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Estimation, costing and evaluation of construction works

By

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PREFACE

This book has been written for a course in Estimating and costing of construction works, primarily targeted at students pursuing civil engineering or public works programs. It is also intended for individuals who are studying construction-related disciplines and need to gain a solid understanding of estimating and costing practices in the construction industry.

The book has grown out of the lecture notes for the course “Measurements and estimation of cost” taught for the 3rd year undergraduate students in the Department of Civil Engineering at Ibn khaldoun university.

The book assumes that readers have a basic foundation in estimating construction projects. It is designed to provide a comprehensive understanding of the estimating and costing processes in construction, equipping students with the knowledge and skills needed for a career in the field.

This book can serve as valuable reference material for professionals working in the construction industry, including civil engineers, contractors, and project managers.

Acknowledgement

I would like to express my special thanks of gratitude to Mr. Tamerdjent Mohamed, architect and manager of the real estate development company "Lakermi Khadidja" for providing data of a construction project for the Estimating and evaluation application which is presented in the last part of this document.

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General Introduction

Building construction estimating is a crucial process in the construction industry that involves determining the probable construction costs for a given construction project before the actual construction begins. This process is essential for various stakeholders, including owners, contractors, and project managers, as it helps in budgeting, securing financing, and making informed decisions throughout the project's lifecycle.

In the design-bid-build (DBB) delivery system, the competitive cost estimate often referred to as a bid or tender, is a crucial step in the procurement process for construction projects. Contractors participating in the DBB delivery system aim to submit the lowest-qualified bid to win construction contracts while maintaining a reasonable profit margin. This competitive process requires careful cost estimation, risk assessment, and the ability to deliver on the project's requirements. Successful contractors effectively balance competitiveness with profitability to remain viable in the construction industry. The ability of the estimator to visualize and understand all the different phases of a construction project is indeed a prime ingredient in successful bidding. It allows estimators to dissect complex plans, anticipate challenges, and provide accurate cost estimates. Successful bidding relies on this visualization capability, as it enables contractors to compete effectively and deliver on their promises during construction.

The working drawings and project manual together provide a comprehensive set of instructions and specifications for the construction project. Contractors and estimators rely on both components to develop accurate cost estimates, understand project requirements, and bid competitively. The combination of visual information in the drawings and detailed written information in the manual ensures that all aspects of the project are adequately addressed during the bidding and construction processes. The working drawings and the project manual are core components of the contract documents in construction projects. Contractors, estimators, and project teams must carefully examine and integrate the information from both sources to prepare accurate bids, meet contractual obligations, and successfully execute the project while adhering to the defined scope of work. The estimator's role is central to the accuracy and completeness of the bid submission. Thoroughly reviewing the drawings and the project manual, performing accurate quantity takeoffs, and documenting all aspects of the estimate are essential steps to ensure a competitive and reliable bid that aligns with the project's scope of work and contractual requirements. Checking the completeness of the plans and the project manual is an essential first step in the estimation process, and it sets the foundation for accurate and successful cost estimation and project management. Then the estimator can begin the quantification process of all the materials presented. Every item included in the estimate must contain as much information as possible. The quantities determined during the estimation process serve as the basis for ordering and purchasing the materials required for a construction project. The estimated quantities and their associated projected costs serve as the foundation for project controls in the field during the construction phase. Project controls are essential for monitoring and managing a construction project to ensure it stays on track, adheres to the budget, and meets its objectives.

Estimating the ultimate cost of a construction project is indeed a complex process that involves the integration of various variables. These variables can be broadly categorized into two main groups: direct field costs and indirect field costs. Construction estimating is a multifaceted process that requires a combination of skills, data, and judgment. Estimators play a critical role in helping project stakeholders make informed decisions about project feasibility, budgeting, and planning.

The preparation of detailed estimate consists of working out quantities of various items of work and then determines the cost of each item. This is prepared in two stages:

- Details of measurements and calculation of quantities;
- Abstract of Estimated Cost.

This handout is divided into three parts; the first one is focused on the estimation of the construction works while the second one is dedicated to the evaluation of the cost of the work. The third part is focused on the implementation phase, i.e studying a construction project.

PART I

Estimation of construction works

I.1. General:

Estimating, in the context of construction and project management, is the technique of calculating or computing various quantities and the expected expenditure to be incurred on a particular work or project. The art of "metering" or "estimating" has always been inseparable from the "act of building". Indeed, there is no work that has not been built without attention to its quality, quantities and costs of the various works to be carried out. The process of measurement in construction indeed involves both qualitative and quantitative analysis of all the work required for project realization, with the ultimate goal of determining the price or cost. It is important to note that the "measurement" is directly related to the different technologies, since it relies on an in-depth knowledge of the materials, their implementation, as well as the way the work is conducted.

These studies require various qualities:

- Scientists, for basic mathematical knowledge of quantity calculations and price study.

- Techniques, through knowledge of materials and materials and their conditions of use and implementation.

- Practices, by the qualities of observation and deduction necessary for the choice of quantities.

I.2.The measurement:

There are two types of measurement:

- The preliminary - measurement: for work quantified on plans;

- The measurement: for work quantified from the statements of existing works

The preliminary - measurement, as the measurement have for object the detailed calculation of the various quantities of elementary works.

The preliminary - measurement must follow the chronological order of the work, unless otherwise justified by practical considerations in order to avoid oversights or to facilitate locating. It must follow a logical order (example: Front East then South, then West, then North), and always resume the same order throughout the study.

I.3.The estimator:

Being a successful estimator in the construction industry requires a combination of skills, knowledge, and attributes beyond simply reading through plans and documents.

A list of abilities most important to the success of an estimator is comprehensive and provides a clear understanding of the essential skills and knowledge required for this role in the construction industry. Each of these abilities contributes significantly to the accuracy and effectiveness of the estimating process and the overall success of construction projects. Here's a brief recap of the key abilities:

- Plan Reading and Quantification: The ability to read and quantify plans and construction documents accurately is fundamental to estimating.
- Mathematical and Geometric Understanding: Proficiency in mathematics and geometry is crucial for performing calculations and measurements.
- Attention to Detail: Patience and a commitment to careful, thorough work ensure that no crucial details are overlooked during the estimation process.
- Computer Literacy: Familiarity with computer takeoff programs and estimating software enhances efficiency and accuracy in cost calculations.
- Visualization: The capability to visualize the project through various construction phases based on drawings is essential for accurate estimations.
- Construction Experience: Knowledge of construction methods, job conditions, material handling, and labor productivity comes from hands-on experience and aids in accurate estimations.
- Understanding of Labor Operations: Knowing how to convert labor operations and productivity into project costs based on conditions and crafts is crucial.
- Cost Database Management: Keeping a database of cost information for labor, materials, project overhead, and equipment, as well as knowledge of item availability, facilitates accurate estimating.
- Computer Skills: Proficiency in using databases, spreadsheet programs, and other estimating software tools is essential for modern estimators.
- Deadline Management: The ability to meet bid deadlines while remaining calm under pressure is crucial, given the competitive nature of the construction bidding process.
- Communication Skills: Effective communication, both in writing and presentation, is vital for conveying bid details, services offered, and project plans to clients, as well as coordinating with project superintendents.

These abilities collectively empower estimators to produce accurate, competitive, and well-communicated estimates that contribute to the success of construction projects and the growth of construction firms. Estimators play a pivotal role in shaping the initial stages of a construction project and influencing its outcomes.

I.4.Units of measurements:

Units of measurement are indeed categorized based on various factors, including their nature, shape, size, and purpose. The principle of units of measurements normally consists the following:

1- Single Units: These are discrete items like sanitary fittings, electrical points, and electrical appliances. They are usually counted and expressed in numbers. For example, you might specify "10 electrical outlets" or "3 ceiling fans."

2- Linear Measurements (Running Meters - RM): Linear measurements involve lengths of components like cornice, fencing, handrails, pipes, bands of specified width, and skirting. These are expressed in running meters (RM), which represent the total length in meters required for these components.

3- Area Measurements (Square Meters - m^2): Area measurements are used for surfaces like plastering, white washing, partitions, glass of specified thickness, flooring up to 40mm in thickness, tiles flooring, wall tile finishing, painting of doors and windows, roofing with specified materials, and various wall works. These are expressed in square meters (m^2), representing the total surface area to be covered.

4- Cubical Contents (Cubic Meters - m^3): Cubical contents measurements involve the volume of materials, such as earthwork, earth fill, cement concrete, masonry, etc. These are expressed in cubic meters (m3), indicating the total volume of material required.

5- Mass measurement (Steel for RCC Works): The quantity of steel used in reinforced concrete (RCC) works is typically expressed in kilograms (kg) or tons. These units reflect the weight of the steel components.

6- For labor or workforce: The unit of measurement for labor force hours is typically expressed as "person-hours" or "man-hours." These units represent the amount of work completed by one person in the span of one hour.

The table 1 resumes the unit measurements and their precisions.

Using these standardized units of measurement ensures that contractors and project stakeholders are on the same page when it comes to understanding the scope of work, estimating costs, and making payments. It helps prevent misunderstandings and disputes and promotes transparency in construction and contracting projects.

Table 1: Unit measurements and their precisions

No	Measurement	Unit	Symbol	Precision (number of digits after the decimal point)
1	Single unit	unit	U	/
2	Linear meter	Meter	M	Two digits after the decimal point
3	Area	Square meter	M^2	Two digits after the decimal point
4	Volume	Cubic meter	M^3	Three digits after the decimal point
5	Mass	Kilogram	Kg	Three digits after the decimal point
6	Labor	Hour	H	Two digits after the decimal point

I.5. Requirements to prepare and estimate

Preparing and estimating for a construction project involves several key requirements to ensure that the project is well-planned, cost-effective, and successfully executed. Here are the essential requirements:

- Project Scope: Clearly define the project scope, including the type of construction, purpose, size, and specific requirements. A detailed scope document serves as the foundation for all estimates and planning.
- Project Drawings and Plans: Obtain detailed architectural and engineering drawings, including floor plans, elevations, and structural plans. These are essential for understanding the project's design and dimensions.
- Bill of Quantities (BOQ): Develop a comprehensive BOQ that lists all the materials, labor, and equipment needed for the project. The BOQ serves as a basis for estimating costs.
- Cost Estimating Software: Utilize specialized cost estimating software or tools to perform accurate cost estimations. These tools help in calculating material quantities, labor hours, and associated costs.
- Market Research: Stay updated with current market prices for construction materials, labor rates, and equipment rentals. This information is crucial for accurate cost estimations.
- Labor and Productivity Rates: Establish labor productivity rates based on historical data or industry standards. This helps in estimating labor costs effectively.

