CAN HASAN WALL PLASTER CONSERVATION

R. PAYTON

1. Hard siliceous salts were mechanically removed from the surface of the plaster using a scalpel. Special care was taken to keep the salt damaged paint on the plaster by brushing on a ~5% solution of Paraloid B-72 in Xylene during the cleaning.

2. The cleaned surface was coated with a number of coats of ~7% Paraloid B-72 in Xylene, to strengthen the plaster.

3. After finding the joins between pieces, sections of three or four pieces were temporarily joined together with H.M.G. adhesive. Wedges and sand bags were used to ensure that the pieces were joined in their correct place.

4. The surfaces of the sections were coated with aluminium foil. This was then smoothed over the surface to follow the contours and cracks of the plaster face.

5. Plaster of Paris was applied to the aluminium foil to a depth of 2-3 cm., overlapping the edge slightly.

6. After the Plaster of Paris had dried the faced sections of wall plaster were turned over and the soil was carefully excavated from the exposed back. Details of positions of mud bricks and pisé plaster were recorded to aid the reconstruction of the pieces.

7. The mud brick and pisé plaster was cut down to within 1 mm. of the back of the wall plaster using scalpels and sharp knives. In places the pisé plaster flaked away easily from the wall plaster. No attempt was made to keep in place this pisé plaster since the interface between it and the wall plaster was obviously a weak one.

8. The adhering pisé plaster and wall plaster were consolidated using a 7% solution of Paraloid B-72 in Xylene.

9. Gaps between the pieces of plaster within the supported sections were filled with a thin layer of 'plasticene' to provide a recess, on removal, for a Plaster of Paris infill during the restoration process (see 21.).

10. A solution of P.V.A. in acetone (~10%) was mixed with soil flour (from the sieving of the debris removed from the back of the wall plaster) and then brushed onto the consolidated back of the wall plaster. This would then act as a release surface; if in the future the removal of the wall plaster from its backing was required the P.V.A. could be dissolved away with acetone or other solvents.

11. Tests were carried out which showed that the proposed backing material – polyester resin mixed with fibre-glass - caused some shrinkage. To minimise this effect on the plaster it was decided to strengthen the back of the plaster with a non-shrinking (less than 1%) resin first, then apply the polyester resin. 'Araldite' epoxy resin '2001' was mixed and applied in a thin coat to the back of the sections covering the pisé plaster and the 'plasticene'. It was then left to harden for one day.

12. Polyester resin was mixed and carefully applied to the epoxy resin surface. Strips of fibre-glass were then stippled into the resin and a lattice-work effect of the strips were built up to provide a strong support. It was then left to harden for one day.

13. The sections were turned over and the Plaster of Paris and aluminium foil facing was removed from the front of the wall plaster. Spillages of resin were mechanically removed with a scalpel from the edges of the sections.

14. The 'plasticene' infills were mechanically removed using a small spatula. A small amount of residual 'plasticene' was dissolved away on swabs of Xylene-soaked cotton wool.

15. To provide a backing for the whole of the sections along one face a sheet of polyester resin and fibre-glass was made to the correct dimensions of that face.

16. The sections were then aligned in their correct position on the panel and levelled to the correct height using small wedges of 'plasticene'.

17. Fibre-glass was mixed into the polyester resin to make a paste which was added to areas of the edges of the sections, which on hardening kept the sections in place. The plasticene temporary supports were then removed.

18. More fibre-glass/resin was applied to bind the sections together and to the back panel.

19. The difference in height between the panel and the top of the wall plaster was 1 cm. This was gap-filled with Plaster of Paris to which granules of expanded polystyrene were added to lighten the weight of the infilling.

20. The Plaster of Paris was smoothed down to a level just below (about 1 mm) that of the wall plaster.

21. The gaps between individual pieces (left by the removal of the plasticene - see 9) were coated first with a layer of 10% P.V.A. in acetone mixed with soil flour to provide a release layer and a rough surface on which the subsequent infill of Plaster of Paris could grip. The plaster was levelled to 1 mm below the wall plaster.

22. The piece of red panelling running along the bottom edge of the panel was held in its correct position and the missing areas of the rest of the panel were backed with polythene, to a depth of 3-4 mm below that of the surface of the existing piece.

23. Polyester resin/fibre-glass was applied to this backing and allowed to harden. The polythene was then peeled off.

24. The whole of the panel with the red bottom section attached was turned over and more fibre-glass/resin was applied to the join between the panel and the attached bottom panel.

