ESEMPI DI ARCHITETTURA

Spazi di riflessione

EdA – Collana editoriale internazionale con obbligo del *Peer review* (SSD Ao8 – Ingegneria Civile e Architettura), in ottemperanza alle direttive del Consiglio Universitario Nazionale (CUN), dell'Agenzia Nazionale del sistema Universitario e della Ricerca (ANVUR) e della Valutazione Qualità della Ricerca (VQR). Peer Review per conto della Direzione o di un membro della Redazione e di un Esperto Esterno (*clear peer review*).

ESEMPI DI ARCHITETTURA

La collana editoriale Esempi di Architettura nasce per divulgare pubblicazioni scientifiche edite dal mondo universitario e dai centri di ricerca, che focalizzino l'attenzione sulla lettura critica dei progetti. Si vuole così creare un luogo per un dibattito culturale su argomenti interdisciplinari con la finalità di approfondire tematiche attinenti a differenti ambiti di studio che vadano dalla storia, al restauro, alla progettazione architettonica e strutturale, all'analisi tecnologica, al paesaggio e alla città.
Le finalità scientifiche e culturali del progetto EDA trovano le ragioni nel pensiero di Werner Heisenberg Premio Nobel per la Fisica nel 1932.

> … È probabilmente vero, in linea di massima, che nella storia del pensiero umano gli sviluppi più fruttuosi si verificano spesso nei punti d'interferenza tra diverse linee di pensiero. Queste linee possono avere le loro radici in parti assolutamente diverse della cultura umana, in diversi tempi ed in ambienti culturali diversi o di diverse tradizioni religiose; perciò, se esse veramente si incontrano, cioè, se vengono a trovarsi in rapporti sufficientemente stretti da dare origine ad un'effettiva interazione, si può allora sperare che possano seguire nuovi ed interessanti sviluppi.

Spazi di riflessione

La sezione Spazi di riflessione della collana EdA, Esempi di Architettura, si propone di contribuire alla conoscenza e alla diffusione, attraverso un costruttivo confronto di idee e di esperienze, di attività di ricerca interdisciplinari svolte in ambito sia nazionale che internazionale. La collana, con particolare attenzione ai temi della conservazione del patrimonio costruito nonché dell'evoluzione del processo costruttivo anche in ambito ingegneristico, è finalizzata ad approfondire temi teorici e metodologici propri della progettazione, a conoscere i protagonisti promotori di percorsi evolutivi nonché ad accogliere testimonianze operative e di attualità in grado di apportare validi contributi scientifici. Le attività di ricerca accolte nella collana EdA e nella sezione Spazi di riflessione possono essere in lingua straniera.

Quando la storia incontra il progetto

Contributi ad AID Monuments 2015 – Perugia

a cura di
Paolo Belardi, Claudia Conforti, Vittorio Gusella

Contributi di
Giuseppe Antista, Luciano Cardellicchio
Rosa Maria Giusto, Romain Iliou, Federica Scibilia

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Prefazione

Paolo Belardi, Claudia Conforti, Vittorio Gusella

Consapevoli del disagio che può derivare dal lungo intervallo tra il convegno e la stampa, di cui ci scusiamo con gli autori e i colleghi, siamo tuttavia soddisfatti di giungere finalmente alla pubblicazione nella collana Esempi di Architettura (Aracne) di alcune tra le più significative memorie presentate al convegno *AID Monuments* 2015.

È opportuno rammentare che le due edizioni del convegno internazionale *AID Monuments* (2012 e 2015) avevano il comune e ribadito obiettivo di mettere a confronto diretto i metodi, le competenze e le professionalità che convergono nell'azione di restauro e di salvaguardia del patrimonio architettonico, che è in stringente relazione con quello paesaggistico e ambientale.

In continuità con le parole d'ordine della prima edizione "Conoscere, Progettare, Ricostruire", il tema della seconda edizione si è focalizzato su "Materials Techniques Restoration for Architectural Heritage Reusing".