- Material Specifications: Clearly define material specifications, quality standards, and quantities required. This information is critical for estimating material costs accurately.
- Subcontractor Quotes: Obtain quotes from subcontractors for specialized work such as electrical, plumbing, or HVAC installations. These quotes contribute to estimating subcontractor costs.
- Permits and Regulations: Understand and comply with local building codes, permits, and regulations. Factor in any associated costs and timelines.
- Contingency: Include a contingency allowance in your estimate to account for unexpected costs or changes in the project scope. Typically, a percentage of the total project cost is allocated for this purpose.
- Project Schedule: Develop a project schedule that outlines the sequence of activities, milestones, and timelines. This helps in estimating labor costs and project duration.
- Risk Assessment: Identify potential risks and uncertainties that may impact the project's cost and schedule. Develop a risk management plan to mitigate these risks.
- Profit Margin: Determine the desired profit margin for the project. This should be based on industry standards and the company's financial goals.
- Bidding Documents: Prepare comprehensive bidding documents, including the scope of work, project specifications, terms, and conditions. These documents are used when soliciting bids from subcontractors and suppliers.
- Quality Control Plan: Develop a quality control plan that outlines how the project's quality will be monitored and maintained, including inspections and testing procedures.
- Communication Plan: Establish effective communication channels with all project stakeholders, including the client, subcontractors, and project team members.
- Legal and Contractual Aspects: Ensure that all legal and contractual aspects, such as contracts, insurance, and payment terms, are properly documented and understood.
- Environmental Considerations: Address environmental impact assessments and any necessary mitigation measures.

- Safety Plan: Develop a comprehensive safety plan to ensure the well-being of workers and compliance with safety regulations.

- Financial Planning: Prepare a detailed financial plan, including budgeting and cash flow projections, to manage project finances effectively.

By fulfilling these requirements, you can create a robust foundation for estimating and managing a construction project effectively, minimizing risks, and delivering a successful outcome.

As a first step, the following documents should be used:

- Drawings i.e. plans, elevations, sections etc. with complete measurements (detailed Specifications).

- The specific technical clauses and the Special Prescriptions Book.

In other words, we have to answer the following questions:

-In what? ⇒ Materials, components

- Where ? ⇒ Location

-How? ⇒ implementation

-How? ⇒ implementation (quality requirements to be obtained, choice, etc.)

I.6.The different steps of estimating:

The steps you've outlined are crucial initial steps in the process of estimating for a construction project. Here's a continuation of the steps involved in the estimating process:

1- Determine Quantities: Once you have a good understanding of the project from the drawings and project manual, start quantifying the materials and components required. This involves identifying and counting items like walls, doors, windows, fixtures, and structural elements. Use the drawings and specifications to extract this information accurately.

2- Material Takeoff: Create a detailed material takeoff list. This list should include all the materials, quantities, and sizes needed for each part of the project. For example, you'll calculate the number of bricks, cubic yards of concrete, linear feet of piping, and so on.

3- Labor Analysis: Estimate the labor hours required for each aspect of the project. This involves analyzing the scope of work and applying industry-standard labor productivity rates to determine how long each task will take. Consider different labor categories such as carpenters, electricians, plumbers, and general laborers.

4- Subcontractor Quotes: For specialized tasks or trades, seek quotes from subcontractors. This can include electrical, plumbing and other specialty work. Incorporate these quotes into your overall estimate.

5- Material and Labor Costs: Research current market prices for materials and labor rates for the specific location of the project. Accurate cost data is crucial for developing a reliable estimate.

6- Overhead and Profit: Calculate overhead costs, which include expenses like office rent, insurance, and administrative staff salaries. Determine the desired profit margin for the project, typically as a percentage of the total cost.

7- Contingency: Add a contingency amount to your estimate to account for unexpected changes, risks, or uncertainties. This contingency is typically expressed as a percentage of the total project cost.

8- Bid Documentation: Prepare all necessary bid documentation, including a detailed breakdown of costs, schedules, qualifications, and any other requirements specified by the client or project owner.

9- Review and Adjust: Review your estimate thoroughly to ensure accuracy and completeness. Check that all quantities, costs, and calculations are correct. Make any necessary adjustments or revisions.

I.7. Methods of estimation

In construction for calculating quantities of various components, including earthwork, foundation concrete, brickwork in plinth and superstructure, and more, can be workout by any of following methods:

I.7.1. Long Wall - Short Wall Method:

This method is often used for calculating quantities of materials for walls, particularly for brickwork or masonry walls. In this method, the wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall.

- To get the length of long wall or short wall, calculate first the centre line lengths of individual walls. Then the length of long wall, (out to out) may be calculated after adding half breadth at each end to its centre line length.

- Thus, the length of short wall measured into in and may be found by deducting half breadth from its centre line length at each end.
- The length of long wall usually decreases from earth work to brick work in super structure while the short wall increases. These lengths are multiplied by breadth and depth to get quantities.

I.7.2. Centre Line Method:

This method is suitable for walls of similar cross sections.

- The total centre line length is multiplied by breadth and depth of respective item to get the total quantity at a time.
- When cross walls or partitions or verandah walls join with main wall, the centre line length gets reduced by half of breadth for each junction.
- Such junction or joints are studied carefully while calculating total centre line length.
- The estimates prepared by this method are most accurate and quick.

I.7.3. Partly Centre Line and Short Wall Method:

This method is adopted when external (i.e., around the building) wall is of one thickness and the internal walls having different thicknesses.

- In such cases, centre line method is applied to external walls and long wall-short wall method is used to internal walls.
- This method suits for different thicknesses walls and different level of foundations.

I.7.3. Method called " Void for full ":

The so-called " Void for full" method is applicable for masonry walls with openings (doors and windows). In this case, the total area of the wall is calculated and then the area of the openings is subtracted from the total area to deduce the surface of the masonry.

I.7.4.The 3-Level Method:

The 3-Level Method is a common approach used in construction and civil engineering to calculate excavation volumes and works of variable sections. It's used to estimate the quantities of earthwork required or removed when dealing with irregular or changing cross-sectional areas. The method involves breaking down the excavation into three levels or sections and then calculating the volumes for each section separately. The general formula for calculating the volume of excavation using the 3-Level Method is given as follow:

$$V = \frac{h}{6}(A + 4B + C)$$

Where:

V is the total volume of excavation.

A is the area of the first cross-section (usually initial section).

B is the area of the middle cross-section.

C is the area of the final cross-section (usually the bottom section).

h is the Height or distance between the first and the end cross-sections (often along the alignment of the excavation). A diagram of the formula is given in Figure 1.

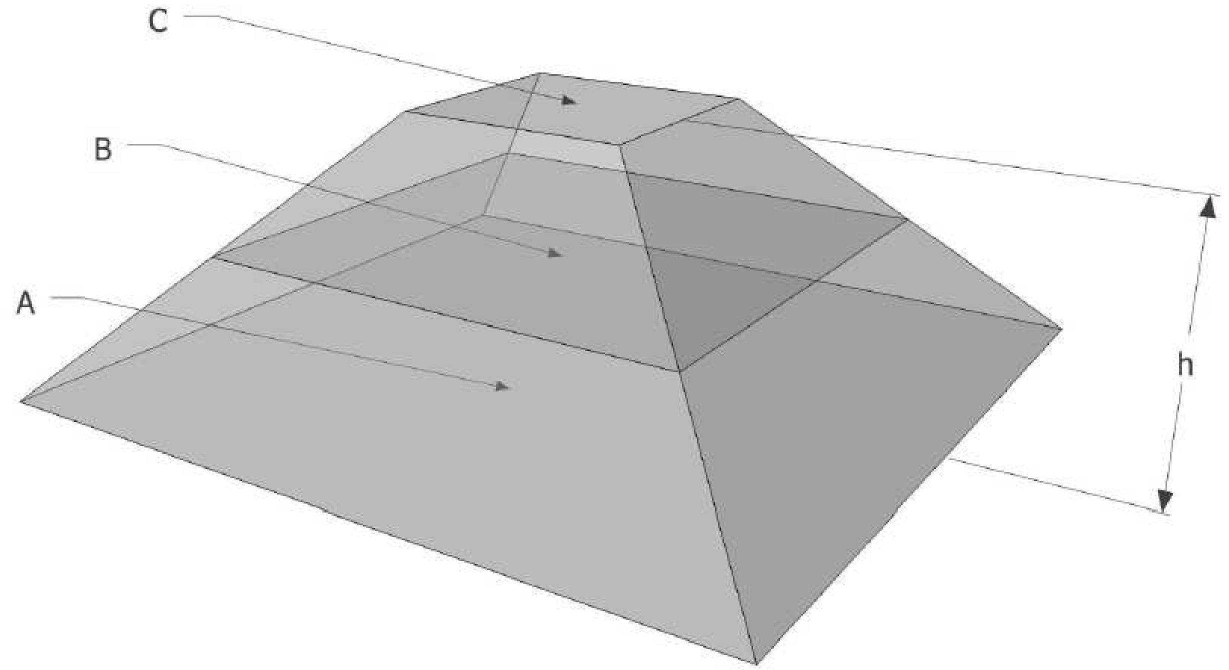


Figure 1: Diagram of the 3-Level Method

I.8. Method of presenting the estimate of work

The estimator uses two basic types of manual takeoff sheets: the workup sheet and the summary sheet. These sheets help estimators organize their calculations and create a comprehensive and detailed estimate.

I.8.1.Workup Sheet:

- Purpose: Workup sheets are used for the detailed breakdown of quantities and costs associated with specific construction elements or categories. Estimators use workup sheets to perform the material takeoff and labor analysis for each component of the project.
- Variety of Forms: Workup sheets can come in various forms, with each form tailored to the type of work being quantified. For example, there may be different workup sheet templates for concrete work, electrical work, plumbing, roofing, etc.
- Content: The content of a workup sheet typically includes columns for item descriptions, quantities, unit measurements (e.g., square feet, linear feet), unit costs (materials and labor), extended costs, and notes. Estimators input the data they gather from the drawings and specifications into these columns.
- Detailed Calculations: Estimators perform detailed calculations on workup sheets to determine the total quantities and costs for each construction element. This includes multiplying quantities by unit costs to obtain extended costs.

An example of worksheet is given in table 2. The details of measurements are taken from drawings and entered in respective columns of prescribed preformed. The quantities are calculated by multiplying the values that are in measurements columns.

Table 2: Estimate Workup Sheet

Item No	**Details of works**	**No**	**Measurement**			**U**	**Q**	**Explanatory notes**
			Length - L	**Breadth -B**	**Height - H**	**(Unit)**	**(Quantity)**	
1	**Construction of a masonry enclosure wall**		**10,00**		**2,70**	**m^2**	**27,00**	
2	…………………………………… …………………………………… ……………………………………							

N.B: A Quantitative estimate can be established at the end of the calculations as showed blow (Table 3).

Table 3: Quantitative estimate

Item No	Description	Unit	Quantity	Remarks
1	**Construction of a masonry enclosure wall**	**m²**	**27,00**	
2	……………………………… ……………………………… ………………………………			

I.8.2. Summary Sheet:

- Purpose: Summary sheets are used to compile and summarize the data from the various workup sheets. They provide an overview of the entire project estimate, breaking it down by categories or trades.
- Content: A typical summary sheet includes sections for each major category of work in the project, such as concrete, framing, electrical, plumbing, and so on. It also includes columns for the total quantity, unit cost, extended cost, and any additional costs like overhead and profit.
- Consolidation: Estimators consolidate the data from their workup sheets onto the summary sheet. The summary sheet provides a comprehensive view of the estimated costs for the entire project.
- Total Project Cost: The total project cost is calculated by summing up the extended costs from each category. This total cost is the basis for submitting a bid or proposal to the client.

