ABSTRACT

Fire protection of historic buildings in only a few cases is able to find adequate solutions under prescriptive rules. Very often, the problems caused by the contemporary presence of conservative and fire safety needs lead to either the alteration of the original lay out of the building or to the unsuccessful implementation of safety measures. In this case performance based techniques seem to be the only approach able to ensure both heritage safety and preservation. The NFPA 914 code, developed for the evaluation of historic structures, is an essential reference for those who want to apply the performance based approach to national heritage. Among the undoubted advantages provided by this code, technicians have to analyse its possible application to large historic structures, where people and works of art are exposed to extremely complex hazards. To this purpose we present the case study of Santa Maria della Scala in Siena, where occupancies like museums, exhibitions, restaurants, cafeteria and a shopping mall share the same structure of 35000 square metres on seven floors, three of which are under the access level for rescuers.

Keywords
Fire protection heritage

FOREWORD

The necessity of enhancing our national heritage by allowing a special use able to finance its maintenance and preservation implies in many
cases the introduction of new occupancies. The activities that are politically acceptable for each historic structure may, in turn, give way to different problems with regard to the structures themselves. One main problem is the risk of fire. In many cases, especially in large structures, their proportions invite the presence of different activities, such as restaurants, conference halls, shopping malls. This option is important to give life and access to the structure and its maintenance, but it creates special problems concerning public safety as well as cultural assets preservation.

![Fig. 1 - Middle age drawing of the hospital](image)

**THE MONUMENTAL STRUCTURE OF SANTA MARIA DELLA SCALA**

The structure is opposite the Cathedral in Siena and it was one of the first hospitals in Europe. It was built to accommodate foundlings, the poor as well as pilgrims walking along the via Francigena. That route connected Rome with countries beyond the Alps, and for centuries it has been one of the most travelled routes in the world.
The original core of the structure is a church, which was built around the mid XIII century and got its actual shape at the end of the XV century. At the end of the XIII century the "Spedale" (hospital) included the city walls which run along its properties downhill and also a road, still evident today inside the structure. Most great artists of Siena worked in the hospital, which can be considered now the third artistic centre in the city, after the Cathedral and the Palazzo Pubblico.

The restoration works of Santa Maria della Scala were launched in July 1998. In 1992 the Town Council of Siena promoted an international contest for the restoration of the "Spedale" after the decision to transfer all clinic activities still carried on in the building. The goal was to restore the historic structure and to transform it into an integrated museum complex containing the Art Gallery, the Archaeological Museum, temporary exhibitions, a Documentation Centre for Restoration Works and other services (cafeteria, restaurant, self-service restaurant).

fig. 2. location of the complex
Since 1998 Santa Maria della Scala can be considered as a building site-museum complex, where visitors and tourists witness the progress of restoration works. Restoration activities are still in progress with the same enthusiasm and determination of 1998 according to the following:

- a decision to carry out works in different areas and intervention modes, keeping open the Museum, to enable the city and the public to enjoy the building during the long restorations;
- planning of guided tours to the construction site, to show the meaning and the features of works to the public;
- organisation of 'teaching sites', to ensure the training of special operators (archaeologists, restorers, decorators).

Even the peculiarity of the economic intervention make this case a "pilot project": the Town Council finances restoration works through the public offering of Municipal BOC ("stocks" purchased by the citizens).

The intervention was developed in three phases:


2° phase -(1999-2000) 'light' restorations to use the old barn and warehouses (Granaio and Magazzini della Corticella) for temporary exhibitions

3° phase -(2000-up to date) Comprehensive restoration of homogeneous areas, aimed at the complete recovery of the structure (from an architectural, technological and functional point of view)

During the last phase the Archaeological Museum was placed in the basement of the structure, the so called "cunicoli" (tunnels). They are particularly attractive rooms, partly excavated in "tufo" stone, partly constructed in brick, which represent the foundations of the Spedale and extend up to Piazza Duomo. During the centuries these underground rooms had been used as storage facilities, technical spaces, warehouses.
Before the restoration they presented several floor level differences, were filled with materials and recent technical constructions, some rooms were not accessible or not communicating, some were filled with "tufo" stone. A large area -which has been preserved- was characterised by the presence of the "carnaio" (carnage), a depot of human bones dating back to the plague which struck Siena in the XVII century. The characteristics of these tunnels seemed to fit particularly well with the exhibition of archaeological finds, intensifying their sacred and ritual features, beyond a simple taxonomy. The Archaeological Museum, the Granaio and the Magazzini della Corticella are now open to the public.