Fra gli oltre sessanta contributi presentati al convegno, suddivisi nelle sessioni tematiche: Techniques/Survey, Techniques/Structures, Materials, Reusing e Restoration, il Comitato Scientifico ha selezionato alcune memorie che, nella versione estesa, sono state sottoposte a un'ulteriore valutazione, preliminare alla pubblicazione in Esempi di Architettura. Questi contributi testimoniano, in termini sfaccettati quanto perentori, la trasversalità disciplinare e la molteplicità teorica e operativa che hanno configurato gli intenti scientifici e pratici di *AID Monuments* 2015.

Al tema delle costruzioni antisismiche, con particolare riferimento alle soluzioni basate sull'uso del ferro, affrontato da Federica Scibilia nella memoria *Development and spread of anti-seismic iron structures in Sicily in the 18th and 19th centuries*, fa eco l'impiego del legno per le tecniche di consolidamento strutturale illustrato in *The strengthening of walls with wooden devices in Norman Architecture in Sicily* di Giuseppe Antista.

Se la valorizzazione e la conservazione, con specifica attenzione al tema delle scuole elementari della banlieu di Parigi, sono state oggetto del contributo di Romain Iliou: *Un nuovo volto per la scuola primaria. Dalle esperienze moderne della banlieue di Parigi degli anni Trenta all'evoluzione della normativa francese per gli edifici scolastici*, la rigene-

razione del patrimonio edilizio pubblico è affrontata gagliardamente da Rosa Maria Giusto nel saggio *Reinterpreting the social function. The complex of San Michele a Ripa Grande in Rome and the Reale Albergo dei Poveri in Naples*. Un punto di vista originale, rivolto a un manufatto architettonico di ultima generazione, è argomentato con analisi sottili quanto approfondite da Luciano Cardellicchio nella relazione: *Sophisticated craftsmanship. The new Hertziana Library in Rome by Juan Navarro Baldeweg*.

Tutti questi contributi estesi rappresentano un campione piccolo, ma molto significativo, della ricchezza metodologica e multidisciplinare che ha caratterizzato, per deliberata volontà degli organizzatori, le due edizioni di *AID Monuments*, che hanno offerto ai numerosi studiosi e tecnici intervenuti la possibilità (quasi unica) di un serrato e vivace confronto, tra aspetti diversi, ma complementari, dell'azione di studio, di conservazione, di messa in sicurezza e di valorizzazione del patrimonio architettonico. Proprio l'originalità e la prodigalità dei risultati dei due convegni ci sprona a ipotizzare nuovi appuntamenti che, a dispetto delle difficoltà logistiche e di finanziamento progressivamente crescenti, tengano vivo il confronto tra discipline diverse, ma intimamente affini, così da propiziare una crescita delle capacità di cura del nostro formidabile patrimonio edilizio, proseguendo nel solco tracciato da *AID Monuments*.

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The strengthening of walls with wooden devices in Norman Architecture in Sicily

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Abstract

The use of wooden planks inside walls was a common practice in the Middle Ages in order to improve structural performance by increasing the elastic strength, allowing for better load distribution and making the structures box–shaped, therefore less vulnerable to earthquakes.

Many literary sources and records about the restoration performed on a few buildings as from the late nineteenth century document the use of such technique in 12th–century Sicilian architecture, concentrated mainly in Palermo — the Norman monarchy's preferred location. Specifically, the case studies of the Palatine Chapel and the church of Santa Maria dell'Ammiraglio show the systematic use — according to an organic structural design — of sleepers in walls and rims in dome imposts.

Keywords: Norman architecture, masonry, wood.

The use of wooden planks in masonry buildings was a common practice in medieval Europe, both in the form of tie beams to counteract the tensile stresses, and sleepers inside walls, in order to improve the structural performance (Wilcox, 1981). The insertion of wooden chains was usually done for consolidation purposes, although it was envisaged right from the start of construction of the building in specific environmental conditions, as shown by some churches in Venice, including that of the Basilica di Santa Maria Gloriosa dei Frari, dating back to 1330, which adopts tie beam horizontal frames between the arch supports to absorb the differential lagoon bed settlements (Patetta, 2000).

Sleepers inside the wall — the presence of which increased elastic strength, allowed for a better load distribution, and made the structures box–shaped, thus less vulnerable to earthquakes — were also envisaged at the very start of construction.