The form of summary sheet is given in table 4.

Table 4: Summary sheet form

Item No	Description	U	Q	Unit cost			Total
				Labor	Material	Equipment	

I.9. Examples of quantity measurement calculation

I.9.1. Example A:

Prepare a detailed estimate of a part of a wall of a building from the given plan and section (Figure 2).

Calculate:

- Earthwork excavation in foundation;
- Lime concrete in foundation;
- First class brickwork in foundation and plinth;
- Brickwork in superstructure

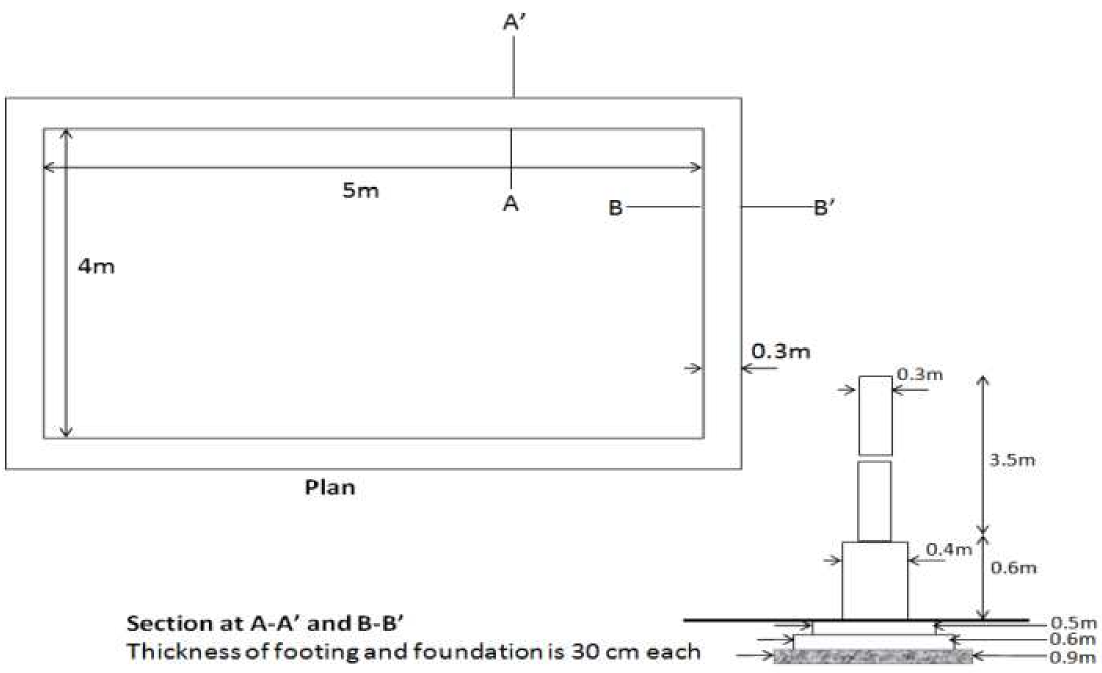


Figure 2: Plan of the wall

Calculation:

- **Center Line Method (figure 3):**

Total Centre line = 5.3 + 5.3 + 4.3 + 4.3 = 19.20 m

The details of the calculation are given in table 5.

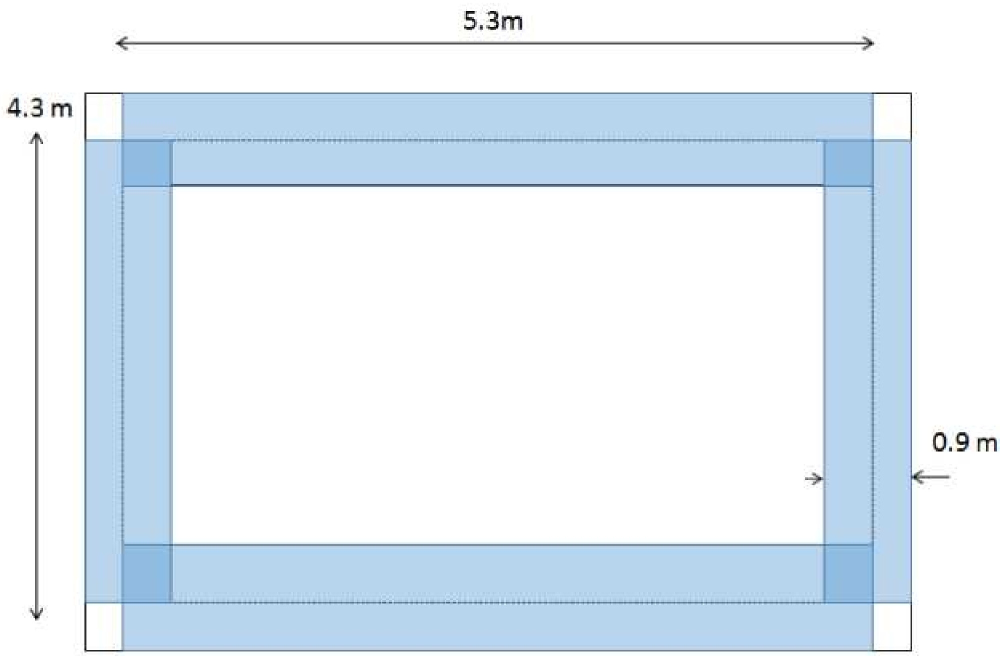


Figure 3: Diagram of the calculation using the center line method

Table 5: Estimation of work construction using the center line method

Contents	No	L	B	H	Unit	Quantity
1. Earthwork excavation on foundation	1	19.2	0.9	0.9 (0.3+0.3+0.3)	M^3	**15.552**
2. Concrete in foundation	1	19.2	0.9	0.3	M^3	**5.184**
3. Brickwork in foundation and Plinth 1st Footing	1	19.2	0.6	0.3	M^3	3.456

2nd Footing 3rd Footing	1 1	19.2 19.2	0.5 0.4	0.3 0.6		2.88 4.608 **Σ10.944**
4.Brickwork in Super structure	1	19.2	0.3	3.5	M^3	**20.16**

- **Separate wall Method (Long Wall - Short Wall Method):**

  A diagram of the calculation using the Separate wall Method is given in figure 4.

  The details of the calculation are given in table 5.

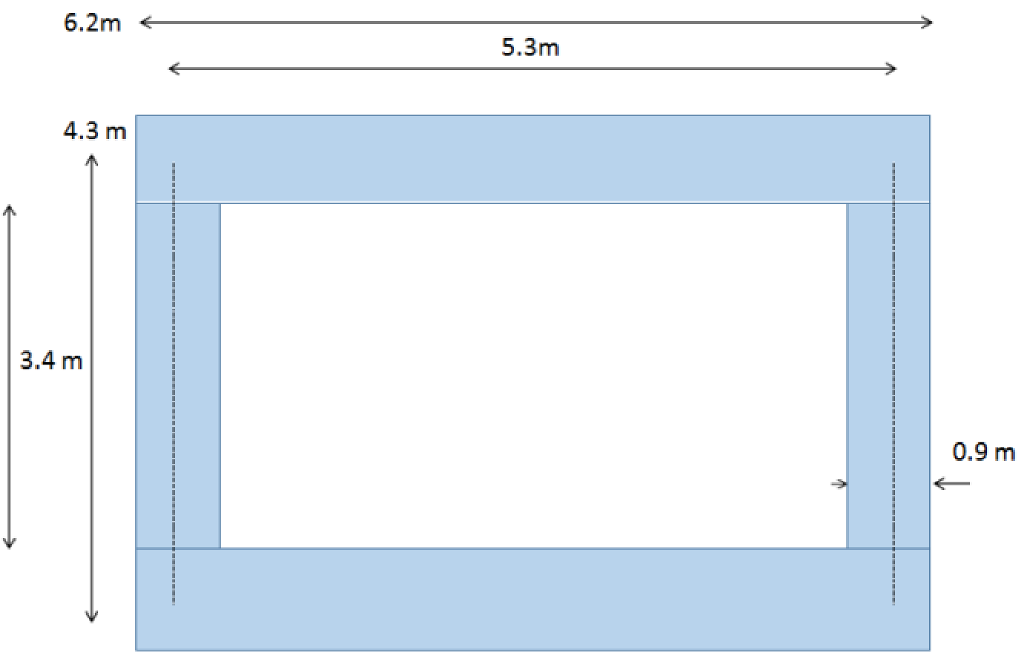


Figure 4: Diagram of the calculation using the Separate wall Method

Long wall = c/c length + one breadth = 5.3 + 0.9 = 6.2 m

Short wall = c/c length – one breadth = 4.3 – 0.9 = 3.4 m

Table 6: Estimation of work construction using the center line method

Contents	No	L	B	H	Unit	Quantity
1. Earthwork excavation on foundation						
- Long wall	2	6.2	0.9	0.9 (0.3+0.3+0.3)	M^3	10.044
- Short wall	2	3.4	0.9	0.9		5.508
						Σ15.552
2. Concrete in foundation						
- Long wall	2	6.2	0.9	0.3	M^3	3.348
- Short wall	2	3.4	0.9	0.3		1.836
						Σ5.184
3. Brickwork in foundation and Plinth						
- Long wall						
1st Footing	2	5.9(5.3+0.6)	0.6	0.3	M^3	2.124
2nd Footing	2	5.8(5.3+0.5)	0.5	0.3		1.740
3rd Footing	2	5.7(5.3+0.4)	0.4	0.6		2.736
- Short wall						
1st Footing	2	3.7(4.3-0.6)	0.6	0.3		1.332
2nd Footing	2	3.8(4.3-0.5)	0.5	0.3		1.140
3rd Footing	2	3.9(4.3-0.4)	0.4	0.6		1.872
						Σ10.944
4.Brickwork in Super structure						
- Long wall	2	5.6(5.3+0.3)	0.3	3.5	M^3	11.76
- Short wall	2	4.0(4.3-0.3)	0.3	3.5		8.4
						Σ 20.16

I.9.2. Example B:

Prepare a detailed estimate of a part of a wall of a building from the given plan (Figure 5). Calculate the area of Brickwork in superstructure using the " Void for full" Method.

