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CONSERVATION OF ASSYRIAN RELIEFS AT THE BROOKLYN MUSEUM

Tina March, Lisa Bruno, Hiroko Kariya, Won Ng, Ellen Pearlstein, and Helen Stockman

Abstract

Conservation of six monumental alabaster reliefs, four broken and two intact, weighing up to 3500 lbs. each, was carried out at the Brooklyn Museum after previous repairs and installation methods failed while they were being moved. The surfaces of all six reliefs were steam cleaned, followed by drying with acetone and ethanol. Cement from a former repair was removed mechanically from the surface with scalpels. The four broken reliefs were disassembled, cleaned of plaster repairs, and reassembled using epoxy. To stabilize the four broken reliefs during movement and reinstallation, a steel mount was attached to the back using bolts. The reliefs were installed in the galleries using a wall cleat with bolts or a turnbuckle system. Small chips of stone were reattached using B-72 in acetone. Ghosting from fill materials remaining on the surface and disfiguring scratches were toned with Liquitex acrylic emulsion paints. The joins were left unfilled.

1. Introduction

Twelve Assyrian reliefs in the Brooklyn Museum collection were installed in the galleries in 1956. Following standard masonry construction methods, they were installed in-situ, section-by-section, secured to each other and the wall with copper alloy pins and plaster. They remained in this location until 1990 when six of the reliefs were deinstalled so that construction in that area could be carried out. During the deinstallation, the joins of four fragmentary reliefs began to give way. It became clear that the previous restoration was not strong enough to remain stable during movement, and that the repairs would have to be redone. It was not until 2001 that treatment was carried out on the six deinstalled reliefs. In addition to surface cleaning, the goal of the treatment for the 4 broken reliefs was to structurally unify the fragments as a whole so they can be safely transported in the future without the joins failing. This treatment would include attachment to a backing/frame for support. While the treatment was fairly straight forward, the logistics of maneuvering, mounting and installing these objects became quite involved.

1.1 History

The monumental stone reliefs were part of the walls of the Northwest Palace of Ashurnasirpal II (883-859 B.C.), of the ancient royal city Kalhu, now Nimrud, in modern day Iraq. Other reliefs from this palace reside in collections that include the British Museum, the Louvre, the MMA, and the Oriental Institute at the University of Chicago (Paley 1976). British archaeologist Henry Layard found the site in 1840, and excavations began in 1845. The first shipment of material from this site was to the British Museum in 1846 (Layard 1849). Interest in this material had peaked, and in 1853 associates of Layard shipped a set of 13 reliefs to London for sale. These reliefs would eventually make their way to the Brooklyn Museum. The earliest documentation

refers to 13 reliefs, however one relief (BM 55.146) consists of joined separate upper and lower halves, now counted as a single object. Soon after their arrival in London, these reliefs were purchased by an American dealer named Henry Stevens. In 1855, he had them shipped to Boston, where they remained for several years until purchased in 1858 by James Lenox for the New York Historical Society. They were installed between 1858-9 on the ground floor of the NYHS building on 2nd Avenue and 11th Street (Dyson 1957). In 1912, the reliefs were moved from the Second Avenue building to the new location of the NYHS on Central Park West. Minutes from a meeting dated 1911 indicate that this move was to include “resetting the frames and fastening the broken pieces with bronze dowels” (NYHS 1911). Transparencies in the BM archives show the reliefs enclosed in frame units that overlap the relief edges (Fig. 1). Brown paint stripes on the surface parallel to the relief edges were noted prior to the most recent treatment, and are thought to derive from repainting these frames.



Figure 1. Archive image from the New York Historical Society showing frames overlapping the edges.

In 1937, as a result of a changing collecting mission at the New York Historical Society, the reliefs were placed on long-term loan at the Brooklyn Museum and installed in galleries on the third floor, dedicated to ancient cultures (Fig. 2). Note in this installation photograph, that there are no wooden frames surrounding the reliefs. It is unclear when these were removed, but presumably at the NYHS before their loan to BM (NYHS 1937). The museum was obligated to periodically update the Historical Society about the care of objects on loan to Brooklyn. Reports were made by then Curator of Egyptian Art at the Museum, John Cooney. The 1937/38 report referred to the stones being “washed with plain water, no solvents of any kind nor soap being



Figure 2. Installation at the Brooklyn Museum around 1937.

used” (Cooney 1937/1938; Fig. 3). The reliefs remained on view until 1949, when due to a changing mission in the gallery, the reliefs were boarded up in situ. The gallery was to become a space used for public lectures, and the Museum could not afford to hire a guard to be stationed in the space to protect the reliefs. Cooney’s 1949 report to the NYHS discussed the possibility of mounting the reliefs onto movable steel frames for display in another gallery space, however this was not done. They remained covered from 1949-54 until 1955, when the BM was able to purchase the reliefs, due to the generosity of Hagop Kevorkian (Nagel 1955). In 1956, the reliefs were installed in a gallery dedicated to Mr. Kevorkian, where they remained until 1990. It is noteworthy that photos of the installed reliefs published in 1957 (Fig. 4) show them without any fills in the losses, indicating plaster fills present prior to the recent treatment were applied some time after that date. These images also show residual material, likely cement, surrounding loss edges on the relief surface, which appears to relate to even earlier undocumented fills. Letters from 1858 in the NYHS Archives indicate that there was discussion of restoration and it is possible that this material relates to this time period (Stevens, B.F. 1858).



Figure 3. During treatment photograph at the Brooklyn Museum, around 1937. The left side has been washed with water.



Figure 4. Installation at the Brooklyn Museum around 1957. There are no fills in the break edges.

In 1966, a proposal was made to clean and coat the reliefs with a “permanent coating”; however no record of that treatment can be found in the Conservation, Curatorial, or BM Archives records (Bothmer 1966). Subsequent analysis of surface deposits by FTIR did not clearly support an applied coating. However, FTIR of brown resinous drips on the surface were identified as gutta percha (Martin 2001). This was also described by Prof. Sam Paley, an Ancient Near East specialist who published detailed information about the Museum’s Assyrian reliefs, as the material used to take impressions of the inscriptions (Paley 1976).

