

RESTORATION OF PROTO-HISTORIC RUINS OF ADOBE LOTHAL, INDIA

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SUMMARY

In following the principle that archaeological remains should be conserved without changing its materials, colour, mass and shape, the exposed ruins of adobe walls of the proto-historic (2450 B.C. - 1600 B.C.) port-town, Lothal (in Gujarat, India) although subjected to surface treatment with preservatives, disintegrated and were lost. The ruins then had to be restored. The paper gives an account of the results of experiments conducted with soil-cement bricks as also the compelling reasons under which a substitute of mud-brick had to be produced. The efficacy of a pozzolonaic cement in the rains (June to September), used at site in early part of the year, will be observed and reported in the symposium.

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## INTRODUCTION

In the Second International Symposium on adobe at Yazd, in Iran, in March, 1970, an account was given of Indian restorers' efforts to preserve the proto-historic excavated ruins of mud-brick structures at Lothal with soil-cement bricks. In that account the site, the structures and the experiments carried out were discussed in detail. But, as far as I know, the paper was not published and is not available. Since further experimental work was done at the same site, for the sake of presenting a coherent picture of the problem and works done earlier, the relevant portions of that paper are repeated here in brief in their proper sequence.

### THE SITE

Lothal (Lat. 22° - 30' : Long. 72° - 0') is situated on the western coast of India, near the Gulf of Cambay which opens out to the Arabian sea. The mound of ruins, rising to a height of 3.5 m. from the surrounding flat and featureless plains, was discovered in 1953 and excavated between 1954 and 1962. The excavations have established that during its life-span of about 850 years, between 2450 B.C. and 1600 B.C., the habitation was destroyed four times by swelling waters of the two rivers, Sabarmati and Bhogava, flanking the city. The gradual silting up of the estuary also resulted in sheet-flooding.

The typical features of Harappan town planning, alignment of streets and sanitary arrangements are also found at Lothal. Encircled by a protective wall against floods, the town had an acropolis, where the rulers with their kinsmen lived and a lower town, thrice larger than the acropolis, where merchants, craftsmen and others dwelt. The houses, in the Lothal acropolis were built, as at other Harappan settlements, on raised platforms and in the lower town on high plinths because of the danger of floods. On the south-east was a ware-house and to the east a dock-yard, roughly measuring 214 m x 36 m: its walls made of baked bricks (Rao, 1973).

In the residential buildings baked bricks were used only in the floor of baths, drains, manholes and cess-pools. It is worth noting that baked bricks had been used in structures which were to come in contact with water. Constructions like houses and shops were of mud-bricks laid in mud-mortar in headers and stretchers. But moulds of two separate sizes measuring 28 x 14 x 6.5 cm. and 25 x 12.5 x 6 cm. were used for both mud and baked bricks.

### THE CLIMATE

The climatic conditions of the site on the whole, are unfavourable for preservation of mud-brick structures. The present annual rainfall is between 70 to 100 cm. But the average annual rainfall between the months of June and September during the first half of the century varies from 91.4 mm. to 112.8 mm. The records, maintained by the Indian Meteorological Department from 1901 to 1950, show that during the month of July, for only 12.5 rainy days (a rainy day has 2.5 mm. or more rainfall) the rainfall was 179.8 mm. These readings were obtained from a station called Dholka which is about 25 km. away from Lothal. Proximity of the site to the Tropic of Cancer affects the temperature; in summer it is about 46°C, though the mercury sometimes shoots up to 49°C. Due to heat the parched land around the site breaks down. In this condition wind-blown sand, by attrition, adds further injury to the dried bricks. The effect of wind is considerable in the open wasteland denuded of trees and shrubs.

### THE SOIL

Sampling of silts collected from a pit in the basin of the dock-yard has shown that at the top, concentration of soluble salts (Chloride 5.27, Sulphate 1.31, Hydro Carbonate 0.06, Sodium Potassium 2.46, Magnesium 0.26 and Calcium 0.68) amounts to as much as 10.60%. On the other hand a sample collected from a depth of 85 cm. from the surface of the basin, showed only 0.31% of salt.

It is thus evident that geographical locations, climatic factors, composition of soils and several other considerations had to be taken into account in conducting the experiment. Although initially the products looked as tolerably approximated substitutes, weathering at site altered their look and shape. Not being fully satisfied with the results, we had decided to conduct further tests to make amends in the earlier works, so as to improve upon the products both from the view points of aesthetical presentation and efficacy.

