



**Addis Ababa Institute of Technology
School of Civil and Environmental Engineering**

Graduate Program in Construction Technology and Management

**Quality Control and Quality Assurance Practices in Selected
Finishing Works: The case of Public Building Construction
Projects in Addis Ababa.**

By

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Addis Ababa University in Partial Fulfillment of the Requirement for
the Degree of Master of Engineering in Civil Engineering
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Declaration

I declare that this independent project entitled “Quality Control& Quality Assurance Practice in Selected Finishing Works in Building Construction Projects in Addis Ababa ” is my original work. This project has not been presented for any other university and is not concurrently submitted in candidature of any other degree, and that all sources of material used for the project have been duly acknowledged.

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Abstract

Construction industry is a major player in economy of any country by generating employment, and wealth to the nations. The Industry also provides infrastructure which is vital for economic growth and provision of service. However, many projects in developing countries experience extremely low performance and face challenge in meeting quality requirements. One of the contributing factors to lower quality among others is poor quality control and quality assurance system.

The objectives of this independent project are to identify the causes of poor quality in plastering, floor and wall finishing works in building projects and to assess the actual practice of quality control and quality assurance in these works; finally to provide mechanism to prevent or to minimize poor quality by applying good quality control and quality assurance system. The methodologies used for this project are literature review, interview and investigating different cases by site visiting and desk study.

Unclear preparation of specifications for materials, poor workmanship and also poor supervision are observed to be highest causes of poor quality of building construction. The irresponsibility of residence engineers and site supervisors lead the project not to be completed as per the schedule, budget and quality. From different research and documentation in most building construction less quality work occurred due to poor quality control and quality assurance system. Some of the finishing works where major quality underperformance is exhibited is in floor and wall finishing works. In the implementation of any projects either public or private, clients need their project to fulfill at least the three common elements, i.e. cost, time and quality requirements. Any deviations from the expected quality result dispute between the contractor and client and also additional cost will be incurred. By identifying public building projects in Addis Ababa and investigating the causes of poor quality in plastering, flooring, wall finishing and malpractice; through good quality control and quality assurance system; the way how to prevent or minimize defects, less standard products and also mechanizing to avoid malpractice will be presented in this independent project .

Key Words: Finishing Work, Quality, Quality Control, Quality Assurance

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Abbreviation

A/E	Architect or Engineer
ASTM	American Society Testing Material
BCB	Based on Contract Price.
BUDSWS	Building Urban Design Supervision Work Center
CIAS	China International Accreditation Service
CP	Contract Price
CVNs	Contract Violation Notices
ECDSWC	Ethiopia Construction Design Supervision Work Sector
EN	European Standard
ES	Ethiopian Standard
ESA	Ethiopian Standard Agency
FIDIC	Federacion Internacional De IngenierosConsultores
ILAC	International Laboratory Accreditation Center
HCB	Hollow Concrete Block
MEP	Mechanical, Electrical and Plumbing
NCRs	Non Conformance Reports
NP	New Price
PMBOK	Project Management Body of knowledge
PPA	Public Procurement Agency
QA	Quality Assurance
QC	Quality Control
W.R.T	With Respect To

1. Introduction

1.1 Background

Construction industry is one of the major development contributors in developing countries. This is mainly because developing countries are considerably dependant on the growth and development of their physical Infrastructure. Construction industry has significant contribution to the national economy of any countries and is a major player in economy of countries by generating employment and wealth to the nations. [1]

Many projects in developing countries experience extremely low performance and face challenges of meeting quality requirements. One of the contributing factors to less quality performance among others is poor quality control and quality assurance systems. To measure quality in construction, both quality control (QC) and quality assurance (QA) are critical. [2]

Quality Control is concerned with comparing the work results with the quality requirements to ensure the result is acceptable [3]. Quality as a delivered performance or result is “the degree to which a set of inherent characteristics fulfill requirements” (ISO 9000:2005). Quality control is an important project management function. It is one of the critical attributes of project success, with the others being cost, time and safety.

Quality assurance is defined a set of procedures designed to ensure that quality standards and processes are adhered to, that the final product meets or exceeds the required technical and performance requirements. Whereas, (ISO 9001:2000) also defined Quality assurance as that part of quality management focused on providing confidence that quality requirement is fulfilled. In other words, all those planned and systematic actions are necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

It is important to know why quality assurance and quality control are applicable in construction, it's also necessary to understand what quality means in general on a project.

Quality assurance is process focused while quality control is product oriented looks into the final product and determines whether it has been built or implemented that correctly. Quality assurance is about proper planning, training, execution, monitoring and documentation of the activities associated with engineering design, construction, manufacturing, professional services, site studies and environmental projects. [5] “Quality control is the part of quality management that ensures products and service complies with requirements. It is a work method that facilitates the measurement of the quality characteristics of a unit, compares

them with the established standards, and analyses the differences between the results obtained and the desired results to make decisions which will correct any differences.” [6].

While QA ensures all the processes are following standards, QC is the final quality check of the result and is conducted after the product has been completed. To improve overall quality on a project, it's essential to have both a quality assurance plan and a specific set of standards for overall quality control. Even forming a dedicated QA team will help to ensure a project's results meet expected and needed quality. Project needs a system to track and manage quality from design to closeout.

Researches show in Ethiopia there are so many problems and defects occur in building projects due to poor quality control and quality assurance system. Defects on plastering, floor and wall finishing are some of the problem. [2], [7]

1.2 Problem Statement

Studies show that in most building construction less quality work occurs due to poor quality control and quality assurance system. [8] In the implementation of any projects either public or private, clients need their projects to fulfill at least the three common elements, i.e. cost, time and quality requirements. Any deviations from these will result in dispute between the contractor and client and also additional cost will be incurred. Studies show most of time quality problem occurred and finally clearly seen in floor, wall finishing and sanitary works. [9], [10] By identifying public building projects in Addis Ababa and investigating the causes of poor quality in plastering, flooring, wall finishing and also malpractice; through good quality control and quality assurance mechanism system; the way how to prevent or minimize defects, less standard products and avoiding malpractice will be presented in this independent project.

1.3 Independent Project Objectives

The main objective of this independent project is to identify the causes of poor quality in plastering, floor and wall finishing work in building projects and to assess the actual practice of quality control and quality assurance in these works; finally to provide mechanism to prevent or to minimize poor quality by applying good quality control and quality assurance system.

The specific objectives of the study are:

- i. Assessing the current quality control and quality assurance practice in plastering, floor and wall finishing works in public building projects in Addis Ababa.

- ii. Identifying the cause of quality underperformance in plastering, floor and wall finishing works in public building projects in Addis Ababa.
- iii. Formulating suitable quality control and quality assurance mechanism to prevent and minimize poor quality performance in plastering, floor and wall finishing works

1.4 Scope of the independent Project

The scope of the study is limited to plastering, floor and wall finishing works for public construction projects in Addis Ababa.

1.5 Project concept

Failure to complete construction projects as per expected quality in plastering, floor and wall finishing work is one of the major problems in building construction projects. Poor quality control and quality assurance is one of major factors which affect the above problems. If good quality control and quality assurance system is in place; it would enable to attain quality requirements of projects

1.6 Research Methodology

The independent project work begins with literature review to find out the appropriate causes of poor quality in building construction and good quality control and quality assurance system in finishing work for building project. Interviews are used to identify the reasons why poor quality in plastering, floor and wall finishing work occurred in building projects and to study the actual practice of quality control and quality assurance on construction projects. Visual inspection and taking pictures of different defects on floor and wall finishing be conducted by site visiting and desk study to get information about remarks during provisional acceptance, the actual practice of quality control and quality assurance on the project for plastering, floor and wall finishing works.

1.7 Independent project layout

This independent project has covered the following chapters.

Chapter – 1 –Introduction: This chapter focuses on the introductory part of the study which includes background of independent project, statement of the problem, Objective, Scope, project concept and Methodology.

Chapter – 2 –Literature Review: The chapter focuses on general review of literature and concept on quality control and quality assurance and also findings from different researchers

who have published on different journals and books, from unpublished researches, seminars and websites.

Chapter – 3 – Research Methodology: This chapter focuses on the methodology adopted to achieve the objectives of the study.

Chapter – 4 – Results and Discussion: This chapter contains the assessed actual practices of quality control and quality assurance in building construction in selected finishing work on public building in Addis Ababa, and also the assessed quality problems in plastering, floor and wall finishing activities. In addition to this it contains the assessed malpractice related to document preparation and variation works in floor and wall finishing.

Chapter – 5 –Conclusions and Recommendations: This last chapter covers the finding obtained from analyzing and discussing of the issues in the above chapters and recommendations from the study are presented

2. Literature Review

2.1 Basic Concepts of Quality

Quality in construction projects means that the project or project components are completed in compliance with what was defined in the Scope of Work. Generally, the Scope of Work gives a clear idea of what the owner's expectations are and how they should be carried out to ensure standards are met. [11]

Quality must be recognized from the point of importance, at the same level as the scope, time and costs of project. Building projects that are delivered within estimated cost, specified quality and calculated time can greatly satisfy client, contractor and consultant and the project can be said it is delivered in successful manner.

As it is stated in the Project Management Body of Knowledge (PMBOK) [12] quality is one of those crucial attributes in construction that relates to all aspects of any construction project. Most component deliverables are visible at some point in time and should be accepted. Quality in construction takes on an additional layer of expectations for the participants when one considers the visible construction work and its construction practices along with how well the project was managed with respect to its cost and schedule. Quality in construction relies on the project management systems to ensure that the project meets all aspects of the constructed project.

The organization implements the quality management system through the policy, procedures, and processes of quality planning, quality assurance, and quality control, and under takes continuous improvement activities throughout the project. As with safety and environmental management, quality management ensures that the project management system employs all of the processes needed to meet the project requirements, and that these processes incorporate quality. The requirements are similar: it ensures that the conditions of the contract (including those contained in legislation and any project technical quality specifications) are carried out to implement quality to the project and its deliverables; it addresses management of the project and the product of the project (and its component parts); and it integrates with project risk, safety, and environmental management processes to accomplish the stated objectives. [11]

2.1.1 What is Quality?

Quality is conformance to requirements or specifications. Quality is fitness to be used. Quality is that the degree to which a collection of inherent characteristics fulfills requirements. The quality of a project is the result of a process that is continuously defined throughout the life cycle of the project from conception through facility management. There are not levels of quality. There is not low quality or high quality; there are simply lesser or greater requirements. Since the requirements, schedule, and budget, they are the requirements for the design quality. "Quality refers to the project requirements established in the contract documents. The contract documents will be prepared resulting from the design process." [13]

Among the well-known definitions given to quality by different authors, the following are the most common quality defined as: [13]

- Fitness for use
- Conformance to specification /standards
- Customer satisfaction
- Doing things right the first time
- Zero defects
- Meeting or exceeding customer needs & expectations
- Delighting customers
- Building the customers point of view into every aspect of a product from design to final recycling.
- Added value

Although each of these definitions contains correct elements, the most complete definition of quality is the one given in ISO 9000: 2005[14]

It states that quality is a degree to which a set of inherent characteristics fulfils requirements.

2.1.2 Factors Influencing Quality

The main three factors that influence buyers' decision to buy a product or a service are: -

- i. Its price caption
- ii. Its quality
- iii. Its delivery at the right time and the right place

As buyers consider buying a product, they weigh the price they have to pay against the benefits they obtain when they acquire the product. This benefit is associated with the quality of the product. Buyers tend to choose products with the highest quality and the lowest price – in fact they are trying to maximize the ratio “Quality/Price” On the other hand, buyers will only buy those products that are present on the market or that can be promptly delivered.

2.2 Inspection and Quality Control

2.2.1 Need for inspection and Quality control

Inspection is the art of checking materials, processes and comparing the same with laid down standards to ensure that the work or the material is according to specifications during construction. Inspection involves constant watch over different operations, so that any defect observed, is got rectified during course of construction and the work is completed according to laid down specification.

Objectives: The inspection and quality control are essentially required to: [15]

- i Improve the quality of the work
- ii Increase the life span, durability and stability of the structure;
- iii Put all available resources into economic output;
- iv Reduce un-necessary repairs and maintenance;
- v Maintain the reputation of the enterprise.

2.2.2 Function of Inspection Department in Organization.

The main functions of inspection department in organization are mentioned below:

- i **Material Inspection:** This is done to ensure that the materials being procured are according to laid down specifications and as per terms and conditions of supply order.
- ii **Process Inspection:** This is done to ensure that the operations are being carried out correctly and systematically, so that the finished job is in accordance with laid down standards and the materials used in the construction are as per standard specifications and free from defects.
- iii **Equipment Inspection:** This is done in order to ensure that the equipment being procured is as per requirements of the project and exactly according to the terms and conditions of supply order.

- iv **Finished Job Inspection:** After the job is completed it is inspected thoroughly so that the same is in accordance with laid down standard.

2.2.3 Principle of Inspection

The following are the principles of inspection or inspection practices or works, required to control the quality of the works:

- i **Control over Materials and Equipment:** The quality control of materials and equipment must be ensured properly. It can be done by inspection of the materials and equipment time to time. There are two ways of inspection, i.e.
 - a) Inspection at sources of supply: - the raw materials required for the project should be inspected at source of supply to avoid low standard material coming to the construction site. Similarly, the equipment to be purchased or hired should be inspected at the place of suppliers to avoid unnecessary botheration and expenses for transporting back the equipment of rejected. The main drawback in this system is to ensure that the supplies actually made are of same materials or equipment as has been inspected. Also, the inspectors have to visit the various suppliers for inspection from time to time. That is not practicable.
 - b) Inspection at construction site: - The second method of inspection of materials and equipment required for work is the inspection at the construction site. This ensures the supply of proper quality of material and equipment.

The method avoids unnecessary visits of inspectors at suppliers' place. The main drawback is that the suppliers have to remove the rejected material from the construction as early as possible.
- ii **Planning of Inspection Operations:** The planning of inspection operations should be done in advance. The supply order and specifications of the concerned supply should be studied carefully. The exact nature of inspection, the possible defects in it, and relative importance of the inspection should be decided in advance so that the inspection is not carried out in haphazard manner.
- iii **Prompt Inspection:** Defective construction is prevented by prompt inspection. The inspectors should make sure on every inspection of works that the defects pointed out on previous occasions have been rectified. Delay in pointing out the defects will likely increase the cost of their removal from site.

- iv **Necessary Degree of Quality Control:** Necessary degree of quality control should be ensured. The frequency and details required in inspection should be such that necessary degree of quality control is maintained.
- v **Inspection Organizing:** The inspection should be organized in such a manner so that it is completed within the time available for it.
- vi **Decision about Boarder Line cases:** The inspection may show boarder line cases at some occasions. Such cases should be handled by setting up a definite procedure. The material purchased if does not fulfill the requirements of quality control should not be used important works as it will reduce the quality of work. These materials with minor defects and having purchased at reduced rates should be utilized on manor works of inferior nature or unimportant ones.
- vii **Use of Inspection Records:** For carrying out inspection successfully the following should be used
 - a Control charts.
 - b Statistical data.
 - a Inspection devices.
- viii **Stages of Inspection:** The following are the important stages of inspection of construction works:
 - b Generally, the materials are inspected at the place of supplier's and checked again at site to ensure that the supply is according to the approved samples or not.
 - c Before using the material in any operation, the material must be checked thoroughly.
 - d The equipment and machinery should be checked at the source of supply by competent persons. A committee is made for inspection consisting of representatives from indenting department and controller of stores, also a specialist if purchased by Government Department.
 - e The tools to be used for construction work should be inspected before and after their use.
 - f The construction of works is inspected at important intervals by the Engineer In charge to remove any deficiency or discrepancies made in construction. The work should also be inspected after their completion.

- g The number of inspections should be adequate. Very frequent inspections cause interruption to work.

2.2.4 Construction Supervision

Design, supervision and contract administration are done mainly by consultant. Proper supervision keeps construction project on schedule, reduce technical risks and prevent construction errors through continuous supervision and also ensure all work conforms to the specified technical documentation and the construction permit. In addition this it complies with relevant building regulations and quality standards. [15]

The main activities in the construction phase are supervision (quality control) and contract administration. [15]

Guideline on control of construction projects:

Pre-Mobilization Stage

Pursuant to the signing of the agreement, the Engineer shall ensure that the contractor submit project's work, material, equipment, manpower schedule, project cash flow and proposed organization chart.

Post Mobilization Stage (Site Control)

The Engineer /supervisor / shall ensure to be present on site to check and approve that the contractors perform is generally in accordance to the conditions of contract. The Engineer's site inspection and approval shall be particularly required to the following construction stages.

- a. Clearing off the site.
- b. Leveling & layout of foundation work.
- c. Checking of foundation depth.
- d. Material quality of Sand, aggregate, water, Concrete block, brick, stone, steel, finishing materials etc.
- e. Concrete mixes, formwork, reinforcement
- f. Masonry work at foundation level, above ground level, elevation wall, Roofing works
And fabrication & erecting of steel & wooden truss
- g. Finishing work
 - Plastering
 - Gypsum plastering
 - Tiling etc

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Check list used for site supervisor or resident engineer in order to ensure uniform system of supervision of building construction project and as a result ensure a safe and durable construction .It is to be used mainly when construction works carried out by contractors and can in some ways be of use for construction carried out by direct labor.

Details of constructions are specified in the drawing, technical specification and the general & special provision of the contract. The duty of the supervisor is to ensure that the construction works are executed in accordance with contract requirement. Therefore, in the application of checking list, the details specified in the contract document always precede before application and use it.

2.3 Project Monitoring

To obtain quality product there are different processes to be achieved properly. Projects are composed of processes. A *process* is a series of actions bringing about a result. Project processes are performed by people. [12]

2.3.1 Controlling Processes

Project performance must be measured regularly to identify variances from the plan. Variances are fed into the control processes in the various knowledge areas. To the extent that significant variances are observed (i.e., those that jeopardize the project Objectives), adjustments to the plan are made by repeating the appropriate project Planning processes. For example, a missed activity finish date may require adjustments to the current staffing plan, reliance on overtime, or trade-offs between budget and schedule objectives. Controlling also includes taking preventive action in anticipation of possible problems.

The Controlling Process Group Contains the Following Core Processes: [11]

- Schedule Control: controlling changes to the project schedule.
- Cost Control: controlling changes to the project budget.
- Quality Control: monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.
- Performance Reporting: collecting and disseminating performance information. This includes status reporting, progress measurement, and forecasting.

2.3.2 Quality Control

It is the most important function of management. The quality of work should be according to the specifications. Quality control can be achieved by making inspections of works during its progress at various stages. Inspection is defined as an art of comparing the materials and performances of works with the specified standards. The prescribed standards specify limits of variability and the purpose of inspection is to find out whether the quality of work done falls within the acceptable limits of variability. In case of the work to be done by the contractor, it is in his interest to lay stress on the quality control so that he can satisfy the inspectors/owners about the quality work. [12]

Inspection, checking and testing of construction work is exercised at suitable intervals to ensure that the work is done as per specified specifications. Different standards and specifications are followed in different types of works. The inspection, checking and testing of construction work is carried out at suitable intervals during course of construction, to ensure that the work is carried out as per laid down specifications and standards. [15]

Quality control involves monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project. Project results include both *product* results such as deliverables and *management* results such as cost and schedule performance. The project management team should have a working knowledge of statistical quality control, especially sampling and probability, to help them evaluate quality control outputs. Among other subjects, they should know the differences between:

- Prevention (keeping errors out of the process) and inspection (keeping errors out of the hands of the customer).
- Attribute sampling (the result conforms or it does not) and variables sampling (the result is rated on a continuous scale that measures the degree of conformity).
- Special causes (unusual events) and random causes (normal process variation).
- Tolerances (the result is acceptable if it falls within the range specified by the tolerance) and control limit (the process is in control if the result falls within the control limits).

