania, the importance of such buildings may imply that some care was used for their construction, suggesting vulnerability class B or even C; a few of them (the Cathedral, the Bishop's palace, the Senate-House and the Ursino castle) may be referred to class C.

8.3 Damage distribution

The earthquakes of 9 and 11 January 1693, which caused the largest seismic catastrophe in Eastern Sicily history, were studied by many authors under varied viewpoints. Sources useful for seismological purposes are found in Barbano (1985), Li Gresti (1992), Boschi et al. (1995a, 1995b), while a review of the documents stored in the Archivo General de Simancas, Spain, is found in Rodriguez de la Torre (1995; it should be recalled that in the XVII century Sicily was under the political rule of Spain).

The sources on earthquake effects in Catania are spread among different archives and libraries (Simancas, Palermo, Catania). Though a number of documents generally refers to the ruinous state of the city, the sources describing the damage in a way useful to quantify it are very few with respect to those dealing with in the reconstruction process. In the State Archive of Catania only some documents were found reporting information on damage suffered by religious buildings (e.g. on the Benedictine Monastery of S. Nicolò l'Arena). Instead, more details on damaged buildings are contained in some reports, published or not, produced by coeval authors.

Sources available so far do not allow detailed mapping of the damage, as performed for instance in the case of Siracusa, 1693 (Boschi *et al.*, 1995a), Fabriano, 1741 (Monachesi *et al.*, 1999), etc. No official, detailed damage survey was found.

Actually, such surveys are usually found when intensity does not exceed 9 MCS, that is, when a significant part of the damaged buildings can be repaired; in the case of Catania, it seems reasonable to guess that, extensive demolition and reconstruction were the obvious issue. Therefore, only an average damage assessment and its interpretation in term of intensity was possible.

The foreshock (January 9, around 22 h.) caused relevant damage in the whole city (Relazione Veridica, 1693; Privitera, 1695; Guglielmini, 1695). Not only the poorest houses but also more solid constructions, such as mansions and some monasteries (e.g. the Benedictines), suffered extensive cracking, detachment of roofs and partial collapse, so that they needed to be shored up. For this foreshock Boschi et al. (1995b) have assigned an intensity $I = 8$ MCS, while in this study we assess an intensity $I = 7/8$ EMS, on the basis of the assumption that the building stock is equally distributed between the vulnerability classes B and A. Two days later, at about 13.30 h., a stronger earthquake struck a city whose buildings had been weakened by the previous event. All sources describe the town after this shock as a pile of ruins, listing few surviving monumental buildings and a few houses (Privitera, 1695; Boccone, 1697). Boschi et al. (1995b) assess $I = 10/11$ MCS; this study estimates $I = 10/11$ EMS on the basis of the same hypothesis as before.

8.4 Damage to monumental buildings

Damage descriptions for the earthquake of January 1693 are available for 41 monumental buildings; for 3 of them, Cathedral, Benedictine Monastery and convent of the Conventual Fathers of San Francesco, they are detailed and concern damage caused by the two events. All of them have been classified in terms of EMS-98 damage grades.

After the first event *"the merlons on the upper part of the main door"* of the Cathedral *"were seen smashed to pieces on the ground"* (Relatione veridica, 1693); EMS damage grade 2/3. After the second event, the belfry *"collapsed on top the nave of the Cathedral, causing the roofs to collapse in their turn"* (Privitera, 1693); *"of the Cathedral nothing more than the lantern without the roof, the major chapel, the two lateral chapels and the new sacristy were left"* (Guglielmini, 1693). The damage grade might be assessed as EMS 4/5, but it must be taken into account that it was mainly caused by the fall of the belfry.

Due to the 9 January event in the Benedictine Monastery *"a quarter of the Gallery together with its twelve marble columns collapsed; and many more cracks were seen"* (grade 4) and *"in the Royal convent of the Conventual Fathers of San Francesco to the inside of the inner cloister fell the dormitory, which was founded upon beautiful columns"* (Guglielmini, 1693); grade 4. All sources agree in that both these buildings totally collapsed after the 11 January event. For both a cumulative grade of damage 5 was assessed.

Synthetic information (*"collapsed"*, *"completely destroyed"* or number of dead), referring to the cumulative effects of the two events, is available for the remaining 38

buildings (ASCt, 1693; Privitera, 1693; Guglielmini, 1693). These are monasteries and convents, churches, military and other public buildings (Senate, Bishop's palace, Seminary).

