

# USE OF SQC TOOLS IN SPECIFICATION OF COMMON BURNT CLAY BRICK

Sujitkumar S. Thorat<sup>1</sup>

<sup>1</sup>Civil and Environmental. Engg. Depart., V.J.T.I. Mumbai,( India)

## ABSTRACT

*Now a day's poor quality construction is going on because of insufficient specification, no proper use of specification on ground, inappropriate writing of specification leads poor quality construction. So it is need to make specifications accurate, easy to understand, with appropriate limitations. If quality is to be improved, more attention must be given to quality control. The brick specification becomes stronger with the use of SQC tools and proper writing of the specification. This study shows how the SQC tools and their use can be incorporated into the common burnt clay brick specification. Finally it concludes the use of SQC tools results specification to become more useful and workable on the ground, easy to understand and maintained proper quality control.*

**Keywords:** brick Specifications, Quality control, Record keeping, Statistical quality control, SQC tools, writing of specification, etc.

## I. INTRODUCTION

Today, whatever specification used for brick material is different for different organisation. These specifications have various problems due to its insufficient provision, complicated writing, and less effort spending on quality control. These problems are leading to poor quality construction. So it is need to make specifications accurate, easy to understand, with appropriate limitations. The increased use of statistics offers potential benefits in the various areas such as project management, improved project quality, etc[1]. So, the use of Statistical quality control (SQC) tools in brick specification can help to improve the specification. The SQC elements consists sampling, defining lot size and sample size, addition of material characteristic to be tested, test procedures, acceptance plan, record keeping proformas, etc[2]. The paper contains the description about problems regarding existing specification, and the solutions for that in terms of statistical quality control. By the use of these tools in specification will helps to give information about brick material and proper quality control. This paper carried out the study of SQC tools in common burnt clay brick. To avoid defected brick material being accepted will need to concentrate on acceptance of brick material. Acceptance plan helps to make decision on acceptance or rejection of a brick material.

## II. COMMON BURNT CLAY BRICKS

After the study of existing brick specifications it comes to know the available specifications are not fully specified, these are unclear and doubtful, the poor writing of specifications, having various drawbacks leads to poor quality construction. And also the existing specifications are missing to use the Statistical quality control tools. The Source used as an existing specification for brick material is CPWD's brick Specification and other

local organisation's specification related to the brickwork [3]. So in this section the problems regarding the existing specification and solution in terms of SQC tools are discussed.

## 2.1 Brick Material Acceptance by LOT to LOT basis

The acceptance of a brick material on the basis of taking fewer samples and not in regular time interval has the possibility of accepting defected brick materials which cause poor construction. For that reason the brick materials accepted on lot to lot basis with compliance of test results and their requirements is very essential and it helps to maintain the quality in construction. Due to the testing on samples at regular time interval by lot to lot basis helps to get the required quality of construction. It helps to minimize the risk of defected items being accepted. To maintain the quality of materials and making the decision of acceptance or rejection of the material, it is important to use lot to lot basis concept. The modification made in the specification by adding following sentences.

- The Bricks are accepted on LOT to LOT basis with compliance of the acceptance criteria given in to the specification.
- The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

## 2.2 Dimension Table

The existing specifications included the dimension table in which the modular and non modular bricks combined together. So, for the clear understanding and with the use of updated IS codes the dimension table of bricks is modified. The changed dimension table is used in which the standard modular size and the non modular size of bricks are given in to the separate tables helps to easily understand.

2.1 The standard modular size of common building bricks shall be as follows

Length(L) mm	Width(W) mm	Height(H) mm
190	90	90
190	90	40

2.2 The following non-modular sizes of the bricks may also be used

Length(L) mm	Width(W) mm	Height(H) mm
230	110	70
230	110	30

2.3 for obtaining proper bond arrangement and modular dimensions for the brick work, with the non-modular sizes, the following sizes of the bricks may also be used,

Length(L) mm	Width(W) mm	Height(H) mm
70	110	$70\frac{1}{2}$

### 2.3 Material characteristics to be tested

In the existing specification there is no clear understanding regarding the tests which are carried on brick material. So addition of this section in the specification helps to know the contractor the tests are to be carried on brick material. This is excellent to know the contractor which tests to be carried on the material and he will work on the same. A material characteristic to be tested is an important section of SQC based specification. the change made in brick specification as below,

- Materials Characteristics to be tested

Samples of bricks shall be subjected to the following tests:

- (a) Dimensional tolerance.
- (b) Water absorption.
- (c) Efflorescence.
- (d) Compressive strength.