In 1990-91, Museum construction necessitated the deinstallation of six of the twelve reliefs. Contract riggers from More Specialized worked with museum conservators to transfer these reliefs to padded wooden A-frames that had been constructed so that they could be moved, with the reliefs on them, using a pallet jack (Fig. 5). This deinstallation provided insight into the 1956 installation methods. Following standard masonry construction techniques, the relief fragments were assembled on top of marble-clad I-beams in the gallery, using copper alloy dowels installed into oversized holes in join surfaces, and between the fragments and the wall. The approximately 6” gap between the relief backs and the wall was maintained by these pins embedded in plaster at the wall surface, and by filling the gaps between the side edges and the wall with a 2” thick layer of plaster. Newspaper had been used behind the reliefs to contain the inner edges of the plaster (Fig. 6).



Figure 5.
Deinstalled
reliefs resting on
A-frames, 1990.



Figure 6. Deinstallation of reliefs in 1990 showing 1957 installation techniques where the reliefs were pinned to the wall and secured using plaster.

2. Condition

The reliefs remained in storage in a closed gallery space on the A-frames until treatment could be carried out in 2001-2002 (Fig 7). The surfaces were grimy and had sustained graffiti and minor scratching and abrasion from years of open display in the BM galleries. The concrete around the break edges and the yellowed gutta percha residue were visually disturbing. Old installation paint was present on many of the edges. The plaster fills were cracked from deinstallation and were both unstable and unsightly, as they had discolored significantly over the years (Figs. 8,9).

3. Treatment

While surface cleaning was one of the goals of the current treatment, the primary goal was to reverse the old joins and structurally unify the fragments as a whole so they can be safely transported in the future without the joins failing. The six reliefs had remained leaning on their custom designed wooden A frames since deinstallation. The faces of the reliefs were visible, to allow for determining the cleaning methods first. The treatment was carried out in a closed

gallery without climate control or a ventilation system. Condition and treatment of each relief were recorded with photographic documentation.



Figure 7. Relief on A-frame in storage, 2001.



Figure 8. Detail of gutta percha residue.



Figure 9. Detail of cement along break edge.

3.1 Cleaning Tests

Although all stone samples were identified as alabaster using FTIR, the slabs have some visual differences that could divide them into two categories (Martin 2001). The first is a relatively uniform and fine-grained stone with a gray-brown appearance. The second type is an uneven

coarse-grained stone with a mottled, translucent appearance, containing large inclusions. Cleaning tests were carried out and differences between test results on both of these stone types were minimal. The following materials and methods were tested to remove surface dirt, grime and possible coating material.

3.1.1 Solvents

The following solvents on cotton swabs were rolled over the stone surface: deionized water, ethanol, acetone, petroleum benzine, xylene, toluene, deionized water with Orvus, a deionized water and ethanol mixture (1:1), a deionized water and acetone mixture (1:1), and 2% dibasic ammonium citrate (pH 8.4-8.6). Also rolled over the surface on swabs were the Keck mixtures, where Shellsol has been substituted for petroleum benzine: Keck I (acetone 10%, diacetone alcohol 5%, Shellsol 85%), Keck II (acetone 20%, diacetone alcohol 10%, Shellsol 70%), Keck III (acetone 30%, diacetone alcohol 30%, Shellsol 40%), Keck IV (acetone 30%, diacetone alcohol 20%, ethanol 10%, Shellsol 40%) (Kushel 2006). All the above solvents removed loose surface dirt to varying degrees while acetone and ethanol appeared to be best for removing embedded grime. Cleaning with deionized water followed by acetone was most efficient and effective. However, visually, the overall stone surfaces appeared only slightly cleaner.

3.1.2 Poultices

Two compositions of solvent gels, acetone gel (60 ml acetone, 12.5ml water, 2.5 ml Ethomeen and .75g Carbopol 934) and acetone/ethanol gel (100 ml ethanol, 100ml acetone, 13.6ml Ethomeen C25, 4g Carbopol 934), were applied to the surfaces with a Mylar cover. After 15-20 minutes, the gel was cleaned with Shellsol and iso-octane alternating with deionized water. It was difficult to completely remove residual gel (Wolbers 2000). Various Attapulgit clay mixtures were tested. Attapulgit with deionized water only, deionized water and Orvus, deionized water/ethanol (1:1), and deionized water/acetone (1:1) were applied to the surfaces with a tissue paper barrier. After drying completely, the poultice was removed and the areas were rinsed with the same solvents used in the poultice. Commercially available paint stripper containing methylene chloride (Zip Strip) was tested as well. The poultice cleaning was no more effective at removing surface dirt and grime as simple swabbing.

3.1.3 Steam cleaning

Steam-cleaning tests were conducted using the Robby VS3000 vapor cleaning system which can supply up to 40 psi of pressurized steam. The nozzle held at about 2-3" from the stone surface. Excess water on the surface was dried with cotton wadding. The surface was further cleaned with cotton wadding saturated with acetone and ethanol (1:1). This removed both dirt and grime better and more quickly than swabbing and poultice methods. However, care was required, especially when cleaning the coarse type stone, because its matrices and veins are vulnerable to loss. This was resolved by controlling the pressure and the distance between the steamer and the stone.

3.1.4 Removal of fill materials

Plaster fills in the joins were easily softened with deionized water. The cementacious material on the surface of the reliefs was unfortunately harder than the stone and was only minimally affected by water, organic solvents and dilute acid (pH around 2.5-3). Mechanical cleaning using an electric engraving pen/tool, fitted with a stainless steel point was found to be effective in reducing thick areas. A scalpel was also useful in reducing the material close to the stone surface.

3.2 Surface Cleaning

Based on the above tests, steam cleaning followed by acetone/ethanol (1:1) in cotton wadding was found to be most efficient and effective in removing surface dirt and grime. This method also minimized exposing the stone to excess water and exposing conservators to excess solvents in an unventilated workspace. The decorated surfaces of all six reliefs were cleaned as follows. An area to be cleaned (approximately 1 foot square) was steam cleaned, followed immediately by wiping the surface with cotton wadding and/or Webril cotton lintless sheets saturated with an acetone/ethanol mixture (1:1). The use of acetone and ethanol not only removed additional grime and old paint residue, but also hastened drying of the water. The distance of the steamer nozzle from the surface of the reliefs was modified as required to provide the best results. This process was repeated until the surface was cleaned to the desired degree. Some areas of overpaint from the previous treatments were reversed with water. The cementacious fill materials were removed mechanically using a scalpel blade and electric engraving tool.

