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trained as an architect and then spent six months working as a labourer before being awarded a travelling scholarship by the Society for the Protection of Ancient Buildings in 1987. Since then he has worked for over eight years for Rodney Melville and Partners, an architectural practice specialising in historic building repair, occasionally taking time off to work on site with traditional plasterers. He recently left the practice and now works for Ward and Co (Tel 01453 835337) a company based in Gloucestershire which specialises in the conservation of historic buildings.

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The Use of Gypsum Plaster

Tim Ratcliffe



18th century hand modelling at Prior Park executed in marble dust, lime and gypsum.

Gypsum plaster is viewed by many people in the conservation world as a modern material which is inappropriate for use in historic buildings, yet it has been used in this country for hundreds of years.

Although there is clearly a role for gypsum plasters in conservation work, there can be little doubt that modern bagged gypsum plasters are unsuitable for re-plastering ancient

buildings. They are too hard and brittle to flex and move with the building, and most of them will break down in the presence of moisture. The ones that are resistant to the action of damp contain water repellents which seal the surface of a wall and prevent it from 'breathing'. There is, therefore, an increasing recognition among specifiers of the need to use lime plasters on old walls and ceilings.

Having recognised the desirability of lime plasters, a further point for consideration is whether adding even small amounts of gypsum to them (a practice known as 'gauging') is acceptable. Many plasterers will add a proportion of gypsum to speed up the set of a lime plaster in order to keep to a tight programme. Lime and sand plasters are quite capable of setting on their own, even though it can take up to four weeks for each coat to carbonate before the next coat can be applied. If gauging is considered undesirable, then adequate time needs to be allowed in the programming of work. There may, however, be circumstances when gauging is considered acceptable or even desirable, for example, when repairing plaster which was gauged originally.

Specifiers of plaster work are sometimes wary of using gypsum not only because it was seen to be harmful, but also because the material was used in the 19th century for the production of fibrous plaster, a form of plasterwork which was reinforced with hessian and laths. Whereas most pre-Victorian plasterwork was worked in-situ, with only relatively small pre-cast decorative elements, the development of fibrous plastering enabled the production of fine plaster mouldings to be industrialised. As a result, cornices and other mouldings could be cast in a workshop and transported to the site for fixing. This contributed to the demise of many traditional decorative plastering skills. Whilst the loss of traditional plastering skills can, at least in part, be attributed to the development of fibrous plastering methods, we need to recognise that gypsum plaster was around a long time before this development.

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The modern uses and forms of gypsum plaster may often be inappropriate in historic building repair work, but we must be wary of 'throwing out the baby with the bath water'.

Historical Uses of Gypsum Plaster

Gypsum plaster is not a modern invention like Portland Cement, as some people might suggest. We know that it was used by the ancient Egyptians to plaster the pyramid at Cheops. In Britain, research being carried out by Claire Gapper, a PhD student at the Courtauld Institute, indicates that considerable quantities of Plaster of Paris were being imported from France during Henry VIII's reign for work on royal properties.

Our knowledge of the use of gypsum plaster prior to the 19th century is limited. However Claire Gapper's research shows that it was being used in the 16th century with lime in floors, walls and ceilings, but decorative plasterwork, which was previously assumed to contain gypsum, is proving to contain only minute traces; the sort of levels at which one would find it as an impurity in limestone. This contrasts with the use of gypsum over the last 200 years, when it was predominantly used for casting decorative elements and for gauging lime when running mouldings, whilst most flat work has been executed using plain lime plasters. Although further investigation is required, it would appear that gypsum was being used in these early gypsum/lime plasters very differently from the way we expected and there is no evidence, at the moment, that it was also used for mouldings or decorative work.

For small decorative embellishments such as scrolling leaves, fruit, figures and heraldic devices, cast decoration allowed repetition. Gypsum or Plaster of Paris allowed crisp details to be produced as it was harder than lime and set before it was removed from the mould. Furthermore, casting in lime is more time consuming than using Plaster of Paris, because the lime has to be used very stiff and has to be punched into the mould. Nevertheless we find in 18th century work that casts were sometimes made in lime rather than gypsum. Its advantage is that, after being turned out of the mould, it can be tweaked and adjusted whilst it is still soft, allowing minor variations in detail from one cast to another. The use of lime and gypsum in different cases may have been partly to do with different local traditions, but may have as much to do with the availability of materials.

