# DEVELOPMENT OF CONSTRUCTION QUALITY ASSESSMENT MODEL FOR RCC FOOTING

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**ABSTRACT**

*Any constructed facility should conform to predetermined quality standards and specifications in order to serve the purpose of a facility. It should satisfy the owner's quality needs, expectations and aspirations about the constructed facility which are the key objectives of a contractor. But unfortunately, most of the times it is a common issue that constructed facilities fail in satisfying the predetermined quality standards, specifications and owner's expected level of quality. This is mainly because of ignorance and misconception on the part of owner's representative who accepts sub-standard. Most of the present methods of quality audit being subjective in nature, there is an emergent need to develop a comprehensive, rational, sensible and objective post occupancy quality measurement model for a constructed facility which would give a clear idea about how contractors are using resources and attaining desired workmanship. The present study was undertaken to develop construction quality index model for a RCC footing of Nashik region in India. The developed model would be helpful in examining the quality level achieved by a Rcc footing and to compare the RCC footing as well as contractors. This model would remain as prime basis for rating the quality of RCC footing and contractor's ability in providing quality facilities*

**Keyword-** *Acceptance Quality Characteristics (AQC's), Construction Quality Characteristics (CQC's), Construction Quality Index (CQI) Model*

## 1.INTRODUCTION

Any construction project management has two philosophies, i.e. time-driven and cost-driven. Managing cost of construction project with completion in time with high quality and achievement of objectives is called project management.

A project shall have its own characteristics set aside so that it can be completed within budget and time. As cost and time for a construction project are interdependent, these shall be carefully planned. An increase or decrease in construction project time affects the budget of construction projects. These set characteristics define the projects and helps in completing the project in time.

Builders often treat low quality construction work no differently with high quality construction work. As a result of this misperception owners are not penalizing the contractors for their poor work. Also cost of construction is increasing with low quality work. For that reason many contractors are taking advantage of the owners' reluctance to penalize them which ends up in low quality facilities. Therefore, there is an emerging need to rate the quality of a facility and providing compensation to contractor accordingly.

## 2. LITERATURE REVIEW

Nabil Semaan and Tarek Zayad (2009) proposed a condition assessment model that evaluates the functional condition criteria (structural/ architectural, electrical, mechanical, and security/ communication functions) of subway stations, using multicriteria decision making to produce a unified an fixed condition index and a scale. [1]

Andrew F. Griffith et al., (1999) developed a project success index which comprised of four initial broad category success variables: budget achievement, schedule achievement, design capacity, and plant utilization to measure the success of a project objectively. [2]

Arthur W. Saarinen and Marlene A. Hobel (1990), "Quality Management is a systematic way of guaranteeing that organized activities happen the way they are planned [3]

D. Ashok kumar (2014), many manufacturing industries are adopting Total Quality Management while construction industries are even lacking in implementing Quality Management System. The reason behind it is every construction project is unique, and quality is ever changing factor from time to time andplace. [4]

Glen R. Anderson and Victor H. Torrey (1995) proposed a methodology for the development of condition-indexing systems for aging civil engineering facilities that formalizes the necessary decision-making process. The methodology represents a rational approach to manage the decision-making process that is necessary in the development of condition-indexing systems . [5]

William R. Duncan (1996), Project Quality Management includes "all activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as Quality Planning, Quality Assurance, Quality Control, and Quality Improvement, within the quality system". These processes will interact with each other and with the processes in other knowledge areas as well [6]

## 3. NEED AND SCOPE OF STUDY

The scope of the study is as under:

- To evaluate the contractor's product or service from a quality perspective.
- To determine the contractor's compensation.
- To calculate the bonuses/penalties to a contractor for a project.
- To calculate cost required for work and its assessment.
- To change the contractor's qualification status if quality of all the contractor's facilities are quantified in a long run.

This kind of quality quantification will increase the awareness in a contractor towards quality which leads to improvement in quality of construction.

## 4.OBJECTIVE OF THE STUDY

The objective of the study is:

- To study the concept of construction Quality index (CQI) and its related terms to quantify the quality of Rcc Footing of residential building.
- To collect Construction Quality Characteristics (CQC) related to materials and workmanship in constructing Rcc Footing of residential building from IS code, Research Paper, text books.
- To collect Cost Quotation related to materials testing and workmanship in constructing Rcc Footing of residential building from DCR
- To sieve the CQCs which are collected from literature survey and to add necessary CQCs for the same from construction experts.
- To analyze the collected data which will help to formulate quality index for building facility in further study along with cost optimization.

