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A PREVENTIVE CONSERVATION CASE STUDY: THE STABILIZATION OF CERAMIC VESSELS AT HARAPPA, PAKISTAN

by
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1. INTRODUCTION

Regular monitoring of collections is an integral part of responsible caretaking in any museum. Periodic evaluation of storage areas allows potential problems to be identified and corrected before major damage is done to valuable collections. As a result of monitoring performed during the 1992 study season at Harappa, Pakistan, conservators were able to devise improvements in storage design and treatments to ensure the continued preservation of Indus Civilization ceramics material excavated from this important ancient site.

The survey, treatment and rehousing of 226 accessioned ceramics from the reserve collection of the Harappa Museum took place during April, 1992. The impetus for the project was the preparation for photography and publication of ceramics from Harappan burial contexts. Most of these had previously received some conservation attention, typically desalination and reconstruction. However, it was found that some of the joints had failed. This observation prompted a general survey of the ceramics collection, followed by treatment of unstable vessels and improvements in housing.

2. STORAGE

2.1 *Description*

The ceramics collection comprises material excavated between 1986 and 1990 by the University of California-Berkeley Expedition to Harappa, under the direction of the late G.K. Dales and J.M. Kenoyer in collaboration with the Department of Archaeology and

Museums, Pakistan. The ceramics are part of the reserve collection, housed in a storage facility that is part of the Harappa Museum Complex at Harappa. This facility is maintained by the permanent museum personnel. The stored collection is not open to the public.

Like many museum storage areas, the one at Harappa was not designed for the function that it now serves. The space designated for the current project's finds is ample. However, other physical characteristics of the area are problematic. Windows and doors in the storeroom are opened for light and air, subjecting the objects to dirt, debris and dust. Moisture enters the storeroom by capillary rise of ground water through the floors (indicated by salt efflorescence on and friability of the walls) and by leaks in the ceiling (indicated by water staining). There are no means to control temperature, relative humidity or air circulation.

At the time of the survey, the ceramics were stored on the shelves of open wooden units, including the uppermost ones which were close to the ceiling. Several large vessels rested directly on the floor. Vessels were packed tightly onto the shelves, often resting near the edges where they could fall if disturbed. Those which could be nested, such as bowls or dishes, were stacked several high without interleaves or padding.

The organization of the shelved material made location and retrieval of specific objects difficult. Vessels were arranged by type rather than by their accession numbers. The accession numbers were often hard to read or obscured by the storage arrangement, being printed in small figures on the undersides of vessels or just above the bases.

2.2 *Improvements to Storage*

Although many aspects of the storage area cannot be changed, some simple measures were taken to reduce unnecessary handling of the objects, the chance for damage because of overcrowding or stacking and the accumulation of dirt on objects.

The painted wooden shelves were lined with polyethylene plastic sheeting to provide a clean inert surface on which to place the objects. This should prevent contact with damp wooden shelving and organic acid fumes exuded by woods, both of which can cause problems in ceramics with residual salts from burial. The back of each shelving unit was isolated from the wall with plastic sheeting to prevent moisture and salts in the walls from contacting the objects. Overlapped sheets of plastic were hung from the top shelves, covering the fronts of the units, to provide protection from dust while still allowing easy access to the objects.

Small vessels were grouped in padded cardboard boxes and stored in two trunks which were placed on the top shelves. This provided more rooms on the shelves so that objects were not crowded or placed precariously close to the edges of shelves. No vessels

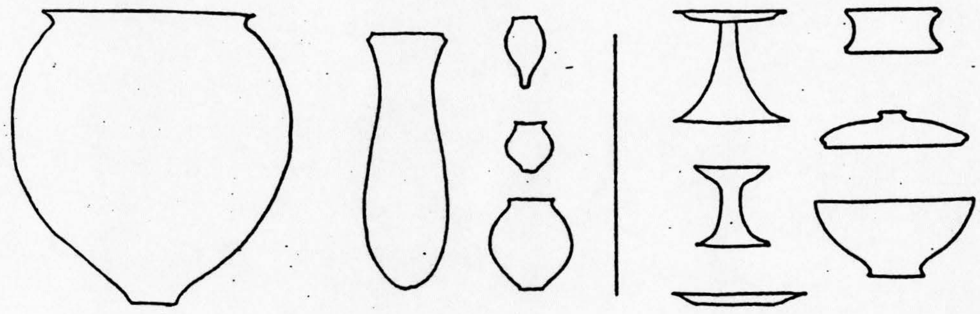


Fig. 89. Harappa: Vessel Forms.

were stored directly on the floor because there is insufficient space to accommodate both vessels and traffic in the storeroom safely.

All vessels, except one which had an extremely unstable surface, were wrapped in polyethylene plastic to protect them from dirt, dust and abrasion during storage, handling and to contain fragments in the event that join failure occurs. The plastic wrappings were loose enough to allow for air exchange and thus prevent high humidity in close proximity to the objects. Polyethylene bags were used for smaller objects, with the tops of the bags tucked into the interiors of the vessels. Medium-sized objects were often wrapped in two bags, one functioning as a lid. Larger objects were wrapped in polyethylene sheeting.

