Maintenance Techniques for Historic Building Facades

Technique de maintenance pour des façades de bâtiments historiques

Unterhaltungstechniken für Fassaden historischer Gebäude

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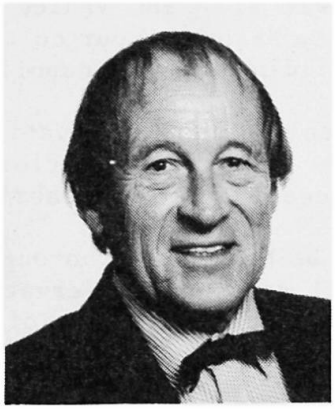

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SUMMARY
The design of a maintenance program for a historic building facade must be based on a technical understanding of the building as well as sound conservation principles. A thorough investigation of the building's history and existing condition is made, utilizing non-destructive testing and monitoring equipment. The selected maintenance procedures should be compatible with the building, should not damage the existing historic fabric, and should be reversible. Regular maintenance and regular periodic inspections will prolong the life of the building facade and reduce major repair costs.

RÉSUMÉ
Le programme de maintenance pour une façade de bâtiment historique doit être basé sur l'appréciation technique du bâtiment de même que sur des principes de conservation reconnus. Une étude détaillée de l'histoire du bâtiment et des conditions actuelles est réalisée à l'aide de méthodes d'essais non-destructifs et d'un équipement de mesures. Les procédures de maintenance choisies doivent être compatibles avec le bâtiment, ne doivent pas endommager le tissu historique existant, et doivent être réversibles. Une maintenance régulière et des inspections périodiques prolongeront la vie de la façade du bâtiment et réduiront les coûts majeurs de réparation.

ZUSAMMENFASSUNG
Das Programm für die Unterhaltung der Fassade eines historischen Gebäudes beruht auf dem technischen Verständnis des Gebäudes und der Anwendung erprobter Konservierungsmethoden. Mit Hilfe zerstörungsfreier Prüfungen wurden Gebäudezustand und -geschichte festgestellt. Die ausgewählten Unterhaltungsmethoden sollen reversibel sein und auf identischen Materialien basieren. Regelmässige Unterhaltung und periodische Zustandsaufnahmen verlängern das Leben der Gebäudefassade und verringern die Reparaturkosten.

1. INTRODUCTION

Historic buildings in our cities must be preserved for future generations because of their cultural heritage and because they represent a valuable economic resource. The current philosophy of historic preservation is based on the "Venice Charter," a resolution adopted by one of the first international conferences on historic buildings held after World War II. The Venice Charter states that it is the responsibility of all people to safeguard our cultural resources, and to maintain and preserve the historic buildings in as unspoiled state as possible.

Regular maintenance is critical to the conservation of historic buildings. When maintenance is neglected the building deteriorates at an accelerated rate, resulting in loss of irreplaceable historic fabric.

The maintenance program must be based on a thorough understanding of the building systems and materials as well as sound conservation principles. A maintenance program should be based on documentation of the building's history and investigation of existing condition. Successful implementation of a maintenance plan requires financial and time commitment on the part of the building owner and well trained maintenance personnel.

2. PRINCIPLES FOR MAINTENANCE

One objective of preservation maintenance is to reduce deterioration and to increase the service life of the historic fabric. The following guidelines, some of which were adapted from I. Holmstrom and C. Sanstrom of the National Swedish Institute for Building Research [1], are suggested for planning a maintenance program:

1. A historic building must be given constant supervision and maintenance. The maintenance must begin before the deterioration has progressed to the point of requiring major repair.

2. The initiation of a maintenance program must be proceeded by a survey of the history of the building and its technical problems.

3. The design of a maintenance program should account for the unique features of the building, the available preservation technology, and the expertise of the maintenance personnel.

4. Maintenance procedures should be based on respect for the original building. It is preferrable to make repairs using original materials and methods because such materials behave and age in the same way as the surrounding fabric. Each intervention affects the building, sometimes in ways unknown, and all interventions should therefore be reversible, that is they can be removed without harm to the surrounding fabric. Minimum measures are often the most prudent.