## 5. METHODOLOGY

### 5.1. Flow Chart of Methodology:

For getting AQCs from the listed CQCs, the respondents were asked to tick mark and put on the rates required for the test n workmanship the prescribed CQC which they felt right for post occupancy quality assessment of Residential Footing. At the end of the Survey form, one section was provided for their suggestions if they felt other CQCs have to be added for post occupancy quality assessment. For their convenience, CQCs were divided layer wise, where in respondents can think over the same from quality assessment prespective before they tick mark the CQC.

### 5.2. Methodology Outline:

1. A comprehensive literature review to understand the definitions and terminology related to quality in construction and its measurement. 2. Identifying and collecting Construction Quality Characteristics and cost of testing related to a particular facility from literature review, IS code, text books, research papers and site visit.
2. Constructing a draft questionnaire incorporating the collected Construction Quality Characteristics (CQC's).

3. Conducting pilot survey to check the correctness of the questionnaire.
4. Modifying questionnaire based on the relevant inputs from the pilot survey.
5. Analyzing the responses using a statistical method to calculate the weighting factors.
6. Formulating Construction Quality Index with the help of Construction Quality Characteristics and theirweighting factors by using a statistical tool.
7. Analyzing results, conclusions and recommendations from the inferences.

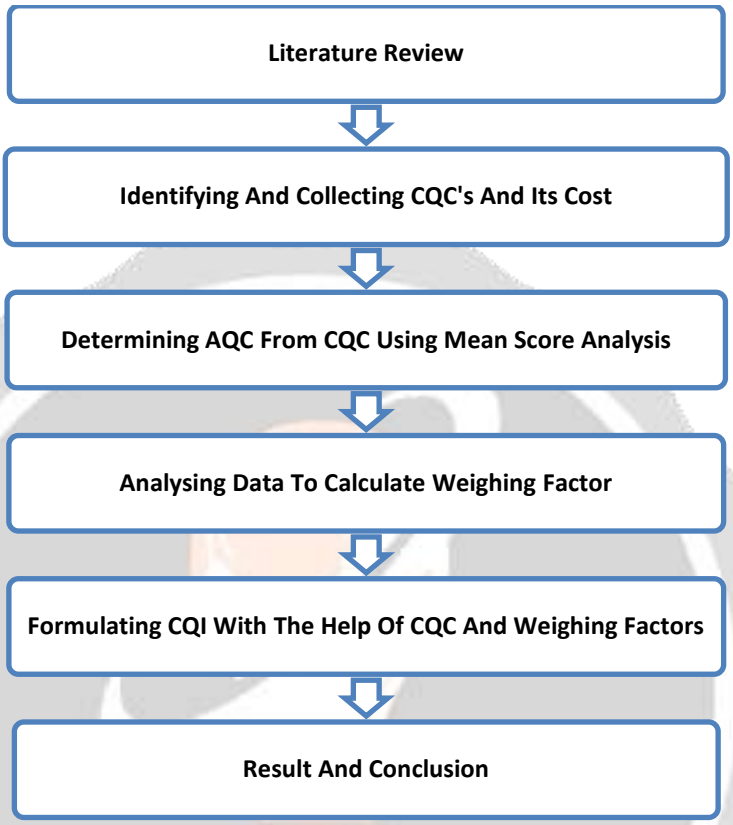


**Chart- 1:Flow chart of Methodology**

## 6. DATA COLLECTION AND ANALYSIS

This chapter includes;

i. Data collection in the form of CQCs and its related cost for constructing footing of residential building from extensive literature survey of research papers, text books, IS specification and code books.
ii. Preliminary survey with construction experts to get recommendation for more CQC's and sieve AQCs from CQCs.

**Construction Quality Characteristics (CQCs)**

CQCs are inherent facility characteristics which can be measurable at the time of construction that significantly effects the facility performance and quality which will be under the direct control of the contractor

**Construction Quality index (CQI)**

CQI is "a rational measure of overall quality of a constructed facility that is calculated by determining the quality of individual components and linking them to obtain a composite quality index for the job."

**Analytic Hierarchy Process (AHP)**

AHP is one of multi criteria decision making methods which was developed by Prof. Thomas L. Saaty in 1970s. It is a structured technique for organizing and analysing complex decisions, based on mathematics and psychology. It is a method to derive ratio scales from paired comparisons. The input can be obtained from actual measurement of entities such as price, weight etc., or from subjective opinion such as satisfaction feelings and preference (Madhu M. Tomar and N. N. Borad 2012). For the present research study,

pairwise comparison of AQCs were taken as basis for calculating weighting factors from AHP technique. In this regard, every AQC was compared with all other AQCs within a layer.