2.3.3 Inputs of Quality Control

2.3.1.1 Checklists.

A checklist is a structured tool, usually industry- or activity-specific, used to verify that a set of required steps has been performed. Checklists may be simple or complex. They are

usually phrased as imperatives (Do this!) or interrogatories (Have you done this?). Many organizations have standardized checklists available to ensure consistency in frequently performed activities. In some application areas, checklists are also available from professional associations or commercial service providers. [7]

2.3.1.2 Operational definitions.

An operational definition describes, in very specific terms, what something is, and how it is measured by the quality control process. For example, it is not enough to say that meeting the planned schedule dates is a measure of management quality; the project management team must also indicate whether every activity must start on time, or only finish on time; whether individual activities will be measured or only certain deliverables, and if so, which ones. Operational definitions are also called *metrics* in some application areas.

2.3.4 Output from Quality Control

2.3.4.1 Quality improvement.

Quality improvement includes taking action to increase the effectiveness and efficiency of the project to provide added benefits to the project stakeholders. In most cases, implementing quality improvements will require preparation of change requests or taking of corrective action and will be handled according to procedures for overall change control.

2.3.4.2 Acceptance decisions

The items inspected will be either accepted or rejected. Rejected items may require rework.

2.3.4.3 Rework.

Rework is action taken to bring a defective or non-conforming item into compliance with requirements or specifications. Rework, especially unanticipated Rework, is a frequent cause of project overruns in most application areas. The project team should make every reasonable effort to minimize rework.

2.3.4.4 Completed Checklists

When checklists are used, the completed checklists should become part of the project's records.

2.3.4.5 Process Adjustments

Process adjustments involve immediate corrective or preventive action as a result of quality control measurements. In some cases, the process adjustment may need to be handled according to procedures for overall change control.

2.4 Quality Assurance

Quality Assurance: -According to Kagan "Quality assurance in a construction project entails establishing a program that will maintain effective quality procedures for the entire duration of the construction project to prevent, correct, identify, segregate and control non-conformities whether they are procedure-related, service-related or product-related. A quality assurance program entails taking a decision on what has to be measured and who measures it."

Quality assurance is developed to ensure that specifications are consistently met.' fit for purpose' and 'right first time' are the principles of quality assurance and the frame of reference for quality assurance is the international quality standard ISO 9000 family of standards. [14]

Quality Assurance emphasizes defect prevention, unlike quality control that focuses on defect detection once the item is produced or construed. Quality assurance concentrates on the production or construction management methods and procedural approaches to ensure that quality is built into the production system.

Quality assurance is broadly the prevention of quality problems through planned and systematic activities (including documentation). These will include: the establishment of a good quality management system, the assessment of its adequacy, the audit of the operation of the system, and the review of the system itself.

"Quality *assurance* (QA) refers to the procedures for guarding against defects and deficiencies before and during the execution of the work. During design, QA may include procedures such as obtaining data indicating performance, properties, and other attributes, which meet the requirements. This may include lists of certified products.

"Quality *control* (QC) refers to the procedures for evaluating completed activities and elements of the design for conformance with the requirements. Procedures during design may include document reviews, simulations, and other forms of validation and review.

Quality assurance and quality control are not exclusive of each other. Quality control for one process may serve as quality assurance for a subsequent process. For example, the QC testing by a manufacturer may be the basis for QA for its intended use. All participants perform various forms of QA/QC, whether or not this is specifically stated in the agreements.

Total project commissioning is a quality process utilizing an independent company providing services that may include monitoring the owner's project requirements and

verifying that the requirements are incorporated into the basis of design. Commissioning continues through the construction stage of the project providing certain QA/QC services.

2.4.1 Establishing Quality

The owner establishes the basis for quality in the program, budget, and schedule. The A/E, during the design phases, should review and provide a preliminary evaluation of the owner's program, schedule, and construction budget requirements. That evaluation should determine whether project requirements are feasible and realistic. It is prudent to inform the owner about what can be realistically achieved with these controlling factors. Owner expectations can vary depending upon their prior experiences and perception of what can be realistically achieved.

The A/E prepares design documents to convey a physical form and materials which should be consistent with the owner's quality requirements. The developing phases of design are forms of QA/QC. Obtaining approvals at each phase verifies the design as a QC. Procedures utilized by the A/E, such as uniform documentation systems, ensure a greater degree of QC.

2.4.2 Supervision of Construction Works

Qualified and competent supervision of construction is often the difference between a successful project and one that is not. The contractor's project manager and superintendent(s) are responsible not only for getting the project constructed correctly, but also safety, coordination, scheduling, dealing with media inquiries, dealing with project visitors, and a large variety of other tasks. **A supervisor** should be aware of the following milestones and follow their timely accomplishment accordingly.

2.4.2.1 Contractor Responsibilities for Supervision of the Work

Different types of contracts describe certain roles and responsibilities differently, but one that is common to all types of contracts is that the contractor is responsible for supervision of the project work. Several forms of contracts have language that is specific as to the experience requirements for the contractor's project manager and superintendent, how much time the individuals must physically be on the project site, and what their responsibilities are.

Generally, the superintendent is the contractor's spokesperson for the project. The responsibility vested in the superintendent usually includes coordinating the subcontractors,

procuring and tracking the materials, coordinating the contract documents for the proper construction of the project, preparing and updating the project schedule, coordinating inspections and testing, choosing the means and methods to accomplish the work, renting equipment, and many other activities.

Superintendents should be competent, have good communication skills, be diplomatic, have strong leadership skills, and have diverse experience. Depending on the contractor's organization, some of the previously mentioned tasks may be performed by a project manager, project engineer, or foreman.

2.4.2.2 *Complying with Contract Documents*

The contract documents represent what is to be constructed. The contract obligates the contractor to comply with the contract documents. Standards and other reference documents are included by reference in the contract documents.

The participants need to be familiar with the referenced documents and comply with requirements. This includes obtaining the proper inspections, tests, transmittal of requested and required information, and routing of correspondence, and not deviating from the contract documents. The contractor is not required to confirm completeness and accuracy of the contract documents, nor is the contractor required to ascertain that the contract documents are in accordance with applicable codes and regulations. However, if the contractor discovers errors, omissions, or inconsistencies in the contract documents, or discovers nonconformity with applicable codes and regulations, the contractor is obligated to notify the A/E as soon as the issue is discovered as a request for interpretation.

2.4.2.3 *Quality Assurance and Quality Control Procedures*

The contractor must verify that the work being performed complies with the contract documents. This verification is a primary aspect of QC. This QC provides QA for subsequent operations. Each participant should verify that existing or preceding work is proper and does not contain obvious defects that will affect subsequent work. Verification of work varies, depending on who is verifying, which portion, and at what time during the process. This verification may include inspecting, testing, and reporting the results. Other verification may be a simple review of work for accuracy and workmanship. The contractor needs to continuously verify that the work performed is according to the planned schedule and sequence. The contractor also prepares progress billings on the basis of verification of the quantity of work performed. Similarly, the A/E verifies the quality and quantity of

work that has been completed, so the A/E can recommend to the owner whether the requested payment should be made. A supervisor should use quality control inputs to supervise the quality of work.

2.5 Project Quality Management Planning

As per Construction Extension to the PMBOK® Guide 2016[11] “Quality standards are comprised of project codes, regulations, and standards. This includes any condition of a contract for which tangible deliverables have been defined and will be used to determine acceptance, including acceptance by default if necessary.”

The contract and documents, such as design drawings and specifications, are the principle project quality standards as these specify the applicable statutory and legislative quality requirements, technical quality codes, standards, and regulations.

2.5.1 Contract Requirements

Contract requirements include any and all requirements specified in the project contract documents (e.g. specifications, regulations, legislation, and standards [technical or legislative]). Permits obtained by the buying organization also become part of the contract. The project management team should consider area-specific standards, specifications, or regulations, including those arising from local, regional, and national regulatory agencies that will affect the project. Specifications, regulations, legislation, and standards generally refer to either: Performance and acceptance criteria that pertain to the product(s) of the project, or Workmanship criteria or how work is to be undertaken.

2.5.2 Quality Management Plan

The quality management plan is a component of the project management plan and describes how the project management team should implement the necessary quality control activities for the performing organization. The quality management plan either contains or makes reference to specific procedures that are applied for ensuring the quality compliance of the work performed.

The project quality management plan defines the monitoring and controlling activities to be employed, especially the following:

- Item of work to be monitored;
- Reference to the applicable document, specification, or standard and acceptance criteria;

- Applicable verification activities that are conducted and times when these activities are performed in relation to the overall process
- Responsible parties for the work and verification activities
- Applicable characteristics and measurements that are taken or recorded; and
- Applicable supporting documentation, which is generated to demonstrate satisfactory or unsatisfactory performance.

2.6 Project Quality Management Executing

The quality management plan describes how quality assurance is applied and performed on the project. In construction projects, executing quality management involves the use of metrics and processes defined in the quality management plan to assure quality is being executed as planned. The project quality management plan provides inputs to perform quality assurance process. [11]

Performing quality assurance in construction projects enforces the prevention of quality problems through planned, systematic procedures to ensure the required or specified quality is built into every project subsystem and deliverable.

Quality assurance measurements generate feedback on quality assurance activity performance and are fed back into the Plan Quality Management process for use in reevaluating and analyzing the process and performing continuous improvement. This feedback may include the planning activities of the performing organization, the criteria and processes employed, and a decision quality assessment as an indicator of areas that may need further investigation and reassessment of the risk or decisions taken in early project phases.

Performing Quality Assurance involves the following:

- Applying the planned, systematic quality activities to ensure that the project employs all processes needed to meet quality requirements;
- Determining whether these processes (and their integration) are effective in ensuring the project management system will fulfill the quality requirements of the project and the product of the project; and
- Evaluating the results of quality management on a regular basis to provide confidence that the project will satisfy the relevant quality standards.

2.7 Project Quality Control

To be effective, quality monitoring, control, and verification should be integrated into the overall construction or project delivery schedule. This process establishes control points or

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gates throughout the process to ensure that the next phase of work does not proceed until the preceding work has been completed and verified to meet the established criteria. [3]

Quality Control involves the following:

- Determining and applying the measures for monitoring the achievement of specific project results throughout the project to identify compliance with the requirements and unsatisfactory performance;
- Identifying techniques to eliminate causes of unsatisfactory performance, which includes identifying failures on the part of quality planning and quality assurance;
- Delivering a quality dossier that compiles all quality control outputs and is an important input to validate the project.
- Items that are inspected and found to be noncompliant with requirements are included in a nonconformance report that outlines the deficiencies, the immediate corrective action to bring the nonconforming work within the permissible tolerance limits, and actions to prevent recurrence of the condition that caused the nonconformance.

Nonconformance reports take many forms, for example:

Field deficiency reports (FDRs). FDRs record product or workmanship defects. Repeated field deficiencies could lead to the matter being elevated to the status of a nonconformance report, because this would indicate problems with the process or system being employed

Nonconformance reports (NCRs). NCRs record system deficiencies or estimate the cost of rework to fix deficiencies, such as those identified during audits. Repetitive nonconformance issues could result in the matter being elevated to that of a contract violation notice, indicating the existence of problems with the management of component parts for the product.

Contract violation notices (CVNs). CVNs record principle contract document violations, which would indicate failure on the part of the performing organization regarding the overall requirements of the contract. The issue may be elevated to other contract actions such as notification of default, cure notice, and termination if the contractor does not correct the conditions.

Observation reports (ORs). ORs are compiled by architecture and engineering teams, typically, and are not necessarily deficiency reports, but rather observations of the site, providing both good and bad information.

Submittals. Verifying conformance of construction materials with the contract requirements begins with the contractor sending product submittals to the designers. The submittals identify the specific products that will be used, detail how they will be installed,

and indicate if there is any variance from the specified material. The architects and engineers check the submittals for conformance with the contract documents and note discrepancies so the contractor can bring the product into compliance with the contract prior to purchasing the materials. This process helps to avoid rework that would be caused if the contractor ordered non specified materials and the designer did not see until they were installed on the job site.

Issues related to Non Conformance Reports (NCRs) or Contract Violation Notices (CVNs) for work on contracts require formal contract correspondence on the noted nonconformance to requirements. Rework is the action taken to bring defective or nonconforming items into compliance with the regulatory requirements or project specifications. Rework, especially unanticipated rework, increases costs and causes schedule overruns on construction projects. The project team should make every reasonable effort to minimize rework. Much rework is caused by poor site supervision or poor-quality trade work at the construction site. Additional causes of rework can often be prevented or minimized by imposing an approved quality control program at a supplier's plant. These supplier quality programs are often developed jointly between the performing organization and the supplier, and can include the project sponsor/owner, other applicable project stakeholders, certified inspectors for various end products of the whole construct, and any applicable industry regulator.

2.8 Overview for Quality Assurance Section of Technical Specification.

The Building and Transport construction Design Authority (BaTCoDA) has issued the first Standard Technical Specification in March 1991. Four years later the Ministry of works and Urban Development has updated the Technical Specification and Method of Measurement in 1995. Finally Ministry of Urban Development Housing and Construction has updated in 2014. In Ethiopia in public projects Technical Specification which consists method of measurement and Standard Technical Specification are one part of the contract. The minimum acceptable qualities of materials and workmanship have been established in this Technical specification by reference to accepted standards, codes or descriptions of required performance. The Engineer has established requirements in each section for the advance submittal of data for review and approval. Such required data shall be submitted and reviewed and resubmitted as frequently as required until compliance with the specific requirements has been obtained.

2.8.1 Timing of Submittals & Substitutions

All submittals and requests for substitutions shall be made in advance allowing sufficient time for inspection, testing review and verification. They shall be submitted in such a way that enough time is left after approval, for the placement of order, delivery, manufacture, etc., prior to time for installation in accordance with the work schedule. Submittals shall always be in groups to the extent possible.

2.8.2 Substitution

Products and Workmanship established in the Specification are the basis for the quality of work in the Contract. Products to be incorporated in the work require approval prior to use. No materials or proposed Workmanship are to be substituted prior to approval. The phrases in the Specification "equivalent or equal, similar, etc.," indicating substitutions do not mean automatic approval unless such approval has been obtained prior to incorporation in the Works.

2.8.3 Standards

The Technical Specification refers to codes and Standards to establish qualities and types of materials and workmanship and methods for testing of materials and work. Where materials, workmanship and tests are required to meet a specific accepted standard, the minimum to be supplied executed shall be those meeting or exceeding specifically named Code or Standard.

When proof of the fulfillment quality of materials, workmanship and test is required such written evidence shall be presented to the satisfaction of the engineer.

2.9 Division of finishing work as per technical specification for building work.

This independent project focuses on quality control and quality assurance practice on floor and wall finishing works. Although the Building and Transport construction Design Authority (BaTCoDA) issued the first Standard Technical Specification in March 1991, it was updated by Ministry of Urban Development Housing and Construction in 2014. The updated standard technical specification described "Division 09 finishes" consist plastering, tiling, ceiling and painting items. This independent project considered only plastering and tiling works. [17]

2.9.1 Plastering

Plastering is a process by which coarse surfaces of wall or ceiling roofs are changed or turned or rendered to provide smoothness. At the beginning, wet materials are spread over the block or brick works and then suitable equipment is used to make the surface smooth level.

Plaster: Mixture based on a binder that, after the addition of water, is applied while plastic and that hardens after application, generally used to obtain a surface finish.

Cement mortar: consisting of cement mortar priming coat, cement mortar undercoat, finishing coat cement mortar, render coat, and float finish.

Compo mortar: consisting of compo mortar priming coat, compo mortar undercoat, and finishing coat lime plaster.

Gypsum plaster: consisting of gypsum plaster priming coat, gypsum plaster undercoat, and finishing coat gypsum plaster.

Pointing: Recessed pointing and flush pointing.

2.9.2.1 Aggregate used for plastering [17]

- Shall comply with ES 2284.
- Aggregate for plaster and pointing shall be naturally occurring sand or crushed aggregate. The aggregate shall be hard, clean, and free from adhered coatings with no clay content.
- Aggregate shall be free of harmful organic and inorganic material that may affect the setting, strength, durability and appearance of render or undercoat and material in contact with it.
- The clay and fine silt content of aggregate shall not exceed 5% by weight.

2.9.2.2 Preparation [17]

- Generally, the preparation of backgrounds that receives plastering and rendering shall comply with the requirements stated in the Referenced Code of Practices and Standards.
- Remove dust, loose particles & other foreign matter which would affect bond of plaster.

- Wet absorptive bases with a fine spray or fog of clean water to produce a uniform moist condition.
- When interior concrete surfaces are smooth, dense, and not suitable for keying of the plaster coat, prepare surfaces and apply bonding compound in conformance with the manufacturer's instructions.
- Concrete surface shall be hammered to form key Chases shall be formed before services are installed and made good thereafter prior to plastering.
- Prior to plastering, joints of stone, brick and concrete blocks shall be raked, to form key. Where making good with plastering is required, the surface shall be cut out to a rectangular shape with the edges forming dovetail key.
- Cracks, blisters and other defects shall be cut out & made good. Where required, dubbing shall be made with the same material as the under-coat application.

2.9.2.3 Quality Assurance[17]

- Plasterers shall be skilled workmen who are thoroughly trained and experienced in the necessary crafts. In addition to these requirements assign at least one person who is thoroughly familiar with the specified requirements and capable of guiding the trades'.
- Do not use asbestos bearing materials & do not add asbestos to plaster mixes.
- Allowable Tolerances: Maximum deviation from true plane shall comply with the requirements of ES 1658.
- Example of Work: Unless specified otherwise, prepare a sample panel for approval before preceding the plastering work.
 1. Construct a 1 m. x 1.5 m. sample panel for each type of plaster, showing color, texture, and workmanship.
 2. Do not proceed with plaster application until sample panel has been approved by the Engineer's Representative.
 3. Maintain sample panel on site for comparison purposes until work of this Section has been finished and approved.
- Ready-mixed plaster mixes are subject to the approval of the Engineer.

Part 1 General, Part 2 Products, Part 3 Execution of plastering are presented in detail in

Annex I.

2.9.2 Tiling

Tiling specifies the installation of wall and floor for ceramic, terrazzo and natural stone tiles, and also specifies the installation of floor for concrete and PVC floor tiles and accessories. The preparation, quality control submittals and quality assurance of tile as per standard technical specification as follow: [17]

2.9.2.1 Preparation

- Provide concrete substrates comply with flatness tolerances specified in ES 3068, ES3069, ES 3070 or ES 3071 as applicable.
- Protection: Protect adjacent surfaces before tile-work begins.
- Cleaning: Clean substrate surfaces in accordance with applicable reference standards and manufacturer's installation instructions.
- Prior to placing mortar bed, cement slurry bonding coat shall be applied to the subsurface. The mortar setting coat shall be immediately applied to the surface.
- Prior to placing tile, glue shall be spread onto surface using trowel to a depth not exceeding 3mm thick. Comb the adhesive with notched edge of the trowel ensuring that continuous horizontal ribs of adhesive are formed.