5. Knowledge of the long-term effect of any treatment is important and techniques for removal or retreatment should be considered before an intervention is made. For example, while a modern paint may be easier to apply or last longer, it is very difficult to remove, and a traditional oil paint would be less expensive and less harmful to the substrate in the long run. The life span of any new component or treatment must be considered in relation to the other components it is attached to.

6. Structural retrofits must be compatible with the existing load carrying system of the building. Any change in the structural system of the building may have long-term unforseen consequences.

7. Complete documentation of the investigation, reasons for selecting materials, procedures for the interventions and their results are invaluable information for future repairs and maintenance.

3. INITIATING A MAINTENANCE PROGRAM

3.1 Background Information Gathering

Historical records such as old drawings, photographs, or journals often provide documentation on the original design and on the construction history of the building. Old photographs may show items such as cornices or gutters which are altered or perhaps missing. Maintenance records should be examined and personnel interviewed regarding past repairs and their performance. All information should be verified on site, since buildings were sometimes not constructed according to the plans.

Drawings can often be obtained from the building owner or local building authorities. Other sources of information are historical societies, libraries, collections of the original architect's work, and owner's receipts for materials and repairs.

3.2 Visual Condition Assessment

Each material to be maintained is identified and examined, recording its condition and whether it is original, repaired, altered, or a replacement material. Careful attention should be paid to inspecting roofs, cornice gutters, joints, basement walls and other sources of water infiltration, one of the most damaging elements to facades.

Visual observations are made of the materials and the structural elements and signs of distress, such as cracks, spalling, rust spots or evidence of leakage, are recorded on elevation drawings and documented with photographs. The drawings are studied to detect failure trends. Close-up examinations are made at representative areas and at ornamental building sections such as cornices, watertables and finials where fractures and distress might be difficult to observe from a distance and where failure often represents a considerable hazard. The inside of a wall can be examined and photographed with a fiberoptic borescope which requires drilling only a 12mm diameter hole into the wall. The viewing field end of the rod is inserted through the small hole into the wall and the interior of the wall can be viewed by looking into the eyepiece.

3.3 Nondestructive Tests

Nondestructive tests are used when more information about the wall is required than can be obtained using visual examination techniques. When evaluating a masonry or stone wall, the location of metal anchors and ties is important in determining the ability of the wall to resist wind and seismic loads. Such embedded metal items can be located by a pachometer which is a metal detector that measures the magnetic field of the wall surface. The pachometer is most useful when the metal is fairly close to the surface which is normal for shelf angles but not always for metal anchors. Gamma radiography and x-ray radiography can also be used to locate embedded steel but both these methods are expensive and somewhat cumbersome to use at a building facade.

The pachometer locates the reinforcing bars, but it provides no information about the condition of the steel such as the presence of corrosion. The copper-copper sulfate test will detect active corrosion in the embedded steel by measuring the voltage drop between the steel and the surface of the concrete.

A moisture meter can help locate wall areas subject to deterioration from water. Readings should be verified by obtaining samples for laboratory analysis.

Ultrasonic testing is used to detect cracks, flaws, or voids in materials such as concrete, masonry, or steel. A low frequency wave is sent from a transducer through a material to a receiver, and the travel time of the wave is recorded. The presence of weak areas, voids, or cracks is observed as a delay of the velocity and travel time of the ultrasonic wave.

The location of internal cracking or delamination often can be found by tapping the surface with a rubber or wooden mallet. The sound made by the mallet is different on the debonded material than on the undamaged wall.

3.4 Monitoring Systems

The behavior and movement of a building is often monitored either continuously or intermittently to determine the cause of observed distress or to help in selection of appropriate repairs. For example, cracks in building walls may have both daily and seasonal changes in width as well as long-term growth. Before repairing a cracked wall, it is useful to know the cause of the cracking and whether the cracks are still moving. Inexpensive plastic "tell-tale" gages installed across the crack can be read periodically to measure changes in the crack width.

Continuous monitoring of cracks can be made using a gage which records crack movements as scratches on a replaceable brass button. The scratches on the button are read with a calibrated microscope. More sophisticated readings can be obtained by installing a small "bridge" with a built-in electronic transducer across the crack. The "bridge" magnifies the crack movement and the transducer, when connected to an automatic recorder, can provide continuous monitoring. The system can be programmed to sound an alarm when unusual crack movements occur.

