Sustainable Structure and Materials, *Vol. 4, No .1, (2021) 012-24*
DOI: https://doi.org/10.26392/SSM.2021.04.01.012

CASE STUDY ON QUALITY ASSURANCE SYSTEM IN CONSTRUCTION

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ABSTRACT. *In the era of open economy, quality has emerged as important parameter that determines the success or failure of an organization. Quality, though an elusive attribute, has always been an important issue in construction. Construction projects are always expected to create a balance between cost, time and quality. Quality assurance is needed because of the involvement of negligence and lack of knowledge especially in smaller projects which deduces the quality of the construction. How to establish a quality assurance system and implement the quality assurance system for overall upgrading of the construction quality has become a very essential topic. In the current paper, 30 construction projects were selected from National Capital Region (NCR) with a construction cost between three to five Crores and data was collected from these projects on various quality and management related aspects. These 30 projects cover structures such as school buildings, community hall, hostel block etc. The study was conducted for construction projects of different government bodies. This analysis has been mainly done covering the factors playing key role in quality of a structure during construction such as client's commitment towards quality, quality of material, documentation, work practices, personnel etc. Based on the data analysis, quality assurance system for these projects were categorized as Excellent, Good, Average and Poor in Quality Grading based on the various factors that directly or indirectly affects the quality and smooth functioning of project during and post construction. This study highlights the negligence and/or ignorance of basic compliance needed during the execution of project which leads to untimely need of maintenance of structures. The study also indicates that there is need to train and create awareness among construction fraternity where still the fundamental quality management needs strengthening. This study was carried out for limited projects from NCR region and hence is not representative sample for whole country. Further studies should be done for more number of projects from various parts of the country to include the regional factors and issues covering environmental aspects related to the behavior of structures in coastal and non-coastal environment.*

Keywords: Quality Control (QC), Quality Assurance (QA), Independent Quality Monitoring (IQM), Quality Assurance System, Quality Grading, and Conformances

RESEARCH SIGNIFICANCE:

The objective of the paper is to analyze the various factors and loop holes that have a significant impact on effectiveness of quality and quality assurance system during construction which leads to reduced design service life and increased maintenance cost during the life cycle of the project.

1. INTRODUCTION

Quality of construction projects, as well as project success, can be regarded as the fulfillment of expectations (i.e. the satisfaction) of the project participants. The construction industry in India has been struggling with quality issues for many years. The construction costs can be significantly reduced if the construction industry embraces the concept of quality assurance and control (1). Quality Control (QC) is concerned with actual measurement, testing or supervision of manufacturers' own final product control, either by inspection of each unit or by sample testing. It has become more important nowadays to test buildings to assess whether they are performing as expected well before their anticipated service life attributing the failure in quality system. Poor workmanship can lead the construction to an extent that may not meet the requirement of a stable and sustainable infrastructure. The standard of workmanship can be improved by providing adequate training, appropriate instructions and clear checklists as well as ensuring there is on-site supervision and monitoring and an ongoing process of feedback to ensure continuous improvement. Unfortunately quality control is often forgotten in the rush to complete the project, or sometimes just turns into a paper exercise (2). Construction Industry is a special sector where it is difficult to achieve one hundred percent quality assurance of the final product. However, it must be ensured that the quality control is treated seriously, is not only about paperwork and that people are delegated with specific responsibilities to deliver the correct quality in decreasing the number of deviations as poor quality results in: (i) additional costs and delays when work have to be redone (ii) additional costs when defects have to be repaired later, for increased maintenance costs or for disruptions to their operations while defects are repaired (iii) Can cause injury and death if the structure fails.

The importance of enhancing the project quality for construction project success where, the quality drawings, standards, constructability of design, management commitment, training and awareness and the team working of all parties involved in the building process may lead to requirements by satisfying all the parties involved in the construction process. The implementation of 3-level quality control systems aims at upgrading the construction quality. Effective quality control system should be established for motivating, remedying, preventing the defects of the contractor's quality control. The content of the establishment are 3 parties respectively as the client, the contractor and Independent Quality Monitoring consultant (Third party).

The main objective of this study is to review the activities for the specific projects keeping in view that the activities pertaining to quality assurance are being performed in accordance with all contractual specifications, codes and standards or government regulations. The QA/QC is verified through checks audits, inspections and witnessing. These audit services are carried out completely independently of the individual contractors, materials suppliers, manufacturer or sub-contractor as well as final user (3). Quality Assurance (QA) provides the facility owner with adequate confidence that a structure, component, material or system meets pre-stated quality standards and will perform satisfactory during service. Independent Quality Assurance (IQA) examines whether projects and programmes are on track for successful completion or whether action is required to prevent failure. It can improve the probability of successful project delivery and minimize the risk of cost and time blowouts. An IQA often provides very large returns by preventing costly project mistakes and delivering benefits earlier (4, 5). An IQA is usually conducted on behalf of the project Sponsor or Executive to provide assurance that the project is appropriately planned, managed and controlled, and that the governance supports the project to best effect. All the quality paperwork in the world, with all their signatures, will not turn a poor quality product into a good quality product. However the paperwork trail is important in ensuring that proper quality procedures have been implemented and followed. For an effective quality assurance, the independent quality assurance team should:

- Determine if the work practices are such that the expected quality standard will be met.
- Examine the quality of the ongoing and completed work to determine that it meets or exceeds the project requirements.
- Ensure that the material used meets project quality standards.
- Issue a report of acceptable work as well as any substandard work.
- Track the corrective work and issue status report until satisfactory completion.
- Examine the quality control methods being used to determine if the supervisor is properly controlling construction activities.
- Review processes, practices and procedures and identify possible areas for change so as to improve the quality of the resulting work and recommend any changes if needed.

