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SPECIFICATIONS FOR BRICK MASONRY ACCORDING TO *SAMARĀṄGANA SŪTRADHĀRA**

R.P. KULKARNI

B-3/3 CDO Quarters
MERI-CDO Colony
Nasik-422004

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INTRODUCTION

Detailed specifications for brick masonry (in lime mortar) are given in chapter 41 of *Samarāṅgaṇa Sūtradhāra.* Its title is *Cayavidhiḥ* and it comprises 33 stanzas. Part of the information is repeated in chapter 48 dealing with faulty construction of houses.

In chapter 41, the first four stanzas specify in a nutshell good and bad quality construction of brick masonry. Stanzas 5 to 20 describe different types of faults in brick construction and the variety of calamities that may befall the owner of the house if these defects are not avoided. This information is again given in chapter 48, stanzas 44 to 57. Stanzas 21 to 31 describe the methods and measures required to be taken, so as to avoid defective construction of brick masonry. Thus, the chapter deals with every aspect of specifications for brick masonry.

GOOD QUALITIES OF BRICK MASONRY

The author mentions 20 good qualities of brick masonry and state that qualities opposite to these are the bad points of brick masonry. These 20 points of good quality brickwork are :

1) *Suvibhakta :* Properly jointed, *i.e.* where the joints are properly broken and are not located in one vertical line.

2) *Samaḥ :* Brickwork shall be level at each layer.

3) *Cāru :* Pleasant looking. The choice of the bond should be such that it

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not only provides the necessary strength but also permits variation in laying of bricks so that the masonry looks beautiful.

4) *Caturasraḥ :* Corners of the wall and also angles between walls shall be perfect right angles.

5) *Asambhrānta :* The brickwork shall be unidirectional and the bricks laid shall not look as if scattered in all directions.

6) *Asandigdham :* There should not be any gaps or hollows between inside and outside layers of brickwork when viewed across.

7) *Avināśya :* The brickwork shall be strong, imperishable.

8) *Anyabarhitam :* The masonry should not spread in any direction.

9) *Anuttamam* or *Anumattam :* The brickwork shall be of approved quality.

10) *Anudvṛttam :* The layers of bricks shall be perfectly horizontal and level throughout the length of the masonry. The bricks should not be laid in a manner that the layers form arcs with long radii.

11) *Akubjam :* The brickwork should not be crooked in its breadth.

12) *Na pīḍitam :* There shall not be any foreign material in between the brickwork. Stones, wood pieces, *etc.* are not to be introduced.

13) *Samānakhaṇḍam :* Bricks of the same diamensions in length, width, and thickness shall be used so that the height of the layers and the length between the joints in one layer remain the same throughout the length as well as the width of the brick masonry.

14 & 15) *Ṛju antam* and *antaraṅgam :* The walls should be straight from outside as well as from inside.

16) *Supārśvam :* The sides of the walls shall be goodlooking.

17) *Sandhisuśliṣṭam :* The joints should be of the same width. The joints shall be horizontal and level throughout their length.

18) *Supratīṣṭham :* Bricks shall be thoroughly bedded in mortar.

19) *Susandhī :* All joints shall be properly flushed and packed with mortar so that they are completely filled with mortar and no hollow is left anywhere.

20) *Ajimham :* The brick masonry shall be perfectly straight and in plumb.

There are 20 points of bad quality work in contradiction to the above points of good quality.

DIFFERENT TYPES OF DEFECTS IN BRICK MASONRY

a) The brickwork should not spread in any direction, east, west, south or north. Different calamities may befall the owner if these faults are not avoided.

b) Masonry should not form cracks or should not fall down, otherwise calamities will befall the owner.

c) The lengths of the diagonals of wall shall be such that the corners of the wall are perfect right angles. If the thickness of the wall is not uniform throughout its length but is thicker at one end, the diagonal of the wall shall not fulfil the Baudhāyana theorem, *viz,* the square of the diagonal is equal to the sum of the squares of the sides in a right angled triangle. This is taken as a major defect in brick masonry. The author enumerated different types of calamities that would befall the owner depending upon the wrong spread of the wall at different corners. From the gravity of these calamities it is to be inferred that in no case this defect is allowed to creep in the masonry.