### 2.4 Sampling, method and location, LOT and Sample sizes [4, 5]

This is an important part of the SQC based specification. In which the sampling procedure and the sample location are mentioned. This helps to contractor to take the sample from a specified location and the procedure for sampling. To avoid any confusion need to mention location of sample. Adding Lot and sample size helps to know the quantity of the lot and the respective sample size. While in existing specification these properties are missing. So, need to add these properties into specification. The lot and sample size should be mentioned in specification. The lot and sample sizes are mentioned as per IS 5454: 1978. These respective changes shown below,

Sampling: Method and Location, Lot size and Sample Sizes

- The Random Sampling method should be used in accordance with IS 4905: 1968 for sampling.
- The sample shall be taken by one of the locations given in below so as to yield the number of bricks required.
- If Sampling in Motion –
  - The sample shall be taken while the bricks are being moved, i.e. during loading or unloading.
  - The lot should be divided into a number of convenient portions i.e. Sublot
  - Approximately equal numbers of bricks should be drawn from each of these portions at regular intervals, such that the requisite number of bricks for inspection and testing is provided.
- If Sampling from a Stack –
  - When a sample takes from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of bricks drawn from each section.
- If Sampling from Lorries or Trucks –
  - The sample bricks shall be taken from a number of lorries/trucks such that the equal number of bricks is drawn from each of the lorries/trucks which are the number of bricks required for the inspection and testing is provided.

## 2.5 Acceptance Criteria for Bricks

In existing specification the acceptance criteria is missing. But, this is an important part of the SQC based specification, it helps in decisions making about the acceptance and rejection of a brick material. The acceptance criteria include the number of acceptance characteristics to be tested and acceptance charts. In acceptance plan by using statistics it will confirm that what percent of the material is within the specification limit. And then the material should accept or reject on the basis of predefined acceptable percentage. So, it is need to mention procedure of constructing acceptance plan in brick specification. In this section the acceptance plan procedure explained.

Acceptance:

- An Engineer should determine the acceptance criteria for the brick material with the use of test results data. The process of drafting the acceptance criteria for material characteristic is given below.

Acceptance plan for Bricks:

- The acceptance should made on the following acceptance characteristics
  - 1) Compressive strength
  - 2) Water Absorption
  - 3) Efflorescence
- Consider one Acceptance Characteristic at one time and Make measurement on each test portion for the respective test.
- Calculate average of all measurements to find mean  $\bar{X}$

$$\bar{X} = \frac{\sum_{i=1}^n x_i}{n} \dots\dots\dots (1)$$

- Find the range (R) by subtracting the smallest value from the largest value in the group of measurements.
- Calculate the Quality Index ( $Q_U$ ) by subtracting the average ( $\bar{X}$ ) of the measurement from the upper specification limit (USL) and dividing the result by the range (R).

$$Q_U = \frac{U - \bar{X}}{R} \dots\dots\dots (2)$$

- Calculate the Quality Index ( $Q_L$ ) by subtracting the lower specification limit (L) from the average of the measurements ( $\bar{X}$ ) and dividing by the range (R).

$$Q_L = \frac{\bar{X} - L}{R} \dots\dots\dots (3)$$

- Estimate the percentage of material, ( $P_U$ ) that will fall within the upper specification limit (U) by entering table which is referenced [6, 7] with ( $Q_U$ ) and using the column appropriate to the total number (n) of measurements.
- Estimate the percentage of material, ( $P_L$ ), that will fall within the lower specification limit (L) by entering table which referenced [6, 7] with ( $Q_L$ ) and using the column appropriate to the total number (n) of measurements.
- In cases where both upper and lower specification limits are concerned, the total percent of the material that will fall within the limits is established by subtracting 100 from the sum which is found by adding

the percent within the upper specification limit ( $P_U$ ) to the percent within the lower specification limit ( $P_L$ )

$$\text{Total percent within limits} = (P_U + P_L) - 100 \quad \dots\dots\dots (4)$$

- After knowing the total percent within the limit for respective acceptance characteristic the decision should be made whether the lot is acceptable or not.