25. The panel was turned over again and P.V.A. (1(% in aceton)/soil flour was painted onto the fibre-glass resin surface of the bottom panel.

26. Plaster of Paris was applied to the bottom panel and smoothed to a depth of just below that of the red plastered piece.

27. The *other face* was cleaned, supported, thinned and backed as in 1) - 14).

28. Pieces of the bottom red panel were placed in their correct position and then joined to the upper plastered face using 'Araldite 2001' epoxy adhesive resin, which was allowed to harden.

29. The face was turned over and fibre-glass/resin was used to strengthen the epoxy adhesive join and to gap-fill a missing area of the bottom red panel (backed with polythene).

30. The upper piece of this face was removed from the Museum display case and conserved as in 1) - 14).

31. The piece was joined to the rest of the face with fibre-glass/resin while keeping it in its correct position with a clamp.

32. Gaps between the pieces backed with fibre-glass/resin were coated with P.V.A./soil flour then infilled with Plaster of Paris to just below the surface of the wall plaster.

33. The *two faces* were supported in their correct position then joined with fibre-glass/resin strips.

34. The gap between the two pieces joined by the sticking of the two faces was gap-filled with Plaster of Paris.

35. To strengthen the join of the two faces two aluminium rails were placed across the diagonal at the top and at the bottom. They were joined to the fibre-glass/resin panels with more fibre-glass resin.

36. Expanded polystyrene boards were placed above the top aluminium rail and below the bottom, stuck to the edge of the faces and to the rail with 'Araldite 2001' adhesive.

37. The top board was coated with Plaster of Paris mixed with expanded polystyrene granules to a depth of 1 cm, level with the remains of the bricks present at the top. The plaster was scored to imitate and indicate the positioning of the bricks behind the wall plaster.

38. The surface of the lower board was not coated as it would not be seen. However, the edge of the lower red panel abutting the board was extended to a uniform depth to just short of the original depth of the red panel.

39. The design of the painted geometric pattern was pencilled onto the dry plastered areas. Since the pattern was extremely regular, though very complex, the full length of the panel up to where the existing pieces extended could be restored.

40. The infilled areas were painted as follows:

The top of the restored bricks were painted with powder pigments mixed with soil flour and ~ 7% P.V.A. in acetone. The restoration on the two faces was painted with 'Winsor and Newton' acrylic emulsion paints mixed with finely powdered Calcium Carbonate. The paint was carefully coloured to a neutral tone so that it became more acceptable to the eye than white plaster but obvious that it was a restoration. The red lines of the design were finally painted on.

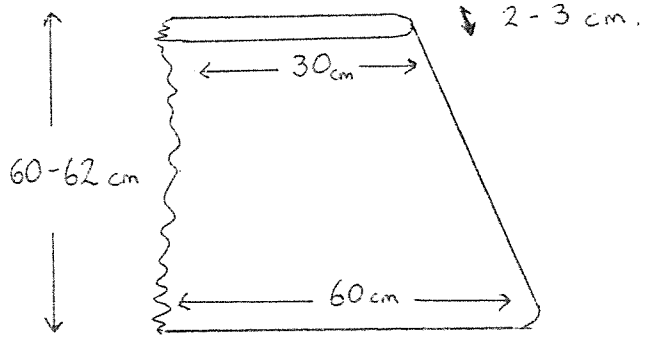
NB

Polyester Resin	=	AP101 PA 100g = 50 drops Catalyst
H.M.G.	=	Nitrocellulose adhesive
Paraloid B-72	=	ethyl methacrylate copolymer
Araldite 2001	=	Epoxy resin adhesive

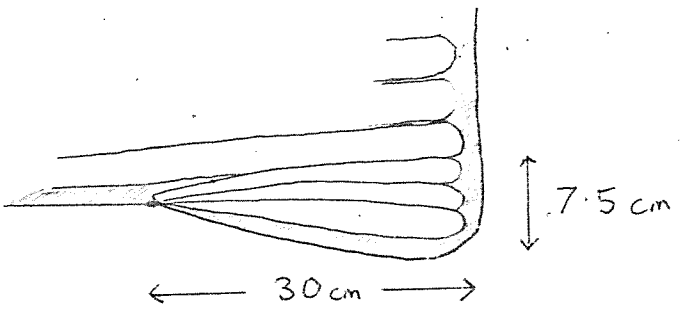
TECHNICAL DATA AND PHYSICAL CHARACTERISTICS OF THE CAN HASAN PLASTERED STRUCTURE

1. From the evidence of the side piece it would appear that the bricks were not cut to a trapezoidal shape, but made into that shape either in a mould or by hand since there the definite edge of the brick followed the incline of the slope.