3.3 Reversal of Previous Structural Treatment

Upon completion of the surface cleaning, the reversal of the previous joins was the next step in the treatment of the reliefs. Engineers and riggers were consulted regarding the possible methods and techniques of join reversal, including vertical disassembly. Although unstable due to the weight of each broken section of a relief, the joins remained firmly in place. The decision was made that in order to keep within the budget and time frame of the project, the joins of the reliefs would best be reversed when flat and face down. The riggers were especially helpful with suggestions regarding the tools and equipment necessary for separating the fragments. Before rigging the reliefs flat, the museum's architect, working with consulting structural engineers from Robert Silman Associates, P.C., confirmed that the load capacity of the workspace floor was adequate to accommodate all four of the fragmentary reliefs.

Contract riggers from More Specialized placed the reliefs flat, face down on padded wood pallets that were elevated to a comfortable working height with timber blocks. Before moving, the front surface of the reliefs were covered for protection with a layer of heavy gauge Mylar, followed by a layer of 1" thick polyethylene foam. Sheets of ultra high molecular weight polyethylene (UHMW) were placed on top of the foam. The UHMW polyethylene provides a slick, friction-reduced surface to assist in sliding the fragments of stone once separated. A second layer of Mylar was attached to the top surface of the wooden pallet with staples (Fig. 10). The pallet was then positioned against the padded face of the relief and secured with nylon straps.

The riggers winched this stone/palette package up off the A-frame using chain hoists hung on a mobile gantry positioned over each relief. The blocks of timber were strategically positioned to support the palette, as it was lower to the horizontal position. The backs of the reliefs were now exposed and accessible for treatment (Fig. 11).

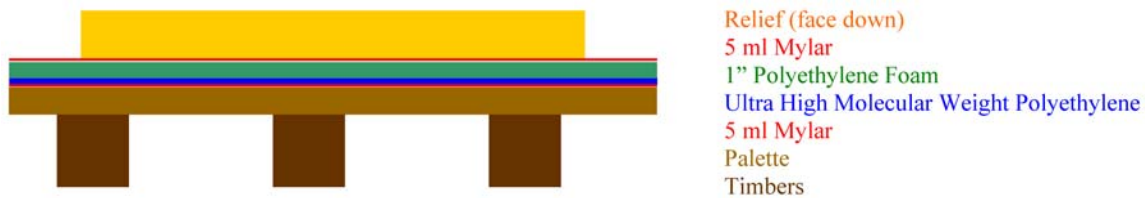


Figure 10. Relief package.



Figure 11. Reliefs are rigged, face down.

The minimal plaster fills present on the back edge of the break lines were removed mechanically using various small tools. High-density nylon and acetyl wedges were cut and shaped from bars of each type of plastic. Each wedge was approximately 11" long, 1 3/4" wide, with a thickness of 3/4" tapering to less than 1/16". These wedges were used with dead blow hammers to separate the stone fragments once the bulk of the fill plaster was removed. Hard plastic was chosen over wood or metal on the advice of the various riggers consulted. The plastic was less likely to damage the surface of the stone than a metal wedge, and the plastic being a harder surface was less likely to compress than wood, which could also abrade the soft stone surface. While working with these plastic wedges, nylon was the preferred material. Acetyl was often too brittle and would chip at the thin end. The various gaps and losses along the break edges allowed for insertion of the thin wedges. The force of repeated hammering alternating between multiple

wedges in sequence was sufficient to separate the joins. This indicated that no structural adhesive had been used in the assembly of these fragmentary reliefs. As the joins parted, short metal copper alloy pins were found in drilled holes along the joins. These were also secured only with plaster and they were removed after mechanically reducing the plaster. Simple wooden benches, made in the museum's carpentry shop, the same height as the palettes, were used as extra working space onto which the now separated fragments could be slip so that the break edges could be accessible for cleaning. Also, a hydraulic lift allowed us to move small relief sections out of the way completely when necessary. Sheets of the UHMW polyethylene were used to assist in the movement of the fragments.

The backs and edges of the fragments were cleaned of dust and grime, plaster, and gallery paint. Vacuuming was done overall. Typically, the plaster was softened with water and mechanically picked off using a scalpel blade. Brushing was sometimes necessary to access plaster imbedded in the recesses. Paint residue from previous gallery painting was removed with various organic solvents. When the backs and edges were cleaned, the riggers returned to flip the fragments face up. Many of the separated fragments, due to their relatively small size could be turned over by hand. The gantry was used to turn the largest fragments. The fragments were now ready for re-joining and mounting.

4. Introduction to the Remounting

Structural engineers were consulted on a preliminary basis to advise on a mounting system for the reliefs. In general, the discussions centered around the belief that only pinning and adhering the fragments together with adhesive would not achieve structural stability. A backing or a custom frame attached to the object would be necessary to achieve structural stability.

4.1 Considerations for Reinstallation

Because the other six reliefs had not been removed from the galleries in 1990/91, there was a desire to have continuity in the presentation of all twelve reliefs. The six reliefs remaining in the galleries are essentially flush against the wall, with the sides of each relief exposed. The space between the back of each relief and the wall had been filled with plaster and painted the wall color. This meant that for the six re-installed reliefs, the structural backing could not be visible at the sides. The reinstalled reliefs should also be relatively the same distance from the wall as the existing installed reliefs. Finally, the newly conserved reliefs should be the same height as the reliefs in the gallery. The reliefs that remained in the gallery had been placed on I-beams, set into a bedding material, so that the reliefs could be leveled and the top edges were in alignment.