2.9.2.2 Quality Control Submittals:

- Tile Grade Certificates/test reports: Furnish tile manufacturer's product quality assurance certificate and/or test reports bearing the manufacturer's certification for each shipment, type and composition of tiles.
- Installers' Qualification Data:
 - a. Name of each person who will be performing the work and their telephone number.
 - b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.

2.9.2.3 Quality Assurance

- Manufacturer: Unless specified otherwise or received instruction from the Engineer, perform the followings;
 - 1. Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the

same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

2. Obtain ingredients of a uniform quality for each mortar, waterproof membrane, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- **Certifications:**
 1. Tile manufacturer's product quality assurance certification for each shipment of tiles.
 - **Installers' Qualifications:** The persons installing the work of this Section and their Supervisor shall be personally experienced in tiles installation and shall have been regularly employed by a Company installing tiles for a minimum of 5 years.
 - **Pre-installation Conference:** Before the work of this Section is scheduled to begin, a conference will be called by the Engineer's Representative at the site for the purpose of reviewing the Drawing and the Specifications and discussing requirements for the Work. The conference shall be attended by the Contractor, the tiles installers, and if needed the tiles distributor.

Part 1 General, Part 2 Products, Part 3 Execution of tile are presented in detail in Annexed II.

2.10 Quality Control and Quality Assurance Practice in Europe

2.10.1 Quality control systems for constructions in Europe.

Several similar trends can be recognized in the quality control systems of the various European Union (EU) countries. Quality control is getting more and more privatized and the control framework is setting checks and balances throughout the construction process. Private controllers play an important role in the quality control process. Private parties play a dominant role in the regular quality control procedure. Certification, recognition or approval of private controllers implies that they are registered and controlled by supervising bodies. Three types of supervision can be distinguished in the various countries: [18]

- (1) Professional organizations or bodies (England, Ireland and Germany).
- (2) National Accreditation Organizations (France and Sweden).
- (3) Governmental organizations (Norway and in the proposed new system in the Netherlands)

Private quality controllers must have the following:

- A professional or academic degree (architects and engineers);
- Practical experience which must be proven by statements, examples and/or an examination;
- Proper professional liability or indemnity insurances; and an independent status.
- There may be no ties or relationships with other parties involved designing or building a construction that they control.

Control activities are distributed evenly during the construction process. All countries have developed systems where the checks and balances are evenly distributed throughout the building process. Every country has set demands on the way plan approval should be carried out. Site inspections are obligatory during construction. The quality control procedure ends in all countries with an end inspection. Constructions can only be taken in to use when a completion certificate or final approval has been issued. Local authority building control has to give building approval and issues a completion certificate at the end of the procedure. Approved inspectors have to submit an initial notice to the local authority at the beginning of the process and submit a final notice at the end of the construction phase.

Wall and floor tiling refers to the laying of tiles of ceramics, mosaic and natural stone on walls, floors and staircases in houses, industrial and public buildings, churches, swimming pools, outside installations and façades to provide protective and decorative finishes. To achieve these works competent contractor or subcontractor expected to use experienced tilers may also specialized in one area of work, such as mosaics. Save working practices common to wall and floor tiling operations; which include health and safety regulations, accident /first aid/, health and hygiene, safe handling of materials and equipment, use of appropriate personal protective equipment, material safety data sheet shall be displayed at work location as appropriate.

2.10.2 Method of statements for floor and wall finishing work. [19]

Method statement for construction project is a mandatory requirement even sometimes at the pre-qualification stage of a construction contractor. Any reputable building construction company will follow best construction methods in order to provide best quality of work. The method statements archive once developed is useful for any future projects as well. Before start of tiling work make sure that ceramic tiles types and color, mortar mix, glue, grout, shop drawings and method of application are acceptable to the consultant or any other approving

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authority. After that make sure that materials that are available from approved manufactures and in original packing. This will ensure that no counterfeit material is used at project site.

Before bulk installation works mock up approval is important that is normal process for smooth site construction activities. Mock up shall be raised for inspection and approval from consultant or contractor as applicable. Approved mock up and sample shall be available at site and the material delivered to site be checked with respect to the approved sample.

2.10.2.1 Pre requisite for tiling work at walls

Ensure the clearance obtained and all other under laying installation are approved prior to start of tiling works.

- Working area to be restricted for un authorized entry
- The surface to which tiles are to be fixed shall be thoroughly dry before fixing commences and free from all defects.
- The areas to be tiled shall be brushed clean and all traces of grease, oil, loose particle etc. must be removed.
- Ensure that the laying of tiles shall be as per the direction and pattern agreed with the consultant.
- Before laying tile obtain approval of setting out by consultant. Provide symmetry about center lines of the space or areas and adjust to minimize tile cutting.
- Layout tile work so that tiles less than ½ full size do not occur and with minimum of cutting. Carefully grind edges of cut tile. Ensure cut tiles are in corners and are equal on each wall face.
- Tile layout out on floor/walls shall follow the layout on floor/ walls as per approved shop drawing.

2.10.2.2 Method statement for tiling at wall

- For concrete block wall and concrete walls to be finished with tile, apply a leveling coat of plaster minimum 12mm thick, sufficient to cover the unevenness of the substrate and to make walls true vertical.
- Plaster shall be finished rough in order to have a strong key for tiling works.

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- Plaster curing period shall be completed before start of tiling work.
- To ensure rows of tiles are truly horizontal, a level line shall be established to position the starting course.
- Tiles of specified and approved sizes shall be fixed to wall surface by approved adhesive.
- Mixing of adhesive shall be strictly followed in accordance with manufacturer's recommendations.
- Mortar shall be used with 2 hours of mixing at normal temperatures or within the pot life of the mix whichever is achieved earlier.
- Material shall not be used after initial set has taken place.

Thin Bed Adhesive- Walls: Apply floated coat of adhesive to dry background in area of approximately 1m² and comb the surface with the recommended solid bed trowel. Apply thin even coat of adhesive to backs dry tiles. Press tiles on to bedding with twisting/sliding action to give finished bed thickness of not more than 3mm.

Thick Bed Adhesive-Wall: Apply floated coat of adhesive to dry background and comb the surface with the recommended solid bed trowel. Fill any keys and apply thin even coat of adhesive over the entire back of each tile. Press tiles onto bedding with twisting/sliding action to give finished bed thickness within the range recommended by the manufacturer.

- Tamp the tile with rubber mallet to obtain required adhesion and level.
- Tiles shall be laid with required spacing and spacers shall be used to align horizontal and vertical joint.
- Lay tile to pattern in accordance with shop drawings. Verify pattern is uninterrupted through openings.
- Establish lines of border where applicable.
- Excessive mix/adhesive shall be removed with a damp cloth before the material has set
- The vertical joints shall be maintained plumb for the entire true level and plane by uniform applied pressure.

- Joints in glazed wall tiles and fitting, after edges of tiles have been thoroughly wet (after 48 hours later) it shall be grouted with neat white or colored approved grout.
- Grout shall be applied to the spaces between the tile using a sponge or a small piece of the soft cloth.
- Ensure the joints are 6mm deep (or the depth of the tile if less), and are free from dust and debris.
- Force grout and fill joint completely to entire depth, tool to an approved profile, clean off surface and leave free from blemishes
- Rub wall tiling with dry cloth when joints are hard.
- Keep expansion/ contraction and control joints free of mortar of grout.
- Control joints: Provide control joints 6mm minimum width in large tile areas at maximum of 4.5m in each direction and at the perimeter walls. Do not saw-cut joints after installing tiles.
- Movement joints shall be located at required and be carried through backing to the structural wall, partially fill with strip and finish flush with sealant to the manufacturer's recommendations.
- Tiling shall be protected from heat and inclement weather until jointing has completed set.

2.10.2.2 Tiling work method for floors

Ceramic tiles type and color, mortar mix, glue, grout, shop drawings and method of application shall be approved by the consultant.

- Ensure that delivered materials from approved manufactures and in original labeled packing.
- Mock up shall be arranged for wall and floor tiles at location designated by the consultant for the final approval.
- Approved mock up and sample shall be available at site and the materials delivered to site shall be checked with respect to the approved sample.
- Tile of approved sizes shall be used for laying

- Ensure the MEP clearance obtained.
- Restrict the working area to prevent unauthorized entry.
- The area of substrate to be tiled shall be brushed clean and finished floor level shall be established by means of dots.
- All traces of grease, oil and loose particles etc, must be removed.
- In wet areas check that approved water proofing is completed as per manufacturer's instruction and tested for leakage.
- Ensure that the laying of tiles shall be as per the direction and pattern agreed with the consultant.
- Setting out shall be done by the surveyor and approved by the consultant.
- Before laying tiles obtain approved of setting out by consultant. Provide symmetry about center lines of the space or areas and adjust to minimize tile cutting.
- Tiling should be started from the start point at fixed on the approved shop drawings.
- Lay out tile work so that tiles less than $\frac{1}{2}$ full size do not occur and with minimum of cutting. Carefully grind edges of cut tile. Ensure cut tiles are in corners and are equal on each wall face.

Preparation of floors: Cast-in-place concrete substrates shall be sufficiently smooth and level such that when thin-set mortar to accept tiles is applied, no voids under the tiles occur. Grind off high spots and fill-in low spots as necessary to ensure no voids occur.

Floor water proofing application: All toilets and pantries to receive water proofing. Apply the liquid water proofing at a rate of minimum 1.5kg/m^2 on horizontal on horizontal surface and extended at least 100mm high on vertical surfaces or as per approved shop drawings and method statement details. Before installation of porcelain tiles, place a 1000 polythene sheet protected by 10mm mortar layer and coordinate floor water proofing works with the porcelain tiles installer. Testing shall be before and after the installation of tiles.

2.10.2.3 Method statement for tiling at floors

- Tiles shall be placed according to level shown in drawing and be placed firmly with the help of rubber mallet.

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- Remove and reset for solid bearing tiles that give hollow sound when tapped with steel rod, after installation.
- Tiles shall be laid level or enough falls in wet areas as may be required.
- Particular care shall be taken in wet areas to prevent low spot and pooling of water.
- The tiles shall be neatly cut, grind, rough on exposed edges around pipes and other obstruction.
- Make provision of floor drains as per approved shop drawings.
- Silicon rubber sealant shall be inserted between tiles and sanitary fitting.
- When the installation has hardened sufficiently (after 48 hours) a thick grout of cement mixed with a minimum amount of water or approved grout shall be prepared and brushed over the floor until all the joints are thoroughly filled.
- Surplus material shall be removed with a dry cloth.

Control joints

- Provide control joints 6mm minimum width in large tiles areas at a maximum of 4.5m in each direction and at the perimeter walls. Do not saw-cut joints after installation tiles.
- Movement joints shall be located at required and be carried through backing to the structural wall, partially fill with strip and finish flush with sealant to the manufacturer's recommendations.
- The joint width shall be 2mm or as mentioned in the approved shop drawings. Joints to be true to the line, continuous and without steps.
- The completed tile floor should be kept traffic avoided in the area for at least 24 hours. If traffic is unavoidable, board walkways shall be used for traffic to avoid damage to floors and to keep floor clean.
- Apply 2 coats of sealer finish to flooring and stairs. Follow sealer finish manufacturer's printed instructions for the application.

2.10.3 Method of statements for plastering work. [20]

- All surface to be plastered or rendered shall be sprayed with water, which shall be allowed to dry out before rush coat is applied.
- Masonry work applied with scratch coat prior to plastering
- Concrete surfaces where plaster to be applied shall be made rough.
- All undercoats shall be scratched to form an adequate key for the next coat.
- Level guides shall be provided up to required thickness.
- All junctions between different materials and also over the embedded conduits shall be reinforced with expanded metal which shall be plugged nailed or stapled as required at required interval.
- All horizontal and vertical and vertical external and internal angles of plastered walls shall be protected with galvanized metal corner beads and shall be securely plugged, nailed, or stapled as required at proper intervals.
- Plastering accessories such as plaster stops shall be used where plastering terminates and is not covered by other finish at wall, ceiling, and window frame junctions and to all openings and corners.
- Plastering shall proceed only when the masonry block works are completed.

2.11 Summary of literature review

The Literature is revised about quality, quality control, quality assurance, and possible solution to minimize defects in building construction. Good quality control and quality assurance system used to assure the building to fulfill at least minimum standards of material and workmanship in order to insure the performance of the facility according to the design and specification and also help to avoid poor quality work and defects.

From the literature review, quality problem occurred during design and specification preparation and also during construction. Design and specification defects are the result of professional's failure to produce a complete, accurate and well-coordinated set of design and contract documents. Construction defects are result of poor quality materials, poor workmanships, and unsuitable equipments. Check list and method of statement are tools for good quality control and quality assurance system. Quality monitoring and verification should be integrated into the overall construction or project delivery schedule. This ensures that the next phase of work does not proceed until the preceding work has been completed and verified to meet the established criteria.

3. Research Methodology

3.1 Introduction

Research methodology will describe and explain based on the objectives and the aims of the study. The preliminary data for this Project paper is collected by literature review, interview, physical observations and desk study which mainly focus on public building construction projects in Addis Ababa.

The literature review is principally based on what is written in different books, journals, unpublished materials, etc. Interview was conducted with clients, consultants, contractors and regulatory body. Site observation was done at construction site and supported by a photo camera. Desk study was done at construction site and head office. With all information result and discussion was done. Finally conclusion and recommendation presented.

3.2 Methodology

3.2.1 The literature review is principally based on what is written in different books , journals, dissertation, seminar and different documents related to topics.

3.2.2 Interview

The interview of this study was conducted with professionals from consultant, client and contractor and institution that are directly concerned with quality control in public building construction projects. The interview addresses quality control and quality assurance system in their organization. The interview questions is included in Annex VIII

3.2.3 Site Observation

Site observations conducted on selected project which finishing work is in progress and completed. This technique particularly useful to see the actual practice of quality control mechanism and defects on finishing works.

3.2.4 Desk Study

Desk study was chosen to assess the practice from relevant studies, reports and documents related on quality control and quality assurance practices to supplement responses founded by interview and site observation.

3.2.5 Case Study

The case study was done on preparation of contract document and variation works on finishing work which cause malpractice and result additional cost to be incurred on the project, the project not to be completed as per the schedule, the quality to be changed.

3.3 Flow Chart of Research Methodology

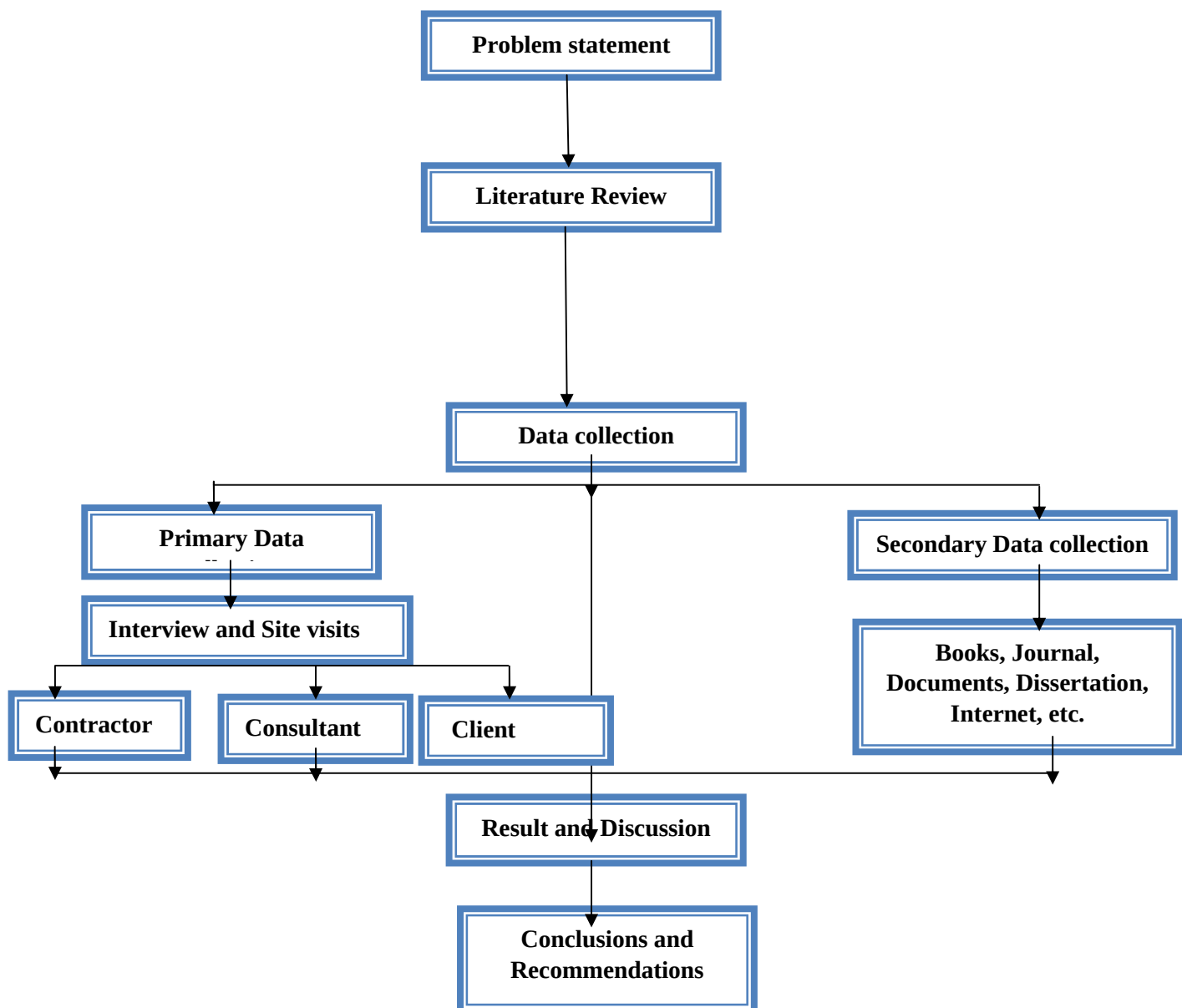


Figure 1 *A Flow Chart of Research Methodology*

Fig.1 Shows Primary data obtained through interview from clients, consultants and contractors. Secondary data obtained from books, journals, related documents, dissertations, etc. Based on above data, desk study and case study; result and discussion were conducted and conclusion and recommendation presented.

4. Results and Discussion

4.1 Actual Quality Control and Quality Assurance Practice.

Quality control and quality assurance are the responsibility of all concerned stakeholders. The contractor is expected to perform the project as per the agreement with the client within contract time as per the specification and drawing. The consultant shall design, supervise and administer the project as per the agreement with client. The client also follows up the project properly until final closing. In Ethiopia public projects the three parties' client, consultant and contractor are major stakeholders.

The contractor is the main responsible for quality of construction materials, quality of workmanship and quality of equipment.

Concerning the workmanship, it is usual to have experienced skilled labor for each type of work continuously till the project is completed.

