

THE CATHEDRAL OF NOTO: FROM THE ANALYSIS OF THE COLLAPSE TO THE RESTORATION AND RECONSTRUCTION PROJECT.

S. TRINGALI (1), R. DE BENEDICTIS (2), C. GAVARINI (3), ROSANNA LA ROSA (4)

(1) Architect professionalist, (2) Engineer professionalist, (3) Dip. Ing. Strut. & Geot. University of Rome, (4) Architect professionalist

SUMMARY

Part of Noto Cathedral collapsed in 1996, almost six years after an earthquake had hit the area and damaged the Cathedral. The damage consisted of cracks along the pillars of the right aisle that did not predict collapse. The objective of the reconstruction project is to express coherence not only regarding form, but also regarding the mechanics of the parts that survived the collapse and the original nature of the building.

1. THE COLLAPSE

A saddening event happened on March 13th 1996 in the Iblean town of Noto, Italy, called the capital of Sicilian baroque: a large part of the Cathedral, that is the major symbolic expression of baroque architecture, collapsed.

In particular, four of the piers of the right part of the nave, one of the four bridgepiers supporting the dome, the entire roof and vault of the nave, three quarters of the drum and the dome with the lantern, the roof of the right arm of the transept and many of the small domes and much of the roof of the right aisle, were lost.

The collapse occurred almost six months after the most recent earthquake affecting Val di Noto, in an area that has always been subject to elevated seismic risk. Although the 1990 earthquake had determined visible cracks, and temporary procedures had been carried out to reinforce the piers at the site of what was considered to represent the major damage, neither collapse nor worsening of the status quo was foreseeable.

In order to understand the dynamics of the collapse and its causes, it has been necessary a special campaign of surveying and investigations which have allowed to reconstruct the

situation standing before the dramatic event: this phase has been performed after the removal of the debris carried out following archeological standards and a methodology which didn't have existing guidelines.

At the same time the past of the monument has been investigated through a specific historical research.

The historical investigation and technical tests made on the ruined structures and on those still standing, have allowed us to identify the causes of weakness in the cathedral. In this concern, destructive tests as stratigraphic dismantling of the ruined piers were necessary in order to make the real structural organization of their interior clear.

The reconstruction project has moved from the deep investigation on materials, building technologies and techniques;

2. PHILOSOPHY AND PROJECT METHODOLOGY

The erection of a Cathedral church represents the greatest moment of aggregation for any community, be it Christian or other.

Reconstructing a cathedral from its ruins after a terrible collapse is surely an extremely "dramatic" intervention as it represents a complex and symbolic act of continuity with the past, pervaded by the doubts and perplexities of the present.

The historical records of the events that characterised the life of this sacred building infer that it was beset with constructive controversies right from the first installation, and that these deeply influenced its destiny.

The detailed phase of removal of debris and the preliminary analysis achieved by careful survey using inspections to detect the nature of the building had already shown a very complex state. This was a result of the superimposition of numerous interventions that the building had been subjected to over the years (also due to repeated collapse), the heterogeneous materials utilized and the different construction techniques adopted, that were not always carried out properly.

Today the reconstruction of Cathedral of S. Nicolò at Noto acquires a complex meaning. On one hand it represents the reconstruction of a major church whose dome collapsed for the third time while, on the other, it is the "contemporary" rebuilding of an important "part" of the city called the capital of Sicilian baroque architecture.

There are technical, albeit elaborate and laborious, answers to the first issue, while the general reconstruction is much more complex. The latter almost assumes the inappropriate message of a "political" project, amplifies the significance of the rebuilding of the monument to such an extent that it becomes the symbol of the reconstruction and rebirth of the local community. It overmagnifies the role of the experts involved in the project who are faced with expectations that go beyond the real project activities and more and more concern the economic, social and cultural issues involved in this type of reconstruction.

The complexity of the major questions involved in the reconstruction of the Cathedral have been purposefully and instrumentally reduced to simple actions that illustrate the lines of the design activities in each architectural project, i.e.:

?? customer's requirements;

?? analysis;

?? data processing;

?? ensuing design solutions.

This was the premise of the reconstruction, and the experts involved were fully aware of all the

difficulties to be faced in the reconstruction of a sacred building at the beginning of the third millennium.

It is a particular building and is imbued with the greatest significance for the Noto community. The local community, the Holy See and Noto Municipality demanded that it be restored to the town to continue to fulfil its original functions and represent the focal point that had been destroyed after the collapse on March 13th 1996.

