International Journal of Emerging Engineering Research and Technology
Volume 3, Issue 3, March 2015, PP 84-89
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

Analyzing Quality Control Aspects in an on Going Construction Projects with Respect to Cost and Time

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ABSTRACT

The objective of the present study is to understand about all the defects caused due to poor quality materials and also to study what are the causes for poor quality of materials at construction site. If proper quality materials are not maintained the cost and time required to perform rework increases. This increase in project cost and time taken to do rework for project completion can be reduced by setting some standard methodologies for construction purpose and by controlling quality of materials at construction site. The study shows to identify a great potential for improvement of standards for maintaining quality at construction site. Case study is also taken to analyze how the defects found in construction project are rectified. The Non-conformances found on an ongoing project are analyzed using Cause and Effect Model.

Keywords: Quality Control, Construction Site, Non-Conformance's, Cause and Effect Model, Standard Methodologies.

INTRODUCTION

Errors on construction sites occur frequently if inferior quality materials are used. Due to this poor quality of materials, the construction cost might not only increase for performing rework, but also consume more time to complete project work. Quality control is designed to set a clear view for organization to follow certain standards while proceeding towards common goal. At construction site if proper standard work is not done with standard materials and procedures defects are caused due to which the cost and time for rework increases. The main objective is to identify what are the defects caused due to the use of poor quality materials, improper methodologies and unskilled labor work at construction site. And also to solve them using Cause and Effect Model. Standards for maintaining quality at construction site are identified to do standard quality work so that there is no chance for rework.

The present case study was done at Chennai. It was noticed that there are many Non-Conformances, produced due to poor quality work, unskilled labor and lack of standard methodologies used.The details responsible for producing Non-Conformances are found and a successful attempt was made to solve the noticed Non-Conformances.

EXPERIMENTAL ANALYSIS

The experimental analysis is done using cause and effect model. Here the root cause for the Non-conformances is found using Cause and Effect Model. The root causes for problem here are found by Brainstorming. By using this model we can first find out from where the problem has started initially. The cause for occurrence of problem may be from lack of skilled men, improper material or improper methodologies followed.

NON-CONFORMANCES OBSERVED IN THE PROJECT

The number of Non-Conformances recorded Till Aug-14 are 281. These defects are solved with the help of Cause and Effect Model.

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Table1. *Showing Type and Number of Non-Conformances*

Category	No's
Honey Combs	35
Cube Failure	20
Alignment / Plumb / Level	32
Porous Concrete / Segregation	20
Curing	6
Process Violation	22
Reinforcement	15
Bulging	28
Slab Cracks	4
Poor Finish	24
Leakage / Dampness	11
Inferior Material	8
Breakages / Damages	9
Non adherence to Methodology / Improper Work Sequence	47
Total	281

Top Three Frequent Non-Conformances

Table2. *Showing Top 3 Non-Conformances*

Category	No. of NCs	%
Non adherence to methodology / Improper Work Sequences	47	18%
Honey Combs	35	13%
Alignment / Plumb / Level	32	11%