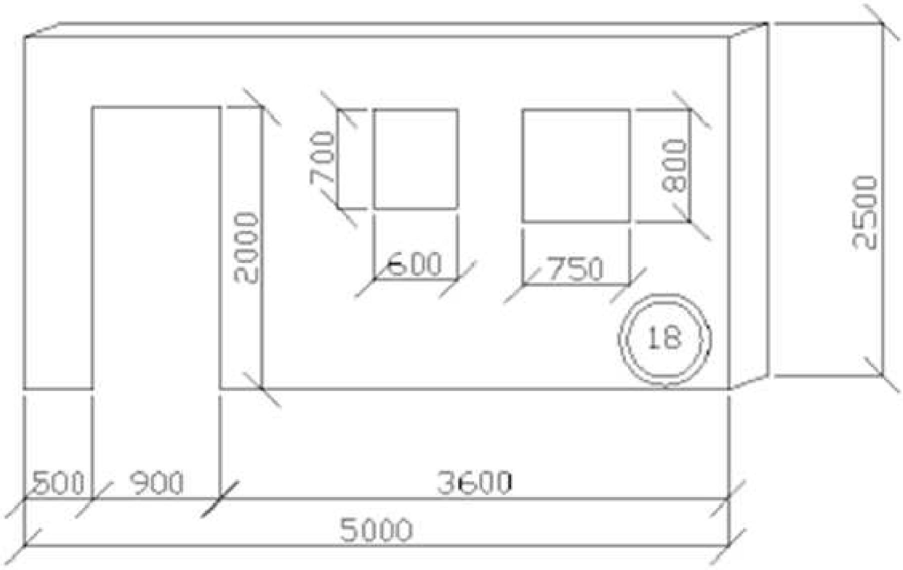


Figure 5: simplified diagram of a front wall (rating in mm)

Calculation:

The details of calculation are given in table 7.

Table 7: Estimation of Brickwork using the "Void for full" Method

Contents	No	L	B	H	Unit	Quantity
-Brickwork in superstructure	**1**	**5.00**		**2.50**	**m^2**	**12.5**
-To be deducted		**0,75**		**0.80**		**-0.60**
		0.6		**0.7**		**-0.42**
		0.9		**2**		**-1.8**
						Σ 9.68

I.10. Application to earthworks and excavations

The problem is to determine the volume of earth to be excavated. This volume depends on the shape of the earthworks, which depends on the environment in which it is carried out in order to guarantee the stability of the soil during the work. The equilibrium of an excavation is achieved by respecting an inclination slope that can be defined by an angle. Otherwise the stability of the excavation is obtained by a land shielding (Figure 6).

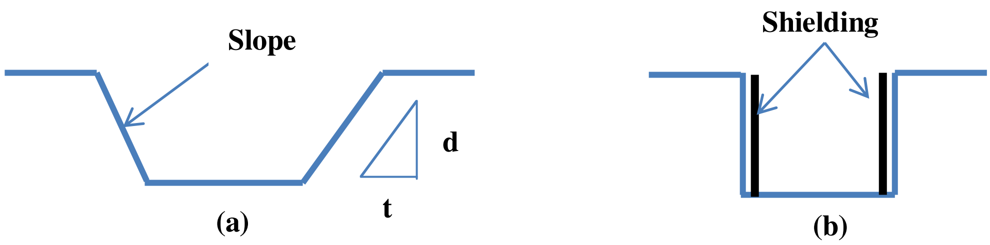


Figure 6 : Types of excavations : (a) Slope excavation ; (b) shielded excavation

Slope inclination is indicated by the slope which represents the ratio of horizontal distance to vertical distance (t/d). The slope = t/d.

Calculation of the excavation volume:

- Excavation bordered by vertical walls : V= S*h
- Slope excavation: In this case, the surface of the excavation varies regularly from the bottom to the surface. Mathematically such a type of volume is calculated by the formula of the 3-Level Method.

Example of application:

-Calculate the volume of the excavation schematized in Figure 7 (dimension in mm).

To calculate the volume of the excavation, the 3-level method is used:

$$\boldsymbol{V = \frac{h}{6}(A + 4B + C)}$$

h: depth of excavation

A is the area of the cross-section of the excavation bottom

B is the area of the middle cross-section.

C is the area of the top cross-section

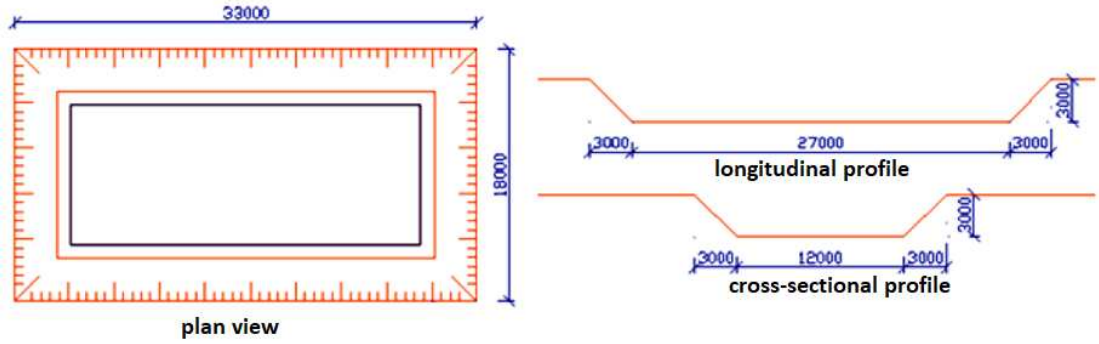


Figure 7: Excavation diagram

h= 3000 mm = 3m.

A = 27 X 12 = 324 m^2.

C = 33 X 18 = 594 m^2.

The inclination of the slope is: 3/3 = 1/1, so at 1.5 m from the bottom the surface of the excavation widens by 1.5m on each side.

So, B = (27+3) X (12+3) = 450 m^2.

Finally, $\boldsymbol{V} = \frac{3}{6}\ (\mathbf{324 + 4X450 + 594})$ = **<u>1359 m^3.</u>**

- **Swelling of soil after excavation:**

Bank materials, which are soil and rocks in their natural state as they exist in the ground, are typically measured in bank cubic meter. When this material is excavated and disturbed, it undergoes expansion, and the increase in volume is referred to as swell (Figure 8).

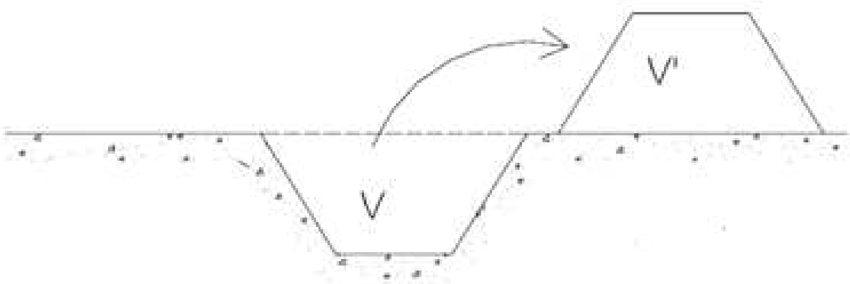


Figure 8 : Swell phenomenon (V' > V)

Three soil states can be identified (Figure 9):

- Initial state or Bank Cubic meters (Vb): This refers to the volume of natural materials (such as soil and rocks) in their undisturbed, compacted state as they exist in the ground. Bank cubic meters are typically used as a reference point for estimating the original volume before excavation.

- Swelling state or Loose Cubic meters (Vs): These are the excavated materials in their loose state, after they have been disturbed and removed from their natural state. Loose cubic meters represent the expanded volume due to swell.

- Compacted state or compacted Cubic meters (**Vc**): These are materials that have been placed and compacted on a construction site. Compacted cubic meters represent the reduced volume due to shrinkage after the materials have been compacted.

Where:

- Cs : Coefficient of swell;
- Cc : Coefficient of compaction
- Csh : Coefficient of shrinkage = Cs x Cc

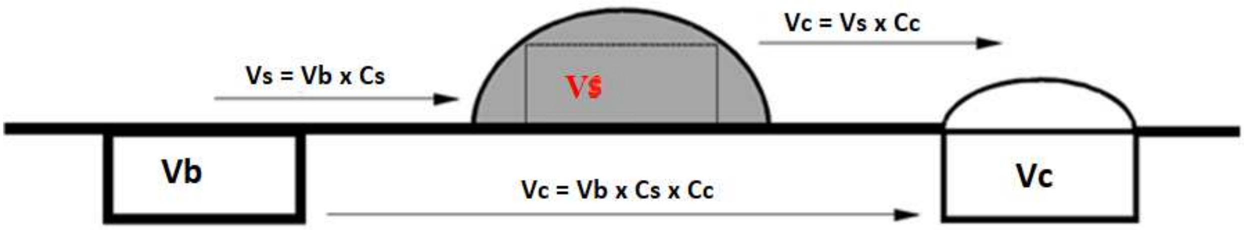


Figure 9: Soil states during the earthworks operation

Example 1 of application: Determining swell and transportation

If 1,000 bank cubic meters (in place at natural density) of dense clay (35 percent swell) needs to be hauled away, how many loose cubic meters would have to be transported away by truck?

Cubic meters of haul = In-place quantity x (1+Swell percentage)

Cubic meters of haul = 1,000 x (1 + 0.35) = 1,350 m^3

If 12 m^3 dump trucks will be used to haul this material away, how many loads would be required?

Number of Loads : 1,350 m3 / 12 m3 per load = 113 loads

Example 2 of application: Determining shrinkage and transportation

If 1000 m^3 compacted in-place of sand/gravel is required, how many loads would be required? The material has a swell of 20 percent and shrinkage of 95 percent.

Required bank volume in m^3 = Required in-place m^3/ Shrinkage

Required bank volume in m^3 = 1000 m^3/ 0.95 = 1 052,632 m^3

The volume of material to be transported is calculated as follows:

Loose volume (M^3) = Bank m^3 x (1 + Swell)

Loose volume (M^3) = 1052,632 m^3 x (1 + 0 .20)

Loose volume (M^3) = 1 263,158 m^3

I.11. Application to reinforcing concrete

The preliminary measurement of a concrete project is generally carried out in three stages:

- Reinforced or unreinforced concrete will be measured by m^3 from the dimensions of the concrete planes.
- Rebar, if any, being counted separately and by weight (kg, or tonne).
- Finally the formwork is counted separately and per m2.

In some cases the whole can be reduced to a single price per m^3 of concrete. This price includes the value of the quantity of concrete, reinforcement and formwork, but it is necessary to know all the same to establish this price, the proportions of reinforcement in kg/m3 of concrete as well as the proportion of the formwork.

Note: It is more accurate to determine each element apart from concrete, reinforcement and formwork.

- **Rebar Weights:**

When working with reinforcing bars in construction or engineering projects, it's important to set up a workup sheet or materials list that includes essential information such as the number of bars, pieces, lengths, bends, and their associated weights.

To calculate the weight, you can use the following formula:

Total Weight (in Kg)=Total Length (in linear meter)×Weight per Linear meter (in Kg/ linear meter)

The weight of the rebar taken into account will be calculated by applying the linear weights fixed by the standards to the lengths of the bars indicated in the execution drawings (Table 8), without any waste, markup for ligatures, wedges, etc.

Table 8 : Weight per Linear meter vs. rebar diameter

Φ(mm)	6	8	10	12	14	16	20	25	32
Weight Kg/Lm	0,222	0,395	0,617	0,888	1,208	1,578	2,466	3,358	6,313

Example of application: Determining weight of bars of a beam

The grade beam in the front of the building is 10 meter long. The specifics of this grade beam are presented in Figure 10. There are four T14 horizontal bars and T8 bars used for stirrups.