3. RECONSTRUCTION PROJECT

“Where it was, and just like it was” was therefore the customer’s request, but the trend of the reconstruction, although constrained by such precise requests, was by no means well delineated, nor were the answers clear. While the first request allowed no leeway, it was clear from the outset that “just as it was” could not be a philological reconstruction utilizing the same stones (because the majority could not be reutilize) and repositing the same identical deficiencies and constructive errors of the collapsed building. It was not a question of recovering the exterior appearance, of *look*, but of conducting a historical, composite and material review of the pre-existing edifice.

It was, in reality, an “Ameliorative Project” that studied the residual parts, analysed the defects of the old construction and adopted efficacious constructive and antiseismic solutions. It progressively corrected the “errors” in the old building and proposed modern solutions that were specially adapted to the reality and construction typology of the product.

The reconstruction project was the outcome of a careful study of the building characteristics, the underlying technical, economic and cultural issues, the understanding of the architectural and structural functions of the various sections of the whole building complex and of all that represented the “material culture” of the edifice, that together with its expressive value, is one of the most precious elements of the relationship between the past and the present.

The course of the project tended to recover know-how that has been lost today, but at one time was part and parcel of every architect and engineer’s background, thanks to the possibility of performing careful inspection of the monument.

The project called for a detailed study of the seismicity of the area and its effects on the Cathedral. Therefore, the history of how the construction had reacted to earthquakes in this constant “seismic” area was investigated and was judged on the basis of the real understanding of its static balance. This operation was extremely important and delicate when related to the fact that the reconstruction work is to be performed after a collapse and consequently the conclusion concerns what had collapsed, but – indubitably – also of what is still apparently intact.

From a structural viewpoint the objective is to commence from the existing structures, detecting and recognizing the intrinsic resources in the original building that could allow them not only to be constructed, but also to withstand a major earthquake.

Therefore, the solution adopted was to correct structural defects, integrate the quality of the structure, add whatever was missing; every operation was carried out punctually only where necessary and was aimed at representing the natural and coherent evolution of the original construction.

The question of “how” to rebuild was still open.

The rebuilding project had to embrace not only the reconstruction of the collapsed parts, but also had to assess what had been saved. Precise assessment of the latter was reached after geognostic and diagnostic inspections that obtained results that provided very important

information for the project.

In fact, the description of the construction techniques of the building cannot – and could not because of the precise task and duty of the experts involved in the project – be considered aseptic and devoid of conclusions: the piers and bridgepiers of the building had been erected using very poor methods, but the ones still standing were no better.

On the contrary, some very interesting and important static devices were observed in the Cathedral, such as the system of the buttresses of the roman vault and the presbytery, and the lateral buttresses connected to the tympanum arches of the ceiling.

Thus, the intervention covered both the issue of reconstruction of the collapsed parts and the problem of consolidation and/or substitution of the parts *in situ*. The former concerned assessment of the parts that had not collapsed entirely: for instance, what had to be done about the residual part of the dome? The latter called for detection of a functional hierarchy of the parts to be consolidated.

Masonry technique was the obvious solution. It allowed many of the particular issues of the case in question to be answered, mainly ensuring the crucial point of maintaining material and technical coherence with the rest of the existing building while, at the same time, answering the theoretical principles of preservation.

Furthermore, use of masonry techniques flanked by advanced technologic know-how in conjunction with the structural interventions foreseen (dismantling and rebuilding the pillars left standing, inserting chains in and consolidating the external walls that survived the collapse) achieved homogeneous structural behaviour of the building that is a primary static objective in restoration work conducted in seismic areas, such as Val di Noto.

The masonry construction technique led to two different, complementary issues: technology and assessment. The latter is evident and widely consolidated in the stages of the project, while the former is noteworthy and expounded herein. In the past stereometry was a crucial moment in building techniques as interlocking stones is not a marginal issue as compared with their characteristics of resistance and the resistance of each single structural element forming them.

It was necessary, therefore – as shown by this example – to punctually define the interior between two outlines of each constructive element, without taking the composition and consequent design of a two-headed masonry, nor the masonry assemblage of the piers, bridgepier, arches, drum or the dome for granted. Assessment of the manner of construction was just as important. For example; how much masonry could be laid in one working day without causing excessive deformation of the mortar before it adhered?; how could the remaining parts *in situ* to be integrated and interlocked with the reconstructed parts be strengthened?.