Numerous literary sources show a significant use of this technique also in 12–century Sicilian architecture, concentrated mainly in Palermo — the Norman monar-

chy's preferred location. Already in 1525, Leandro Alberti, a Dominican from Bologna, while describing Zisa Castle (Fig. 1) — built in 1165 to the delight of the monarch — praised the quality of its walls, (Alberti, 1581) *this building was made with great skill, one sees that all was built with thick walls, measuring five feet at the top, and chained with enormous oak beams placed within the walls, as one sees in many half–ruined places*. In turn, the local Jesuit, Giovanni Maria Amato, in *De Principe Templo Panormitano* (1728) identified the reasons for the solidity of Palermo Cathedral, dating from 1185, in the very use of wooden chains «fabricam adeo robustam, ut post saecula 5, plurimosq. terraemotus, vitium fecerit nullum, nam catenarum loco, ipsis in muris, roborae trabes infertae» (Amato, 1728; Nobile, 2013).

Besides, the following analysis of the documentation of the restoration from the late nineteenth century in other constructions, such as the Palatine Chapel and the church of Santa Maria dell'Ammiraglio, confirms the systematic use of wooden items in the Norman walls.

The chapel — universally recognized as one of the most significant architectural results of the time and which has enchanted travellers of all ages for its mosaics and its unique *muqarnas* ceiling (Fig. 2) — was founded by King Roger II around 1131, and is set between the two courtyards of the Royal Palace, known as Maqueda and Fontana (Pirri, 1716; Carafa, 1749; Buscemi, 1840; Pasca, 1841; Terzi, 1889; Boglino, 1894; Krönig, 1955; Delogu and Scuderi, 1969; Pottino, 1970; Giordano, 1977; Rocco, 1983–1984; Trizzino, 1983; Kitzinger, 1992; Lavagnini, 1992; Tronzo, 1997; Andaloro, 2000; Malignaggi, 2006; Brenk, 2010; Longo, 2010; Cannella, 2011).

Among its many design features, a number of in–wall wooden devices must be also included, which, underestimating their original function, were eliminated during

Figure 1. Palermo. Zisa Castle.

the restorations because of deterioration, by filling their gaps with brick and cement mortar, or with the addition of metal armour (Figs. 3–4; Antista 2016); already in the years 1887–1888, on the occasion of some work led by Giuseppe Patricolo, wooden elements were discovered in the southern wing of the presbytery (Trizzino 1983, p. 15), and many others were found in other parts of the construction during the restoration carried out under the direction of superintendent Francesco Valenti, between 1921 and 1930, and then from 1937 to 1942 (Valenti 1932 and Valenti 1949).

Among the most challenging works, there was the consolidation of the triumphal arch and spandrel walls at the aisles, which brought to light many beams, as can be seen from a report in October 1936:

> … the stalactites — adhering to west front of the triumphal arch — are supported by strengthened oak brackets, above a wooden stringer originally laid on the wall thickness… other wooden stringers that are in the midst of the ancient walls, and especially on the lower arches at the end of the smaller aisle and at a distance of 0.65 m from the summit, were built in the 12th century, with the intention to relieve these arches of the weight of the imminent constructions (Valenti 1936).

In a subsequent report, the architect also pointed out that in the arch at the north aisle, «an ancient wood beam had been already noted… Then the examination was also performed on the southern arch extrados… where fearful gaps — due to the removal of wooden material during previous old repairs — were found.» (Valenti 1939); the replacement of all rotten oak common joists with brick masonry was then provided for.

Originally, these wooden elements also went all round the nave with the purpose of evenly distributing the loads in the masonry portion above the arches, whose thickness was occupied for two–thirds by a pair of beams, leaving space for a single row of stones from the inner side, in contact with the mosaics; however, the wood deterioration had caused a considerable wall inward rotation over time, so that the gap was filled with brick masonry, and metal chains were used to connect the summit parts of the nave, as well as the chapel perimeter wall arches (Valenti 1939, c. 49 c).

Other wooden elements were used to hold the *muqarnas* ceiling, as already found above the triumphal arch, «two wooden stringers, which run the entire length of the nave, with a section of 0.12 x 0.20 m each, on which eleven joists normally rest perpendicularly… protruding bracket–like toward the nave, originally put to support the wooden framework of the fine stalactite ceiling» (Valenti 1928).