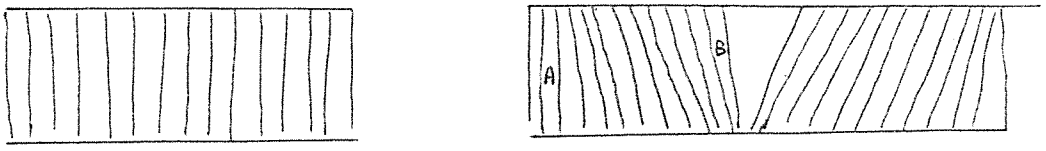
2. The full length of these bricks is not known but their thickness is 2-3 cm and the width 60-62 cm. Since no edge was found in the large side section (equal to the length of the brick) then it is at least longer than 60 cm at the bottom and 30 cm at the top:-



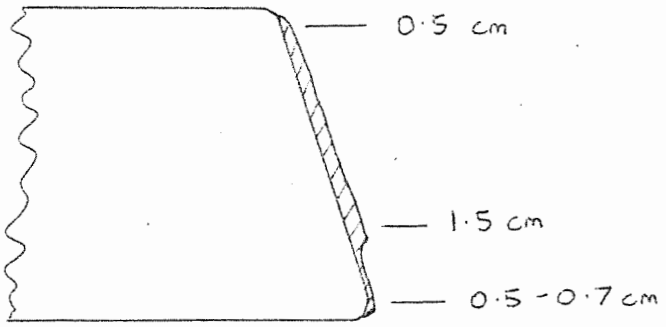
3. In order to make a more rounded corner, three wedge-shaped bricks were added to the end brick. Their width is again 60-62 cm but their length is only 30 cm:-



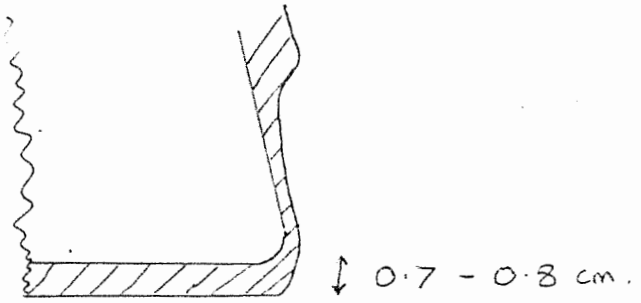
4. It is not positively known but it would appear that the trapezoidal bricks were stacked vertically to make the structure. However, an alternative theory is that the bricks were stacked at an angle to cover an arched structure. This is less likely since it would mean that the bricks had to be made of different widths (*cf.* A to B).



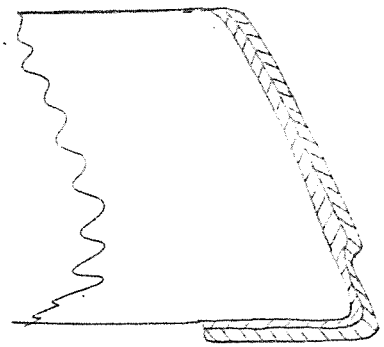
5. The stacked arrangement of bricks were then covered in a layer of pisé. More was added to the 'upper' section to make this area outstand to more than 0.5 cm - 1.0 cm. than the lower section. This was done by adding 0.5 - 1.5 cm of pisé to this upper part and only 0.5 - 0.7 cm to the lower section:-



The surface of this pisé layer was found to be extremely smooth, possibly from being wiped with a wet cloth. On the side face and partially around the front side the pisé had traces of orange/red pigment visible in hollows and depressions, whereas this same pigment was not found on the front face. Instead the plaster there had a slight white colouring to it. This could possibly indicate that (a) the side and front faces had originally not been lime plastered but simply a red and white wash had been applied as decoration to the side and front faces respectively of the pisé; (b) the colouring could have been the result of earth pigments being washed out of the pisé and deposited, on drying, on the surface after the pisé had been wiped with the wet cloth (though why one face should be predominantly red and the other white is difficult to explain). On the bottom edge of the bricks (though it might have extended further under the bricks, but since this is missing it is not possible to say) a 0.7 - 0.8 cm layer of pisé was applied:-



