

HISTORIC FARMS IN ITALY: SURVEY ON EFFECTS OF LACK OF MAINTENANCE

G. CARDANI¹, C. TEDESCHI¹, L. BINDA¹, G. BARONIO¹
¹ Dep. of Structural Engineering (DIS), Polytechnic of Milan

SUMMARY

The growth of Milan in the last century occupied some rural areas still active in the fifties and sixties; the buildings were abandoned by the owners and remained under continuous decay due to lack of maintenance. The authors will report on surveys carried out on two historic farms showing how through on site and laboratory tests the progressive decay of materials and structure could be monitored. This decay is causing the total loss of one of the two farms while the other could be saved by restoration and repair intervention.

1. INTRODUCTION

Aggressive environments [1] and the presence of animal waste are generally the principle cause of the porous material decay in rural building [2]. Nevertheless chemical-physical decay does not cause generally structural problems, if repair and protection are carried out. A continuous lack of maintenance speeds up the damage phenomena and the masonry decay, causing serious static failures.

The two examples here reported are: the “Cascina Rosa” (CR in the following) and the “Cascine Chiesa Rossa” (CCR in the following) barns, which are part of the buildings. The CR farm is in a period of neglect, awaiting since years the approval of the intervention project. Continuous carelessness worsened the situation of the complex in such a way that it will be probably ruin. Same critical conditions had reached the CCR farm in 1960, when a first rough restoration took place. Only in 1999 a reuse project was accomplished, which saved the buildings at the very last moment.

The diagnostic investigations carried out by DIS, Polytechnic of Milan, aimed to know the structural behaviour of the two complexes, and in particular of one of the better preserved elements: the stable. The effective state of preservation was observed by means of: (i) an accurate geometrical survey, (ii) a material and damage survey, (iii) a decay and crack pattern survey, followed by in situ and laboratory experimental tests and structural analysis [3]. Tests were also carried out in subsequent times in order to detect the decay evolution [4].

2. BUILDINGS DESCRIPTION

CR represents a typical example of Lombard farmhouses. It shows two courts with different functions and very interesting architectural elements such as the dome vaults of the barns, the barrel vault of the stable and the owner house (16th cent.). Originally “Cassina Ferrarion”, it changed its name in “Cascina Rosa” after it was sold to the Spanish Ordogno da Rosales Family in the years 1637/38. The barns in the main court and the stable were built in 1834-36. During the second world war, the farm was bombed and had serious damages never repaired. Until 1983 the farm was still in use, then the Municipality of Milan became owner and the farm was abandoned to itself (Fig. 1).



Figure 1: "Cascina Rosa": the stable (1989)

The name of the complex of “Chiesa Rossa farms” is due to the old church S. Maria Rossa (10th cent.) of great historical artistic interest, built on the foundations of a pre-existing Roman sacellum. According to the historic documents, the farm dates back to the 16th century. The stable was built in the second half of the 19th cent. and since this period this complex did not change its configuration (Fig. 2).



Figure 2: "Cascine Chiesa Rossa": the stable (1996)

3. DAMAGE EVOLUTION DUE TO LACK OF MAINTENANCE

Since 1983 the preservation of CR was planned by four projects proposing different solutions but meanwhile the farm was forgotten. The lack of use and maintenance



Figure 3: CR: damages evolution of the owner house (1940-'91-'98)

allowed chemical-physical-biological synergisms to cause initially light but then more and more heavy damages and collapse of also large parts (Fig.3). In addition in 1989 the farm was illegally occupied by about 600 emigrants for more than two years. At the end of this occupation the structural elements were found to be seriously damaged; the static conditions of the main building seemed to be compromised. The state of conservation of the CCR was already critical since 1996 when the danger of collapse of the stable roof lead to provisional repair. Finally on March 1999 the restoration started based on a study and diagnosis of the state of damage which lead to an appropriate design.

4. ON SITE SURVEY AND TESTING

For both the stables a damage survey was carried out. The knowledge of the state of conservation of the single structural elements, of the links with masonry and with wood elements and the materials decay survey are very important for the choice of appropriate techniques of repair.

4.1 Geometrical and damage survey

The geometrical, damage and crack pattern survey and the out of plumb of wall and piers measured in different times, allowed to observe the slow increase of the damages in the last years. In fact in January 1988 the decay of the CR stable was not very serious. Only a small part of the roof was damaged but at the end of the occupation, in 1991, the last part of the porch roof failed together with the last west column. The geometrical survey was realised with traditional simple equipments (tapes, etc). By measuring the out of plane points, it was observed that the structure tends to rotate in the north direction, that means in the opposite part of the porch; this is typical for buildings with non-symmetrical structures.