**6.1. CQCs Related To Materials Testing**

CQCs related to materials are composed of raw material tests and in-process inventory tests. The following were the CQCs related to materials, collected from literature survey of research papers, Text books, IS codes and experts. The following were the CQCs related to workmanship, collected from literature survey of research papers, IS 10262 RA(2014)concrete mix design, IS 456-2000 RA(2011)coarse and fine aggregate. A total of 37 CQCs related to materials were collected from literature survey which is as shown in the Table I

**Table I**: COC's related to material testing and its related cost for constructing RCC footings

| Foundations Steps | Cqc's Related To Material Testing | Cost (Rs.) |
|---|---|---|
| EXCAVATION | Seismic test<br>Plate load test<br>Penetration test<br>Split spoon test<br>Proof test by core drilling<br>Vibration test<br>Dynamic load test | 500/-<br>5000/-<br>3000/-<br>1000/-<br>45000/- |
| BASE COURSE | Dry density of compacted layer<br>Sieve analysis of coarse aggregate<br>Water absorption of coarse aggregate<br>Aggregate impact value | 500/-<br>500/-<br>300/-<br>500/- |
| BASE COURSE | Aggregate crushing value<br>Aggregate abrasion by los angles test<br>Specific gravity<br>Silt content | 500/-<br>500/-<br>1000/-<br>500/-<br>500/- |
| PCC | Soundness by Le- chateliers method<br>Standard consistency of cement<br>Initial and final setting time of cement | 500/-<br>2900/-<br>600/- |
| REINFORCEMENT | Tensile test<br>Ultimate strength<br>% elongation<br>Torsion test<br>Izod Impact test<br>Bending test<br>Rockwell hardness test<br>Single & double shear test | 1000/-<br><br>600/-<br>300/-<br>300/-<br>300/-<br>600/- |
| FORMWORK | Surface finish of form work | As per site condition |
| CONCRETING OF FOOTING | Soundness of cement<br>Los angles abrasion value<br>Aggregate impact value<br>Alkali aggregate reactivity<br>Water cement ratio<br>Slump test<br>Comp strength of concrete tube<br>Flexural strength of conc beam | 500/-<br>1000/-<br>500/-<br>500/-<br>500/-<br>300/-<br>1200/-<br>1200/- |
| POST CONCRETING | Honeycomb<br>Spalling and dusting<br>Cracks<br>Depressions | 2000/- |

| | | |
|---|---|---|
| | Bulges<br>Abrupt irregulations<br>Rebound hammer test<br>Compressive strength | <br><br>2000/-<br>1200/- |
| | Total cost of all test for material | 76,800/- |

**6.2.CQCs Related To Workmanship**

It is equally important to measure CQCs related to workmanship along with CQCs related to materials as it measures the degree of workmanship utilized in constructing a RCC footing. The following were the CQCs related to workmanship, collected from literature survey of research papers, Text books, IS codes, IS 10262 RA(2014)concrete mix design, IS 456-2000 RA(2011)coarse and fine aggregate. A total of 28 CQCs related to workmanship were collected from literature survey as shown in the Table 2

**Table 2**: CQCs related to workmanship in constructing a RCC Footing

| Foundations Steps | Cqc's Related To Workmanship | Costs (In Rs) |
|---|---|---|
| EXCAVATION | Setting of corner benchmark<br>Marking position<br>Setting for ground level<br>Setting for top level<br>Excavation to apparent depth<br>Constructing dewatering level<br>Constructing protecting level | 2600/-<br>*As per site condition |
| BASE COURSE | Dressing of loose material<br>Marking of cut off level | 512/- |
| PCC | Surface level<br>Layer thickness<br>Marking canter line | 640/- |
| FORMWORK | Joint sealing<br>Marking concrete level<br>Tolerance of position of formwork | 2560/- |
| CONCRETING OF FOOTING | Surface levels<br>Surface regularity<br>Alignment of joints<br>Surface texture<br>Tolerance for level and alignment<br>Alignment of embedded item such as anchor | 1280/- |
| POST CONCRETING | Level of finished concrete<br>Alignment of finished concrete<br>Surface texture | 320/- |
| | Total cost of workmanship for 1 footing | 10,792/- |

Note: - Workmanship is calculated as per footing studied at site (size: 8x8 ft)

