

Restoration Method for the Facade of Jahangir's Tomb, Shahdara, Lahore

M. Y. Awan¹ and N. S. Kazmi²

¹ Department of Architecture, University of Engineering & Technology, Lahore, Pakistan

² Technical Education and Vocational Training Authority Punjab, Lahore, Pakistan

Abstract

Historic buildings have their own specialized and traditional techniques used in their construction. These are not generally practiced in modern buildings. Working with stone is very technical, laborious and time consuming job. It needs sensitivity and perfection both at workers and supervisor level. It is required to prepare different stone members in exactly the same size, proportion and design according to the requirements of location. To discharge conservation responsibility efficiently and effectively, one has to be conversant with the methods for restoration of stone masonry.

This paper describes and examines the method involved in the restoration of stone facade of Mughal Emperor Jahangir's Tomb. Method, as considered here is a sequence or process of treatment of the raw material, from beginning to end of work. The southern facade of Jahangir's Tomb was being restored in the year 2004 by the Department of Archaeology and Museums, Pakistan. Thus there was an opportunity to systematically document the method of restoration at this monumental building of the Mughal period.

Any work of stone passes through a series of steps, from obtaining the material to final placement of stone member in a building. Working on stone is a subtractive technique. A stone worker can only subtract more stones to correct his mistakes. Therefore all techniques of stone working are based on the need to avoid breaking the stone or removing the material that may be needed later.

Key words: Tomb; Facade; Process; Tools; Restoration; Carving; Chiseling; Motif

1. Introduction

The Jahangir's Tomb at Shahdara (Figure 1) may be regarded as pride of Lahore. It represents one of the important monuments of Mughal period. Jahangir's tomb was built on the site of Bagh-i Dilkusha, a garden previously laid out by Emperor Jahangir's wife, the empress Nur Jahan. The tomb was constructed on orders from Shah Jahan after his father's death in Kashmir in late 1627. It took ten years to build and was completed in 1637 AD, at a cost of Rupees ten lac. The tomb rests on a high podium and is surmounted with tall minarets on all four corners [1].

The mausoleum is considered next to Taj Mahal in ornamentation and embellishment, especially for its pietra-dura work for interior decoration, marble inlay in red sand stone facade and zigzag pattern formed by inlaying of different coloured stones in the corner minarets.

The building of Jahangir's tomb suffered much at cruel hands of the Sikh rulers, who stripped it off most of its ornaments [2]. Jahangir's tomb was also used as railway depot during the British period [3]. The Shahdara gardens were identified as "objects of antiquarian interest" in 1857 and later designated as "protected monuments" [4].

The building was originally constructed with red sand stone available in India. Thus the stone for restoration work is always required to be imported from India for similar quality. This stone was imported from India in 1980 and never afterwards.

The master plan for restoration of the Tomb building is under way. Repair of the stone inlay work on the southern and eastern facades is now complete and work on the northern facade has begun.



Figure 1: A view of Jahangir's Tomb, Shahdara, Lahore

The process / restoration method of facade consists of about 14 steps. This paper is based on systematic recording of these steps involved during restoration of stone works at the tomb of Jahangir during the year 2004. During the recording, it has also been considered appropriate to include the local terminology being used by the craftsmen and conservation workers. After explanation of the process of 14 steps, mortar used for installation of the stone members has also been discussed. At the end conclusions are drawn.

2. Techniques & Process

The method of restoration is documented here and the series of work process involves following steps:

2.1 Selection of Target Area

After identification of causes of decay and condition of deteriorated parts of building, the first step is to fix the priority that which stone member(s) need immediate replacement. A complete documentation is essential before restoration, in the form of photographs, drawings, video etc (Figure 2). Detailed measurements are necessary for preparation of new stone members for restoration work.

2.2 Selection of Stone

While selecting the similar type of stone, it is also necessary that the selected stone should have similar

strength, colour, texture etc. The size of selected stone should be a little larger than the original size to get the finished member in accurate size and proportion.

2.3 Transportation of Stone

After selection of stone, then it is transported to work site. The stone of bigger size is transported by a group of 4 to 6 persons, who carry stone either on trolley or on their shoulders with the help of bamboos, chains and ropes (Figure 3 & Figure 4).



