PREVENTIVE CONSERVATION FOR MARBLE-CLAD BUILDINGS AND MARBLE SCULPTURES

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Introduction

Marble is an attractive material used as aesthetically pleasing facade cladding on old and modern prestige buildings and as a preferred material for sculpture. However, outdoors, marble is more sensitive to weathering than many other stone materials and marble cladding on buildings often suffers damage in that the panels start to bow permanently in-situ on the building walls, and after few years a disastrous situation may develop. Recent research in the EU-project HERMES and elsewhere has shed new light on the deterioration process which appears to be quite different from the deterioration of other stone materials. Damage in marble is not caused mainly by air pollution but rather by temperature and humidity fluctuations which cause a fatigue-type failure in the grain boundaries of the marble. Rainfall directly onto the marble tends to accelerate the damage. Certain marbles are more prone to deterioration than other marbles, probably as a consequence of their internal microstructure and their pore structure on a nanometer scale.

The following rules are suggested to maintain marble objects in the best possible condition:

A. Reduction of moisture

A conclusion from HERMES is that moisture is necessary in practice for the damage processes for marble. If moisture is reduced, the chances for survival of the material are drastically improved. There are different possibilities to reduce the presence of water in the marble:

1. Move the object indoors if this is feasible.
2. Shelter the object with a roof or baldakine from the direct impact of rain. Small roofs over sculptures were often incorporated in the architectural design of buildings and monuments already in ancient times. Today we may look upon these roofs as purely aesthetic but they are probably there mainly for technical reasons – rain protection.
3. Make sure by suitable drainage of the surrounding ground and by proper building maintenance (cleaning of gutters, etc.) that water cannot migrate and reach the object from below or behind. In humid locations, for instance on the north side on a building, removal of nearby trees may be necessary to allow the object to dry up sufficiently. This will also reduce algae.
4. Consolidate the marble and treat the marble surface regularly with wax or some other surface active compound. This will keep the surface hydrophobic.

B. Reduction of thermal variations

Variations in temperature tend to cause internal disintegration of marble, particularly under moist conditions. The following measures will reduce temperature variations:

1. Avoid direct sun exposure especially in direct south or southwest directions. The sun will cause high peak temperatures during the day. The daily temperature differences as well as the annual differences are much higher for surfaces exposed to the sun during daytime than for surfaces always away from the sun. Some shadow is believed to be beneficial in most cases to avoid the highest temperature peaks in the summer. Marble panels are usually more damaged on south and southwest facades than on facades facing other directions and also sculptures with these locations are likely to be more vulnerable to damage unless at least partly shaded. There is a balance between the beneficial effect of the sun in drying up the material and the detrimental effect in causing large thermal stresses, but in direct south and southwest directions it seems that the detrimental effect of sunshine dominates.
2. Construct a wooden shed around the marble sculpture in the wintertime. This will protect from sunshine in the early spring when most outdoor stone objects are saturated with moisture and particularly vulnerable to thermal stress. It is desirable, of course that the shed is built in such a way as to allow free air circulation to assist the drying of the object during dry weather.

C. Choice of marble material

Marbles have different sensitivity to weathering. There is a need for a quick and reliable screening test to assess various marbles being considered for use in important buildings and monuments. No such test exists yet and for the time being the following suggestions may be made from the experiments and the proposed model in HERMES:

1. Use a dolomitic marble rather then a calcitic marble.
2. If a calcitic marble needs to be used, the microstructure, the porosity distribution and the tendency for swelling in water should be carefully evaluated.

D. Hydrophobizing and consolidation. Monitoring for renewed treatment

A primary aim for any remediation treatment is to keep water

away. HERMES has demonstrated encouraging possibilities to improve the condition of marble objects by applying surface active compounds and consolidants. Surface active compounds tend to remain on the surface for a few years and help to keep most of the water out. The treatment has to be renewed periodically. Consolidation compounds penetrate a certain distance from the surface into the interior of the marble along the grain boundaries, react chemically and leave a residue, which partly fills the pore structure. Thus, the internal damage is reduced by the treatment and the rate of further accumulation of internal damage may also be reduced. A consolidation treatment for marble is expected to last for about 25 years.

The need for renewed hydrophobising or consolidation treatment should be monitored on a yearly basis. A simple test that may easily be applied in situ, is to measure the water absorption with a Karsten tube. A high value for the water absorption indicates that a new hydrophobising is necessary. A conservator may judge the need for new consolidation from the tendency of the marble surface to "sand", i. e. to release fine particles on being touched.

E. Monitoring of bowing

A building with marble panels needs regular inspection to identify if a bowing problem is about to appear. Early detection may make remediation measures possible. A straight ruler applied horizontally and vertically across the panel will reveal any deviation from flatness. The deviation may be measured using a mechanical fixture suitably adapted to the dimensions of the panels. The panels have to be removed and exchanged for new ones when there is a danger of panels breaking loose from their attachments.

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