Apart from this the building materials are tested to ensure the quality. The materials should fulfill the standards specified by the code before using them in the construction project. These tests are mostly done by Ethiopian Standards Agency, by consultants, as well as university and private sector laboratories.

The representative of consultant, the Resident Engineer, and assistance will supervise all the laboratory and field tests conducted by the contractor's staff and conduct necessary and advisable inspection, sampling, testing and analysis to ensure whether it complies with the technical specifications. Any test, which does not comply with the specification, shall be rejected. The Resident Engineer will have overall responsibility for appropriate quality control, records keeping and reporting in respect of materials testing.

4.1.1 Establishing and Monitoring Construction Supervision by Consultant

The Engineer /Resident Engineer will develop and discuss with Employer the management procedures and reporting requirements necessary for supervising the construction contract. The Engineer/ Resident Engineer will prepare standardized construction supervision and reporting forms and procedure in agreement with employer. As per Ethiopia Construction Design and Supervision Works Corporation Building and Urban Design and Supervision works sector; the following list of forms and procedures will be developed for the project.

- Procedures for quality control
- Guide lines for material testing
- Check lists for supervision
- Recording site measurement

- Forms to the payment made
- Forms for Labor and material record
- Forms for work order and site instruction
- Forms for the monthly progress report
- Forms for daily and weekly report
- Forms for Official correspondence and communications Forms for conducting certification of completion of works.

4.1.2 Resident Engineer's Responsibility

The Resident Engineer's responsibility in construction projects is high. The quality of different construction projects getting poor not only due to poor quality of construction materials and workmanship, but also due to lack of proper supervision [14]. Among the various reasons of poor supervision, irresponsibility or being unaware of the responsibilities of supervisor/ Resident Engineer/ is to be mentioned first. Some of the responsibilities of a Resident Engineer are pointed out and outlined below:

- Familiarizing himself with and understand fully the detail in the contract documents which include the technical specifications, the general provisions, the special provisions, and any other referenced standards.
- Checking and approving the quality, price and time of the project to be as per the required standard.
- Approving and supervising the work progress schedule and revising of whenever required
- Ordering the contractors to submit their periodical short-term schedules and following up of their implementation.
- Checking, measuring and approving of works executed daily.
- Approving payment certificates on time
- Preparing detailed plan for the site activities based on the plan of the project office.
- supervising the man power, equipment and materials supply of the contractors
- Controlling and approving the performance of every contractor to be as per their agreement.
- approving the quality of construction materials supplied and checking their proper handling and placing
- supporting all contractors on the site technically,
- handling of different documents properly to provide any information required

- Preparing and submitting periodical progress report of the site.
- Approving efficiency of equipment and manpower onsite
- Collecting and submitting the necessary data for variation works when observed.
- Implementing different orders given by the project engineers.
- Check the delivered materials with approved samples
- Reject materials which is not comply with
- etc.

4.1.3 Consultants practice in quality control.

As per PPA2011 [16].Consultant (Engineer) means a person named in special condition of contract or appointed as such by public body and notified in writing to the contractor to act as the representative of the Public Body to supervise and inspect works and to test and examine the materials employed and the quality of workmanship, including any authorized representative of such person.

In Ethiopia there are licensed consultants which appointed by the clients to act as the representative of them in order to supervise and administrate their projects. Different consultant used their own check list format for supervising different activities on site and at office level.

Check list that they used on site almost similar. Check list used for all item works consist conformance, non conformance and not applicable respond.

4.1.3.1 Check list for plastering work inspection at construction site consists the following request for approval before proceeding work [21]

- Qualification of plasterer.
- Location of item wall or ceiling, or parapet.
- Plumb state of erected wall.
- Wall material to be plastered.
- Testing of pipe before plastering.
- Condition of surface to be plastered.
- Types of plaster mortar /mix proportion for various coats.
- Watering of surface before plastering.
- Minimum days gap between date of second coat and last coat.
- Perfection of designed angle at junction points.
- Linearity of plastered wall.

- Allowable duration time of mortar between mixing and placing etc. The work will proceed when it fulfills the check list.

The check lists are annexed at the end of the independent project.

4.1.3.2 Example of check list for cement screed work inspection: [21]

- Qualification of mason.
- Completion of preceding works/Ceiling/Plastering.
- Leveling state of floor to be screed.
- Mix proportion of screed material.
- Quality of fine aggregate, water.
- Method of mixing of mortar.
- Checking of F.F.L form nearby rooms.
- Protection measure of finished surface from damage.
- Provision of expansion joint.
- Curing period of screed surface etc.

4.1.3.3 Example for solid floor tile (Terrazzo, Granillia, Cement) work inspection: [21]

- Qualification of tile layer.
- Testing of material.
- Material approval slips number and sample.
- Color of selected tile.
- Size of tile material (Length, width, thickness).
- Leveling condition of floor to be covered.
- Designed pattern of tile placing.
- Nature of binder (mortar) /Mix ratio.
- Presence of spacer,
- Slope condition with respect to floor drains.
- Grouting material type, colour etc.

4.1.3.4 Example of plastic/ PVC tile flooring work inspection: [21]

- Qualification of tiller.
- Readiness of floor W.R.T other works.
- Material approval sample and sample.
- Size of plastic tile (Length, width, thickness).
- Nature of adhesive (approved with new deliveries).
- Nature of screed to be tiled, (Clean, washed, dried etc..).

- Duration from cast of screed to tile placing.
- Rectification method of defective screed.
- Protection measure for unnecessary surface spread of adhesive.
- Cleaning state of finished surface etc.

4.1.3.5 Example of wall tile work inspection: [21]

- Qualification of tiller
- Location of item internal /external wall
- Type of tile material ceramic/ precast element etc
- Design of patterns
- Thickness of tile
- Maximum projection of tile from wall surface.
- Immersion of tiles in water before fixing
- Quality of adhesive.
- Mix proportion of tile paste.
- Checking of approved sample with site delivers.
- Nature of tools
- Checking of surface nature to be covered

4.1.4 Consultants practice in quality assurance.

Quality Assurance of materials is done based on the referenced standard and code. Cement that used for floor and wall finishing work shall fulfill the required properties. It is checked and certified by the Ethiopian Standards Agency. In addition to this, before construction, different tests will be conducted at laboratory especially for concrete works and approved or rejected by the by consultant. Cement, sand and water that are used for floor and wall finishing work are also tested in laboratory. The materials that fulfill the requirement and standards will be accepted. If the material fits the requirement, the contractor will be notified to use the materials. On contrary if the material does not fulfill the requirements it will be rejected and recorded on Not Acceptance Record (NAR).

4.1.5 Inspecting and Approving Works in Progress

The Engineer/Resident Engineer will carry out inspection of works in progress and issue instruction for acceptance. In case of non-acceptance of any work, the Engineer/ Resident Engineer will ensure that the contractor to meet the standard redoes the work.

If any item of work is found to be unacceptable, or if there is any other problem the Engineer/ Resident Engineer will inform to the client giving details of the problem. The

Engineer or Resident Engineer will recommend possible solutions such as removal of unacceptable work and rendering work to confirm to the specification and specified tolerance.

For the works to be carried out the Method of Statement will be prepared and submitted to resident Engineer for review and approval. It is after the approval or acceptance of the method of statement (work methodology) the contractor can proceed the work. At any level of activities if there is non-conforming material, process or workmanship Non conformity report will be opened and the work will be suspended till rectification. Having rectified the non-conformity report will be closed.

4.1.6 Inspecting and Approving floor and wall materials

For floor and wall finish materials like Terrazzo tile, Cement tile, Plastic tile, PVC roll, Marble, Granite, porcelain, ceramic floor and wall tile etc. are checked by two methods.

1. By Visual inspection and Checking size, thickness, and color. Example material like marble, Terrazzo tile, window sill, coping is checked by experienced professional Architect. If the sample accepted the concerned professional signed on the sample and confirmation slip will be given official by attaching approved sample.
2. By checking product certificate for imported materials which fulfill EN (European Standard), ASTM (American Society Testing Material), CNAS (China International Accreditation Service) and ILAC (International laboratory Accreditation center) standard and requirement and also by looking test report which is given by ESA (Ethiopian Standard Agency).
3. The product certificate which is submitted and checked consist chemical (chemical resistance) and physical properties (dimension, thickness, water absorption, modulus rupture, abrasion) etc. Whereas ESA gives only report about physical properties such as water absorption, breaking strength, straightness of size, deviation of thickness. Once the certificate is checked and accepted the contractor submits the sample for approval.

4.1.7 Test report for floor wall tile consists [22]

- Length Deviation $\pm 0.5\%$
- Width Deviation $\pm 0.5\%$
- Thickness Deviation $\pm 10\%$
- Straightness of sides $\pm 0.3\%$

- Rectangularity $\pm 0.5\%$
- Surface Quality: A minimum of 95% of the tile shall be free from visible defects.
- Water Absorption: Average $>10\%$; Individual minimum 9%
- Modulus of Rupture: $>15\text{Mpa}$
- Crazeing Resistance: No craze of glazed surface
- Resistance to Household Chemicals: Minimum Grade B

4.1.8 Documents required for sample approval

- Product certificate
- Test reports
- Catalogues and Guarantees.
- Shop drawing
- Contract documents and drawing

4.2 Quality Problem in Building Construction.

4.2.1. Quality problem

The existing quality controlling system for various activities of Building construction in our country needs to have improvements.

Basically, quality problems can occur in all stages of a project and in all levels of construction as well. Problems of quality in construction can be grouped into three major parts namely Quality problems associated with materials, Quality problems associated with Equipment and Quality problems associated with workmanships. In addition to these due to poor document preparation and malpractice materials will be changed during construction and affect the progress and budget.

Although the standard technical specification which was updated by Ministry of Urban Development Housing and Construction for building work in 2014 [16] clearly mentioned "materials used in construction work shall be new, of the qualities and kinds specified elsewhere in the contract agreement and equal to approved samples" is not applied practically in some cases. In addition to this the Standard Technical Specification mentioned "no material shall be used until approved, and materials not approved shall be immediately removed from the work site at the contractor cost and also materials shall be transported, handled, and stored on site or elsewhere in such a manner as to prevent

damage, deterioration or contamination." But practically there are different cases which are not applied in the construction projects.

Information gathered from interview survey by presenting different questions to clients, consultants, and contractors representatives as mentioned in chapter three; by site observation at different construction projects, and also desk study by referring different documents related to actual practice and quality problem.

Based on the data from observation in different construction projects, interviews, desk study and from past experiences the actual practice and quality problems in different activities of building construction projects are presented in the subsequently

4.2.2. Plastering and Rendering

4.2.4.1. Quality Problems Associated with Materials

- Quality of fine aggregate, water, lime etc. not checked properly.
- To use less cement proportioned mortar.
- To reduce the given specified dimension of plastering thickness.
- Absence of regular, series and close quality control on the materials
- Attention is not be given for allowable duration time of mortar between mixing and placing.
- Not to use mixer for mixing mortar to get thoroughly mixed mortar
- Not to clean the surface before applying
- Not to do the work in accordance with technical specification
- Uneven wall finish.

4.2.4.2. Quality Problems associated with Workmanship

- Lack of Sufficient skill to do the given job proficiently.
- Having less perceptions/understandings on the importance of Quality
- Preferring to use workmanships having less capabilities with lesser price rather than to use workmanships having high capabilities with reasonable price.
- In some construction projects, there is absence of series and consistent quality controlling operation on the capability of the workmanship for each and every construction activities.

- In most construction projects, it is usual to give more attention/focus to execute larger quantity of an activity rather than to give more attention to quality.
- Not to do the work according to the given technical specification and work methodology.
- Not to provide relevant trainings to the workers in order to introduce recent technologies.
- Not applying water on wall surface before plastering
- Not checking the preceding works completed properly and also not announces if they get correction work because of they do not want to suspend their work.
- Not recessed at connection point of hollow concrete work and concrete structure like column and beam.
- Not clean the surface and surrounding properly after finishing the work.

4.2.3. Data's collected from Observations of Building Construction Sites

A Defects on Plastering

Fig2.a) Continuous cracking occurred at joint place of concrete column and plastered hollow concrete block wall. Since expansion coefficient of concrete and hollow concrete block different, crack will be occur during expansion and contraction. Therefore, to avoid this defect the connection place shall be recessed and pointed properly during plastering.

Fig2.b) Vertical joints shall be maintained plumb for the entire true level. But as we have seen in the figure hollow concrete wall vertical alignment is not kept properly. The plumping at top and bottom is not equal. The gap between door frames at top less and when it goes down it is wide. Therefore before plastering the vertical alignment of the wall shall be checked properly by plump. If correction is needed, it is possible to correct by decreasing and increasing plastering thickness with in maximum limit. But if it is beyond the limit the hollow block wall shall be demolished and reconstructed.



a) Crack at joint b/n column and HCB wall b) vertical wall plumping problem

Fig2.c) Continuous cracking occurred at beam and hollow concrete block, column and hollow concrete block wall connection place. These cracks shall be avoided by recessing at connection place of column and hollow concrete block wall, top tie beam and hollow concrete block during plastering.

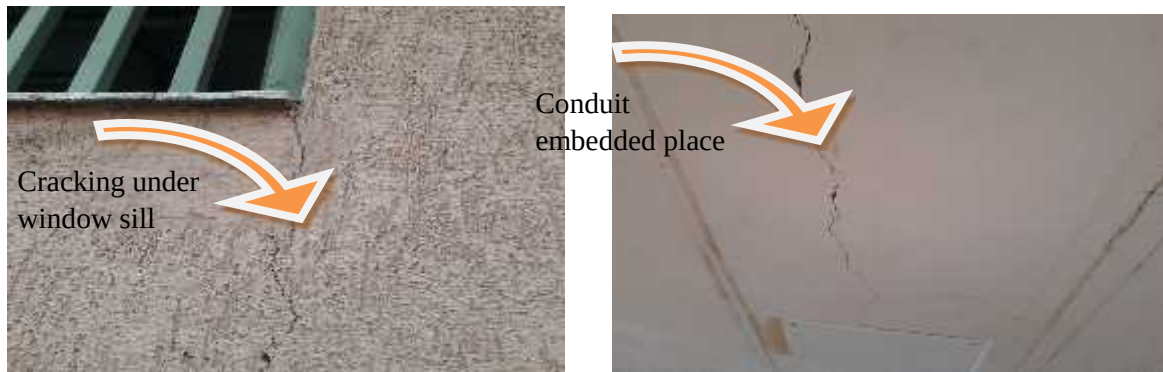
Fig2.d) Continuous cracking occurred at grade beam and basement hollow concrete block wall. These cracks shall be avoided by recessing and pointing at connection place of beam and hollow concrete block wall during plastering.



c) Crack at joint between beam and HCB wall d) Crack at joint between beam and wall and column and hollow concrete block wall

Fig2.e) Cracking occurred under window sill due to window sill was not inserted to wall properly. The window sill shall be inserted to hollow concrete block wall and reinforced in order to have good bondage between the different materials.

Fig2.f) Continuous crack occurred due to the installed conduit was not embedded and plugged properly. All junctions between different materials and also over the embedded conduits shall be reinforced with expanded metal which shall be plugged nailed or stapled as required at required interval.



e) Crack under window sill

f) Conduit is not embedded properly.

Figure 2

Picture Defects on Plastering

4.2.4. Flooring

4.2.4.1. Cement Screed Flooring: during construction there is a problem associated to material quality and related work .

4.2.4.1.1. Quality Problems associated with Materials as follow:

- To use unapproved sand.
- To use less cement content proportioned and this cause cracking
- In most construction projects there is no practice to use crushed fine aggregate which minimize cracking.
- Not to use mixer for mixing mortar to get thoroughly mixed mortar
- Not to use construction joint for large area.

4.2.4.1.2. Quality Problems associated with Workmanship as follow:

- Lack of Sufficient skill to do the given job proficiently.
- Not clean the surface properly before applying cement paste on the surface.
- Not chisel properly to make good bondage.
- Constructing flooring before ceiling work.
- Joint between screed panel is not be accurately located before the spreading of the under coat.

- The finish coat on cement screed is not be properly spread with cement powder and trowel led to an even & level surface
- Expansion joint is not sealed properly.
- Not clean the surface properly after finishing the work.

4.2.4.2. Floor and Wall Tile

4.2.4.2.1. Quality Problems associated with Materials as follow:

- To use unapproved material which is not conducted for flexural & water absorption test.
- To use different type of approved samples which are not uniform due to shortage of materials
- To use less cement content proportioned mortar.
- To use less mortar thickness for bedding.
- To use tile which is not straight, edged & smoothed.
- To use less thickness floor tile.
- To use the glue for fixing PVC tile and skirting which is not matching in accordance with the instruction of manufacture.

4.2.4.2.2. Quality Problems associated with Workmanships as follow:

- Lack of Sufficient skill to do the given job proficiently.
- Tile is not soaked in water for a minimum of 15 minute before laying
- Cement slurry bond coat is not be scrubbed to prepare slab prior to placing mortar bed.
- Tile is not accurately cut & fitted to door, wall, ends, opening and projection.
- Finishing floors shall not be perfectly true and level or laid to falls.
- The flooring is not be wetted for 7 days
- The ground tile is not cleaned off dust & not polished at completion of work.
- Not use spacer for appropriate laying. This cause non uniform Pattern
- PVC tile lay before two coats of painting applied to wall & ceiling.
- The joint of wall tile is not be grouted in white cement and cleaned at completion of work
- Not clean the surface properly after finishing the work.

4.2.5. Cement, Water and Sand used for Floor and Wall Finish

Water

- To use not clean water
- Not usual to conduct necessary tests by taking samples.
- Adding Extra water to the mortar in order to facilitate handling purpose.
- Not to wetting the surface before placing mortar.
- Lack of proper curing to the plastering & flooring.

Cement

- Not to use as per the given specifications
- To use cement having stored for long time off period.
- Lack of proper handling and storing
- Not usual to conduct tests for cements of having stored for more than six months
- To use less cement proportion.

Sand

Not to use tested sand which fulfill the required quality.

- To use sand from different source.

B Defects on Flooring

Fig3.a) The floor must be executed as per approved sample but as we have seen on the figure damaged tile is executed. In addition others tiles are not grouted properly.

Fig3.b) Terrazzo tile is not neatly and properly cut and laid at connection place of marble floor. Grouting is not done properly. Both defects occurred due to poor workmanship.



a) Damaged terrazzo tile



b) Poor workmanship at marble and terrazzo floor joint

Fig3.c) finished floor level shall be established by means of dots in order to avoid leveling problem. But as we have seen in the figure there is a level difference between the internal and external floor due to poor workmanship.

Fig3.d) all materials used for construction shall be checked by conducting test and by professionals. But as we have seen in the figure Un approved tile executed during execution.



c) Level difference in floor



d) Different type of terrazzo tile is executed

Fig3.e) Level difference is occurred due to poor workmanship. In addition to this different types of terrazzo is executed.

- Fig3.f) Tiles shall be laid with required spacing and spacers shall be used to align horizontal and vertical joint. As we have seen in figure the alignment of granite tile is not done properly and also grouting is not done properly.



e) Different type of terrazzo tile and level problem f) Alignment and grouting defect

Figure 3 Pictures different type of tile and poor workmanship in floor tile works

Fig4. a) Broken ceramic tile was executed and filled with mortar which is an acceptable.