2. AIM OF STUDY

Quality is the characteristic element of an item that can be evaluated as a meeting standard, whereby if it meets or exceeds the standard, it can be said to be of good quality or high quality. However if the item does not meet the standard, it is considered poor quality. Quality Assurance is defined as a systematic activity to develop a formal structure, organization and operational procedures to ensure specified quality throughout the project life cycle (6).

Due to the risk engaged in any project, quality assurance is significant in the construction industry and engineering. It is vital that a built-in quality assurance system is developed to keep away from any inefficiency that could result in poor quality of construction and service being delivered to the customers (7).The objective of the paper is to analyze the various factors that have a significant impact on effectiveness of quality and quality assurance system used by different clients and to suggest recommendations to increase the quality performance of the construction projects. The aim here is to put forward various key aspects and challenges encountered in achieving the quality in construction. This paper also highlights the need of incorporating Independent Quality Monitoring (IQM) system in construction sector, which can contribute to overall up gradation in quality of projects.

3. STUDY ANALYSIS

To analyze the quality of the different construction projects, 30 construction projects were selected from National Capital Region with a construction cost between three to five Crores and data was collected from these projects on various quality and management related aspects. These 30 projects cover structures such as school buildings, community hall, hostel block etc. The study was conducted for construction projects of different government bodies. These projects were assessed for the quality assurance based on the factors playing key role in quality of a structure during construction such as client's commitment towards quality, quality of material, documentation, work practices, personnel etc. Figure 1 shows the factors considered to evaluate the quality of project.

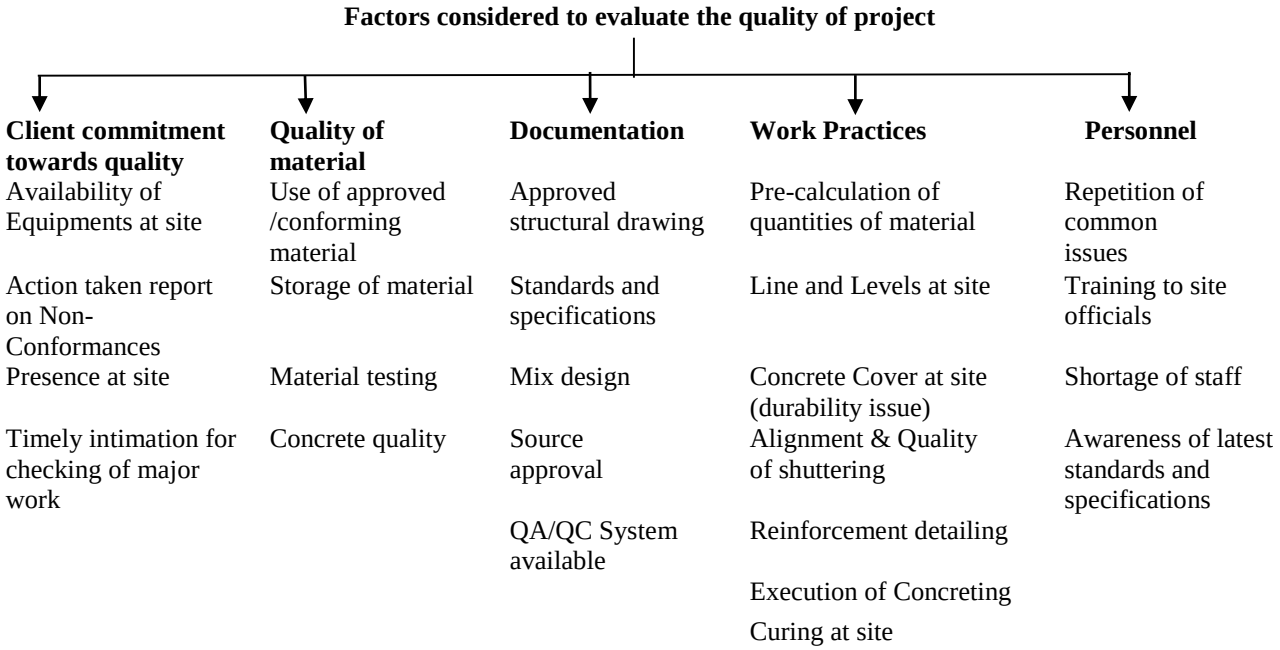

Figure-1: Factors considered to evaluate the quality of project

3.1. Factors considered

3.1.1. Client commitment towards quality:

Client's attitude towards the project shapes the progress and quality of project. Presence of client's representative at site ensures the proper workmanship and work practices used in construction. Major problem with the projects is availability of equipments at site that results in improper construction practices. Client can play an important role by ensuring that the action is taken on the non-conformances reported and by timely intimating the checking of major work to the independent quality assurance agency. The Figure 2 shows the percentage of the projects where client's commitment towards the quality was upto the mark.

