Kolam designs, a Dravidian art form, in Indus Valley Civilization

Preprint · March 2019

DOI: 10.13140/RG.2.2.14206.02885

1 author:

Rethinasamy Kittappa

10 PUBLICATIONS **95** CITATIONS

SEE PROFILE

Kolam designs, a Dravidian art form, in Indus Valley Civilization

R. Kit Kittappa
formerly Lincoln University, Pennsylvania USA
rk_kittappa@yahoo.com

It will be shown in this paper that a sign in a seal of the Indus Valley Civilization (IVC) (3200 BC -1700 BC) is formed by overlapping two designs of the Dravidian art form called *kōlam.* This art form is practiced to this day in South India. Because a paper was presented at a recent conference [2] by the author, on the mathematical properties of kolam, it has been possible for the author to formulate a definition of a kolam and establish that the design, mentioned above, is a kolam, in spite of some variations that possibly happened during the long passage of time. It will also be shown that another sign is also a kolam design, after "restoring" changes that possibly happened during handling the seal or reproducing the sign.

The progressive period of IVC when the seals were in use is also known as the Harappan period or Harappan Civilization, after the name of a present day town, Harappa, situated near the site of one of the larger cities of IVC. The seals are small in size and carry pictures and/or linear sequences of signs. According to Lawler [3], rudimentary signs began to appear by 3200 BCE, began to diminish by 1900 BCE and vanished entirely by 1700 BCE.

These signs have been considered to be a script for a long time. Many have attempted to decipher the seals but there has been no general consensus to accept the "decipherments". A paper in 2004 put forth the idea that the sign sequences do not encode speech but possibly had religious, political or social functions or were just memory aids. In this paper, no attempt to decipher the message in any seal and no attempt to find out how any sign should be read will be made.

The most popular proposal for the language of the seals has been Proto-Dravidian and this proposal is called the Dravidian Hypothesis. This paper could possibly lend credence to this hypothesis.

1**. A design found in a seal from IVC**

Figure 1: IVC seal 478-A. Only the left most sign is of interest in this paper.

The seal in Figure 1 is 478-A in the Corpus by Parpola and Joshi [5]. The leftmost sign in the seal, which is the only sign in the seal that will be considered in this paper, is strangely not found in the well known sign-lists that have been compiled by Mahadevan [4], Parpola [6], Brian Wells [10] and Kumbhar and Buriro [7]. These lists are intended for signs that are supposed to have linguistic value. So, it appears that the sign under consideration was not included because it was possibly thought of as a decoration or it was possibly not readily available when the lists were compiled.

Another sign  , E502 in NFM-Indus Script by Kumbhar and Buriro [8], which is also No. 265 in the list of signs by Parpola [6], appears to share some similarity to the leftmost sign in the seal in Figure 1. It will be discussed later, in this paper.

From a long time, kolam has been drawn on the ground, with rice powder, at the entrances of South Indian homes, marriage halls and places assigned for worship. Kolam is a Tamil word meaning “form”. Tamil is one of the Dravidian languages spoken in South India. The word kolam has been used at least from the 17th century onwards, as seen from Tamil literary works like *Maturai Mīnāṭci Ammai Kuṟam*, (verse 6) by Kumara Guruparar and *Thiru Kuṟṟāla Kuravañci* (song 56, 1) by Tirikūda Rāsappa Kavirāyar. These literary works say that the ground must be smoothed out and then kolam must be drawn, as is the practice today. Professor Rukmani [9] writes that during the period of the ancient Tamil Academy called the Sangam (also the Last Sangam or the Third Sangam), 400 BC to 200 AD, kolam was called *vari* (Tamil: *vari* = straight or curved line). Use of this term can be seen in Sangam works like *Pattiṉapālai* (verse 165) and *Naṟṟiṉai* (verses 123 and 378).

The leftmost sign in Figure 1 appears to be the image of a design, made with strings and twelve wooden triangles framed on a rectangular wooden board. A model constructed by the author can be seen in Figure 2. The description of the method of construction of the model will be given here to show that such a model can be constructed. A dot was painted at the center of each triangle. Eight holes, two on each side of the frame, just large enough for the string to pass through, was made. For each of the twelve triangles, a horizontal hole from one midpoint of a side to another was made, for the string to pass through and groves along the edges of the triangle were made to hide the string.

