THE PRESERVATION OF STONE TODAY:
Technology Awaits Philosophy

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> "It is impossible for anyone to know the horror and contempt with which I regard modern restoration- but it is so great that it simply paralyses me in despair....Of course all restoration is accursed architect's jobbery, and will go on as long as they can get their filthy bread by such business."
>
> John Ruskin

Ruskin's comments to a correspondent in 1877 were prompted in part by the ongoing restoration of San Marco in Venice, and came at a time when decidedly few options were available for the restoration of deteriorating stone buildings. Although some primitive stone preservatives had been tried, the replacement or retooling of failing stone was the most common solution, much to Ruskin's dismay. Today a growing and sometimes baffling array of chemical consolidants and preservatives face architects and conservators restoring structures of stone. What would Ruskin say of today's "high tech" approach to the retention of weathered stone surfaces? What philosophy should govern the decisions of employing consolidants and coatings to counteract decay? In light of the acknowledged irreversibility of some treatments, how should the Venice Charter be interpreted to guide attempts at the preservation of stone? Can current cultural differences in the acceptability of weathered surfaces be accommodated by this philosophy?

Understanding stone as a material requiring maintenance

No one questions that roofs must periodically be replaced, or that paints or protective coatings on wooden structures need frequent renewal. By its nature stone is one of the most durable of building materials, and in a favorable environment it may last hundreds or even thousands of years with little visible change. Thinking of stone as a material in need of periodic maintenance may require a new perspective.

Even the most pristine and unpolluted environment will act to alter this durable material. Direct sun and diurnal temperature changes create stresses within the stone; "pure" rainwater is itself mildly acidic, and dissolves marbles and certain sedimentary rocks. The widespread use of fossil fuels has dramatically altered the twentieth century environment, and

atmospheric pollutants have greatly accelerated stone decay. Architectural ornament which might have survived unscathed in a rural environment for two or three hundred years may succumb to urban industrial pollutants in a matter of decades. Little wonder, then, that research in stone preservation is rapidly expanding and that in the past ten years the application of commercially developed treatments and consolidants has become commonplace. What must be remembered is that while stone may no longer be considered a "maintenance-free" material, preservation treatment itself imposes a cycle of inspection and maintenance.

Cultural differences in the philosophy of preservation: "craft" versus "artifact"

Until relatively recently, traditional craft practices determined what methods would be used to restore an historic monument or building. Through the nineteenth century deteriorated stone elements were typically replaced with new pieces of like or similar material, shaped by skilled hands and tools scarcely different from those which had wrought the originals. Original fabric was lost, but the craft was respected. Not atypically even statuary and elaborate ornament were replaced. Impassioned critics like Ruskin argued that deteriorated stone was an artifact, and that such renewal was no better than destruction. Today the desirability of the retention of historic fabric is widely accepted by western preservation professionals. Nowhere is the "artifactual" approach more firmly entrenched than in Italy, where chemical consolidation treatment is common, even for lineal moldings and other architectural ornament that might be easily replicated (and would, indeed, be in other countries). Some would say that the pendulum has swung the other way, and that altered stone which no longer conveys the architectural intent of the monument is retained solely for antiquarian value. The primacy of this approach in archaeological sites ,at least, is easily understood. After all, heavily damaged marble columns of a first century temple are artifacts as much as they are architectural elements - how could they be replicated or replaced?

There is no disputing, however, that significant cultural differences exist in the philosophies guiding the restoration of stone monuments in the world today. In developing countries a craft approach generally predominates, and replacement and retooling of deteriorating ornament is widely practiced. In northern Italy, similar ornament would most certainly be chemically consolidated. One suspects that differences in approach reflect cost and commercial availability as much as philosophy. In the United States, surprisingly, the use of chemical consolidants is just beginning to see wide use, perhaps because all but the most sophisticated of preservation architects and laymen expect restoration to yield a "like new" appearance rather than one with a significant patina of age. Currently in the U.S. replacement, retooling, and stucco repair are

professionally accepted techniques which see wide use, although all involve some loss of original fabric. There is no doubt that this is changing over time, and the restorations of the 1980s in this country are not so likely to be heavy reconstructions as were the efforts of the early twentieth century. Who is to say that current interventions won't seem equally heavy handed to ardent artifactualists of the future, however?

The Venice Charter: A responsibility for reversibility; a bias toward the artifact?

> "When traditional techniques prove inadequate, a monument may be reinforced by all the modern preservation and conservation techniques whose efficacy has been shown by scientific data and guaranteed by experience."
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> Article 6, The Venice Charter

In the absence of a cultural consensus one might turn to the Venice Charter for a philosophical basis for the preservation of stone. After all, the importance of the "reversibility of treatments" is well established, and what could be less reversible than the replacement or retooling of stone ornament? Unfortunately, few of the chemical treatments themselves are reversible in more than theory. Some, epoxies for instance, form reticular polymeric structures within the stone and leave no possibility of removal. Others, such as acrylic resins, may theoretically be redissolved with solvent, but the practicality of such future removal is disputed. Ultimately the decision to treat is made in crisis, as deterioration unchecked leads to total destruction. Chemical consolidation becomes the least evil, a less drastic intervention than replacement, and less drastic ultimately, than no action at all. The Venice Charter might thus be interpreted as biased to an artifactual approach.

Preserving the artifact: The chemistry of consolidation

While there has been little unanimity in which techniques or chemicals are most appropriate for the preservation of stone, the important properties of an "ideal" chemical consolidant have generally been agreed upon:

1. The consolidants must impart good mechanical resistance and should have adequate elasticity so as not to separate from the stone due to expansion and contraction.

2. The consolidant must be resistant to atmospheric pollutants and to aging.

3. The consolidant must render the treated surface water repellent, without hindering the vapor permeability of the material.