### III. SPECIAL CONDITION: RECORD KEEPING PROFORMA'S

A special condition contains the record keeping Proforma's used on construction site for the purpose of recording the sampling and testing data and their results. Now a day's whatever proformas used on construction site are not appropriate, these are constructed as per need of the test, so no standard proformas are using on construction site. It leads to poor record keeping on sites and made confusion. If an engineer or a specifier designs the format which is use on site for record keeping, and put these in to the construction specification as a standard proforma, may helps to the contractor and engineer to record data of sampling and testing for their respective responsibilities during process control and acceptance. In record keeping Proforma's the both sampling and testing data are recorded. Where sampling data include the information regarding sources of material/work, LOT size and Sample size. And testing data include the test observations, mean and the result. There are also the data recorded other than the sampling and testing data which are the specification requirements of a particular characteristic, date of testing, remark by testing authority, and sign of authority. It gives the information such as the source used for particular material, its lot size, sample size, tests observations, averages, results, specification requirements, remarks, date of testing, and signature of authority. This helps designing the control plan and acceptance plan.

#### Sampling and Testing Proformas for Record keeping for bricks

Common burnt clay brick physical tests:

**Table.1 Dimension test:**

**Test date:**

Batch No. & Batch Size	Sample Size (No.)	Sample Sr. No.	I.D. Marks	Dimensions, mm			Tolerances as per IS 1077 :1992 (for modular bricks)		Remark
				Length	Width	Height	Description	Tolerances	
							Length	3800±80 mm	
							Width	1800±40 mm	
							Height	1800±40 mm	

**Table.2 Compressive strength test: (assuming brick class designation is 15 N/mm<sup>2</sup>)**

Test start date:

Test end date:

Batch No. & Batch Size	Sample Size (No.)	Sample Sr. No.	I.D. Marks	Size of Brick(mm)	Crushing Load,(KN)	Comp. Strength, (N/mm <sup>2</sup> )	Requirement as per IS 1077 : 1992	Remark
							Average Comp. Strength is not less than 15 N/mm <sup>2</sup>	
Average Compressive Strength, N/mm <sup>2</sup>								

**Table.3 Water absorption test:**

Test start date:

Test end date:

Batch No. & Batch Size	Sample Size (No.)	Sample Sr. No.	I.D. Marks	Size of Brick(mm)	Oven dry Wt. (gm)	Saturated Wt. (gm)	Water Absorption %	Requirement as per IS 1077 : 1992	Remark
								Not more than 20% up to class 12.5 & 15% for higher class.	
Average Water Absorption %									

**Table.4 Efflorescence test:**

Test start date:

Test end date:

Batch No. & Batch Size	Sample Size (No.)	Sample Sr. No.	I.D. Marks	Rating of Efflorescence	Requirement as per IS 1077 : 1992	Remark
					The rating of efflorescence shall not be more than Moderate up to class 12.5 and slight for higher class.	

**Table.5 Final record keeping:**

Batch. No.	No. Of bricks in one Batch	No. Of samples selected for testing	Size of brick	Identification No. Of sample	Date of testing	% Water Absorption
1	2	3	4	5	6	7

Compressive Strength, N/mm <sup>2</sup>	Efflorescence Test	Reference No. From Laboratory	Dated signature of the Engineer	Remarks
8	9	10	11	12

#### IV. CONCLUSION

It concludes that the paper brought the importance of the SQC tools in to the bricks specification. The outcome of this study is to increase the confidence level of quality of product where minimizes the risk of defected material being accepted. With the modified changes in brick specification helps to keep proper quality of materials. Addition of statistical quality control in brick specification helps to make specifications accurate, easy to understand, with appropriate limitations. Specification becomes more useful and workable on ground due to the simple wording and its sequential manner.

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