

Analysis of Quality on Construction and Construction Cost

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Abstract:

It is rightly said that “You get what you Inspect, not what you Expect”. A careful inspection at each stage of construction leads to minimization of error which results in improvement in the quality of construction. If we are talking about construction industry many times contractor didn’t bother about the quality of construction and he didn’t want to appoint the required engineers and lab staff. Main focus is always on Time and Cost whereas Quality is first factor that comes into focus for adjustment. Though it seems like it doesn’t make significant impact but fact is adjustment with quality leads to serious damage technically. Now a days, many of the organization appoint quality control consultant to keep a watch on quality of construction. This is really having good impact on improvement in the quality. But whether this additional cost is justified?

In view of this, present research work is carried out in order to understand malpractices during R.C.C. activities, impact of poor quality on construction cost, impact on builders, contractors and customers, relationship between quality and degree of control. For study purpose multi-storeyed building at ‘Amaltas Pvt. Ltd.’ residential scheme, Bhopal is taken into account.

For methodology of research, Checklists are prepared which gives idea about base facts of various sub activities of Reinforced cement concrete (R.C.C.). Furthermore Non-conformities/Defects are identified with the help of checklists and final Master sheet is prepared which highlights total Non-conformities/defects, root-causes, impact of Non-conformities/defects on quality and what actions are taken to recover that Non-conformities/defect.

After detailed analysis of data, it is mainly observed that Non-conformities/defects go on increasing floor wise. Severity of Non-conformities/Defects also goes on increasing floor wise. From all this it is concluded that major factor for this is degree of control. It shows inverse relation with Quality cost .i.e. as degree of quality control increase, construction cost decreases as maintenance and rework cost related with quality decreases. Quality damage makes negative impact on customers as problems like spalling of concrete, seepage, leakages, cracks, bad aesthetic view etc. which ultimately hampers the reputation of builder and contractor in market and that ultimately causes the failure of upcoming projects.

To overcome these problems and to achieve desired quality few recommendations like daily quality assessment report (it includes laboratory testing of the concrete and materials sample also taken into account), training programs for labours etc. are suggested in last section of report.

Keywords — Quality control, workability, r.c.c., Cost of Quality etc

CHAPTER- 1 INTRODUCTION

1.1 Rationale and Significance of study

Construction industry is an economy pillar for every country including India. It contributes to a massive growth to the country Gross Domestic Product [GDP], and plays a very significant role in Indian economic development. Recently the 12th Five-year Development Plan is expected to revive, in

particular, the construction sector which has undergone several up and down cycle in the past ten to twenty years. Construction contributes to the growth of many related industries such as the manufacturing of construction’s material industry, cement, pipes, sanitary wares, tiles, ready mix concrete. Asides from being an important asset that generates profit to the country, construction encourage the development of human resources in India and creates massive job opportunities within the country.

Considering the significance of the construction, it is necessary to identify major issues affecting the efficiency of its sector. The main objectives of any project are improvements in time,

cost and quality. The poor state of technology adopted by the construction industry in many countries leads to fragmented relation between construction cost and delay time of delivery. Many clients nowadays are dissatisfied with contractor's performance in terms of keeping to the quoted price and time delivering a final product of the required quality.

Nowadays, more and more management of construction companies are focusing on quality issue as a competitive edge. Delivering projects that satisfies client requirement has become a main priority in order to maintain business relationships. Hence, the construction industry should develop common standards during procurement stage in order to deliver satisfactory products. The Indian market has become highly quality conscious due to the globalization and the liberalization policies of Indian economy. The international organization for the standardization (ISO) has been formed to promote the development of standardization, therefore the acceptance of ISO standards in construction industry should be widely implemented in order to achieve high quality product in every stage of construction process.

It is hopeful that the result of this research may give contribution to further study on the Quality Management practice and provide other guidelines and solutions to improve the current practice through ISO quality standard and modified quality checklist. It also hoped this research will contribute to how modified standard quality checklist enhances the efficiency and effectiveness of the Quality Management process.

1.2 Need for study

Time, Cost and quality are three major parameters considered for evaluation of any project. In Construction industry it is commonly observed that Quality of work is always compromised for speedy completion and some financial benefits. But in long run, Quality damage always leads to dissatisfaction of customers and hampering reputation of builders. Hence there is need to see quality of site work in more serious way. There is need to find out how actually quality makes an impact on the cost of construction, what exactly relation between quality and degree of supervision, what remedies should be adopted to achieve desired quality.

