The Wood Trusses of the "Red House" in Palermo's Parco D'Orleans

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Introduction

The intervention in question regards the restoration of the wooden structures of the roof covering of the "Red House"[i], a nineteenth century farm building that served Palermo's Parco d'Orleans. The decay of the wooden structures of this covering was caused by various interconnected factors. In fact, the decay was initially caused by the presence of moisture and by the infiltration of water and subsequently by biotic attacks.
Today the building lies on the grounds of the University Campus that was created in the 1950s and, in spite of the countless changes made to the area of the former agricultural estate, it continues to be an important landmark for people who get on to the main road of the estate, today Viale delle Scienze, coming from the city centre (Fig. 1).

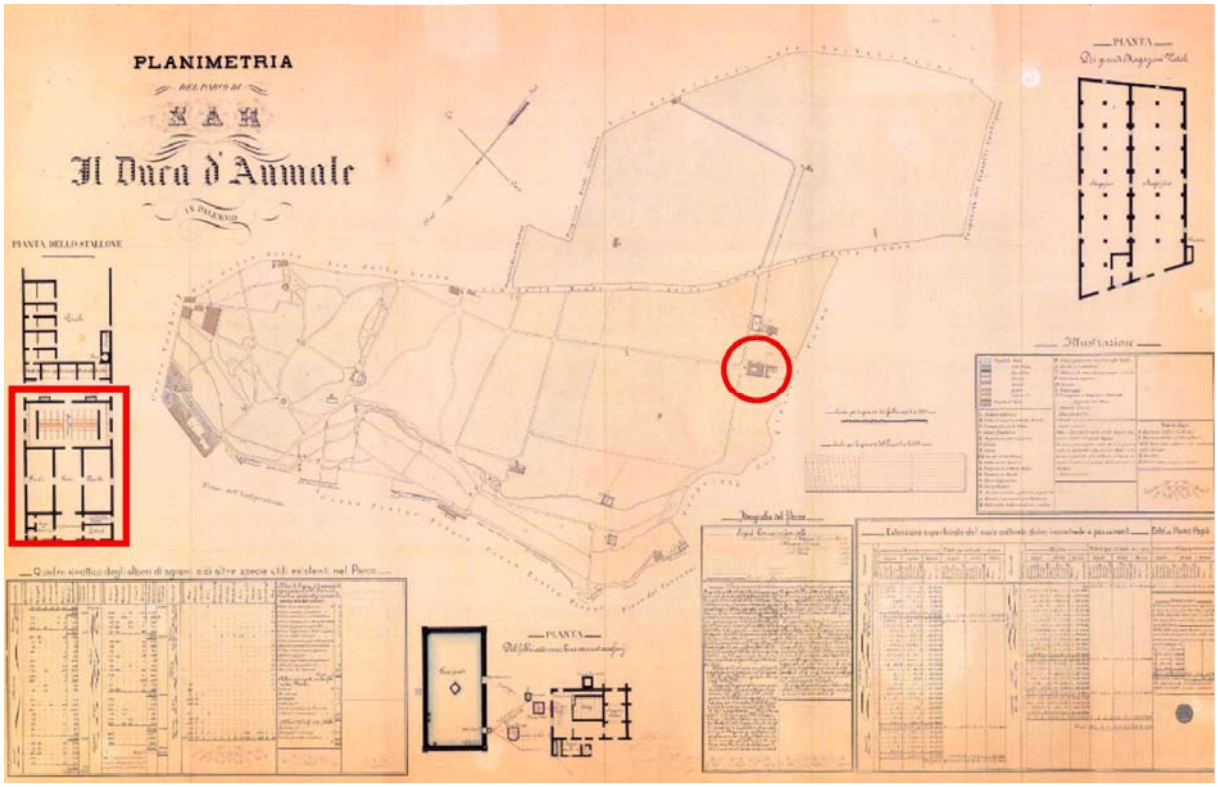


Figure 1. Plan of Parco D'Orleans. The red lines show the ground floor plan of "Red House" and its location on the agricultural estate