Vessels were re-arranged by accession number for easy location and reduction in handling. The numbers were clearly written in large print on the plastic or on separate tags using a black permanent marker.

3. THE COLLECTION

3.1 Description

The 226 accessioned vessels represent five seasons of excavation. However, most were found in burial contexts from the 1986, 1987 and 1988 excavations of the Harappan Cemetery R37. In describing the corpus of ceramics material, the vessels are generally divided typologically by specific form. However, from a structural standpoint, the vessels can be divided into two basic groups which emerged as significant to their overall stability: geometrically enhanced forms and geometrically vulnerable forms (Fig. 89). Geometrically enhanced forms include small, medium and large jars, jar/pots and pots. These have enclosing forms which tend to lock the fragments in place mechanically. Geometrically vulnerable forms include bowls, dishes, ringstands, lids and pedestaled vessels such as the dish-on-stand (DOS) and the bowl-on-stand (BOS). These have elements which are cantilevered or are otherwise inadequately supported by lower

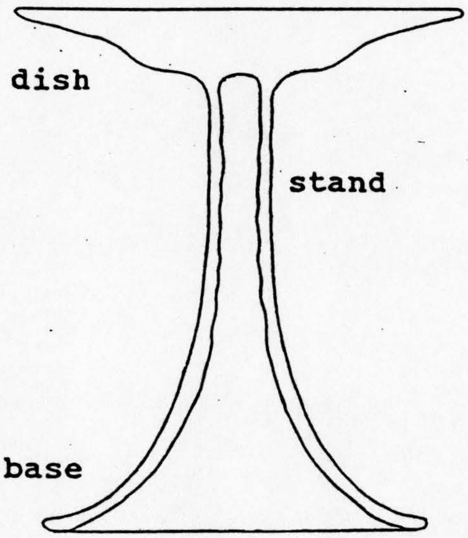


Fig. 90. Harappa: Dish-on-Stand.

sections of the vessel. The most exaggerated examples of this vulnerability are the unsupported dishes of the DOS (Fig. 90).

3.2 *Condition*

Most vessels were in good condition, although all were covered with a layer of dirt and dust acquired during storage. No active salt efflorescence was observed because of successful desalination efforts in previous seasons. However, surfaces on a few vessels remained fragile because of previous salt damage from long-term burial. A few fresh breaks were noted which may have been the result of improper storage or handling. However, the main problem affecting the reconstructed vessels in storage was failure of previous joints, found on approximately 15% of the collection. These failures resulted from inherent structural weakness because of vessel form, adhesive type, reconstruction technique and/or high ambient temperatures in storage.

The primary factor affecting joint stability was related to vessel form. Geometrically vulnerable forms exhibited adhesive slumping and failure, resulting in collapsed vessels, losses at failed joint edges and fresh breaks from falling fragments. The DOS and BOS were the most vulnerable forms. Of the thirteen accessioned pedestaled objects in storage only two were intact. In contrast, no join failures were noted on vessels with geometrically enhanced forms, such as globular or cylindrical vessels.

Another factor affecting joints was related to the properties of the adhesives used. Vessels which had been treated in the conservation lab were reassembled using Acryloid B-72™ (methyl acrylate/ethyl methacrylate copolymer) dissolved in acetone with a small amount of Cabosil™ fumed silica to improve its thixotropic properties.[1] B-72 was chosen because it has excellent longterm aging characteristics: it remains reversible in several solvents and exhibits no tendency to discolour, harden or embrittle over time.[2] However, its glass transition temperature (T_g), the temperature at which it begins to soften, is relatively low (40° C). Temperatures close to or above 40° C are undoubtedly reached in the storeroom at Harappa during the hot season, especially on the top shelves where the pedestaled vessels had been stored. These temperatures allowed unsupported fragments to stretch the softened adhesive until joints failed.

On some vessels the use of another adhesive proved to be the problem. Many of the vessels which had not been reconstructed by the conservation staff had been assembled using a cellulose nitrate adhesive such as Duco™ or HMG.™ This adhesive sets quickly but deteriorates with age, evidenced by shrinking, yellowing and embrittlement.[3] It was observed that joins failed as the adhesive contracted from the break edges, often removing the surface of the ceramic in the process.

Improper adhesive application also contributed to joint failure. Some joints appeared to have been adhesive starved: apparently either too little adhesive was used to effect a secure joint or much of the adhesive wicked into the porous fabric of the vessel.

4. TREATMENT

All vessels were cleaned of dirt and debris with a soft, dry brush. Vessels with friable or delaminating surfaces were consolidated with dilute concentrations of B-72 in acetone (generally less than 5% by weight) applied with a brush. Vessels with failed or failing joints were disassembled and reconstructed. In some instances vessels were not disassembled but cracks and insecure joints were reinforced with patches of Cerex™ spunbond nylon fabric applied to the interior with B-72.

4.1 Preparation for Reassembly

Joints were disassembled by softening the adhesive using cotton or paper poultices wetted with acetone. Solvent evaporation was slowed by using plastic wrap, plastic bags or aluminum foil to create an airtight enclosure. Larger fragment groups were supported in a sandbox to prevent damage when the adhesive released. After fragments had been separated, acetone was applied to the edges of those which had been joined with B-72 in order to dilute the adhesive and thereby consolidate the edges. When another adhesive had been used, it was removed with solvent, and the edges were consolidated by application of a dilute solution of B-72 (approximately 5 to 10% by weight). Consolidation was done in order to strengthen the edges and to ensure that the newly applied adhesive would remain in the joint.