For the CCR stable a more accurate geometrical survey was necessary, realised with electronic devices able to rapidly collect data from the structure and to provide information on the evolution (Fig.4). In fact almost all the columns were out of plumb in different directions due to a lack of connections, as tie beams or floors. Since September 1997 the two columns at the west end of the stable, were out of plumb for 40 cm (Fig.5). As a consequence a displacement of the top beam and of its connected trusses took place (Fig.6). Furthermore due to lack of maintenance the whole timber structure suffered bad decay. The pictures, in order to represent the material decay, acquired for the geometrical survey were also used for the photographic rectification.

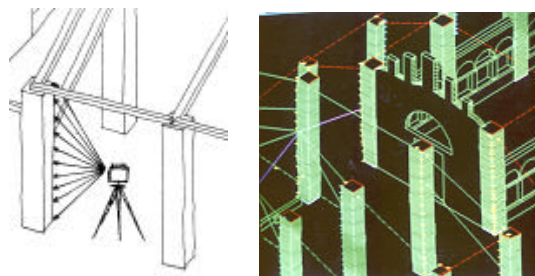


Figure 4: CCR: detailed survey of the columns

In conclusion, for both farms, foundation settlements and materials decay, above all located in the elements connections, allowed individual movements of the different structural elements (walls, pillars, trusses and ties) [5].



Figure 5: CCR: rigid rotatio



Figure 7: Damaging processes: a) freeze/thaw; b) salt crystallisation

The photographic rectification and the visual survey showed a diffused superficial and deep decay in the bricks and in the mortar joints, combined with biological growth and patinas. The different types of damage are mostly due to water presence, increased by the lack of maintenance and bad state of conservation of the roof, causing different damaging processes like salt crystallisation and freeze/thaw (Fig.7). Percentages of the decayed masonries were calculated, dividing them in different levels of decay. The 80% of the mortar joints was declared to be repointed and a large part of the bricks showed serious decay: 46% for CCR but only the 11% for CR. The stone elements showed to be in a better state of conservation.

4.1 In situ tests on the structures

Two types of sonic tests were carried out on the masonry structures and on the columns of both the farms: direct (or through-wall) and indirect (on the same face of the wall) at a height of 130 cm. The average velocity in all masonries resulted greater than 1000 m/sec. That means, from previous research, that in both cases the masonries decay was not deep. A comparison of the results was done carrying out the same tests on the same columns 5 years later: no worsening due to progress of the decay was measured. In the case of CCR the values measured in the columns located on the north side were higher probably due to the presence of moisture. A direct inspection of the masonry was performed by removing few bricks in order to verify the constructive technique. The surveys showed in both cases solid brick masonry. The investigations carried out in some of the foundations of CCR showed a good construction technique and therefore no need for intervention. Few trusses were inspected due to difficult access and the recovery of their out of plumb appeared to be possible avoiding their

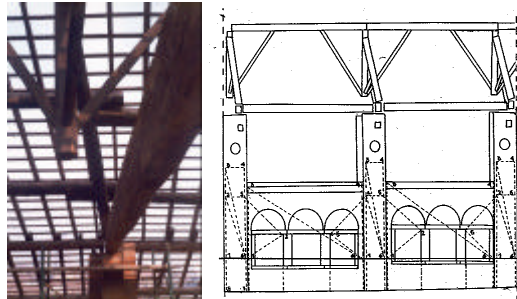


Figure 6: CCR: a) displacement of the post;
b) survey of the displacement;



substitution; nevertheless some trusses were continuously exposed to rain and humidity and temperature variations causing a further damage. The survey of the nodes near the bearings was conducted in every truss in order to find the possibility of conservation.

5. LABORATORY TESTS

The laboratory investigations aimed to: (i) verify the state of the material conservation, (ii) characterise the existing materials, (iii) study the compatibility between the new materials that were to be chosen for restoration and the existing materials and structures. Some bricks were sampled from the masonry structures, columns and connecting walls choosing the sampling areas according to specified finalities. Sampling to characterise mortar and bricks was carried out in the internal part of the masonry and sampling to analyse the decay was carried out on the surface. The analysis on sampled materials provided significant information on their chemical-physical and mechanical characteristics. The superficial decay did not seem to compromise the mechanical strength.