Figure 2: Deteriorated Facade of the tomb before Work for its restoration



Figure 3: Transportation of stone on trolley



Figure 4: Transportation of stone with chains and bamboos

2.4 Tempering and Shaping the Tools

Tempering is a mean of achieving particular hardness in cutting edge and shaping the tool according to requirements, by a process of heating to red hot and controlled cooling. The tools are redrawn by a blacksmith and this process is called “Auzaar Thukana” (Figure 5) and tempered many times during its working life. The shape is sometimes re-adjusted to meet specific requirements of stone carving/cutting.



Figure 5: Re-shaping of tools by blacksmith (Auzaar Thukana)

2.5 Cutting of Stone

The traditional way of cutting the stone is by means of wedge chisels (chhanies) and hammer. This technique is called “Turan”. A cotton thread (sooter), coloured with grinded coal is used to mark line at required points, from where the stone has to be cut. The line is then confirmed with hammer and sharp chisels. After that wedge chisels are hammered and inserted one by one, on three sides of stone (Figure 6). A great care is necessary in inserting the chisels at equal intervals and hammering these with the uniform power, to avoid the danger of wrong cutting. During this process, water is poured continuously around the chisels to make the stone swell, which will then cause the stone to split into the required size (Figure 7).

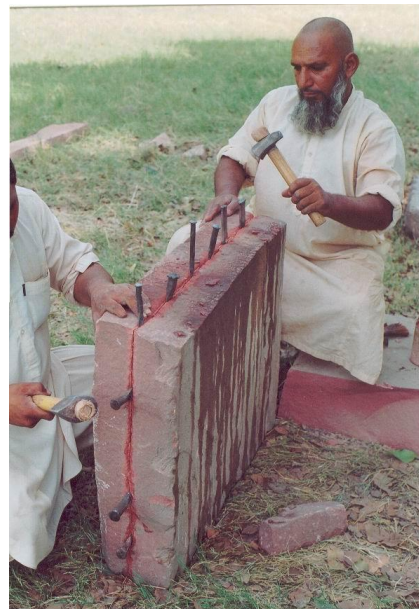


Figure 6: Inserting the chisels



Figure 7: Splitting of stone slab (Turan)

2.6 Rough Chiseling

First step of dressing the stone is rough chiseling, which is done to make the surface roughly even. The technique is called “Payta Karna” (Figure 8). For this purpose flat takla and tooth chisel is used.

The uniformity of level is checked by means of sooter, fixed on small copper rods (Tippay), between two points. This technique is called Tik Tika (Figure 9).

After two courses, strips of even surface are made horizontally and vertically. This technique is called “Paaya Dalna.” (Figure 10). The level of whole surface is then maintained according to the level of these strips. Rough chiselling is a lengthy process. Great care is necessary while checking the uniformity of level.

2.7 Fine Chiseling

After rough chiseling, stone surface is further dressed with tooth chisels (datary) and whole surface is levelled. During this process, the stone surface is kept wet for smooth working of tools. The uniformity of level is checked with steel L-shape scale, called “Gunia Bithana” (Figure 11).



Figure 8: Making the surface roughly even (Payta Karna)



Figure 9: Checking uniformity of level with thread and tippay (Tik_Tika)

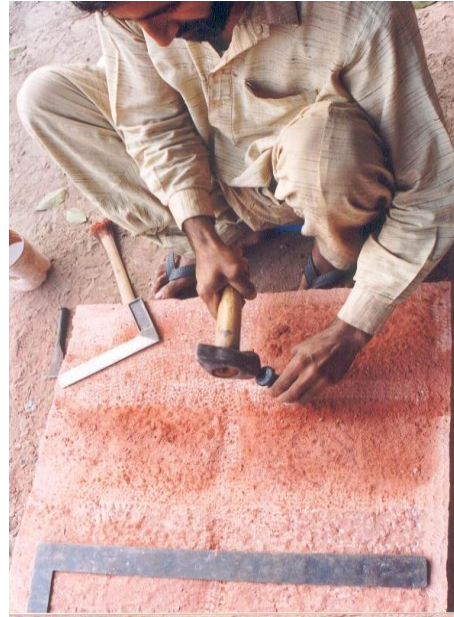


Figure 10: Making horizontal and vertical strips (Paaya Dalna)



Figure 11: Checking uniformity of level with L-scale (Gunia Bithana)

Sometimes stone surface is made fully even and smooth by means of hammer and thalak. This technique is called “Mathai” (Figure 12). This type of dressing the stone does not need grinding for its smoothness.