4.2 Reassembly

Fragments were joined using concentrated B-72 in acetone (approximately 50% by weight) with a small amount of Cabosil fumed silica (approximately one tablespoon per

100 grams of resin). This solution was dilute enough to be applied easily with a brush. Both joint edges were completely covered with a thin layer of the B-72 solution. Fragments were momentarily joined, pulled apart to facilitate evaporation of excess acetone and rejoined. Care was taken that fragments were properly aligned and closely fitted. Joints were held in place using gravity, clips or rubber bands, depending on the nature of the joint and the preference of the conservator. Excess adhesive was removed from the joint edges with cotton swabs dampened with acetone.

4.3 *Reinforcement*

In some instances, joined fragments were unstable due to eroded edges or adjacent losses. These were reinforced with patches of Cerex nylon adhered with B-72 to either the interior or exterior depending on the joint. When necessary, patches were toned with acrylic emulsion paints to make them less obtrusive. Losses were filled with pigmented plaster of paris when both structural support and aesthetic integration were required. Break edges were thoroughly consolidated with B-72 prior to filling. The finished fills were toned with acrylic emulsion paints.

4.4 *Adhesive Considerations*

Care must be taken in any treatment to choose suitable and well tested materials. Many of the problems that conservators now face are the results of aging and unforeseen changes in treatment materials previously used, such as those noted in Section 3.2 for cellulose nitrate. Other problems result from poor matches between ambient temperatures in display and storage and the T_g of materials used in treatment, as can occur with PVA (polyvinyl acetate)[4] or, at higher temperatures, B-72.

B-72 was chosen for reassembly because of its strength, reversibility and stable physical properties despite the previously noted failures. The effects on the adhesive of inherent structural weaknesses in certain vessel types and high ambient temperatures were mitigated by using additional supports or reinforcements for potentially unstable joints (see Section 6.0). These steps in conjunction with careful application of adhesive to avoid the problems of inadequate consolidation or insufficient quantity and coverage should prevent reoccurrence of adhesive failures.

Another resin in the Arcyloid series, B-48 (methyl acrylate/butyl methacrylate copolymer), has been used as an adhesive for ceramics although it is more commonly used as a coating or adhesive for metals. Because of its greater strength and higher T_g (50° C), it is capable of withstanding higher ambient temperatures. However, it is harder and more brittle than B-72, which may make it an inappropriate choice for use on fragile archaeological material. It has been used primarily as a surface coating or adhesive for metal artifacts. It has not been subjected to the same rigorous testing as B-72, and although closely related, it may not age as well.

The use of a different class of adhesives such as the epoxies is not recommended for ceramics. Although successfully used in certain applications on stone, they are generally to be avoided because they age poorly, becoming discoloured and brittle. These adhesives are very difficult to remove, typically requiring strong, toxic solvent mixtures and mechanical cleaning.

5. SPECIAL WRAPPING AND PADDING OF VESSELS

Special packing for storage was devised for many of the vulnerable vessel forms to provide additional protection and support.

5.1 *Large enclosed Vessels*

Although not inherently vulnerable, it seemed advisable to provide additional support to large enclosed vessels due to their size. Unless prohibited by unstable surfaces, these vessels were supported by bandages made from undyed cotton gauze, tied around their exteriors. Globular jars were then wrapped in plastic and placed in plastic washtubs. The tubs have handgrips for carrying which reduces handling of the vessels. Tall cylindrical jars were wrapped in plastic sheeting with the loose ends tucked inside and stored on their sides, supported by cushions made from undyed cotton muslin stuffed with cotton wool. They were not stored upright because they can be easily knocked over in that position.

5.2 *Lids*

Lids were packed right side up, the interiors padded with cushions made from polyethylene bags stuffed with crumpled acid-free tissue. Plastic sheeting was wrapped around each lid and cushion and tucked underneath. The wrapped lids were stored individually or stacked in pairs on plastic trays.

5.3 *Ringstands*

Bandages of undyed cotton gauze were tied around the ringstands to support them. The interiors of ringstands were supported with cushions made from polyethylene bags and acid-free tissue. Each ringstand was wrapped in plastic sheeting which was tucked into the interior on the underside and stored on a tray.

5.4 *Dishes*

Each dish was wrapped in a large sheet of plastic and the excess folded into the concavity. A pad of folded acid-free tissue was placed on top, covering the loose ends of the plastic. This assemblage was tied with string and stored upside down with the plastic and tissue supporting the form. When stacking could not be avoided, additional padding was provided for the bottom dish in the stack. A maximum of three dishes was stacked together.

6. SPECIAL MOUNTS FOR VESSELS

Specially designed mounts were fabricated to provide support for a large bowl and thirteen of the vulnerable pedestaled vessels.

