International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

Importance of Quality Control During Execution Phase in Small Scale Residential Projects

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Abstract - *Quality Management System is the most important branch in any construction company which enables the team to complete a project in the best quality possible. Even though playing a significant part, QMS is still missing in various number of small scale construction companies which leads to number of defects on-site which results in delays, cost overruns and wastage of materials, affecting the quality of the project. First step towards QMS in order to minimize defects and ensure quality product, is adopting a quality measure during execution stage, that is, Quality Control. By implementing quality control system, which falls under QMS, number of defects can be reduced, thereby, improving quality of the project. Quality control is the improvised method to check the quality of the project at every stage during construction by using Quality tools. One of the main activity group which is affected due to lack of QC during execution phase is RCC. Components considered for the study are – Slabs, Beams and Columns. Generally occurring defects on-site were identified of the selected components and likelihood and impact was recorded by risk assessment table from four different construction sites. Further, with the help of questionnaire survey, the present scenario, causes of defects and factors affecting the quality of the project was found out and analysed. The data collected in five point likert's scale was studied in SPSS software. Recommendations were suggested to implement the quality control team in execution phase by making slight changes in organisation structure of the Company's execution team.*

Key Words: **Quality Management, Quality Control, Site execution, Defect on-site.**

1. INTRODUCTION

Quality management is the act of overseeing all activities and tasks needed to maintain a desired level of excellence. In general, quality management focuses on long-term goals through the implementation of short-term initiatives. Quality management in construction can be defined as "The policies, processes and procedures put in place by the management team to improve an organisation's ability to deliver quality to its customers - whether those customers are clients/owners, contractors or subcontractors - on a consistent and constantly improving basis."

The main goal of any construction company should be to deliver quality product to the customer with keeping in mind their profit loss scale in order to satisfy the client's as well as the company's stakeholders.

The famous Quality Trilogy was first developed and written by Joseph M. Juran. Juran is a management consultant and an Engineer, specialized in Quality management. The Quality Trilogy explained by Juran is: Any organization taking up a journey in Quality Management will have to have three Processes in place, which are: i) Quality Planning ii) Quality Control and iii) Quality Improvement.

1.1 Aim

To study the importance of Quality Control in residential buildings with reference to the defects for small scale construction companies.

1.2 Objectives of the study

1) To study the role of Quality Control in construction industry.
2) To identify the defects in RCC members (Slab, beam and column).
3) To analyse Risk Assessment tables of identified defects.
4) To suggest quality control measures for frequently caused defects.
5) To identify the barriers and determine the benefits of implementing Quality management in small scale construction companies.

1.3 Need and Scope of the study

In India, small scale construction companies focus on short term goals and may compromise the quality of the construction. This leads to unsatisfied client's and may result in their downfall in the market. Therefore, to retain their position in the competitive market, it is essential to search for the problem area and refine their strategies. One of the problem found out in the organisation structure and management was Quality Control. During execution phase, it is the final control procedure between the producer and the ready product; it directly affects the client's reaction on the final product. Thus, periodic inspection is required during the execution phase and study is carried out further accordingly.

The scope of the study is to study one of the four key components of quality management, that is, Quality Control. It has been studied with reference to the defects during the construction process. From various construction activity

groups, the defects are studied for RCC group, and the components studied are - Slabs, Beams and Columns. The study is limited to small scale construction companies as there is a need to implement quality control process as mentioned above and restricted to residential building typology with 100 to 300 units. The data is collected from the primary sources limited to Pune and secondary sources in the form of literature reviewed and articles.