Total quantity of bars T14 = 4 bars x 10 m per bar = 40 linear meter

Total weight of bars (Kg) = 40 x 1,208 Kg/m = 48,32 Kg

Total weight = 48,32 Kg

Add 10 percent for lap and waste, Use **53,15 kg**

Stirrup length = 0.25x4+0.10 = 1.10 m

Stirrup spaces = 10 m /0.15 m stirrup spacing

= 67 spaces, use 68 stirrups

Total length of T8 stirrups = 68 x 1.10 = 74.8 m

Total weight of stirrups = 74.8 x 0.395 Kg/m = 29,55 Kg

Total weight = 29,55 Kg

Add 10 percent for lap and waste, use **32.5 Kg**.

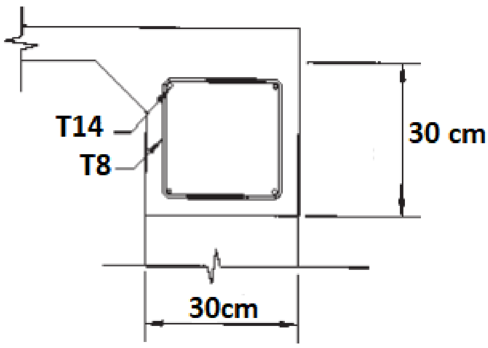


Figure 10: Grade Beam Details.

Part II

Costing and valuation of construction work

II.1. General:

Costing and valuation of construction work are essential processes in the construction industry that involve estimating the costs associated with a construction project and determining its overall value. These processes are critical for project planning, budgeting, financial management, and decision-making. The objectives of costing and valuation of construction work are multifaceted and play a crucial role in the construction industry; they can be summarized as follows:

- Project Budgeting: Develop a comprehensive budget that outlines expected costs for all aspects of the construction project, including materials, labor, equipment, overhead, and contingencies.
- Cost Control: Monitor and control project expenses to ensure they stay within the approved budget. Identify and address cost overruns promptly.
- Financial Planning and Management: Provide a financial roadmap for the construction project, helping stakeholders plan for funding, allocate resources, and manage cash flows effectively.
- Accurate Cost Estimation: Determine the anticipated costs of construction work with a high degree of accuracy to avoid underestimation or overestimation of expenses.
- Resource Allocation: Allocate resources such as labor, materials, and equipment efficiently to optimize project performance and minimize waste.
- Contract and Bid Evaluation: Assist in evaluating bids from contractors by comparing them to the estimated project costs, helping stakeholders make informed contract award decisions.
- Risk Assessment: Identify potential cost-related risks and uncertainties in the project and develop strategies to mitigate these risks.
- Performance Measurement: Evaluate project performance by comparing actual costs and progress against the budget and schedule. This aids in making informed decisions and adjustments as needed.
- Value Engineering: Seek opportunities to reduce costs without compromising the quality, functionality, or safety of the project through value engineering techniques.
- Legal and Regulatory Compliance: Ensure that the construction project complies with local laws and regulations, including those related to cost reporting and financial transparency.

- Appraisal and Valuation: Determine the current and future value of the construction project, which is essential for financing, insurance, taxation, and investment decisions.
- Investor and Stakeholder Confidence: Build trust and confidence among project stakeholders, including investors, lenders, clients, and regulatory authorities, by providing accurate and transparent cost and valuation information.
- Life-Cycle Cost Analysis: Consider the long-term costs associated with the construction project, including maintenance, repairs, and operational expenses, to make informed decisions about project sustainability and durability.
- Documentation and Reporting: Maintain thorough records of cost estimates, valuations, financial transactions, and progress reports for auditing, legal, and historical reference purposes.
- Quality Assurance: Ensure that the construction work meets specified quality standards and that quality-related costs are appropriately considered in cost estimation and valuation.
- Decision Support: Provide essential data and insights to support decision-making throughout the project lifecycle, from initial planning to project completion.

II.2. Estimated cost:

The cost of each item of work is worked out from the quantities that already computed in the details measurement form at workable rate. But the total cost is worked out in the prescribed form is known as abstract of estimated form.

The first step in estimating the cost of a construction project is to calculate the quantities of various items of work required for the project. These quantities are typically computed based on detailed measurements taken from architectural and engineering drawings. These measurements provide a precise assessment of the materials, labor, and other resources needed for each element of the project. Then, we have to apply appropriate rates to each item of work. These rates are derived from historical data, market rates, or specific agreements with contractors and suppliers. Workable rates represent the unit cost for each item of work and are used to calculate the cost of materials, labor, and equipment required for each task. The total cost of the construction project is calculated by summing up the costs of all the individual items of work. This summary of costs is typically presented in a prescribed form known as the "abstract of estimated form" or simply the "abstract." The abstract provides a comprehensive overview of the project's estimated costs, broken down by various work items and cost categories. The abstract of estimate form is given in table 9.

Table 9: Abstract of estimate form

Item No.	Description/ Particulars	Quantity	Unit	Rate	Per (unit)	Amount

II.2.1. Fixing of Rate per Unit of an Item:

The process of working out the cost or rate per unit of each item is called as Data. In preparation of Data, the rates of materials and labor are obtained from current standard scheduled of rates and while the quantities of materials and labor required for one unit of item are taken from Standard Data Book (S.D.B)

The rate per unit of an item includes the following:

a- Quantity of Materials & Cost:

- Materials Requirement: The quantity of materials required for a specific item of work is determined using a standard data book (S.D.B) or industry-standard references. This ensures that the materials needed are based on established standards.
- Cost of Materials: The cost of materials includes not only the purchase cost but also additional expenses such as freight, insurance, and transportation charges to bring the materials to the construction site. These additional costs are factored into the rate.

b- Cost of Labor:

- Labor Requirement: The exact number of laborers needed to complete the unit of work is determined based on the complexity and scale of the task. This requirement is based on labor productivity norms and project-specific considerations.
- Cost of Labor: The cost of labor is calculated by multiplying the number of laborers required by their daily wages. This accounts for the direct cost of the workforce involved in the construction activity.

c- Cost of Equipment (T&P - Tools and Plant):

- Special Equipment Requirement: Some construction tasks may require specialized equipment, tools, or machinery for efficient execution. These can include cranes, excavators, or specialized tools.

- Equipment Cost: A certain percentage of the estimated project cost (typically 1% to 2%) is allocated to cover the cost of renting or operating such equipment. This ensures that the cost of using necessary equipment is included in the rate.

d- Overhead Charges:

- Overhead Expenses: Overhead charges are included to cover various indirect expenses associated with the construction project. These expenses can include office rent, depreciation of equipment, salaries of administrative staff, postage, and lighting.

- Overhead Percentage: An amount equal to a percentage of the estimated project cost is allocated to cover these overhead expenses. This percentage reflects the administrative and operational costs incurred to support the construction activities.

The schema below presents the composition of sales cost for a construction company.

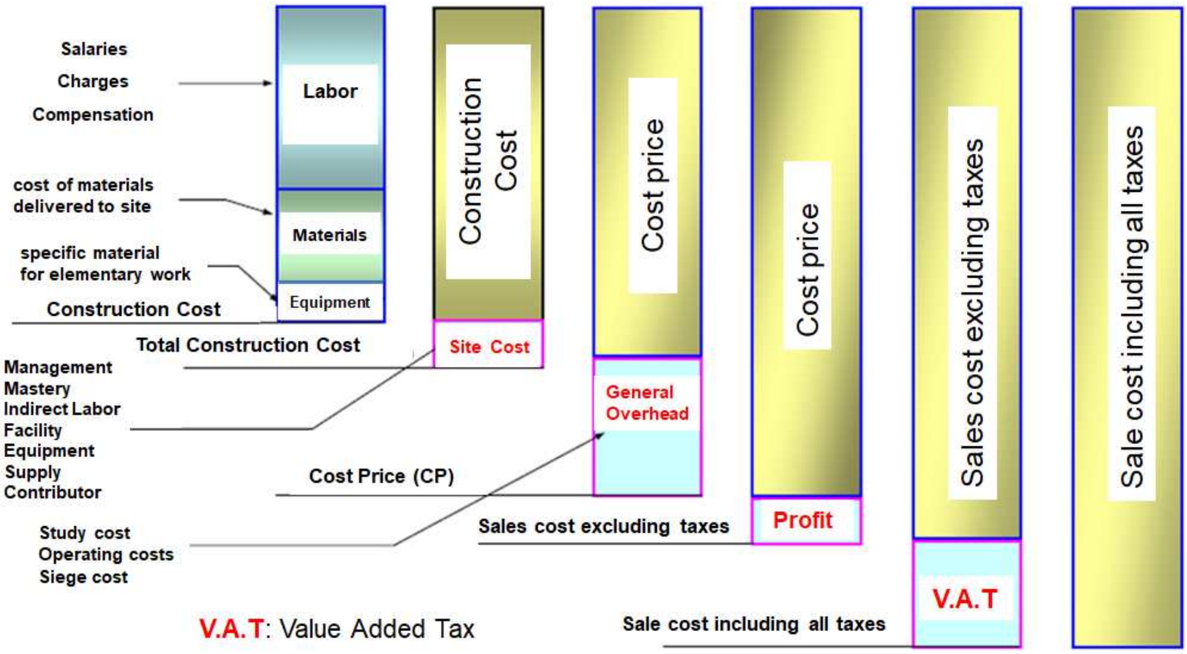


Figure 11: Explanatory diagram for establishing the sale cost

The following formulas can also be used to calculate the Sales cost:

Production cost = Construction cost + Site cost

$$PC = CC + SiC$$

Direct Cost = Production cost + Operation cost

$$DC = PC + OC$$

Cost price = Direct cost + General Overhead

$$CP = DC + GO$$

Sales Cost without taxes = Cost Price + Profit and hazards

$$SC = CP + PH$$

Sales cost coefficient

The Sale cost (SC) is composed of the followings elements (table 10):

Table 10: Sale Cost compounds and their percentages

Sale cost components	Value rating
Construction cost (CC)	30 to 60%
Site cost (SC) calculated in % of CC	15 to 25%
Operation cost (OC) expressed in % of SC	0 to 10%
General Overhead (GO) calculated in % of SC	20 to 30%
Profit and Hazards (PH)	0 to 5%

The sales price coefficient K represents all the costs that are applied to the construction cost to obtain the sales price: **SC = K. CC**

The company coefficient of big enterprises is higher than that of medium-sized companies, which in turn is higher than that of small companies; in general, we have:

For big companies: k = 1.70 to 2.00;

For medium-sized companies: k = 1.40 to 1.70;

For small companies: k = 1.20 to 1.40.

Example:

Calculate the sales cost coefficient having the following data:

Site Cost (SiC) = 12% of construction Cost (CC)

Operation cost (OC) = 2% of Production Cost (PC)

General Overhead (GO) = 23% of Direct Cost (CC)

Profit and Hazards (PH) = 3% of Sales Cost (SC).