Later on, working methods and the materials used became more standardised. Our understanding of plastering methods and practices from the end of the 19th century is very good, thanks to William Millar's excellent book, *Plastering - Plain and Decorative*, which was published in 1897. It describes 'best practice' working methods from the period, and established standards to which good plasterers have aspired ever since. We know that gypsum was readily available throughout the 19th century and was used almost all the time to gauge lime mixes for running mouldings, as well as being used on its own, for cast work.

We need to understand a lot more about the history of the production of gypsum plasters in this country and also about their availability in different parts of the country, before we can fully understand why they were being used differently. In Derbyshire, for example, we know that alabaster was being burnt to make gypsum plaster in the 17th century, particularly for floors, whilst in other parts of the country gypsum was being imported from Paris. This may have been simply because the French plaster was purer, but it may also indicate that they were used for different purposes.

Although the interest in the composition of old plaster may appear slightly academic it is an important part of repairing on a 'like for like' basis. If a repair is incompatible with the original, then the older material could end up being damaged. It is important, therefore, that original plaster is examined to establish its basic properties before repairs begin. With experience, it is often possible to tell whether an old plaster contains gypsum just by breaking a piece off and poking at it. In some cases dissolving

a small piece in dilute hydrochloric acid can help, as a fine white residue is often left, along with the aggregate, if there is gypsum present. Occasionally, particularly with older plasters, it is worth carrying out a proper laboratory analysis to ascertain the proportion of gypsum used in the mix.

Conservation and Repair

Gypsum is a naturally occurring crystal of calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). It can be quarried in different parts of the world in slightly different forms, but in this country the most commonly known form is alabaster. Plaster is made from gypsum by grinding it to powder and then gently heating it to drive off some, or all, of the water of crystallisation.

If it is heated to about 150°C , then only some of the water is lost and the hemi-hydrate is formed ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$). Plaster of Paris, casting plaster, dental plaster and Helix, are all forms of hemi-hydrated gypsum. They all set rapidly (within 10-20 minutes) by recrystallising when mixed with water. Modern bagged plasters are also made from hemi-hydrated gypsum, but contain retarders which slow down the speed of the set, and also include fillers and other additives.

If gypsum is heated to higher temperatures, then all of the water can be driven off. Fully hydrated gypsum will not readily recombine with water and can only be used as a plaster when an accelerator is added to it. During the 19th century, and the first half of the 20th century, a number of patent plasters were produced using this method. Plasters like Sirapite, Keenes Cement and Parian Cement, as well as many others which appear in old plastering books, are made from fully hydrated gypsum. These plasters set in a few hours, and could be worked-over to achieve a highly-polished finish. They were particularly popular for use in hospitals and public buildings, because of their hardness and durability. We also sometimes find them used in domestic properties to form skirtings and door surrounds.

Lime and gypsum are obviously different materials with different properties. Lime sets slowly by absorbing carbon dioxide from the air, whereas gypsum plaster sets rapidly by crystallising (even fully hydrated gypsum plaster sets within about a day). Also, as a lime plaster dries it shrinks slightly, while a gypsum plaster expands slightly as it sets. Historically gypsum has generally tended to be used as an additive to lime. The speed at which a mix of lime and gypsum set (which is slightly slower than gypsum on its own) and the slight expansion that occurs, are particularly useful when running cornices and other mouldings in-situ.

As we repair and reinstate historic plasterwork, it is important that we understand the materials and methods used in the first place. Many visually inappropriate and other physically damaging repairs have been executed in the last few decades because modern methods and materials have been used without thought. (Ian Constantinides of St Blaise Ltd discussed and expounded this point in his article *Traditional Lime Plaster: Myths Preconceptions and the Relevance of Good Practice*.)

The general knowledge and understanding of old plasterwork in the conservation world has increased enormously in the last five years or so. The reinstatement of fire damaged ceilings at Uppark (near Petersfield, West Sussex) and Prior Park (Bath), have given people a chance to understand how they were put together in the first place. This has also led to the re-learning of some traditional skills, like the hand modelling of stucco. As we repair old plasterwork it is important not only to use compatible materials but also to use compatible skills and methods.

Over the next few years we need to investigate why, where and how gypsum was used historically in plastering. The challenge which then leads on from this is how we should train and encourage plasterers to match the methods and skills used originally in both lime and gypsum plasterwork. Research and the dissemination of information such as this are crucial to the future of the country's rich heritage of historic plasterwork.

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