Non-Conformance Category Wise

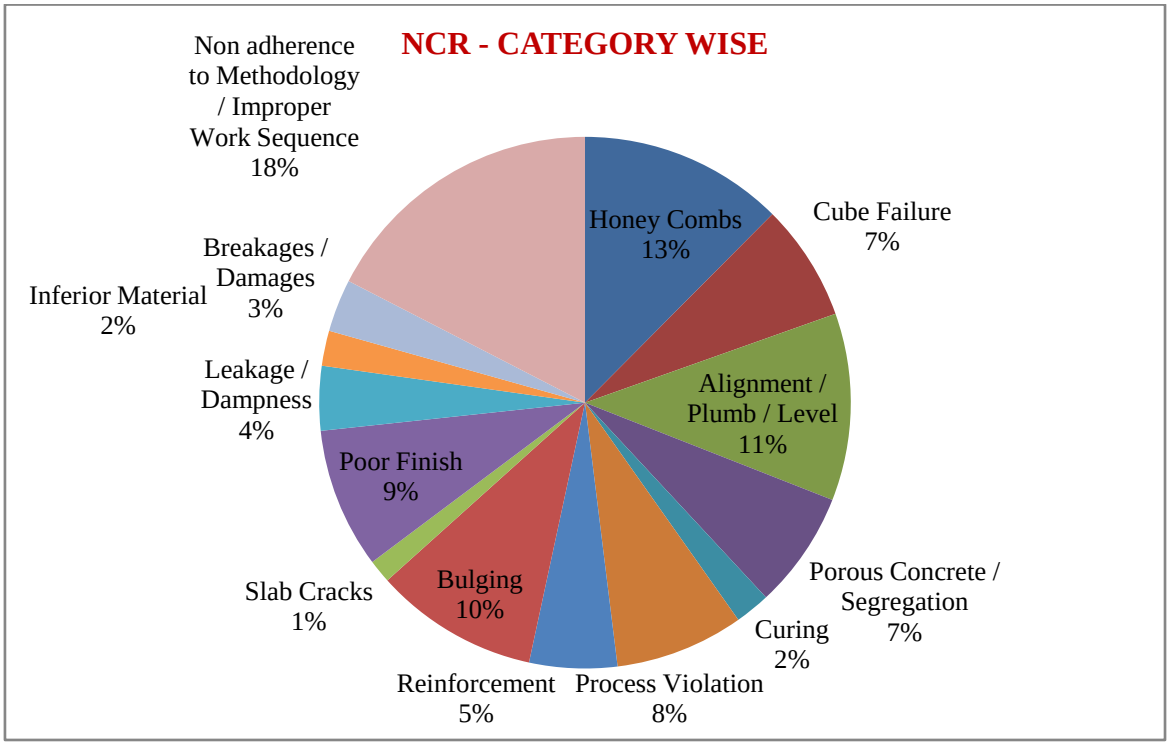

Figure1. *Showing Percent of Non-conformances in Each Category*

Action Plan to Control Non-Conformances

- Job specific trainings
- Fortnight quality review meetings to check the implementation
- 16 stage check point have been arrived considering slab cycle of 18 days and is been mandatory for continual improvement in quality

Actions Taken To Implement First Time Right

Job specific training for each activity is given to all associated labors, engineers, supervisor to make them aware of standard operating procedures and to ensure they perform an activity first time right.

Problem Solving by Cause and Effect Model

The Hollowness in top screed led to water stagnation at some location on roof top. Cracks and dampness are observed on the roof slab in top screed due to water stagnation. This problem is solved by using Cause and Effect Model.

Analysis - Discovery of Main Root Causes

Possible causes for the water stagnation, cracks, and dampness are made using cause and effect model by Brainstorming and discussions. The causes identified are based on lack of skilled labor, poor materials and improper methods followed during construction process.