Suggestions and recommendations:

- Essential equipments should be made available at site for proper testing and to ensure proper methods are used for construction.
- For all the non-conformance action should be taken accordingly and action taken reports should be maintained for review and records.
- Client should ensure quality by visiting during major work and intimating to independent quality team for verification.

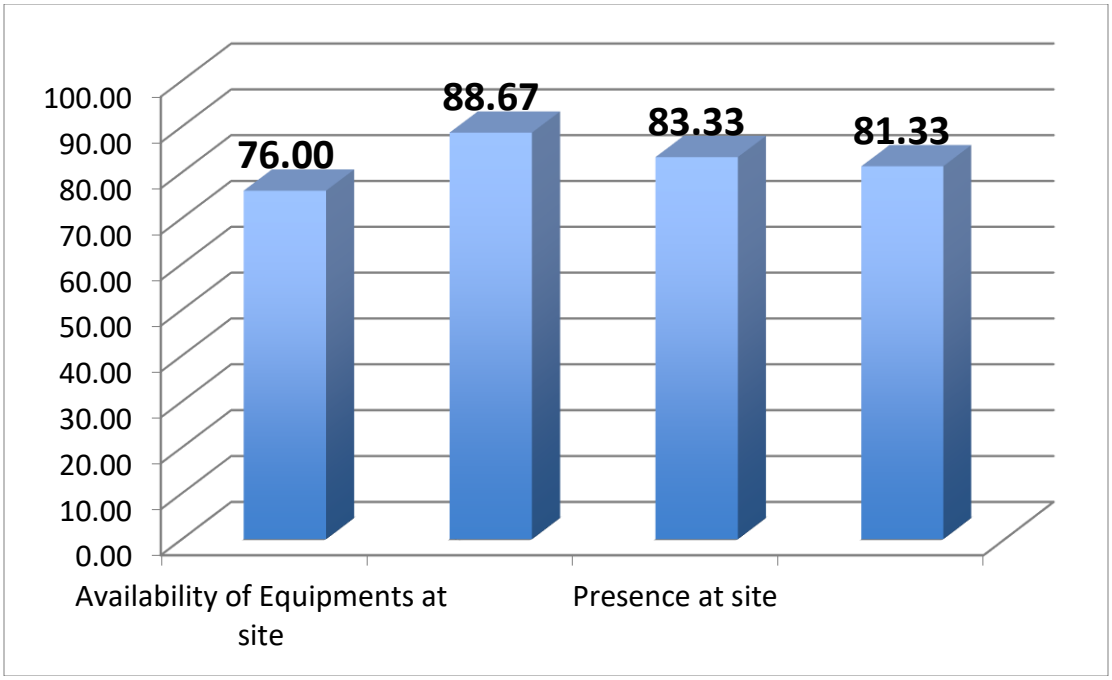

Figure-2: Graph representing the projects where client ensured quality

3.1.2. Quality of material:

To ensure the quality of materials, all the materials should be procured from the approved sources as per the tender documents and the source should not be changed during course of the project. Storage of material (steel, cement, water & bricks etc.) plays an important role and small negligence will result in reduced quality and increased overall cost of the project. Material testing is one of the major tools with the construction industry to check the quality of materials used in construction. The major part in any construction project includes concrete and hence quality of concrete has direct influence on the overall performance of structure. Taking care of following governing factors can ensure concrete quality:

- Workability and Control / checks on w/c (water cement ratio)
- Transport and placing time lag, tools used for placement
- Finishing of concrete including placement, compaction
- Provision for maintenance of concrete surface

The Figure 2 shows the percentage of the projects that were fulfilling the requirements of the quality of the material used for the construction including the approved source, proper storage and ensuring timely material testing under quality control. The Figure 3 shows that the storage of materials was not as per the specifications for many projects which is major point of concern. Improper storage of materials results in degradation of the even good quality materials.

For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipments with proper access and proper manoeuvrability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipments at different stages of construction shall be considered. Materials shall be stored in such a manner as ‘to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Materials, like timber, coal, paints, etc shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under firefighting conditions and in general they shall not be more than 4.5 m in height. The provisions given in IS: 13416 (Part 5): 1994 shall be followed.

Cement shall be stored at the work site in a building or a shed which is dry, leak proof and as moisture-proof as possible. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed as far as possible. Stones shall be stacked on dry firm ground in a regular heap not more than 1 m in height.

Bricks shall be stacked on dry firm ground. For proper inspection of quality and ease in counting, the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time

along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack.

