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A NOTE ON THE USE OF SILICONE RUBBER FACINGS IN THE REASSEMBLY OF ARCHAEOLOGICAL PAINTED PLASTERS

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Summary—*In order to hold archaeological painted fragments firmly while a new support is built, a silicone rubber based facing was applied. After the fragments had been prepared and protected with an effective de-moulding agent, silicone rubber was poured directly onto the painted surface. Removal of the facing involved only very small amounts of water and consequently the risk to the paint layer was very low.*

Introduction

Archaeological excavations in the city of Geneva (Switzerland) from 1987 to 1990 revealed the remains of a Romano-Gallic quarter [1, 2]. A large building with a peristyle built between AD 20 and 40 was found, with the remains of a richly decorated wall painting of the third provincial Pompeian style. The painting has red panels separated by narrow black panels with columns and foliage scrolls. The lower part (dado) is marbled with green, red and white splashes on a brown background. The dado and the red panels are separated by a series of black outlined panels with pairs of swans holding strings of pearls in their beaks.

The fragments of painted plaster have been thoroughly studied and analyzed [3]. It was decided to attempt their reassembly with a view to including the plaster in a reconstruction of part of the peristyle. The reassembled panel measures 3·2 × 3·9m.

It is the work on these fragments which is discussed in this paper.

Past methods for the reassembly of archaeological fragments

The reassembly of archaeological painted plaster on a new support causes a major problem for conservators, namely, how to hold the fragments firmly and accurately in place during the manufacture of the new support. Many different techniques have already been tried by other conservators. These were examined in order to evaluate the pros and cons of each solution.

The most common method used in the past when assembling a large number of fragments was to set the ancient plaster into new plaster. This tends to produce panels of considerable weight, particularly when the ancient plaster is thick and requires a large volume of new plaster to support it and fill the gaps.

More recently, a new type of support has been made by Sturge, who cast polyester resin onto the back of the fragments [4]. This does not involve reducing their thickness and accommodates a variety of fragment thicknesses with ease. This method gives a support that can be easily modified and, being cast directly on the back of the fragments, its accuracy is high. The casting has to be made with the paint layer face down. The fragments have to be properly aligned on a Melinex sheet which has had a tracing of the fragments drawn on it whilst the fragments were face up. The plaster fragments are not attached to the Melinex. This seems a disadvantage, as fragments may move during the casting of the new support and faults in alignment would be very time-consuming to correct.

In contrast, other restorers [5–7] have adopted a facing to retain every fragment in its correct place and have ground down the back of the plaster to a thickness of a few millimetres. The fragments were then glued onto a laminate with a honeycomb core. This method has the advantage of high accuracy and the resulting support is neat and light. Even the smaller fragments cannot move as they are held firmly by the facing. However, the major disadvantages are the use of a *stacco* style facing, made of hessian and animal glue, and the grinding down of the plaster. As anyone who has carried out a *stacco* will testify, the removal of animal glue facings involves thorough washing of the surface with hot water. This can damage the fragile paint layers and leave the fragments wet for some time. As animal glue is organic and difficult to remove completely, mildew growth is possible. 'Forgotten' particles of animal glue (difficult to see when wet) may cause tearing of the paint layer whilst drying. The dimensional stability of animal glue facings is poor and can cause alignment errors. In addition, because the fragments are ground down, the possibilities for

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making changes in the future are limited as the fragments lose their individual strength.

The problems associated with previous methods were important in defining the aims of this research. It was considered of great importance that the pieces of painted plaster be held securely with a facing to avoid misalignment of the fragments while at the same time presenting no obstacles to the manufacture of the new support. It should also be able to hold both small fragments and very large and heavy ones.

The requirements of the facing material were that it should be poured onto the paint surface, it must contain no water or solvents, it should be dimensionally very stable, chemically inert, and should not cause staining of the paint layer.

Choice of the facing compound

In addition to the methods and materials discussed in the previous section, other materials were considered. The use of acrylic polymers for the facing was avoided because of the large amount of solvent needed to remove them. Rubber latex (supplied by Sinopia s.a.s., Castiglione Torinese) was tried, but gave facings too weak to hold the larger fragments which weighed up to 3kg each.