4. The consolidant must penetrate deeply into the stone and not remain concentrated at surface layers, nor dramatically alter the porosity of treated layers.

5. Ideally, the consolidant must be reversible, that is, capable of being redissolved and removed with a solvent.

In practice, no one material has proven satisfactory for all stones and types of deterioration, and consolidants and treatment methods are selected on a case by case basis. To add to the confusion for an architect or conservator, each method has its own strong adherents, and the personal biases which result quite frequently conflict. The disputes between practitioners may seem arcane and technical, but unfortunately they affect the future of our monuments. For the non-initiate, a brief primer in stone conservation chemistry is in order.

Consolidants in current use may be divided into categories as organic or inorganic treatments. Inorganic consolidants are, in general, more durable than organic resins, but may lack adequate elasticity to give treated stones good mechanical resistance. Inorganic treatments that act through chemical reaction with the stone itself may also have problems of inadequate penetration. Of the two major inorganic systems in use, treatment with silicon esters (generally tetraethyl orthosilicate) is by far the most common. These ethyl silicates are widely marketed for the consolidation of sandstones and function by depositing colloidal silica within the pores of the stone. They are not generally suitable for use with limestones and marbles and do not impart a water repellency to the treated stone. A barium hydroxide treatment for limestones and marbles works through chemical combination/transformation of the calcium carbonate of the stone itself and by depositing interstitial barium carbonate within the pores of the stone. While the barium hydroxide method has some strong proponents, it is not in general commercial use today, in part because it is relatively difficult to apply, requiring lengthy application periods and the use of caustic solutions.

The organic consolidants currently in use may be very generally categorized as acrylic resins, silicone resins, and epoxy resins. Acrylic resins, generally combined with an amount of silicone resin to foster water repellency, have seen extensive use in northern Italy for the consolidation of marbles. Acrylics may be redissolved, and thus theoretically are reversible, although in practice they would be difficult to remove completely. For in situ treatments acrylics may be brush applied.

Different types of silicone resins with greatly variable properties have enjoyed significant popularity as stone consolidants. Alkoxy silanes, one type of silicone resin, has been widely marketed as a sandstone consolidant, often applied in combination with ethyl silicate.

Epoxy resins are not generally considered suitable as consolidants because of problems of inadequate penetration and susceptibility to photodegradation and changes in color. They offer significant advantages where structural strength is a factor however, and in solution with organic solvents have found use as consolidants for very porous stone, particularly in some eastern European countries. New types of epoxies have shown greater resistance to photodeterioration.

Thus it becomes apparent that the selection of a consolidant may be highly subjective. Add to this an extraordinary variability in methods and conditions of application and we see the difficulty of assuring that a treatment will be successful or of understanding why an unsuccessful treatment has failed. Preliminary laboratory experimentation and careful field control become of paramount importance.

The rush to consolidate: the problem of commercialization

If stone preservation remained in the laboratory, or in the hands of a few trained specialists, one might be assured that decisions to consolidate would be based upon careful study, weighing the dangers of treatment against the threat of continued deterioration. In an imperfect world, treatment decisions are frequently made by an architect relying on the technical expertise of a commercial supplier, who is at least as concerned with the commercial success of his product as with its long term efficacy. In the U.S., application is more likely to be by a "waterproofing" or masonry restoration firm than by a trained restorer. Little differentiation may be made between deteriorated stone and adjacent sound stone which requires no treatment. This should not be construed as a criticism of the supplier or applicator, but as a warning to the architect who sees treatment as a panacea, and to the custodian of the monument, who may think that further inspection and maintenance is unnecessary. Both views are incorrect.

Given that these materials are being aggressively marketed as stone preservatives and will see greatly increased use in the future, the need for a comprehensive philosophy for their application is apparent.

Toward a philosophy for the preservation of stone

As with the selection of the consolidant itself, the difficult decisions of when and what to consolidate will necessarily be made on a case by case basis. It will never be possible to eliminate the subjective element from this decision making process. It is possible, though, to establish a rationale for the preservation of stone; a set of guidelines for the architect and conservator follows:

1. Establish the value of the deteriorated stone as an

"artifact". As with most evaluations of this nature, judgments may be criticized as subjective. Still, some relative values may be established: a bas-relief or a column capital may be considered a more appropriate candidate for consolidation than an untooled block of ashlar.

2. Determine, on a case by case basis, where "artifact" or "craft" approaches are warranted. In a country where craft practices have been preserved and replication of ornament is traditionally accepted this may mean adoption of a hybrid solution where some carved ornament is consolidated and other elements are replicated.

3. Employ consolidation treatments only when the stone is in such an advanced state of deterioration that destruction is threatened or replacement otherwise necessary.

4. Perform no treatment without analysis and thorough documentation of existing conditions. Select a treatment based upon its suitability for a particular application, not just commercial availability.

5. Record conditions, methods and materials used in treatment. Both conditions documentation and treatment records must be assembled for archival storage.

6. Assure before treatment that the custodian of the monument accepts responsibility for periodic inspection and maintenance of the treated stone.

7. Lastly, and most importantly, monitor and publicize the performance of the materials in use. By these reports advances in chemistry and application will be achieved, and decisions for retreatment will be made.

An historical perspective

What would Ruskin have said about this practice of turning plastic into stone? No doubt he would have been disturbed about the prospect of artificially arresting decay, but he may have preferred consolidation to the alternatives - replacement or destruction. In another letter of 1877 he offered an opinion about " what means of preservation ought to be used for a building which is impossible to restore" saying that " the single principle is that after any operation necessary for the safety of the building, every external stone should be set back in its actual place."

This is an easier goal for the critic to recommend than for the architect to attain. It is, in effect, what contemporary stone preservation technology is attempting to achieve.