6. To this smoothed pisé was applied another layer (both of which were highly tempered with chopped straw(?)). The thickness of this second layer varied considerably: for the one area which survives, where the red lime-plaster was applied under the bricks edge, the thickness is 1.5 cm.; along the recessed bottom area (later painted red) the thickness varies from 0.3 cm to 2.5 cm., though the average appears to be approximately 0.7 cm. To maintain the raised effect of the upper part of the faces a great amount of pisé was applied, which again varied from 0.7 cm to 2.5 cm (average 1.4 cm.). This gave the final cross section before it was lime-plastered:-



The small differences in thickness of this second coat might imply that there was a definite attempt at trying to fill in any irregularities produced by the first application of the pisé, prior to lime-plastering.

7. An examination of all the pieces indicated that there was no prepared ground applied before the lime plaster. The surface of the pisé was left rough (unlike after the first pisé layer) - presumably to enhance the adhesion of the lime-plaster to the pisé. The plaster was not applied in many layers, but in one single application to a depth of 1 mm., which is uniform throughout all the pieces.

8. For the recessed lower panel area a red pigmented lime-plaster was applied which was also applied under the edge of the panel.

9. A red paint was applied to the white lime-plaster to make up the design. Whether it was applied after the plaster had hardened is not known. However, there is sufficient evidence in the form of scratches and marks along the red painted areas to suggest that it was applied while the plaster was still slightly damp and soft, just prior to hardening, when it would be vulnerable to scratches by whatever form of paintbrush was used. There is no evidence of pre-painting planning marks (though these could easily have disappeared if, for example, an organic dye was used) and therefore the intricate and highly geometric design constitutes a remarkable feat in free-hand, free-style painting. The edges of the designs both at the top and bottom, especially the corner (where the two different designs met) obviously presented problems for the painter since the regular design becomes crowded and distorted. There is no evidence of burnishing on the plaster and the paint, though some areas were extremely smooth and dense.

THE COMPOSITION OF THE PLASTERS AND PAINT

Robert Payton

Plasters (Red and White)

(a) Test procedure: The samples of plaster were immersed after weighing in concentrated nitric acid. The samples were crushed to ensure a full reaction with the acid. After the reaction had ceased (*i.e.* no more bubbles were given off) the acid was carefully poured from the residue, which was then rinsed with clean water. The samples were then fully air dried and re-weighed.

(b) Results.

1. White plaster: Sample before 700 mg
   after 90 mg

   The sample contained 12.85% Acid insoluble matter
   87.15% Acid soluble matter

   A second test with another sample gave:

   15% Acid insoluble
   85% Acid soluble

2. Red plaster: Sample before 360 mg
   after 190 mg

   The sample contained 63.33% Acid insoluble matter
   36.67% Acid soluble matter

   A second test with another sample gave:

   45% Acid insoluble
   55% Acid soluble

(c) Microscopic examination of acid insoluble residue:

1) From the White plaster.

Most of the residue was a very fine powder which became sticky and 'plastic' when wetted with water. There were also minor amounts of fine grit, maximum diameter 0.5 mm. An examination of a fracture in the white plaster showed that the grit was uniformly distributed throughout the plaster.

2) From the Red plaster.

The residue was a mixture of approximately 2/3 red powder and 1/3 grit. The grit was white and had a fairly uniform diameter of 0.1 mm. An examination of a fracture in the red plaster showed that the heavier grit was at the bottom of the plaster layer and the very fine red powder (which produced a fine dispersion in water, which settled out very slowly) was mostly concentrated on the top.

(d) Summary.

The results indicate that the white plaster is composed of mostly Calcium Carbonate (lime plaster) which is produced by the carbonation of lime wash:

$$Ca(OH)_2 + CO_2 \xrightarrow{water} CaCO_3 + H_2O$$

A small amount of filler is present (mainly as clay dispersed in the plaster) which is probably an accidental additive, though the grit could have been added to bind together the lime plaster as it was setting, as the plaster layer is rather thick (1 mm).

The results from the red plaster indicate that the lime wash was mixed almost 50/50 (approximately) with red pigment and filler, to produce the light red colour of the hardened plaster.

Pigments

(1) Orange-red pigment found on the surface of the first pisé layer on the side face:

A positive result was obtained when scrapings of the pigment (taken under the microscope) were slightly acidified with dilute Sulphuric Acid. A drop of this test solution was put on a spot plate and one drop of 2% solution of 2,2' - bipyridyl in ethanol was added. A pink-red solution which immediately formed indicated the presence of iron. (Test recommended by the I.U.P.A.C. Report). The pigment is therefore probably Fe_2O_3, haematite, red ochre.

