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QUALITY MAINTANENCE AND MATERIAL TESTING PROCESS IN CONSTRUCTION INDUSTRY

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"Quality is never an accident. It is always the result of intelligent effort"

"Quality is when the customer comes back, and not the product "

ABSTRACT

Quality is an important factor when it comes to any product or service. Quality control is essential to building a successful business that delivers products that meet or exceed customers' expectations. It also forms the basis of an efficient business that minimizes waste and operates at high levels of productivity. Quality control in construction means making sure that things are done according to the plans, specifications and permit requirements. The quality assurance process checks the quality plan and quality control process to confirm that quality standards are implemented on the project site. 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. Recommend any changes to project staff and/or management.

KEYWORDS: quality control, quality design, quality assurance, plan, check, projects & management.

1. INTRODUCTION

1.1 General

Quality in construction industry can be defined as the attainment of acceptable levels of performance from construction activities. The quality of any product or service is achieved when it conforms to the desired specifications. Expected quality can be ensured through quality assurance and quality control activities. The quality control process confirms that the project outcome meets the client's standards. The quality assurance process checks the quality plan and quality control process to confirm that quality standards are implemented on the project site. To improve the quality construction of the project, understanding project requirements and standards is essential. This is usually done by a team outside of the project construction team, and the goal of this practice is to maintain quality standards.

The success of any project has two key factors: one is the completion of the project on schedule as per the contract document and the quality of the project as per department standards. A failed project cannot lead to achieving business goals, and moreover, it leads to losses.

Proper project planning is the first step for the success of the project. The plan describes the number of phases in the project and the list of construction activities to be carried out in each phase. Individual responsibility of each project phase, the duration of the project and the overall project budget are also included in the project plan.

Generally, there are four steps in construction project management for improving quality. The steps are planning, executing, monitoring and quality assurance. Each and every step of project management should contain a document within itself. These four steps help to increase productivity and quality as per the client's requirements. The team should evaluate the overall project on a regular basis to validate the quality standards of the project. The responsibility of the project engineer is to ensure that quality control is implemented effectively. It is best to have professional engineer exam certified candidates in charge for better productivity and overall quality.

Quality improvements raise profits, and making quality an expectation will foster good build processes, and establish a good reputation.

1.2 Improvement of Construction quality

The following ways to improve quality in construction

- Improve your planning
- Find good construction management software
- Start using Building Information Modeling (BIM)
- Listen & learn to your staff
- Invest in training
- Improve your communication
- Establish performance measurements and hold your crew accountable
- Skilled labors are used in construction
- Training Programs for Workers and Employees
- Efficient Safety Programme
- Effective Procurement system to obtain quality resources and suppliers
- Reward scheme for innovative works
- A competitive career progress scheme
- Selection of types of material and methods to be included in design,

- Ensure design in accordance with all applicable codes and regulation
- Satisfaction of Contract Specifications
- Completion of Project within Time
- Proper check list preparation and monitoring.

1.3 Construction quality checking

During construction work checking of each and every stage of work execution is very important to maintain quality standards. Based on this checking process following instructions to be followed.

- Investigate the soil.
- Determine the structure design
- Check the concrete mix
- Inspect the wall thickness.
- Ensure safety features.
- Look for paint and plastering quality
- Examine the elevators.
- Check the building material as per standard quality acceptance

2. BASIC ELEMENTS TO IMPROVE THE CONSTRUCTION QUALITY

2.1 Quality of design

It refers to the quality with which the design is carried out. It primarily related to meeting the requirement of the standard, functionally efficient system and economical maintainable system.

Design quality is not always the primary objective for the client; time or cost may be more important. Furthermore, it is only realistic to specify a very high standard of design quality, if the budget is available to achieve that standard.

The client should appoint an internal senior design champion to be responsible for ensuring the design achieves the required design quality.

The design champion's role is:-

- To ensure that the vision for design quality is defined.
- To ensure that objectives for design quality are described in briefing documents and are properly understood by the consultant team.
- To monitor and evaluate design quality throughout the design process.

2.2 Quality Characteristics

A quality characteristic is related to the parameters with respect to which quality control processes are judged.