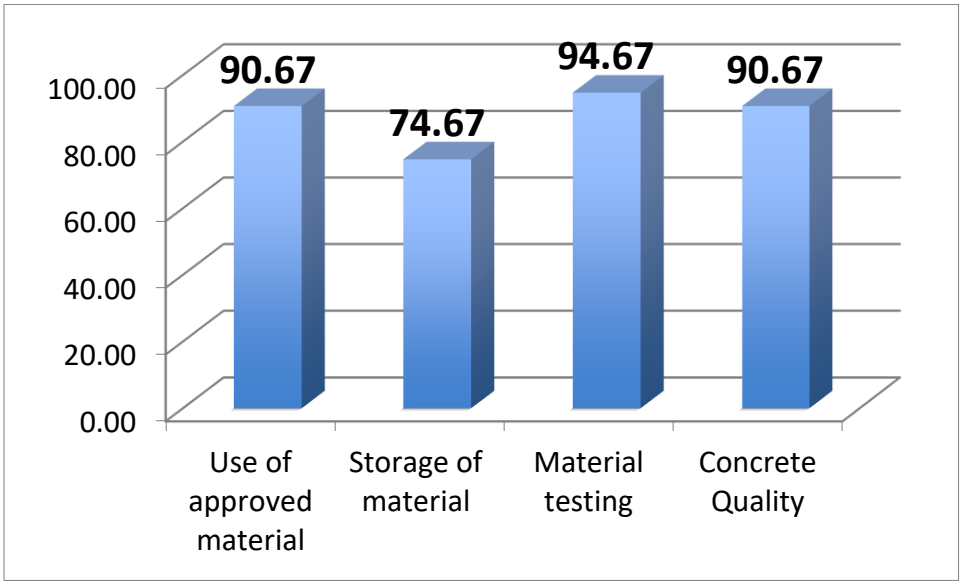

Figure-3: Graph representing the projects fulfilling the quality of material used

Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent contamination with clay, dust, vegetable and other foreign matter. Fly ash shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in such a way that any intrusion of foreign matter is avoided. Fly ash in bags shall be stored in stacks not more than 10 bags high. Tiles of different quality, size and thickness shall be stacked separately to facilitate easy removal for use in work. Tiles when supplied by manufacturers packed in wooden crates, shall be stored in crates. The crates shall be opened one at a time as and when required for use. Steel reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting. Aluminium sections of different classification, sizes and lengths shall be stored separately, on a level platform under cover. The aluminium sections shall not be pulled or pushed from the stack nor shall be slided over each other, to protect the anodizing layer. All other materials including paint, sanitary appliances, PVC pipes etc. shall be stored as per guidelines given in Indian Standard IS: 4082-1996.

Steps to be taken to improve the storage quality:

- Materials used during the construction should be from the source approved prior construction and if the source has to be changed than again approval should be taken after complete testing of the materials.
- Storage of the materials should as per the Indian Standards specifications. Special care should be taken for materials sensitive to environment such as cement, steel, admixtures, water etc.
- Materials should be tested at regular interval for the validation of the quality as per the approved quality at approved laboratory. An independent testing by independent party should also be done to avoid any malpractices. The testing of materials as per relevant Indian Standard / specifications shall be carried out keeping in view the requirement of the projects including the durability requirements of the project. In order to improve the testing, the relevant testing conditions and sampling procedure as per relevant Indian standards are critical for accuracy of test results based on which decision on use of materials is taken in construction project. For example if sampling of cement is not done as per IS: 3535-1986, then there will be the variation is results and subsequently the quality of construction at large will be affected. Similarly, in case of concrete cube testing, if the loading rate, calibration of machine etc. is not proper at site, the improper testing will subsequently affect the quality of construction as whole. The testing for concrete shall be carried out as per procedure laid down in IS: 516-2018.
- Concrete quality should be maintained by strictly following the mix design, proper mixing and using appropriate admixtures. Many factors may affect the durability and overall performance of concrete structures such as structural design, concrete quality (which include mix design, quality and consistency of raw materials, mixing and delivery), workmanship (placing, compaction, finishing and curing), structure usage and environmental exposure. The quality of concrete in detail will depend upon water to cement ratio,

type of cement, quality of aggregates and other concrete ingredients including admixture apart from the factors listed above.

3.1.3. Documentation:

Quality records describe the work involved and contain evidence that work items met the requirements of the plans and specifications; sampling and testing personnel, procedures and equipment were properly certified or accredited; and corrective action was taken for any nonconforming conditions. Documents such as Structural drawing, Standards and specifications, Source approval and Mix design ensure that the construction meets the quality requirement as well as functional requirement post construction. Availability of QA/QC System ensures the evaluation of overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards. The Figure 4 shows the percentage of the projects that were fulfilling the requirements of the documentation with all the documents duly approved and were used during the construction for better results.