2. LITERATURE REVIEW

I. D.Ashokkumar, Student, ME – CEM, Erode Builder Educational Trust's Group of Institutions, Kangayam-638108,Tamil Nadu, India, conducted a research on "Study of Quality Management in Construction Industry". The aim and objectives of the study was to determine the major factors affecting the quality of construction during execution phase, to minimize the indirect cost of the project and also reduce the wastage of wastage of materials, time, money, manpower, etc. To achieve this aim, literature search, interviews with builders, contractions, consultants, questionnaire was created from the interviews and the results were analysed through SPSS software. From the interviews, 5 main categories were identified where defects can occur during execution phase, namely, Column work, Beam work, Slab work, Brick or Block work, Plastering work. For customer satisfaction and continuous improvement different "measurement methodologies" were identified and described, namely, check-list, check-sheet, Pareto diagram, Fishbone diagram, other statistical analysis, PDCA cycle, histogram Pilot survey, Flow charts. The result of the thesis exposed the factors which affected the quality of the construction which may result in increase in overall cost of the construction. The study creates awareness of implementation of Quality management to all level construction companies. The study is also useful for minimizing the material waste, time wastage which will increase the indirect cost. Thus increase in customer satisfaction and company reputation.

II. Pravin P. Mane, Dr. Jalindar R. Patil, Dr. D. Y. Patil College of Engineering, (2015), conducted a study on "Quality Management System at Construction Projects", and stated that the quality isone of the critical factors responsible for the success of the construction projects. The authors carried out the study in the form of questionnaire survey in three parts, namely, quality planning, quality control and quality assurance circulated to the Builders, Contractors, Engineers. The questionnaire was prepared on the 5 point rating scale for all the probable variables. It was found out that, the mostly used quality tool on-site was check-sheets and check-lists; the top three barriers to working of project with respect to quality was poor planning, bad attitudes/abdication of responsibility, lack of proper training; customer satisfaction, stakeholder's satisfaction and a safe place in competitive market were of utmost importance.

III. Yogen Sadashi v Masurkar, Abdulrashid Chand Attar, 2014, conducted a study on "Investigating the Causes for Failures in Construction by Taking a Case Study". The authors studied the case of collapse of G+3 building in Khed, Maharashtra. The building was under construction when the mishap occurred. Several tests were conducted and from the local sources, it was found out that, the reasons of failure were – use of stone grit in place of sand for making concrete, the concrete was entirely separated and crushed, there was presence of cobbles in concrete, proper sieve analysis was not carried out and the curing time was insufficient. This shows the importance of quality assurance and quality control on-site. In case of presence of the quality personnel, standard checklist and periodic checking, the problem could have never been so crucial.

3. METHODOLOGY

1. Identify various defects of Slab, Beams and Columns.
2. Rating of Defects - Low to High on the scale of 1 to 5 for 4 different small scale construction projects;
3. Risk assessment table - Likelihood impact table for defects;
4. Conduct questionnaire survey to understand present scenario, causes of defects and factors affecting quality of construction, circulated to 8 different site Engineers.
5. Analyse the data from SPSS software and bar charts.
6. Find out the barriers and benefits of implementing Quality management in small scale construction companies and determine benefits of its adaptability.

4. DISCUSSION AND RESULTS

From the data collected from four different construction sites, various frequently occurring defects identified in Slabs, Beams and columns are mentioned below:

Table -1: Identified Defects

Slabs	Beams	Columns
Blisters	Sagging	Shifting of reinforcement
Curling	Hogging	Bulging Column
Uneven or Bouncy Floors	Alignment	Honeycombing
Cracks	Bulging	Twisting
Surface spalling	Twisting	Alignment