6.1 *Bowl*

A form-fitting plaster mount was fabricated for a reconstructed bowl. The mount was made by moulding Gypsona™ (a gypsum-impregnated gauze bandage) and plaster of Paris to the inside of the bowl over a separating layer of plastic. A strip of unbleached cotton muslin was incorporated into the plaster to form handles for lifting. The finished mount was padded with cotton wool and wrapped in a sheet of polyethylene plastic. This padding ensures a good fit and prevents abrasion to the object during insertion and removal of the mount. The mounted bowl was stored upside down in a plastic tub, from which it can be lifted using the muslin handles. The fabrication procedure is described more fully in Appendix 'A' and illustrated in Figures 91 and 92.

6.2 *Pedestaled Vessels*

Due to their size, shape and weight, the dish-on-stand (DOS) and bowl-on-stand (BOS) vessels required more elaborate mounts, shaped specifically to support the geometrically vulnerable stand and dish components. These mounts were also designed to provide a safer means of moving the object. Form-fitting plaster cones with cotton wool padding and polyethylene covers were fabricated to fit inside the stands of DOS and BOS vessels using the methods used for the bowl mount described above and in Appendix A. The vessels were placed on carrying trays made from sheets of Plastiglass™ cast acrylic whose corners were heated and bent to form sides and handles. For the DOS vessels, Plastiglass collars and ring-shaped pads were added to the mount to support the

Fig. 91. Harappa: Moulding a Plaster Bowl Support.

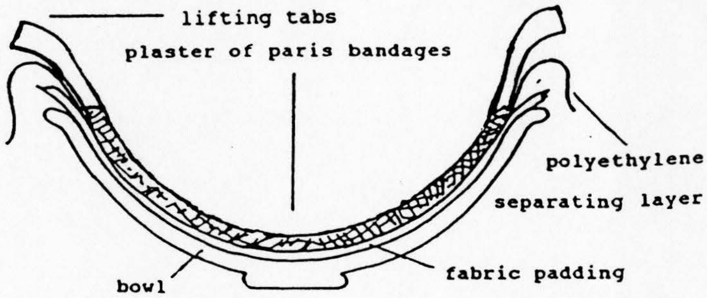
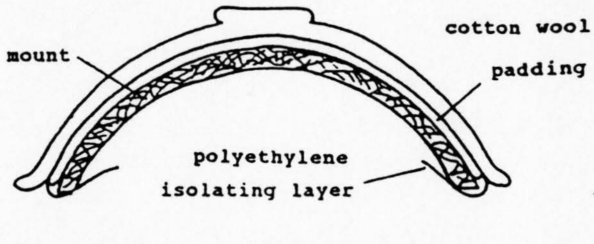


Fig. 92. Harappa: Plaster Bowl Support in use.



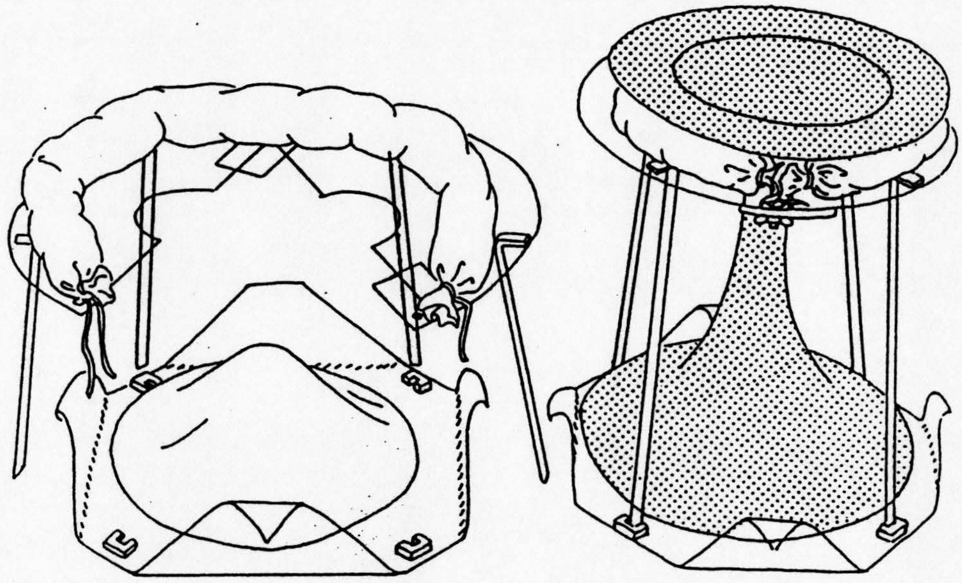


Fig. 93. Harappa: Support for Dish-on-Stand.

dishes. Each collar rests on four legs and is hinged so that it can be opened and closed to remove the object. The fabrication procedure is described more fully in Appendix 'B' and illustrated in Figures 93 through 101.

CONCLUSIONS

The responsibility for the preservation of excavated artefacts begins upon their removal from the soil when the issues of stability are first addressed. However, this responsibility continues well after the objects leave the laboratory and is fulfilled most effectively through periodic monitoring of the collection. Monitoring allows the conservator to detect any conservation problems of individual objects which may have developed after a time in storage or on display. By identifying the actual causes and potential hazards, the conservator can then modify environmental conditions and adjust treatments accordingly.