The original floor plan had a characteristic courtyard, typical of rural buildings of West Sicily at that time, and four buildings, in load-bearing masonry, three of which were on one level, while the fourth, the most important, in the form of a "tower", was on two

levels and had a room above the entrance hall. This room was originally the master bedroom, while the building parallel to it, made up of one very big rectangular room, covered by a pitched roof, was formerly the stable. The two side buildings that closed off the courtyard, which also had pitched roofs, served for other activities, associated with grape harvesting and wine making.
The building[ii] would continue to be used for its original purpose until the end of 1940 when the entire estate would be taken away from the d'Orleans family because they were foreign citizens, what's more heirs to the throne of France against whom Italy was fighting. First on account of the war, during which parts of the building collapsed and substandard reconstruction was effected so that it could be used as lodgings for war victims, and then as a consequence of years of abandon during which it was lived in as a squat, the red house reached its worse state of repair. Indeed, this period brought about great morphological and structural changes.
The entity of the damage was such that even a plano-altimetric reading was difficult, as discovered in 1993 when the feasibility[iii] of the intervention was being studied. In fact, the building was to be turned into a "*….nursery school for people (teaching and technical - administrative staff of the University of Palermo and students) who move within the Parco d'Orleans and who fill the insufficient public and private facilities of the area …*"[iv]. At that time, the only parts of the buildings still remaining, even though seriously damaged, were the front building and the big room behind it, originally used as a stable. Of the two adjoining wings, one had collapsed and had been rebuilt in a different way from the original with unauthorized structures that leant against the tower-like building, while the other had almost completely lost its roof covering (Fig. 2).

Figure 2. Photo-mosaic of the main façade following

Although 1993 marked the end of this period of neglect, a further ten years would pass before the building would be completely restored. This was mainly due to the difficulties encountered in evacuating the occupants who claimed rights that the judicial authorities, after a lengthy lawsuit, considered as being null and void. In fact, the restoration work began on 30.05.2002, on completion of the above mentioned lawsuit, almost ten years after the feasibility study had been effected, while the finished product was handed over on 26.11.2003.
The project *Renovation of the Red House in Parco d'Orleans for use as a Nursery School*[v] aimed at restoring the symmetry of the building that had been seriously damaged by collapse and by unauthorised structures; however the distinctive characteristics of its

new function had to be taken into due consideration as did the fact that it was a historical building to be protected in accordance with the Municipality's town planning. Although at that time the building was not legally bound by the Palermo's Monuments and Fine Arts Office, the designer took great care to recapture the original characteristics and living-spaces, so that the overall impression of both the inside and outside of the building would be that of the original house.
Therefore, although it was decided that traditional materials and techniques pertaining to the period in which it was constructed would be used, they would however be used alongside new functional and structural solutions, albeit reversible. Indeed, with this in mind, a metal staircase, which led to the room on the first floor, and a light, covered, steel, wood and polycarbonate catwalk that crossed the courtyard were added to the building (Fig. 3).

