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QUANTIFYING QUALITY THROUGH THE DEVELOPMENT OF CONSTRUCTION QUALITY INDEX MODEL FOR RIGID PAVEMENT

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ABSTRACT

Anyconstructedfacilityshouldconfirmtopredeterminedqualitystandardsandspecificationsinordertoservethepurposeofafacility.Itshouldsatisfytheowner'squalityneeds,expectationsandaspirationsabouttheconstructedfacilitywhicharethekeyobjectivesofacontractor.Butunfortunately,mostofthetimesitisacommonissuethatconstructedfacilitiesfailinsatisfyingthepredeterminedqualitystandards,specificationsandowner'sexpectedlevelofquality.Thisismainlybecauseofignoranceandmisconceptiononthepartofowner'srepresentativewhoacceptssub-standardworksandalsotheirreluctanceinpostoccupancyqualitymeasurementofaconstructedfacility.Forthesamereason, contractorsarenotworryingaboutqualityandendupdeliveringsub-standardqualityworksandfacilities.Mostofthepresentmethodsofqualityauditbeingsubjectiveinnature,thereisanemergentneedtodevelopacomprehensive,rational,sensibleandobjectivepostoccupancyqualitymeasurementmodelforaconstructedfacilitywhichwouldgiveaclearideaabouthowcontractorsareusingresourcesandattainingdesiredworkmanship.Thepresentstudywasundertakentodevelopconstructionqualityindex model for arigid pavement.. The developed model would behelpfulinexaminingthequalitylevelachievedbyarigidpavementandtocomparetherigidpavementsaswellascontractors. Thismodelwouldremainasprimebasisforratingthequalityofrigid pavement and contractor's abilityin provid ing qualityfacilities.

Keywords: Acceptance Quality Characteristics (AQC's), Construction Quality Characteristics (CQC's), Construction Quality Index (CQI) Model.

I. INTRODUCTION

TheconstructionindustryisthesecondlargestindustryinIndiaimmediatelyafteragriculture.TheIndianconstructionindustry hasbeenplayingavitalroleinsocio-economicdevelopmentofthecountrywithagoodcontributiontowardsGrossDomesticProduct(GDP).Generally,constructionistranslationofowner'sneedsandrequirementsintoafacilitybuiltbyacontractorasstipulatedincontractdocuments,plans, andspecificationswithinbudgetandonschedule.Asitisaworkoftranslatingdocumentedworkanddesignintoarealfacility,m anyuncertaintiesandconstraintswillcomeintopicturewhichwon'tgivetotalsatisfactiontoallthestakeholdersinvolvedinconstructionproject.Forthesamereason,contractorsare not getting here quired and specified quality compliances end in gup in feriorquality facilities.

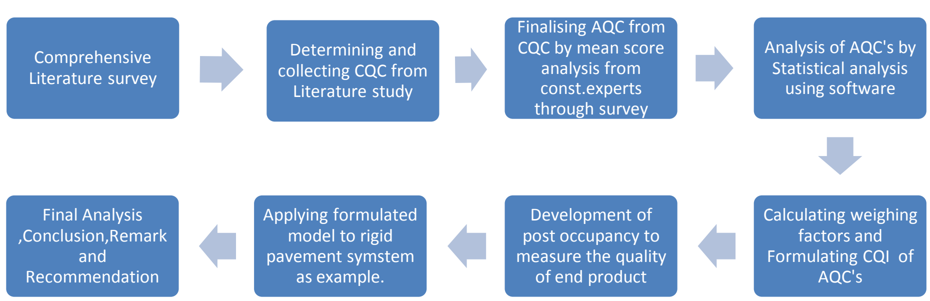
Everyoneknowsthatqualityisthelatestbuzzwordsoundingeverywhereandineveryindustry.According to R. Edward Minchin (2008), many organizations /agencies are currently rating or quantifying quality of a built facility through subjective questionnaire completed by project personnel which is a chief complaint from many contractors. The question then becomes "can one objectively rate the quality of a built facility." The answer was given by Florida Department of Transportation (FDOT), USA by developing a Construction Quality Index (CQI) which is "a rational measure of the overall quality of a constructed facility that is calculated by determining the quality of the individual components and linking them to obtain a composite quality index for the job". The CQI can be used to rate the quality of the contractor's end product. This is one of the better ways to quantify quality of a facility which will help the quality managers/quality circles to plant quality attitude in contractors.

II. OBJECTIVE

The objective of the research studyis

1. To study construction Quality index (CQI) and its related terms to quantify the quality of Rigid pavement system.
2. To collect Construction Quality Characteristics (CQC) related to materials and workmanship in constructing a rigid pavement system.
3. To sieve the CQCs which are collected from literature survey and to add necessary CQCs for the same from construction experts to finalize Acceptance Quality Characteristics (AQC).
4. To analyze the collected data which will help to formulate quality index for building facility in further study.