Damage grade 5 was assigned when the description clearly reported "*total collapse*"; grade 4 was assessed when the source simply reported "*collapse*" or, in the few cases, when the only available information was the death toll. Grade 2/3 was assigned to the Ursino Castle and the Rotonda church, both described as slightly damaged. No damage grade was assessed for the University and the Collegiate buildings, mentioned among the other buildings but without any details on damage.

The summary of the damage is reported in Table 8.1. The identification of the buildings was performed on the historical map (Catania, 17th cent.) (Fig.8.2); then, on the basis of studies on urban development and history of specific buildings (e.g. Dufour and Raymond,1992; Recupero, 1994) it has been possible to locate them on the building coverage of present day Catania (Fig. 8.3).

Table 8.1: Damage to the monumental buildings - Numbers up to 89 refer to the original legend of the historical map (Catania, 17th cent.); numbers from 109 on were added on the basis of information from studies on the topography of Catania (e.g. Recupero, 1994).

N	bldg denomination	damage grade (EMS-98)	N	bldg denomination	damage grade (EMS-98)
1	Cathedral	(4/5)	38	Rotonda church	2/3
2	Senate-House	4	39	Augustinian Friars	4
3	Seminary	4/5	44	Benedictine Friars	5
4	Dominican Fathers of S. Caterina (State Archive)	4	67	Bishop's palace (Vescovado)	4
5	Monastery of S. Agata	4	68	Ursino castle	2/3
6	Monastery of S. Lucia	4	70	Collegiate (S.M. dell'Elemosina)	?
7	Monastery. of S. Placido	4	71	Minorite Friars	4
8	Monastery. of S. Caterina	5	77	Dominican Friars	4
9	Monastery of S. Benedetto	4	78	Capuchin Friars (Convent of S.M. della Speranza)	5
10	Mon.. of S. Giuliano (S. Gaetano)	5	79	Carcàra of S. Agata (S. Agata alla Fornace or S. Biagio)	
11	Monastery of Monte Vergine	4/5	4		
12	Monastery of Porto Salvo	5	80	Dominican Friars (Convent of SS. Annunziata)	5
13	Monastery of S. Chiara	4	81	Old Capuchin	4
14	Monastery. of S. Girolamo	5	89	PP. Agostiniani Scalzi or S. Maria di Nuova luce	5
15	Monastery of the Holy Trinity	5	109	Reformed Friars (S.M. di Gesù)	5
18	Franciscan Friars of 3rd order	4	110	S. Agata la Vetere	4
19	University	?	111	Convent of Monte Santo (S.M. dell'Indirizzo)	4
25	Conventual Fathers of S. Francesco	5	112	Mercy Friars (S.M. della Misericordia)	4
29	Teresiani Friars	4	113	Monastery of Verginelle (conservatory)	4
30	College of Jesuit Friars	5			
31	Franciscan Friars of the strict Observants	4			
33	Trinity Friars (S. Sebastiano)	4			
37	Tower of D. Lorenzo	5			

8.5 Conclusions

The severity of the destruction caused in Catania by the 1693 earthquakes probably explains the absence of historical sources, e. g. in the form of damage surveys, that would allow us to map the damage distribution in the whole city. The interpretation of the available sources describing the damage, limited to monumental buildings, must take into account that the destruction of Catania was the consequence of the combined effects of the two events. A recent study (Azzaro and Stucchi, 1999), suggesting an approach for dealing with the possible vulnerability increase in the course of a seismic sequence, comes to the conclusion that the intensity assessed in Catania considering damage after the second 1693 event may be not higher than 10 EMS. However, the same study also stresses that this estimate does refer to the cumulative effect of the two events, without hopes of separating their effects, and that it should be taken only as a very rough estimate of the effect of the second event alone.

Damage to 41 monumental buildings was assessed in terms of EM-98 intensity scale. This data, though not useful for detecting possible amplification or de-amplification zones, can provide useful information on the vulnerability of the surviving buildings and serve as an input for evaluating the ground shaking.