**6.3. Some of the CQCs Related To Materials And Workmanship Obtain From Case Study of RCC Footing as Shown**

**Fig.1** CQC cleaaning for excavation

**Fig.2** Demarkation of the site

**Fig.3** Dressed base course

**Fig.4** Excavation and dewatering work

**Fig.5** completed pcc work of Footing

**Fig.6** Form work and Reinforcement

**Fig.7** Casting work

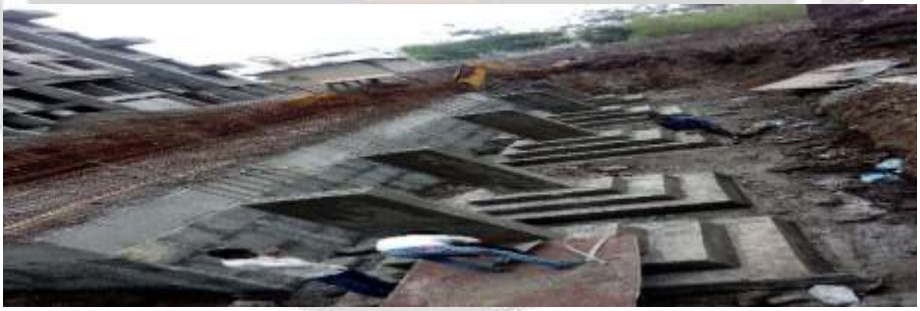

**Fig.8** post concreting work

**Fig.9** 2nd phase work of footing

**Fig.10** 2nd phase work of footing

**Fig.11**Compactor for dressing of base course

### 6.4 Analysis Of Collected Data

Based on the 10 responses obtained from the preliminary survey, the results were compiled in such a form that each tick mark against a CQC was given a score of 1 (one) while the vacant cell against a CQC was given a score of 0 (Zero) and calculating the mean score for all CQCs. The CQCs with mean score >= 0.5 were selected as AQCs for further analysis indicating agreement of 10 respondents which is as shown in the Table 3

**Table 3**: Mean score analysis of CQCs

| Residential Footing Layer | CQC's related to materials and workmanship | Respondents | | | | | | | | | | Mean Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| EXCAVATION | **Plate load test** | **0** | **0** | **1** | **1** | **0** | **1** | **1** | **0** | **0** | **1** | **0.5** |
| | **Sesmic test** | **1** | **1** | **0** | **0** | **1** | **0** | **0** | **1** | **1** | **1** | **0.6** |
| | Penetration test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Split spoon test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | **Core drilling** | **1** | **1** | **0** | **0** | **1** | **0** | **0** | **1** | **1** | **1** | **0.6** |
| | Vibration test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Dynamic load test | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.3 |
| | **Setting of benchmark** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0** | **0.9** |
| | **Marking position** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Setting for ground level | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.2 |
| | Excavation to app depth | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | Setting for top level | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.4 |
| | **Dewatering level** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Protecting level | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| BASE COURSE | **Dry density of comp layer** | **0** | **1** | **1** | **1** | **0** | **1** | **1** | **0** | **1** | **1** | **0.7** |
| | **Sieve analysis** | **1** | **1** | **0** | **1** | **1** | **0** | **0** | **1** | **1** | **1** | **0.7** |
| | **Water absorption** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Agg impact value** | **1** | **1** | **1** | **0** | **1** | **0** | **0** | **1** | **1** | **1** | **0.7** |
| | Agg Crushing value | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0.4 |
| | Abrasion by los angles tst | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Specific gravity** | **1** | **1** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0.9** |
| | Silt content | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | **Dressing of loose mtrl** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Marking of cut off level | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0.4 |
| P.C.C | **Soundness test** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Standard consistency test** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Initia n final setting time** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Surface levels** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Layer thickness** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Marking centre line** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| REINFORCEMENT | **Tensile test** | | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0** | **1** | **0.8** |
| | **Ultimate strength** | **1** | **1** | **1** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **0.9** |
| | **% elongation** | **0** | **1** | **1** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **0.8** |
| | **Torsion test** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Izod impact test | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | **Bending test** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0.9** |
| | Hardness test | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0.4 |
| | Single & double shear tst | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.1 |
| | **Centering** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Setting of corner benchmark0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| | Minimum re1bar size | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| | **Cover and spaces** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| FORMWORK | Surface finish of formwork | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| | **Joint sealing** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0** | **1** | **0.8** |
| | **Marking conc level** | **1** | **1** | **1** | **0** | **0** | **1** | **1** | **0** | **1** | **1** | **0.7** |
| | Tolerance of pos of formwork | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| CONCRETING OF FOOTING | **Soundness of cement** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Los angles abrasion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | Aggregate impact value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.2 |
| | Alkali agg reactivity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.1 |
| | **Water cement ratio** | **1** | **1** | **0** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **0.9** |
| | **Slump test** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Comp strength of conc** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | Flexural strength | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | **Surface levels** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Surface regularity** | **1** | **1** | **1** | **1** | **1** | **0** | **1** | **1** | **0** | **1** | **0.8** |
| | Alignment of joints | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0.4 |
| | Surface texture | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| | Tolerance of level | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0.2 |
| | **Alignment of anchor** | **0** | **1** | **1** | **0** | **1** | **1** | **1** | **0** | **1** | **1** | **0.7** |
| POST CONCRETING | Honeycomb | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.4 |
| | Spalling and dusting | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Cracks** | **0** | **1** | **1** | **1** | **0** | **1** | **0** | **0** | **0** | **1** | **0.5** |
| | Depressions | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| | Bulges | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| | Abrupt irrregulations | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.1 |
| | **Rebound hammer test** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| | **Compressive strength** | **1** | **0** | **0** | **0** | **1** | **1** | **0** | **1** | **1** | **1** | **0.6** |
| | Level of finish conc | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.3 |
| | Alignment of conc | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Surface texture** | **1** | **1** | **1** | **1** | **1** | **0** | **0** | **1** | **1** | **1** | **0.8** |