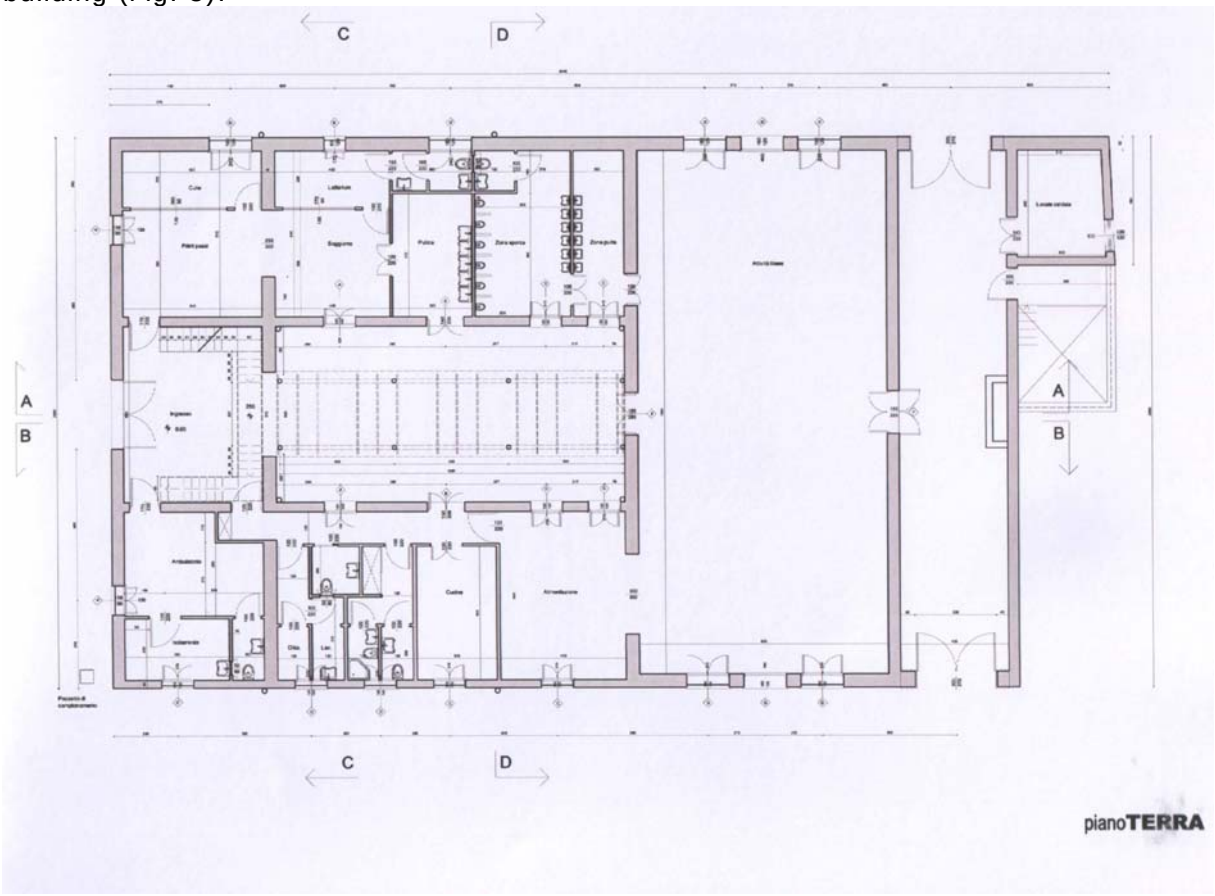


Figure 3. Project: ground floor plan

The wooden structures of the red house

When restoration began, the building was in an extremely bad state of repair: of the two side buildings, only one remained standing, although a large amount of it had crumbled and most of the covering was missing, while the other, on the north-west side, had completed collapsed (Fig. 4). All the remaining wooden structures, due to the perishability of the material and because they had been exposed to the inclemency of the weather, were in a complete state of decay, and had almost totally collapsed. These wooden structures were the floor - ceiling of the small tower, the remaining trusses of the south-east (Fig. 5) wing that had almost completely collapsed, and the trusses of the large room that closed the courtyard (Fig. 6). Because the floors were in seriously bad condition, because there were no constraints and because false ceilings were to be fitted in the rooms, it was decided that the wood would be substituted with girders and hollow block floor. This was also a 19th century technique, but it was better suited to bear the loads that would be brought to bear on these structures by a nursery school, while still respecting the original plan of the structure. Only two of the supporting structures of the

pitched roof of the building on the south-east side remained intact, what's more in a bad state of repair. It was therefore decided that they would be substituted with steel trusses, which were constructed using tradition English lattice trusses made out of Fe 430 (Fig. 7).