1.3 Outline of research work

1) 1.3.1 Aim

The aim of this research is to analyse the impact of Quality on Construction with special reference to R.C.C. activities & its cost.

2) 1.3.2 Objectives

- To identify the major factors that contributes to bad construction quality.

- To analyse Non-conformity/Defects reports, Degree of Control/Degree of Supervision, Severity of Non-conformity/Defects floor wise and its interpretation with respect to number of floors.
- To determine the cost of Quality/cost of Rework and its relation with degree of control.
- To compare cost of rework with quality management and without quality management.
- To determine the impact/effect of bad quality on Customer, Builder and Contractor.

3) 1.3.3 Scope and Limitation

No doubt, each and every construction activity is important as far as quality and technicality of project is concerned but R.C.C. is soul part of any structure hence for the present research R.C.C. activity is taken into account for detailed quality analysis. A multi-storeyed building (9 floors) is considered for the Quality evaluation of R.C.C. activity.

4) 1.3.4 Problem Statement

A risk is involved in any construction project. Considering the significance of the construction, it is necessary to identify major issues affecting the efficiency of its sector. The main objectives of any project are improvements in time, cost and quality. Time & Cost overrun in construction projects is a major problem. Further, there is a need to enhance quality in construction works. In present work reasons of poor quality, its impact on construction cost, impact of bad quality on customers, builders and contractor and the recommendations to improve quality during R.C.C. work is taken into account.

CHAPTER-2

LITERATURE REVIEW

In order to understand the quality practices adopted intimately, and other research done in this area, extensive literature survey was done. Journal papers, international conference papers, articles, and library were referred. In addition to that, internet websites, online journals and electronic data base were also browsed for supplementary information.

2.1 General

5) 2.1.1 Basic Concept of Quality

Quality has a broad definition under different aspects. David Hoyle¹¹ in his book named ISO 9000 Quality System Handbook, mentioned that quality means degree of excellence, conformance with requirements, the totality of characteristic of an entity that bear its ability to satisfy stated or implied needs, fitness for use. It also defined as freedom from defects, imperfections or contamination, and delighting customers.

6) 2.1.2 Quality Parameters

According to David Hoyle¹¹, difference in design can be denoted by grade or class or can also be the result of poor attention to the customer need. It is not enough to produce products that only conform to specifications or supply services that meet management requirements. Quality is a composite of three parameters: quality of design, quality of conformance and quality of use.

- Quality of design is the extent to which the design reflects a product or Service that satisfy customer needs. All the necessary characteristics need to be designed into the product or service at the outset.
- Quality of conformance is the extent to which the product or service conforms to the design standard. The design has faithfully translating the client needs and is now depends on the process to realize the design into an actual end products.
- Quality of use is the extent by which the user is able to secure continuity of use from the product or service. Products that need to have a low cost of ownership be safe and reliable and maintainable in use.

Harold Sandberg et.al⁽²⁰⁾

This paper gives emphasis on what actually quality means and how it can be misinterpreted as per convenience.

This paper highlights that Firstly quality is not free. It is not serendipitous. To achieve quality requires dedication, effort, and an adequate amount of time to plan, study, and innovate. Secondly quality requires consistency and responsibility. You cannot stress quality only when you begin a job, or only in the last stages. There must be a conscious, consistent, and complete effort to achieve quality. Lastly quality is a team effort. Each member of the team must be dedicated to quality and must assume a share of the responsibility.

Finally report summarizes that quality is really measured by the satisfaction of all the parties

involved. The satisfaction of the owner at the expense of the satisfaction of the contractor would diminish the quality of the project. Similarly, the protection of the engineer and owner to the harm of the user would go against the quality.

Thus this report clears what the actually quality means and how it is related to the parties involved in the construction project.

P. A. Bowen et.al⁽¹⁸⁾

This paper has reported on the findings of a South African national questionnaire survey of the opinions project team participants hold about the relationship between time, cost and quality management and the attainment of client objectives. This work is carried out in order to examine causal link of Time-Cost-Quality, the opinions of clients, architects, quantity surveyors, project managers, consulting engineers and general contractors in South Africa were obtained by means a national questionnaire survey. The questions sought to establish their perceptions concerning client objectives and the project time, cost and quality associated with building procurement systems in South Africa.