At Harappa, it was noted that additional support of certain reconstructed ceramics was critical to their stability. Solutions were devised to address this need using materials readily available in Pakistan. Reinforcement patches, careful wrapping and padding and specially designed mounts were chosen as practical and effective means of supporting vulnerable vessels. Simple steps, such as enclosing shelving units with plastic sheeting, were also taken to mitigate potential hazards in storage.

In anticipating and addressing the needs of the collection more completely, these conservation measures become preventive ones, reducing the need for future interventions. It is hoped that those outlined here will ensure the preservation of these important ceramics for years to come.

ACKNOWLEDGEMENTS

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LIST OF MATERIALS

Acryloid B-72 (Paraloid B-72), a methyl acrylate/ethyl methacrylate copolymer, is manufactured and distributed by Rohm and Haas, Philadelphia, PA 19105. The acrylic beads are also available through Conservation Materials Ltd., 240 Freeport Blvd., Box 2884, Sparks, Nevada 89431.

Cerex, a spunbonded nylon fabric, is distributed through Conservation Materials Ltd.

Gypsona, a Plaster of Paris bandage, is manufactured by Smith and Nephew (Pakistan) Ltd., Karachi.

Liquitex acrylic emulsion paints are manufactured by Binney and Smith Inc., Easton, PA 18044. Winsor & Newton acrylic emulsion paints are manufactured by Winsor & Newton, London HAS5RH.

Magic Stone, a two-part epoxy (resin and hardener), is manufactured in the United States and distributed locally.

Plastiglass, a cast acrylic sheet, is manufactured by Pak Poly Industries Ltd., Karachi.

Plastic trays and tubs, polyethylene bags and sheeting, Plaster of Paris and undyed cotton fabrics are available locally. Cotton fabrics were washed in distilled water prior to use.

Permanent marking pens were purchased in the United States but are also available locally. They were tested for light and abrasion fastness prior to use.

Notes

1. S. Koob, (1986). "The Use of Paraloid B-72 as an Adhesive and Its Application for Archaeological Ceramics and Other Materials," *Studies in Conservation* 31, pp. 7-14.

2. R. Feller, N. Stolow and F.H. Jones, (1985).*On Picture Varnishes and their Solvents*, Cleveland, OH.

3. S. Koob, (1982). "The Instability of Cellulose Nitrate," *The Conservator* 6, pp. 31-34.

4. S. Koob, (1991)."The Use of Acryloid B-72 in the Treatment of Archaeological Ceramics: Minimal Intervention," *Materials Issues in Art and Archaeology* II, pp. 592-593.

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APPENDIX A

MOULDING A PLASTER SUPPORT FOR A CERAMIC BOWL

Padded plaster mounts were made to support a reassembled bowl and the stand components of the pedestaled bowl-on-stand (BOS) and dish-on-stand (DOS) vessels. Manufacture of the plaster support for the bowl is outlined below. The fabrication procedure takes approximately one hour.

1. Materials

Plaster of Paris

cotton fabric (thin gauze or muslin to use as bandages)

Gypsona™ gypsum-impregnated bandages (or other commercial brand) cotton muslin scraps (to use as padding)

thin plastic sheeting (to use as a separating layer)

polyethylene sheeting (to use as a permanent isolating layer) cotton wool.

2. Procedure

a. Preparation

Place the bowl upright. Pad the interior with several layers of cotton muslin. The padding should be form-fitting, but should pad out any undercuts in the form to avoid mechanical locking of the plaster mount to the interior of the bowl. Cover the padding with a thin sheet of plastic to act as a separator. Drape excess plastic over the edges of the bowl to protect the vessel from drips and spillage of plaster. The bowl and its protective layer appear in Figure 91.

b. Fabrication

Build the mount by applying gypsum-impregnated bandages to the interior of the bowl. Bandages are overlapped and applied in layers; each layer is applied while the previous one is still damp. Commercial bandages such as Gypsona™ gypsum-impregnated bandages are applied by cutting and dipping in distilled water. Homemade bandages can also be used. These can be made by dipping strips of cotton fabric (gauze or fine muslin) into fresh plaster of Paris. Apply plaster of Paris putty in between bandage layers as necessary to make the mount heavier and stronger. Build up the mount by layering bandages and putty until it is the desired thickness (approximately 3-7 mm depending on the size and weight of the vessel).

If desired, lifting tabs can be incorporated into the mount by using a long strip of heavy cotton muslin which protrudes several inches on either side of the mount. Layer this strip in with the plaster of paris bandages as the mount is built.

c Finishing

Remove the mount when the plaster has set. Turn the mount over. Trim the bottom edges of the mount so they are even. Finish the edges of the mount by applying a layer of bandages to cover the cut edges. Allow the mount to airdry thoroughly. Seal the mount with a brush coating of a suitable consolidant such as Acryloid B-72 in acetone to prevent it from powdering when handled. Allow the consolidant to dry. Cover the mount with a 1-2 cm thick mat of cotton wool. Cover the cotton with a sheet of polyethylene, tucking the ends of the plastic underneath the edges of the plaster form to secure them, leaving any lifting tabs accessible. The padding ensures a good fit and prevents abrasion to the object or the plaster form during handling. The completed mount is depicted in Figure 92.