d) If the masonry started spreading in all directions in its width, it would have many protuberances and the wall will have shape like the body of a goose. This type of construction is not only faulty but increases the cost of construction so much that the owner of the house becomes poor and finally has to run away.

e) On the other hand if the width of the wall is thinner at some places, the construction is called *Brahma* (?) and the owner has to suffer displeasure of the king in consequence of it.

f) If the thickness of the wall is less in the central portion (along length) and is more at the ends, it is called a *tanumadhya* fault and the owner may suffer from hunger.

g) Each layer of brick of the wall shall be perfectly level. If the corners are at a higher level in comparison to the middle part of the layer, the defect is called *nimata* and shall be avoided.

h) If the layer of brick is having all the corners at a lower level in comparison to the middle portion, the fault is called *kūrmonnata.* It is a very great defect in masonry and shall be avoided.

i) If some of the corners are at a lower level and others at higher level in comparison to the middle portion, the fault is called *draviṇakṣaya* and may lead to the loss of wealth as its name implies.

METHODS AND MEASURES TO AVOID THESE DEFECTS

The methods given are as old as that of Baudhāyana period, and are standard methods followed by masons even today.

a) The level of each of the brick layer is to be checked by using a *water level* and it is to be seen that each layer is perfectly level and horizontal in the middle as well as at the corners.

b) To ensure that the corners of the wall are perfectly rectangular and also that the angles between walls are perfect right angles the procedure given below is followed :

'Take a length of twine twice the length of the wall (say x), and divide it in two lengths 5/4 x and 3/4 x and make a mark at the division. It is called *nirancchana.* Place the twine along the length of one of the walls so that the ends of the twine be at the two corners of that wall. Then hold the *nirancchana* between forefinger and thumb and stretch the twine. The location at which the *nirancchana* is placed, should be along the length of another wall which is then at right angle to the first wall.'

This method is also used to ensure that the length and width of the same wall are at right angle to each other. This method of obtaining a perfect right angle is given in Baudhāyana's *Śulbasūtra* (1.32-35). This is the famous 3:4:5 method of getting a right angle triangle as $3^2 + 4^2 = 5^2$ and the method is used from the period of Baudhāyana or may be earlier, even to this day.

d) In order to ensure that the joints are equidistant as well as are broken along the vertical, and are horizontal along the length of the walls, brickbats shall not be used. Brickbats may be used when ends are to be adjusted, and in those cases also are to be placed not at the end but in the middle of the layer. Bricks not having parallel sides shall not be used or these are to be made of parallel sides by breaking the protruding part.

e) Bricks are to be so laid that the wall is perfectly vertical. For this purpose repeated use of the plumb bob shall be made. Also bricks are to be placed in such a manner that they do not touch the twine placed along the length of the wall. These measures ensure that the thickness of the wall is the same throughout its length and height, and also that, it is perfectly vertical. These measures are standard and are used even today.

By the use of the above methods, masonry is to be constructed without the defects mentioned earlier.

DISCUSSION

It is noted that points indicating good quality brick-work are enumerated and defects in brick masonry that may creep in because of negligent work are described. Methods and measures to be adopted, so that these defects in masonry are avoided, are also described. Different types of calamities mentioned along with defects are not described here as there is no logic behind them except presumably the intention that the owner of the house should scrupulously try to avoid defective construction of brick masonry.

Modern specifications described in the Maharashtra State P.W.D. Handbook are almost similar to those given in *Samarāṅgaṇa Sūtradhāra* of King Bhoja. This is, of course, not surprising as the art and science of brick laying was in an advanced state in India even at the time of Indus civilization.

In any specification of construction, it is necessary to specify the quality of material to be used. It is noted that the specifications for good quality brick as well as of lime mortar are not given in this chapter, nor covered anywhere else in the book.