The purpose of the research was to explore the proposition that recognition of the 'human' factor, i.e., perceptions within the project team in the management of time, cost and quality, would assist attempts to address the perceived shortcomings of TCQ management.

The findings of this survey indicate that misperceptions do exist among project team members regarding the time; cost and quality management associated with building projects and potentially have an impact on the ability of the project team to achieve client objectives. While the findings of the research do not warrant any change in practice at this stage, the research itself has aided in gaining a richer understanding of the complexities of 'human' issues inherent in the management of time, cost and quality. More importantly, it points the way forward for further research into the 'human' aspect of how project teams can be more effectively managed in order to achieve client objectives, thereby providing a catalyst for change in practice.

This research work carried out with designed questionnaire. It highlights how human perception and three basic parameters i.e. Time, Cost and Quality are interlinked. It gives an idea about how these perceptions can be useful in designing TCQ management system.

Tan Chin-Keng et.al⁽²³⁾

This research is the study of a research on overcoming the problems of implementation of quality management in construction projects in Malaysia. It is an exploratory study in nature aimed to ascertain perceptions and experiences of practitioners in the industry in the below:

- Practices of quality management in construction projects from the perspective of tools and techniques applied;
- Level of commitment of management towards the implementation of quality management in construction projects;
- Problems in relation to the implementation of quality management in construction projects.

This research explores preliminarily the practices of quality management, management commitment in quality management, and quality management implementation problems in construction projects in the context of the Malaysian construction industry. The research applies semi-structured interview approach with twelve project management practitioners. The findings of the study indicate that the state of quality management in construction projects in Malaysia needs to be strengthened and there are problems in relation to quality management implementation that require attention and further research.

This research finally concludes that ISO certification is majorly used for marketing purpose rather than the actual quality management system. Implementation of quality management is greatly perceived as a mean to fulfil contractual obligations instead of satisfying the needs of clients. Furthermore it highlights that Leadership and participation of top management of construction companies in quality management need to be strengthened and allocation of financial and human resources for the purpose of problems of the implementation of quality management should be further increased.

Thus this research paper was helpful in order to understand lacunas in the quality management process, practical difficulties in achieving zero defect work, administrative loopholes and financial resource allocation for quality improvement.

2.3 Literature regarding relation between Quality and Construction cost

Quality and Cost are two major factors for any project. In the previous section, Concept of quality is cleared. Furthermore is necessary to study its impact on construction cost. Undoubtedly there is relation between quality and construction cost but for constructive conclusion it is necessary to study research carried out regarding this topic.

Anthony Mills et.al⁽³⁾

The paper discusses the nature of the most important defects and investigates the impact of contractor type and building type. The research reported in this paper aims to determine the extent and impact of defects in residential construction. Specific objectives of the paper are to determine the:

- Relative cost and incidence of defects;
- Incidence and cost of defects by various groups within the industry, including owner builders and general builders
- Impact of rework on various types of constructions; including new work, renovations, and extensions.

CHAPTER-3

RESEARCH METHODOLOGY & DATA COLLECTION

3.1 Introduction

This chapter focuses on the methodology adopted for research work based on quality control implementation on construction sites. In order to ensure a smooth running of this research data collection, the research methodology divided into two distinct phases. The first phase involves the source of the problem or the research by setting the aims & setting out the checklists for Reinforced Cement Concrete construction work. The second phase deals with the collection of the needed data for analysis, assessment of that data and recommendations on that. As stated in section 1, the main aim of this study is to correlate the cost spent on Quality Control to the actual cost of implementation in Quality. For this, continuous data collection has done which took six months. The collected data is put into tabular form and then analysed.

3.2 Research Methodology

The research methodology comprises of six fundamentals elements shown as below.

1. Identifying background of the problems.
2. Determining the objectives and scope of tasks.
3. Literature review from various sources as primary information.
4. Setting out checklist ready to search additional and adequate information.
5. Data collection, arranged in tabular format and analysis.
6. Evaluation of analysed results and result presentation in graphical format.
7. Comparison of cost of rework in Construction Projects with quality

management and without quality management.

3.3 Case Study – Details of Study area

For the study, a construction site by “Dwarkadheesh Nagar Haveli Builders Ltd.” which is a reputed construction company in Bhopal carrying out various on-going projects is considered. “Dwarka Heights” is one of their residential projects which have a great location, which is chosen for this case study. The quality consultant is Adept Consultants.