Quality characteristic includes strength, colors, texture, dimension, height and product. Some important testing of materials meets the quality standards as per code. Constructed facility conformed the design and specification. Quality of conformance is affected by field construction methodology and Inspection

Example: compressive strength of concrete, usability of concrete in slump, etc.

2.3 Quality Assurance

Quality assurance is the process of identifying or deciding on all the quality requirements for a project. It also includes identifying existing quality documents that are relevant to the quality requirements of the project, and making them available for use. It is a way of preventing mistakes and defects in manufactured products and avoiding problems when delivering products or services to customers; which ISO 9000 defines as "part of quality management focused on providing confidence that quality requirements will be fulfilled".

A quality assurance plan is a document, constructed by the project team, meant to ensure the final products are of the utmost quality. A quality assurance plan contains a set of documented activities meant to ensure that customers are satisfied with the goods or services a company provides.

There is always some risk involved in any construction project, and Quality Assurance is essential in preventing problems with a build and reducing risk. If quality issues are only identified after an activity has been completed, the result is re-work and programme delays. When quality issues aren't identified at all during the build, it can lead to painful defect-liability periods, or buildings that fail years after practical completion.

The Quality Assurance process can involve recognizing standards when any applied in software development methods. To carry traditional processes, for example, quality reviews Conduct process test data recording processes. Encouraging the documentation procedure measures.

2.4 Quality control

Quality control in construction means making sure that things are done according to the plans, specifications and permit requirements. The quality assurance process checks the quality plan and quality control process to confirm that quality standards are implemented on the project site.

The Construction Quality Control Manager (CQCM) is responsible for managing and performing the daily QC responsibilities of specific projects to ensure the project is constructed in accordance with the established minimum standards.

It establishes a framework with defined procedures and practices to ensure that the completed product meets or exceeds the project specified quality requirements.

Following process are improve QC

- Implement a Centralized Document and Issue Management System.

- Bolster Your Inspections Tracking Process (ITP) with Digital Checklist Inspections.
- Correlate Inspections to Your Look-Ahead Plans.
- Perform Collaborative Inspections with Your Trades and Subs.
- Project personnel.
- Quality Communications.
- Quality assurance surveillance.
- Subcontractors and suppliers.
- Project quality specifications
- Inspections and material tests.
- Control of non-conformances.
- Project completion inspections.

Quality control methods are:-

- Inspection: Inspection, in fact, is the common method used for quality control purposes not only in production but also in services. ...
- Statistical Quality Control: It is an advanced method or technique used to control the quality of a product.

3. MATERIAL TESTING FOR QUALITY IN CONSTRUCTION

Materials should be tested at regular interval for the validation of the quality as per the approved quality at approved laboratory. 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.

Construction supervision, quality control, and field and laboratory testing are among the main pillars of quality achievements in construction which develops the quality control plans and procedures for each project, including technical specifications and testing procedures. We maintain over design, construction, documentation, recordkeeping, purchasing, equipment calibration, materials handling, storage, shipping, inspection, and testing are thoroughly detailed in the plans.

3.1 Quality Control process:-

Construction supervision: periodical inspection regulates time and costs, assure compliance with design and construction specifications, and control the quality of a construction project.

Control over testing & inspections: assure that any deficient work is corrected. Perform project preparatory, initial, follow-up and completion inspections; assure that test procedures include test and instrumentation requirements develop requirements for measuring and monitoring; assure that careful consideration is given to environmental concerns and develop detailed acceptance criteria before project work begins.

Test records: ensure that all tests are documented and test records include the items tested, the date of the test, the test conductor or data recorder, acceptance criteria, type of observation, results and acceptability, action taken in connection with any noted deviation, and the signature, affiliation and title of the person evaluating the test results.

Control of special processes: control engineers assure that certain tests, for example, welding radiographic and non destructive tests, are performed by qualified personnel using approved written procedures prepared in accordance with the contract drawings and specifications and the referenced codes and standards.

Handling, storage and shipping: Materials and equipment that are handled, stored or shipped by a contractor or supplier are required to meet the applicable requirements defined in the project specifications. QC engineers review and assure compliance with any special handling instructions, including the use of specially tested and inspected handling tools; the storage procedures required by the drawings and specifications; preventive maintenance requirements; and requirements for the appropriate protection of shipped items.