2.8 Grinding of Stone Slab

After the completion of rough and fine chiseling, the stone is rubbed manually with the help of carborundum (grinding) stone (watti) of square or circular shape. Grinding makes the surface fully even and smooth and makes it ready for tracing the design or drawing work. These days, electric grinders are used (Figure 13) which looses the cohesion between upper layers of sedimentary stones, thus shorten its life.



Figure 12: Making surface fully even (Mathai)



Figure 13: Electric grinders are used for polishing surface

2.9 Tracing / Drawing Work

Drawing work or “Likhai” on the stone is required to be done by any of the following way:-

- Geometrical designs are directly drawn with actual measurements on the stone surface. For this purpose gunia, pencil, parkar and sooter is used (Figure 14).
- Floral and curved patterns are traced from the butter sheet to stone surface by using carbon paper (Figure 15).



Figure 14: Drawing design on stone slab (Likhai)



Figure 15: Tracing design from butter sheet on stone slab (Likhai)

Complicated patterns are drawn with stencils. These stencils are made of formica or steel-sheet on the scale and design as per original.

If the stone member has to be prepared in two pieces then both the pieces are jointly placed and drawing / tracing is done, to keep the continuity of pattern. Great precision is necessary to draw accurate design / drawing with actual measurements. After thorough checking/ verification of correctness of design details, the drawing is then confirmed with the help of sharp chisels (nurgies) and hammer. This technique is called “Tipan” (Figure 16).



Figure 16: Confirming design with sharp chisels (Tipan)

2.10 Carving of Stone

Carving of stone is done with the help of different kind and sizes of chisels called nurgies, flat takla, pointed takla, bhampra, dachah etc. Carving is done up to required depth from 1/2" to 1-1/2" inch depending upon the design (Figure 17 & Figure 18). Carving of fine designs is a very sensitive job. It needs use of right tool, accuracy and concentration. A slight mistake may destroy the whole job.

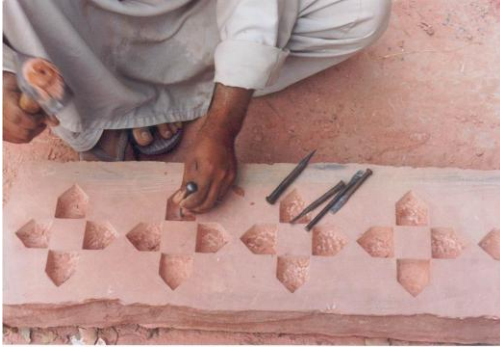


Figure 17: Carving, making sockets for inlay work



Figure 18: Carving, making fine design of nasik

2.11 Preparation of Inlay Work

Different stones such as Sang-e-Musa, Sang-e-Khattu, and marble etc. are used for inlay work. These inlay motifs are called "Raqam".

A transparent plastic sheet is placed on carved stone and the design is traced with the help of pointed marker (Figure 19). Each design element is traced separately, and then the design is cut into stencil. With the help of stencil, the design is transferred on marble or any other colored stone as per design requirements (Figure 20).



Figure 19: Preparing stencil, by drawing socket design on plastic sheet



Figure 20: Transferring design on marble, to cut inlay motif

Rough cutting of the design is done with electric cutters (Figure 21). Every inlay stone motif is then carefully rubbed from its edges with file (rayti), to fit it precisely in the socket of carved area (Figure 22). Each motif, when fit properly, is placed in its specific socket and same number is allotted to the motif and its location on stone slab. The whole design is then completed one by one. Adjustment of inlay motifs according to the carved sockets, needs high precision and excellent craftsmanship.