Each interior triangle was kept flat on the board by passing a smaller piece of string through the horizontal hole in the triangle and through two holes on the board under the triangle. The string was tied at the back of the board. Notches, on the underside of the grooves, was made to hide the string. Now, a long string was passed through the holes in six triangles, two at the top, two of the top triangles along the sides and two of the bottom triangles in the interior, after passing the string through the corresponding holes on the frame. The remaining six triangles were similarly connected in an upside down fashion. We have redrawn the design for clarity in Figure 3.

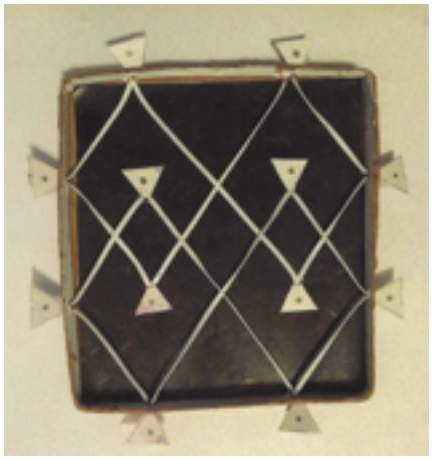


Figure 2: A model of the object depicted in the left most sign of the seal in Figure 1.

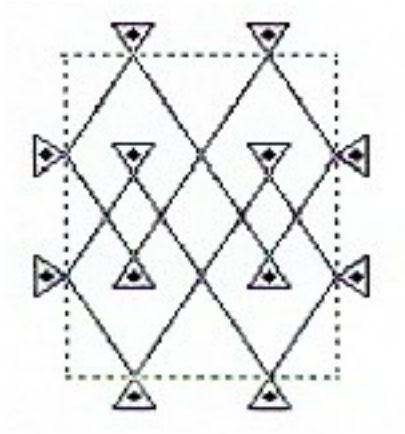


Figure 3: Diagram of the left most sign in Figure 1, redrawn for clarity.

The frame, shown in dotted line in Figure 3, is not apart of the sign and hence will be omitted hereafter, as in Figure 4. The components of the design in Figure 4 are shown in Figure 5.

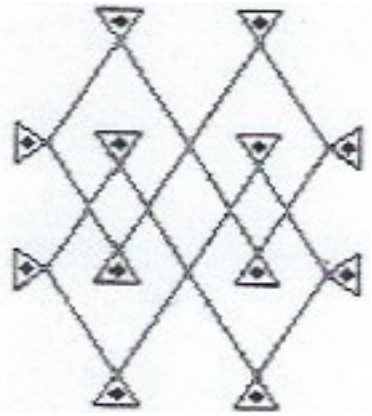


Figure 4: The design in Figures 1, 2 and 3 without the frame.

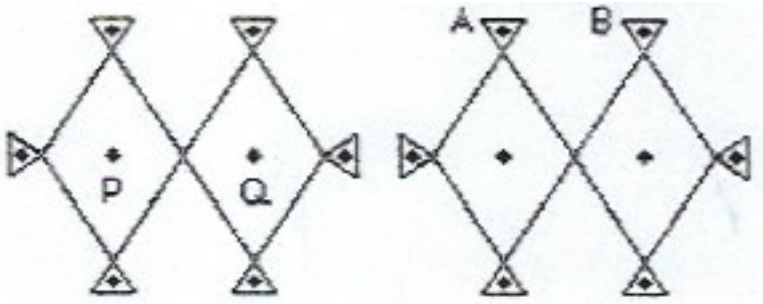


Figure 5: The components of the design in Figure 4. If dots A and B are overlaid on dots P and Q respectively, Figure 4 is obtained.

3. Transformation of the design

Kawai et al [1] have used tiles to construct kolams. Other researchers in Computer Science have also mentioned tiles. It should be kept in mind that the tiles are not part of a kolam. A definition of a kolam that depends on tiles and the rules to put the tiles together will be formulated. This definition would allow us to identify, with sufficient certainty, that the designs in Figure 5 are kolams. Such a definition for an artistic form is possible because kolams have mathematical properties as shown by Kittappa [] in a paper that was presented recently at a conference.