Adept Consultants is a specialist construction quality organization dedicated to enhancing Quality and safety at construction projects varying from real estate to commercial to infrastructure project. Some of the services that Adept Consultants offer are Pre Delivery Inspection, independent 3rd party Stage wise audits, Quality Management and Advisory Services, Project, Management Training of Site staff, Cost and Materials Audit etc. Adept Consultants has developed a unique Quality Indexing mechanism through its proprietary software called Benchmark which indexes quality on a 10 point scale for all trades covering R.C.C., Shell, Finishes and services like Plumbing, Electrical and HVAC.

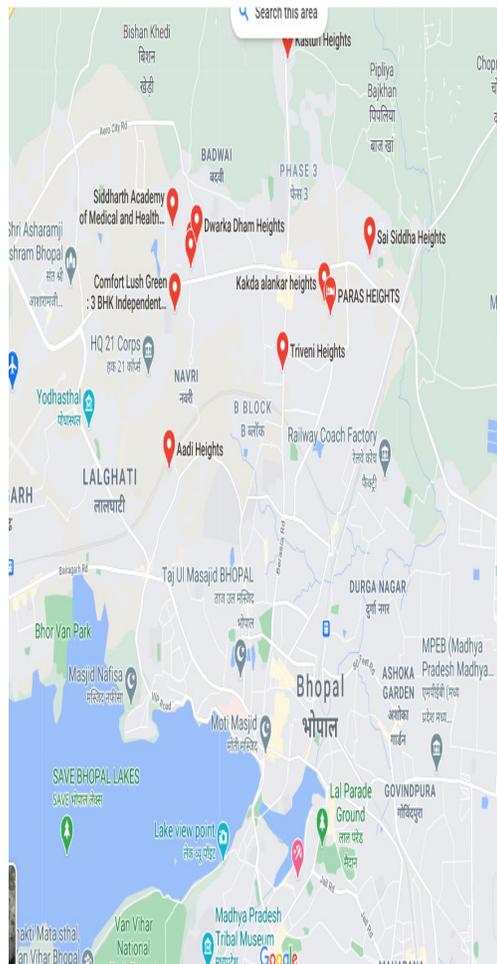
Name of Site : Dwarka Heights, Ayodhya Bypass Road, Badwai Bhopal.

Site Location : Badwai, Bhopal

Number of Buildings Tower : Three

Building for case study : B Block

1.3.1 Location Map of Case Study



Location on Google Map

3.3.2 Distances from Dwarka Heights

- 16 km from M.P.Nagar,
- 18 km from Habibganj Station,
- 10 km from Main Railway Station,
- 6.0 km from Bhopal Airport,
- 17 km from ISBT.

3.4 Data collection

Detail data collection is needed for accurate results and findings. Detail data collection is needed for accurate results and findings. The data collection process was divided into two parts, first; a volume of data was collected from site and in addition to this information pre-data collection was done to get report of checklist filled from companies, and received data from the actual site (on-field record) as a second part. The purpose of this pre- data collection is to enable to develop complete and suitable updated data sheets which in turn lead to better results.

For this study, some checklists of R.C.C. activities are used with the help of Quality Consultant (Adept Consultants). Using these checklists, the slab wise NC report found out. This NC report data is then organised activity wise called data sheet. Using these data sheets, Master sheets generated which include all the work related to this study. These Master sheets are attached in the Annexure chapter in this report. The Cost of rework without quality management is referred from thesis named "Cost overrun due to Delays and Reworks in Residential Projects"⁽¹⁹⁾

7) **3.4.1 Quality Checklists for Reinforced Concrete Work (R.C.C)**

The checklists are developed by Adept Consultants after extensive work and experience of many years. Some modifications are made to suit the requirements of this study. These checklists are referred to understand nonconformities/defects during R.C.C. work.

These checklists give information about the number of NCs and its formal description. These checklists are filled by site engineer during every R.C.C. activity by checking and observing every R.C.C. NCs/defects. These checklists are helpful for identifying the number of NCs and their description.

These checklists are divided into five various categories as follows.

