CHAPTER - IV
ARCHITECTURAL MATERIALS AND TECHNIQUE

Architectural Material:

The Harappan settlement pattern took 1000 of years to achieve its urban town planning, it was a dynamic process. The different artisans like masons, stone grinders, brick makers, carpenters etc. contributed for the development of Harappan town planning. Government authority and architect designed the town planning of the cities. The structures in the Harappan cities were built of mud bricks, baked bricks and stones. The climatic conditions and relief features influenced the Harappan Structure. In Mohenjodaro, Harappa and in the sites of Sindh people used baked bricks. At some sites the stones were used along with baked bricks by them, stones were imported from the region of modern Rajasthan. In Gujarat the stone were used massively in the architectural structures of Harappan cities. At Dholavira and Surkotada stones were used in the fortification walls and house structures. At Lothal stones were used to tie the vessels. People at Lothal were engaged in trading activities, which is reflected in their buildings. They imported stones from their surrounding. The good economics conditions of the people also reflect in their architectural structure. At Mohenjodaro the burnt bricks were used at large scale because it was in the agricultural production

region. The houses of the common people were also built with burnt bricks it was due to their sound economy and good type of clay available for brick making. Gurdeep Singh said that the modern Sindh and Rajasthan had dense forests during Harappan period which provide wood for brick baking.\(^2\)

(a) Brick:-

The Harappan brick makers made the bricks with mud. The standard size and surface texture of the bricks were probably formed in wooden mould and then turned out to dry in the open air. The sun dried bricks were firmed in the kilns at a constant heat. The brick of the different size were used in the different sites of Harappan civilization. In the early Harappan period the brick size ratio was 3:2:1 and during Mature Harappan period it was replaced by 4:2:1.\(^3\) The uniformity in brick making also shows the link of the different Harappan sites. The craft tradition spread to the settlements of the different region. In city town planning the baked-bricks were used with mud bricks in the same building.\(^4\) Bricks of different types like mud bricks, baked bricks, unbaked bricks, burnt bricks etc. were used at different Harappan settlements. The size of bricks was also different like in the drains large sized brick were used while in the houses some smaller sized bricks were used.\(^5\)


\(^3\) D.P. Agrawal (2007), *The Indus Civilization*, p. 78.


(i) Mud-Bricks:-

In the Early Harappan and Mature Harappan period the mud-bricks were used by the people. At Lothal the sun dried bricks, made of blackish clay, were used during Harappan Period. In the construction of smaller house the mud-brick of small sized, $14\times 12\times 7$ins were used and the larger size bricks, $40\times 20\times 10$ins, were used in building and city wall. At Balu the large sized mud-bricks, $72\times 36\times 12$ cm, were used in the houses and fortification wall. It is exclusive size of mud bricks used by the Harappans. The size of mud bricks used at Balu was larger than the mud bricks used at another Harappan sites. At Lothal sun-dried bricks were used in the construction of houses and platforms. The bricks made of buffish alluvial clay were much stronger than the bricks made of blackish clay. The most common size mud-brick used at Lothal was $11\times 5.5\times 2.5$ins but some other sized like $12\times 6\times 3$ins, $14\times 7\times 3$ins and $15\times 8\times 3.5$ins. etc were used. In the construction of warehouse the mud bricks, $18\times 9\times 4$ins, were used and $15\times 9\times 3$ ins. size bricks were used in Grave 7 of Cemetery area. In the fortification $40\times 20\times 10$ins, size mud-bricks were also used. At Surkotada the mud-bricks of same size were used in the construction of Rampart. At Mohenjodaro in D.K. Area sun dried bricks of different size ($13.9\times 7.35\times 3.5$ins; $15\times 7.15\times 3.1$ins; and $14.55\times 7.25\times 3.3$ins) were used in the construction of houses. At Harappa smaller size mud-bricks measuring $28\times 14\times 7$ins used in

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6 Arun Kesarwani (2002), Excavation at Balu, p. 24
8 Ibid, p. 65
9 J.P. Joshi, (1990), Excavation at Surkotada 1971-72 and Exploration in Kutch, p. 81
10 E.J.H. Makay (1938), Further Excavation at Mohenjodaro, p.88.
houses and large size \(40\times20\times10\)ins mud bricks were used in the construction of fortification of citadel.