Wood was also present in the presbytery area, in particular in the projections which make square the bema elongated field, on which the dome tambour is set (Fig. 5); some essays unveiled their material consistency, about which experts had questioned at length, and the one nearest the triumphal arc turned to be formed by «four 0.22 x 0.24 [meters] media section oak beams, while on the main apse opposite… only three similar cross–section beams were found… the two projections were also connected by pairs of beams arranged at right angles in the tambour walls» (Valenti 1939). Unlike other parts of the building, these items were not removed; instead, they were

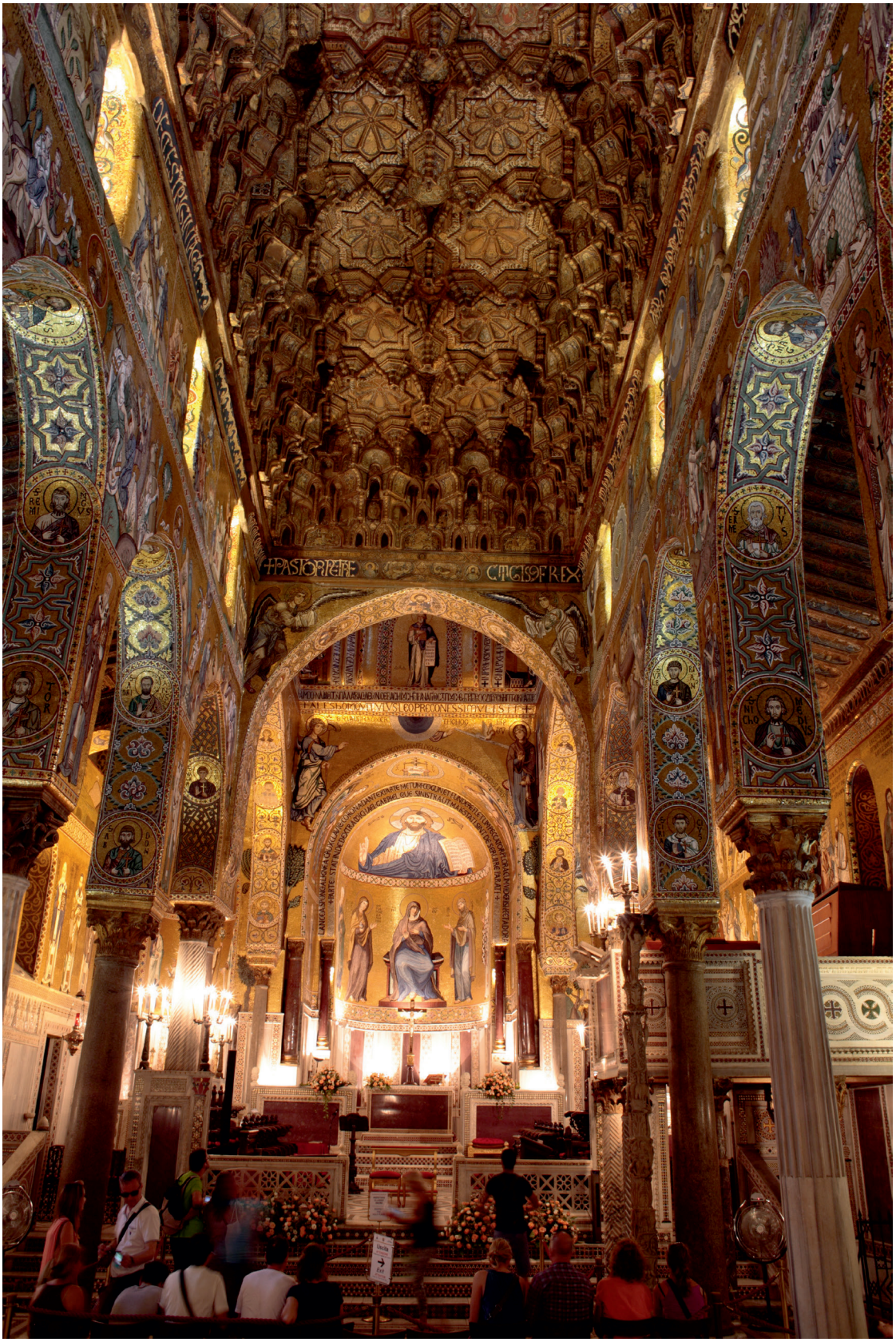

Figure 2. Palermo. Interior of the Palatine Chapel.