Resource Mobilized Checklist	<ul style="list-style-type: none"> We need various resources used during different construction activities. For most appropriate utilization of resources, proper mobilization is basic need. Hence resource mobilized checklist is prepared for checking availability and utility of resources.
Formwork – Workmanship Checklist	<ul style="list-style-type: none"> Formwork is very important part of R.C.C activity and no activity will gain accuracy without proper workmanship. Hence it is necessary to have a checklist for various tasks regarding formwork and workmanship. This checklist highlights check points at various stages of R.C.C. work. Theoretically, there are always ideal standard values for activities. But practically it may not be possible to achieve exact value. Hence it becomes necessary to decide permissible limit or tolerance. This checklist is prepared to check technical feasibility based on decided/accountable tolerances.
Liability Checklist	<ul style="list-style-type: none"> Concrete is considered as a sole of R.C.C activity. Any defect or NCs in concrete reflects into R.C.C. It is much necessary to provide special attention with checklist on concreting as it is one of the major component contributing the strength of structure.
Concrete Members Checklist	<ul style="list-style-type: none"> It is said that R.C.C is a skeleton of any structure and steel is skeleton of R.C.C. Corrosion of steel gives rise to various defects and it is most important structural part of building. Hence checklist is prepared to have better degree of control over reinforcement.
Reinforcement Checklist	

Figure Error! No text of specified style in document..1 : Description Quality Checklists

These checklists further divided into subcategories as shown in following tree diagram.

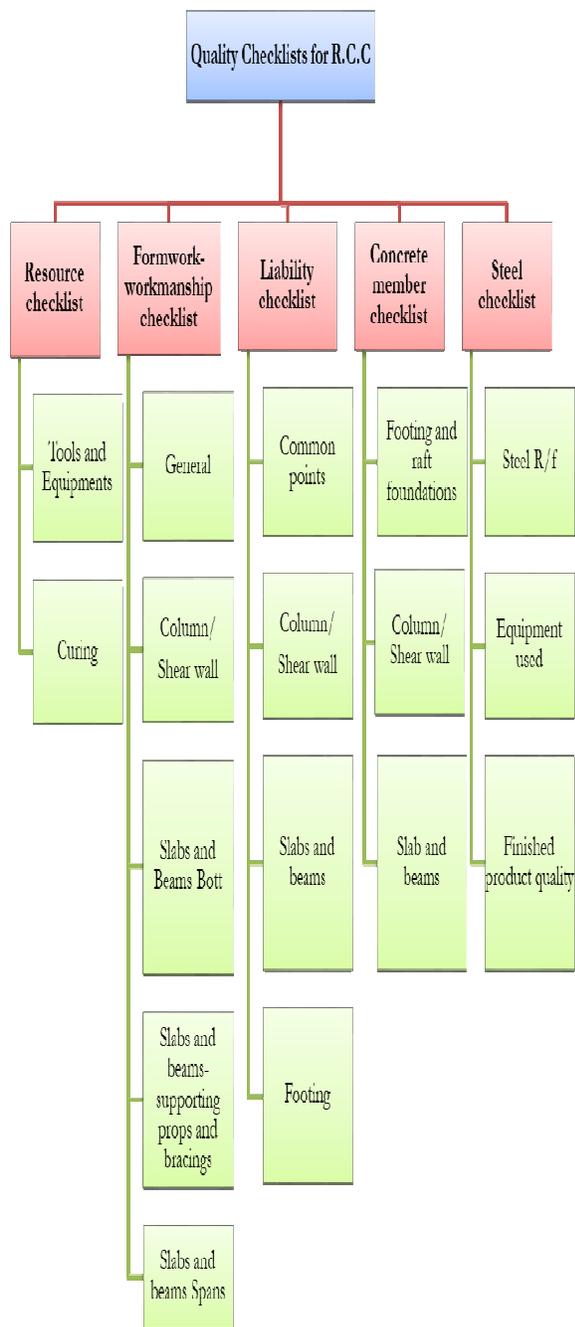


Figure Error! No text of specified style in document..2 : Subcategories of Quality Checklists

CHAPTER-4 RESULTS & DISCUSSION

4.1 Results, Observations and Analysis

Using the findings from Master sheets and after gathering all needed data from onthe field and from checklists, data have been organized and presented in a more useful, simplified and easier way to understand them, such as flowchart, graphs and tables. Descriptive statistic such as non-conformity numbers, cost of material, cost of labour and combine total cost will be used to analyse the validity ofthe result. Checklists collected and information gathered from literature review are analysed statically. Incomplete works are not considered, so it will be not included in this research.