III. METHODOLOGY



IV. LITERATURE REVIEW

Extensiveliteraturesurveyofinternationalandnationalresearchpapers,text books,ISspecificationandcodebooks,onlinetechnicalpapersandreportsprovidedanaidincollectingsecondary data about the way of collecting CQCs, the way of design in gpreli minary and schedule survey form sand admin is teringthesurvey,modeldevelopmentandformulationprocesses,methodologytobeadoptedtoanalyzequalitylevelachieve dbyarigidpavementetc.whichareuseful for present study.

4.1 Project Quality Management

According to 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 the other knowledge areas as well. According to Arthur W. Saarinen (1990), "quality management is a systematic way of guaranteeing that organized activities happen the way they are planned".

4.2 Quality management in construction sector

According to D.Ashokkumar (2014), many manufacturing industries are adopting Total Quality Management while construction industries are 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 and place to place.
According to Wenzhe Tang (2009), implementation of Total quality management in construction industry has barriers such as:

- Fragmented nature of the construction industry due to diverse responsibilities underlying it.
- Each project in the construction industry isunique.
- The competitive nature of the construction industry and high risk nature of the works involved.

4.3. Measurement of Quality, Condition, Project Success of a Facility

R. Edward Minchin et al., (2008) developed a model to measure the quality of pavements in Florida. The methodology adopted was as follows: identified acceptance quality characteristics regarding materials used in constructing the pavement; conducted focus group meetings to procure input from pavement experts from Florida Department of Transportation, construction industry, academia and consulting firms to generate model weighting factors by using SuperDecision software in which Analytical Hierarchical Process was coded; formulated the Construction Quality Index by using a statistical tool.
Irene Wong et al., (2014) developed a methodology based on Design Quality Indicator (DQI) to access the quality of building design for high-rise residential buildings in Hong Kong. The assessment was focused on identifying the required qualities in architectural design that can reduce future maintenance problems and setup a measuring system for the identified design qualities with rankings.

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Glen R. Anderson et al., (1995) proposed a methodology for the development of condition-indexing systems for aging civil engineering facilities that formalizes the necessary decision-making process. The developed index can be used as the criterion for prioritization of repair, evaluation, maintenance, and rehabilitation (REMR) expenditures.

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

Semra Comu et al., (2013) developed an Engineering & Construction globalizing index to assess the globalizing performance in two dimensions: degree of global reach and degree of global integration. The relationships between international revenue and global reach score and with global integration score have checked for correlation and found that they were significant

V DATA COLLECTION AND ANALYSIS

This chapter in cludes the identified and collected CQC sre lated to material sand workman ship testresults from the surve yedliterature,prep are dpreliminary survey form, methodology adopted orfinalizing AQC sfromase to fCQC sand methodology adopted forad ministering the survey forcal culating AQCweightingfactors.

5.1 Construction Quality Characteristics

According to R. Edward Minchin (2008), construction quality characteristics are inherent measurable facility character ristics that significantly effects the facility performance which will be under the direct control of the contractor and can be measurable at the time of construction. All the test results obtained regarding materials used in constructing a facility were construction quality characteristics which are the inputs for CQI model to calculate the construction quality index.

Table 5.1.1 -CQCs related to materials in constructing a rigid pavement (IRC 2002; IRDP 2008)

Rigid Pavement Layer	CQC Related To Material
Earthwork	Plastic limit
	Liquid limit
	Plasticity index
	CBR value
	Dry density of compacted layer
	Deleterious material content
	Gradation of aggregates

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Sub Base Course	Deleterious material content
	Flakiness index of aggregates
	Elongation index of aggregates
	Los angeles abrasion value
	Aggregate impact value
	Dry density of compacted layer
	CBR value
Base Course	Gradation of aggregates
	Deleterious material content
	Flakiness index of aggregates
	Elongation index of aggregates
	Los angeles abrasion value
	Aggregate impact value
	Dry density of compacted layer
	CBR value
CC Pavement	Soundness of cement
	Los angeles abrasion value
	Aggregate impact value
	Alkali aggregate reactivity
	Water cement ratio
	Workability of fresh concrete (slump value)
	Compressive strength of concrete cube
	Flexural strength of concrete beam
Footpath	Gradation of sand for sand bed
Rcc Drainage	Soundness of cement
	Los angeles abrasion value
	Aggregate impact value
	Alkali aggregate reactivity
	Workability of fresh concrete (slump value)
	Compressive strength of concrete cube

Table 5.1.2 -CQCs related to workmanship in constructing a rigid pavement (IRC 2002; IRDP 2008)