(ii) Burnt Bricks:

Burnt brick were also used by the Harappan people mainly in large building and drains. In great bath building at Mohenjodaro and in Dock at Lothal the burnt brick were used by the people. In the drains some large size burnt-bricks were used in their construction and to cover them. At Lothal the drains in street 2 in the Acropolis area was constructed with burnt bricks.\(^\text{11}\) The burnt bricks of different size \(28\times14\times7\) cm: \(24\times12\times5\) cm, were used. Some large bricks, \(40\times20\times10\)cm, were used to cover the drains.\(^\text{12}\)

(iii) Wedge shape Brick:

The wedge shaped bricks were also manufactured with wooden mould. These bricks were used by the Harappan in the construction of wells to give them cylindrical form. At Mohenjodaro in DK area a well was found in which wedge shaped bricks, \(11.5\times3.75\times2.5\)ins, were used. In another wells the bricks of different size, \(10.25\times3.5\times2.25\)ins were used by the Harappans.\(^\text{13}\)

\(^\text{11}\) S.R. Rao (1979), op. cit, p. 102.
\(^\text{12}\) J.M. Kenoyer (1989), Ancient cities of the Indus valley civilization, p. 57
\(^\text{13}\) E.J.H. Mackay (1938), op. cit, p. 93.
(iv) **T Shape Bricks:**

Some T-shape bricks were found at Lothal. (Fig.28) It is exclusive feature of bricks used by the Harappan. This type of bricks was used in the opening of the drain. It provides extra strength to the drain.

(v) **Stone:**

In the region of Saurashtra the stone were used massively by Harappans. People at Dholavira made dressed stone blocks and architectural components with hard hammer percussion but some immense ring stones and square column bases reflect much more refined stone working traditions. At Dholavira a large number of pillar bases, with damru shaped bases, have been found at the east and north gate of the castle. (Fig.29) They used hammer stones and chisels to shape the large discs and square blocks. Abrasive drills were used for the making of holes in the stones. These stones were dressed in a factory near the gate of the castle. Pillars with mushroom like tops have been found. Dressed tones were also used, as building materials,

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for the construction of houses and fortification wall at Dholavira. At Mohenjodaro the stones were used with burnt-bricks in the large buildings and drains. A drain in First Street was covered with stone slabs. (fig.17) At Harappa some stone slabs were found which were also used to cover the drain.

At Surkotada the stones were massively used in the construction of fortification wall and in the houses. At Rojdi the fortification and houses were built with dressed and undressed stones of some unusual size. Some large and massive stones were found near the dock at Lothal. They were used to tie the ships with ropes.

(vi) Wood:-

In the Harappan structures the evidences of wooden work in the houses were found. The doors were made with wooden frame and a socket set in the threshold served as a door pivot. The socket in the sill of the doorway indicates that it was used to hold the door. A toy was found at Harappa which indicate the wooden framework of the Harappan people. Some rectangular and square socket was found in the walls of the houses at same heights at Mohanjodaro in which the wooden beam were inserted to support the roof.

(vii) Charcoal:-

Harappans used charcoal for strengthening of the structures. B.B. Lal points that they first put a soling of

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15 G.L. Possehl and M.H. Raval (1989) Harappan Civilization and Rojdi, p. 49
16 J.M. Kenoyer (1998) op. cit, p. 58
terracotta nodules in mixed with pieces of charcoal. Over it they laid the clay floor. This process was repeated while the renewing of the floor. The purpose of intermixed charcoal pieces was of two fold one, it prevents moisture from traveling upwards along the wall, a problem often faced in mud houses. Second, it was an anti-termite charcoal in the foundation of houses.  

(b) Building Technique:

Harappans used scientific and advanced building technology for the construction of fortification, houses and other structures at different sites of the Harappan civilization. At Mohenjodaro, the houses were built over huge platforms of mud bricks to save the structures from floods and capillary action. The buildings at Mohenjodaro, Harappa, Kalibangan, Banawali and Lothal were built on platform of mud or mud-bricks.

The walls were generally vertical but some important buildings have battered walls. The walls were without any decoration. The houses had doors and windows with gratings. Corbelled arches were found over the windows, doors and drains. The houses were much higher than the lane level. Floors of the rooms in the houses were made of beaten earth, sun dried bricks and burnt bricks. The bathrooms had four to five bricks thick floors. Some doors had stone socket to hold the pivot of wooden door. A staircase was used to reach the first floor. Roofs were flat, wooden rafters were used and some matting was also laid

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17 D.P. Agarwal (2007) The Indus civilization An interdisciplinary Perspective, p. 91
over which clay and sand were spread. The chutes drained out the water from the roof. There were small drains to drain the sullage out from the houses, and these were connected to a bigger drain or soak pit. The base of the drains was rammed and paved with bricks.