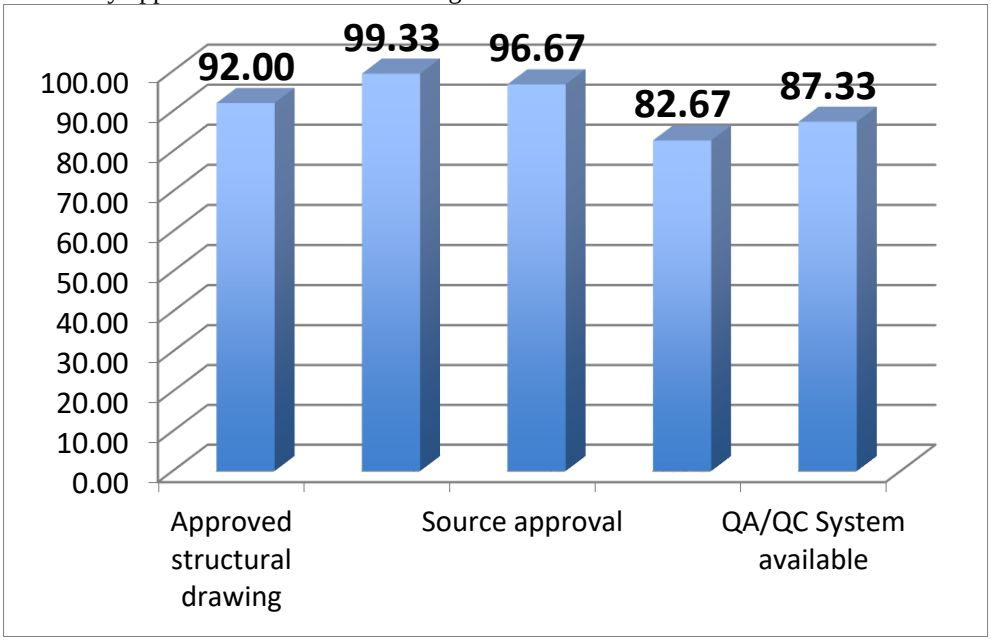

Figure-4: Graph representing the projects fulfilling documentation requirement

Major negligence was observed with the mix design, which can influence the quality of concrete used and hence degrading the overall quality of the project.

Suggestion recommended to increase the quality of project

- Availability of approved readable structural drawings indicating name of consultant and latest revisions if any.
- Availability of latest standards and specifications at site and should be followed.
- Prior testing of materials before anticipated use in structure should be done.
- Mix design should be available at site and should not be more than one year old. If material source is changed than mix design should also be updated as per the new materials.
- Along with the independent quality monitoring system, quality assurance/quality control system should be there that monitors the quality on regular basis.

3.1.4. Work Practices:

Even ensuring the quality of materials will not result in the good quality end product if the construction methods used are not as per the standards. Construction procedures and the technology used have a great influence on the quality, which if not met to the specifications will result in structure that is not safe and sustainable. Some factors that needs to be taken care of during construction includes pre-calculation of quantities of material, line and levels at site, durability related issues such as size, grade, spacing of cover blocks at site, alignment & quality of shuttering and proper reinforcement detailing that can be understood by the site personnels. Since the major part of the structure comprises of concrete along with its quality precautions should be taken during the execution of concreting such as proper transportation, placement, compaction and finally curing once concrete is hardened. The Figure 5 shows the percentage of the projects that were fulfilling the requirements of the work practices by ensuring the correct methods and procedures during the execution of the work.

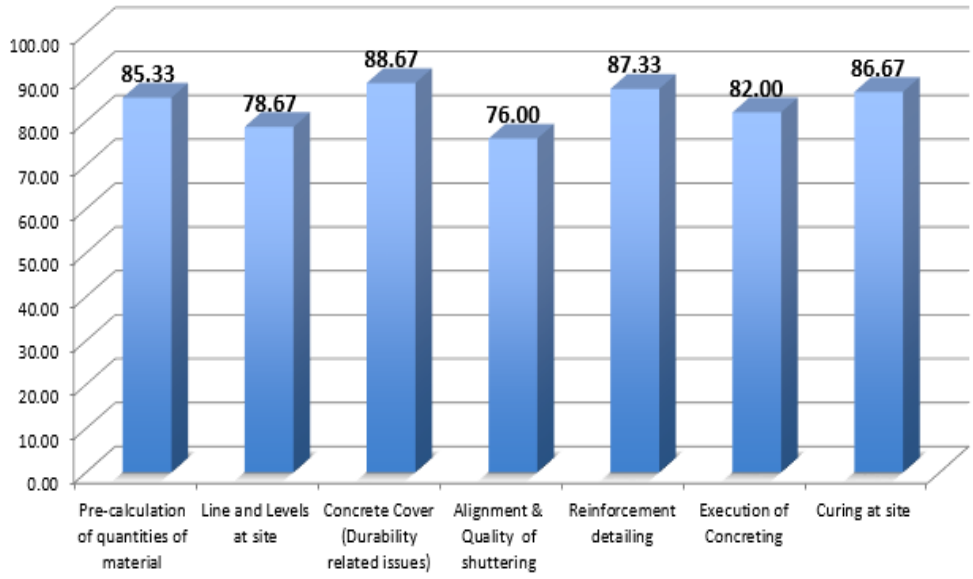

Figure-5: Graph representing the projects fulfilling the work practices

Suggestion recommended for better results:

- Pre-calculation of quantities of materials should be done to avoid use of inferior materials during shortage at later stage.
- Proper line and levels should be maintained for both structural and aesthetic requirements.
- Factors affecting durability of structure such as cover, compaction and water/cement ratio etc. should be taken care for long life of the structure.
- A detailed readable reinforcement detailing should be available at site and should be strictly followed. Bar bending schedule should be prepared for better understanding of the reinforcement distribution.
- Concrete execution should be done under strict supervision of experts and proper transportation, placing, compaction and curing should be ensured as per the IS codes.