Cause and Effect model is shown below

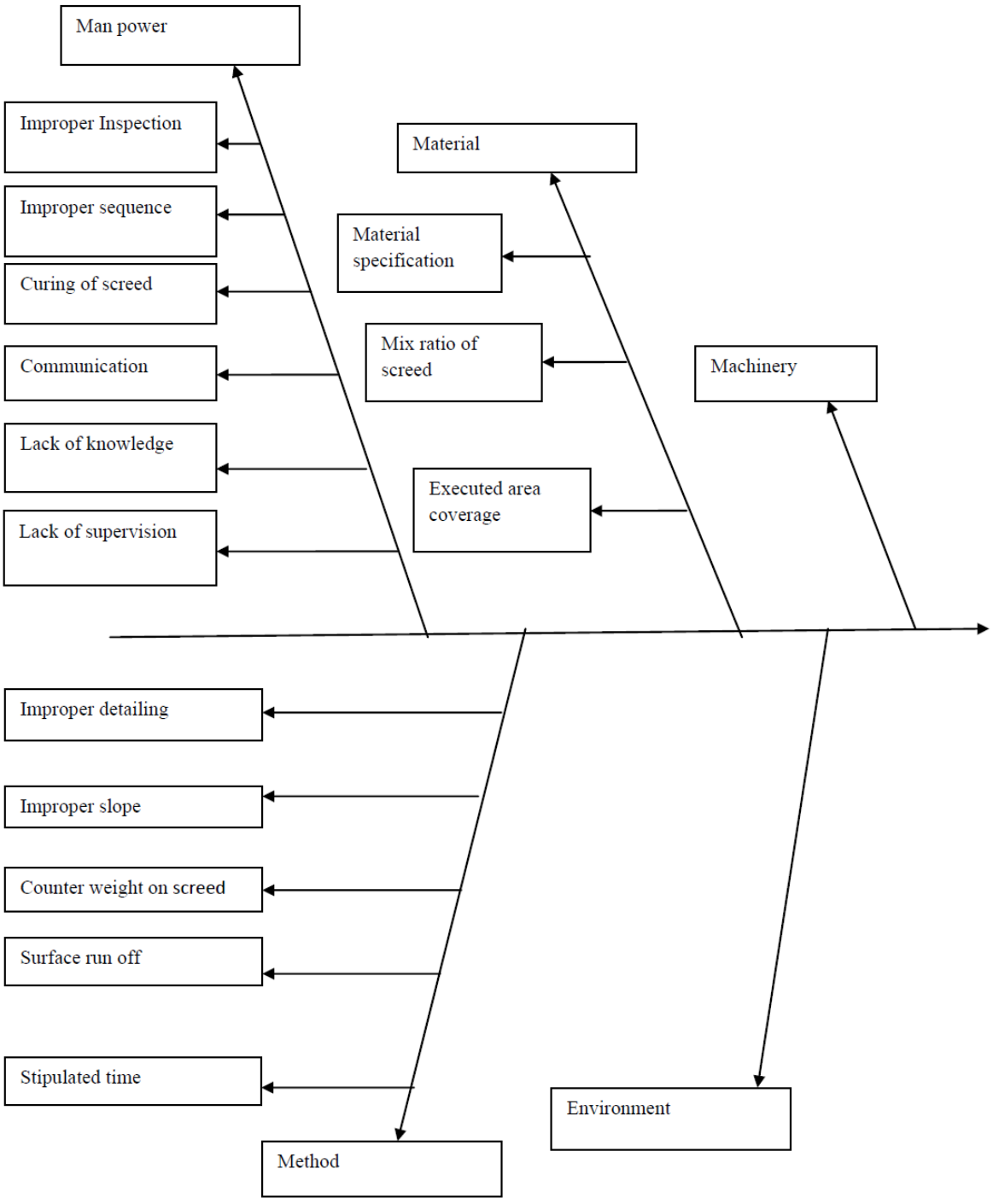

Figure2. *Cause & Effect Diagram*

Probable Causes

Based on observation of current process by Brainstorming and pressure testing process causes are shown in table below.

Table3. *Shows Probable Causes*

Sr. No.	Probable causes	Classification
1	Improper detailing	Method
2	Improper slope for water drain	Method
3	Lack of knowledge	Man
4	Material specification	Material

Cause and Effect Diagram

Thus these are all the relevant brainstormed causes identified after elimination and are shown in figure below.