(i) Foundation of Building:-

At Mohenjodaro, Harappa, Kalibangan, Lothal, Dholavira, Rakhigarhi etc. the large building structures have good foundations. During intermediate period, the large buildings were carried to a great depth and laid with much care. In smaller structures, they were shallower but were commonly bedded on a layers of burnt clay. In the houses of poorer class (During late period) the foundations were laid on almost any kind of debris. At Surkotada and Rojdi the foundation of the house was constructed with stones. In the alluvial region the foundation was of mud-bricks. At Lothal the mud-bricks, 40×20×10ins were used in its foundations.

Floods became common in the Indus plain, so the buildings were erected over artificial platforms. The foundations that held the fillings were usually thicker than the walls above, so that a well defined footing was left around the inside of each chamber. Sometimes old houses were filled with refuse, unbaked bricks and clay before the succeeding building activity. At Mohenjodaro the dwelling structures were built over the earlier structures and at Kalibangan the fortification walls was built over the fortification of Early Harappan Period. At Surkotada, the eastern

19 John Marsall (1931), Mohenjodaro and the Indus Civilization, Vol 3, p. 16
rampart is well exposed on both the inner and outer sides up to maximum height of 4.80m. It was built over a hard and rammed raised ground. The maximum basal width of rampart was 7m while it had ten courses of dressed stones on the outer face. The inner face had only seven courses of dressed stones used as a veneer at the base. The inner core of the rampart consisted of mud bricks and mud lumps. The size of bricks used in this foundation is uniforms i.e. $40\times20\times10$cm

In the western slope of the mound excavation was conducted up to the depth of 5.40m,$^{20}$ It revealed that the Harappan first raised the ground just above the natural soil by ramming with mud. The layer consists of hard, compact yellow earth and had a thickness of 54cm.and the western rampart had eleven courses of mud bricks. The entrance of rampart of citadel had foundation of ashen and loose material had a width of 50cms.

At Bagasra in district Rajkot of Gujarat the Harappan perimeter wall was constructed in two different periods. The wall was constructed of stone build basal part and had over it a high mud-brick construction. The foundation of the wall was constructed with large sandstone blocks have simple preliminary dressing, is followed by the wall which has a foundation trench and then followed by the brick wall of ten extant courses. The depth of foundation was 1.20m. The mud bricks are of three colors (i) dark grayish, (2) yellowish brown and (3) light ashy grey and having three sizes $48\times24\times12$cm: $32\times16\times8$cm and $36\times18\times9$cm, the ratio being the same 4:2:1 for all. The base of

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$^{20}$ J.P. Joshi (1990), *Excavation at Surkotada 1971-72*, p. 68.
the wall is slightly broader than the top and its outer side was occasionally plastered with mud plaster and basal part was strengthened with bricks. This is one of the site giving a clear evidence of the repair of the periphery wall with a strong foundation trench.

The batter was also noticed at Kalibangan in outside and inside the fortification wall of citadel. The inner side of the rampart was plastered. At Harappa the wall of the rampart also has batter. At Mohenjodaro, the batter on the outer face of the building is noticed. The addition of revetment as buttress to some walls is found at Mohenjodaro, Harappa, Kalibangan, Lothal and Banawali. This technique gives extra strength to the wall.

(ii) Platform:

The Houses and buildings in the Harappan Civilization were constructed on the raised platforms. The higher platforms were constructed mainly in flood prone area. At Lothal the houses were constructed on the raised platform to prevent from the flood because Lothal was frequently struck by the floods. At Mohenjodaro the houses were constructed on the platform.\(^{21}\) The Ware houses at Mohenjodaro, Harappa and Lothal were constructed on the series of platforms.\(^{22}\) Some houses at Kalibangan were also constructed on the platforms. A 6m. high platform was found at Harappa. Some of the Early Harappan culture were filled and used as platforms by Mature Harappan people.

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\(^{21}\) E.J.H. Mackay (1998), *op. cit*, p. 92
\(^{22}\) S.R. Rao (1979), *op. cit*, p. 114
(iii) Staircase:-

Staircases were constructed by the Harappan people which indicate that some families lived in the double storey houses. The staircases were constructed with burnt bricks. At Mohenjodaro stairs were found in Great Bath building.