Fig4.b) Broken ceramic tile was executed and filled with filler which is an acceptable.



a) Broken ceramic floor tile

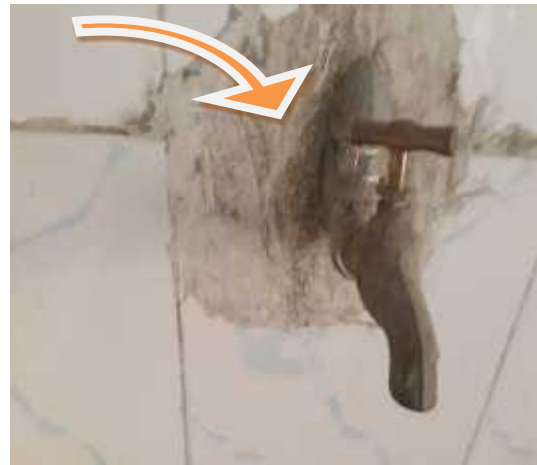


b) Broken ceramic floor tile

Fig4. c) Cracked ceramic tile was executed and filled by filler. The defect might be occurred during laying tile but as soon as crack occurred it must be changed and substituted by new tile.

Fig4.d) When opening is necessary in ceramic wall tile, the opening size shall be minimum gap between the installed material. As we have seen in the figure the gap between the water

tap and ceramic wall is too much wide and filled by filler which is unacceptable. In addition to this the tile edges is not cut and is grinded properly.



c) Cracked ceramic wall finish

d) Improper ceramic wall finish around tap

Fig4. e) During Layout tile as much as possible tile less than $\frac{1}{2}$ full size not to be occurred. As we have seen in the figure less than $\frac{1}{2}$ full size occurred and filled by filler rather than ceramic tile.

Fig4. f) Silicon rubber sealant shall be inserted between tiles and sanitary fitting. As we have seen in the figure only filler is filled around shower tray which can be easily damaged by water. The gap between floor and shower can be covered by ceramic tile.



e) Gap between floor and wall

f) Gap between floor & shower tray

Figure 4 Pictures of Poor workmanship and un proper filling at toiler room

Fig5. a) The gap between ramp tile and ground floor was filled by mortar. This is due to poor workmanship. Laying tile must be started by proper division starting from the finished floor to pavement floor in order to eliminate this gap.

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Fig5.b) Continuous cracking occurred at connection place between grade beam and ground floor slab due to un consolidated sub base.

Fig5.c) crack was occurred at connection place between grade beam and pavement and also on the pavement. Construction joint was not provided to separate grade beam and pavement and also the pavement was not divided with specific gap by construction joint. This causes crack to be happened.



a) Poor connection method at ramp and floor b) Crack at grade beam and floor joint place



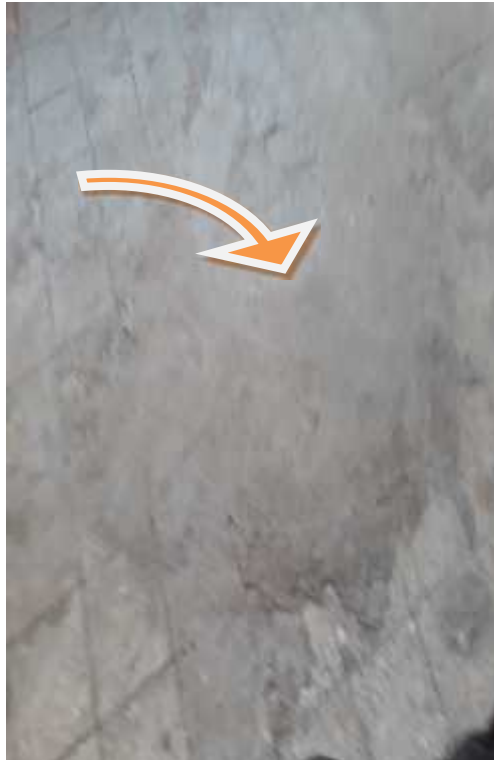
c) Cracked on pavement around building

Figure 5 Pictures Crack on floor due to unconsolidated of preceding work and not providing construction joint

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Fig6. a) Mortar was mixed on terrazzo tile which is not acceptable. In addition to this it was not cleaned. The mortar cured on it left as flooring.

Fig6. b) The gap between terrazzo tiles and wall which is greater than $\frac{1}{2}$ of full size shall be laid by terrazzo tile. As we have seen in the figure more than 10cm gap was filled by mortar which is not acceptable.



a) Cured mortar on terrazzo tile b) The gap b/n terrazzo tile & wall filled by mortar

Figure 6 Pictures of poor quality due to mixing mortar on terrazzo tile and not cleaned properly

Fig7 Balcony marble sill was not extruded and grooved properly to drain water outside the wall. In addition to this at joint between marble sill were not grouted properly .



Figure 7 Picture of defect on balcony external wall.

Fig8. The external clinker wall cladding defect occurred may be due to adhesive quality and thickness problem, or the wall surface was not prepared properly to receive adhesive, or the clinker quality is poor or the tile was not tamped properly due to poor workmanship.



Figure 8 *Picture of defect on external wall cladding*

Fig9.a) Although the granite tread is approved, it has no nose and has not been laid at per drawing.

Fig9.b) Poor quality terrazzo tread was executed and the broken part rectified by mortar instead of changing the broken terrazzo tread.



a)Marble tread which has no nose



b)Broken tread has been rectified by mortar

Fig9.c) The tread is not cleaned properly and mortar cured on it,

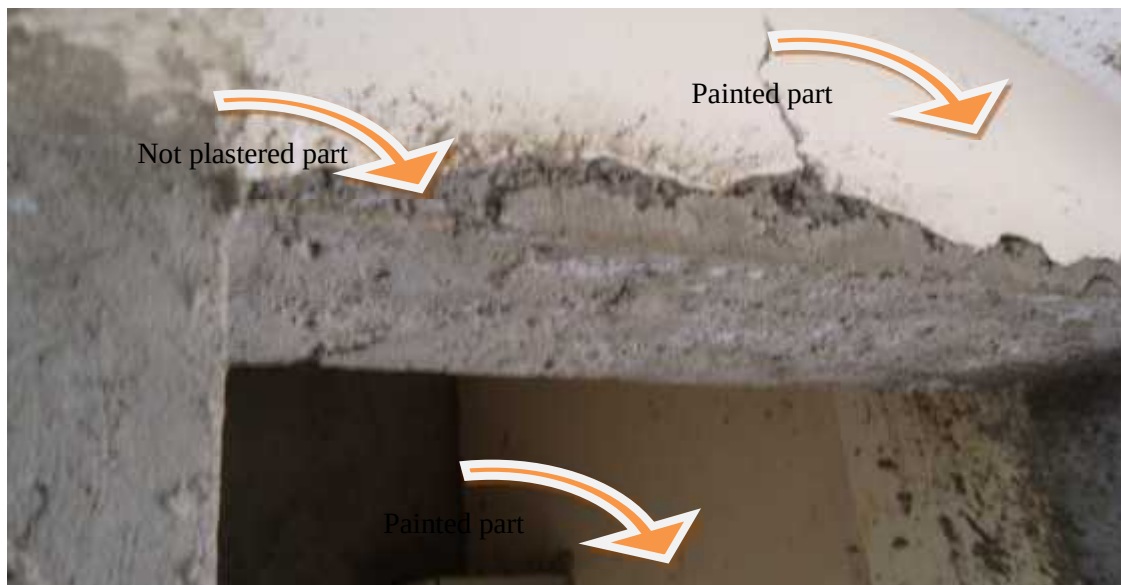
Fig9.d) Cracked terrazzo tread laid and also the length is short which is not fit to the space. But the gap was filled by mortar which is not acceptable. Before ordering the tread the actual measurement must be taken on site in order to avoid this problem.



c)Unclean tread& mortar mixed on it, d) Cracked tread and short length

Figure 9 Pictures of defect on marble tread, poor quality of material & poor work man ship

Fig10) painting was done before plastering completion at lintel area and it results rework.



Uncompleted plastering at lintel but painting was done near by

Figure 10 Picture of defect on plastering and work procedure is not kept properly

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

4.2.6. Quality Problem associated with Document Preparation & Malpractice.

Note all data are only for academic purpose

Case: *I*
Project: *Staff Apartement*
Client: *Debretabor Univeristy*
Contractor: *Abay Demissie B.c*
Consultant: *BUDSWS*
Year of Construction *2010E.C.*

A. Omission work which is in contract document with contract price (cp) and changed to new item new price (np).

Table 1 below shows the description, quantity and unit price of PVC floor tile and skirting in the main contract document. The contract unit price is not cover even for labor cost. But during construction time the client requested PVC floor tile to be changed to Porcelain tile flooring.

Table 1 Omission Plastic Tile

Item	Description	Unit	Quantity	Rate (ETB)	Amount (ETB)
7	FINISHING WORK				
7.1	2mm thick high-quality PVC floor tile flooring laid with approved type adhesive material	m ²	1,337	16.00cp	21,392.00
7.2	10cm high PVC skirting stuck to wall with proper adhesive	ml	1,193	4.00cp	4,772.00
	Total in birr				26,164

B. Addition work to substitute the omission work

Table 2 below shows the addition work description, quantity, and new price of Porcelain tile flooring and skirting which substitute the omission work.

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Table 2 Addition Porcelain Floor work

Item	Description	Unit	Quantity	Rate (ETB)	Amount (ETB)
7	FINISHING WORK				
7.1	Porcelain tile flooring & skirting Porcelain tile Shall be in compliance with ES C.D2,003 Ethiopian standard 10mm thick	m ²	1,337	900.np	1,203,300.00
7.2	Porcelain skirting	ml	1,193	200.np	268,600.00
	Total in birr				1,441,900.0

The above comparison tables are presented to show the malpractice on preparation of contract document and variation work which cause additional cost and affect the completion time of the project. Since quality includes complete the project as per the specification and drawing, complete with in contract time and budget. The above addition and omission work caused variation and additional budget was incurred. In addition to this the contract completion time extended due to late decision for price approval.

As it is seen in above comparison tables, it is clear that during tender time the contractor purposely quoted unit price for PVC floor tile under estimated price either to win the tender or thinking of that the material will be changed during construction.

During construction time the client requested the consultant to change plastic tile to Porcelain tile. The consultant design team just by seeing the client request; ordered the contractor to submit rate for additional work and to omit Plastic tile. The contractor submitted new price for additional work. Finally, when the cost evaluated by contract administration team the addition and omission amount gap is high due to very less contract price of Plastic tile which cannot be executed with that rate. Then the consultant announced to the client the gap between the additional work price and the omission work price which is the additional budget is the difference in amount between addition and omission work = 1,415,736 (One million four hundred fifteen thousand seven hundred thirty-six) birr; and also mentioned the work order might had influenced the bidding process.

After 6 month the client decided the work to be proceed with the main contract price and to cancel the work order. But within a week interval the client decided again the work to be executed as per the additional work with new price and to omit the main contract item.

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Finally, the consultant approved the final decision of the client which result the client to pay additional cost 1,415,736 (One million four hundred fifteen thousand seven hundred thirty-six) birr for floor work.

In case I; during tender time the contractor rated for plastic floor tile 16-birr m² which cannot cover even for labor. And also, the contractor rated for metal work 38 birr per m² which cannot cover even for labor. During construction the contractor requested the materials to be changed through the client and the client requested the consultant to omit the materials and to add other quality material.

The malpractice is first the consultant shall design and prepare the contract document as per client interest. Second when materials change requested by client or contractor during construction time, the contract work price and new work price estimation shall be seen and compared thoroughly before giving work order. Third the client shall select decision of his benefit. Once the client knows the big difference of new work unit price and the contractor quoted contract unit price which was underestimated; the client shall stand to his first decision which is " the contractor shall to execute the work as per the main contract". In addition whatever the decision is; the client shall give prompt decision in order to minimize time claim and avoid financial claim.

Case:	<i>II</i>
Project:	<i>Student Lounge Building</i>
Client:	<i>Debremarkos Univeristy</i>
Contractor:	<i>Mulken Bitew B.C</i>
Consultant:	<i>BUDSWS</i>
Year of Construction	<i>2009E.C.</i>

A. Omission work which is in contract document and changed to new item because of out of stock.

Table 3 below shows the description, quantity and unit price of 1.5cm thick non slippery ceramic floor tile and skirting in the main contract document which the contractor notified the material is out of stock. After checking by consultant it was substituted by 1cm thick non slippery ceramic floor tile

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Table 3 Omission 1.5cm Thick Ceramic Floor Tile

Item	Description	Unit	Quantity	Rate	Amount
11	FINISHING WORK				
11.2	Floor and Wall Finishing				
11.2.1	1.5 cm thick non slippery ceramic floor tile and skirting shall be in compliance with ASTM/EN quality standard 1.5cm thick	m ²	2,061	710 cp	1,463,310.
11.2.2	10cm high skirting	ml	689	120.cp	82,680.00
	Total Birr				1,545,990.00

B. Additional work to substitute the omission item.

Table 4 below shows the addition work description, quantity, and new price of 1cm thick non slippery ceramic floor tile and skirting which substituted 1.5cm thick non slippery ceramic floor tile.

Table 4 Addition 1.cm thick Ceramic Floor Tile

Item	Description	Unit	Quantity	Rate	Amount
11	FINISHING WORK				
11.2	Floor and Wall Finishing				
11.2.1	Non slippery ceramic floor tile and skirting shall be in compliance with ASTM/EN quality standard 1.cm thick	m ²	2,061	639.bcp	1,316,979. 00
11.2.2	8 cm high skirting	ml	689	108.bcp	74,412. 00
	Total Birr				1,391,391.00

In case II; The contractor rated for 1.5cm thick non slippery ceramic floor tile 710-birr per m² during tendering which cannot be executed with this price. Since the materials must be imported from abroad it cannot cover even material cost. During construction time the

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contractor notified the material is out of stock and to be changed with 1cm thick. The consultant checked the material is out of stock and ordered to be constructed by 1cm thick. The contractor rated for addition work 1000birr per m² which is greater than the contract price of 1.5mm thick none slippery ceramic tile. Although 1000 birr per m² is fair for 1cm thick at this time for new item, due to the omission contract price too less; the contractor forced either to execute 1cm thick by less price or he should deliver 1.5cm thick from abroad and execute as per the contract agreement. Finally, the contractor selected to execute with 1cm thick with less price even though the price is not profitable.

The malpractice from this case is first during design and document preparation out of stock materials shall not be mentioned. Second the contractor thinking of that if he forced to execute as per the agreement fair price must be rated. If the contractor knows the description work on tender document is out of stock, he will fill underestimated price for winning purpose by assuming as it will be changed during construction time.

Case: *III*
Project: *Teaching and Referral hospital*
Client: *Dilla University*
Contractor: *Flintstone Engineering*
Consultant: *BUDSWS*
Year of Construction *2007E.C.*

A. Omission work which is in contract document and changed to new item with client request.

Table 5 below shows the description, quantity and unit price of 3cm thick white marble tread and riser in the main contract document which the client requested to be changed to granite tread and rise during construction.

Table 5 Omission White Marble Work

Item	Description	Unit	Quantity	Rate	Amount
11.2	FLOOR AND WALL FINISH All Marble shall be in compliance with ESC.D2,003 Ethiopian Standard				
1	Steps Tread 3cm thick shaped White Marble	m ²	418	1,500 cp	627,000.00.
2	Riser 2cm thick White Marble	m ²	194	1,200 cp	232,800.00

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	Total Birr				859,800.00
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B. ADDITION

Table 6 below shows the addition work description, quantity, and new price of granite tread and riser which substituted the omission work.

Table 6 Addition Granite Work

Item	Description	Unit	Quantity	Rate	Amount
11.2	FLOOR & WALL FINISH All Marble shall be in compliance with ESC.D2,003 Ethiopian Standard				
1	Granite Tread & Riser for stairs T 3cm thick Granite tread	m ²	418	2,683.np	1,234,180.00.
2	Riser 2cm thick Granite	m ²	194	2,180.np	1,002,800.00
3	Granite Floor tile & Skirting for Landing 40x40x2cm thick	m ²	260	2040.5 np	530,530.00
4	10x2cm thick Granite Skirting	m ²	876	262.2 np	229,687.20
	Total Birr				2,997,197.2

In case III; the contractor rated for white marble tread and riser 1500 and 1200 birr per m². During tender time the price is fair. But after three year the price might not cover material cost. The client requested after three-year material change by mentioning the surrounding area is red soil and the white marble to be changed with red granite tile. The consultant as per client request ordered the contractor to omit white marble and execute red granite. Since the work item is new; the contractor rated new price for additional work and this result additional cost incurred to the client.

The malpractice from this case is first during design and document preparation the client interest shall be kept. Second when the color type commented by client as consultant to save the client from additional cost it is possible to change the white marble color to other color without additional cost.

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Case: *IV*
Project: *Office and Site work*
Client: *Ministry of revenue*
Contractor: *Berket Endeshaw*
Consultant: *BUDSWS*
Year of Construction *2009E.C.*

A. OMISSION work which is in contract document and changed to new

Table 7 below shows the description, quantity and unit price of fine coat in cement plaster in the main contract document which the client requested to be changed to gypsum plaster.

Table 7 Omission Fine Coat Cement Plaster

Item	Description	Unit	Quantity	Rate	Amount
11	FINISHING WORK				
11.1	Plastering and Pointing				
1	Fine coat cement plaster Internal plastered vertical surface	m ²	13,868	1. cp	13,868.0
2	Fine coat to concrete soffit	m ²	16047	1.cp	16047.0
	Total Birr				29,915.0

B. ADDITION

Table 8 below shows the addition work description, quantity, and new price of gypsum plaster which proposed to substituted the omission work.

Table 8 Addition Gypsum plaster work

Item	Description	Unit	Quantity	Rate	Amount
11	FINISHING WORK				
11.1	Plastering and Pointing				
1	Gypsum plaster to internal plastered vertical surface	m ²	13,868	69.60 cp	965,212.80
2	Gypsum plaster to concrete soffit	m ²	16047	69.6cp	1,116,871.2
	Total Birr				2,082,084.0

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In case IV; During tender time the contractor rated for fine coat plaster 1(one) birr per m² which can not cover even labor cost. At finishing time, the contractor proposed to do with gypsum plaster in order to get good finishing surface. The client convinced only for good quality surface finish and requested the consultant to omit fine coat cement plaster and to add gypsum plaster.

The consultant design team prepared addition and omission work and work order. But the contract administration team when received the work order visualized the big difference price between the two almost similar works and announced to the client the addition work needs additional cost of 2,052,169.0 (Two million fifty-two thousand one hundred sixty-nine) birr. The client understood the big gap of the addition and omission work and decided the contractor to work the plastering as per the main contract description. Finally, the contractor willing to do the fine coat with gypsum plaster without additional cost which is 1-birr per m² and the consultant approved addition and omission work without any additional cost. In my opinion the contractor accepted the decision due to it is better for him to select gypsum plaster since the surface will accept painting easily.

Case: V
Project: National Archive and Library
Client: National Archive and Library Agency
Contractor: FE Construction
Consultant: BUDSWS
Year of Construction 2010 E.C.