While working on soil-cement bricks, we were still hopefully looking out for an effective soil-stabilizer or preservative which might be discovered by some of our colleagues. From the experiences gained at Yazd and in Santa Fe, one could see that a solution to the problems is still eluding, but the search is still on. The same impression reflects in the Status Report (Clifton, 1977) wherein the results of various experiments have been discussed in an objective manner. It quotes a scientist who after trying for over 20 years, nearly all types of soil-stabilizers, stated: 'no single chemical or combination of chemicals have been found acceptably effective or economical as a major soil stabilizer' (Kinter, 1975) and ended with an optimistic note that planned research may possibly lead to the development of an effective chemical treatment. Sharing his optimism and expecting to be benefitted from the eventual development of a potent chemical, we have filled up the trenches and covered with earth all the adobe-ruins of excavated sites of proto-historic periods, and concentrated our efforts of preservation at the only exposed site of Lothal.

In this paper before an account of further work is given, I may be allowed to indulge in a little digression to explain the philosophy that led us to the use of substitute bricks.

#### THE PHILOSOPHY

Ancient monuments in India are conserved or preserved and seldom restored. The word 'restoration' is used, with reservation, only in respect of specific cases where restoration work is involved. This attitude agrees with the latest thinking of ICOMOS as reflected in Article 2 of the Venice Charter wherein restoration is defined as a work that is reversible. On the other hand, compared to the modern trend of restoration in European countries, Indian approach to the preservation of archaeological remains might be considered as puritanic. Viewed against the background of orthodox approach restoration work executed at Lothal with a substitute material might appear to be inept. Therefore, for deviating from the established policy and time honoured practice, there must be some overriding factor or compelling reason for us to take an unconventional (in Indian context) step to restore the ruins which had disintegrated and got lost.

In the earlier report it was mentioned that to prevent loss of the exposed surface of the side walls of mud-brick platforms, on which residential houses were built, peripheral walls were erected with water-resistant soil-cement bricks. But the walls of houses being open on both sides, started disintegrating on exposure. The ruins were kept on view, as long as possible, without interfering with the fabric of the structure; only some surface coatings of available preservatives were applied without any success. The discovery of the dock-yard of Lothal, supposed to be the earliest one of its kind exposed so far, made the people of the State feel especially proud of their cultural heritage. They insisted on the ruins being restored so that they and their posterity when they go to visit the site, could have the visual experience and derive pleasure in seeing the handiwork of their forefathers. It needs no reiteration that the object of preservation is primarily to educate the common people of the larger section of the society. To meet the popular demand and in the absence of the original mud-bricks, substitutes or simulated bricks had to be adapted for restorations. But efforts were made to remodel the restorations as realistic as a restorer could render them, subject to the tools (method and materials) available to him at a given time.

Thus in India, restoration of adobe-ruins was attempted for the first time at Lothal, about two decades ago, not as a pre-planned organised project based on any earlier technical experience or available scientific data but as an isolated effort. The work was taken up rather improptu to meet a popular demand - in a democratic system of government, in response and with respect to the aspirations, expectations and desires of the people at large. At the same time it should be noted that the mistake committed at Lothal viz., keeping the excavated ruins

of mud-brick walls exposed before evolving a technique for preservation, was not repeated anywhere subsequently. As a matter of policy, now all the excavated sites are covered with earth to avoid any damage to the structural ruins of adobe. Further experiments and improvements on methods of preservation of adobe are being conducted only at Lothal where no risk of damage to original structures is involved and earlier works with different materials and effects are available for comparison.

#### THE EXPERIMENTS

Article 9 of the Venice Charter mentions that all additions should harmonize with the original elements but also remain identifiable. In respect of soil-cement bricks, therefore, it was decided that the new material should meet the following conditions:

- (i) the material should merge with the mud-bricks in colour and texture;
- (ii) it should not be washed away by rains;
- (iii) the coastal gale carrying sand may not cause damage to it by attrition; and
- (iv) it should be less prone to the corrosive actions of soluble salts.

The mud-bricks of Lothal are composed of mud, sand, a small percentage of nodules of limestone and occasionally chips of baked bricks. In the preparation of new bricks, these materials were used by volume, in the proportion of 1 cement: 1 lime: 4 sand: 3 gravel which included coarse sand and 5 parts of the chips of baked brick in granular form. The first batch did not prove to be satisfactory. The bricks were not composed of the required quantity of cementing material as a result there was erosion. The mortar (1 cement:4 sand) used in the work being stronger than the bricks, it was not affected to that extent.