(2) Red pigment used as decoration on the white plaster faces:

The pigment was solubalised with great difficulty and only after boiling for 2-3 minutes in concentrated Hudrochloric Acid. The yellow-orange solution was diluted to about 5% with water, then Potassium Iodide was added. To test for iron a 2% solution of 2.2' - bibyridyl in ethanol was added and a pink-red solution developed (test as above). The pigment is therefore Fe_2O_3, haematite, red ochre.

(3) Red pigment used to colour the plaster in the lower band:

Test and result as above.

To confirm the presence of iron in the samples, two other tests were carried out which were less specific than using 2.2' - Bipyridyl, but nevertheless indicates the presence of iron:-

(i) Sample solubalised in hot concentrated Hydrochloric Acid diluted with water to 5%.

Drop of Potassium Iodide added to a drop of the test solution.
A drop of 1% dimethylglyoxime in alcohol was added.
2-3 drops of Ammonia solution were added.

- A red colour developes which, on standing in air, fades.

(ii) Sample solubalised in hot Concentrated Hydrochloric Acid, diluted with water to 5%.

Drop of 1% Potassium Iodide added to a drop of the test solution. Drop of 0.1% solution of 8-hydroxy-7-iodoquinoline-5- Sulphonic Acid (Ferron) was added.

- A green colour developes.

Summary

It appears that in all cases red ochre (haematite, Fe_2O_3) was used to give the red colour found in the paint and in the red plaster (and also on the side face of the first pisé plaster layer). No traces of other red colouring matter were found - such as red lead, or realgar.

REPLICATION OF BONE SPATULAS FROM CAN HASAN IN KARAMAN MUSEUM

(19-22 June 1984)

Copies of six bone 'spatulas' from Can Hasan:-

1. Can III 69/19
2. Can III 69/25
3. Can III 69/31
4. Can III 69/33
5. Can III 69/41
6. Can III 69/185

were requested by the British Museum. It was decided to make two-piece moulds with a plaster casing (mother mould). These were made as follows:-

1. The spatulas were embedded in 'plasticine' (modelling clay) so that only half the flat spatula was visible. Care was taken to make a clean interface where the 'plasticine' met the edge of the bone tool.
2. Silicon rubber (Silastic 9161 RTV) was mixed carefully with 2% catalyst (9162 N). Care was taken to avoid air bubbles being mixed and trapped in the rubber. The rubber was then applied by brush to the bone and the surrounding 'plasticine', and allowed to harden (about 2-3 hours).
3. The rubber was cut with a sharp knife so that the bone was surrounded by about 1 cm of rubber. Small dovetails were cut into the rubber surround at intervals of approximately 1-1½ cm.
4. Small shaped wedges of 'plasticine' were cut and placed on the 'plasticine' surrounding the rubber at intervals of about 2 cm. These would provide the mould with locking holes to keep the two halves of the mould in the correct position.
5. Plaster of Paris was poured over the rubber and the plasticine to a depth of about 1 cm. Once slightly hardened, the sides of the plaster were trimmed to neat faces.
6. The mould was turned over and the 'plasticine' was carefully removed, taking care not to disturb the Silicon rubber or the bone.
7. A release agent was applied to the bone, rubber and plaster exposed by the removal of the 'plasticine'. 'Nivea' hand cream was used and spread thinly over the surfaces.
8. A small funnel of plasticine was placed at one end of the mould so that its narrowest point touched the edge of the bone and its widest end protruded out of the plaster. This, on removal at stage 12, would provide the mould with a hole through which the casting resin could be inserted.
9. More Silicon rubber was mixed and applied to the bone and over the other rubber previously applied on the other side of the mould.

10. After hardening dovetails were cut into the edge of the rubber taking care not to cut into the rubber below it.

11. Plaster of paris was poured over the rubber to a depth of 1 cm and allowed to harden. The edges were trimmed to the same dimensions of the lower half of the mould.

12. After fully hardening the two halves of the plaster mould were prised apart with a screw-driver. The rubber could be taken out of the plaster support moulds and the bone removed from inside by gently peeling the flexible rubber off the bone surface.

13. The moulds were then re-assembled, joined with tape and sent to the British Museum where good quality resins could be used to cast the moulds and make an accurate replica of the spatulas.

ROBERT PAYTON