Silicone rubbers were also tried and gave interesting results. These related to their high dimensional stability and the absence of solvents. They also held the heavy fragments securely. Different types of silicone rubber were tested in order to ascertain which was the most suitable for the facing: Palesit 370 resin + Palesit W catalyst (Sika Chemie GmbH, Stuttgart), RTV 585, RTV 1320, RTV 1522, RTV 1597, RTV M 539 (Wacker-Chemie GmbH, Munich), Rhodorsil RTV 11504A (Rhône Poulenc Italia, Milan). The main problem when using silicone rubbers is the risk of staining the surface of the object. As Maish [8] has stated recently, staining is due to the release of low molecular weight silicone compounds while setting. The level of staining was closely linked to the porosity of the fragments. It was also found that a short setting-time for the compound was essential in stain reduction. A short setting-time, combined with high dimensional stability, was therefore crucial in the choice of material to be used.

Another very important factor is the use of an effective de-moulding agent which will aid the removal of the facing from the painted surface and help to prevent staining. Different types of de-moulding agent were tested: beeswax dissolved in 1,1,1-trichloroethane (15% w/v), Wacker Protective Film SF18 (Wacker-Chemie), polyvinyl alcohol (Rhodoviol 40–20, molecular weight 3000, Rhône Poulenc Italia), hydroxypropyl cellulose (Klucel G, supplied by Sinopia s.a.s.), Sika de-moulding agent W (Sika Chemie).

Beeswax showed unsatisfactory behaviour, giving uneven protection. Polyvinyl alcohol required a considerable amount of water for its removal. Cellulose produced foam for a long time when wetted for removal. Most common de-moulding agents are soaps, with strong alkali components, so they were discarded as they may promote soluble salt formation. Other de-moulding agents are based on unsaturated polyesters strongly coloured to help their identification for removal. These were unsuitable also, as dye migration occurred.

Eventually a colourless, water-soluble, unsaturated polyester was found, tested and adopted (WM 3200 KL). This de-moulding agent is easy to remove. When it is wetted with a fine mist of cold water it swells and can be removed by rolling it with a finger.

A two-component silicone rubber was chosen (Palesit 370 + Palesit W hardener). This compound has a viscosity of 20,000mPa.S^{-1} at 25°C, a pot life of 15 minutes and linear shrinkage of 0·1%. The colour shift in the paint layer after application and removal of the de-moulding agent plus silicone rubber has been measured with a Minolta Color Meter, taking the average of 10 readings for each sample. The measured average colour shift ΔE was 1·26, barely noticeable to the human eye. This is substantially less than the colour change caused by the application of Paraloid ($\Delta E = 1{\cdot}9$, when used as described in the following section).

Preparation of fragments

The plaster needed consolidation and desalination. Desalination was carried out with poultices of micronized silica gel and deionized water. The poultices were applied to the paint layer over a sheet of Japanese tissue paper and left to dry. The dry silica was then mixed with distilled water and 10ml of the solution were injected in a Dionex Ionic Chromatograph to check the salt content. Desalination was stopped when two consecutive measurements showed no difference. After desalination, impregnation was carried out with ethyl silicate. The fragments were placed, paint surface up, in Petri dishes of consolidant and allowed to absorb it by capillary action. Excess consolidant was removed immediately after impregnation, using paper towel and propanone (acetone). Experience showed that if, during drying, evaporation of the solvent was too rapid, silica sometimes migrated onto the surface. To prevent this, and to ensure slow polymerization, the fragments were kept in

aluminium foil for four weeks. The impregnation considerably reduced the porosity and water absorption of the plaster [9, 10]. The paint layer was further protected with Paraloid B-72 in propanone (3% w/v). The de-moulding agent was then applied to the paint surface with a brush. It was applied as supplied by the manufacturer, without dilution.

The fragments were laid out on sand and the gaps between them were filled with sand. Great care was taken to ensure that all the fragments were flat and level with one another: this was checked with a spirit level. Because the facing was to be applied to the plaster while it was held in the sand, the risk of fragments being misaligned was small.