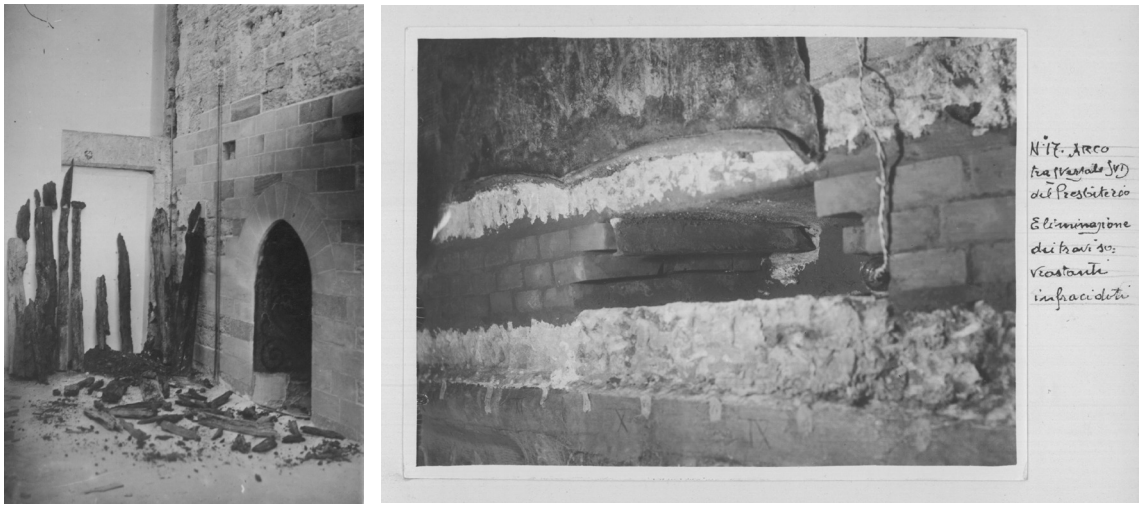

Figure 3. Palermo. Palatine Chapel, wooden items disposed from the walls (Palermo City Library, Fondo Valenti, 5 Qq E 187 no. 1800103).
Figure 4. Palermo. Palatine Chapel, disposal of wooden items in the presbytery (Fondo Valenti, 5 Qq E 14600073).