Figure 4. The north-west side of the building, that had crumbled
Figure 5. The remaining trusses on the south-east side of the building
Figure 6. The trusses of the large room (i.e. former stable)
Figure 7. The new roof covering with steel trusses

This decision was also made not only because of the small number of remaining trusses and their insufficient load-bearing capacity, but also because it was necessary to use false ceilings in the rooms which, in the new structure would have been used for small children.
On the other hand, a careful examination of these remaining trusses established the fact that the wood could not be used to build the new trusses of the structure; however it could instead be used in parts of the supporting structure of the roof covering of the stable. Therefore the wood, seen as sacrificial material, had the same essence and age, hence seasoned, of the wood of the trusses of the very big building that closed the courtyard, therefore its use would have avoided, or at least limited, eventual rejection phenomena which could instead have been encountered had new wood, or worse lamellar wood, been used.

The wood of the trusses of the former stable

The aim of this article is to concentrate on the study of how the roof of this big, 10 mt long room that was to be used for small children's games, was to be rebuilt.
A special feature of the trusses of this room was that they had angle braces, knee rafters and double lower chords, probably due to the fact that they had to extend over quite a span; furthermore they supported a secondary beam layout on which the roof boarding and covering, made up of double layer Sicilian ridge tiles, rested[vi].
The choice of preserving the trusses and leaving them in full view, unlike those of the other side buildings, was made for various reasons: a) all the trusses were available, although in a very bad state of repair; b) they had great anthropologic value; c) the visual impact of a structure of this kind would have been extremely positive and was compatible with the new environment, i.e. that of a nursery school.
Naturally, to preserve the trusses of the "stable", an in-depth study of the actual condition of the wood needed to be effected; therefore the consultancy of Prof. Giovanni Liotta[vii], an entomologist, was requested. He was asked to ascertain specifically: 1) whether the deterioration of the wood was to be referred to biotic agents; 2) the entity of the damage worked by xylophagous insects; 3) whether an attack by termites was still in progress; 4) whether an infestation by insects was in progress or had occurred in the recent past.
To this end each truss was examined in depth, first in-place and then, after it had been dismantled, on the ground. Particular attention was paid to the study of the head pieces of the beams which had been completely sunk into the masonry; in fact they were more at risk both as regards insect attack and also as regards inefficiency of their load-bearing capacity[viii].
The result of the study was that many of the head pieces were still under attack by beetles of the *Anobiidae* family that were boring numerous tunnels in different directions, and which had caused the wood to become spongy; in the past some of the trusses had been attacked by beetles of the *Cerambicidae* family as clearly evinced by the presence of larval tunnels as could be seen by the fact that part of the outer surface of the wood had come away, underneath which you could see some yellowish red powder. In spite of the fact that these beetles were not active at the time of the inspection, the remains of the last infestation could have attracted further attacks had environmental conditions been favourable. Although both types of attack were visibly significant, they were only superficial and therefore did not irreparably jeopardise the mechanical function of the beams. However, in those areas where the beams had been attacked simultaneously by the beetles of the *Anobiidae* family and by termites of the *Kalotermitidae* family, the cross sections of the girders of the trusses had noticeably thinned, although in certain points they were still in tolerable condition (Figs. 8,9,10).
The designer-foreman and the entomologist reached the conclusion that the trusses would not be able to bear the load of the roofing structure, but that at the same time, considering their historical and artistic value, they could not justify their substitution. It was therefore decided that the trusses would be preserved, while a "brace" would be used to bear the load that should have been the trusses function.
Although the trusses were considered as having insufficient load-bearing capacity, the wood still had to be restored by eliminating the biotic attacks in progress and by inserting suitable wooden prostheses using traditional methods. These prostheses would be made from the wood taken from the lateral trusses that were in bad condition and that had to be substituted, after it had been duly disinfested. Therefore, the surface of all the trusses, and all the new wood, was duly painted with a special substance containing insecticides against termites and other insects that had been added to *autobollente* solvents. The treatment was then completed by applying two transparent, protective layers of alkylik resins, having a UV filter; they contained natural essential oils with anti-mould and anti-fungus substances and also with an intumescent fire resistant coating.
Furthermore, again following the advice of the entomologist, for safety's sake the supporting masonry was sprayed with a *"chlorphyrifos"* substance, so as to avoid it being an infection vehicle.

