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Table of Contents

[1. INTRODUCTION 4](#_Toc137018841)

[2. LIFE CYCLE COST ANALYSIS (LCCA) 5](#_Toc137018842)

[2.1 INITIAL INVESTMENT COST 6](#_Toc137018843)

[2.2 OPERATION AND MAINTENANCE COST 7](#_Toc137018844)

[2.3 RESIDUAL VALUE OF THE BUILDING 9](#_Toc137018845)

[2.4 CALCULATE LCC (NPV) 10](#_Toc137018846)

[3. SENSITIVITY ANALYSIS 11](#_Toc137018847)

[4. RECOMMENDATION 12](#_Toc137018848)

# INTRODUCTION

Life cycle cost analysis (LCCA) is a systematic method of evaluating the total expenses of facilities throughout their lifetime. It examines all costs involved in facility ownership, including construction, operational expenses, and ongoing maintenance. In LCCA, alternatives are evaluated for their net present value (NPV) or their total net benefits to ascertain their value in comparison to the total cost.

In the specific case of our paper, we conducted a life cycle analysis of different flooring types. Our study examined solid slabs, ribbed slabs, and prefabricated slabs and found that each of them has its own unique advantages and disadvantages.

Solid slabs are made of concrete and are an excellent choice for both residential and industrial construction. They are relatively simple to construct and have a long lifespan. However, the total cost associated with the amount of material required for constructing the slab can be high.

Ribbed slabs, on the other hand, are also made of concrete, but they have ribs that help support the weight of the slab, which makes them lighter and more efficient than solid slabs. Despite their lightweight features, they may be more difficult to construct, and more formwork may be required in the construction process.

Prefabricated slabs are made entirely in factories and then transported to the construction site. This makes them faster and more efficient to assemble than either ribbed or solid slabs. However, they can be more costly than other types of slabs, and their use may be limited to certain types of construction projects.

Overall, our study found that each type of slab has its strengths and weaknesses. Based on the specific needs and cost requirements of construction projects, contractors must evaluate different types of slabs and assess the LCCA to determine which is the best option for maximizing value while minimizing overall costs.

# LIFE CYCLE COST ANALYSIS (LCCA)

The life cycle cost analysis for flooring of different types of construction methods including:

* Solid slab
* Ribbed slab
* Precast slab

The objective of this evaluation is to identify the most economical technique for constructing slab from the available options. To achieve this, six measures have been incorporated to assess the life cycle cost of different materials.

* First calculate the initial investment required from the takeoff
* Then calculate the operation and maintenance cost for each construction methods.
* Then calculate operation and maintenance cost of each material,
* Then calculate the residual value of the building, and draw LCC diagram
* Then Calculate LCC by considering discount rate.

The steps mentioned above are done for all three types of floor construction methods.

Components of the flooring systems

1. **Solid slab**
2. Concrete
3. Reinforcement bar
4. Formwork

**2. Ribbed slab resource needs**

A. Ribbed beams

B. Ribbed blocks

C. Reinforcement bar

**3. Precast slab resource needs**

A. Precast beams

B. Precast slab panels

**Given Information**

* It is assumed that all the proposed building materials have same useful life under their categories. For instance, all structural framing building alternatives have same useful life.
* Assumptions are taken that the useful life of the new housing project is to be 50 years.
* The residual value of the investment options has one third of their initial investment cost.
* Discount rate of 10% is considered by the FHC normally for analysis of investment appraisal options. And to simplify the analysis, it is assumed that all operation costs are incurred uniformly over the construction period.
* In addition to this, assumptions are taken for other necessary information reasonably at each topic.

## 2.1 INITIAL INVESTMENT COST

**Solid Slab**

The investment cost for solid slab or cast in situ reinforced concrete slab

In this step, we have formulated a cost breakdown for all the materials or resources needed for the construction of a solid slab to determine the unit rate of each work item. As we can see from the BOQ for the constructed solid slab unit rate, the total cost of all 7-story building slab construction if cast in situ reinforced concrete was used, will cost 218,893,180.4 ETB *(from solid slab BOQ summary)* which indicates the investment made if we construct our floor by using cast in situ reinforced concrete (solid slab).

Total cost before VAT = 190,341,896 ETB *(direct and indirect cost)*

VAT 15% = 190,341,896 ETB\*0.15 = 28,551,284.4 ETB

Total cost after VAT = 190,341,896 ETB + 28,551,284.4 ETB = 218,893,180.4 ETB

**Ribbed slab**

Investment cost for when we use ribbed slab

In this step, we have formulated a cost breakdown for all the resources that are required to construct a ribbed slab. As we can see from the BOQ constructed using a ribbed block and ribbed beam. The total cost of all 7-story building slab construction if the ribbed block construction method is used will cost 18,256,444.26 ETB *(from ribbed slab BOQ summary).* This indicates how much will be invested if we construct our floor by using ribbed slab.

Total cost before VAT = 15,875,168.93 ETB *(direct and indirect cost)*

VAT 15% = 15,875,168.93 ETB\*0.15 = 2,381,275.33 ETB

Total cost after VAT = 15,875,168.93 ETB + 2,381,275.33 ETB = 18,256,444.26 ETB

**Prefab Slab**

The investment cost for when we use precast slab

In this step, we have formulated a cost breakdown for all the resources that are required to construct a precast slab. As we can see from the BOQ constructed using pa recast beam and precast panel. The total cost of all 7-story building slab construction if the precast slab construction method is used will cost 8,784,122.809 ETB*(from precast BOQ summary). Grouting and other installation are not included.* This indicates how much will be invested if we construct our floor by using the precast slab method.

