New Materials For Conservation And Safeguarding Cultural Heritage

Jason Bolton

Faculty of the Built Environment, Dublin Institute of Technology, Bolton Street, Dublin 1, Ireland

1. Introduction

Mr name is Jason Bolton, and I work with Dr Sara Pavía in the Faculty of the Built Environment of the Dublin Institute of Technology in Ireland. Our research is centered on the conservation and repair of traditional, historical and modern building fabrics and archaeological monuments.

Our approach to conservation is based on the study of the materials comprising the building fabric, their qualities, interactions and the causes and mechanisms of decay which affect them. In this way, we can understand how fabrics have performed over time, and to advise on conservation work to best increase their lifespan.

2. Aims of the presentation

This presentation seeks to show a State of the Art regarding new materials for conservation and safeguarding cultural heritage in Ireland. The presentation will be composed of a brief overview of some current issues – and then illustrated through current work on a case study building – the romanesque building fabric of St. Brendan's Cathedral, in Clonfert, Co. Galway in the rural west of Ireland.

3. Some current issues

3.1 Traditional versus new technologies applied to conservation

In Ireland there is a very sharp separation between traditional versus new technologies applied to conservation. In Ireland there is a desire to use "traditional" methods and materials for conservation work. In recent years, there has been a move to the use of traditional craft skills and traditional materials to repair, restore and conserve historic building fabrics. These include stone masonry, traditional pointing, rendering and plastering with lime mortars, thatching, mud wall and dry wall construction, carpentry and joinery and the re-use of salvaged materials wherever possible.

3.2 Resistance to change

New materials and technologies are introduced cautiously – conservationists in Ireland often tend to be very conservative, and it can be difficult to introduce innovative solutions. For example, there is a general opposition against the use of consolidants due to the risks involved.

Is there any use in developing new technologies – compatible with historical building fabrics – unless we can market them effectively as acceptable options? As we introduce new technologies, we must bring other conservation disciplines on board during their development in order to ensure that they will accept and support the final products.

3.3 Compromise

As a compromise, we can show how new technologies can enhance our understanding of, and improve on existing traditional technologies. We can use new technologies to analyse and assess historical building materials in order to reproduce old materials and technologies, and modify them where needed. For example, we often need to introduce new mortars into historical building fabrics which require repointing, replastering etc. We can use new technology to analyse the original mortars to determine their original components and decay. This enables us to reproduce them, and in some cases, it is also necessary or desirable to change, modify or otherwise improve these materials.

4. Conservation Project: Conservation of Saint Brendan's Cathedral in Clonfert, Co. Galway.

Saint Brendan's Cathedral was built in the romanesque style and dates from the 11th century. The conservation project concentrates in the doorway.

In this project we acted as consultants undertaking a preliminary study of the building fabric and providing advice on conservation solutions.

We based our conservation approach on the study of the materials comprising the fabric, the problems affecting them and their needs. Based on our findings, we proposed to mix new materials and technologies with traditional materials and technologies.

This project illustrates the use of new technologies to analyse and assess historical building materials in order to reproduce old materials and technologies, and modify them where needed. The project also illustrates the resistance against the introduction of new conservation technologies.

4.1 Objective

The overall aim of the project has been to conserve the sandstone doorway at St. Brendan's Cathedral.

Our objectives were set into two phases:

The first phase involved the understanding of the material and it's needs. This included:

- To assess the type and condition of the sandstone.
- To study the original mortars binding the doorway.
- To diagnose the material failure and decay of both the sandstone and the mortar binding it.
- To locate the original sandstone quarries OR to locate and sample a stone match.

The second phase involved to output the data gathered in phase one to conserve the fabric of the doorway. This included:

- To examine the range of cleaning and conservation treatments which could be applied to the doorway.
- To test cleaning and consolidation treatments for the sandstone.
- To advise on the most appropriate treatments for the sandstone doorway.
- To provide specifications for the application of these conservation treatments.
- To design replica mortars for repointing to match the original.
- To provide specifications for mortar repointing at the doorway.

4.2 Study of the historical material with 'modern' techniques

Petrography is the systematic description of rock textures and mineralogy in thin section and as hand specimens. The technique of examining rock using this technique was developed in the mid 19th century, however, it's application to mortars in order to make replicas is certainly a new application. We have used petrography for:

- The nature of the sandstone at the doorway
- The decay of the sandstone at the doorway
- Matching stone for the doorway
- Mortars used in the doorway to bind the sandstone

4.2.1 The nature of the sandstone at the doorway

The study of the sandstone with a petrographic microscope revealed that the doorway was built with a predominantly siliceous sandstone, varying to feldespathic, with a scarce matrix of clay minerals and iron, carbonate and silicate cements.

The sandstone doorway at Clonfert cathedral is a great example of the variability found in Irish sandstones. This particular sandstone varies in colour and texture –locally conglomeratic, pebbly-. The colour changes with the light and the moisture content.

There are six different sandstone varieties recorded with regard to colour and texture (brown, dark brown, dark red, greyish brown, brownish red (pale red) and yellowish).

- Major components : quartz and feldspar.
- Clay minerals range from major to minor.
- Minor components : calcite, micas, metallic minerals.
- Secondary and accessory minerals: lithic fragments, chlorite, rutile.

The variation in composition is not as great as variations in colour and texture would suggest. Variations are due to slight changes in composition and differential weathering.