Document control: prepare material requisitions and purchase orders, revise procurement documents, if required, and control compliance with instructions and procedures prescribing activities that affect quality.

Record control: QC engineers develop and implement programs to control the collection, storage and maintenance of the records generated throughout project construction, such as material mill certificates, test certificates from off-site laboratories, test records from on-site laboratories, calibration documents, check list records, standard forms appendices, and schedules of approved and/or rejected materials.

Calibration control: implement a program to control the calibration, recall, repair, and maintenance of measuring devices, instruments, and equipment that are used for inspection and testing, ensuring that all tools, gauges, and other measuring equipment are calibrated and maintained in accordance with the manufacturer's recommendations. Items that typically require calibration control are batching plants, testing machines, pressure gauges, torque wrenches, survey instruments, scales and balances, and voltage and amperage meters.

Control of purchased items and services: QC engineers work with project managers to evaluate and select suppliers of purchased items and subcontracted services, in accordance with the requirements detailed in drawings and specifications. In coordination with subcontractors, QC engineer develops a schedule for inspections and tests.

The following material tests are conducted for the purpose of quality,

3.2 soil tests -In Situ Testing

- **S**tandard Penetration Tests
- **F**ield Vane Tests
- **C**one Penetration Tests
- **S**eismic Cone Tests
- **D**ilatometer Tests
- **F**alling Head Permeability Tests
- **P**acker Permeability Tests
- **C**ompaction Tests
- **P**ile Load Tests
- **P**late Loading Tests
- Classification tests
- Grain Size Distribution Tests
- Shear Strength Tests
- Consolidation Tests
- Compaction Test

Rock Testing

- Point Load Test
- Uniaxial Compression Test

Other tests

- Concrete Testing
- Aggregate Testing
- Asphalt testing
- Inspection Services
- Sub-grade inspection
- Foundation Installation Inspection
- Earthworks Quality Control
- Pile Driving and Installation Inspection
- Pavement Distress Inspection
- Inspection on Foundation Damages

3.3 Laboratory Testing for soil

Soil samples extracted from boreholes in the field are sent to laboratory in to obtain soil classification and physical and mechanical properties.

Index Tests: water content determination, Atterberg limits, grain size distribution, specific gravity, and bulk density and maximum/minimum density

Strength Tests: unconfined compression test, unconsolidated-un drained triaxial compression test, consolidation-un drained triaxial compression test, consolidation drained triaxial test, point load test, direct shear test, laboratory vane test, and slake durability test **C**ompressibility Tests: one-dimensional consolidation test and collapse potentials test

Swelling Tests: one dimension swell test **chemical** testing for soil and groundwater samples: PH-sulphate-chloride-carbonate contents-total dissolved salts

Aggregate Tests: soundness, resistance to abrasion (using Los Angeles machine), organic impurities in fine aggregates, crushing value of coarse aggregates, alkali reactivity by chemical and rock cylinder methods, and determination of total dissolved salts, chlorides, and sulphate

3.4 Construction Material Tests - In Situ Testing

Determine the common properties of main construction materials in the field.

Properties of fresh concrete: consistency and workability (slump test), density, temperature, and air content.

Properties of earth fill and pavement subsoil layers: field density (sand cone test), moisture content (speedy test), plate loading test, and Field California Bearing Ratio (CBR) Evaluating properties of an existing reinforced concrete

Structural element in the field: compressive strength by rebound test (Schmidt hummer), uniformity (using ultrasonic velocity test), cover thickness and/or the reinforcement ratio (using the Cover Meter), and loading tests

3.5 Laboratory Test for cement, aggregate & concrete

Cement: fineness of cement (Blain Air Permeability Test), soundness (Le chateier), compressive strength of standard mortar, setting time (using Vicate apparatus), and full chemical analysis

Aggregate: sieve analysis, soundness, resistance to abrasion (using Los Angeles machine), organic impurities in fine aggregates, crushing value of coarse aggregates, alkali reactivity by chemical and rock cylinder methods, and determination of total dissolved salts, chlorides, and sulphate