Solution:

Production Cost (PC) = Construction Cost (CC) + Site Cost (SiC)

PC = CC + 0.12 CC = 1.12 CC

Direct Cost (DC) = Production Cost (PC) + Operation Cost (OC)

$$\mathbf{DC = PC + OC = 1.12\ CC + 0.02x1.12\ CC = 1.1424\ CC}$$

Cost Price = Direct Cost + General Overhead

$$\mathbf{CP = DC + GO = 1.1424\ CC + 0.23x1.1424\ CC = 1.40515\ CC}$$

Sales Cost without taxes = Cost Price + Profit and Hazards

$$\mathbf{SC = CP + PH = 1.40515\ CC + 0.03\ SC}$$

$$\mathbf{SC\ (1-0.03) = 1.40515\ CC}$$

$$\mathbf{SC = 1.449\ CC}$$

So, the sales cost coefficient: **K = 1.449**

II.2.2. Methods of preparation of approximate estimate:

The preliminary or approximate estimate is a crucial step in the early stages of a construction project. It serves various purposes, including obtaining administrative approval, assessing the feasibility of a project, and providing a rough cost estimate for budgetary purposes.

The following are the methods used for preparation of approximate estimates:

a) Plinth Area Method:

This method is commonly used for estimating the cost of residential and commercial buildings. The estimate is based on the total built-up area or plinth area of the building. The plinth area is multiplied by the rate per square foot or square meter to calculate the approximate cost.

b) Cubical Contents Method:

This method is suitable for estimating the cost of structures with irregular shapes. It is based on calculating the total volume or cubical contents of the structure. The volume is multiplied by the rate per cubic meter to determine the approximate cost.

c) Unit Base Method:

The unit base method involves estimating the cost of individual units or components of a project. The project is broken down into various items or units, such as walls, floors, roofs, etc. The cost of each unit is calculated separately based on historical data, market rates, or similar completed projects. The costs of all units are then summed up to obtain the total approximate cost of the project.

Each of these methods has its own advantages and is chosen based on the nature and complexity of the project. The choice of method depends on factors such as the type of construction, available data, and the level of accuracy required for the preliminary estimate.

II.3. Analysis of rates

Rate analysis, also known as analysis of rates, is a crucial process in the construction industry used to determine the unit rate (cost per unit of measurement) for a particular item of work. This unit rate is essential for estimating the cost of that specific work item within a construction project. Rate analysis involves studying various factors that influence the rate of an item, and these factors can vary depending on the type of construction work and location.

The rates of particular item of work depend on the following:

a. Specifications of works and material about their quality, proportion and constructional operation method.

b. Quantity of materials and their costs.

c. Cost of labors and their wages.

d. Location of site of work and the distances from source and conveyance charges.

e. Overhead and establishment charges

f. Profit

II.3.1. Cost of materials at source and at site of construction:

The costs of materials are taken as delivered at site inclusive of the transport local taxes and other charges. It serves several important purposes, as follows:

- Calculation of Actual Unit Cost: The primary purpose of rate analysis is to calculate the actual cost per unit of a particular item of work. This is essential for accurate project cost estimation and budgeting. By analyzing the rates, contractors and project managers can determine the cost of various construction activities, materials, and labor required for specific tasks.

- Economical Use of Resources: Rate analysis helps in identifying the most economical methods and processes for completing specific construction tasks. It allows for the optimization of materials, labor, and equipment usage. By analyzing rates, construction professionals can make informed decisions to minimize wastage and maximize efficiency.

- Cost Estimation for Extra Items: In some cases, additional work items may be required that were not initially included in the contract. Rate analysis enables the calculation of costs for these extra items based on established unit rates. This ensures transparency and accuracy when accounting for changes or additions to the project scope.

- Rate Revision: The construction industry is subject to fluctuations in material costs, labor rates, and construction techniques. Rate analysis allows for periodic revisions of the schedule of rates to reflect changes in the cost of materials, labor, and the adoption of new construction technologies. This ensures that rates remain up-to-date and competitive.

II.3.2. Cost of labor -types of labor, standard schedule of rates

The cost of labor is a significant component in construction project estimation. Labor is typically classified into various categories based on the skills and experience of the workers. There are three main categories: Skilled 1st Class, Skilled 2nd Class, and Unskilled labor. The labour can be classified in to:

-Skilled 1st Class (1st Class):

Skilled 1st Class labor consists of highly skilled and experienced workers who have specialized knowledge and expertise in their respective trades. They are proficient in performing complex tasks and are typically responsible for critical and intricate aspects of the construction work. Skilled 1st Class labor usually commands higher wages due to their expertise and experience.

Skilled 2nd Class (2nd Class):

Skilled 2nd Class labor represents skilled workers who are proficient in their trades but may have less experience or expertise compared to 1st Class labor. They are capable of performing various tasks efficiently and with a certain level of skill. Skilled 2nd Class labor typically earns lower wages than 1st Class labor but more than unskilled labor.

Unskilled Labor:

Unskilled labor includes workers who do not possess specialized skills or training in a particular trade. They are usually employed for tasks that do not require specific expertise and can be trained relatively quickly. Unskilled labor typically receives the lowest wages among the three labor categories.

The labor charges can be obtained from the standard schedule of rates.

II.3.3. Lead statement:

The distance between the source of availability of material and construction site is known as "Lead" and is expected in Km. The cost of conveyance of material depends on lead. This statement will give the total cost of materials per unit item. It includes first cost, conveyance loading, unloading stacking, charges etc.

II.4.Example:

Prepare an approximate estimate of manufacturing 1 m^3 of concrete dosed at 350 kg/m3. The composition and cost of materials delivered to the site are given in table 11.

For the manufacture of concrete, a small concrete mixer of 250 l with an output of 6 m3/ day with 4 maneuvers is used. The daily work rate is 8 hours.

The concrete mixer is rented at 3000 DA per day and each maneuver is paid at the rate of 1000DA/ Day.

Table 11: Composition and cost of materials

Materials	Quantity needed for 1m3 of concrete	Unit	Rate (DA)
Cement	7 bags of 50 kg	Unit	500,00
Sand	0,450	M^3	1500,00
Gravel	0,750	M^3	2000 ,00
Water	0,045	M^3	1500,00

Solution:

To calculate the manufacturing the cost of 1m3 of concrete, the following table is used (Table 12):

Number of hours required to manufacture a m3 of concrete:

- Concrete mixer rental: to produce 6m3, it takes 8h, so: to produce a m3 of concrete, it will take 1.33h.

- The 4 maneuvers are paid at 500DA/h.

Table 12: Calculation of the cost of 1 M^3 of concrete

N°	Designation	Unit	Quantity	Rate Per unit	Amount
01	Cement	Bag	7	500,00	3850,00
02	Sand	M^3	0,45	1500,00	675,00
03	gravel	M^3	0,75	2000,00	1500,00
04	Water	M^3	0,045	1500,00	67,50
05	Concrete mixer rental	h	1,33	375,00	498,75
06	Labor	h	1,33	500,00	2660,00
				Total	9251,25

The approximate cost is estimated at 9251.25 DA excluding Tax, or 11008.99 DA in all taxes included (19%).

N.B: By knowing perfectly the unit cost of the different concrete components, we can make an exact estimate of the cost of 1 m3 of concrete.

Part III

Project application

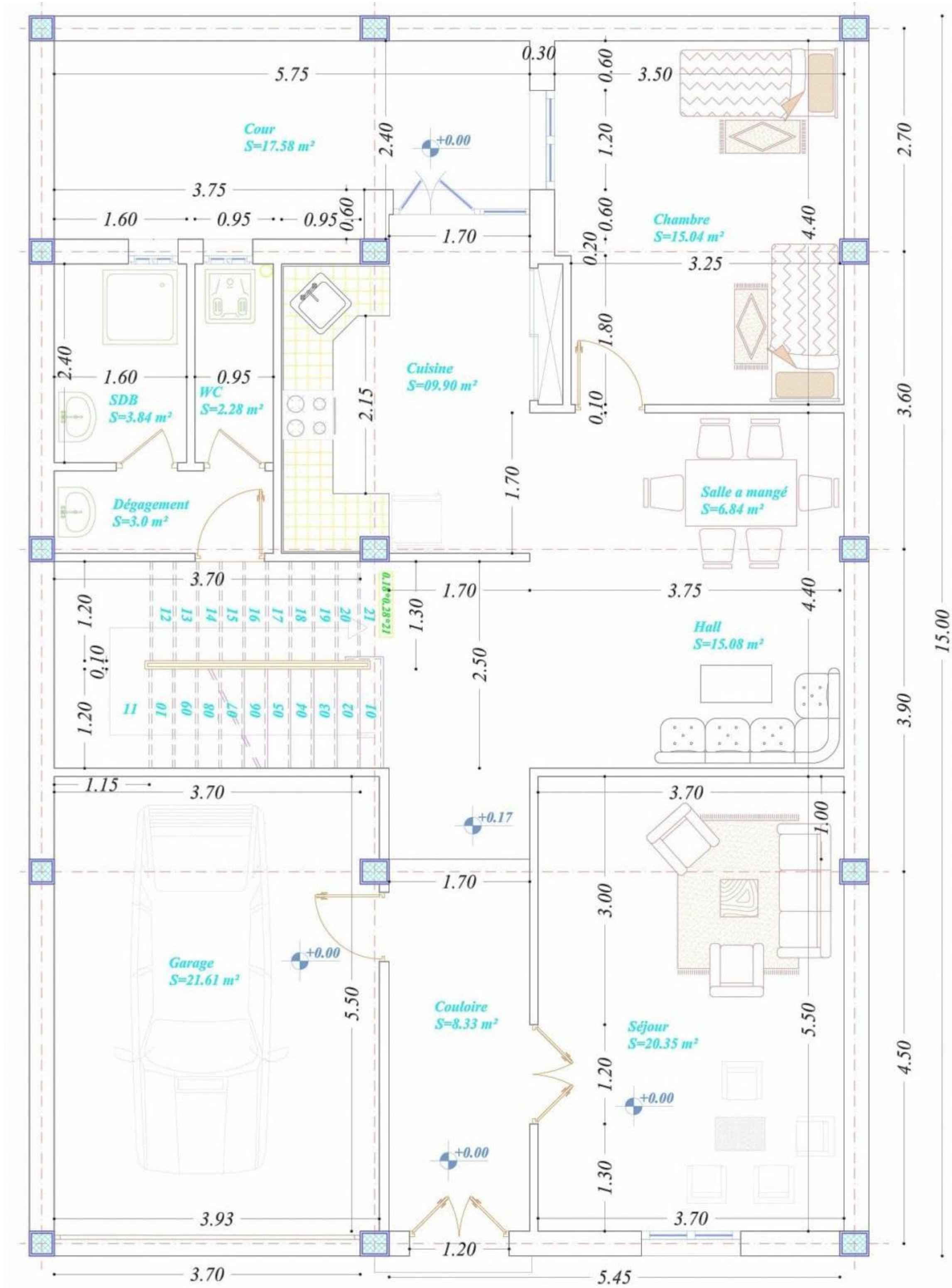
III.1. Presentation of the project:

The project consists of construction a house R+1 for residential use for an individual. The project is located in Tiaret and it is composed of a ground floor and floor (R + 1), according to the plan of the architecture and graphic document below.
The architecture plan provided can be described as follows:
On the ground floor, there is a bedroom, living room, kitchen, hall, dining room.
At the floor, there are 3 bedrooms, kitchen and a hall.
The various plans (GF, Floor, foundation, sanitation) are presented below.