The evidence of double staircase was found in block 1 of DK Area at Mohenjodaro. These two flights of staircase were at the end of wide passage. Each flight was 3ft.14ins wide and a space of 1ft.8ins separates these two flights. Between these two flights of steps there was a drain which drained towards the open area outside of the city. The bricks used in the construction of these remarkable staircase measure 10.5×5.45×2.01ins. The bricks were laid in mud mortar. They became semi-polished by the bare feet of the people. This was the communication passage (9ft. 7ins wide) which was used by the people to enter in the house complex area. In both sides of staircase there were walls of baked bricks and the drain was also covered with baked bricks of same size.23

(iv) Interlocking of Walls:-

The Harappan could not develop the technique of interlocking of walls. Many large rooms of houses were divided by a partition wall.

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23 E.J.H. Mackay (1998), op. cit, p. 68
(Fig. 30) The partition wall did not interlock in their brick work with main walls of the room. All the walls were not constructed at the same time. The partition wall was constructed at right angle with the main wall. The wall could be removed without damaging the main walls. In the houses at Mohenjodaro the large sized rooms were divided into small rooms by constructing a partition wall. The large sized burnt-bricks $40 \times 20 \times 10$ cm, were used in the construction of this wall.

(v) **Watertight backing technique:**

This technique used in the water body and drainage of the Harappan town planning. Harappan people used this technique to stop percolation of water. The wall of Great bath building was plastered with bitumen and to prevent the bitumen from creeping, a thin retaining wall built against it. The gap between the retaining wall and the outer wall of the building was filled with rammed clay. In construction of drains this type of technique was applied to make the drains water tight.

(vi) **Plaster:**

The use of plaster was not unknown for the Harappan people. They used plaster for the coating of the walls of their houses to increase the strength and life of the walls. In Rajasthan and Kachchh, houses are plastered with the mixture of Cattle dung, clay and husk during recent period also. Harappan people plaster their houses every year to prevent the walls from adverse conditions.

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25 John Marshal (1931), *Mohenjodaro and the Indus Civilization*, p. 132
effects of climate like precipitation and the hot winds (loo). The plaster was made of different materials during Harappan period. They used Husk, Clay, cattle dung, potsherds etc. The gypsum was also used to plaster the houses. The drains and other hydraulic structures like Great Bath were plastered with bitumen.

At Kunal a furnace, 6×8m, was constructed in brick edging and plastered with a mixture of husk, clay and potsherds. The sides and floor of the furnace had become red and hard by constant firing.\(^{26}\) Some special type of clay was used in the making of plaster. At Lothal lime plaster was used in the drains. At Harappa a mud brick house was plastered with mud and straw. These two components of plaster were well mixed and then used to plaster the house.\(^{27}\)

(vii) Mortar:-

The Harappan people used mortar in the laying of bricks for constructing the buildings or house. The mud different sites. At Lothal the mud mortar was use as binding material in the construction of residential buildings. The use of lime-mortar being limited to the construction of drains, baths, water chutes etc.\(^{28}\) Floors paved with baked-bricks were occasionally lime-plastered. At Mohenjadaro gypsum was used as mortar. Bitumen was also used as mortar in some large buildings. In India bitumen

\(^{28}\) S.R. Rao (1979), op. cit, p. 73
is rarely found but the Harappan people import it from Mesopotamia.\textsuperscript{29} The bitumen was used only in large building and in the houses of traders.

(viii) Cement:-

The cement used by the Harappans was white in colour and composed of sand mixed with a large proportion of gypsum and a smaller amount of lime. It was prepared as powdery form condition. Water was used at the same time when it was used. It was used to increase the strength of the walls. In Great Bath building the cement was used to make the tank watertight. The bitumen was used more than cement in the Harappan structures. The proportion of different materials used in the making of cement was.\textsuperscript{30}

<table>
<thead>
<tr>
<th>Material</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum</td>
<td>43.75%</td>
</tr>
<tr>
<td>Carbonate of lime</td>
<td>13.78%</td>
</tr>
<tr>
<td>Sand</td>
<td>40.00%</td>
</tr>
<tr>
<td>Alkaline Salts</td>
<td>2.47%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

(c) Brick-Bonding Technique:-

Many walls with excellent height were found at Mohenjodaro, Harappa and other sites. The height of some walls at Mohenjodaro is upto 15ft.in ruin condition. The excellent condition of the walls is a result of the brick bond used by them.