Total cost before VAT = 7,638,367.66 ETB *(direct and indirect cost)*

VAT 15% = 7,638,367.66 ETB\*0.15 = 1,145,755.149 ETB

Total cost after VAT = 7,638,367.66 ETB + 1,145,755.149 ETB = 8,784,122.809 ETB

## 2.2 OPERATION AND MAINTENANCE COST

**Solid Slab**

Maintenance period every 10 years up to the design period

The maintenance cost for the solid slab will be

1. **Plastering due to crack in the soffit**

The plastering rate from the breakdown is 432 ETB/m2.

Therefore, the total maintenance cost for plastering will be = 432 ETB/m2\*809/m2 = 349,488 ETB *(assuming that this is the maintenance cost incurred for plastering every ten years)*

1. **Painting of the soffit**

The painting rate of the soffit from the breakdown is 210.6 ETB/m2.

Therefore, the total maintenance cost for painting will be = 210.6 ETB/m2 \*809m2 = 170,375.4 ETB *(assuming that this is the maintenance cost incurred for painting every ten years)*

349,488 ETB + 170,375.4 ETB = 519,863.4 ETB *(assuming that this is the solid slab maintenance cost every ten years)*

**Ribbed Slab**

Maintenance period every 10 years up to the design period

The maintenance cost for the ribbed slab will be

1. **Plastering due to crack in the soffit**

The plastering rate from the breakdown is 432 ETB/m2.

Therefore, the total maintenance cost for plastering will be = 432 ETB/m2\*809/m2 = 349,488 ETB *(assuming that this is the maintenance cost incurred for plastering every ten years)*

1. **Painting of the soffit**

The painting rate of the soffit from the breakdown is 210.6 ETB/m2.

Therefore, the total maintenance cost for painting will be = 210.6 ETB/m2 \*809m2 = 170,375.4 ETB *(assuming that this is the maintenance cost incurred for painting every ten years)*

349,488 ETB + 170,375.4 ETB = 519,863.4 ETB *(assuming that this is the solid slab maintenance cost every ten years)*

**Precast Slab**

The precast panels are manufactured with a finishing surface therefore plastering is not required the only maintenance consideration is painting the soffit.

Maintenance period every 10 years up to the design period

The painting rate of the soffit from the breakdown is 210.6 ETB/m2

*Therefore, the total maintenance cost for painting will be = 210.6 ETB/m2 \*809m2 = 170,375.4 ETB (assuming that this is the maintenance cost incurred for painting in every ten years)*

## 2.3 RESIDUAL VALUE OF THE BUILDING

We have given the residual value of the investment options have one third of their initial investment cost.

**Solid Slab**

Residual Value = 1/3\*218,893,180.4 ETB **=** 72,964,393.467ETB

**Ribbed Slab**

Residual Value = 1/3\*18,256,444.26 ETB = 6,085,481.42 ETB

**Precast Slab**

Residual Value = 1/3\*1,145,755.149 ETB = 381,918.383 ETB

## 2.4 CALCULATE LCC (NPV)

NPV is calculated by considering 10% discount rate.

NPV = Income – Expenses

NPV = -I + (PMT x ((1 - (1 + r)^-n) / r))

Where; - PMT = the periodic payment

r = the interest rate per period

n = the number of periods

I = the initial investment

**Solid Slab = -146,247,769.98 ETB**

**Ribbed Slab = -12,489,945.88 ETB**

**Prefab Slab = -8,506,745.136 ETB**

# SENSITIVITY ANALYSIS

By performing a sensitivity analysis, cost-efficient approaches can be evaluated and decision-makers can select the most cost-effective solution that maximizes profits and minimizes costs. Sensitivity analysis can also identify areas of potential risk and uncertainty, allowing managers to prepare contingency plans to mitigate any potential negative impact on the project. Overall, sensitivity analysis is an essential decision-making tool to achieve cost efficiency in any business process or project.

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| --- | --- | --- | --- |
| Costs | Solid slab | Ribbed slab | Prefabricated |
| Operation and maintenance cost |  |  |  |
| Residual value 1/3\*IC |  |  |  |
| Revenue |  |  |  |
| Renovation cost |  |  |  |
| Discount rate | 0.1 | 0.1 | 0.1 |
| Service year | 50 | 50 | 50 |

# RECOMMENDATION

Comparing the life cycle cost of the house with different construction techniques of the floor (solid slab, ribbed slab and precast slab) by making the other elements of work cost constant. Therefore, the alternative building technique among the above three with respect to LCC is

1. The precast slab flooring is the top option for reducing life cycle costs. It requires minimal initial investment and less labor, saving time and reducing potential cost variations caused by extended construction periods. It also has a hard surface that requires minimal finishing.
2. Ribbed slab flooring is the second-cost-effective alternative. It requires less labor than solid slabs as the ribbed beams and blocks are pre-manufactured. Additionally, its lightweight characteristics minimize foundation construction costs such as footings, foundation columns, and grade beams.
3. Solid slab flooring is the last among the three alternatives due to its high labor and construction time requirements. Moreover, its maintenance costs are more significant than precast slab flooring.