Concrete: compressive strength of hardened concrete samples, compressive strength and chemical analysis of concrete core samples drilled from an existing concrete element, flexural strength, indirect tensile strength, modulus of elasticity

Brick & Block Work: check of dimensions, density, absorption, compressive strength, efflorescence

Chemical analysis of water to determine its acceptance criteria for use in mixing and curing concrete (e.g., PH-sulfate-chloride-carbonate contents-total dissolved salts) **Chemical mortar:** compressive strength,

bond strength, length change, and exposure (such as to acids, oil, high temperature)

Bituminous material: extraction of bitumen from bituminous paving mixtures, coating and stripping of bitumen-aggregate mixture, resistance to plastic flow of bituminous mixtures (using Marshall apparatus), stability of bituminous mixtures (using Marshall apparatus)

Earth fill and pavement subsoil layers: dry density/moisture content relationship (Proctor test) and California Bearing Ratio (CBR)

Official Materials Laboratory Testing of certain materials is conducted in official laboratories.

- **P**etrographic test for aggregates
- Petrographic test for concrete core samples
- **T**ension test for steel
- **C**old bent test for steel
- **A**brasion test for tiles and concrete
- **C**hemical analysis of steel
- X-ray diffraction (XRD) test
- Ultrasonic test for welded connections

4. RISKS INVOLVED IN QUALITY MAINTENANCE

Risk is the common factor for all construction projects. Lacking of improper checking and unskilled labours are major problems for affecting quality standards.

Construction quality maintenance is based on labours, engineers and material quality, so lacking of these category quality of construction is not achieve certain level of standards.

The following factors are affected during construction in quality aspects.

Improving construction quality management starts with an understanding of the factors that can impact both safety and quality.

Last-Minute Changes:-When essential features are still being engineered or discussed at late stages in the construction process, these last-minute changes often lead to serious quality issues. Damaged and **Low-Quality Materials:-** Too much water or sand in a concrete mix, lumber cut from undersized trees and improperly graded steel can all result in widespread construction quality issues.

Supplier and Vendor Failures:- Even when the materials themselves aren't to blame for a quality issue, problems with suppliers and vendors can raise costs and lower quality levels. Replacing the requested building supplies with other brands and materials that don't offer the same quality can result in unhappy clients and time-consuming rework requests.

Subcontractor Mishandling:- According to some studies, and un skilled labor working in construction execution also affect the quality in construction.

Failure to Document Changes and Practices:-
Some quality issues aren't directly related to a mistake or design change, but rather to the lack of documentation of the change.

Miscommunication between Teams:- Miscommunication leads to misapplication of new techniques, mismatched materials, And a lack of secondary and tertiary testing to discover existing problems.

Lack of Project Management System:- lacking of communication between engineers, clients and labors are most important problems for construction quality risks. Implementing a project management system based around mobile apps is a flexible and fast way to bring current projects under control.

5. MAINTENANCE AND DEVELOPMENT OF QUALITY IN CONSTRUCTION

Maintenance is the process of ensuring that buildings and other assets retain a good appearance and operate at optimum efficiency. Inadequate maintenance can result in decay, degradation and reduced performance and can affect the quality standards in construction.

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. Recommend any changes to project staff and/or management.

5.1 Quality development process.

Set your quality standards:-Each department of business will have different quality control standards. In some industries, you may have to meet quality standards set by an outside body, such as an industry association, the local health and safety inspector, or a government regulatory agency. In others, there aren't any official quality standards

Decide which quality standards to focus on:-to ensure quality in all aspects of your operation. However, begin by focusing on the most important measures like material, labours, design and quality checking those that have the biggest effect on your profits and your customer experience.

Create operational processes to deliver quality: modern quality control, believed that well-designed processes lead to high-quality products and services. If you create good processes, continually measure the results of the processes, and work to consistently improve the process, our quality will get better and better.

Review your results. Most of civil engineering software, from financial and accounting apps to customer relationship management or customer service tools, lets you customize the information you collect and use dashboards to view it at a glance. Review your data regularly to see how well your company is meeting its quality standards.

Get feedback:-Use measurable feedback from external sources, such as customer surveys, online ratings and

reviews and net promoter scores (NPS), to get a fuller picture of product and service quality.