4.1 Analysis of Risk Assessment table for defects

SLAB

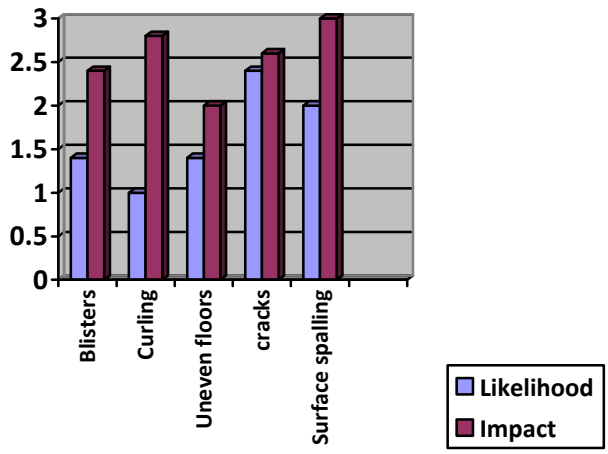

Chart -1: Risk Assessment table for defects in Slabs

Findings: Likelihood for cracks is more but the impact is less. As compared to other defects, likelihood and impact of Surface spalling is more followed by cracks in concrete. The cause of which is improper water-cement ratio and labour workmanship.
Impact of curling is more, but likelihood is less. Cause of curling is due to the drying shrinkage which allows the slab to curve upward or downward.
Recommendations: Surface Spalling and cracks – Checking during water-cement ratio mixture, grade of concrete should be used as per the specifications. Care should be taken during de-shuttering. Formworks should be cleaned before reuse.
Curling – Use of lowest practical water content in concrete to avoid bleeding, use of largest practical maximum size aggregate content to minimize drying shrinkage, use shrinkage-reducing admixtures.

BEAM

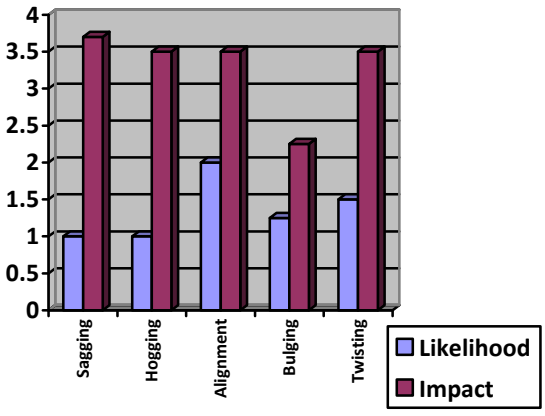

Chart -2: Risk Assessment table for defects in Beams

Findings: Sagging of beams has the highest impact but likelihood is the least.
Alignment of beam has the highest impact and likelihood.
Recommendation: The main cause is poor workmanship and improper checking by site supervisor. Checking of wall plates by the site supervisor, proper Formwork and shuttering should be done and the distances should be checked by the supervisor.

COLUMN

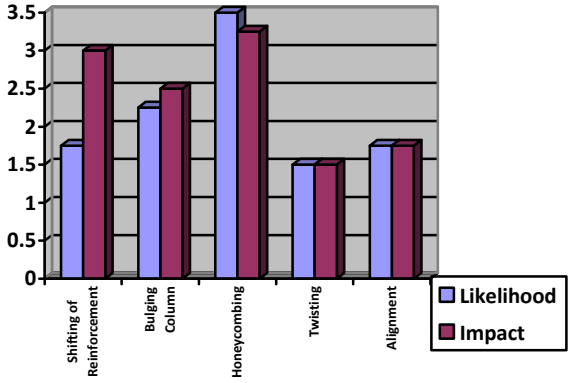

Chart -3: Risk Assessment table for defects in Columns

Findings: Both Likelihood and impact of honeycombing is more as per the findings. The problem area is improper compaction.
Shifting of reinforcement is another defect whose impact is more as compared to other defects. The cause is identified as poor workmanship or negligence by site supervisor.
Recommendations: Honeycombing - Taking care during pouring from concrete from certain height. Fluid mortar with maximum amount of water in the mixture should be poured at the bottom of the column. Needling should be done once the concrete is poured on the liquid mortar for even distribution of concrete components. Faces of the shuttering must be cleaned and free of dust.
Shifting of Reinforcement - Proper joggling of bars must be done instead of overlapping. Sufficient cover should be provided.