Initially, the use of aluminum honeycomb panels as backing support for the reliefs was investigated primarily because it is a strong, lightweight, rigid material that had been successfully used to remount large heavy mosaics (Blackshaw and Cheetham 1982; Sweek et al. 2000), and by the Museum of London to back their Assyrian reliefs (Stockman-Todd 2002). According to the preliminary discussions with engineers, if aluminum honeycomb was used as a backing, the reliefs would need to be completely backed, however, the reliefs are larger than the largest honeycomb panel manufactured at the time. The panels for our reliefs would need to be

made by joining separate panels together at the factory. They would then need to be attached to the backs of the reliefs, either with an adhesive or by means of a mechanical attachment. As using an adhesive would completely obscure the backs of the reliefs, mechanical attachment by drilling into the stone was investigated. Because the thickness of each relief is not uniform and the surface of the backs are uneven, the mechanical attachment had to be adjustable to enable leveling of the honeycomb panel. The honeycomb panel needed a certain minimum number of attachment points, uniformly distributed across the surface, and not at a join of two honeycomb panels, to insure that there would not be a point of weakness in the panel itself. On the relief, the attachment points could not fall at or along a break line. These points of attachment would have to be pre-determined so that holes for the hardware could be drilled in the honeycomb by the manufacturer, as they did not recommend self drilling into the panels. A cleat would need to be attached to the back of the honeycomb panel to secure the relief to the gallery wall during installation. With all of these factors to consider, mechanically attaching the panel to the relief had become quite complex. Additionally, the thickness of the relief and backing package would exceed the current installation parameters of the six reliefs that remained on display.

The use of a steel mount or framing system was then researched. According to the preliminary discussions with engineers, the simplest method to structurally mount these reliefs would be to construct a metal frame around the reliefs, holding all of the fragments in place. This would have been ideal, in that no mechanical attachment or drilling was required, and likely was the reason for the frame around the reliefs when they were at the NYHS. Unfortunately, this did not fit our design parameters, as the frame would be visible around all sides. However, a metal mount could be mechanically attached to the back of each relief, designed to span the breaks only. Most of the back of the relief would remain visible. The profile could be designed to be minimal to mimic the current installation, yet provide the needed structural support for each relief. The specifics of the mounting will be further discussed in the treatment section.

4.2 Consideration of Methods of Reassembly

Various options for reassembly of the fragmentary reliefs were considered. Ultimately, it was decided to reassemble the fragments horizontally, face up on the wood palettes. Had we chosen to assemble the fragments vertically, we would have needed outside riggers for an extended period of time. This would have proven to be both time consuming and expensive. By assembling the fragments horizontally, the work could be performed in-house, on the already existing palettes, and time could be taken to ensure that adjoining fragments aligned well. It would keep the cost of the project within budget, while taking advantage of equipment on hand.

Test-fitting the fragments was conducted before the actual reassembly. All of the fragments were moved manually by the objects conservation staff, greatly aided by the slick surfaces of the Mylar and UHMW Polyethylene sheeting. Due to the uneven backs of the reliefs, the face of each fragment was usually not level and would rest at a slightly different height creating steps at the join line. Wood and plastic wedges were used to level out individual sections to ensure proper alignment, and wedges were secured to the back of the relief with microcrystalline wax where necessary to prevent them from becoming dislodged while moving the fragments into position. Their positions were mapped out on the pallet.

5. Structural Treatment

Since the support backing was designed to attach to the back once the reliefs were vertical, the goal of the structural treatment was to stabilize the joins so that they could withstand the force of being rigged from horizontal to vertical.

5.1 Adhesive and Pins

As the previous joins using plaster and copper alloy pins were clearly not structurally strong enough to withstand any movement, structural epoxy was considered. Desirable qualities in this adhesive were: a record of acceptance for conservation use, a pot life with a long enough working time to get all fragments aligned and leveled at once, a neutral color, to be of sufficient viscosity to remain in the location applied and also serve as a gap filler where there are significant gaps between the fragments, to be easy to mix with a simple epoxy:hardener ratio, and finally, be financially feasible and available in large quantities. The following four epoxies were explored and tested after a literature search: Sikadur 32, Hi-Mod LPL (high-modulus long pot life) by Sika, Sikadur 35, Hi-Mod LV LPL (high-modulus, low-viscosity, long pot life) by Sika, Araldite AY103 with HY991 by Vantico, Araldite 2011 by Vantico.

The Araldite 2011 by Vantico was selected because it met most of our requirements. This epoxy has a medium viscosity, golden honey color, a 2-hour pot life, 50/50 volume-mixing ratio, and is available in a variety of sizes with no minimum order. It is composed of a bisphenol A epoxy with an amine hardener.

Although the engineer suggested that the use of pins between pieces would contribute little to strengthening of the joins, we selected to use pins in strategic positions as an added precaution. Our goal was to use the extant dowel holes and not drill new ones. Ease of removal of the pins we applied now was important in the event they need to be removed in the future. Therefore, instead of securing the pins in place with an adhesive, we used pressure fit epoxy and bulked B-72 sleeves (Krumrine and Kronthal 1995). The holes identified to be used for pins were coated with two coats of 10% Acryloid B-72 in acetone, lined with a paste composed of 60 ml 20% B-72 in acetone, 40g cellulose powder slightly dampened with acetone, and 3g fumed silica. The lining was lightly sanded to a smooth finish when dry. Preparation of the selected holes proceeded with inserting Pliacre epoxy putty into the hole on one side of the break edge at a time. While the putty was still soft, a pre-measured 1/4" diameter stainless steel pin, covered with Vaseline, a petroleum jelly, then plastic wrap, was inserted into the Pliacre. The two sides of the adjoining fragments were pushed together and the Pliacre was allowed to set. Once set, the pin was removed, and the corresponding hole on the adjoining fragment was prepared with the Pliacre in the same manner. When the second side was set, the pin was removed and cleaned of the barrier layers, and then repositioned in the hole to await assembly. This procedure was followed for all pins used in the four reliefs requiring assembly.