The metallic "braces" used to help support the roofing structure

In spite of the fact that the trusses had been treated to eliminate the infestations and in spite of the fact that special prosthesis had been inserted in the particularly damaged head pieces of the beams, it was ascertained that the trusses would not be able to bear the new load of the roofing structure of the nursery school, nor would they be able to bear the stress contemplated by regulations regarding seismic events.

Figures 8,9,10. Various attaks by different kinds of beatles

The new project intended to lighten their load bearing function by introducing a system of two rafters made with channel irons and two iron chains with large diameter round bars fixed to steel shoes anchored in the masonry. His intervention was effected in various phases. The first dismantling phase saw the freeing of the head pieces of the beam from the masonry (Fig. 11), which were then transported by a crane that stacked them on the ground. After the wood elements on the ground had been disinfected, an armoured concrete perimeter kerb was laid all around the perimeter of the room. Four stainless steel threaded bars (f 20) were sunk into the kerb, which were to serve as anchors for the steel shoes where the trusses would be subsequently lodged (Fig. 12). A *neoprene* sheet, 5cm thick, was placed between the steel shoes and the top kerb below, to avoid the transmission of torsional stress to the underlying masonry. A 10 cm channel iron was also welded to the back of each steel shoe, the purpose of which was to oppose the effect of the iron chains (Fig. 13) used to accomplish the task of the pre-existing wood lower chords, which were made of iron rods (30 cm in diameter).

Figure 11. Dismantling of the head pieces from the masonry
Figure 12. The metal shoes anchored in the perimetral kerb

There were iron rods for each truss which were anchored to the steel shoes by means of bolts that would have allowed them to be stretched. This operation was made easier by closing off the summit masonry behind the steel shoes. This was achieved by means of a

small wall built of bricks and hydraulic lime at the head, in which holes were bored to make the area easily accessible (Fig. 14). At the same time we applied the following structural aids, out of contract, to the trusses: channel irons were used to gird the upper part of the struts, which were fastened by means of a system of bolted brackets. A *neoprene* sheet was placed between the steel extrusions and the wood struts to avoid them coming into direct contact, considering their different reactions to thermal stress, and thereby avoiding subsequent condensation phenomena which would have made the wood an easy prey for biotic attacks (Fig. 15). The two new steel rafters were fastened to the steel shoes by means of two angle irons that were welded to the end parts, and that were connected to each other by means of a pair of gusset plates that were also bolted (Fig. 16).

Figure 13. The steel shoe with the channel iron and the connection to the king post
Figure 14. The birks on the summit masonry used to areate the head pieces of the beams

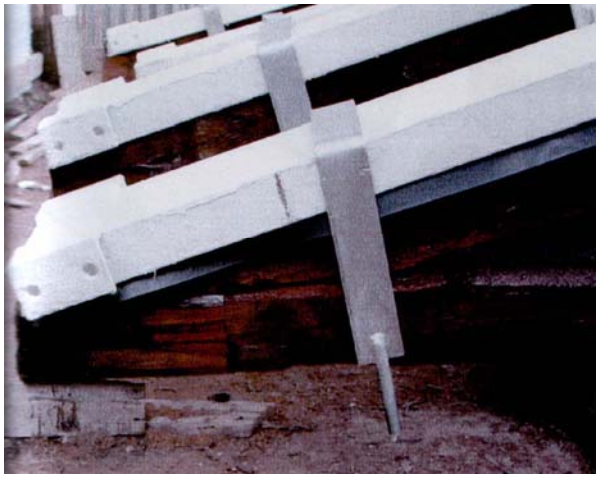
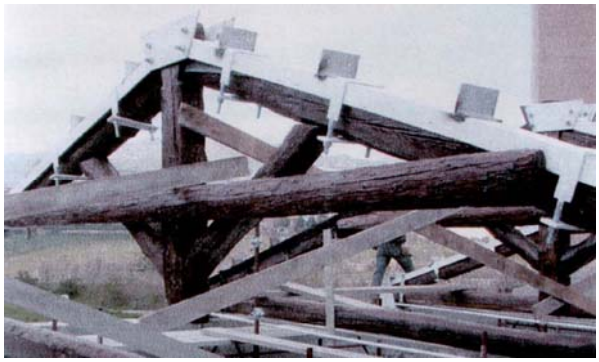