One of the two identical designs shown in Figure 5 is shown in Figure 6, with rectangular non square tiles, all of the same size. However, the tiles shorter sides are touching the tiles containing the diamonds. However, the middle two tiles, at the top and bottom, have triangles on the shorter side of the tile and each of the middle tiles, on the left and right sides, have the triangle on the longer side of the tile. So, these two kinds of tiles cannot be interchanged, even after rotating them. This loss of symmetry can be removed by squishing the diamonds into squares. Then all the tiles become squares as in Figure 7. The triangles have also been drawn out to become teardrops to correspond to modern kolam. Mathematicians will recognize that the designs in Figures 6 and 7 are

equivalent topologically (in rubber-sheet geometry). That is, if one of the designs is drawn on a rubber-sheet, it is possible to stretch and/or squish the rubber-sheet and change one design into the other. Mathematically speaking, kolam is a pseudograph in Graph Theory which is a part of Topology. Archaeologically speaking, it can be said that the design in Figure 6 has evolved into the design in Figure 7, in course of time.

Figure 7, excluding the tile outlines, will be immediately recognized as a kolam by kolam artists. However, instead of depending on a visual inspection, the definition of a kolam, to be formulated, will be used to identify the design, as mentioned above. Mathematicians will recognize that the designs in Figures 6 and 7 are equivalent topologically (in rubber-sheet geometry). That is, if one of the designs is drawn on a rubber-sheet, it is possible to stretch and/or squish the rubber-sheet and change one design into the other. Mathematically speaking, kolam is an entity in Graph Theory which is a part of Topology. Archaeologically speaking, the design in Figure 6 has evolved into the design in Figure 7, in course of time.

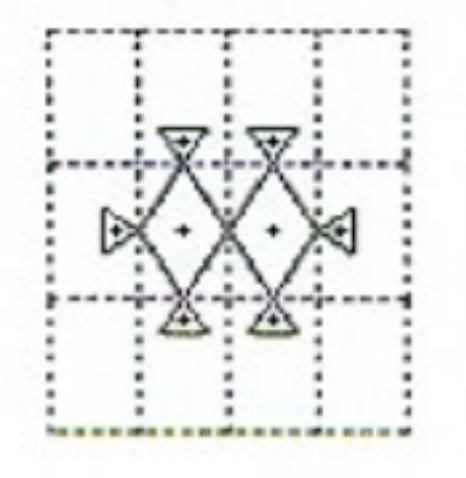


Figure 6: One of the design in Figure 5 with tiles. (Size has been reduced for convenience.)

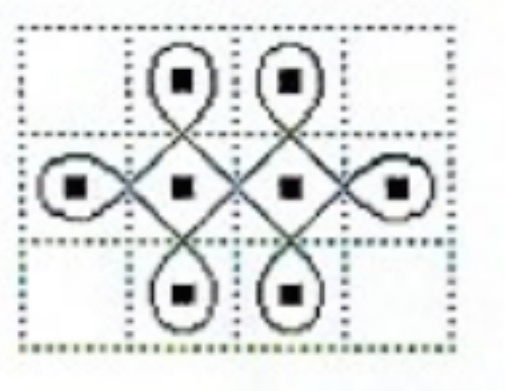


Figure 7: Diamonds in Figure 6 have been changed to squares and triangles to teardrops.

Kawai et al [1], use six kinds of tiles (16 if rotation is not allowed) and they are shown in Figure 8. The design in Figure 7 uses an empty tile, a tile not found in Figure 8. However, kolam artists switch an empty space with a dot in a circle (a dot-circle). This convention will be adopted here and an empty tile and a tile with a dot-circle will be considered equivalent. When we have replaced empty tiles with tiles with dot-circles and all tiles are equal squares, we will say the kolam is in **standard form** (Figure 9).

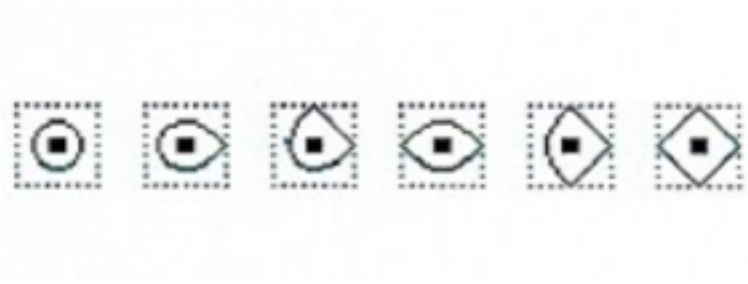


Figure 8: Tiles used by Kawaii et al.