5.2 Assembly

The edges to be joined were coated with 2 coats of 10% B-72 in acetone and allowed to dry for 2 weeks. A recently published study had shown that the B-72 layer was unlikely to significantly undermine the strength of the epoxy in a structural join, and would aid in its reversal when necessary (Podany et al. 2001). One relief was assembled at a time. The epoxy was mixed in plastic containers using wood tongue depressors and applied with a brush onto one section at a time, to both sides of the adjoining break edge. Mylar strips had been placed under each edge of the stone to catch dripping epoxy. Just before pushing the two adjoining sections together, the Mylar was removed. Extra care was taken when fragments with pins were being joined to ensure good alignment. This process continued until each fragment was in place. Wedges were added as necessary to level or hold pieces in the desired position. This process was used for all four fragmented reliefs. Even with the multiple test assemblies performed prior the actual adhering together of the fragments, additional adjustments were necessary in the final assembly since not all activities could be precisely replicated (Fig. 12).

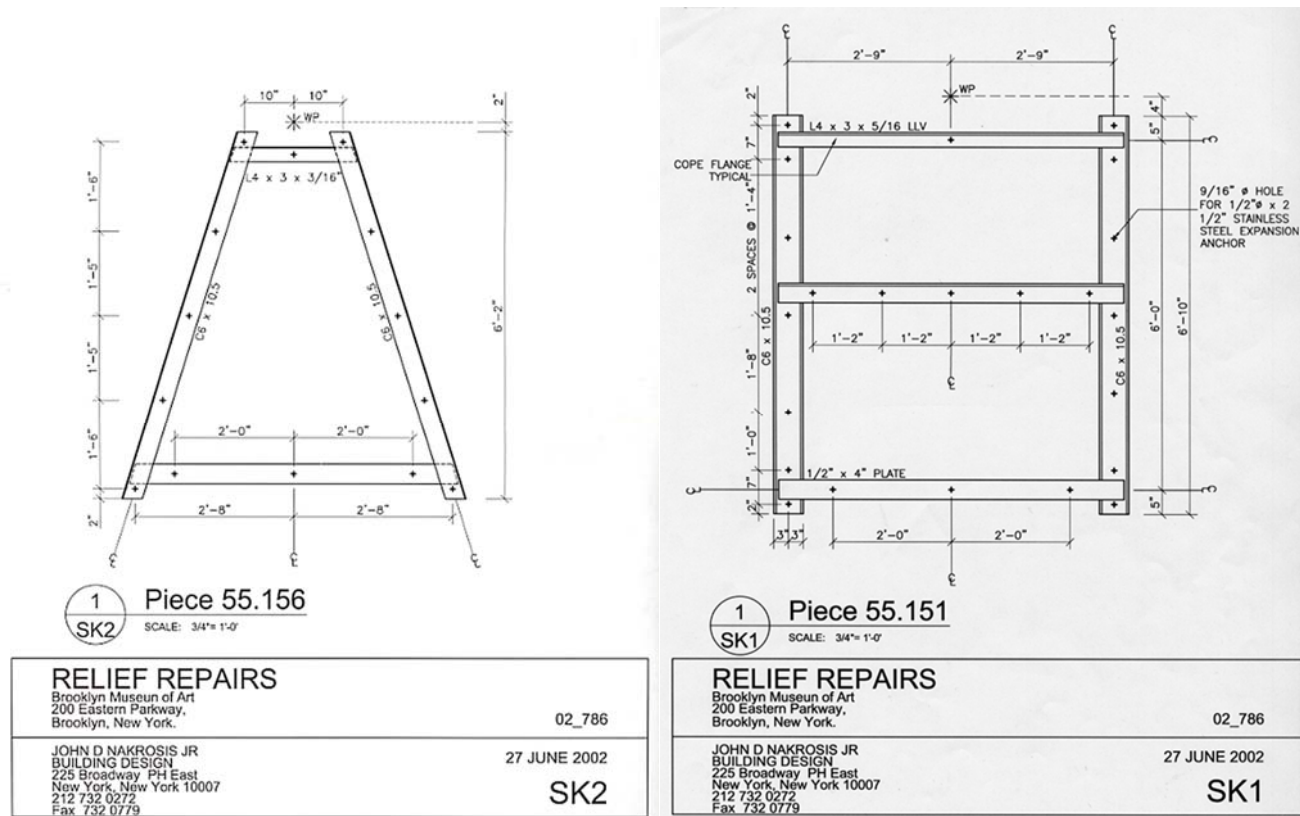


Figure 12. Horizontal assembly of reliefs.

6. Backing Support

The final design chosen for a support was a steel structural backing, which was secured mechanically to each fragment of the four broken reliefs. The backings, designed by John Nakrosis of Nakrosis Building Design, were customized for each of the reliefs, the shape determined by the configuration of the breaks (Figs. 13,14). As determined by the engineer, the steel backing was attached to each fragment with at least two bolts. The backing members were made out of a combination of C6 x 10.5 or C4 x 7.25 steel channel, and L4 x 3 x 5/16 LLV. The steel backings were fabricated by D.V.S. Iron works. Holes were predrilled for the bolts used to attach the backing to the relief. The horizontal top section of each backing was used as the

connecting piece to a steel wall bracket that secured the reliefs to the wall. Since the backings were attached to the reliefs while vertical, steel hooks were welded to the top of the backings so that they could hang from the reliefs while we were working. The backings were coated with a neutral grey paint by the manufacturer to inhibit rusting. The two unbroken reliefs did not require a backing.



Figures 13 (left) and 14 (right). Backing designs by John Nakrosis.

7. Rigging the Repaired Reliefs Upright

Two of the repaired reliefs were rigged and returned to the A-frames without incident. These reliefs were strapped to the palette with nylon straps padded with Ethafoam. This package was winched up by chain hoists hung on a mobile gantry and placed on the A-frame, face in, in preparation to attach the backing. A third relief, 55.156, presented more of a problem. As the package was lifted, the adhesive joins failed instantly. The package was immediately placed back on the timber blocks. Neither injuries nor new breaks occurred, but this relief would have to be reassembled. The lifting method for the final fragmentary relief was adjusted to avoid more joint failure. In order to counter the inward pressure of the straps on the relief as it was winched, the face of the relief was sandwiched by covering with 1" Ethafoam followed by a large plywood board (Fig. 15). The lifting of this more rigid package was successful.