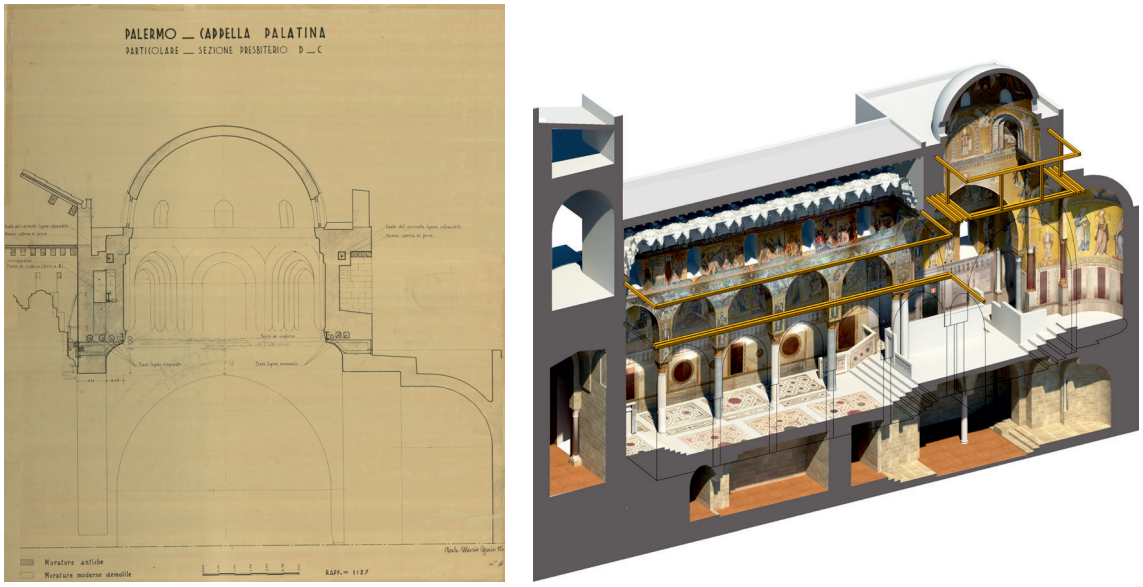

Figure 5. Palermo. Palatine Chapel, section of presbytery (Fondo Valenti, 5 Qq E 188 no. 1700036).
Figure 6. Palermo. Palatine Chapel, axonometric cross section showing wooden reinforcement devices (drawing by Mirco Cannella).

flanked by metal armour to avoid compromising the stability of the dome, which was ensured by an axis complex three–dimensional system; in addition to these elements, at a higher level, there was, in fact, another horizontal frame, with large section oak beams (0.22 x 0.28 m), and four pairs of vertical common joists at the corner niches, connecting the two frames (Valenti 1939).

At the base of the vault, a further chain with common joists of lower section (0.14 x 0.15 m) was placed, which Valenti believed subsequent,

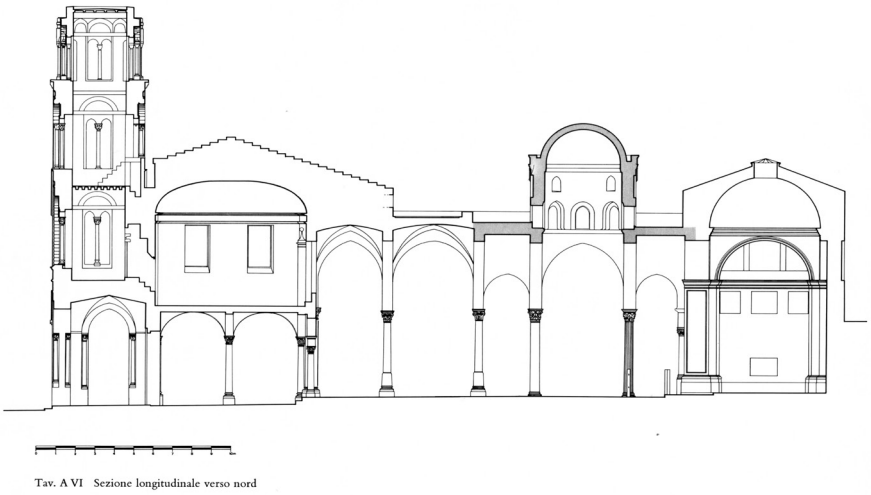

Figure 7. Palermo. Church of Santa Maria dell'Ammiraglio, longitudinal section in Kitzinger, E. 1990. *I mosaici di Santa Maria dell'Ammiraglio a Palermo, con un capitolo sull'architettura della chiesa di S. Curcic* (Palermo: Sicilian Institute of Byzantine and Neo–Hellenic Studies).

> The position of this chain, found under a brick surface made around the dome, certainly towards the end of 12th century… clearly shows that the chain itself had to be built, not at the time of King Roger, that is around 1140, but later, at the time of his grandson, William II, the Good, when the celestial earthquakes — of which [the Andalusian Arab traveller] Ibn Jubayr informed us — took place… (Valenti 1937, c. 5).

The massive presence of wood in the relatively thin chapel walls (Fig. 6) has been explained by the need to quickly proceed with its construction, without waiting for the full setting of lime mortar, complying with the tight deadlines imposed by the royal patrons; this hypothesis could be corroborated by the discovery of two coupled beams, cantilevered within the wall section on which the presbytery transverse arch from the south side rests: their presence would, in fact, have made possible the inclusion of sculptural elements, such as the pillar and capital, at a time subsequent to the construction of the arch (Valenti 1937 cc. 20–21).

Note that wood was used in the walls even in the early church of the Royal Palace, built between 1101 and 1112 below the Palatine Chapel, in fact, in the west wall, a thick plank is still visible, perhaps internally flanked by others, just above the last ashlar row at the cross vault impost that defines the coverage (Zoric 2002; Dittelbach and Sack 2005).