**6.5 Acceptance Quality Characteristics (AQCs)**

AQCs are the CQCs that are measured for acceptance purposes of the project. From the mean score analysis, 38 AQCs were selected out of 71 CQCs. The remaining 33 CQCs were dropped for further analysis to develop a manageable construction quality index

**Table 4:** AQCs selected related to materials 38 AQC's selected

| FOUNDATIONS STEPS | COC'S RELATED TO MATERIAL TESTING | COST (rs) |
|---|---|---|
| EXCAVATION | Seismic test<br>Plate load test<br>Proof test by core drilling | 500/-<br>5000/-<br>45000/- |
| BASE COURSE | Dry density of compacted layer<br>Sieve analysis of coarse aggregate<br>Water absorption of coarse aggregate<br>Aggregate impact value<br>Specific gravity | 500/-<br>500/-<br>300/-<br>500/-<br>500/- |
| PCC | Soundness by Le- chateliers method<br>Standard consistency of cement<br>Initial and final setting time of cement | 500/-<br>2900/-<br>600/- |
| REINFORCEMENT | Tensile test<br>Ultimate strength<br>% elongation<br>Torsion test<br>Bending test | <br>1000/-<br><br>600/-<br>300/- |
| FORMWORK | Surface finish of form work | |
| CONCRETING OF FOOTING | Soundness of cement<br>Water cement ratio<br>Slump test<br>Comp strength of concrete cube | 500/-<br>500/-<br>300/-<br>1200/- |
| POST CONCRETING | Cracks<br>Rebound hammer test<br>Compressive strength | 2000/-<br>2000/-<br>1200/- |
| | Total cost of all test for material goes for: | 60,300/- |

**Table 5:** AQCs selected from CQCs related to workmanship

| FOUNDATIONS STEPS | COC'S RELATED TO WORKMANSHIP | COSTS (in Rs) |
|---|---|---|
| EXCAVATION | Setting of corner benchmark<br>Marking position<br>Constructing dewatering level | 2000/- |
| BASE COURSE | Dressing of loose material | 448/- |
| PCC | Surface level<br>Layer thickness<br>Marking canter line | 512/- |
| REINFORCEMENT | Cantering<br>Cover n spaces for reinforcement | 2240/- |
| FORMWORK | Joint sealing<br>Marking concrete level | 2048/- |
| CONCRETING OF FOOTING | Surface levels<br>Surface regularity | 960/- |

| | | |
|---|---|---|
| | Alignment of embedded item such as anchor | |
| POST CONCRETING | Surface texture | 320/- |
| | Total cost | 8528/- |

## 7. CONCLUSION

The purpose of conducting preliminary survey with construction experts helped to:

- Study construction Quality index (CQI) and its related terms to quantify the quality of building facility ie. Residential Footing
- Identified suitable measurement scales for Construction Quality Characteristics of materials and workmanship and its cost to quantify quality by determining acceptance quality characteristics (AQC) from CQC from construction experts.
- Incorporated Construction Quality Characteristics related to Levels of Footing system in the development of quality index which gives more contribution in quantifying quality of the same. This will result in developing a manageable quality index.
- Got necessary recommendations from the construction experts as a guideline for further study to formulate construction quality index for building facility.
- Quantify quality which will increase the awareness in a contractor towards quality which leads to improvement in quality of construction.
- Total cost of all testing goes for 76,800/- from survey it is observed that basic testing of material to quantify quality can be done in 60,500/- (saved 16,300/- for material testing) For workmanship cost per footing was 10,792/ which has drop down to 8,528/- (saved 2,264/- per footing) Therefore reduction in costing achieved

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## 9.REFERENCES

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