A. Omission work which is in contract document and changed to new item

Table 9 below shows the description, quantity and unit price of aluminum panel in the main contract document which the client requested to be changed to granite wall cladding.

Table 9 Omission Aluminum panel to external wall

Item	Description	Unit	Quantity	Rate	Amount
	Contract 1 10. ALUMINIUM WORK External wall Cladding Aluminum				
1	Aluminum Panel (Granite Decorated)	m ²	2489	95. cp	236,455
	Total Birr				236,455.0

B. Additional work to substitute the omission work

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Table 10 below shows the addition work description, quantity, and new price granite stone wall cladding which substituted the omission work.

Table 10 Addition Granite tile to external wall

Item	Description	Unit	Quantity	Rate	Amount (ETB)
1	Granite tile Wall Cladding to External specified wall surface Execute Granite stone wall cladding of size 600x1200x30mm for external wall fixed to the wall with Steel in lay price includes every steel structure work to support the cladding, fixing accessories, sealant for joint and primer that does have a water proof impact Every structural steel part of the supporting system has to be confirmed in detail design for its serviceability and safety. Quality product of the system has to be also submitted and be accepted. The workmanship to be deployed has to have an experience of such system cladding enabling to provide an acceptable work methodology. All the work to be completed according to the detail drawing attached and any necessary details needed to make the system complete.	m ²	2489	7984np	19,872,176.
	Total Birr				19,872,176.

In case V; During tender time the contractor rated for external Aluminum wall cladding 95birr per m² which is extremely less price. At finishing time, the client requested the external wall to be executed with **Granite tile wall cladding** for good appearance and match to function of the building. The consultant announced to the client the additional cost 19,635,721 (Nineteen million six hundred thirty-five thousand seven hundred twenty-one birr) incurred for new work. But the client accepted the new cost. Because of this, addition and omission work order has been given to the contractor.

The malpractice from this case is first during design and document preparation the client interest shall be kept and the client shall inform his interest clearly. Second when the

change is necessary the contract price for the omitted description shall be seen thoroughly in order to see other option. Third if the new work is mandatory, the new price shall be fixed by negotiation by not considering any profit to the contractor. This is because of if the contractor forced to execute as per main contract, he will loss more money. Therefore, he prefers to execute the additional work without profit.

4.2.7. Discussion on the Quality Problem and Mal practice

Qualities include completing the project on schedule meeting, the owner's requirement within budget, fulfilling the specification mentioned in the contract, avoiding disputes claims, ensuring facilities/final product performs for its intended purpose. But when we see in reality the problem occurred during construction, design, document preparation and also contract administration. The executed works are not as per specification and drawing. It will not fulfill the required quality mainly due to poor workmanship and some time due to poor quality of materials. In addition to this the project is not completed as per the schedule, additional cost incurred for project due to excess quantities and variations. Because of delay consultant fee is paid beyond budget due to most of clients and consultants supervision and contract administration agreement is time based. The other problem is works are not executed as per the specification and approval; due to variation work and late respond from consultant related to design and other issues; time claim is requested by the contractor. As we have seen above in different cases due to malpractice of contractor, client and consultant unnecessary expense incurred on Government budget.

If the quality control and quality assurance done properly from feasibility study, designing, document preparation, supervision and contract administration good quality of work will be obtained; the project is completed as per the schedule; the client is not exposed to additional budget; the product will be ready for the intended purpose; claim related to time and cost will be minimized.

Although the contractor is responsible for any poor quality of work, the consultant also responsible to supervise and administer the projects properly. During construction time the Resident Engineer or site Engineer who is assigned by the consultant must supervise each item works with check list and by giving work permit. This minimizes the defects which occur on the project. In addition to this the design team and the contract administration team shall be counter checked each other during any variation work in order to avoid the malpractice which can be raised by contractor, consultant and client.

5. Conclusion and Recommendation

5.1 Introduction

The objective of the independent project has been achieved based on the literature review from books, journals, thesis, seminars and different documents; finding from interview, site observation and desk study. The study addresses a gap in quality control and quality assurance which results poor quality works and malpractices.

5.2 Conclusions

- Unclear preparation of specifications for materials, poor workmanship and also poor supervision are observed to be highest causes of poor quality of building construction.
- Checklist for each activity is not submitted and checked properly and also some the activities proceed without confirmation of resident engineer. In addition to this work methodology or method of statement is not submitted to resident engineer for approval before starting the activity.
- Many consultants & contractors believe that professionals are not conducting properly quality control and quality assurance activity which compiles to the requirement in the drawing, specifications & other standard documents. In general, there is unethical professional practise of quality control and quality assurance.
- Most contractors do have neither responsible quality control & quality assurance department nor effective quality control system.
- Most consultants believe that the general condition of contract and standard technical specification is effective to enforce quality control and quality assurance while many contractors has less perception.
- The high gap between contractors & consultants on the effectiveness of the general condition and technical specification shows that the enforcing tools are not addressing requirement of the contractor for enforcing proper quality control system and quality assurance.
- In most cases the under estimated contractor price causes delay of project, variations and poor quality.
- The late respond of resident engineer and consultant lead the project not to be completed as per the schedule, budget and quality.
- The malpractice in variation work initiated by the contractor, consultant and also by client.

- Most of time plastering, flooring and wall finishing works are executed by sub contractors; and plasterers and tilers give more attention to their output rather than quality.

5.3 Recommendations

- The design & document preparation of building works should focus on clear specification of required workmanship level, defining characteristics and requirement of material to be included in the design. So that evaluation & approval of materials will not be subjective.
- Attention must be given by the regulatory body so that contractors and consultants should understand the need for quality control and quality assurance department equipped with organized quality control system and implement accordingly.
- Contractors and consultants should develop the practice of using quality control tools at construction stage. Such as, using work permit, check list and working method techniques prior to commencing execution of any activities. This method is preferable to inspection as it will avoid reworking and in turn saves cost and time lost by demolishing and reworking.
- Contractors should be aware about the necessity of work method of statement as it is a tool for ensuring operation of the work to be executed based on specification and drawing, with planned time, allocated budget and with the necessary safety Compliance. The contractors should be responsible in creating awareness for the staffs, as it is vital to stay competitive in the market.
- Author control by designers is necessary during construction time; especially for major items before starting preparation and execution.
- To avoid and minimize the malpractice which can be initiated by consultant or client or contractor; the external body Construction Works Regulatory Authority which was established by government in proclamation number 1097/2011 article 32 shall be equipped with competent and enough manpower and also organized well in order to control the quality of the construction and to approve variations.
- As most of defective works are observed in the plastering, floor finishing and sanitary works of the building process, it is vital to provide the appropriate training for specialists carrying out these activities and close supervision is required during execution.

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ANNEX- I Plastering

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Mortar and Masonry Grout: Section 040513.

1.02 REFERENCES

Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of the following Referenced Standards.

- A. ES 1658: Workmanship on Building Sites, Code of Practice for Plastering and Rendering.
- B. ES 2142: Building Lime-Conformity Evaluation.
- C. ES 2119: Code of Practice for External Renderings.
- D. ES 1487: Code of Practice for Internal Plastering.
- E. ES 2284: Aggregates for Mortar.
- F. BS 1369: Metal lathing for Plastering.
- G. BS 1199: Sand for External Rendering and Internal Plastering with Lime and Portland Cement.
- H. BS 1198: Sand for Internal Plastering with Gypsum Plasters.
- I. BS 1230: Gypsum Plasterboard.
- J. BS 6100-1-3-7: Glossary of Building and Civil Engineering Terms. Part 1. General and Miscellaneous. Section 1.3. Parts of Construction Works: Subsection 1.3.7 Finishes.
- K. BS 6100-6-1: Glossary of Building and Civil Engineering Terms. Part 6. Concrete and Plaster. Section 6.1. Binders.

1.03 DEFINITIONS

- A. Unless specified otherwise, the terms in this section shall conform to the terms and definition stated in BS 6100-1-3-7, BS 6100-6-1 including the following:
 - 1. Plaster: Mixture based on a binder that, after the addition of water, is applied while plastic and that hardens after application, generally used to obtain a surface finish.
 - 2. Gypsum: Naturally occurring or chemically produced Calcium Sulphate Dehydrate from which binders are produced by varying degrees of dehydration.
 - 3. Lime: Quicklime, hydrated lime, lime putty or slaked lime.

4. Coat: Continuous layer of coating material that results from a single application.
5. Coating: Process that leads to the production of coat.
6. Coating material: Material used to cover a surface for protective, decorative or other purposes.
7. Substrate: Surface to which a coating material is applied.
8. Priming coat: Initial coat applied directly to the substrate.
9. Finishing coat: Final coat of a coating system
10. Undercoat: Coat between a priming coat and a finishing coat.

1.04 DESCRIPTION OF PLASTER SYSTEMS

- A. Cement mortar: consisting of cement mortar priming coat, cement mortar undercoat, finishing coat cement mortar, render coat, and float finish.
- B. Compo mortar: consisting of compo mortar priming coat, compo mortar undercoat, and finishing coat lime plaster.
- C. Gypsum plaster: consisting of gypsum plaster priming coat, gypsum plaster undercoat, and finishing coat gypsum plaster.
- D. Pointing: Recessed pointing and flush pointing.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's name & brand, material type, & specifications:
 1. Cement.
 2. Lime.
- B. Quality Control Submittals:
 1. Sand and aggregates: Name and location of source, & test certificate.

1.06 QUALITY ASSURANCE

- A. Plasterers shall be skilled workmen who are thoroughly trained and experienced in the necessary crafts. In addition to these requirements assign at least one person who is thoroughly familiar with the specified requirements and capable of guiding the trades' men in the section of materials and execution of the works of this section.
- B. Do not use asbestos bearing materials & do not add asbestos to plaster mixes.
- C. Allowable Tolerances: Maximum deviation from true plane shall comply with the requirements of ES 1658.

- D. Example of Work: Unless specified otherwise, prepare a sample panel for approval before preceding the plastering work.
 - 1. Construct a 1 m. x 1.5 m. sample panel for each type of plaster, showing color, texture, and workmanship.
 - 2. Do not proceed with plaster application until sample panel has been approved by the Engineer's Representative.
 - 3. Maintain sample panel on site for comparison purposes until work of this Section has been finished and approved.
- E. Ready-mixed plaster mixes are subject to the approval of the Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The delivery, storage and handling of materials and components shall comply with the requirements stated in ES 1658 and the followings.
 - 1. Deliver manufactured materials in original sealed containers, with manufacturer's label intact and legible.
 - 2. The material and components to be delivered to the project site shall be of approved quality, clean and undamaged.
 - 3. Keep cement, gypsum and lime dry, stored off ground, under cover.
 - 4. Keep different materials in separate stacks.
 - 5. Stack bags away from walls, closely together not more than eight bags high.
 - 6. Stack bags so that consignments can be used in the order of delivery.
 - 7. The storing of sand & aggregates shall be as specified under Cast-in-Place Concrete Section.
 - 8. Remove wet, lumpy, and hardened materials from the site.

1.08 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with the environmental requirements of applicable Referenced Standards and the following;
 - 1. Do not use frozen materials in plaster mixes.
 - 2. Do not apply plaster to surfaces that are frozen or contain frost.
 - 3. Do not apply plaster when ambient temperature is less than the requirement.
 - 4. Interior Plastering: Make arrangements thru the Engineer's

Representative to have the required temperature maintained for a minimum of 24 hours prior to application, during application, and until plaster has cured.

5. Exterior Plastering: Provide heated shelters when necessary. Maintain required temperature for a minimum of 24 hours prior to application, during application, and until plaster has cured.
6. Small on-the-job mix adjustments recommended by the plasterer for working characteristics and drying conditions may be made with the approval of the Engineer's Representative.

B. Protection:

1. Protect adjacent finishes with suitable, non-staining covers.
2. Protect plaster from uneven and excessive evaporation and from temperature differentials until it has cured.

PART 2 PRODUCTS

2.01 GYPSUM PLASTER MATERIALS

- A. Gypsum plasters for internal plastering shall comply with the requirements of ES 1487.
- B. Sand: Shall comply with BS 1198.

2.02 GYPSUM PLASTER BOARD

- A. Gypsum plasterboard when used as a background to plastering system should comply with BS 1230.

2.03 COMPO MORTAR AND CEMENT PLASTER

- A. Cement shall comply with one of the following:
 1. ES 2169 for low heat Portland cement.
 2. ES 2171 for sulfate - resisting Portland cement.
 3. ES 2179 for pozzolanic pulverized-fuel ash cement.
- B. Lime: Shall comply with ES 2142.
- C. Sand: Shall comply with BS 1199.

2.04 MISCELLANEOUS MATERIALS

- A. Water: Potable, clear, and free of substances harmful to plaster.

B. Bonding agents: Shall comply with the requirements stated in ES 1487.

C. Metal lath for plastering: Shall comply with the requirements of BS 1369.

2.05 CEMENT PLASTER MIX COMPOSITION

A. The mix proportion of cement-sand for priming coat, undercoat and finishing coat shall comply with the requirements stated in ES 1487.

2.06 COMPO MORTAR MIX COMPOSITION

A. The mix proportion of compo mortar for priming coat, undercoat and finishing coat shall comply with the requirements stated in ES 1487.

2.07 GYPSUM PLASTER MIX COMPOSITION

A. Shall comply with the requirements stated in ES 1487.

2.08 RENDER COAT MIX COMPOSITION

A. The mix proportion of cement-lime-sand, cement-ready mixed lime-sand, cement-sand and mortar cement-sand shall comply with the requirements stated in ES 2119.

2.09 FLOATING MIX COMPOSITION

A. 1 part cement to 2 parts of fine sand by volume.

2.10 POINTING MIX COMPOSITION

A. 1 part of cement to 2 parts of fine aggregate by volume.

2.11 AGGREGATES

A. Shall comply with ES 2284.

B. Aggregate for plaster and pointing shall be naturally occurring sand or crushed aggregate. The aggregate shall be hard, clean, free from adhered coatings with no clay content

C. Aggregate shall be free of harmful organic and inorganic material that may affect the setting, strength, durability and appearance of render or undercoat and material in contact with it

D. The clay and fine silt content of aggregate shall not exceed 5% by weight.

2.12 MIXING

A. General:

1. Mixing process for mortar shall comply with the requirements of the “Section 040513” of this Specification
 2. Accurately proportion materials for each batch with measuring devices of known value.
 3. Size batches for complete use within maximum of one hour after mixing.
 4. Do not use frozen, caked, or lumpy materials. Remove such materials from the site.
 5. When sand is required in mix proportions, use moist loose sand.
 6. Withhold 10% of mixing water until mixing is almost complete. Add remainder as needed to produce necessary consistency.
- B. Machine Mixing:
1. Unless otherwise approved by the Engineer’s Representative, mix materials in a power mixer.
 2. Clean mixer of set materials before loading each new batch.
 3. Maintain mixer in continuous operation while adding the components. After all materials are in the machine, continue mixing for at least 2 minutes.

PART 3 EXECUTIONS

3.01 PREPARATION

- A. Generally, the preparation of backgrounds that receives plastering and rendering shall comply with the requirements stated in the Referenced Code of Practices and Standards in this Section.
- B. Remove dust, loose particles & other foreign matter which would affect bond of plaster.
- C. Wet absorptive bases with a fine spray or fog of clean water to produce a uniform moist condition.
- D. When interior concrete surfaces are smooth, dense, and not suitable for keying of the plaster coat, prepare surfaces and apply bonding compound in conformance with the manufacturer’s instructions.
- E. Concrete surface shall be hammered to form key Chases shall be formed before services are installed and made good thereafter prior to plastering.
- F. Prior to plastering, joints of stone, brick and concrete blocks shall be raked, to

form key. Where making good with plastering is required, the surface shall be cut out to a rectangular shape with the edges forming dovetail key.

- G. Cracks, blisters and other defects shall be cut out & made good. Where required, dubbing shall be made with the same material as the under-coat application.

3.02 INSTALLING ACCESSORIES

- A. Provide all accessories required for a complete finished installation.
1. Set accessories plumb or level, and true to line. Use shims where necessary. Align joints with concealed splices and tie plates. Attach accessories to substrate as per the requirements stated on the Referenced Standards.
 2. Install continuous corner beads at all external corners of plaster.
 3. Unless otherwise indicated, install continuous casing beads to terminate plaster at head and jambs of doors and windows, at each side of expansion joints, and at internal corner junctions of load bearing and non-load bearing elements.
 4. Unless otherwise indicated, install screeds at control joints and along top of wainscots.

3.03 PLASTER APPLICATION AND CURING

- A. General:
1. Internal plastering: shall comply with ES 1487.
 2. External rendering: shall comply with ES 2119.
 3. Workmanship: shall comply with ES 1658.
 4. Application of metal lath: comply with BS 1369.
 5. Provide plaster thicknesses complying with the Referenced Standards or on the Drawings. On solid base, thickness will be measured from face of base material. On metal lath base, thickness will be measured from the back plane of metal lath.
 6. Apply plaster by hand or machine, unless otherwise indicated.
 7. Over metal lath, apply plaster by hand only.
 8. Provide 3 coat applications consisting of priming coat, undercoat, and finishing coats as required.
 9. Final coats shall form true, sharp lines at angles and against other items. Where plaster abuts flush trim, make a small V-joint in the final coat at the trim.

10. Stop off plaster application only at junctions of plaster planes, at openings, or control joints.
11. Except for metal lath, apply base & finishing coats to moist surfaces only.
12. Ready-Mixed Materials: Follow the manufacturer's application instructions.
13. In spaces where plastering is indicated on the Drawings, apply plaster on surfaces of reveals, soffits, pilasters, columns, and other related surfaces, except where other finish is shown.
14. Extend priming coat and undercoat in back of built-in casework unless otherwise indicated. Carry final coat a maximum of 3mm past edges of built-in casework.

B. Priming Coat:

1. Allow scratch coat to set hard, but not dry, before application of brown coat. Maintain moisture by fogging with clean water as necessary.
2. The priming coat shall have maximum thickness of 5mm and shall be trowel, spread or machine sprayed, struck off level and left to cure for 24 hours.

C. Undercoat:

1. Plumb line for the second coat shall be established on wetted priming coat.
2. The undercoat shall have a maximum thickness of 12mm applied by trowel and left to cure.
3. Straighten and float gypsum plaster to an even plane to allow for finish coat of uniform thickness. Let second coat set hard. Make certain that brown coat is moist when applying final coat.
4. Straighten and float compo mortar and cement plaster to an even plane and cross scratch lightly to form key for finishing coat. Moisture cures for not less than 24 hours by fogging with clean water. Maintain moist curing until finishing coat is applied.

D. Finishing Coat:

1. Finishing coat shall be applied by trowel or machine sprayed, finished level and smooth to a maximum thickness of 3mm and left to cure.

E. Curing of Plaster:

1. The successive coats in turn shall be wetted and the priming coat left to cure for 24 hours, undercoat for 21 days and finishing coat for 25 days before further finish is applied. Where finishing coat is cement plaster, this coat shall be applied within 24 hours of the undercoat.

3.04 POINTING

A. General:

1. Surface to receive pointing shall be thoroughly cleaned and wetted before surface application.
2. Prior to application joints of stone, brick and concrete blocks shall be raked out to a minimum depth of 5mm. Raked out joints shall be flush or recess pointed with stuck weathered horizontal joints and square vertical joints.
3. Pointed surfaces shall be cement dusted or cement paste applied to form a final even and smooth surface, wetted for seven days and left to cure for 28 days.