\textsuperscript{29} John Marshal (1931), \textit{op. cit.} p. 268  
\textsuperscript{30} John Marshal (1931), \textit{op. cit.} p. 132
Harappan people developed the different bonding technique. The most common bonding technique, English bond, used in the modern buildings was given by the Harappan. Other than English bond they also used Flemish Bond, Stretching bond, Heading bond, American Bond, Stack Bond etc. in the construction of their houses and other large buildings. The bonding technique was used to increase the strength of the walls. The walls were found collapsed where the proper bonding technique was not used.

(i) **English Bond:-**

The English bond technique was commonly used by the Harappans. In this type of bonding the headers and stretchers laid in alternate courses. It was considered as a strong bond. In the Great Bath building at Mohenjodaro The walls were constructed in English Bond technique. (Fig. 31) The walls which were constructed with this bonding technique were more durable and could hold the weight of the double storey for long time. In the construction of the fortification wall at Lothal English Bond technique was used.\(^3\) They used different type of brick bond and mortar in the laying of bricks but English Bond was common in all the Harappan sites. It seems that the

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\(^3\) S.R. Rao (1979), *op. cit*, p. 55
English-Bond was prescribed by the governmental authority of the Harappan people, so it was used widely.

(ii) **Flemish Bond:**

The Flemish Bond was the second important brick bond use by the Harappan people at their different sites. (Fig. 32) In this bonding technique the headers and stretchers are laid alternatively in the same course. Every header in each course lies centrally over every stretcher of the underlying course. It was less strong than English Bond. The Flemish Bond was occasionally seen at Mohenjodaro. The wall of a kitchen and a room in a house in DK Area at Mohenjodaro the Flemish Bond was used.

(iii) **Stretcher Bond:**

This type of bonding technique was adopted in a few houses at Lothal and Mohenjodaro. In this type of bond all the bricks are laid as stretcher in every course of the wall. Every alternative course is to be started with half bats for breaking the continuity of vertical joints. (Fig. 33) At Lothal in the construction of mud
brick platforms in the Acropolis area and in the platform of warehouse the stretcher Bond was also used by the Harappan people.\textsuperscript{32}

**(iv) Header Bond:**

In this type of bond, all the bricks were laid as headers in every course of a wall. (Fig. 34) Every header in each course lies centrally over every header of the underlying course. It was also less strong bond. The walls of some houses in Block G at Lothal were constructed in Header Bond technique.\textsuperscript{33}

**(v) American Bond:** (Fig. 35)

The American Bonding technique was also used by the Harappan. In this type of bond a course of header was laid after every 5 or 7 course of stretcher. (fig.35) At some places the eastern wall of a house at Lothal was constructed in American Bond.

\textsuperscript{32} S.R. Rao (1979), \textit{op. cit}, p. 61.
\textsuperscript{33} S.R. Rao (1973) \textit{Lothal and the Indus Civilization}, p. 121.
(vi) Stack Bond:-

In this bonding technique the pattern made up of stretchers with each stretcher centered on the stretcher below it. All joints run vertically down the entire wall. It was not strong bond at all. It was used for decorative purposes. The mud-brick platform of the houses at Lothal was constructed with the help of this bonding technique.

(d) Architectural Tools:-

Harappans were master in building technology. They achieved the prodigious methods to establish their settlements in north-western part of the Indo-Pakistan subcontinent. It required favorable climatic conditions, knowledge of civil engineering, different type of tools and building materials and the skills in creating monumental architecture with an abundant availability of labour. The architectural plan and structures reveal that the Harappans had a good idea of geometrical instruments. Harappan used ropes for the measuring of bigger areas. A charred rope piece was found at Surkotada. Such ropes could be used for measuring large building like Great Bath, Granaries, dockyard etc. Some large buildings at Lothal, Kalibangan and Mohjenjodaro have the evidence of steps. The Harappan masons knew about the division, length, and height of the staircase. In the construction of stairways, the Harappans mesons divide the height and length of the staircase. The angles and division of

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34 S.R. Rao (1979), *op. cit*, p. 60.
steps were accurate according to their calculation.

They had a very good idea of accurate circles, squares and rectangles. They could divide a line into a given number of parts, drawing a perpendicular on a given line, transforming a square into a rectangle, parallelograms, rhombus of equal dimensions, etc.