3.1.5. Personnel:

The construction industry is booming and as a result, increase in construction defects is common nowadays. One of the major areas of concern is poor workmanship. In simple terms, workmanship is the skill and quality used in making the product or completing a project. Workmanship is about quality; good or bad. If workers are careless or don't follow proper protocol then it leads to a finished product that lacks the quality anticipated. The failures of building structures are due to workmanship negligence and the lack of effort put into quality control processes on the construction site. The construction industry and the professionals at every level are responsible for meeting standards of quality, care, and expertise. Quality work begins with the conscious efforts of contractors to execute the specifications of the contract. Unskilled workman, unsuitable equipment and materials, and lack of project management lead to poor workmanship. Poor workmanship can results in problems such as corrosion, molding, plumbing issues, injuries and death, cracks in foundation and walls and leaking roofs. The Figure 6 shows the percentage of the projects that were fulfilling the requirements of the good manpower with awareness of latest specifications and technology used in the construction.

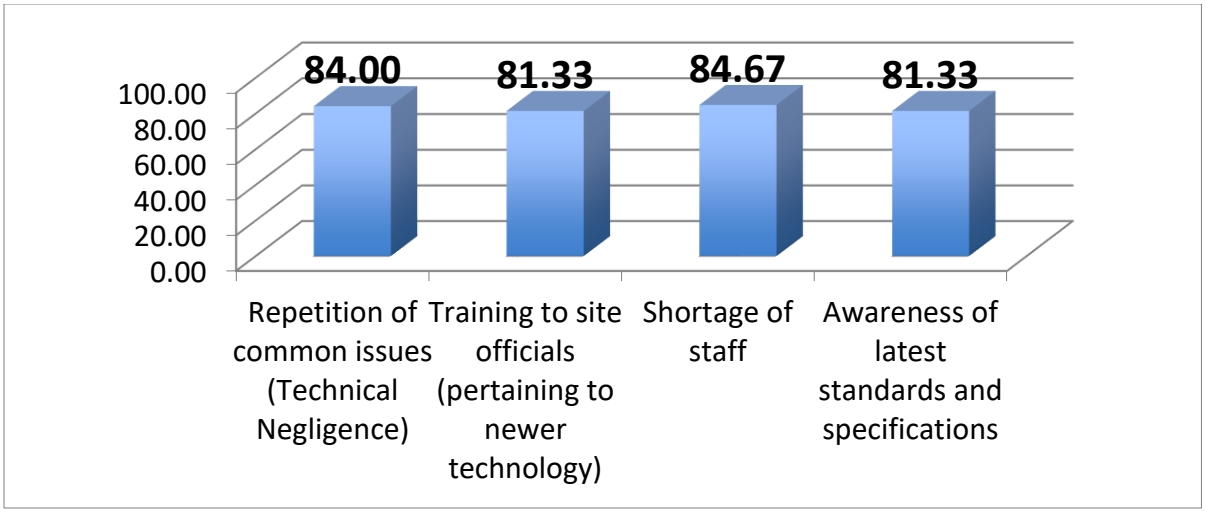

Figure-6: Graph representing the projects fulfilling the requirement of personnel

Steps to be taken to improve the quality of workmanship

- Training regarding newer materials and technology should be provided to the staff for the effective use of resources.
- Training regarding work practices should be provided to the workers to avoid the repetition of common issues during construction.
- Shortage of staff should be avoided to ensure the quality of work.

4. QUALITY GRADING OF THE QUALITY ASSURANCE SYSTEM FOR PROJECTS STUDIED

Each factor mentioned above was given weightage (1 to 3) (see Table 1 and Table 2) based upon its relative importance towards the quality of the project and was rated on a scale from 2 to 5 based on the inspections and analyzing the data from the projects. The scale from 2 to 5 was selected based on relative importance of the issue involved in construction in authors view keeping in view the overall impact on the quality of the structure as whole. Maximum total sum of the ratings of all the factors was kept as 265. The sample questionnaire sheet used in study is enclosed as appendix-1. Based on the ratings obtained by the project, it can be classified under following categories:

Table-1: Rating of various factors

Category/ Range of Rating	Conformances to the factors considered	Range of Rating	No. of Projects
Excellent (250-265)	All major and minor factors conforming.	250-265 (appendix-2)	3
Good (230-249)	All the major factors conforming and few nonconformance related to the minor factors such as source approval, pre-calculation of quantities of materials and presence of client at site.	230-249 appendix-2)	15
Average (215-229)	Few non conformances to major and minor factors considered such as durability, availability of equipments at site, line & levels and alignment & quality of shuttering.	215-229 (appendix-2)	8

Poor (200-214)	Non conformances for the major factors considered such as structural drawings, material testing, concrete quality, durability, training of staff, awareness to latest standard and specifications.	200-214 (appendix-2)	4

The grading distribution obtained for Quality Assurance System of projects shows that the most of the projects were categorized under good and average category as shown in Figure 7. For nearly 13 % of the projects, quality assurance is just satisfactory which is point of concern. Keeping in view the lapses in quality system of various parameters, the Quality Assurance System of these projects were categorized as poor.