For both stables the mortar resulted based on hydrated lime and mainly on siliceous aggregate with a low binder/aggregate ratio. Also the mineralogical-petrographical analysis confirmed the low quality of the mortar and consequently the low mechanical strength. As far as the bricks are concerned the physical and mechanical tests showed a material of low quality but useful for the low loads of the buildings. The strength of the masonry was found by compression tests carried out on small specimens cut out on site: the ultimate strength for CR was 3.22 N/mm^2 and for CCR was 5.28 N/mm^2 . The reported values are of course only indicative because they refer to few specimens [6]. Samples of salts collected from the masonries of both stables were submitted to diffractometric analysis, which showed a prevalence of magnesium sulphate, an hydrated salt that may become very expansive causing high damage on the external masonry surface.

7. REPAIR DESIGN OF "CHIESA ROSSA FARMS"

The authors supported the designer in the choice of the material and in the intervention techniques for the stable. An intervention aimed to eliminate the high salts and moisture content in the masonries was planned, together with a drainage of the ground, controlling the flow of the meteoric water. No soil and foundations consolidation were planned, because compatible with the project. More attention was paid in the strengthening of the structures, reinforcing the connections among the roof, floor and masonry elements. Particular care was proposed for the conservation of the trusses. Cleaning was proposed to be made only through brushing, avoiding sandblasting. The missing part had to be substituted using bricks with the same physical and mechanical characteristics as the old ones. Decayed mortar joints had to be cut out and repointed



Figure 8: CCR: a) rising damp; b) damage of the repointing

with lime based mortar, carefully chosen. Unfortunately not all the suggestions were fulfilled and moisture source was not completely removed. In figures 8 rising damp is still visible in spots and the repointing mortar is already detached.

8. CONCLUSIONS

The serious state of damage of the two farms is mainly due to the lack of use and maintenance in the last years. Capillary rise of water, moisture movements in masonries were the consequences which caused salt crystallisation and freeze/thaw processes. However the surveyed decay is slow in time and only a lack of use for many years may caused irreversible damages. For CCR farm, the intervention although realised after years could still preserve the buildings.

The history of the two farms, similar in many aspects, led to different situations. For the CR the lack of maintenance is still continuing and consequently also structural failure took place causing the loss of large parts of the farm. The CCR had a better luck. Thanks to repair and restoration intervention of the complex and of the area around it, it is ready for new use.

9. ACKNOWLEDGEMENTS

The authors wish to thank: Istituto. dei Tumori for the CR, Metropolitana Milanese for the CCR and MURST-Cofin. '98 for their financial support. C. Tiraboschi, G. Frigerio, M. Antico, M. Cucchi, G. Ghilardi, M. Iscandri, P. Perolari and the students who worked on the arguments.

10. REFERENCES

- [1] Binda, L.; Charola A.E.; Baronio G. - "Deterioration of porous materials due to salt crystallisation under different thermohygrometric conditions" in *Vth Int. Conf. on Deterioration and Conservation of Stone*, 279-288, Losanna, 1985.
- [2] Binda L.; Anti L., Baronio G. - "Durabilità delle murature in ambiente aggressivo e delle tecniche di conservazione e protezione", Atti del Corso di Aggiornamento in Ingegneria Sismica *"Progettazione, Restauro e Adeguamento di edifici in muratura in zona sismica"*, Augusta, pp.799-869, 1991.
- [3] Prof. L. Binda et al. - *Indagini sperimentali sui materiali e determinazione dello stato di conservazione delle strutture del complesso di Cascina Rosa*, Relazione del contratto di ricerca (Istituto dei Tumori-Milano), Dicembre 1997.
- [4] Prof. L. Binda et al. - *Indagine sperimentale per la determinazione dello stato di conservazione dei materiali e delle strutture del Complesso Cascine Chiesa Rossa in vista dell'intervento di restauro*, Relazione contratto di ricerca (Metropolitana Milanese), Aprile 1998.
- [5] Binda, L.; Baronio, G.; Cardani, G.; Frigerio, G. - "Effetti della mancanza di manutenzione: Cascina Rosa a Milano", Atti del Convegno di Studi *"Ripensare alla manutenzione"*, XV *Convegno Internazionale SCIENZA E BENI CULTURALI*, Bressanone, pp 543-554, 1999.

- [6] Cardani, G.; Tedeschi C., Binda, L.; Baronio, G. - "Effetti della mancanza di manutenzione: indagini sui materiali e sulle strutture di edifici rurali storici", *5th International Congress on Restoration of Architectural Heritage, Firenze 2000*, to appear.