(i) Scale:-

Harappan people used scale for linear measurement, four specimens of scales have been found at Mohenjodaro, Harappa, Lothal and Kalibangan. They used different types of materials for the making of scales. A scale made of ivory measuring 5×0.6ins found at Lothal. (Fig.36) It is marked with 27 lines covering a distance of 1.81 ins giving an average of 0.0689 in per division. These twenty divisions approximate to the Mohenjodaro scale of shell. (Fig.37) The distance between the five divisions in the Mohenjodaro scale is 1.32 ins which is almost equal to the
distance between 20 divisions 1.338 ins on the Lothal scale. It is interesting fact that the first ten division on the Lothal scale give a distance of 0.689 ins and if mean error is added, the distance measured is 0.699 (0.7) ins.\textsuperscript{35} This unit of length (0.7ins) is almost equal to the angula of Arthasastra. The Lothal scale may be said to be near the Mohenjodaro scale. Due to the smaller divisions the Lothal scale was more useful in measuring small lengths of the seals etc. The Lothal people used this scale to draw the plan of the building etc.

\textsuperscript{35} J.P. Joshi (2008), \textit{op. cit.} p. 160
A bronze scale found at Harappa. It has marking graduation lines at regular interval of 9.34 mm(fig38). A Shell scale found at Mohenjodaro. It has a full circle on one mark and five marks. A hollow circle was also carved unit. It is 0.05mm thick and each division on it is 6.7 mm. The distance between the five divisions was 33.52 mm. The length of the basic recurring of the scale has been taken as 67mm.36

The scale found at Kalibangan is made of terracotta. It was used for rough measurement or for drawing lines and not for precise measurement. (Fig.39) The scale found at Lothal and Mohenjodaro have been made with considerable precision and accuracy. The large divisions of the Lothal scale (25.56 mm.) are almost equal to an inch. Brij Bhushan Vij observes that 'the Indus civilization certainly knew the realistically "exact" value for the ratio of Pi and hence the measured dimension of the circumference of the earth was within their technological capability.'

36 J.P. Joshi (2008), op. cit, p.161
(ii) **Plumb-bob:**

Plumb-Bob was also used by the Harappans. Two plumb-bob were found at Lothal, these are made of terracotta. (Fig. 40) These are of two types, one of them has a vertical hole in which the string can be inserted vertically and in the other there is a horizontal hole on the knob, so that it can be suspended by passing a string through it. A perforated terracotta cylinder was placed over the knob. A plumb-bob of faience 7.2 cm in height was also found.

It is bud-shaped with two on the corner around to fasten thread with the central released weight to assess through top to bottom. The two side threads, perhaps to keep the central thread corrected at the centre. The type of tools were used by the Harappan masons for the layout of streets and houses to maintain the vertically of the structures and angles in the drain. Evidence of a plumb-bob was found at chanhu-Daro. It is 57.17 grams in weight and 2.0 ins. high. It has irregular and made up of yellow coloured lime stone. Its upper portion is round which suggests that it was used as plumb-bob. At Mohenjodaro the Great Bath

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38 E. J.H. Mackay (1943), Chanhudaro Excavation 1935-36, p. 229
and other important buildings were constructed with the help of plumb-bob.

(iii) Compass:-

Compass is also an important mason tool and it was used by the harapans to provide angles. Compasses have been found at Lothal and Dholavira. A hollow cylindrical object of shell having eight slits, four in the upper margin and four in the lower found at Lothal. This instrument can be used for producing angles of $45^0$, $90^0$, $180^0$ and so on unto $360^0$. Without the aid of such instruments it would not have been possible for the masons and architects to determine the alignments of streets, houses stairs and drains accurately. The original purposes of this instrument were to measure angles on a plain surface and in the horizon. The lines passing through opposite slits when drawn on plain surface cut at $45^0$ in the case of Lothal compass and at $30^0$ in the case of Kotada compass. The compass found at Kotada made of shell and similar to as found at Lothal. It has six slits on each of two margins. The same type of diagrams is noticed in ancient Greeks texts and they are the simplest devices used by an ancient navigator. The people of the other contemporary civilization did not know about the use of compass. It is now considered that two thousand years before the Greeks had thought of an eight fold division of the sky and horizon, the Harappans had already achieved it and devised an instrument to measure the angles.

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39 S.R. Rao (1979), op. cit, p. 74