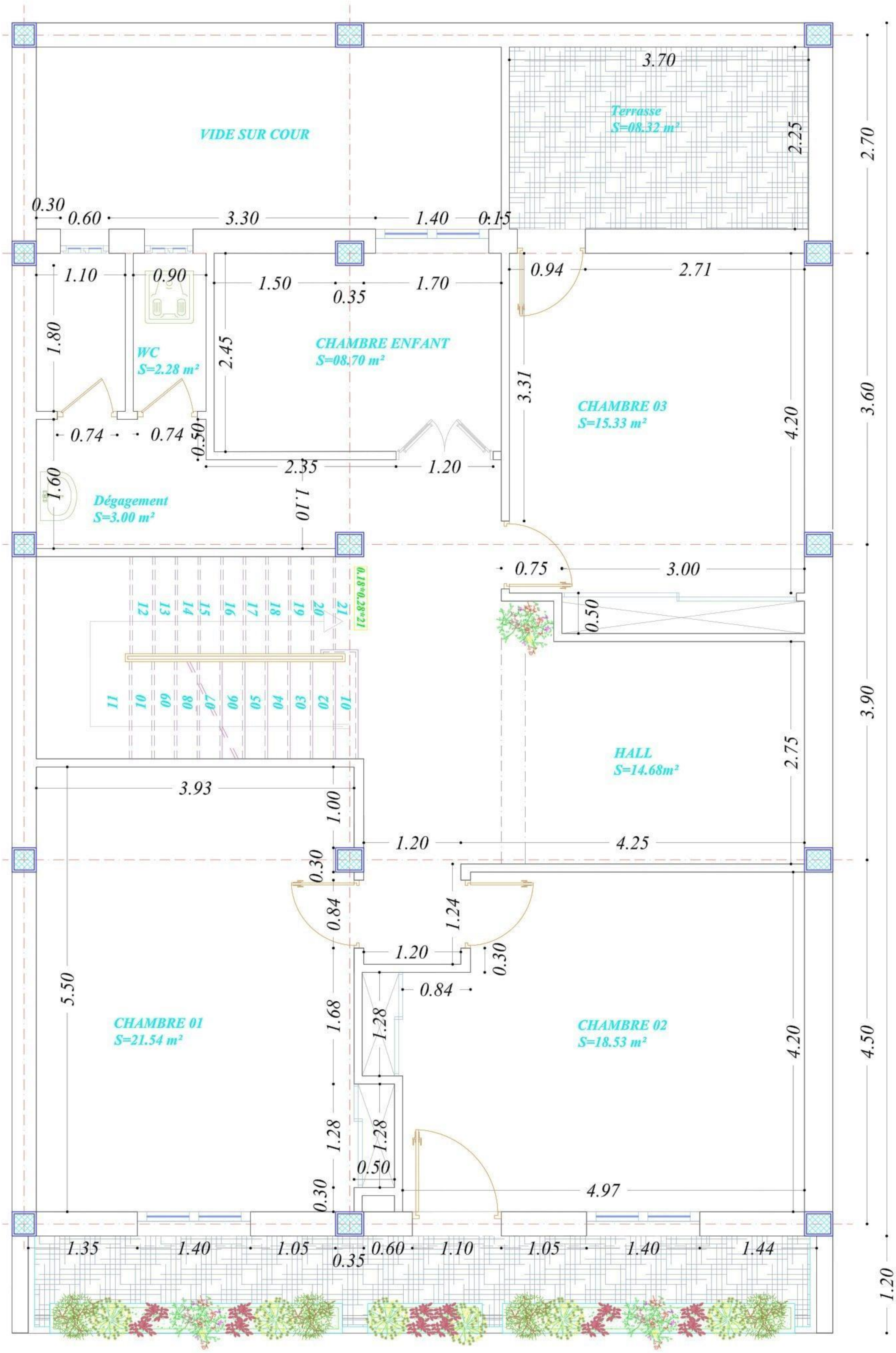
The parts to be quantified are:
a. infrastructure:
Excavations
Footings
Sills
b. Superstructure:
Columns
Beams
Floor

III.2. Plans project:

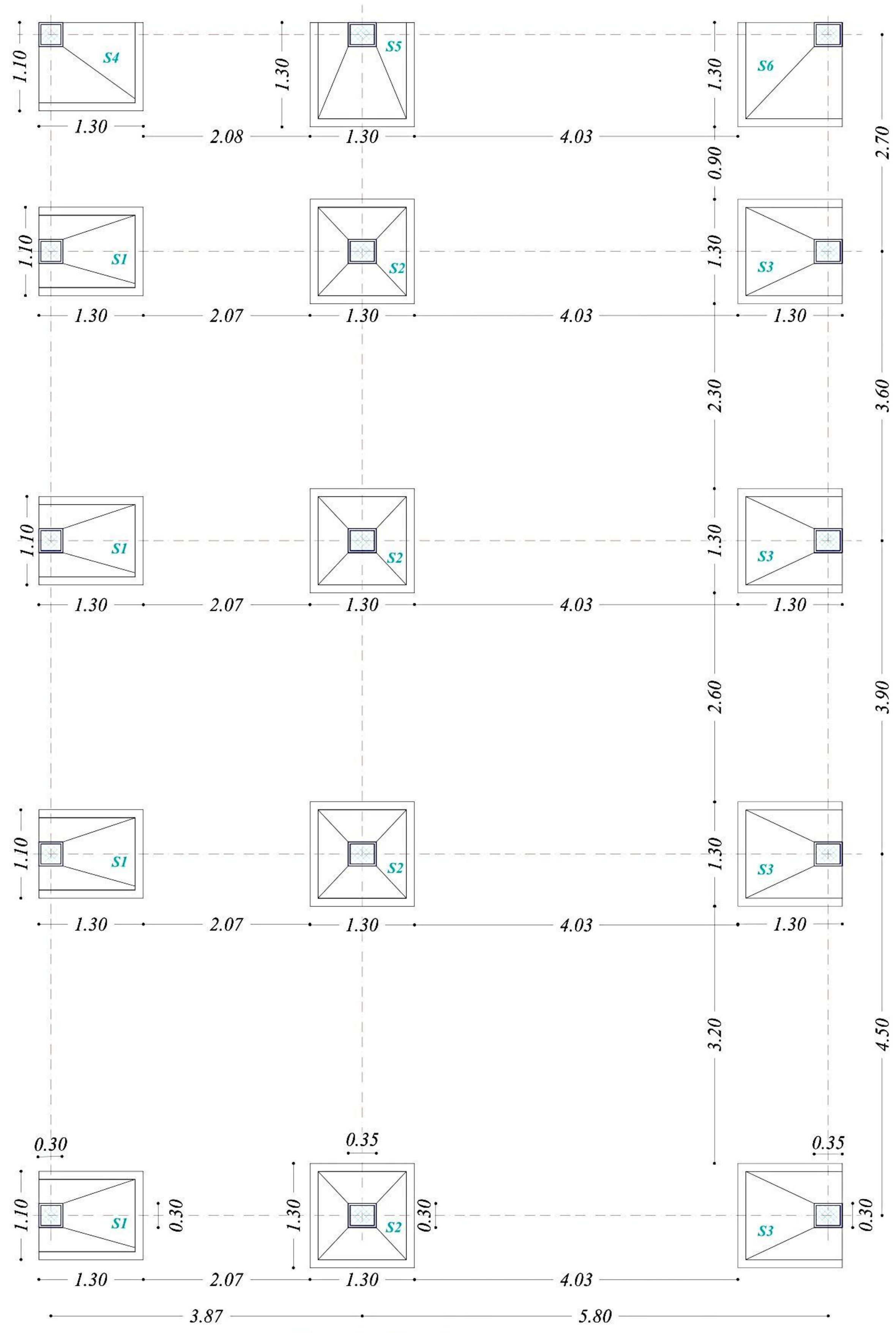
The different plans related to the project are presented as follows.


Cour
S=17.58 m²
Chambre
S=15.04 m²
SDB
S=3.84 m²
WC
S=2.28 m²
Cuisine
S=09.90 m²
Dégagement
S=3.0 m²
Salle a mangé
S=6.84 m²
Hall
S=15.08 m²
Garage
S=21.61 m²
Couloire
S=8.33 m²
Séjour
S=20.35 m²
15.00

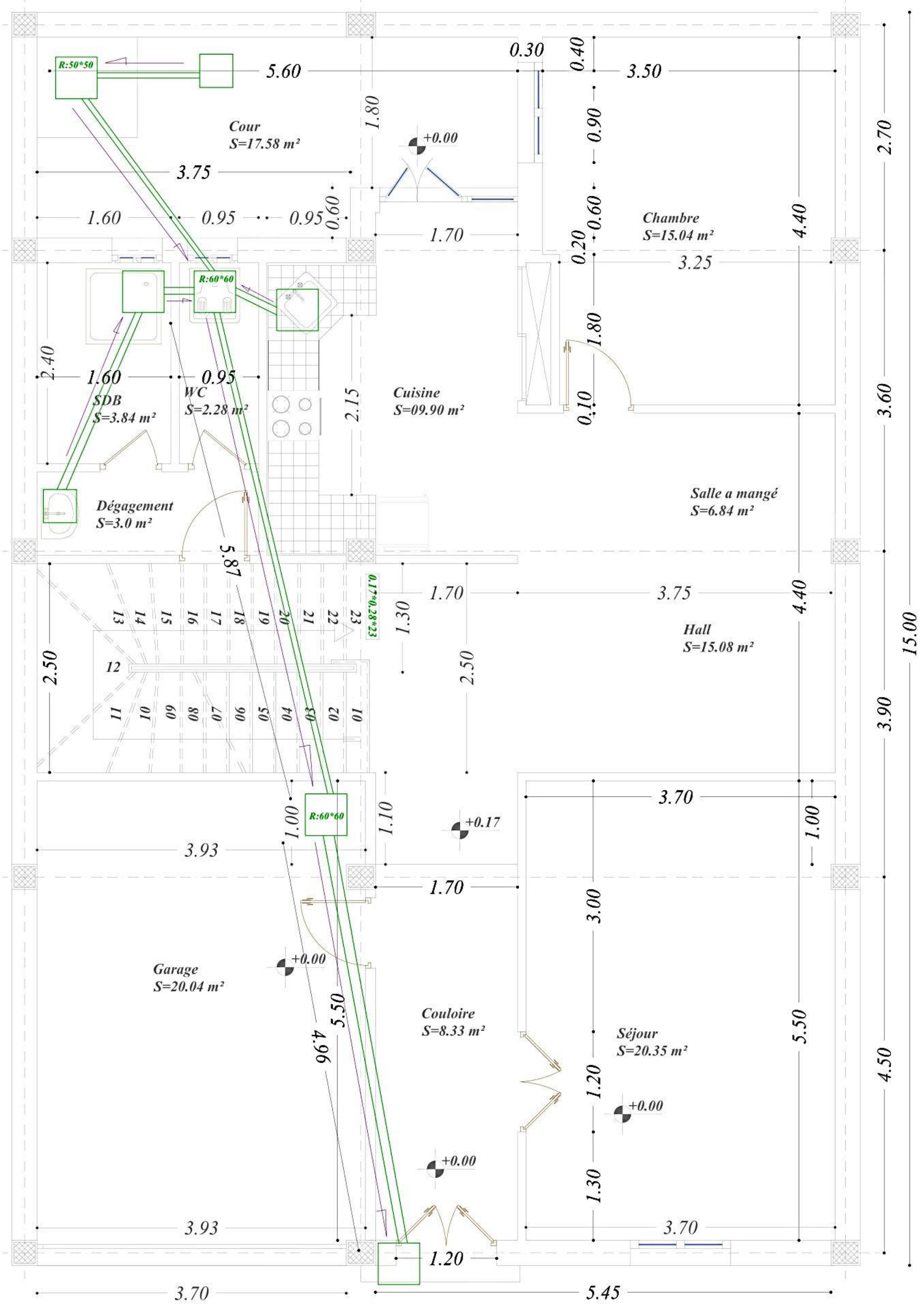
Plan de RDC



Plan du 1er Etage



Plan de Fondation



Plan de d'assinissement

III.3. Estimation of works:

A. Infrastructure:

-Calculation of the Footings:

A total of 15 footings were counted (thickness of the footing = 0.30 m)

$1.30 \times 1.30 \times 0.30 \times 10 + 1.10 \times 1.30 \times 0.30 \times 5$ =**7,23** m^3

- **Calculation of excavations :**

(Depth of the excavation = 0.96 m)

$1.70 \times 1.70 \times 0.96 \times 10 + 1.50 \times 1.50 \times 0.96 \times 5$ =**38,54** m^3

- **Calculation of concrete cover :**

(Thickness of the concrete cover = 0.10 m)

$1.60 \times 1.60 \times 0.10 \times 10 + 1.40 \times 1.40 \times 0.10 \times 5$ =**3,54** m^3

- Platform:

$(5.80-0.35) \times (4.5-0.30) = 22.89$ m^2

$(5.80-0.35) \times (3.9-0.30) = 19.62$ m^2

$(5.80-0.35) \times (3.60-0.30) = 17.98$ m^2

$(5.80-0.35) \times (2.70-0.30) = 13.08$ m^2

$(3.87-0.35) \times (4.50-0.30) = 14.78$ m^2

$(3.87-0.35) \times (3.90-0.30) = 12.67$ m^2

$(3.87-0.35) \times (3.60-0.30) = 11.62$ m^2

$(3.87-0.35) \times (2.70-0.30) = 8.45$ m^2

Total Platform area: **121,09 m^2**.

– **Sills:**

$10 \times 0.30 \times 0.30 \times 5 = 4.50\ m^3$

$13.5 \times 0.30 \times 0.30 \times 3 = 3.66\ m^3$

– **Lower column:**

$0.35 \times 0.30 \times 0{,}70 \times 15 = 1{,}10\ m^3$

Recapitulation of infrastructure work

N°	Designation	Unit	Quantity
1	Excavations for footings	M3	38,54
2	Concrete cover	M3	3,54
3	Reinforced Concrete for footing	M3	7,23
4	Lower column	M3	1,10
5	Sills (axis)	M3	4,5
6	Sills (File)	M3	3,66
7	Platform	M2	121,09

B. Ground Floor:

(Floor height =3.28 m)

– **Calculation of columns:**

$0.35 \times 0.30 \times 3.28 \times 15 = 5.16\ m^3$

– **Calculation of beams**:

a) Main beams :

$0.30 \times 0.50 \times 10.20 \times 5 = 7.65\ m^3$

b) Secondary beams :

$0.30 \times 0.40 \times 13.50 \times 3 = 4.86\ m^2$

Ground Floor

Columns

Lines	Designation	Nombres	Unit	Length	Breadth	Height	Quantity
1	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
2	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
3	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
						Total	**5,16**

Beams

a) Main beams :

lines	Designation	Nombres	Unit	Height	Breadth	Length	Quantity
1	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
2	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
3	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
4	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
5	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
						Total	**7,65**

b) Secondary beams :

Lines	Designation	Nombres	Unit	Height	Breadth	Length	Quantity
1	Reinforced concrete for secondary beams	1	M3	0,3	0,4	13,5	1,62
2	Reinforced concrete for secondary beams	1	M3	0,3	0,4	13,5	1,62
3	Reinforced concrete for secondary beams	1	M3	0,3	0,4	13,5	1,62
						Total	**4,86**

2) 1st Floor :

Calculation of columns:

$0.35\times0.30\times3.28\times15=5.16\ m^3$

Calculation of beams:

a) Main beams :

$0.30 \times 0.50 \times 10.20 \times 5 = 7.65\ m^3$

b) Secondary beams :

$(15- (0.30\times5) + 1.20) \times 0.30 \times 0.40 \times 3 = 5.28\ m^3$

1st Floor :

Columns

Lines	Designation	Nombres	Unit	Length	Breadth	Height	Quantity
1	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
2	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
3	Reinforced concrete for columns	5	M3	0,35	0,3	3,28	1,72
						Total	**5,16**

Beams

a) Main beams :

Lines	Designation	Nombres	Unit	Height	Breadth	Length	Quantity
1	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
2	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
3	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
4	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
5	Reinforced concrete for main beams	1	M3	0,3	0,5	10,2	1,53
						Total	**7,65**

b) Secondary beams :

Lines	Designation	Nombres	Unit	Height	Breadth	Length	Quantity
1	Reinforced concrete for secondary beams	1	M3	0,3	0,4	14.7	1,76
2	Reinforced concrete for secondary beams	1	M3	0,3	0,4	14.7	1,76
3	Reinforced concrete for secondary beams	1	M3	0,3	0,4	14.7	1,76
						Total	**5,28**

<u>Calculation of the floor :</u>

(5.80-0.35) × (4.5-0.30) = 22.89 m^2

(5.80-0.35) × (3.9-0.30) = 19.62 m^2

(5.80-0.35) × (3.60-0.30) = 17.98 m^2

(5.80-0.35) × (2.70-0.30) = 13.08 m^2

(3.87-0.35) × (4.50-0.30) = 14.78 m^2

(3.87-0.35) × (3.90-0.30) = 12.67 m^2

(3.87-0.35) × (3.60-0.30) = 11.62 m^2

(3.87-0.35) × (2.70-0.30) = 8.45 m^2

Total: 121,09 m^2

III.4. Cost estimating

The estimation of the cost of the project can be done either by calculating the unit prices of each item to have an exact estimate or by using the prices charged and updated by the administration/owner of the building to have a quick estimate of the works. As an example, we present below the detailed breakdown of work prices.

Concrete cover				
Labor cost : 200,00 DA/M² (1 000,00 DA/M^3)				
	Unit	Quantity	Rate/unit	Amount
Cement	Bag	3	500,00	1 500,00
Aggregates	M^3	1,5	2 000,00	3 000,00
water	L	175	1,00	175,00
Labor	Set	1	1 000,00	1 000,00
Company mobilization	Set	1	400,00	400,00
				6 075,00
Profit	10%			607,50
				6 682,50
Business activity tax	1,50%			100,24
COST PRICE				6 782,74
COST PRICE (AJUSTED)				**6 800,00**
VAT (Value Added Tax) 9%				612,00
	Sale cost including all taxes			**7 412,00**

Excavation	Unit	Quantity	Rate/unit	Amount
Wheeled excavator	H	0,5	700,00	350,00
Labor Construction worker	H	0,5	200,00	100,00
Site cost	Set	1	400,00	400,00
Profit	10%			85,00
				935,00
Business activity tax	1,50%			14,03
COST PRICE				949,03
COST PRICE (AJUSTED)				**950,00**
VAT (Value Added Tax) 9%				85,50
	Sale cost including all taxes			**1 035,50**

Reinforced concrete for columns				
Quantity of Rebar for concrete: 1,813 Q/M3 Adjusted to 1,80 Q/M3				
Labor cost : 1 000,00 DA/Ml				
	Unit	Quantity	Rate/unit	Amount
Rebar	Quintal	1,8	13 000,00	23 400,00
Cement	Bag	7	500,00	3 500,00
Aggregates	M3	1,5	2 000,00	3 000,00
water	L	175	1,00	175,00
Labor	Set	1	5 720,00	5 720,00
Site cost	Set	1	800,00	800,00
				36 595,00
Profit	10%			3 659,50
				40 254,50
Business activity tax	1,50%			603,82
COST PRICE				40 858,32
COST PRICE (AJUSTED)				**41 000,00**
VAT (Value Added Tax) 9%				3 690,00
	Sale cost including all taxes			**44 690,00**

Reinforced concrete for beams and sills				
Quantity of Rebar for concrete: 1,571 Q/M3 Adjusted to 1,60 Q/M3				
Labor cost: 1 200,00 DA/M²				
	Unit	Quantity	Rate/unit	Amount
Rebar	Quintal	1,6	13 000,00	20 800,00
Cement	Bag	7	500,00	3 500,00
Aggregates	M3	1,5	2 000,00	3 000,00
water	L	175	1,00	175,00
Labor	Set	1	4 000,00	4 000,00
Site cost	Set	1	800,00	800,00
				32 275,00
Profit	10%			3 227,50
				35 502,50
Business activity tax	1,50%			532,54
COST PRICE				36 035,04
COST PRICE (AJUSTED)				**36 000,00**
VAT (Value Added Tax) 9%				3 240,00
	Sale cost including all taxes			**39 240,00**

Mesh reinforcement Concrete for platform				
Quantity of Mesh reinforcement : 1,1 M²/M²				
Labor cost: 1 000,00 DA/M²				
	Unit	Quantity	Rate/unit	Amount
Mesh reinforcement	M²	1,1	300,00	385,00
Cement	Bag	0,5	500,00	250,00
Aggregates	M3	0,15	2 000,00	300,00
water	L	1,75	1,00	1,75
Labor	Set	1	100,00	100,00
Site cost	Set	1	100,00	200,00
				1 236,75
Profit	10%			123,675
				1 360,43
Business activity tax	1,50%			20,41
COST PRICE				**1 380,83**
COST PRICE (AJUSTED)				1 380,00
VAT (Value Added Tax) 9%				124,20
	Sale cost including all taxes			**1 504,20**

In the following table, we present the estimate cost of infrastructure works.

Abstract of estimate form for infrastructure work

N°	Designation	Quantity	Unit	Rate/unit	Amount
1	Excavations for footings	38,54	M3	1 035,50	39 908,17
2	Concrete cover	3,54	M3	7412,00	26 238,48
3	Reinforced Concrete for footing	7,23	M3	39240,00	283 705,20
4	Lower column	1,10	M3	44 690,00	49 159,00
5	Sills (axis)	4,5	M3	39240,00	176 580,00
6	Sills (File)	3,66	M3	39240,00	143 618,40
7	Platform	121,09	M2	1504,20	182 143,58
				Total	**901 352,82**

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