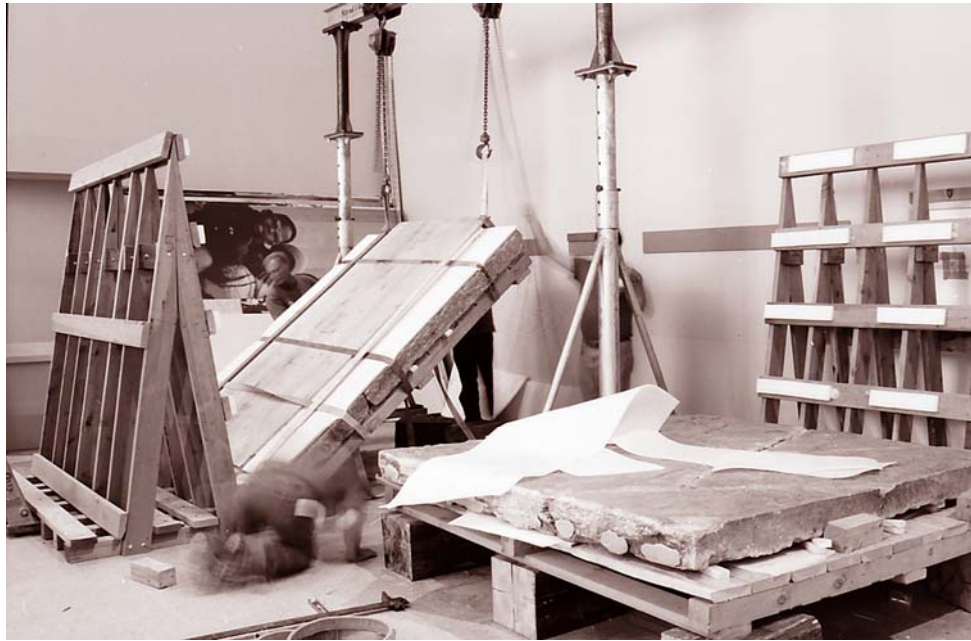


Figure 15. After assembly, reliefs get rigged upright onto A-frames.

7.1 Re-Treatment of 55.156

The cause of the joins failing was a very simple one. As we took the sections apart, we realized there were very few points of actual contact between these pieces. The epoxy we used did not have enough bulk to fill the gaps between the stone. In areas where there was contact, the epoxy sheared off the break edge with very little stone being pulled off. The break edges were prepared by mechanically removing the little epoxy that was in contact with the stone surface with scalpels and small chisels. Acetone was selectively used on the epoxy to assist in the mechanical removal.

Although various options for repair were discussed, it became clear that we would need to reassemble the relief the same way, horizontally, but using a more highly bulked epoxy. After investigating more viscous Araldite epoxies, Araldite 2013 was chosen for the re-treatment. This is a paste epoxy, grey in color, 1-hour pot life, 50/50 volume mixing ratio.

After assembling as before with this new epoxy, the relief was strapped around its perimeter to hold the sections together while the epoxy cured. Straps had also been placed around the relief in a grid pattern, and these were cinched to hold the fragments in place.

When the riggers returned to flip the relief, the straps conservation put on remained in place. The rigid sandwich was reconstructed as before using plywood and Ethafoam and the relief was successfully raised and placed on its A frame.

When viewing the reliefs from the back, it was apparent that there were large gaps in the break edges. Additional filling with the Araldite 2011 epoxy heavily bulked with fumed silica

(approximately 1:2 epoxy: silica) was conducted to reinforce the joins where edges are thin (Nagy 1998). The bulked epoxy could be rolled into coils and pushed into the voids by hand or with small tools. Occasionally, additional fumed silica was added while working to maintain this dough-like consistency.

8. Attachment of Backing

Various fasteners were investigated for attaching the steel backings. Working with our structural engineer for the project, John Nakrosis, we chose the Wedge-Bolt by Powers Fasteners. The wedge bolt is a one-piece anchoring device with a dual lead thread. It is easy to install, removable, has good load performance and is vibration resistant. The fact that this was a one-piece system and removable was very appealing. With the other anchoring systems, the bolt itself could be removed, but the sleeve would remain imbedded in the relief unless drilled out.

Before attachment, the backings were padded with 2-3 layers of ¼" Volara foam adhered with PVA-AYAC in toluene. With the aid of several art handlers, the backings were placed on the backs of the reliefs, being held in position by the hanging hooks at the top. Wooden blocks, used as shims, were placed under the hooks in order to raise and level the backing to the appropriate location for each relief. Once the correct position was achieved, straps were placed around the backings and reliefs to help hold them in place. The predrilled holes in the steel members were used as guides for drilling the holes into the stone. Conservation drilled ½" diameter holes into the stone using a special Wedge-bit fitted in a hammer drill. Teams of two conservators were used for this process. While one person drilled, a second would gauge the drill insuring the desired angle of entry was maintained. The engineer advised that a minimum of 1 ½" was necessary for the drilled holes to provide sufficient depth for secure anchoring of the bolts. The bolt length used in any one location was determined by the thickness of the stone in that area and the distance of the back surface of the stone to the backing. Depending on the length of a bolt used in a given area, the drilled hole depth in the stone was a minimum of 1 ½" but deeper at times depending on the thickness of the stone. The holes were vacuumed of the stone dust, and the bolts inserted. (Fig. 16)

At the recommendation of the engineer, once all bolts were inserted, Pliacre epoxy putty discs, approximately 4" in diameter, were placed around the bolts between the backing and the stone, to make up for gaps and to help support and distribute the weight of the backing and the tension on the bolts. Mylar (1 ml.) squares were used as separators between the Pliacre and left in place. Once the Pliacre hardened, the bolts were tightened. The hanging hooks on the top of the backings were then removed by cutting with a small angle grinder.



Figure 16. Backing in place with hanging hooks at top.