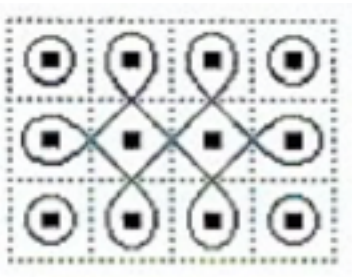


Figure 9: Figure 7 with dot-circles introduced.

4. The formation of the different kinds of tiles

In Figures 6, 7 and 9, we observe that if the pattern in a tile touches the pattern in another tile, it will do so only at the mid point of the sides of the tiles. We will call such points **attraction points**. (Kawai et al [1] call them as "connecting terminals".) We will consider that each kind of tile is supposed to have a circle in it but the attraction points attract and change the circle into different shapes. See Figure 8. When there are no attraction points in a tile, the pattern is a dot-circle. When there is one attraction point, the circle gets attracted by that point and becomes a teardrop. When there are two attraction points, one each on adjacent sides, the points attract the circle into a shape like that of a bread slice. If two attraction points are on opposite edges, the points attract the circle into a shape like an eye. When there are three attraction-points the attracted shape is like a fan. When there are four attraction points the attracted shape is a square. We have discussed all possible cases of choosing mid points of the sides of a square. Hence, there can be only six kinds of tiles.

5. Definition of a kolam

Kawai et al [1] did not develop rules to put together the tiles to generate a design similar to that in Figure 7, probably because they were interested in developing graphical tools that will create kolams. They have not given an explicit definition of a kolam either. We will fist formulate the rules for putting the tiles together and then devise a definition for a kolam.

Rules for putting the tiles together

(a) Tiles should be placed such that each attraction point should be touching another attraction point that is on another tile.

(b) Tiles should be placed such that the dots in the design should form a rectangular

pattern.
(c) Tiles should be allowed to be rotated through multiples of 90°.
(d) As many tiles of each kind, as needed, should be available.

An immediate corollary of Rule (a) is that there can be no attraction points on the outermost rectangular border that encloses all the tiles. In Rule (b) if the rectangular pattern of dots has m rows and n columns, then then the design will be called a design of **size** m**x**n. The size of the design in Figure 7 is 3**x**4.

Definition of a kolam
A design is called a kolam if and only if it can be constructed with one or more of the six kinds of tiles in Figure 8, using the rules described above for putting the tiles together. It is also stipulated that when tiles with a dot-circle are replaced with empty tiles, the resulting design will also be called a kolam. It is also stipulated that the topological equivalent of a kolam will also be called a kolam. (This implies that if the tear drops are replaced with triangles and the square tiles are stretched into rectangles, it would still be a kolam.)

It can now be seen that the designs in Figures 6 and 7 are 3**x**4 kolams. So, the left most sign in the seal in Figure 1 is a design with two layered 3x4 kolams. Mathematically speaking, only the attraction points are important in a tile. A unique standard form of a kolam can be recovered from a design that is created with tiles having any pattern within the tiles but connected to appropriate attraction points, if any, and obeying the rules, above to put together the tiles. So, considering a triangle and a teardrop as equivalent is again justified.

6. A discussion of a second sign

Earlier it was mentioned that the sign  is E502 in NFM-Indus Script by Kumbhar and Buriro [8] and is also No. 265 in the list of signs by Parpola [6]. The marks in the interior of the square appear to be identification marks possibly introduced by investigators With that assumption the marks in the interior will be removed. Also, the darkened triangles will be replaced with triangles with a dot and a dot will be introduced and a dot will be put in the center of the square. If these “restorations” are justified then a rotation through 45° can be shown to be a kolam according to the definition of a kolam. (See Figures 10 (a), (b) and (c)) Then E502, with some “restorations, is a kolam.

