

Analysis of terracotta scale of Harappan civilization from Kalibangan

The first urbanization of the Indian sub-continent is represented by the Harappan Civilization (3000–1600 BC), with the major centres being Mohenjodaro, Harappa, Lothal, Dholavira and Kalibangan. It is now well understood that the urbanization achieved by the Harappans was due to the economic advantage of a surplus economy. A consequence of this urbanization was the engineering skill achieved by the Harappan Civilization, as reflected in the elaborate town-planning and architecture. In this context, it is important to realize that such construction activities must have required the use of geometric tools for measurement (like scales, plumb-bob, etc.). The use of scales implies the utilization of some standard units of measurement. It is now well known that the Harappan Civilization used standard weights and measures¹. Engineering instruments related to length and weight are available in some of the Harappan sites².

It is evident that the Harappans possessed a good idea of geometrical principles as revealed by their intricate town-planning and use of specific units of measurement. The standardization of measurement is also evident from the standard manner in which the bricks were designed¹. The transmittance of Harappan techniques and crafts virtually unchanged to the historical and later periods in Indian history, has been further confirmed by a detailed re-analysis of the dimensions of the Delhi Iron Pillar³. This analysis utilized the basic Harappan unit of measurement of 17.63 mm. Danino^{4,5} has recently shown, after a detailed statistical analysis of available length measurements of several Harappan civilization settlements, that the basic unit of measurement is 17.63 mm. This was taken to mean the traditional Indian unit, the *angulam*. Further, 108 *angulams* make one *dhanus* (108 *angulams* = 19.04 m). Danino has demonstrated, through a simple procedure and with no a priori assumption, that this value of *dhanus* will result in all the dimensions of the important Harappan Civilization settlement of Dholavira, expressed as integral multiples of *dhanus*^{4,5}. It is interesting to note that the number 108 is held sacred in classical Hinduism, initially because of astronomical reasons⁶.

Some interesting objects related to the engineering profession were discovered

at Kalibangan². Notable among them were a crude terracotta length scale, a terracotta hour-glass, plumb-bobs, terracotta pans for balances and several weights. These objects have been described, including their detailed dimensions and weights, in the excavation report². The terracotta hour-glass appears to have been used for time-keeping. The plumb-bobs were of terracotta, faience and shell. The weights were of chert and agate.

This correspondence analyses the terracotta linear scale discovered at Kalibangan, to obtain further insights on the basic unit of measure of the Harappan Civilization. The terracotta scale appears to be a relatively inexpensive measuring instrument, based on the material of its construction. Scales made of ivory, metal or shell would have been relatively more expensive. This terracotta scale can throw new insights on the Harappan unit of measurement.

The total length of the Kalibangan terracotta scale is 122 mm (Figure 1). The

scale is damaged on both sides. It appeared to be slightly tapered in shape. The distances between the markings on the scale have been measured and the dimensions are shown in Figure 2. The marking on the scale can be described as follows. The measured distance between two major tick marks is 17.5 mm. The minor tick marks on the right, four together, make up 17.5 mm. Therefore, each minor tick mark on the Kalibangan scale corresponds to one-fourth of the major tick mark.

The markings in the Kalibangan scale approach the 17.5 mm standard that is also noticed in the Lothal (ivory)⁷ scale. Moreover, the direct connection between this standard unit and the unit in the Mohenjodaro (shell)⁸ and Harappan (metal)⁹ scales has been established¹⁰. The major tick mark is indicative of the *angulam*^{4,5}, which is equal to 17.63 mm. On the lower side, each *angulam* is divided into eight *yavas*. Most minor tick mark on the Kalibangan scale is equal to one-fourth



Figure 1. Crude terracotta scale discovered at Kalibangan.

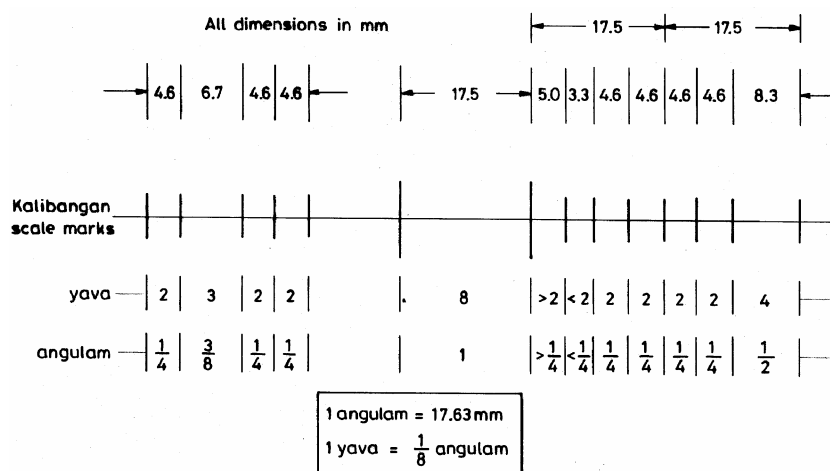


Figure 2. Technical analysis of dimensions of the Kalibangan terracotta scale.

of the *angulam* of 2 *yavas*, except the one that measures three-fourth *angulam* (Figure 2).