As previously mentioned, there was also the question of assessing the resistance and antiseismic features of the complex. When we use the term *assess, consider*, etc., we refer to neither models nor abstract reflections, but to the need to arrive at calculus that enables *real* assessment of material resistance, even resistance of a masonry structure that has been subjected to defect after part of it collapsed. Leaving the residual parts of the drum and dome *in situ*, could not be a matter of brilliant conversation or ideological positions, but had to be the subject of careful scientific assessment.

Likewise, it was necessary to assess how the characteristics the current composition of the masonry could be affected by use of new injection mortars, and long term compatibility.

In addition to determining the punctual and local resistance of the single elements, antiseismic features were also determined. The transversal section of the church was the focal point of investigations and analysis because it presented possible collapse mechanisms.

The fact that the reconstruction aimed at restoring the likeness prior to collapse did not rule out

formal and architectural evaluations on what had predated the collapse which represented an *unicum* also with the static aspects (how could it be otherwise when dealing with architecture?).

4. PROJECT SOLUTIONS

4.1 Roof

The reconstructed Cathedral will have its original pitched roof that was replaced with a flat brick and cement roof at the end of the 1950's.

The latter was destroyed in the March 1996 collapse.

A "new" pitched wooden roof built on the same lines and using the same material and structure as the original will enhance the function of continuity of the external buttresses with the tympanum arch of the ceiling. The latter will be enabled to bear the weight of the roof and to perform the function of connecting the side walls of the nave.

4.2 Piers

The piers are one of the focal points of the reconstruction work.

Even if the experts involved in the project were not directly responsible for determining the cause of the terrible collapse on March 13, 1996, there is no doubt that the poor workmanship of the piers played a key role in the disaster.

The body of the piers (in the plan covering 78% of the entire area) is made up of irregular stones (large river cobbles for approximately the first three metres in height) laid haphazardly, without internal interlocking and using low quality lime to fill up the spaces.

Only the external face of the wall is made up of squared stones (about 25-27 cm) that do not join up with the masonry body of the pier and therefore totally lack interlocking.

The new piers will be built using the old constructive techniques adopted for masonry, but the errors causing the collapse will be corrected.

They will be built in stone that reflects the linguistic and structural theme of the Cathedral walls, but the use of technical devices will guarantee elevated resistance and mechanical features compatible with the old building and with present day requirements.

4.3 Dome and drum

Within the framework of the reconstruction of the dome, it will be the dome that collapsed on March 13th 1996 that will be rebuilt. That is to say, the dome erected according to the project designed by Cassone, an engineer, after a severe earthquake in 1848 had damaged the pre-existing dome. Cassone's dome was completed in 1862.

It is not the original dome, nevertheless it is the one that has become a symbol to the generations of the last one hundred and fifty years. It was the dome that once towered over the Noto skyline and its loss has been felt greatly. Its restoration will be an act of urban recovery, the reintegration of the symbol of a city, more than the mere reconstruction of a monument. For the inhabitants of Noto and others, it will be the restitution of an element charged with meaning and expressive value.

It will be rebuilt in stone. The numerical tests of the calculus have revealed that the new structure is compatible with the antiseismic safety requirements set down by law. Few, small corrections, only where required to improve performance, will respect and maintain the geometry and structural conception of the dome. The thickness of the base of the dome will be increased by few centimetres and metal hooping will be positioned to guarantee equilibrium in event of severe earthquake.

The procedure regarding the residual parts is to remove the stones from the collapsed dome as the reconstruction will adopt the solution of superimposed rings starting from the base and rising upwards. This operation will attempt to recover wherever possible, the stones in place thanks to the salvage work carried out immediately after the collapse, while the stones that fell during the collapse cannot be reutilized as they were severely damaged.

Most of the drum that did not collapse can be left in place. It will be necessary to dismantle only the extremity in order to achieve efficacious interlocking between the new part of the completion ring and the residual part.

4.4 Lantern

The new lantern was studied in great detail and mirrors the design of the pre-existing one. Antiseismic tests revealed that the latter presented major problems of stability due to the slenderness of its structure. Studies were performed to find a solution to overcome this defect and innovative materials, such as titanium, will be used for the new lantern and will reinforce the structure thanks to a project of bearing frames that serve as frames for the new openings.

4.5 The clergy's quarters

The rooms of the clergy's quarters will be made more functional than they are at present, but will also respect the function of the presbytery buttresses more. In time, these have been enveloped in the walls and, perhaps unwittingly or because of unawareness, even perforated to make doors and windows, or gutted to make stairs to the reinforced cement roof.