Figure 21: Rough cutting of, inlay motif with electric cutters

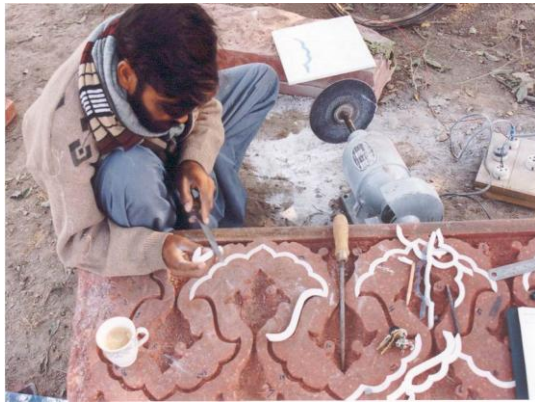


Figure 22: Fitting of inlay in socket after rubbing from edges

2.12 Fixing of Inlay Motifs

The department of Archaeology is using cement for restoration work. Mortar is prepared by mixing dry ingredients of white cement, grey cement and surkhi. The ratio of white cement and grey cement is 3:1. The quantity of surkhi depends upon the requirement of the shade. A thick paste is prepared by adding water in small quantities.

Before fixing the inlay motifs, it is necessary that all sockets of carved stone should be cleaned with blower or brush and properly wetted with water. Inlay motifs are then fixed in sockets with stained mortar. The mortar is partially filled in the carved sockets and inlay motif is then pressed in it, to fit properly (Figure 23 & Figure 24). After correct fixing, the excess mortar lumps are removed from the edges.

After fixing all the motifs the stone is left one day for complete setting of mortar. There after curing is done for a week by spreading sand on the stone and keeping it wet with water. If the joints of marble motifs are visible at some location then final touching is done with a paste of white cement. A small quantity of Zinc Oxide powder may be added to increase the whiteness of cement.

2.13 Polishing of Stone

After one week of curing, the stone is ready for final polishing. The surface is rubbed manually with the help of carborundum stone, until the whole surface is clean and inlaid motifs become visible. The final polishing is done by spreading sand over the prepared stone and rubbing it with sand-stone watti (Figure 25).



Figure 23: Partial filling of mortar in sockets to fix inlay motif



Figure 24: Fixing of inlay motif



Figure 25: Polishing of stone slab with sand and watti

Water is dropped on the sand continuously during this process, until the surface becomes polished and presentable. The stone member is now ready for fixing at its specific location in the building.

2.14 Fixing of Stone Panel against Wall

The fixing of stone panels (Figure 26) is done with sand cement mortar having ratio of 1:2, where as cavities behind are filled up with cement concrete having ratio 1: 3: 6.



Figure 26: Fixing stone panel against wall

Two different types of copper clamps are used to fix stone panels: one is a 3-inches long rod, of 3-mm diameter, and the other is of $\frac{3}{4}$ inch wide strips of “U” shape, having 1-½ mm thickness. Rods are used to support vertical members with each other, while the strips are used to fix the stone panels against the wall. One end of strip is fixed in stone panel while other end is embedded in mortar, behind the panel.

During fixing, great care is necessary to check the alignment of stone panel with its adjoining panels. The vertical alignment is also checked thoroughly. The joints, if any, are then treated with stained mortar. The beauty of facade is thus enhanced after restoration work. (Figure 27-a & Figure 27-b)

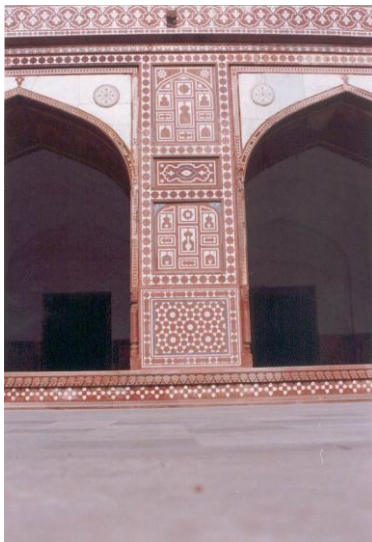


Figure 27-a: The Façade after restoration



Figure 27-b: Deteriorated Façade of the tomb before restoration

3. Mortar Used for Restoration Work

Mortar plays vital role in the functioning of a structure. The stability and solidity of old structures depend much on their binding mortar. Traditionally lime has been used for binding, rendering and plastering of stone masonry. Its presence is almost guaranteed in any historic building. A general requirement for material to be used for repair and restoration of ancient structures is that its composition should include the same range and types of aggregate particles as the original mortar, to ensure that the new mortar performs in the same manner as the old, is similar in appearance and will not cause an acceleration of the deterioration rate of adjoining ancient material, in future.