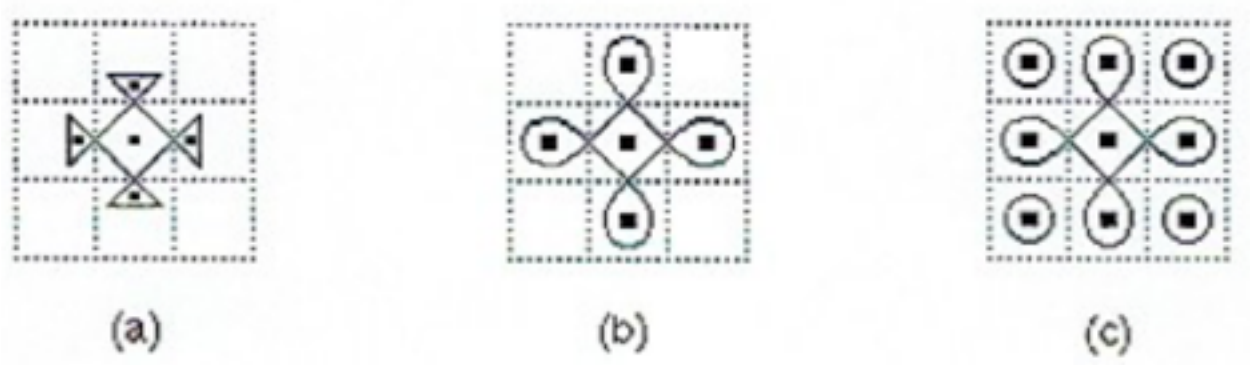
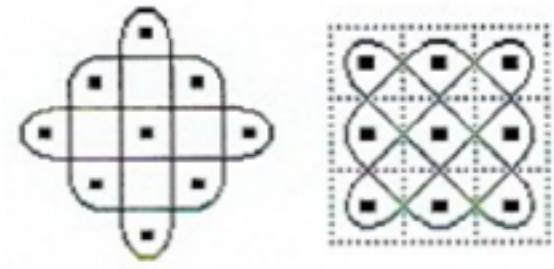


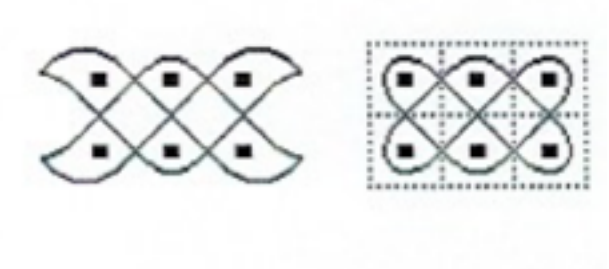
Figure 10: (a) The design in sign E502 has been (i) rotated through 45°, (ii) the "scratches" in the interior of the square have been removed, (iii) a dot has been put in the center of the square, (iv) dark triangles have been changed to triangles with a dot and (v) tiles have been introduced. The designs (b) and (c) are the modern forms of (a).

7. Even in modern kolams that are drawn by artists, some modifications may be necessary to consider them systematically (mathematically). Figures 11(a) and 12(a) are examples of common designs that are being used in South India, today. Figures 11(b) and 12(b) respectively are the corresponding kolams in standard form. Figure 11(b) was obtained with a 45° rotation and 12 (b) after trimming embellishments. The designs in 11(b) and 12 (b) are kolams according to definition in Section 5.



(a) (b)

Figure 11: After giving a rotation of 45°, to figure in (a) and introducing tiles a a 3x3 kolam is obtained.



(a) (b)

Figure 12: After artistic embellish -ments in (a) are trimmed the 2x3 kolam in (b) is obtained.

8. Kolam as an art form today

Kolams are supposed to be drawn with rice powder. However, today powdered whit stone is also used. First dots are put down. Then lines, straight and curved, going around the dots are drawn. Each kolam can have one or more components each of which can be drawn continuously in one stretch. This is a mathematical property (Kittappa [2]) arising from the fact that four lines lines meet at each intersection (vertex, node).

Kolam is an abstract art form and does not represent any object. Nowadays, there are people, especially in urban areas of South India, who mistakenly consider any picture drawn on the ground is a kolam. This trend has arisen because kolam-competitions began to be judged by celebrities and not by kolam-artists. The celebrities have been giving prizes to eye-catching colorful drawings that are not necessarily kolams.

Today, the following five types of designs are being drawn on the ground today in South India.