The facing

The silicone rubber was applied by pouring it directly from the stirring bucket. To avoid undesirable movement of the smaller fragments, the silicone rubber was poured onto the sand zones rather than the fragments themselves, and then allowed to flow over all the fragments set in the sand. The total area of the assembled plaster was very large and it was necessary to divide it into sections of up to $2m^2$. If the sections were larger than this they would later become too difficult to handle. Dividing the plaster into smaller sections also made it easier to apply silicone rubber. This was because the chosen silicone has a fairly short pot-life and there was no time to pour it accurately over a very large area. Divisions were created by means of polyvinyl chloride (PVC) bands wide enough to be pressed vertically into the sand and protrude 2cm above the plaster. A mark on the bands indicated the level to which the rubber should be applied in order to have a facing of regular thickness. With the chosen rubber, a facing thickness of 3mm was sufficient to provide the necessary strength. To give rigidity to the facing, plywood panels were attached to the surface of the rubber. This was necessary because many of the fragments were heavy (up to 3kg) and, although held firmly by the silicone rubber facing, uncontrolled bending could have caused damage. After the silicone rubber had set, the protruding edges of the PVC bands were painted with putty paint. While the paint was still wet, 8mm-thick plywood panels were pressed gently down onto the paint to transfer the outline to the timber, and the plywood was cut out using the paint lines as a guide. The plywood panels were then attached to the silicone facing with more silicone rubber combined with an intervention layer. The intervention layer was made of 1mm-thick polystyrene sheet and was included between the timber and the previously applied silicone rubber. A further, identically shaped plywood panel was pushed beneath the fragments through the sand on which the fragments were assembled. This allowed the panels, sandwiched between two plywood boards, to be lifted and turned over.

The backing

The faced panels were reassembled, paint layer face down. Again they were separated by PVC bands. Sand was added in the gaps and empty spaces so that the front surface of the new support would be 1cm below the painted surface in areas where there was no plaster. This was required so that a gap-filler could be applied once a new support had been built.

A new support can now be manufactured on the back of the fragments, using the desired methods and materials.

Removing the silicone rubber facing

After the fragments, on their new support, had been turned face up again, the facing was removed. The intervention layer between the plywood and the facing was readily removed by injecting an organic solvent (such as propanone) into the polystyrene. This rapidly dissolves and destroys the polystyrene and releases the plywood panel on the front.

The removal of the facing was carried out by bending the rubber away from the plaster and spraying a fine mist of cold water onto the joint between the silicone and the plaster. The de-moulding agent gently swelled, allowing very safe removal of the facing. The amount of water needed to make the de-moulding agent swell was very small, about 200ml per square metre. The swollen de-moulding agent could then be removed by rolling it away. The painted surface was cleaned with soft, wet sponges to remove any remains of de-moulding agent.

The amount of water needed for this stage of the work was surprisingly low. Its effects on the painted surface and the protective layer of B-72 were not noticeable. Because the bulk of the fragments were impregnated with Wacker OH and the paint layer was protected by B-72, their capillarity is low; coupled with this, the water stays in contact with the plaster for only a short period of time. As a result there is very little penetration of the plaster by water. In addition, preventive desalination early in the process avoids salt migration. No alteration in the paint layer has been observed.

Conclusions

The use of silicone rubber could be a useful method of holding fragments of painted plaster when manufacturing new supports. Its main advantages are its great dimensional stability, lack of solvent injurious to health during application and removal, and its strength and ability to hold very large fragments securely as well as the smaller ones. If an effective release agent is used, the removal of such a facing is easy and trouble free. The major problem when using silicones, staining of porous surfaces, can be avoided by careful preparation of the plaster.

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Materials employed

Steinverfeistigung OH (ethyl silicate) and Wacker Hochdisperse Kieselsaure HDK micronized silica: Wacker-Chemie GmbH, Postfach 8000, Munich, Germany. This and all the other Wacker products were supplied by Wacker Chemie Italia, 20068 Peschiera Borromeo (MI), Italy.

Paraloid B-72 (acrylic copolymer): Rohm & Haas Company, Philadelphia, PA 19105, USA. Supplied by Bresciani s.r.l., Milan, Italy.

Palesit 370 (resin) + Palesit W (catalyst): Sika Chemie GmbH, Stuttgart, Germany. Supplied by MM Plastics, Geneva, Switzerland.

WM 3200 KL unsaturated polyester de-moulding agent: Walter Mader AG, Tagelswangen, Switzerland. Supplied by MM Plastics.

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