3.04 CLEAN-UP

- A. Clean adjacent surfaces that have been soiled or defaced due to performing the work of this Section. Restore marred or damaged surfaces.

ANNEX- II Tile

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

- A. ES 13006: Ceramic Tiles – Definitions, Classification, Characteristics and Marking.
- B. ES 1822: Glass in Building – Special Basic Products 2. Glass Ceramics.
- C. ES 1536: Specification for Adhesives for Use with Ceramic Tiles and Mosaics.
- D. ES 2139: Adhesives for Tiles – Definitions and Specifications.
- E. ES 1659: Workmanship on Building Sites. Code of Practice for Wall and Floor Tiling. Ceramic Tiles, Terrazzo Tiles, and Mosaics.
- F. ES 1660: Workmanship on Building Sites. Code of Practice for Wall and Floor Tiling. Natural Stone Tiles.
- G. ES 3068: Wall and Floor Tiling – Part 1: Code of Practice for the Design and Installation of Internal Ceramic and Natural Stone Wall Tiling and Mosaics in Normal Conditions.
- H. ES 3069: Wall and Floor Tiling – Part 2: Code of Practice for the Design and Installation of External Ceramic Wall Tiling and Mosaics (Including Terra Cotta and Faience Tiles).
- I. ES 3070: Wall and Floor Tiling – Part 3: Code of Practice for the Design and Installation of Ceramic Floor Tiles and Mosaics (Formerly Part of CP 202).
- J. ES 3071: Wall and Floor Tiling – Part 4: Code of Practice for Tiling and Mosaics in Specific Conditions.
- K. ES ISO 10545-(1-16): Ceramic Tiles.
- L. ES 2386: Terrazzo Tiles – Part 1: Terrazzo Tiles for Internal Use.
- M. ES 2387: Terrazzo Tiles – Part 2: Terrazzo Tiles for external Use. N. ES 2408: Specification for Precast Terrazzo Units.
- O. ES 2410: Specification for Terrazzo Tiles.
- P. ES 2409: Specification for Concrete Flooring Tiles and Fittings.
- Q. ES 2284: Aggregates for Mortar.
- R. ES 2142: Building Lime-Conformity Evaluation.
- S. ES 2169: Specification for Low Heat Portland Cement.
- T. ES 2171: Specification for Sulfate - Resisting Portland Cement.
- U. ES 2179: Specification for Pozzolan Pulverized-fuel Ash Cement.

- V. ES 2174: Specification for Ready-Mixed Building Mortar.
- W. ES 1665: Workmanship on Building Sites, Code of Practice for Sealing Joints in Buildings using Sealants.
- X. BS 3260: Specification for Semi-Flexible PVC Floor Tiles.
- Y. BS 6100-1-3-3: Glossary of Building and Civil Engineering Terms: Floors and Ceilings.

1.03 DEFINITIONS

- A. The terms under this section shall comply with the definitions stated in BS 6100-1-3-3 and the following:
 - 1. Tile: Thin, flat or shaped component used to form a covering.
 - 2. Mosaic: Surface finish that consists of an arrangement of tesserae.
 - 3. Tesserae: Cubic, square or irregular unit, usually small and of marble, glass or ceramic, used as a surface finish.
 - 4. Terrazzo tile: Tile that consists of Portland cement and marble aggregate with a surface that is ground and polish.

1.04 SYSTEM DESCRIPTION

- A. This section specifies the installation of wall and floor for ceramic, terrazzo and natural stone tiles, and also specifies the installation of floor for concrete and PVC floor tiles and accessories.

1.05 SUBMITTALS

- A. Product Data: Catalog sheets, specifications, and installation instructions for each of the following:
 - 1. Tile and trim units.
 - 2. Setting materials.
 - 3. Grouting materials.
 - 4. Marble door thresholds.
- B. Samples:
 - 1. Tile and Grout: Each type and color required.
 - 2. Trim Units: Each type and shape required.
 - 3. Color Samples:
 - a. Tile manufacturer's standard range of colors and textures for each tile type required.

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- b. Grout manufacturer's standard range of colors for each grout type required.
 - 4. Marble thresholds.
 - 5. Metal edge strips.
- C. Shop Drawings:
 - 1. Layout of patterns shown on the Drawings or as directed by the Engineer.
 - 2. Edge strip locations showing types and detail cross sections.
- D. Quality Control Submittals:
 - 1. Tile Grade Certificates/test reports: Furnish tile manufacturer's product quality assurance certificate and/or test reports bearing the manufacturer's certification for each shipment, type and composition of tiles.
 - 2. Installers' Qualification Data:
 - a. Name of each person who will be performing the work and their telephone number.
 - b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.
- E. Contract Closeout Submittals:
 - 1. Maintenance Data: Tile and grout manufacturer's recommended cleaning and stain removal methods and materials.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Unless specified otherwise or received instruction from the Engineer, perform the followings;
 - 1. Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.
 - 2. Obtain ingredients of a uniform quality for each mortar, waterproof membrane, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- B. Certifications:
 - 1. Tile manufacturer's product quality assurance certification for each

shipment of tiles.

- C. Installers' Qualifications: The persons installing the work of this Section and their Supervisor shall be personally experienced in tiles installation and shall have been regularly employed by a Company installing tiles for a minimum of 5 years.
- D. Pre-installation Conference: Before the work of this Section is scheduled to begin, a conference will be called by the Engineer's Representative at the site for the purpose of reviewing the Drawing and the Specifications and discussing requirements for the Work. The conference shall be attended by the Contractor, the tiles installers, and if needed the tiles distributor.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.
- B. Materials from containers which have been distorted, damaged or opened prior to installation will be rejected.
- C. Store materials in weather-tight and dry storage facility.
- D. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

1.08 PROJECT CONDITIONS

- A. Environmental Requirements: Do not install tile until construction in spaces is completed. Set and grout tile when ambient temperature and humidity conditions are being maintained to the requirements of applicable Referenced Standards.
- B. All work to meet material manufacturer's recommendations.
- C. Do not install PVC tile flooring until building is permanently enclosed and wet construction in or near areas to receive tile materials is complete, dry and cured.
 - 1. Environmental Requirements:
 - a. Maintain temperature of materials a minimum of 22 °C (70 °F,) for 48 hours before installation.
 - b. Maintain temperature of rooms where work occurs between 21 °C and 27 °C (70 °F and 80 °F), for at least 48

hours, before, during and after installation

1.09 MAINTENANCE

- A. Extra Materials: Furnish extra tile, for the amount as specified in the Contract Documents, of each type, composition, pattern, size and color of tile required. Also furnish a proportionate number of trim units. Place extra materials packaged with protective covering in storage at the site where directed.

PART 2 PRODUCTS

2.01 TILES

- A. Mosaic:
 - 1. Comply with ES 3068 for internal wall tile.
 - 2. Comply with ES 3069 for external wall tile.
 - 3. Comply with ES 3070 for floor tile.
 - 4. Comply with ES 1659 for wall and floor tile (as alternative).
- B. Glazed ceramic tile:
 - 1. Comply with ES 1822.
- C. Ceramic tile: The classification and characteristics to which ceramic tiles conform shall comply with ES 13006 and the following Standard products characteristics unless specified otherwise in the Contract Documents:
 - 1. Sampling and basis for acceptance - ES ISO 10545-(1-16).
 - 2. Dimension and surface quality - ES ISO 10545-2.
 - 3. Water absorption, apparent porosity, apparent relative density and bulk density - ES ISO 10545-3.
 - 4. Modulus of rupture and breaking strength - ES ISO 10545-4.
 - 5. Impact resistance by measurement of coefficient of restitution - ES ISO 10545-5.
 - 6. Resistance to deep abrasion for unglazed tiles - ES ISO 10545-6.
 - 7. Resistance to deep abrasion for glazed tiles - ES ISO 10545-7.
 - 8. Linear thermal expansion - ES ISO 10545-8.
 - 9. Resistance to thermal shock - ES ISO 10545-9.
 - 10. Moisture expansion - ES ISO 10545-10.
 - 11. Glazing resistance for glazed tiles - ES ISO 10545-11.
 - 12. Frost resistance - ES ISO 10545-12.

13. Chemical resistance - ES ISO 10545-13.
 14. Resistance to stains - ES ISO 10545-14.
 15. Lead and cadmium given off by glazed tiles - ES ISO 10545-15.
 16. Small color difference - ES ISO 10545-16.
- D. Terrazzo tile:
1. Comply with ES 2410 for floor and wall tiles.
 2. Comply with ES 2408 for precast terrazzo units.
 3. Comply with ES 1659 for wall and floor tile (as alternative).
- E. Concrete flooring tiles and fittings:
1. Comply with ES 2409.
- F. Natural stone tiles: Comply with ES 1660.
1. Granite: Polished, eggshell, honed, fine rubbed, fine axed, dolly pointed, bush hammered, flame textured, air abrasive blasted or tooled.
 2. Marble: Travertine, & hard limestone: polished, eggshell, honed or gritted.
 3. Slate: Fine rubbed, sawn, riven, or flame textured.
 4. Quartzite: Riven.
 5. Limestone: Fine rubbed, sawn or tooled.
 6. Sandstone: Fine rubbed, sawn, tooled or riven.
- G. PVC tile:
1. Shall comply with the requirements of BS 3260.
 2. Tiles shall have a minimum thickness of 1.6mm for residential use, 2 mm for commercial use and 3mm for industrial use.
- H. Trim Units:
1. Furnish necessary trim shapes of same material, grade, type, and finish as indicated on the Drawing. Furnish trim for head, jambs and sills of openings, external and corners as per the Contract Documents Requirements.
- I. Colors: Tile colors shall be as indicated on the Drawings, or if not indicated, as selected by the Engineer from tile manufacturer's standard range of colors.

2.02 SETTING MATERIALS

- A. Portland Cement Mortar:
1. Portland Cement: Shall comply with one of the following as

appropriate:

- a. ES 2169 for low heat Portland cement.
 - b. ES 2171 for sulfate - resisting Portland cement.
 - c. ES 2179 for pozzolanic pulverized-fuel ash cement.
2. Sand: Comply with ES 2284.
 3. Hydrated Lime: Comply with ES 2142.
 4. Water: Clean and potable.
- B. Adhesive:
1. Comply with ES 1536 for ceramic and mosaic tiling.
 2. Comply with ES 2139 for natural stone, terrazzo, & concrete flooring tiling.
 3. Comply with the requirements of BS 3260 for PVC floor tiling.
- C. Primer: As recommended by the mortar/adhesive and tile manufacturer.
- D. Mortar mix: The mix, materials, proportion, method and application of mortar shall comply with the following standards.
1. Comply with ES 3068 for internal ceramic and natural stone wall tiling and mosaics in normal conditions.
 2. Comply with ES 3069 for external ceramic wall tiling and mosaics (including terra cotta and faience tiles).
 3. Comply with ES 3070 for ceramic floor tiling and mosaics.
 4. Comply with ES 3070 for ceramic wall and floor tiling and mosaics under specific conditions.
 5. Comply with ES 2409 for concrete flooring tiles.
 6. Thickness of mortar as specified in the Drawings.

2.03 GROUTING MATERIALS

- A. Sand for grouting: Sand for joints with respect to nominal widths shall comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
- B. Proprietary grouts: Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable for;
1. Mix based on cement and sand but modified by the inclusion of various additives.
 2. Mixed based on epoxide resin.

- C. Cement: sand mortar grouts: Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
- D. Admixtures to grouts:
 - 1. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
 - 2. Admixtures to grouts should be used strictly in accordance with manufacturer's instructions, and they should not be added to a proprietary grout unless approved by the manufacturer of the product.

2.04 ADHESIVE FOR PVC TILE

- A. Use adhesives, underlayment, primers and polish recommended by the floor resilient material manufacturer.

2.05 WATERPROOFING

- A. Waterproofing: As required by the Contract Documents or one of the following, in compliance with the flooring manufacturer's printed recommendations:
 - 1. Elastomeric rubber membrane, neoprene or urethane, one or 2 component liquid formulation.

2.05 MISCELLANEOUS MATERIALS

- A. Metal Edge Strips: As required by the Contract Documents or white zinc-alloy terrazzo strips, 0.32 cm wide at top edge with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.
- B. Expansion Joint Materials:
 - 1. Sealants:
 - a. Comply with the requirements stated in ES 1665 and
 - b. For materials used for movement joints comply, as an alternative, with the requirements for flexible material selection and properties stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
 - 2. Back-up Strip:
 - a. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

2.06 MARBLE DOOR THRESHOLDS

- A. Marble: As required by the Contract Documents.

- B. Fabricate thresholds to equal width of door jambs, with true planes, edges straight, and free of chipped or broken arises and corners.
 - 1. Raised Thresholds: Depth shall be as required to finish 1.3 cm above finished tile floor and have a minimum thickness of 2.5-0.65 cm, unless otherwise shown. Bevel exposed edge arises 0.65 by 0.65 cm.
 - 2. Flush Thresholds: 2 cm thick, unless otherwise shown.
 - 3. Finish: Honed finish on exposed faces and edges, unless otherwise shown.

2.07 SOLID PLASTIC THRESHOLDS

- A. Solid Plastic Thresholds: Fabricated of a synthetic, homogeneous, monolithic material.
 - 1. Fabricate to profile shown with eased edges and sanded smooth.
 - 2. Fabricate thresholds to equal door jamb opening and equal width of door jamb, unless otherwise shown.
 - 3. Raised Thresholds: Depth and profile shall be as shown on drawings.
 - 4. The manufacturer's recommended epoxy type adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide concrete substrates comply with flatness tolerances specified in ES 3068, ES3069, ES 3070 or ES 3071 as applicable.
- B. Protection: Protect adjacent surfaces before tile-work begins.
- C. Cleaning: Clean substrate surfaces in accordance with applicable reference standards and manufacturer's installation instructions.
- D. Prior to placing mortar bed, cement slurry bonding coat shall be applied to the subsurface. The mortar setting coat shall be immediately applied to the surface
- E. Prior to placing tile, glue shall be spread onto surface using trowel to a depth

not exceeding 3mm thick. Comb the adhesive with notched edge of the trowel ensuring that continuous horizontal ribs of adhesive are formed.

3.03 SUBFLOOR PREPARATION FOR PVC FLOOR TILING

- A. Shall comply with the requirements of BS 3260.
- B. Fill cracks, joints and other irregularities in concrete with leveling compound:
 - 1. Do not use adhesive for filling or leveling purposes.
 - 2. Do not use leveling compound to correct imperfections which can be corrected by spot grinding.
 - 3. Trowel to smooth surface free of trowel marks, pits, dents, protrusions, cracks or joints.
- C. Clean floor of oil, paint, dust, and deleterious substances: Leave floor dry and cured free of residue from existing curing or cleaning agents.
- D. Preparation of existing installation shall include the removal of existing resilient floor and existing adhesive. Do not use solvents to remove adhesives.

3.04 INSTALLATION

- A. Install wall and floor tiles in accordance with the printed installation instructions of the tile and setting material manufacturers and the followings;
 - 1. ES 3068 for internal ceramic and natural stone wall tiling and mosaics in normal conditions.
 - 2. ES 3069 for external ceramic wall tiling and mosaics (including terra cotta and faience tiles).
 - 3. ES 3070 for ceramic floor tiles and mosaics.
 - 4. ES 3071 for the installation of ceramic wall and floor tiling and mosaics in situations where there are specific functional or environmental requirements and/or conditions that are potentially detrimental to the installation or the background or both.
 - 5. Comply with the requirements of BS 3260 for PVC tile flooring.
 - 6. Neutralize and seal substrate as required by the mortar/adhesive manufacturer's instructions.
 - 7. Mix and apply proprietary setting and grouting materials in compliance with the manufacturer's instructions.
 - 8. Tiles (other than PVC) shall be thoroughly soaked in water for a

minimum of 15 minutes before laying/fixing and shall be taken out before use.

- B. Joint Pattern: Install tile in grid pattern with joint width in accordance with ES 3068, ES3069, ES 3070 or ES 3071 as applicable, unless otherwise indicated.
- C. Layout tile-work on principal walls, with tile-work field centered in both directions on the floor and lengthwise on walls in each space, so that no tile less than one-half full size will occur, unless otherwise approved to suit the features of the space. Align joints when adjoining tiles are the same size. Maintain uniform joint width.
- D. Extend tile-work into recesses and under equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate tile-work neatly at obstructions, edges, and corners without disruption of pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. PVC tile Layout: Unless specified otherwise, comply with the requirements of BS 3260 and the following.
 - 1. If layout is not shown on drawings, lay tile symmetrically about center of room or space with joints aligned.
 - 2. No tile shall be less than 150 mm (6 inches) & of equal width at walls.
 - 3. Place tile pattern in the same direction; do not alternate tiles.
- G. Expansion and Control Joints: Comply with preparation, joint depths and widths, and installation in accordance with ES 3068, ES 3069, ES 3070 or ES 3071 as applicable. Keep expansion and control joints free of setting and grouting materials. Do not saw-cut joints after installing tiles.
 - 1. Install continuous expansion joint at perimeter of floor/wall juncture.
 - 2. Install sealants in accordance with manufacturer's printed instructions.
- H. Edge Strips: Install metal edge strips at edge of tile meeting other types of flooring, unless otherwise indicated.
- I. Edge Strips for PVC floor tiling:
 - 1. Locate edge strips under center line of doors unless otherwise shown.
 - 2. Set PVC tile edge strips in adhesive. Anchor metal edge strips with anchors and screws specified.
 - 3. Where tile edge is exposed, butt edge strip to touch along tile edge.
 - 4. Where thin set ceramic tile abuts PVC tile, set edge strip against floor

tile and against the ceramic tile edge.

- J. Grouting: Comply with ES 3068, ES 3069, ES 3070 or ES 3071, as applicable for type of grout and grouting procedure, and manufacturer's installation instructions. Make joints watertight, and without voids, cracks and excess grout. Damp cure in accordance with reference standards and manufacturer's instructions when applicable.
- K. Solid Plastic Thresholds: Set the thresholds in a full bed of adhesive as recommended by the Threshold manufacturer.
- L. Install waterproofing to comply with waterproofing manufacturer's written instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate.
 - 1. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.
- M. Marble Door Thresholds: Set marble thresholds in a full bed of the same type of setting material specified for adjoining tile-work, unless otherwise indicated.
 - 1. Wood Subfloors: Set marble thresholds in a full bed of epoxy mortar.

3.05 FIELD QUALITY CONTROL

- A. Tests: Perform electrical performance testing of the conductive tile floors as required by the Engineer's Representative after installation in accordance applicable Referenced Standards.

3.06 CLEANING AND MAINTENANCE

- A. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
- B. PVC tile flooring:
 - 1. Comply with the requirements of BS 3260.
 - 2. Clean adhesive marks on exposed surfaces during the application of resilient materials before the adhesive sets. Exposed adhesive is not acceptable.
 - 3. When protective materials are removed and immediately prior to acceptance, replace any damage tile, re-clean resilient materials, lightly re-apply polish and buff floors.
- C. Check the tile-work installation. Remove defective tile and retile. Leave finished installation free of cracked, chipped, broken, un-bonded, and otherwise defective tile- work.