It is important to note that the unit of 17.5 mm was obtained precisely in the Kalibangan scale. It is likely that the measurement when marked on unbaked clay, would have contracted on shrinking due to the firing operation. This appears to have been taken into account in the design of the scale. The remarkable closeness of the Kalibangan scale to the Harappan units obtained from the Lothal⁷ scale is striking.

In summary, the Kalibangan terracotta scale offers conclusive proof that the basic Harappan Civilization unit of measurement may have been 17.63 mm, confirming the proposal of Danino.

1. Agrawal, D. P., *The Indus Civilization: An Interdisciplinary Perspective*, Aryan

Books International, New Delhi, 2007, pp. 132–139.

2. Joshi, J. P., *Excavations at Kalibangan, The Harappans, Volume II, Part I*, Archaeological Survey of India Report, 2007.

3. Balasubramaniam, R., *Curr. Sci.*, 2008, accepted.

4. Danino, M., *Man Environ.*, 2008, **33**, 66–79.

5. Danino, M., *Puratattva*, 2005, **35**, 76–84.

6. Kak, S., *The Astronomical Code of the Rgveda*, Munshiram Manoharlal, New Delhi, 2000, p. 101; 124.

7. Rao, S. R., *Lothal: A Harappan Port Town*, Manager of Publication, Government of India Press, Delhi, 1955–62, vol. II, pp. 689–690.

8. Mackay, E. J. H., *Further Excavation at Mohenjodaro*, Manager of Publication, Government of India Press, New Delhi, 1938, pp. 601–611.

9. Vats, M. S., *Excavation at Harappa*, Manager of Publication, Government of India Press, Delhi, 1940, pp. 365–366.

10. Mainkar, V. B., In *Frontiers of the Indus Civilization* (eds Lal, B. B. and Gupta, S. P.), Books and Books, New Delhi, 1984, pp. 141–152.

Received 12 December 2007; revised accepted 21 July 2008

R. BALASUBRAMANIAM^{1,*}
JAGAT PATI JOSHI^{2,†}

¹Department of Materials and Metallurgical Engineering, Indian Institute of Technology, Kanpur 208 016, India

²Formerly with Archeological Survey of India, New Delhi

[†]Now deceased

*For correspondence.

e-mail: bala@iitk.ac.in

CURRENT SCIENCE

Display Advertisement Rates

India

| No. of insertions | Size | Tariff (rupees) | | | | | |
|-------------------|-----------|-----------------|----------|--------------------|----------|-----------------|----------|
| | | Inside pages | | Inside cover pages | | Back cover page | |
| | | B&W | Colour | B&W | Colour | B&W | Colour |
| 1 | Full page | 10,000 | 20,000 | 15,000 | 25,000 | 20,000 | 30,000 |
| | Half page | 6,000 | 12,000 | – | – | – | – |
| 6 | Full page | 50,000 | 1,00,000 | 75,000 | 1,25,000 | 1,00,000 | 1,50,000 |
| | Half page | 30,000 | 60,000 | – | – | – | – |
| 12 | Full page | 1,00,000 | 2,00,000 | 1,50,000 | 2,50,000 | 2,00,000 | 3,00,000 |
| | Half page | 60,000 | 1,20,000 | – | – | – | – |

Other Countries

| No. of insertions | Size | Tariff (US \$) | | | | | |
|-------------------|-----------|----------------|--------|--------------------|--------|-----------------|--------|
| | | Inside pages | | Inside cover pages | | Back cover page | |
| | | B&W | Colour | B&W | Colour | B&W | Colour |
| 1 | Full page | 300 | 650 | 450 | 750 | 600 | 1000 |
| | Half page | 200 | 325 | – | – | – | – |
| 6 | Full page | 1500 | 3000 | 2250 | 3500 | 3000 | 5000 |
| | Half page | 1000 | 2000 | – | – | – | – |

Note: For payments towards the advertisement charges, Cheques (local) or Demand Drafts may be drawn in favour of 'Current Science Association, Bangalore'.