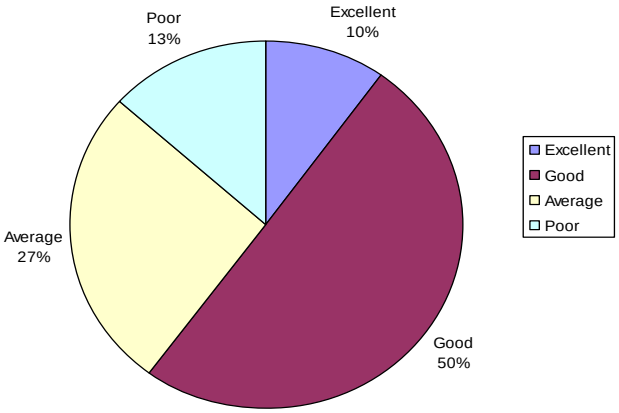

Figure-7: Pie Chart indicating Quality Grading of Quality Assurance System for Projects Studied based on detail study given in Table Below

5. CONCLUSION

The grading distribution obtained for Quality Assurance System of the projects shows that the most of the projects were categorized under good and average category. For nearly 13 percent of the projects quality assurance is just satisfactory which is point of concern, keeping in view the lapses in quality system of various parameters, the Quality Assurance System of the projects were categorized as poor. This study highlights the negligence of basic compliance needed during the execution of project which leads to untimely need of maintenance of structures. The study also indicate that there is need to train and create awareness among construction fraternity where still the fundamental quality management needs strengthening. The major negligence from the study carried out was found with mix design, storage of materials, work practices used during construction and availability of equipment's at the site which should be improved in order to attain the desired quality and service life of finished infrastructures. Quality is an essential element for sustainability and consumer satisfaction. The high cost of the infrastructures makes it necessary to ensure the quality of the finished structure. Therefore, an independent Quality Assurance Monitoring System with adequate technical expertise and integrity is important to act as catalyst for durable and sustainable infrastructure.

Based on the study done, it can also be concluded that the coordination of client and Independent Quality Assurance Monitoring Consultant is very important in improving the quality system at site which ultimately will lead enhanced service life of structure. This study was carried out for limited projects from NCR region and hence is not representative sample for whole country. Further studies should be done for more number of projects from various parts of the country to include the regional factors and issues covering environmental aspects related to the behaviour of coastal and non-coastal environment.

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Appendix – 1

Sample sheet for Quality Grading

Quality Grading of the Quality Assurance System					
Project No:				**Date:**	
	S. No.	**Factors Considered**	**Weightage**	**Grade**	**Rating**
Client's commitment towards quality	1	Availability of Equipments at site	3	5	15
	2	Action taken report on non-conformances reported.	2	5	10
	3	Presence at site	1	5	5
	4	Timely intimation regarding checking of major work	2	5	10
Quality of material	5	Use of approved material as per the tender documents	2	5	10
	6	Storage of material (steel, cement, water & bricks etc.)	2	5	10
	7	Material testing	3	5	15
	8	Concrete Quality	3	5	15
Documentation	9	Approved structural drawing	3	5	15
	10	Standards and specifications	2	5	10
	11	Source approval	1	5	5
	12	Mix design	2	5	10
	13	QA/QC System available	2	5	10
Work Practices	14	Pre-calculation of quantities of material	1	5	5
	15	Line and Levels at site	2	5	10
	16	Durability related issues such as size, grade, spacing of cover at site	3	5	15
	17	Alignment & Quality of shuttering	2	5	10
	18	Reinforcement detailing	3	5	15
	19	Execution of Concreting	3	5	15
	20	Curing at site	3	5	15
Personnel	21	Repetition of common issues by workmanship	1	5	5
	22	Training to site officials for newer materials and technology	3	5	15
	23	Shortage of staff	2	5	10
	24	Awareness of latest standards and specifications	2	5	10
		Total			265
*Rate from 2 to 5 based on quality assurance. 2 being lower value and 5 indicates higher grade.					
Evaluated by:					
Verified and approved by:					