- D. On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter. Comply with grouting specifications and with grout manufacturer's printed instructions for materials and method.
 - 1. Remove latex-Portland cement grout residue from tile as soon as possible.
 - 2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

3.07 PROTECTION

- A. Apply heavy Kraft paper, or other approved heavy protective covering, masked in place over tile-work to prevent staining, damage, and wear.
- B. Prohibit foot and wheel traffic on newly tiled areas for seven days after completion of installation unless otherwise approved by the Engineer's Representative.
- C. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.
- D. PVC tile flooring protection:
 - 1. Comply with the requirements of BS 3260.
 - 2. When construction traffic occurs over tile, cover PVC materials with reinforced Kraft paper properly secured and maintained until removal is directed by Resident Engineer. At entrances and where wheeled vehicles or carts are used, cover tile with plywood, hardboard, or particle board over paper, secured and maintained until removal is directed by Resident Engineer.

ANNEX- III Check List For Work Permit

Project: _____

Employer: _____ Block/Bill: _____

Contractor: _____ Axes: _____

Consultant: _____ Floor: _____

Location: _____

Document Referred: _____

Plastering work inspection

Make a (✓)

	C	NC	NA
▪ Qualification of plasterer	☐	☐	☐
▪ Location of item wall/ceiling/parapets	☐	☐	☐
▪ Plumb state of erected wall	☐	☐	☐
▪ Wall material to be plastered	☐	☐	☐
▪ Chiseling state of concrete surface	☐	☐	☐
▪ Testing of pipes before plastering	☐	☐	☐
▪ Condition of surface to be plastered	☐	☐	☐
▪ Clearing of excess mortar of masonry joints/Recess provision	☐	☐	☐
▪ Type of plaster mortar /mix proportion for various coats	☐	☐	☐
▪ Watering of surface before plaster	☐	☐	☐
▪ Quality of fine aggregate, water, lime etc..	☐	☐	☐
▪ Method of mixing of mortar;	☐	☐	☐
▪ Nature of labour tools; (Trowel, ramming pan, Straight edges etc.)	☐	☐	☐
▪ Max. allowable thickness of coats of plaster (1 st coat, 2 nd coat, 3 rd coat)	☐	☐	☐
▪ Duration between 1 st and 2 nd coat	☐	☐	☐
▪ Minimum days gap between date of second coat and last coat	☐	☐	☐
▪ Curing state of plaster	☐	☐	☐
▪ Method of spray of curing water	☐	☐	☐
▪ Plumbing state of plaster	☐	☐	☐
▪ Perfection of designed angle at junction points	☐	☐	☐
▪ Linearity of plastered wall	☐	☐	☐
▪ Allowable duration time of mortar between mixing and placing	☐	☐	☐

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▪ Joining nature of wall to framing/Recessing	☐	☐	☐
▪ Smooth nature of last coated surface	☐	☐	☐

Additional Remarks _____

For the above items are *fulfilled* ☐ /not *fulfilled* ☐, the Contractor is hereby allowed ☐/refused to ☐ proceed Plastering work. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant: -

Name _____

Signature _____

Date _____

For the Contractor:-

Name _____

Signature _____

Date: _____

C=conformed

NC= not conformed

NA= not applicable

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

CHECK LIST FOR WORK PERMIT

Project: _____

Employer: _____ Block/Bill: _____

Contractor: _____ Axes: _____

Consultant: _____ Floor: _____

Location: _____

Document Referred: _____

Cement Screed flooring Inspection Work

Make a (✓)

C NC NA

Qualification of mason

- Completion of preceding works/Ceiling/Plastering
- Leveling state of floor to be screed
- Adopted method of leveling course
- Surface nature of floor chiseled/Washed
- Mix proportion of screed material
- Presence of colors pigments in mix
- Quality of fine aggregate, water etc..
- Method of mixing of mortar
- Nature of labour tools (Mason tools)
- Thickness of designed screed
- Precision on the level surface to be screed
- Smooth nature of finished level
- Curing period of screed surface
- Checking of F.F.L form nearby rooms
- Protection measure of finished surface form damage
- Provision of expansion joint

☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐
☐	☐	☐

Additional Remarks: _____ For the

above items are *fulfilled* ☐ *not fulfilled*, ☐ Contractor is hereby allowed ☐ refused ☐ proceed
Floor screed works. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant: -

For the Contractor:-

Name _____

Name _____

Signature _____

Signature _____

Date _____

Date: _____

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

Solid Floor tile coverage Terrazzo ☐ Granillia ☐ Cemen ☐ Other

Inspection works

Make a (✓)

C NC NA

▪ Qualification of tile layer	☐	☐	☐
▪ Testing of material	☐	☐	☐
▪ Material approval slip number and sample	☐	☐	☐
▪ Nature of tile material ceramic /Terrazzo etc..	☐	☐	☐
▪ Colour of selected tile	☐	☐	☐
▪ Size of tile material (Length, width, thickness)	☐	☐	☐
▪ Comparison of site deliveries with sample	☐	☐	☐
▪ Selection of equal sizes/colour for placing	☐	☐	☐
▪ Leveling condition of floor to be covered	☐	☐	☐
▪ Designed pattern of tile placing	☐	☐	☐
▪ Nature of binder (mortar) /Mix ratio	☐	☐	☐
▪ Quality of water, fine aggregate etc..	☐	☐	☐
▪ Method of mixing of mortar	☐	☐	☐
▪ Adopted leveling course material for level correction	☐	☐	☐
▪ Surface condition of floor to be covered (Well chiseled, washed etc...)	☐	☐	☐
▪ Presence of spacer	☐	☐	☐
▪ Immersion of tile in water before placing	☐	☐	☐
▪ Cutting method of tiles	☐	☐	☐
▪ Nature of tools	☐	☐	☐
▪ Slope condition wrt floor drains	☐	☐	☐
▪ Tile nature at outlets of floor embedded elements	☐	☐	☐
▪ Checking uniform spread of underneath paste/thickness	☐	☐	☐
▪ Curing period of placed tile	☐	☐	☐
▪ Level state of placed tile	☐	☐	☐
▪ Grouting material type ,colour and application/colour	☐	☐	☐

Additional Remarks: _____ For the above items are *fulfilled* /not *fulfilled* ,the Contractor ☐ is hereby allo~~ed~~ /refused to proceed Floor ☐ screed works. The take-o~~ff~~ sheet of this activity shall immediately be signed upon completion

For the Consultant

For the Contractor

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

Plastic/PVC tile flooring work Inspection

	Make a (✓)		
	C	NC	NA
▪ Qualification of tiller	☐	☐	☐
▪ Readiness of floor W.R.T other works	☐	☐	☐
▪ Material approval slip and sample	☐	☐	☐
▪ Submittal of tiling module	☐	☐	☐
▪ Colour of selected material	☐	☐	☐
▪ Size of plastic tile (Length, width, thickness)	☐	☐	☐
▪ Checking physical properties of sample with site deliveries;			
a) Product data of sample with deliveries	☐	☐	☐
b) Flexibility of tile	☐	☐	☐
c) Nature of underneath fiber of tile	☐	☐	☐
d) Smooth/plane nature of surface	☐	☐	☐
e) Nature of adhesive (approved with new deliveries)	☐	☐	☐
▪ Nature of screed to be tiled, (Clean, washed, dried etc..)	☐	☐	☐
▪ Leveling state of screed	☐	☐	☐
▪ Rectification method of defective screed	☐	☐	☐
▪ Duration from cast of screed to tile placing	☐	☐	☐
▪ Adhesive application rate per unit area	☐	☐	☐
▪ Presence of tile spacer	☐	☐	☐
▪ Cutting method of tile for wall side position	☐	☐	☐
▪ Method of stabilization of tiled surface (Rolling, consolidation)	☐	☐	☐
▪ Protection measure for unnecessary surface spread of adhesive	☐	☐	☐
▪ Cleaning state of finished surface	☐	☐	☐

Additional Remarks: _____

_____ For the above items ☐ are fulfilled / ☐ not fulfilled, the Contractor is hereby allowed ☐ /refused ☐ to proceed Floor screed works. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant: -

Name _____

Signature _____

Date _____

For the Contractor:-

Name _____

Signature _____

Date: _____

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

Marble flooring Work Inspection (112)

	Make a (✓)		
	C	NC	
NA	☐	☐	☐
▪ Qualification of tiler	☐	☐	☐
▪ Designed pattern	☐	☐	☐
▪ Checking of specified rooms with quantity	☐	☐	☐
▪ Material approval slip number and sample	☐	☐	☐
▪ Type of marble (Wellega Gojam, Harar etc.)	☐	☐	☐
▪ Size of marble checking			
a. Length	☐	☐	☐
b. Breadth	☐	☐	☐
c. Thickness	☐	☐	☐
▪ Eadge condition of delivered piees	☐	☐	☐
▪ Surface nature of delivered pieces (free from cracks, holes perforations)	☐	☐	☐
▪ Condition of floor to be covered			
a. Adopted levelling course correction	☐	☐	☐
b. State of chiselling of surface	☐	☐	☐
c. Washed and free from dust grits etc	☐	☐	☐
d. Checking application of designed mortar thickness	☐	☐	☐
▪ Type of mortar and mix ratio for laying	☐	☐	☐
▪ Grouting type (material)	☐	☐	☐
▪ Quality of fine aggregate, water etc..	☐	☐	☐
▪ Method of mixing of mortar	☐	☐	☐
▪ Mortar volume needed for immediate use	☐	☐	☐
▪ Method of cutting of pieces induce of necessities	☐	☐	☐
▪ Spacer type and size to be adopted	☐	☐	☐
▪ Checking uniform spread of mortar under elements	☐	☐	☐
▪ Condition of labour tools for fixing	☐	☐	☐
▪ Shapes to made at vertical obstructions	☐	☐	☐

Additional Remarks: _____

For the above items are *fulfilled* ☐ /not *fulfilled* ☐, the Contractor is hereby allowed ☐ /refused ☐ to proceed Floor screed works. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant: -

For the Contractor:-

Name _____

Name _____

Signature _____

Signature _____

Date _____

Date: _____

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

Wall tile coverage inspection work

Make a (√)

	C	NC	NA
▪ Qualification of tiler	☐	☐	☐
▪ Location of item internal /External wall	☐	☐	☐
▪ Transverse/water absorption test	☐	☐	☐
▪ Type of tile material ceramic/ precast element etc.	☐	☐	☐
▪ Design of patterns	☐	☐	☐
▪ Material approval slip and sample	☐	☐	☐
▪ Color of selected tile	☐	☐	☐
▪ Checking of approved sample with site delivers	☐	☐	☐
▪ Size of tile and deviation one to the other	☐	☐	☐
▪ Thickness of tile	☐	☐	☐
▪ Selection of equal sizes for placing	☐	☐	☐
▪ Checking of surface nature to be covered	☐	☐	☐
▪ Maximum projection of tile from wall surface	☐	☐	☐
▪ Immersion of tiles in water before fixing	☐	☐	☐
▪ Checking of plumbing, corner angle etc. before placing	☐	☐	☐
▪ Mix proportion of tile paste	☐	☐	☐
▪ Quality of adhesive	☐	☐	☐
▪ Availability of tile spacer	☐	☐	☐
▪ Cleaning and wetting of surfaces	☐	☐	☐
▪ Nature of tools	☐	☐	☐
▪ Cutting provision of uniform paste backings	☐	☐	☐
▪ Curing period of tiles surface	☐	☐	☐
▪ Application time of white cement/quantity/Unit weights	☐	☐	☐
▪ Protection measure of unnecessary spread of pasted/cement on Surfaces/adhesive	☐	☐	☐
▪ Plumbing/levelling/Linearity of wall surface	☐	☐	☐
▪ Tile condition at outlets of embedded element	☐	☐	☐
▪ Pressure test for embedded pipes	☐	☐	☐

Additional Remarks: _____

For the above items are *fulfilled* ☐ /not *fulfilled* ☐, the Contractor is hereby allowed ☐ /refused ☐ to proceed Floor screed works. The take-off sheet of this activity shall immediately be signed upon completion.

For the Consultant

For the Contractor

ANNEX- IV Material Approval Form

Material Approval Form

A) Project Information

I) Project Name: _____

II) Project Title: _____

III) Client: _____

IV) Contractor: _____

V) Location: _____

Contractor's approval request letter Ref. No. _____ Date _____

B) Submitted Samples (by the Contractor)

Ser. No.	Samples Submitted for approval	Contractor Name, Signature & Date	ECDSWC, BUDSWS Name, Signature & Date

C) Inspection (by the Consultant)

Ser. No.	Samples Submitted for approval	Approved Signature & Date	Rejected Signature & Date	Contractor Signature & Date

D) Comments and

Suggestions _____

E) Material Inspector: -

Architectural Design Team Leader: Name _____ Sig. _____ Date _____

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

Sample Receiving and Submission for

A) Project Information

I) Project Name: - _____

II) Project

Title: _____

III) Client: _____

IV) Contractor: _____

V) Location: - _____

❖ Contractor letter Ref. No. _____ Date _____

B) Sample to be Approved

AR ☐ SN ☐ EL ☐ ME ☐

C) Brief Description of the Samples submitted for approval (To be filled by the Contractor)

D) Required documents as per to the contract document

I) Product Certificates.....Yes ☐No ☐

II) Test Reports..... Yes ☐ No ☐

III) Catalogues & Guarantees.....Yes ☐ No ☐

IV) Shop drawings.....Yes ☐ No ☐

V) Contract document, drawings & othersYes ☐No ☐

❖ Submitted by (Contractor) _____ Date _____

E) Sample submitted for approval (To be filled by the Consultant) is:-

I) As per the contract document _____

II) As per the drawing _____

F) Remark _____

F) Sample submitted for approval: -

Checked by (Quality control) expert):

_____ Date _____

C.C

▪ Central Archive

Note: - Rejected samples should be collected within 5 days. The company is not responsible for lost items.

ANNEX- V Sample of floor and wall materials for approval

Sample of floor and wall materials for approval



Sample of granite tile for approval



Sample of granite tile for approval



Sample of ceramic tile for approval



Sample of porcelain tile for approval



Sample of granite tile for approval



Sample of porcelain tile for approval



Sample of terrazzo tile for approval

Figure 11 *Picture of samples submitted for approval*

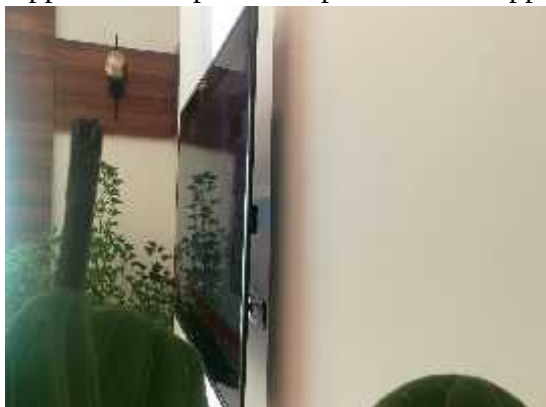
ANNEXVI. Approved Sample of floor and wall finishing



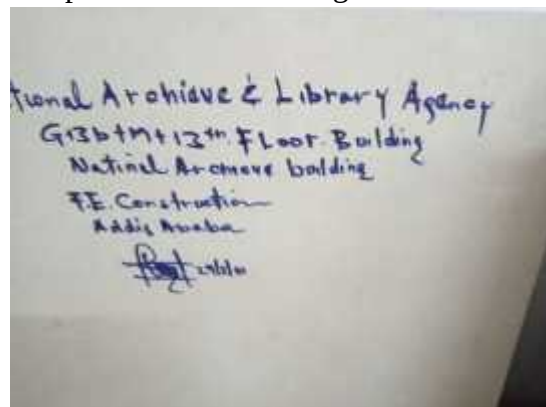
Approved sample of Carpet



Approved sample of Granite skirting



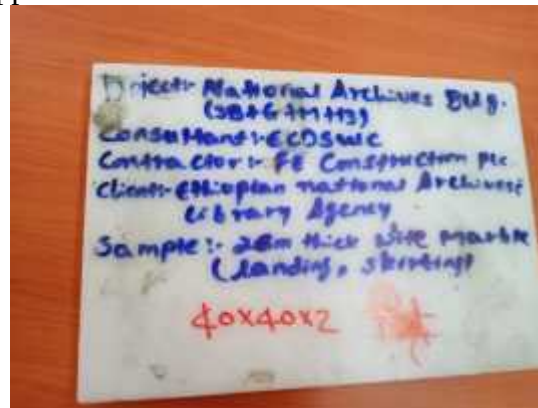
Approved sample of Wooden wall cladding



Approved Porcelain

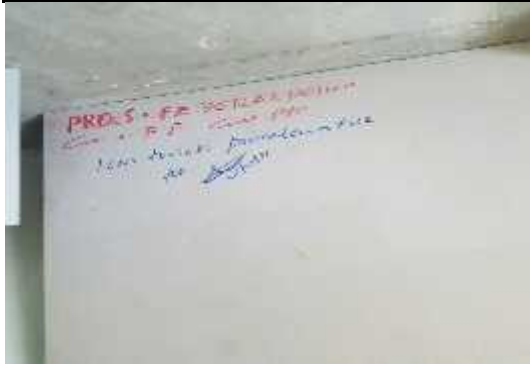


Approved Terrazzo tile



Approved sample of white marble

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa



Approved sample of Porcelain



Approved sample of ceramic tile



Approved sample of Porcelain



Approved sample of Granite tile



Approved sample Ceramic of Skirting



Figure 12 *Picture of approved samples*

ANNEXVII Interview Questions

The interview is mainly to identify:

- 1) whether the organization has responsible department for quality control and quality assurance or not.
- 2) whether they have good quality control system or not.
- 3) whether the concerned party submit work methodology before starting work execution for each items or not.
- 4) whether the concerned party submit work permit requisition and expect confirmation to proceed the work or not.
- 5) When the concerned body gives inspection certificate?
- 6) Whether the general condition and technical specification enforce the quality control and quality assurance to be achieved properly or not.
- 7) Whether the specification on the contract gives clear description or not.
- 8) Whether the Resident Engineer control the quality of work properly as per the specification and drawing or not.
- 9) Whether the concerned professionals approved materials as per certification and quality assurance maintained properly or not.
- 10) Whether the organization assigned the required qualified professionals and skilled labors at construction site or not.
- 11) Whether the assigned professional do their job ethically or not.
- 12) Whether they satisfied with their quality control quality assurance system or not.
- 13) Whether their employee trained related to quality control and quality assurance in floor and wall finishing works.
- 14) Whether they have standard specification and check list for controlling the quality of finishing works.

Quality Control & Quality Assurance Practices in Selected Finishing works: The case of Public Building Projects in Addis Ababa

15) Which part of works on building construction most of time quality problem occurred in sequential?

16) The causes of less quality?

17) The frequency and the time of the concerned bodies cross check whether the executed work in accordance with the approved and accepted materials or not.

18) What measure they take when unaccepted material delivered on site and changed to construction.

19) Whether the concerned stockholders work jointly to obtained the required quality work or not.

20) The trend of supervision and implementation of quality control and quality assurance in their organization.

ANNEXVIII Sample of product certificate used for quality assurance