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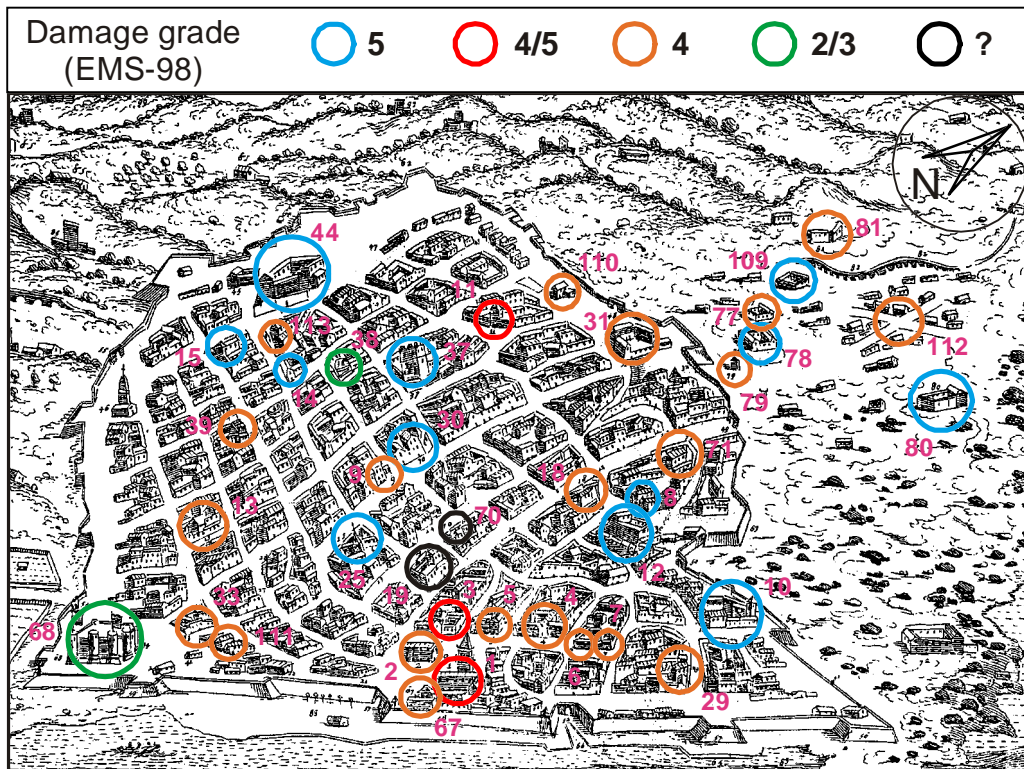


Figure 8.2 - Grade of damage and location of the 41 damaged buildings described in table 8.1, on a historical map showing the plan of Catania before the 1669 eruption (detail, from Dufour and Raymond, 1992). The numbers are the same as in Table 8.1.

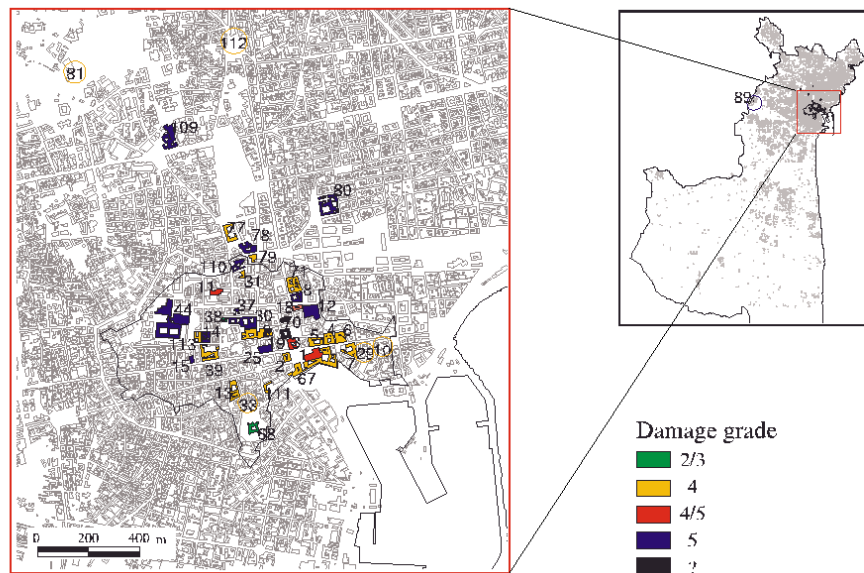


Figure 8.3 - The same representation of Figure 2 on the building coverage of today Catania (original scale: 1:2,000). Circles indicate buildings with uncertain location.