8) 4.1.1 Non-conformity reports and Degree of Control

It is necessary to find out the relation between NCs/defects and degree of control. So floorwise NCs/defects and Degree of Control is obtained from Master sheets. Details of it are shown inthe table below.

Table Error! No text of specified style in document..1 : Floor wise NCs/defects and Degree of Control

Floor No.	No. of Non-conformities/Defects	Degree of Control (calculated with respect to No. of Visits of Engineer per floor)
First	683	46
Second	694	39
Third	739	41
Fourth	759	37
Fifth	789	28
Six	812	26
Seven	691	44
Eight	729	41
Ninth	733	37
Total	6629	339

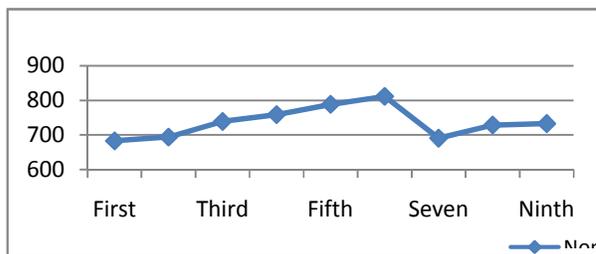


Figure Error! No text of specified style in document..3 : Floor wise NCs/defects

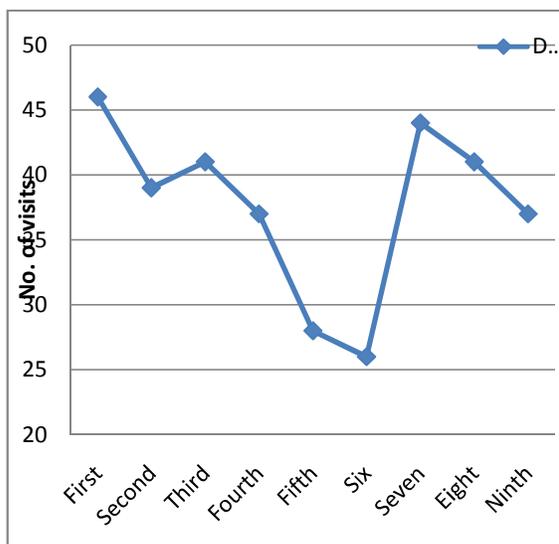


Figure Error! No text of specified style in document..4 : Degree of Control

Observations

- It has been observed that no of NCs/defects are minimum at first floor and maximum on the sixth floor.
- There is a considerable decrease in NCs/defects at the seventh floor.
- It has been observed that degree of control goes on decreasing floor wise up to the sixth floor. Then there is the increase in degree of control at the seventh floor and again gradual decrease at the eighth and the ninth floor.

Analysis and Discussion

- From observations, it is analysed that as the degree of control goes on decreasing floor wise, which

results in an increase in the number of NCs/defects. When monitoring of activities is made in a more precise manner there is a significant gap in NCs/defects as observed at the seventh floor.

- From observations, it is analysed that as the degree of control increased at the seven floor due to shifting of executional office the third floor when sixth floor slab casting complete which results in an increase on no of visits during R.C.C. activity at seventh floor.

9) 4.1.2 Floor wise Quality Cost

The Cost of rework is calculated on the basis of the cost of material and cost of labour required to repair detected NCs/defects. These costs of rework are referred from Master sheet. The Cost of rework is calculated as shown below.

$$\begin{array}{l}
 \text{Cost of} \\
 \text{Material} \\
 \bullet (\text{Quantity of} \\
 \text{required} \\
 \text{material}) \\
 \times \\
 \text{(Rate} \\
 \text{of} \\
 \text{material})
 \end{array}
 +
 \begin{array}{l}
 \text{Cost of} \\
 \text{labour} \\
 \bullet (\text{No.} \\
 \text{of} \\
 \text{Human} \\
 \text{Resource}) \\
 \times \\
 \text{(Man} \\
 \text{hours)} \\
 \times \\
 \text{(Labour} \\
 \text{rate)}
 \end{array}
 =
 \begin{array}{l}
 \text{Cost} \\
 \text{of} \\
 \text{Rework}
 \end{array}$$

Flat wise and floor wise cost of quality/rework cost calculated are shown in the table given below.

Table Error! No text of specified style in document..2 : Cost of Quality

- degree of quality and degree of control.

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