APPENDIX B

FABRICATION OF A SUPPORT FOR A DISH-ON-STAND (DOS)

The support for a dish-on-stand (Fig. 90) consists of three parts: an interior plaster support for the stand, a ring-shaped pad and an exterior Plastiglass™ support for the dish (Fig. 93). The plaster support for the stand is moulded and padded as described for the bowl in Appendix A. The ring-shaped pad is made from cotton muslin stuffed with cotton wool (Section A below). The remainder of the support, consisting of a tray, four legs and a collar, is made from Plastiglass cast acrylic sheet (Section B below).

Plastiglass was chosen as a mount-making material because it is chemically and physically stable under the prevailing storage conditions, and therefore should not deteriorate. It is not attractive to insects and is less susceptible to biodeterioration than wood. The Plastiglass is easily shaped with standard carpentry tools and heat and can be glued with epoxy. The other materials were chosen for their workability and availability in Pakistan.

It takes approximately four hours to fabricate the complete mount: one hour for the completion of the padded plaster support, two hours to lay out, cut and bend the Plastiglass sections, one half hour to cut, stitch and stuff the ring-shaped pad and one half hour to assemble to complete support system.

A. FABRICATION OF THE RING-SHAPED PAD

1. *Pad Materials*

undyed cotton muslin

cotton wool

cotton twine

cotton thread

2. *Procedure*

Wash the undyed cotton muslin in water, preferably distilled, to remove the sizing, then allow it to dry thoroughly. Cut a strip of fabric 20 cm in width and approximately 6 cm longer than the circumference of the dish of the DOS. Fold the fabric lengthwise and sew along the edge to form a tube. Turn the tube inside out and loosely stuff it with fluffed cotton wool. Tie both ends of the tube with twine. Tie the two ends of the tube together with a small amount of overlap to form the ring-shaped pad (Fig. 93).

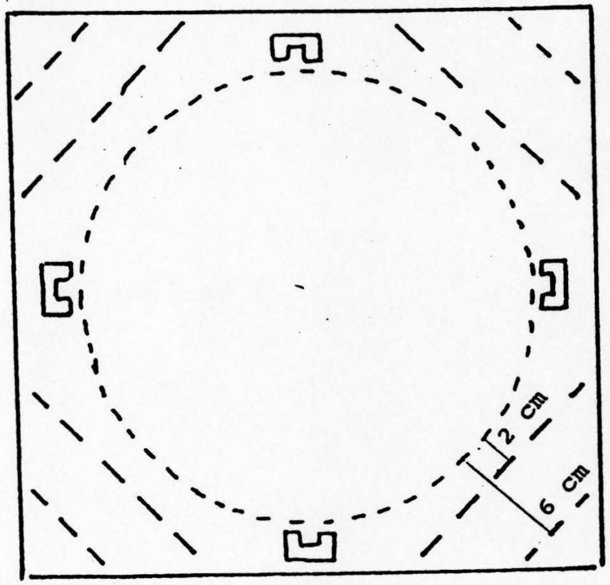

Fig. 94. Harappa: Tray layout.

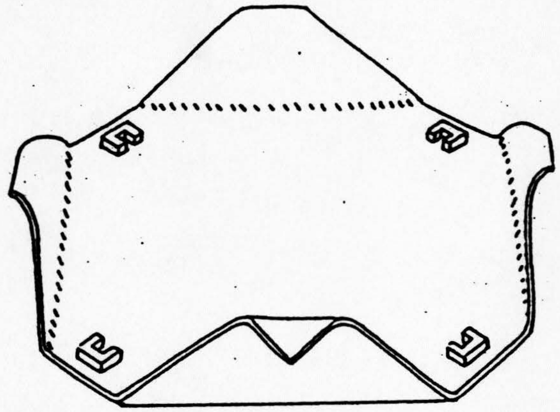

Fig. 95. Harappa: Finished Tray.

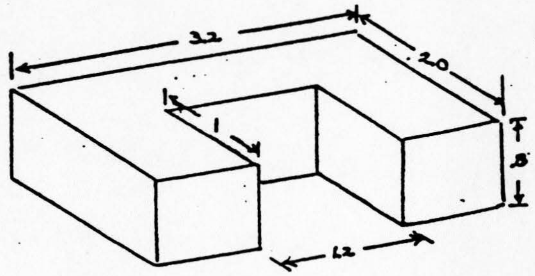

Fig. 96. Harappa: Leg Bracket (dimensions in centimetres).

B. FABRICATION OF THE CAST ACRYLIC SHEET SUPPORT

1. Mount Materials

4 mm thick cast acrylic sheet (such as Plastiglass™)
8 mm thick cast acrylic sheet (if available)
quick-setting two-part epoxy (such as Magic Stone™)
2 bolts
1 nut
1 wing nut
3 washers

2. Procedure

a. Tray

Cut a square approximately 8 cm larger than the diameter of the base of the DOS out of the 4 mm thick cast acrylic sheet. Trace the diameter of the base of the DOS onto the centre of the square, leaving a 4 cm margin between the circle and the edges of the square.