Monitoring of material deterioration is done, especially in areas with industrial pollution, on original and restoration materials. One method commonly used is photography, either in the form of simple photographs, rectified photographs or photogrammetric mapping from which complete drawings of surface contours can be made. The periodic measurement of the facade should be augmented by monitoring of air quality and meteorological events and the recording of special conditions that affect the site, such as humidity, temperature and hours of sunshine.

Other types of monitoring systems are designed to record wind-induced sway of high-rise buildings, measure vibrations from traffic, or obtain response characteristics of the structure from measurements of induced dynamic forces.

3.5 Field Tests

Field tests are used as investigative tools to assess safety or performance of existing building elements, to establish strength of building materials, and to evaluate proposed methods of repair.

Water permeance of masonry walls is measured in a field test using a frame attached to the exterior wall while air pressure and water spray are applied from nozzles inside the frame. Strain relief tests are used to measure the amount of accumulated built-up strain in masonry facades by attaching electrical resistance strain gages

to the face of the wall, reading the gages, cutting out the segment of wall to which the gages are attached and again reading the gages.

It is often desirable to test maintenance procedures on a small portion of the structure before treating the entire building. When making the test, the procedures and conditions should be as close as possible to those which will be used on the entire facade. If the test involves patching or coating it should be allowed to weather before final selection is made. Evaluation criteria must be established for judging the acceptability of the tested procedure.

3.6 Laboratory Analysis

Laboratory analysis is an essential part of many investigations and is performed both on specimens from existing walls and on proposed repair material. Specimens from the walls are cut out and brought to the laboratory where they are prepared and tested. The cutting, transporting, and preparation of samples call for great care in order not to disturb the material. This type of testing is generally only feasible for small specimen sizes.

Commonly performed laboratory tests include standard tests for compressive strength, shear, modulus of rupture, and cyclic tests in which a reversible load or simulated environmental exposure is applied to the specimen and the performance is monitored through many load cycles. Laboratory tests are also performed on proposed repair materials. Their composition and compatibility with existing materials are analyzed and their long-term performance and durability are evaluated by accelerated weathering tests.

4. DESIGN OF A MAINTENANCE PROGRAM

Design of the maintenance program, which is defined in a Maintenance Manual, should consider the following items [2,3]:

1. Documentation: Information gathered during the planning of a maintenance program must be documented and these documents will be included in the maintenance manual. In addition, provisions should be made for recording all future inspections, maintenance and repair work on the building.

2. Building history: A brief history of the building and its past maintenance as obtained from the Background Information Gathering should be included. Copies of all known documents should be included or should be referenced.

3. Condition assessment: The physical structure and building materials are described based on results from visual observations and field and laboratory testing. The description should be updated during subsequent inspections.

4. Inspections: Routine inspections by maintenance personnel are undertaken at regular intervals and sometimes on a daily basis. Periodic inspections of the facade should be performed by an architect or a structural engineer. The inspection interval, depending on the building condition, should not exceed five years. The results of each inspection should become part of the maintenance manual.

5. Treatment specifications: The manual should specify treatments, their location, frequency of the treatment and method for

evaluating the success of the treatment. The criteria for applying treatment should also be included. The specifications should list all materials, list of suppliers and any specialized tools required. A summary of maintenance treatment for the entire facade should be included together with forms to record dates and treatments of each building component.

6. Personnel: The names and contacts of all consultants and contractors and a description of their scope of work on the building should be listed.

7. Maintenance budget: The cost of regular maintenance and of periodic maintenance should be documented in the maintenance manual to help management in budgeting funds necessary to perform the maintenance program.

5. REFERENCES

1. Holmstrom, Ingmar and Sandstrom, Christina, "Maintenance of Old Buildings Preservation From the Technical and Antiquarian Standpoint", Document D10: 1975, National Swedish Institute for Building Research.

2. Chambers, J. Henry, "Cyclical Maintenance for Historic Buildings", Interagency Historic Architectural Services Program, U.S. Department of the Interior, Washington, 1976.

3. Crosby, Anthony, "Preservation Maintenance in the Southwest", Association for Preservation Technology Bulletin XVIII No. 3, 1986.