9. Installation Considerations

As previously mentioned, the height of all the newly backed reliefs had to be consistent with the installation of the six reliefs that had remained on display. W-beams (wide-flange beams) were used to raise the reliefs off the ground to bring them to single height uniformity. W-beams were used over I-beams because their extra wide flange provided more surface area for the reliefs to rest upon. Once in place, the W-beams would then be clad in granite to disguise them and visually match the existing installation. As all the reliefs are a unique height, the height difference between each relief in the previous installation had been compensated for with plaster applied to the I-beams. Rather than using plaster, we made up the height difference with Medex boards, a brand of fiberboard, which sat on top of the W-beams. These boards were made up of layers of $\frac{1}{2}$ " – $\frac{3}{4}$ " thick Medex laminated together with a piece of 1" thick, 9 lb. high density Ethafoam hot glued to the top of the Medex stack. Although this is a very dense piece of foam, we hope it will provide some cushioning for the bottom edge of the stone. The amount of Medex layers varied to achieve our target height for each relief. The beams and boards were done in sections with gaps left in between, not as a single long piece, to allow the riggers to get straps or a forklift underneath the stone during installation.

9.1 Anchoring to the Wall

The designs for attaching the reliefs to the wall were also discussed with the structural engineer. They were designed in such a way to allow for adjustment during installation, thus ensuring the

faces of the reliefs were plumb to the wall. For the four reliefs that required the backing attachment, an L-shaped steel wall bracket was made. The long leg would be attached to the wall and the short leg would meet the short leg of the L-shaped angle on the top of the backing. Pre-drilled holes on both short legs would be lined up, and a bolt inserted to hold them together. For the two reliefs without a backing, a different system was devised. We did not want to drill unnecessary new holes into the backs of these reliefs, therefore we chose to use the existing holes along the top edge of each relief. An L-shaped rod, attached to the wall, would pivot downward into the holes once the relief was in place between the backing and the wall attachment. The excess space in the holes around the rods would be filled with Pliacre epoxy putty. Both the brackets and L-shaped rods were installed into the wall with Hilti brand fasteners (Hilti HIT Adhesive Anchoring System). These fasteners are compatible with the wall structure, which is a hollow, concrete masonry block. This system consists of bolts screwed into an internally threaded insert placed in the wall and secured with an epoxy system formulated for concrete.

9.2 Installation

The riggers returned to install the reliefs, which involved the use of 2 gantries, a forklift, a palette jack and a J-bar. Each relief was strapped with loops at the top. The arms of the forklift slipped through the loops of the straps overhead. The relief was lifted straight up, and moved into place, over the W-beams, with the assistance of riggers guiding it into place. Conservation staff adjusted the placement of the W-beams as needed. Once everything was in place, the bolts were simply slid into place. Fine adjustments could then be made. If one side needed to move slightly forwards or backwards, it was adjusted using a J-bar, while holding the other side in place (Fig. 17).



Figure 17. Installation, 2002.

Medex shims were added or removed from the W-beams to level while lifting an edge with the J-bar. Also, further adjustments were made to bring the face of the relief into plumb. For almost all of the reliefs, they were leaning slightly backwards at the top. To compensate, the screws in the threaded inserts were loosened, resulting in the wall plate moving forward with the relief. The resulting gap between the wall plate and the wall was filled with finger shims cut from Medex (Fig. 18). This basic process of installation was carried out for all four reliefs with backings.

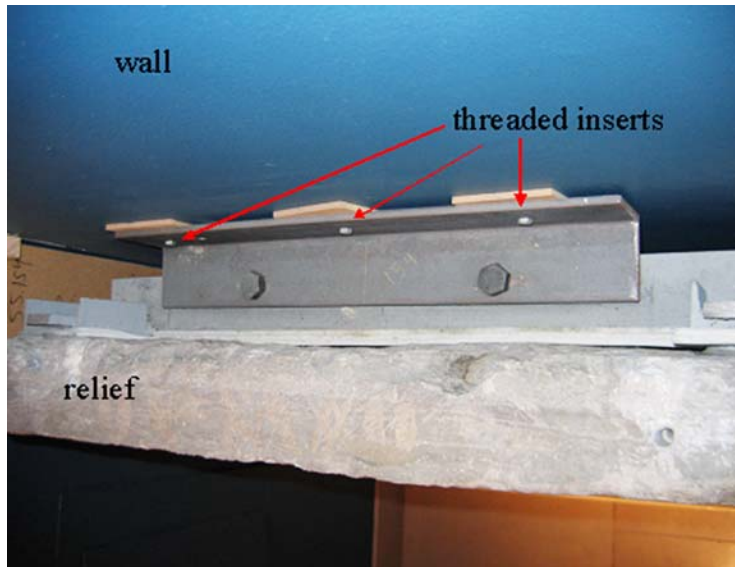


Figure 18. Installation, attachment to wall.

The two reliefs without backings followed the same basic adjustment routine; the only difference being how they attached to the wall. For these, a turnbuckle system was used. On one end is a straight rod which screws into the threaded wall insert. On the other end is a left hand threaded L-shaped rod. The L-shape rod fits into existing holes along the top of the relief. The excess space in the hole was lined with Mylar and filled with Pliacre. Once the Pliacre cured, the turnbuckle was turned to make additional adjustments to the plumb. Although this was a somewhat tedious process, the concept is very straightforward, easily reusable, and most importantly, it enabled us to use pre-existing holes in the relief for installation.

10. Compensation

Granite kick plates were fabricated and installed by an outside contractor. The reliefs had approximately 6" gaps on the left and right sides between the back edge and the wall, and of varying height along the bottom edge, which needed to be filled. As discussed before, in the 1950's installation this was done with plaster. We shaped ¼" Medex to fit into this void. After a rough cut was made to get a basic shape, the edges were further shaped with a Dremel tool for a snug pressure fit (Fig. 19). The boards on the side were painted the color of the gallery walls, as specified by the Design Department, and the area between the relief and granite, also filled with the shaped Medex, was painted a neutral beige.



Figure 19. Medex “fills” between relief and wall.

After installation was complete, the surfaces of the reliefs were vacuumed with a soft brush and lightly wiped with acetone and ethanol on Webril wipes to remove any dust and grime that resulted from installation. After discussion with the Curator, Jim Romano, it was decided not to fill the break edges or compensate for losses. However, it was decided to tone out any remaining concrete and plaster ghosting along the break edges. Also toned out were any major disfiguring scratches. Liquitex acrylic emulsion paints were used (Fig. 20).