Draw two parallel diagonal lines across the four corners of the square approximately 2 cm and 6 cm from the outer circumference of the circle (Fig. 94). Soften the Plastiglass using heat along the inner line at each corner, and bend the sheet upwards at a 90° angle to form sides. Heat and bend the sheet along the second line outward and downward to form handles (Fig. 95). A charcoal fire was used at Harappa to heat the acrylic sheet but other suitable heat sources may also be applied.

The finished tray is then fitted with u-shaped brackets to secure the legs. These brackets are 8 mm thick, made either from 8 mm acrylic sheet or from two thickness of 4 mm sheet glued together with epoxy. To make the brackets, cut four 3.2 x 2 cm squares. Into each, cut a 1 x 1.2 cm rectangular notch on the centre of one side to form the u-shape (Fig. 96). The brackets are glued using epoxy at the center of each side of the tray approximately 5 mm from the edge of the drawn circle (Fig. 94).

b. Legs

Cut four 1 cm wide strips from the 4 mm thick acrylic sheet. The length of these strips corresponds to the height of the DOS. Draw a line 3 cm from one end on each strip. The strip will be bent on that line at a sharp 85° angle using a prepared jig (Fig. 97).

To prepare the jig, cut one end of a block of wood (approximately 2 cm x 10 cm x 4 cm) at an 85° angle. Clamp or nail this block onto a flat wooden base. Gouge a hole in the base approximately 5 mm diameter and 3 mm deep at the angled corner to accommodate the slight lateral expansion of the acrylic sheet when bent.

Heat the end of the acrylic leg along the drawn line. Place the leg along the angled block and use a second block to bend the 3 cm end around the 85° angle. Hold the leg in place until it has cooled.

c. Collar

Draw a circle 4 cm larger than the diameter of the dish component of the DOS on another piece of 4 mm thick acrylic sheet. Inside this circle draw a smaller concentric circle which is 4 cm larger than the diameter of the stand component where it joins the dish. Draw a line across the diameter of both circles (Fig. 98). Cut the acrylic sheet along the outer circle. Cut this circle in half along the line. Cut along the inner semicircle on each half, thus forming the two collar halves. Cut two 5 x 8 cm rectangles out of the 4 mm acrylic sheet to form flanges to hold the collar together. Glue one flange to the underside of one end of each of the collar halves with epoxy as illustrated in Fig. 99. Fit the two collar halves together. Drill through the outer corner of each collar half and the underlying flange of the adjacent plate. Round one corner of one of the collar halves using a file or rasp. A bolt and nut through the hole adjacent to the rounded corner create a hinge. A bolt and wing nut in the opposite hole allows the collar to be opened and closed (Fig. 100).

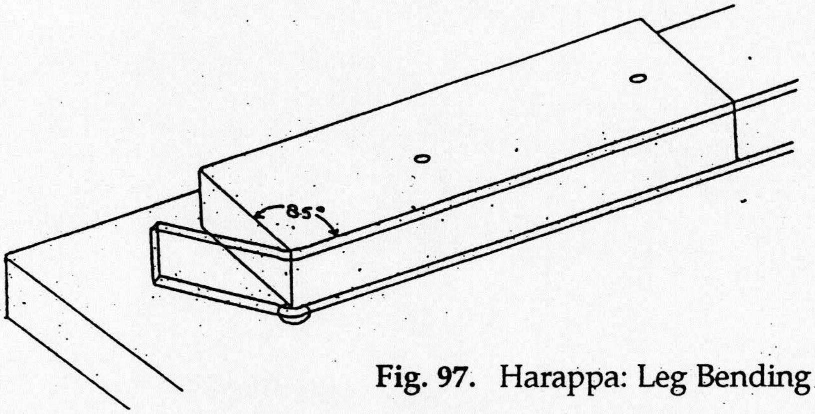

Fig. 97. Harappa: Leg Bending Jig.

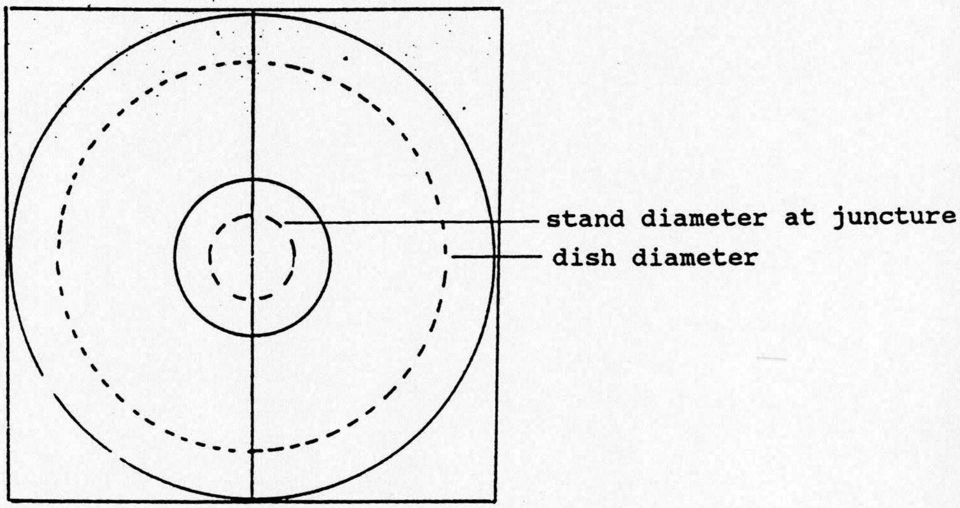

Fig. 98. Harappa: Collar layout.