The other case study building is the church of Santa Maria dell'Ammiraglio, known as the Martorana (Fig. 7), which was founded around 1143 by Giorgio di Antiochia, an official working for the same Roger II (Di Stefano, 1955; Santoro, 1977; Kitzinger, 1990); here, the restorations conducted by Giuseppe Patricolo in the years 1870–1873 revealed an abundant use of beams, both in the bell tower and the dome. In particu-

Figure 8. Palermo. Church of Santa Maria dell'Ammiraglio, interior of dome.

lar, during recovery of the roofing, it was found that the latter's stability was ensured by four pairs of beams, presumably linked to one another, in order to form a frame for thrust containment; in fact,

> the remains of two large beams placed on the extrados of each of the four arches supporting the dome were unearthed… But, having been almost completely worn out over time, nothing remained but the gaps alone, and the remnants of the beam skeleton in some spots; therefore, the dome rested only on the two courses of small ashlars, placed at the ends of the drum thickness (0.70 m), each course being 15 cm wide (Patricolo, 1877–1878).

Another wooden chain was also located at the vault impost, behind the frieze defined by shingles with an inscription in Kufic script visible from inside (Fig. 8).

Apart from the wall portions above the major openings, a number of beams are still visible in the inner walls of the bell tower which, due to the church's position on the longitudinal axis and the fine architectural composition, plays an important role in the monument's image (Fig. 9).

The first level consists of a through barrel–vault and is roofed with a carefully prepared cross vault; the second floor is open by three large double–lancet windows and decorated with lava stone inlays, while the last two show cylindrical towers at the corners, lightened at the bottom by small arches on small columns — in the past probably topped by small domes — according to a recognizable pattern in the cathedral towers of Laon, dating back to the years 1180–1195 (Clark, King, 1983), or in other southern Italian cathedrals like Gaeta, Caserta Vecchia (D'Onofrio, 1973), and Amalfi, whose bell towers dates from after the Martorana, although still during the Norman rule.

Before the earthquake that struck Palermo in 1726, the top floor of the city bell tower — now truncated — ended with an ashlar dome (Patricolo, 1877–1878), whose

Figure 9. Palermo. Church of Santa Maria dell'Ammiraglio, view of bell tower.
Figure 10. Palermo. Church of Santa Maria dell'Ammiraglio, interior of fourth level of bell tower.
Figure 11. Palermo. Church of Santa Maria dell'Ammiraglio, interior of second level of bell tower.

remains are a crown of small arches that served as a connection between the square base of the tower and the circular impost (Fig. 10).

From the testimony of the Arab traveller, Ibn Giobair, it is clear that the construction must have already been completed in 1185, «this church has a bell tower supported by marble pillars (of various) colours and topped by a dome (resting) on other pillars: they call it Sawma'at 'as Sawari (the pillar bell tower)» (Amari 1880–1889). While the art historian Giuseppe Bellafiore assigns the tower terminal part to a later phase since it showed

> a stylistic divide in half of its four tiers: of marked stereometry the lower ones… and of clear Fatimid nature, and the higher ones extraneous to this nature, both for their sketchy craftsmanship and distinctly plastic character. These are similar to the fourteenth–century bell towers of Palermo Cathedral that might have been used as models. (Bellafiore 1990).

Figure 12. Kairouan. Great Mosque, prayer room.

Actually, this "divide" between the parts no longer exists inside the tower, which — through an analysis of the masonry — shows a certain homogeneity and construction characteristics: the fourth level wall corners are open and the perpendicular walls present no toothing; moreover, until the aforementioned earthquake, the corresponding circular towers were emptied at the bottom. This structural virtuosity — perhaps due to the need to enhance the acoustic effectiveness of the bells — is made possible thanks to careful execution, which uses stereotomic techniques, and close wooden chains to encircle the walls; in fact, in addition to the dome impost, pairs of chains can be seen beneath the floor structure — no longer existing at the third tier — and at the height of the double lancet window archivolt, which is crossed for much of the wall thickness by more juxtaposed beams (Figs. 10–11) in all the three levels above the porch. Additional individual elements are then placed in the wall in contact with the church, where access to the bell tower can be found.