Appendix -2

	S. No.	Factors Considered	Weightage	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
Client's commitment towards quality	1	Availability of Equipments at site	3	4	5	4	3	3	5	3	3	3	5	4	5	2	5	3
	2	Action taken report on non conformances reported.	2	5	4	5	5	3	5	3	4	5	5	4	5	3	5	5
	3	Presence at site	1	4	4	5	4	2	5	5	4	4	5	5	5	3	4	4
	4	Timely intimation regarding checking of major work	2	4	2	5	4	5	5	5	3	4	5	4	5	4	5	4
Quality of material	5	Use of approved/conforming material	2	5	5	4	5	4	5	5	5	5	4	4	3	5	4	5
	6	Storage of material (steel, cement,water & bricks etc.)	2	2	4	5	2	5	3	5	2	4	5	2	5	4	5	3
	7	Material testing	3	4	5	5	5	4	5	5	5	4	5	5	5	4	5	5
	8	Concrete Quality	3	5	4	5	5	5	3	4	5	5	5	4	5	5	5	4
Documentation	9	Approved structural drawing	3	5	5	4	5	3	4	5	5	5	5	4	5	5	4	5
	10	Standards and specifications	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	11	Source approval	1	5	4	5	5	5	5	5	5	5	4	5	5	5	5	5
	12	Mix design	2	5	4	5	5	2	5	2	5	3	5	4	2	5	5	5
	13	QA/QC System available	2	5	5	4	5	5	4	3	5	5	5	2	3	5	5	4
Work Practices	14	Pre-calculation of quantities of material	1	5	2	5	2	5	4	5	5	5	5	3	5	2	5	5
	15	Line and Levels at site	2	3	2	5	2	3	3	5	5	4	4	4	5	5	3	5
	16	Durability related issues such as size, grade, spacing of cover at	3	4	5	5	3	4	4	3	5	5	5	4	5	3	5	5
	17	Alignment & Quality of shuttering	2	5	2	4	3	2	5	4	5	3	5	5	2	5	2	5
	18	Reinforcement detailing	3	5	3	5	5	4	5	5	5	4	5	3	5	3	5	4
	19	Execution of Concreting	3	5	5	4	5	3	5	2	4	4	5	4	3	5	3	4
	20	Curing at site	3	5	5	5	5	5	3	5	3	4	4	5	2	5	4	5
Personnel	21	Repetition of common issues (Technical negligence)	1	4	5	5	3	5	5	2	5	5	4	3	5	5	2	5
	22	Training to site officials for newer materials and technology	3	4	4	5	3	5	4	4	4	5	5	5	5	3	4	3
	23	Shortage of staff	2	4	4	5	3	4	5	4	5	5	4	4	5	4	3	5
	24	Awareness of latest standards and specifications	2	4	4	5	4	2	4	4	3	5	5	2	5	4	5	4
		Total (Maximum = 265)		**235**	**220**	**250**	**217**	**205**	**231**	**215**	**230**	**232**	**254**	**210**	**230**	**218**	**230**	**233**

	S. No.	Factors Considered	Weightage	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30
Client's commitment towards quality	1	Availability of Equipments at site	3	3	3	3	5	3	5	4	5	3	3	5	4	3	3	5
	2	Action taken report on non conformances reported.	2	3	4	5	5	4	5	4	5	5	5	4	5	5	3	5
	3	Presence at site	1	5	4	5	3	5	5	3	4	4	4	4	5	4	2	5
	4	Timely intimation regarding checking of major work	2	5	3	4	2	3	5	4	5	3	4	2	5	4	4	5
Quality of material	5	Use of approved/conforming material	2	5	5	5	4	4	3	5	4	5	5	5	4	5	4	5
	6	Storage of material (steel, cement,water & bricks etc.)	2	5	2	4	5	2	5	4	5	3	2	4	5	2	5	3
	7	Material testing	3	5	5	4	5	5	5	4	5	5	4	5	5	5	4	5
	8	Concrete Quality	3	4	5	5	3	4	5	5	5	4	5	4	5	5	5	3
Documentation	9	Approved structural drawing	3	5	5	5	5	4	5	5	4	5	5	5	4	5	3	4
	10	Standards and specifications	2	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5
	11	Source approval	1	5	4	5	4	5	5	5	5	5	5	4	5	5	5	5
	12	Mix design	2	2	5	3	5	4	2	5	5	5	5	4	5	5	2	5
	13	QA/QC System available	2	3	5	5	4	4	3	5	5	4	5	5	4	5	5	4
Work Practices	14	Pre-calculation of quantities of material	1	5	5	5	5	5	5	4	5	5	5	2	5	2	5	2
	15	Line and Levels at site	2	5	5	3	5	4	5	5	3	5	3	2	5	2	5	3
	16	Durability related issues such as size, grade, spacing of cover at site	3	3	5	5	5	4	5	4	5	5	4	5	5	4	5	4
	17	Alignment & Quality of shuttering	2	4	5	4	5	5	2	5	2	5	5	2	4	2	2	5
	18	Reinforcement detailing	3	5	5	4	5	3	5	4	5	4	5	2	5	5	3	5
	19	Execution of Concreting	3	2	4	3	5	4	3	5	3	4	5	5	5	5	4	5
	20	Curing at site	3	5	3	5	4	5	3	5	3	5	5	5	5	5	3	4
Personnel	21	Repetition of common issues (Technical negligence)	1	2	5	5	4	3	5	5	2	5	4	5	5	3	5	5
	22	Training to site officials for newer materials and technology	3	4	4	5	3	3	5	3	4	3	4	4	5	3	5	4
	23	Shortage of staff	2	4	5	5	3	4	5	4	3	5	4	4	5	3	4	5
	24	Awareness of latest standards and specifications	2	4	4	5	5	3	5	4	5	4	4	4	5	4	2	4
		Total (Maximum = 265)		**215**	**231**	**233**	**230**	**207**	**233**	**234**	**227**	**231**	**232**	**217**	**253**	**218**	**204**	**232**