Questionnaire survey was carried out to understand the present scenario, it was found out that -
1. None of the four small scale companies implemented quality management team.
2. None of the studied companies used any quality control tools and neither of them used any documents to maintain records.
3. All of the Engineers interviewed were aware of Quality Management System.
4. The above questionnaire proved that quality control is given minimal importance for small scale construction projects even if it necessary.

4.2 Results of Likert's scale for Causes of Defects:

Table -2: Analysis of Causes of Defects

Causes of Defects					
	Least Affected (%)	Less Affected (%)	Moderately Affected (%)	Highly Affected (%)	Most Affected (%)
Labour Efficiency	0	0	75	25	0
Quality of Material	0	50	25	25	0
Improper Supervision	25	37.5	12.5	25	0
Lack of equipment and machinery	0.0	37.5	37.5	0	25
Improper Labour Adequecy	37.5	50	12.5	0	0
Communication issues	0	50	12.5	25	0
Local Weather	50	37.5	12.5	0	0

From the above data, and average of replies from 8 different Engineers, it is analysed that defects on-site are mostly caused due to

- Lack of labour efficiency.
- Lack of equipment's and machinery.
- Communication issues.

4.3 Results of Likert's scale for Factors affecting quality of construction:

Table -3: Analysis of Factors affecting quality of construction

Factors affecting quality of construction					
	Least Affected (%)	Less Affected (%)	Moderately Affected (%)	Highly Affected (%)	Most Affected (%)
Limitation of Finance	0	25	25	50	0
Improper communication on site	50	25	25	0	0
Limitation of time	12.5	50	25	12.5	0
Different construction methods	75	25	0	0	0
Limitation of rules and regulations	62.5	25	12.5	0	0
Training Policies	12.5	0	37.5	37.5	12.5
Lack of co-ordination among departments	62.5	37.5	0	0	0
Building design	50	50	0	0	0
Availability of materials and Equipment's	0	37.5	62.5	0	0
Availability of Machinery	25	50	25	0	0

The factors that affect mostly the quality of construction are as follows:

- Training policies both to the labours and site supervisors.
- Limitation of finance.
- Availability of equipment's and materials.

5. CONCLUSIONS

Construction industry has been facing quality issues since many years. Large scale companies have adopted the concept of quality management, however small scale companies are still giving minimum importance to quality. Mostly quality of construction is affected on-site during the construction phase. Quality control methods deal with inspection of quality on-site during the execution phase. Adopting the quality control methods can majorly tackle the problem of quality.

To understand the present scenario, risk assessment table was made for generally occurring defects in slabs, beams and columns where the likelihood and impact was judged on the five point rating scale by the site engineers.

Risk assessment table showed that even if the likelihood of some defects is less, the impact with respect to the cost, safety and time is more, which may result in delay in projects, increase in budget and in some extreme cases can cost several lives. It proves that, lack of quality check during the execution phase leads to number of defects.

To understand the causes of those defects, questionnaire was generated, which showed that the major reasons behind the defects were lack of labour efficiency, availability of machinery and materials and communication issues on-site. To find out the factors that affect the quality of construction, another questionnaire was generated and the major factors were training policies to labours, limitation of finance and availability of machinery and materials. Small scale construction companies instead of long-term profits focuses on short term gains which refrains them from investing in company assets. Due to unavailability of required machinery,

quality of construction is affected. On the other side, low quality materials are used to work in budget, which further results in defects.

From the study it is concluded that, due to limited budget required machinery and materials is not available on-site, it also indirectly affects the labour efficiency on site which acts as a barrier for adopting training policies both for labours and site

ACKNOWLEDGEMENT

I would first like to thank Prof. Aparna Panganti for her continuous support and for always motivating me to do better for the project. I am grateful to Prof. Prasad Ganpule for being there for me as my external guide and guiding me constantly at each and every step to carry out my project. I would also like to thank Prof. Bhagyashree Apte for pushing me in the correct direction and helping me to achieve my target.

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