From the case studies and other examples mentioned here, it can be said that this technique — based on interaction between the stone wall and wooden planks — was widely used in Norman architecture, also because it was useful to mitigate the effects of the frequent earthquakes, including that of 1169 mentioned above by Valenti; it is, however, difficult to identify its origin, not only because it spread in the most elementary forms in the vast territories that experienced the Roman domination, but also because it was known to the three cultural components comprising 11th and 12th–

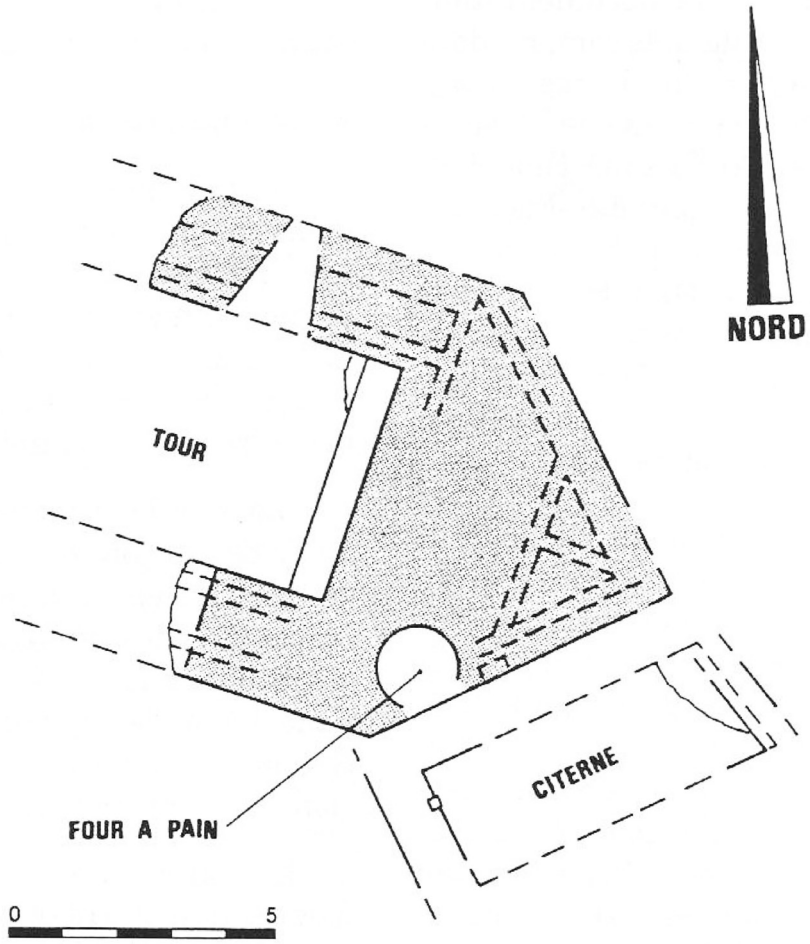

Figure 13. Verclause. Diagram of dungeon in Estienne, M.P. 1996. *Le donjon de Verclause*, in «Archeologie en Baronnies», 2, p. 118.

century Sicilian architecture, i.e. Byzantine, Arab, and that of the new conquerors' homeland, Normandy (Di Stefano 1955).

Already in 1883, A. Choisy showed how the use of wood — in the Byzantine building tradition — was common, both with an anti–seismic function and mitigation of the wall deformations during the mortar setting phase (Choisy, 1883, Chapter X Les Chaînages). Even in Islamic architecture wooden elements in walls were not rare; the Great Mosque of Kairouan, Tunisia, shows another interesting use of wood for structural purposes — between the capitals and pulvinos of the hypostyle hall destined for prayer, lowered supports are interposed serving various purposes, including to distribute the weight evenly, to deaden the upper arches eccentric loads, and also to act as seismic dampers (Fig. 12). This is the oldest building of worship in the capital of the kingdom of Aghlabids, and apparently it reached its final form in the years 836–837, under the Emir Ziyadat Allāh I, who had also extended Muslim rule in Sicily (Marçais, 1925; Sebag 1963; Golvin, 1968; N. Djelloul, 2000).