11. Conclusion

The process of working closely with a structural engineer and art riggers during the treatment phases of such large objects proved invaluable, especially when dealing with budget and time constraints. The expertise of these two groups greatly assisted in the creative problem solving processes that conservators often undertake when facing less than ideal working circumstances. Our goal of stabilizing the reliefs was carried out with a relatively simple and inexpensive backing and installation design that can be easily removed and reused in the future, should the reliefs be deinstalled again.



Figure 20. After Treatment, 2002.

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Consultants

Preliminary designs for backing system and general mounting advice provided by Dave Geiger, Geiger Mountmaking and Design, Inc., 2407-2413 Third Ave. 1R, Bronx, NY 10451.

Advice on separating and moving fragments provided by Bob Eberheim, Eastern Rigging Supply Company, Inc. Box 39, Cos Cob, CT 06807-0039

Engineering Consultant for mounting and installation provided by John D. Nakrosis Jr., Building Design, 225 Broadway PH, NY, NY 10007

Engineering Consulting for Brooklyn Museum provided by Robert Silman Associates, P.C., 88 University Place, NY, NY 10003-4542, www.rsapc.com

Suppliers

Iron Frames:

DVS Iron Works, Inc. 117 14th Street, Brooklyn, NY 11215

Ultra High Molecular Weight Polyethylene, nylon and acetyl bars and stainless steel rods, dead blow hammers:

McMaster-Carr, P.O. Box 440, New Brunswick, NJ 08903-0440, www.mcmaster.com

Pliacre (Phillyseal R – Rat Seal):

ITW Philadelphia Resins, 130 Commerce Drive, Montgomeryville, PA 18936

Rigging:

Eddie McAveney of More Specialized Transport, 145-147 Myer Street @ R. R. Avenue, Hackensack, NJ 07601

Araldite 2011, 2013 epoxy resins:

Vantico, 4917 Dawn Avenue, East Lansing MN 48823-5691

Engraving tool/pen:

Sears Craftsman or Dremel brand. Dremel tools available at hardware stores.

Robby VS 3000 Chemical free steam cleaning machine:

Robby Vapor Systems, Inc., 8930 State Road 84 #323, Davis, FL, 33324

Powers Fasteners:

Tanner Bolt and Nut Corp., 4302 Glenwood Road, Brooklyn, NY 11210, (www.tannerbolt.com)

Fasteners:

Hilti Inc., 5400 South 122nd East Ave., Tulsa, OK, 74146, (www.hilti.com)

Orvus WA Paste, Webril Wipes, PVA, Volara foam:

Talas, 20 West 20th Street, 5th Floor, NY, NY, 10011, (212) 219-0770

Zip Strip:

manufactured by Star Bronze, PO Box 2206, 803 S Mahoning Ave, Alliance, OH, 44601, (800) 321-9870, available at local hardware stores

Ethafoam (Polyethylene closed cell foam planks, 9lb.):

Atlas Material Inc., 116 King Street, Brooklyn NY, 11231, (718) 875-1162

Hydraulic Scissor Lift, GL168076:

Global Industries Equipment, 22 Harbor Park Drive, Port Washington, NY, 11050, (800) 645-2986

References

Blackshaw, S., and H. Cheetham. 1982. Foaming epoxy resin – a useful mounting medium for conservation. *Studies in Conservation* 27:70-74.

Bothmer, B. 1966. Personal communication with Miss Marjorie Kevorkian. The Brooklyn Museum, Brooklyn NY.

Cooney, J. 1937/38, 1949. Reports from Brooklyn Museum to New York Historical Society. The Brooklyn Museum Archives, Brooklyn, NY.

Dyson, R.H. 1957. A gift of Nimrud sculptures. *The Brooklyn Museum Bulletin* 18(3): 1-23.

Krumrine, C., and L. Kronthal. 1995. What a relief! A practical inexpensive approach to the conservation of a large 19th dynasty sandstone stele. In *Conservation in Ancient Egyptian Collections*, ed. C.E. Brown, et al. London: Archetype Publications. 153-163.

Kushel, D. 2006. Personal communication between Tina March and Dan Kushel, Distinguished Teaching Professor, Buffalo State College, confirming the Keck mixture lore.

Layard, A. H. 1849. *Nineveh and Its Remains*. New York: G. P. Putnam.

Martin, J. 2001. Unpublished report of analysis of stone samples and gutta percha residue from Assyrian relief, Orion Project #978. The Brooklyn Museum Archives, Brooklyn, NY.

Nagel, C. 1955. Personal communication to Robert Vail, Director of the New York Historical Society. The Brooklyn Museum Archives, Brooklyn, NY.

Nagy, E. E. 1998. Fills for white marble: properties of seven fillers and two thermosetting resins. *Journal of the American Institute for Conservation* 37:69-87.

New York Historical Society Executive Committee Minutes. 1911. NYHS, NY.

New York Historical Society Loan Agreement. 1937. Brooklyn Museum, NY.

Paley, S. 1976. *King of the world: Ashur-nasir-pal II of Assyria 883-859 B.C.* Brooklyn, New York: The Brooklyn Museum.

Podany, J., K. M. Garland, W. Freeman, and J. Rogers. 2001. Paraloid B72 as a structural adhesive and as a barrier within structural adhesive bonds: evaluations of strength and reversibility. *Journal of the American Institute of Conservation* 40:15-33.

Stevens, B. F. 1858. Personal communication to George H. Moore. New York Historical Society Archives, N.Y.

Stockman-Todd, H. 2002. Personal communication to Lisa Bruno, Objects Conservator, The Brooklyn Museum, Brooklyn, NY.

Sweek, T., A. Middleton, C. Johns, and K. Uprichard. 2000. The materials, conservation, and remounting of the Hemsworth Venus mosaic. *The Conservator* 24:40,61-68.

Wolbers, R. 2000. *Cleaning Painted Surfaces Aqueous Methods*. London, U.K.: Archetype Publications.

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