(a) kolam with white dots and white lines with each dot being totally enclosed.
(b) rangōli, a design in which enclosed regions are filled in with color. It appears to be of North Indian origin
(c) geometrical designs which appears to be of recent origin
(d) drawings of objects like those related to the Hindu religion, birds and flowers
(e) a combination of the above types of designs

There are people who call all of them as kolams. The prevailing confusion has prompted some to call kolam as pulli kolam (Tamil: *pulli* = dot) or kambi kolam (Tamil: *kambi* = wire).

An examination by the author of the available literature on sand drawings and other designs in many cultures around the world shows that only some and not all of the Sona drawings of the Chokwe people of Angola in Africa, as given by Gerdes [7], can be changed to kolams with minor modifications. The Sona drawings are not abstract and are drawn by men for story-telling. Kolams are abstract decorations that have been drawn by women, especially young women.

As an aside, we note that the kolams in Figure 10 have one diamond or square surrounded by triangles or tear drops and the kolams in Figures 6 and 7 have two attached diamonds or squares surrounded by triangles or teardrops. In fact, this pattern can be extended linearly to three, four, etc., diamonds/squares. This happens to be the molecular structure of the alkane series C_nH_{2n+2} of organic chemistry, with the diamond representing carbon atoms and the triangles representing hydrogen atoms. The author is definitely not implying that this molecular structure was known in the IVC. Sadly, this had to be said because there are people in India, in high positions, who have claimed with

"national" feeling that all scientific inventions and discoveries were known in ancient India and were stolen by the West. By attaching more diamonds (squares) appropriately, the pattern can also be extended to cover the whole plane.

9. Conclusion

In this paper, a definition of a kolam, an ancient Dravidian art form practiced to this day in South India, has been formulated using the kolam tiles mentioned in Kawai et al [1]. Rules to put together kolam tiles has also been set down. The leftmost sign in the seal, 478-A in the Corpus by Parpola and Joshi [5], has been shown to consist of two identical 3x4 kolams laid one over the other with a shift.

Another sign, E502 in the NFM-Indus Script list by Kumbhar and Buriro [8] which is also No. 265 in the list by Parpola [6], appears to be of questionable reproduction. We assume that certain aspects of the sign, that became changed during handling or reproducing the seal, can be restored. The "restored" design is shown to be a kolam,

The results of this paper may add credence to the Dravidian Hypothesis for the language of the seals.

References

1. Kawai, Yasuo, Kosuke Takahashi and Shojiro Nagata, 2007, PsyKolo3D — Interactive, Computer Graphical Content of "kolam" Design, Forma, 22, 113-118
2. Kittappa, Rethinasamy, 2018, Combinatorial Aspects of Kolam, an Art Form of South India, paper presented at The Sixth Annual Conference for the Exchange of Mathematical Ideas, Embry-Riddle Aeronautical University Prescott, Arizona, USA. http://noetherian.net/conference23/ program.html
3. Lawler, Andrew, 2004, The Indus script: Write or wrong?, Science 306, 2026-29. Also available online at http://science.sciencemag.org/content/306/5704/2026.full
4. Mahadevan, Iravatham, 1977, *The Indus Script, Text Concordance and Tables*, Archaeological Survey of India, New Delhi. Also available at, http://www.rmrl.in/wp-content/uploads/2014/02/papers/5a.pdf
5. Parpola, Asko and Jag Pati Joshi, 1987, *Corpus of Indus seals and Inscriptions*, Helsinki : Suomalainen Tiedeakatemia
6. Parpola, Asko, 2017, Mohenjodaro, Corpus by Asko Parpola, Sign list of the Indus script, http://www.mohenjodaroonline.net/index.php/indus-script/corpus-by-asko-parpola
7. Paulus Gerdes, 1999, *Geometry from Africa, Mathematical and Educational Explorations*, Mathematical Association of America.

8. Kumbhar, Shabir, Amar Fayaz Buriro, 2017, Mohenjodaro, Indus script, National Fund for Mohenjodaro, http://www.mohenjodaroonline.net/index.php/indus-script
9. Professor Rukmani, 2016, Tamiḻar paṇpāṭṭil kōlaṅkaḷ, Siragu. http://siragu.com/author/rukmani/
10. Wells Bryan, 1998, *An Introduction to Indus Writing*, a Thesis, Department of Archaeology, Calgary, Alberta, Canada. Also available at https://www.scribd.com/document/32368939/An-Introduction-to-Indus-Writing