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Rigid Pavement Layer	CQC Related To Material
Earthwork	Horizontal alignment
	Surface level
	Surface regularity
	Layer thickness
Sub Base Course	Horizontal alignment
	Surface level
	Surface regularity
	Layer thickness
Base Course	Horizontal alignment
	Surface level
	Surface regularity
	Layer thickness
CC Pavement	Horizontal alignment
	Surface level
	Surface regularity
	Pavement thickness
	Alignment of joints
	Surface texture depth
Footpath	Horizontal alignment
	Surface level
	Surface regularity
	Footpath thickness
Rcc Drainage	Horizontal alignment
	Surface level
	Surface regularity
	Drainage gradient

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5.2 Mean score analys is of Pre liminary surve yresponses

Based on the 6responsesobta in edfrom preliminary survey,there sultswere compiled in sucha form tha teach tickmark again sta CQC wasgivena score of one (1)while the vacan tcellagainsta CQC wasgive nascore of zero (0)and mean score of all CQC swerecal culated. The CQC s with means core≥ 0.5were selected as AQC sfor fur the ranal ysisindicatin ga greemen to fatleast3 respond entsamon g6 respondents .

5.2.1 Mean score analysis of CQCs

Rigid Pavement Layer	CQC Related To Materials And Workmanship	Mean Score Of 6 Respondents
Earthwork	Plastic limit	0.33
	Liquid limit	0.17
	Plasticity index	0.33
	CBR value	**1.00**
	Dry density of compacted layer	**1.00**
	Deleterious material content	0.00
	Horizontal alignment	0.00
	Surface level	**0.50**
	Surface regularity	0.17
	Layer thickness	**0.50**
Sub Base Course	**Gradation of aggregates**	**1.00**
	Deleterious material content	0.17
	Flakiness index of aggregates	**0.67**
	Elongation index of aggregates	0.33
	Los angeles abrasion value	**0.67**
	Aggregate impact value	**0.67**
	Dry density of compacted layer	**0.83**
	CBR value	**0.83**
	Horizontal alignment	0.17
	Surface level	**0.50**
	Surface regularity	0.33
	Layer thickness	**0.67**
	Gradation of aggregates	**1.00**
	Deleterious material content	0.00
	Flakiness index of aggregates	**0.67**
	Elongation index of aggregates	0.33
	Los angeles abrasion value	**0.83**

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Base Course	**Aggregate impact value**	**1.00**
	Dry density of compacted layer	**0.67**
	CBR value	**0.50**
	Horizontal alignment	0.17
	Surface level	**0.50**
	Surface regularity	0.00
	Layer thickness	**0.67**
CC Pavement	**Soundness of cement**	**0.83**
	Los angeles abrasion value	**0.67**
	Aggregate impact value	**0.83**
	Alkali aggregate reactivity	0.33
	Water cement ratio	**1.00**
	Workability of fresh concrete (slump value)	**1.00**
	Compressive strength of concrete cube	**1.00**
	Flexural strength of concrete beam	**0.83**
	Horizontal alignment	0.00
	Surface level	**0.67**
	Surface regularity	0.33
	Pavement thickness	**1.00**
	Alignment of joints	**0.67**
	Surface texture depth	**0.67**
Footpath	**Gradation of sand for sand bed**	**0.50**
	Horizontal alignment	**0.50**
	Surface level	**0.83**
	Surface regularity	0.33
	Footpath thickness	**0.83**
RCC Drainage	**Soundness of cement**	**0.67**
	Los angeles abrasion value	0.33
	Aggregate impact value	0.33
	Alkali aggregate reactivity	0.33
	Workability of fresh concrete (slump value)	**0.50**
	Compressive strength of concrete cube	**0.67**
	Horizontal alignment	0.00
	Surface level	**0.83**
	Surface regularity	0.17
	Drainage gradient	**1.00**

VI. RESULT AND CONCLUSION

1. Studied construction Quality index (CQI) and its related terms to quantify the quality of Rigid pavement
2. Identified suitable measurement scales for Construction Quality Characteristics of materials and workmanship to quantify quality by determining acceptance quality characteristics (AQC) from CQC from construction experts.
3. Incorporated Construction Quality Characteristics related to major layers of a rigid pavement system in the development of quality index which gives more contribution in quantifying quality of the same pavement system. This will result in developing a manageable quality index model .
4. Got necessary recommendations from the construction experts as a guideline for further study to formulate construction quality index for building facility.

VII. FUTURE WORK PLAN

1. The finalized AQCs are to be taken for generating weighting factors in order to develop a Construction Quality Index. The weighting factor of AQC is an indicator of the importance of the AQC with respect to the composite construction quality index.
2. Conducting schedule survey with construction experts to generate weighting factors for AQCs.
3. Data analysis for schedule survey responses by AHP method by using Superdecisions software to generate weighting factors for the same.
4. Formulating a Construction Quality Index with the help of Construction Quality Characteristics and their weighting factors by using a statistical tool.
5. Quantifying quality will increase the awareness in a contractor towards quality which leads to improvement in quality of construction.

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