Figure 15. The steel-wood structure

Figure 16. New metal structure connected to a pair of gusset plates

Figure 17. The head piece of the wood lower cords

Figure 18. The angle braces on the channel irons used to haed secondary beam



Figures 19, 20, 21. The covering following restoration

It should be said that the size of the steel extrusions that were to gird the wood struts, which was calculated by assuming that the new metal structure would bear the load alone, was decided on in reference to artistic value, i.e. they were the size of the maximum width of the wood strutting. On the other hand, the new supporting structure of the covering needed to seen but at the same time it shouldn't have prevailed over the original one, thereby resulting predominant; indeed it was to be a unique, new, composite structure. However, the harmony between the two pairs of wood and metal elements did not only derive from the above mentioned necessity, but was statically necessary.
In fact when deciding on the size of the metal structure it was especially necessary to take into due consideration the maximum combined bending and compressive stress peak load, the eventual warping of which was prevented by the simultaneous use of the two structures.
These new trusses were then placed on the steel shoes, after a further sheet of *neoprene* had been placed between them. Thus the head pieces of the wood lower chords were never in direct contact with the steel, so that they could be ventilated appropriately (Fig. 17). The secondary beam layout was fastened to the extradoses of the channel irons by means of angle irons, which were used to hold the 10x10 wood rafters on which the 2cm wood floor planks rested (Fig. 18). A coat of waterproofing, a layer of insulating and Sicilian ridge tiles (the lower ones of which were new while the upper ones had been restored) completed the roof covering.
From an overall point of view, the intervention on the roofing structure, effected using perimeter kerbs, steel shoes and lower chords, put the big room in the position to resist seismic stress in compliance with the law, which otherwise would not have been possible in such a large room that completely lacked intermediate "wall shields", unless it had been substantially reduced in size (Figs. 19,20,21).

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[i] The building is so-called because of the peculiar colour of its plaster
[ii] In 1810 the park, situated immediately outside the cities 16th century walls, was bought by Filippo, Duke of Orleans, who transformed it "*…from an experimental agricultural farm into an ornamental park, a recreational park that was adjacent to the house, and a very extensive park that was used as a landscape garden on the model of the English garden…"* (Cottone, A., Cottone, D.). About 50 years later, in 1857, the Duke's son started renovation on the park. The "Red House" was probably built at that time to serve the modern and complex irrigation system. In 1934 the entire Parco D'Orleans, originally pasture land, was turned into vineyards, as a result of which the house, that had hitherto been used as a shelter for animals, was used not only as a stable but also for other activities associated with grape harvesting and wine making
[3] In Memorandum MS/dm prot. 64/gr dated 29/11/1993, the Chancellor entrusted Eng.-Arch. Antonio Cottone with the preliminary investigation to ascertain the condition of the buildings and the feasibility of the restoration of the "Red House" that was to be used as a crèche and a nursery school
[iii] The project was approuved with D.R. n° 2541, 01/08/1997
[iv] Cottone A., Cottone D., *op. cit.*
[v] After the Head of the University's Technical Department had given his technical approval in memorandum Prot. 1858 dated 23/05/1997, the project was approved by Decree n. 2541 dated 01/08/1997
[vi] Unlike the side buildings whose ridge tiles rested directly on the rafters, here there was a wood floor
[vii] Liotta G., *op. cit.*
[viii] During this same consultancy, samples were collected that were later examined in the lab