At present four different development schemes are being implemented to improve the overall grandeur of Jahangir's tomb. The mortar used for the restoration of Red Sand Stone Facade is as under [5].

- Fixing of all sand stone members, with cement: sand mortar having ratio 1:2.
- Filling up the cavities behind, with cement concrete having ratio of 1:3:6 (one cement three sand and six parts of bajri / coarse aggregate).
- Fixing of marble jali and other marble elements, with white cement mortar having cement: sand ratio of 1:1.

4. Discussion

In restoration works of historic monuments, for their conservation, maintenance of originality of the building is extremely important. In this regard, sensible repair can reduce the necessity for restoration works. The Restoration Method, comprising of fourteen steps, given in this paper, is considered comprehensive and appropriate. The artisans and craftsmen, involved in the restoration work, have learnt the skills and techniques from their forefathers. Since the times of Mughals, these skills have transferred from generation to generation within the same families. Now low wages of these craftsmen are discouraging them to continue their inherited crafts. There are no facilities available for formal training in the traditional stone works. That is why the original quality of workmanship has slightly suffered. Wrong alignment and slight change in the details of design has also been witnessed at few places.

Red Sand stone, originally used in this building, is sedimentary rock, which consists of grains of sand or quartz cemented together. The type of grains, shape and size and cementing material determine the color, texture and durability of stone. Proper seasoning is also needed before its use. Unfortunately red sand stone as of original quality is not available in Pakistan. The stone imported from India in 1980 is now left in small quantity. The Department of Archaeology and Museums is trying to import more stone from India. The officials of the Department are hopeful to get the stone imported within next two years, i.e. in 2010. Meanwhile if the available stone finishes, the preventive measures can be taken to stop further decay and deterioration. For this purpose red sand stone available in Sindh and Chakwal (Punjab) areas of Pakistan, though of low quality, can be temporarily used.

The most critical issue in restoration work is the use of Portland cement. No doubt, Portland cement is magnificent material for modern structures but it is not designed for use in historic buildings, because it is too strong in compression, adhesion and tension, so it lacks elasticity and plasticity when compared with lime mortar. Cement also produces soluble salts on setting, which may dissolve and damage porous materials. According to Bernard M. Feilden, "Portland cement should not be used for mortars or plasters in historic buildings, but as a last resort a small proportion of white cement, not more than 10 % of volume of lime can be added." [6]. The use of Portland cement

by the Department of Archaeology, for fixing stone panels may further damage the structure of a building.

5. Conclusion

The Restoration Method as systematically documented and described in this paper reveals that the Department of Archaeology and Museums, Pakistan is trying hard to keep alive the traditional techniques used in stone-work. The procedure adapted is comprehensive and accurate, but due to shortage of skilled persons for carving and inlay of stone work, a little low workmanship (slight difference in design pattern and slightly wrong alignment) may be possibly pointed out at different location of restored areas. The clamps used for fixing stone panels also need modification in shape and thickness; to hold the stone panels more tightly with back masonry instead of embedding it in mortar. In this regard the Department should arrange comprehensive training of craftsmen and also run short courses and workshops. The stone craftsmen should also be encouraged by raising their wages and providing security of job. This will further ensure accurate and systematic conservation work on the historic buildings.

The red sand stone of similar quality was once imported from India in 1980 and never afterwards. The shortage of stone has resulted in the reduction of slight thickness of stone panels as compared to the original one used by the Mughals. Even the thickness of inlay motifs has been reduced from 1-½ inches to ¼ inch. The stone available in Pakistan, is of low quality. Its color and strength also does not match the original stone. Thus this can only be used for preventive measures taken towards stopping further decay and deterioration. Therefore the Department should make serious efforts for the import of more stone from India.

Another important consideration should be avoiding the use of Portland cement in the restoration work. In this regard lime mortar and lime plaster should be used to maintain the original construction material and technique. Portland cement is too strong in compression, adhesion and tension, so it lacks elasticity and plasticity when compared with lime mortar. Cement also produces soluble salts on setting, which may dissolve and damage porous materials. Thus it may further damage the structure of a building. Therefore it should not be recommended in the repair and restoration works on the historic monuments.

6. Acknowledgements

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7. References

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