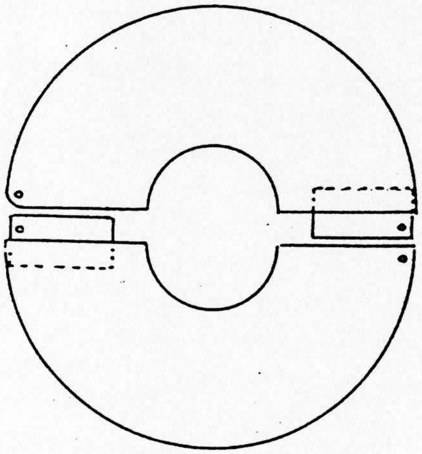

Fig. 99. Harappa: Collar fabrication.

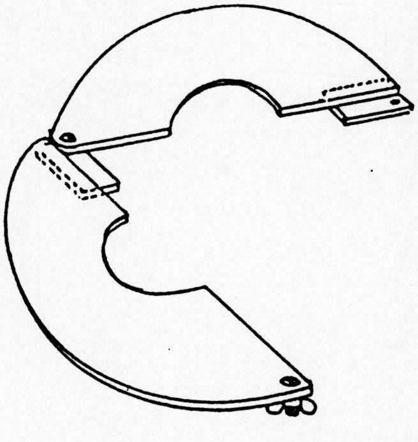

Fig. 100. Harappa: Finished Collar.

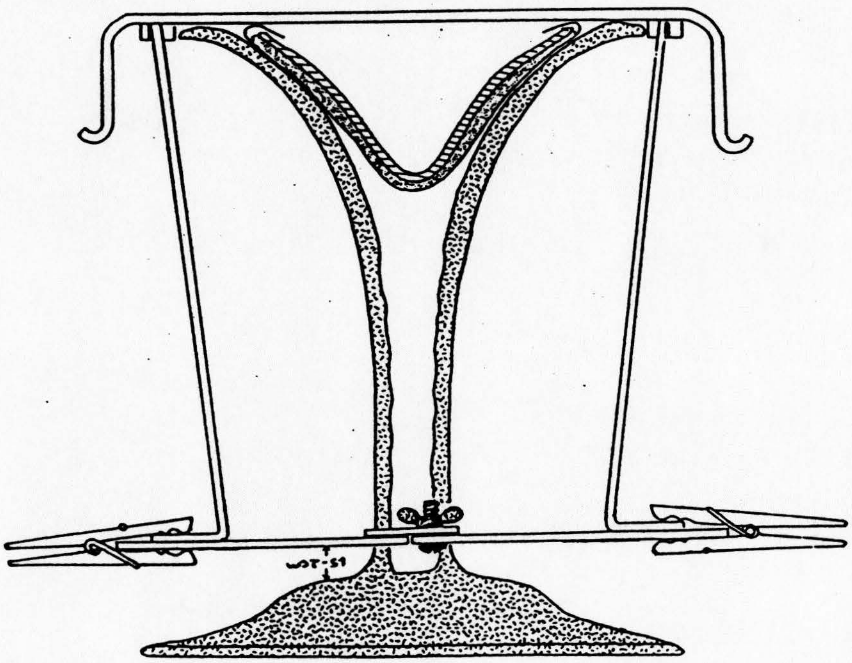

Fig. 101. Harappa: Attaching Legs to collar.

C. ASSEMBLY OF THE CAST ACRYLIC SHEET SUPPORT AND FINAL MOUNTING

1. Additional Materials for Assembly

4 clips or clamps (such as clothespins)
permanent marker (check for fastness to light and abrasion)

2. Procedure

a. Fitting

Centre the padded plaster support on the tray. Place the DOS on the Plaster support. Open the support collar and fit it around the stand of the DOS. Fit each leg into a bracket on the tray and clamp (using clothespins) the bent upper ends to the underside of the collar, as shown in Fig. 101. There should be a 1.5-2 cm space between the top of the collar and the underside of the dish of the DOS. Shorten the lower end of the legs if necessary. After the four legs are correctly fitted, the bent upper ends are then glued in position to the underside of the collar as follows. Remove the clamps one at a time; apply epoxy to the bent end, reposition the leg and reclamp each until the epoxy has set (allow 24 hours). Assign a number or letter to each leg and its matching bracket. Write the number/letter on each corresponding piece to ensure correct assembly. To avoid confusing various sections of different supports, write the accession number of the mounted DOS on each removable section.

b. Final Mounting of a DOS Vessel

Centre the padded plaster support on the support tray. Place the DOS on the plaster support. Open the support collar and fit it around the stand of the DOS. Close and bolt the collar. Place the lower ends of the legs into the corresponding brackets. Open the ring-shaped pad. Place the tube around the DOS below the dish component and resting on the support collar. Tie the tube to form a ring-shaped pad. The mounted DOS is depicted in Figure 93.

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