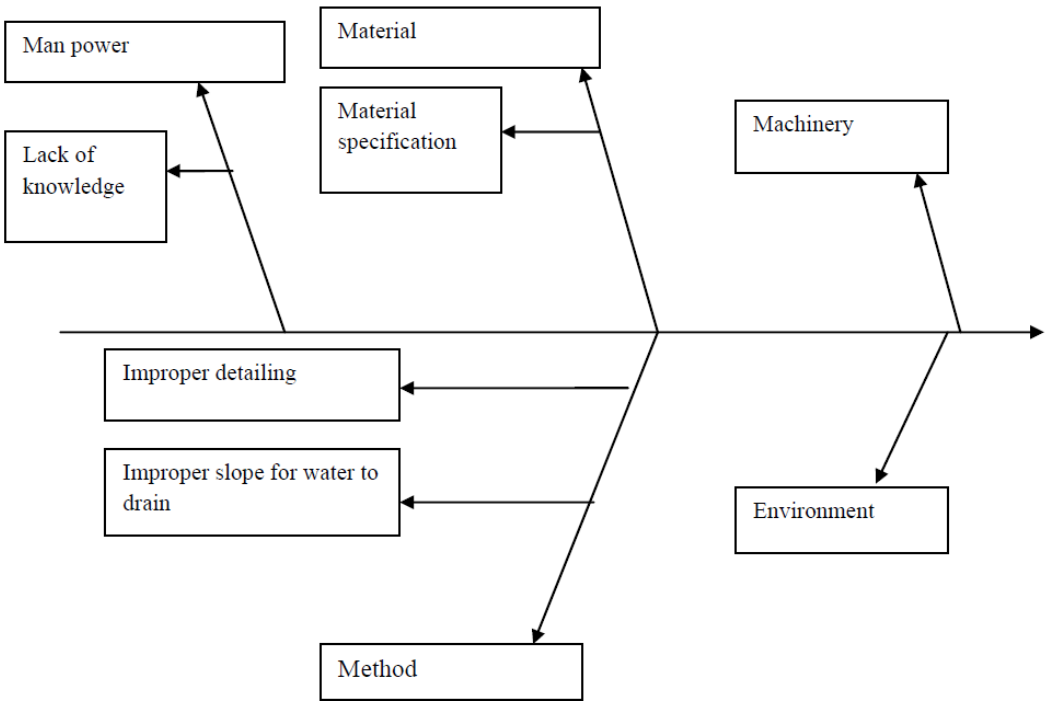

Figure2. *Shows Cause & Effect Diagram*

Cause- Effect Matrix Score Used

Table4. *Shows Cause-Effect Matrix*

Score used to Identify whether the Cause has any relation to Leakage or not after doing Test of Hypothesis
0 = No Relation , 3 = Less Relation , 6 = Moderate Relation , 9 = Strong Relation

Table5. *Cause - Effect Matrix Score Used*

Sr. No.	Probable causes	Classification	0	3	6	9
1	Improper detailing	Method				✓
2	Improper slope for water to drain	Man				✓
3	Lack of knowledge	Method/Man			✓	
4	Material specification	Material				✓

Tables 4 and 5 gives strong reasons for the cause of Non-Conformances.

Testing of Hypothesis

Valid reasons for the cause of Non-Conformances are shown in figure below.

Table5a. *Testing of Hypothesis*

No.	Probable Causes	Test of Hypothesis	Conclusion
1	Improper detailing	Proper sequence of detailed methodology to coordinate waterproofing/screed is not available	Valid
2	Improper slope for water to drain	Presently the rainwater is allowed to drain on the surface which is not advisable	Valid
3	Material specification	Polypropylene waterproofing material has high thermal expansion and does require adequate protective screed.	Valid

Major Root Causes

Actions to eliminate each Root Cause are shown in 6 table below.

Table6. *Major Root Causes*

No.	Probable Causes	Why	Why	Why
1	Improper detailing	Waterproofing and the successive activity detailing is not incorporated	Lack of Team co-ordination	
2	Improper slope for water to drain	Improper detailing of drain	Slope considered was 1:200 supposed to be 1: 100	To maintain the aesthetically sleek slabs
3	Material specification	Material selection has not been done w.r.t climatic condition	Lack of data	

Development of Remedies

Table7. *Development of Remedies*

Root Causes	**Action Plan**	**Target Date**	**Checking mechanism**
1)Lack of Team co-ordination	Design co-ordination team need to review and prepare Detailed section and methodology	Dec'13	Jan'14
2)To maintain the aesthetically sleek slabs 3)Lack of data	Detailed section and Methodology prepared in above level is to be reviewed and approved.	Dec'13	Mar'14

Final Remedy Developed

Finally Kerb of 100mm x 100mm is done on the periphery of roof slab avoiding the surface drain and also to have proper end detail for waterproofing and also the plaster and screed are shown in figure below helped to avoid cracks. This improvement made through standard methodologies helped to rectify the cracks and dampness on the top roof.