In the bricks of the second batch, the proportion of cement was slightly raised (from 1 part to 1.25 parts) and the result achieved was slightly better. In this case again the mistake, of making the mortar strong, was committed. In case of another structure where the mortar was judiciously applied in pointing and kept recessed, looks better. The bricks of the same composition as that of the second batch, though weathered, give a better appearance and is in keeping with the type of ruins.

The look of the fourth example, when compared with an excavated wall, approximates the original. In it, two types of pointing have been applied. The portion treated with recessed pointing produces a better effect than the other portion which had received flush pointing. In making these bricks the ratio of ingredients used were 1 cement: 2 powdered burnt brick: 4 sand: 6 gravel. Thus the results obtained in the experiments show the efficacy of ordinary portland cement.

In the early part of this year, the ruins of walls of the wharf or

ware-house and of a house in the lower part of the town were re-done with newly manufactured bricks. The bricks were made of 1 pozzolona cement: 2 fly-ash: 1.5 parts river sand and 2.5 parts soil. Laboratory tests of the bricks show the quantity of water absorption as 16.2% and its compressive strength as 44.4 kg./sq.cm. on an area of 418.9 cm<sup>2</sup>.

Earlier, Alumina cement combined with fly-ash free from sulphur compound was recommended for use. But the executive engineer who approached the Associate Cement Companies for supply of Alumina cement, was informed that they produced an Aluminous cement called Calundum which was used for repairs/construction of furnaces and it was not suitable for the repairs to the adobe-ruins of Lothal. They, however, advised the engineer to use pozzolona cement. The engineer in consultation with the archaeologist in-charge who also happened to be the excavator of Lothal, used pozzolona cement.

I have visited the site in late May when I took some photographs of the new works done. The slides will give an idea of the effect they produce. It has to be seen as to how these new bricks fare in the rains and the nature of action of salt on them thereafter. Since the paper is to reach the organizers of the symposium by 15 July and at the time of writing this report (first week of July) the site is having heavy rains, I propose to visit the site in early September to inspect the effects of rain and prepare some slides for a comparative study. As mentioned earlier, the rainy season in the area around Lothal, is from June to September.

#### CONCLUSIONS

The walls of buildings at Lothal were originally covered with a layer of mud-plaster. But floods and rains ruined the structures along with the plaster. A stump of a ruined wall, therefore, could not have retained its coat of plaster. If applied afresh, the plaster lends to the walls a different appearance which is unlike ruins. At certain excavated sites, the ruins of adobe have been covered with a mud-cement plaster. The visual effect they produce in a visitor can be compared from the slides.

The impact created by the bare brickwork of ruins appears to be more effective, realistic and convincing than the portions protected by 'encapsulation'. The treatment of the broken wall-tops have been finished flushed with a slope for drainage of water. In India the ruins of walls are treated with a broken 'sky-line' retaining the character of broken walls.

In repairing the portions which were eventually 'encapsulated', mud-cement bricks of different dimensions, than those of original ones, were used. The risk involved in this method is that posterity might confuse them to original ones from their apparent look. Studies of archaeological sites have shown that in any given cultural horizon, the size of bricks normally does not remain

the same-there are variations. Sometimes, occupants of a site at a subsequent period, carried out repairs with bricks of a different size which were collected from other sites. I have made a study of brick-size used in India from the proto-historic period up to A.D. 1000. In the proto-historic period (Harappan) nine sizes were recorded. Similarly, during the period from 600 B.C. to 200 B.C. altogether sixteen sizes and in the period from 100 B.C. to A.D. 300 as many as thirty-four sizes of bricks were recorded. Again, in the case of a fifteenth century dome, three sizes of bricks have been used in the original construction.

So, in the use of different sizes of bricks there is an element of risk involved as stated above. To avoid such a contingency, we have decided to use baked bricks of the same size, as was used originally. But to distinguish the new ones from the old there will be a stamp on them with the letters ASI and the year of production. To withstand saline action, the bricks will be slightly over-burnt. In respect of adobe, the bricks being substitutes of original ones with a different composition, there is little likelihood of mistaking them for old. Besides, for the information of visitors, at the site there is a notice which reads:

'Visitors will please note that the exposed ruins of mud bricks having been decayed, the walls have been restored with simulated soil-cement bricks recently manufactured. The walls of burnt-bricks are mostly original; new bricks wherever introduced for repairs bear an inscription 'ASI-1980 i.e., Archaeological Survey of India and the year of manufacture'.

We may have tried to fake the original mud-bricks for aesthetic reasons, but have been honest enough to make it known to the visitors, to avoid any misunderstanding or misinterpretation of the restoration whatsoever.

#### REFERENCE

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