**PERFORMANCE BASED APPROACH AND NFPA 914 CODE**

This new approach requires the definition of fire scenarios, the identification of performance criteria and the verification of performances themselves. When applying this approach to historic buildings it is necessary to take into account the following elements:
- knowledge of material behaviour, which usually differs from the behaviour of modern materials (no availability of accurate data concerning fire resistance);
- identification of fire scenarios, i.e. of the conditions which might be significant to evaluate fire spread.

The identification of fire scenarios is an essential element in the process of performance assessment, because in this phase technicians have to define the characteristics of the activity with regard to the risk of fire. In case of historic monuments the problem of the identification of scenarios is more complex because it is necessary to evaluate the effects of fire on particularly exposed and valuable property.

In order to solve this problem technicians have to refer to current regulations. In particular in Italy and Europe no one has developed a code concerning the application of performance based criteria. General guidelines have been provided by ISO with the document “Technical Report 13387” and in the United Kingdom by British Standard DD 240. However, the reference for application criteria is the NFPA 101 code and the NFPA 914 (historic structures). Both NFPA codes envisage the assessment of eight fire scenarios. NFPA 914 adds four more scenarios with the aim of assessing works of art or buildings to be protected.

![Fig. 4 the inner road](image)

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On the basis of the gained knowledge of the monumental complex of Santa Maria della Scala in Siena, some elements will be presented which - according to the authors - make it advisable to carry out an in-depth assessment:

a) Emergency routes and architectural barriers
Historic structures are rarely accessible and, in many cases, the removal of architectural barriers can be a difficult problem to solve for those who have to evaluate escape possibilities and speed for both able and disabled people.

b) Construction sites for building or restoration works
Historic structures are, by their nature, subject to frequent ordinary and extraordinary maintenance works. Moreover, restoration sites can be active for years and their presence can heavily affect the parts open to the public. Historic investigation has revealed that renovation works are the most frequent source of fire in historic buildings.

c) Temporary installations and exhibitions
Usually the public is admitted in the most significant areas, where smoke damages are not allowed. In such areas exhibition cases are set up with built-in electrical systems, or other devices installed after the necessary fire prevention approvals, because they are not considered significant for safety purposes. Also in case of temporary exhibitions there is the risk of frequent changes in the exhibition lay out with the consequent impossibility to determine the effects of each scenario on the historic structure. In this framework the management of electrical systems and devices is of paramount importance. Even if the use of such devices is ruled by specific standards, the authors would like to highlight some particular aspects:

- light fittings installed on tracks with clamps, which may fall onto combustible materials;
- floor lamps (while moving them to clean the floor it is possible to touch curtains or other materials);
TV sets, screens, projectors, loudspeakers, etc. which sometimes are installed in walls or cases reducing their cooling possibilities (they may be equipped with cooling fans or vents for heat exchange).

TV sets, screens, projectors, loudspeakers, etc. left in stand-by mode even when they are not used;

alterations of electric systems and plugs, use of extensions;

overheating of multiplugs due to joule effect of electric system wires. They are subject to cracks and "loosening" which cause local temperature increases;

extensions which can be placed in passageways and be subject to wear and tear due to trolleys, closing doors, etc. Sometimes they are fixed on walls with unsuitable systems (e.g. nailed) and become de facto an unauthorised change of the fixed system;

everything which is not included in the fixed electric systems (which are built-in in walls) and may be subject to additions, changes, etc.

CONCLUSIONS

The NFPA 914 code allows technicians to carry out risk assessments according to the performance based approach in historic structures. In case of particularly complex buildings such an assessment must take into account not only the problem of accessibility, but also management issues. In fact, the possible differences between the real situation and the situation assumed in fire scenarios force the planner to take into account different conditions. The complex structure and preservation requirements of historic buildings do not exclude the possibility of temporary non compliance with current legislation.

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