5.2 Building Maintenance Activities for quality

1. Cleaning walls and floors

Proper cleaning of walls and floors, possibly every day (depending on the dirt exposure) must be done to avoid accumulation of dirt and dust. If the building has washable paints, it is supposed to clean with water as well.

2. Cleaning Glass panels and windows

There are certain cleaning liquids that can be employed in glass and woods, that won't affect wood quality. This helps in keeping the glass and wood clean for a lifetime.

3. Cleaning Wash areas and toilets

Cleaning water closets are essential primarily for hygiene and proper maintenance

4. Cleaning the Environment

The outside surrounding, the utilities must be cleaned, besides the inside cleanliness.

5. Special Treatments in Building Maintenance

Certain treatments in special areas must be done at regular intervals for the building maintenance. Some of them are explained below:

6. Plinth area projection

The projection of plinth area of the building has to be cleaned. The accumulation of dust in this area causes dampness

7. Ventilators

The cleaning of ventilators provided in the ceiling areas requires regular cleaning, to avoid dirt accumulation. Regular cleaning will help avoid tough cleaning during its extreme stages.

8. White or colour washing

A fresh coat of whitewashing or colour washing has to be done for the walls after 1 to 2 years. This mainly depends on the climatic condition exposure and another environment of the building. Using oil paints will help in maintenance be free for 6 to 8 years. Repainting has to be carried out before the old paint starts to degrade. Now exterior and interior paints are differed to avoid the moisture penetration. This makes use of special exterior paints.

9. Maintenance of doors and windows

Generally, at an interval of 4 years, it is advised to paint the windows as well as the door. This interval depends on the cleaning and usage. The hinges of the doors and windows must be oiled if their opening causes noise.

10. Maintenance of metal grills and utilities

The cleaning of shutters, painted grills must be done regularly. This will help in having a check on the corrosion. If any rust is found, it must be removed completely with no trace and must be repainted.

11. Floor Treatment and maintenance

The treatment of floor mainly depends upon the type of floor that is installed. To clean the floor that is of marble made, which is soiled by grease stains is cleaned with the help of chalk dust with acetone paste. This paste is placed overnight which is then cleaned the next day by means of a sponge.

The marble floor that has organic stains, like food liquids are cleaned with the help of paste of chalk dust and hydrogen peroxide. This paste helps in the removal of rust stains from the floor.

The terrazzo floors having oil and grease are removed with the help of lime powder that is hydrated and the marble dust. Or the use of benzoyl for writing or clear gasoline for 12 hours accompanied by washing, helps in giving a clean terrazzo floor.

The PVC floors will have an improvement in its appearance with periodic polishing.

The white kerosene oil in linoleum floors helps in clearing the dirt.

12. Water Carrying Systems

Sumps and overhead water tanks that must be fully hygiene as they are supposed to store water must be cleaned at regular intervals. This interval must not be greater than 3 months.

13. Tree Root Problem

The tree roots that grow in lateral direction creates problem to the building substructure. The moisture from the underground of the building is taken by these trees causing cracks in the walls of the structure. Now the trees those creates such problem must be removed at early stages. If fully grown trees are present, we must trench along the walls of the building and cut the root. The root cut must be

coated with coal tar, to avoid further growth in that direction.

14. Supply lines

The leakage in water supply lines can be avoided by proper check. The leakage in sewer lines, rainwater pipes, must be sealed at the earliest. These must be opened cleaned and then reassembling must be made.

15. Electrical utilities

The electrical lines, the related wires, and switches must be checked at regular intervals.

6. CONCLUSION

This theory was analyzed based on method of quality process in building construction on execution. Based on quality maintenance material testing methods and risk assessment criterions are discussed. In this journal particularly mentioned maintenance of quality based on current situation in execution and construction material testing process mentioned as per laboratory and in-situ testing methods. Also discussed about risk factors involved in building construction execution.

Quality of construction is one of the important factors for development of construction industry. Each and every construction materials are meet quality standards when using in execution. If these materials are not in quality standards, the overall output will come poor.

Quality improvement or development is based on overall project members in construction execution. These processes are fall down some factors. Periodically checking the overall construction execution based on quality checklist, project engineer and client coordination is the best solution for maintaining the quality in construction industry.

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