4.2.2 The decay of the sandstone at the doorway

Typical decay is the weathering of feldspar and the loss of cementing material leading to subsequent loss of cohesion of the stone.

Water-related damage includes:

- Granular disintegration.
- Scaling.
- Flaking.
- Preferential erosion along the bedding and fractures inherent to the sandstone.

All of the above are leading to a loss of carved detail. The decay is stronger on the upper elements of the doorway and to scattered stone blocks.

Surface deposits include:

- Salts
- Remains of renders.
- Lichen and algal deposits.

Weathering rates and patterns do not correlate to composition or colour/texture. However some trends were noted:

- Yellowish variety –tends to be more susceptible to weather- this variety may contain more abundant carbonate cements.
- Red variety –sometimes shows a greater degree of damage (jambs)- this variety is of variable composition.

Sources of moisture at the doorway include:

- Rainfall –mainly affecting the upper elements-
- Capillary rising ground moisture – mainly affecting the lower elements-
- Partially detached masonry units at the top
- Cobble /portland cement paving at the ground
- Several generations of portland cement repairs to joints are increasing the amount of moisture being driven into the doorway.

Szerelmey stone liquid was applied in the 19th century to the sandstone as a consolidant. This stone treatment was developed in 1841 and used widely between 1876 and the 1930s. The product was highly praised at the time. A number of types are known – one of them was an alkaline-silicate formula with an oil-based medium. Many of these 19th century consolidants led to surface crust development and exfoliation. Part of the decay recorded at the doorway at Clonfert may derive from the application of this consolidant.

4.2.3 Matching stone for the doorway

Aim - To use modern techniques in order to locate the historical sandstone quarries OR to locate and sample a stone match.

- No quarries were found locally (using a combination of aerial photography, cartography and documentary research).
- The study revealed no quarries within easy land access to Clonfert
- Fieldwork was focused on the Killaloe area, Co. Clare. Work here was narrowed down thanks to previous work by Duchas.
- Site of quarry on stream which links to the Shannon.
- Overgrown quarry fronts located.
- Sandstone is similar in texture, colour and composition to the dominant variety at Clonfert.

4.2.4 Mortars used in the doorway to bind the sandstone

The original mortars were analysed with new techniques with two objectives:

- To record the type, composition and proportions of aggregate, binder and additions in order to design matching replicas.
- To assess the mortar quality and performance and modify components if necessary to improve performance.

4.2.4.1 The original pointing mortar used in the doorway.

The original mortar mix was a finely textured, binder-rich mortar including aggregate of calcareous composition (limestone sand). The aggregate was finely graded and sized less than 1 mm.

The mortar was strongly weathered, the aggregate was partially missing and the binder display abundant fractures and water dissolution.

4.2.4.2 The replica mortar designed

This mortar replica was based on the composition of the original pointing mortar, however, the amount of aggregate was increased in order to minimise the risk of fracturing of the binder.

Mortar Mix 1: to be used for pointing / bedding the sandstone doorway

The pointing mortar was as follows:

Pointing / bedding mortar for doorway			
Aggregate			
Type and grading		Morphology	composition
Well graded fine sand 1 - 0.07 mm.		Sharp to sub-rounded.	Limestone sand.
Brick powder	graded between 1 and 0.07 mm.		
Binder	lime putty		
	Aggregate	**Brick powder**	**Binder**
Parts by volume	2	¼	1

4.2.4.3 Conclusions

- The sandstone contains vulnerable clay matrix and carbonate cements.
- The porosity has been enhanced by 10-20%.
- There is extensive significant weathering – leading to progressive loss of carved detail-
- There is intense water –induced decay.
- The sandstone is becoming vulnerable to lichen hyphae.

Due to the factors listed above, the sandstone requires additional cementation. We need to introduce a consolidant to conserve the carvings.

In many cases when conserving a historic built fabric, the solution may not be a simple choice between a particular old technology versus a new technology. Instead, we may need to develop more complex approaches where we are combining old and new technologies in order to best conserve our heritage.

This case study is presented to illustrate how this is being achieved on a working site in Ireland. To date, old and new technologies have been combined in order to replicate the

original pointing mortars. New technologies have also been effectively combined in order to locate a sandstone match.

4.3 Conservation of carved sandstone doorway.

The research work on the doorway to date has resulted in the following recommendations:

- Very mild cleaning using no chemicals in solution. Neutral or slightly alkaline chemicals can be applied in a poultice. Removal of surface deposits including biological growth.
- Removal of all existing mortars –including previous repairs and weathered originals-.
- Repointing with the replica mortar designed following the specifications provided as a result of analytical work.
- The introduction of additional cementation in the form of a consolidant– applied through fracture injection and superficial application-.
- Additional ventilation is required, and alteration of the existing ground level to bring down moisture levels.

These measures above include a combination of new and old technologies combined to form a conservation work plan to safeguard the heritage.

One of the challenges we will face is how can we prove and convince the effectiveness of existing, new and developing technologies to a conservative audience? We are considering to test an ethyl silicate in Clonfert. The testing will take the form of artificial ageing tests (wet/dry, freeze/thaw, and salt crystallisation cycles) and the porosity will be recorded before and after consolidation. There is concern regarding the effectiveness of these standard tests – is there a better way to test consolidants on stone? Szerelmey's stone liquid was highly regarded at its time – how can we best ensure that the existing, and the new developing technologies are safe over the long-term? How can we be sure that the new consolidant we apply will not interfere with the previously applied Szerelmey?