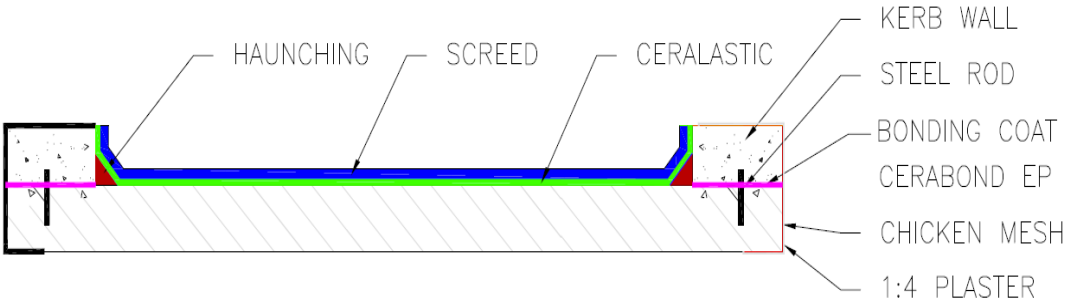

Figure3. *Showing Remedy Diagram*

Closing of Non-Conformances

All the Non-conformances observed are solved with the same cause and effect model as shown above. Finally time taken for closing of non-conformances is shown in table below.

Table8. *Showing Closing Of Non-Conformances*

	Statistics	Action taken
Number of Non-Conformances recorded Till August-14	281	281 closed
Number of Non-Conformances recorded Till September-14	5	4 closed
Number of Non-Conformances recorded Till October-14	--	--
Number of Non-Conformances recorded Till November-14	3	2 closed(1 will be closed by dec-5th)

RESULTS AND DISCUSSION

A comprehensive case study was done on an ongoing project. There are many non-conformances found, which led to inconvenience to live in. The work done to rectify Non-Conformances comprises

of finding out initial causes, which led to initiation of defects in buildings during construction. This is done by using Cause and Effect Model. Here in this model the causes are framed out based on lack of skilled labor, poor materials and improper methodologies followed.

In this project one of the major problems found is water stagnation in the top roof surface which led to cracks and dampness. This problem is selected and causes for the initiation of this problem is framed under Cause and Effect Model by Brainstorming and discussions. Finally the Effect Matrix score used and Testing of Hypothesis gave causes for the problem. The framed causes are improper detailing, this is because no proper sequence of detailed methodology to coordinate water proofing/screed is not available. Improper slope for water to drain, that is presently the rainwater is allowed to drain on the surface which is not advisable and material Polypropylene waterproofing material has high thermal expansion and does require adequate protective screed.

Effort is taken to rectify the Non-conformance by effective team coordination and improving slope of slab which was previously 1:200 to maintain the aesthetically sleek slab is now rectified to 1: 100 and even the material specification is now selected properly with respect to climatic conditions. Kerb of 100mm x 100mm is done on the periphery of roof slab avoiding the surface drain.

CONCLUSION

In the present case study all the Non-conformance's observed at the site are solved using Cause and Effect model, in the same way as shown for solving cracks at top roof surface. By understanding the problems that has occurred and being solved the project team framed new methodologies. As an initiative towards "Do the things at first time right" they had focused on the specialized activities in their project. They prepared an step by step detailed methodologies in focus with the solutions to the issues of feedback on the customer perspective and also to avoid any lapses in coordinated scope of work by the contractor and the sub-contractor. They paved the way in the approach towards standardizing the methodology of the specialized activities and also the vendor across the project.

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