Economical Structural Design of Mosque by Using Software

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Abstract

Mosques are very important buildings in the Islamic world countries, especially in Saudi Arabia, the goal of this project is to develop a mosque with open areas, vast spans, and a few columns that is economically designed.

The modeling procedure for three different models, each with a span of 8.33, 10 and 12.5 meters. For this project, analysis and design for Dome, Ring beam, Ribbed slab, Beams, Columns and Footings, Autodesk Revit is used to create the models. Robot structural analysis is used for analysis and design. Microsoft Excel is used to compare the results with our calculations

Three systems of the one-way ribbed slab system were designed; their quantities were calculated using a robot program, and their costs were calculated manually. After calculating the costs, we noticed that the largest percentage of the costs went to the slabs and beams. As for the columns and footings, their percentage was small compared to the beams and the slab. After that, an equation was developed to calculate the cost based on the span, and then the results were compared with other structural systems. The optimum system 10x10 was chosen, and the dome and a ring beam were designed on it, and their costs were calculated. We found that their impact was increasing in cost by 0.7% on the total cost which means no effect in cost if dome and ring beam are provided.

Problem Statement

This project will present the analysis and design of reinforced concrete mosque with different spans by using software, also will provide the effect of decreasing the number of interior columns on the cost of structural design of Mosque.

Project Objectives

- Learning how to use different software in design and analysis of (Dome, Ring beam, Ribbed slab, Beams, Columns and Footings)
- Apply what we have learned to a real project.
- Learn how to write and read research and scientific papers.
- Use of standards and appropriate constraints, such as economic factors and safety
- Reporting and presenting a teamwork effort.
- Understanding the importance of professional and ethical responsibility.
- Preparation of Excel sheets for load calculation and design.
- Represent the data by using Power BI

Models

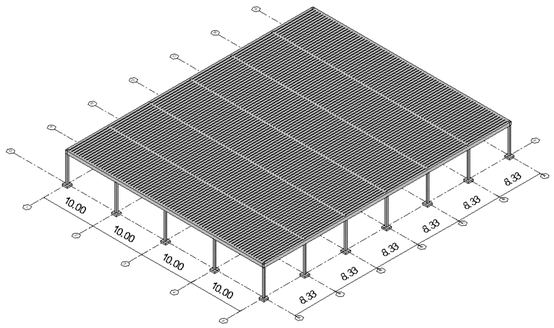

Figure 1: 3D Modeling for 8.33 x 10 m spans

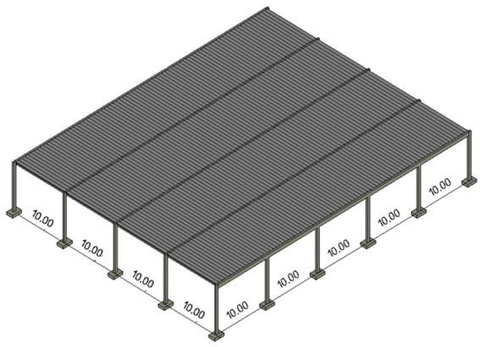

Figure 2: 3D Modeling for 10 x 10 m spans

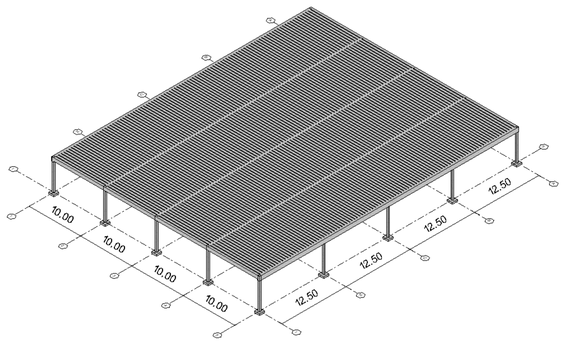

Figure 3: 3D Modeling for 12.5 x 10 m spans

Results

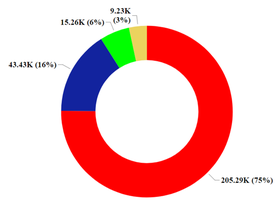

Figure 4: Detailed cost of the 8.33m span system

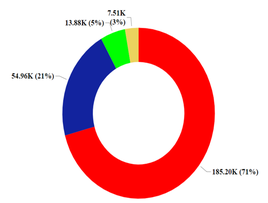

Figure 5: Detailed cost of the 10m span system

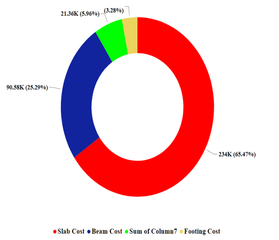

Figure 6: Detailed cost of the 12.5m span system

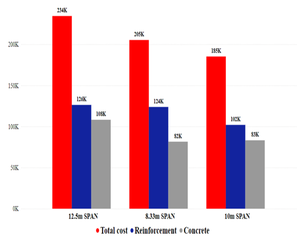

Figure 7: Comparing the costs of slab in different systems

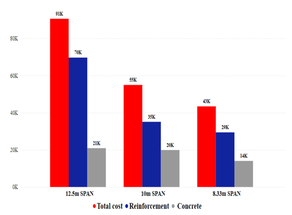

Figure 8: Comparing the costs of beams in different systems

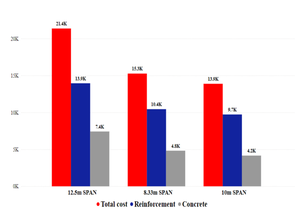

Figure 9: Comparing the costs of columns in different systems

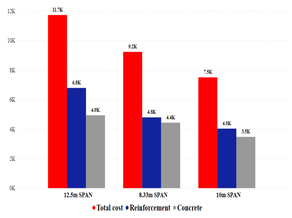

Figure 10: Comparing the costs of footings in different systems

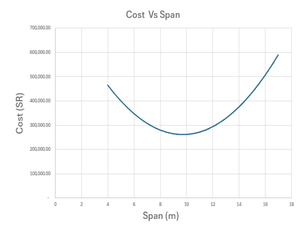

Figure 11: Curve developed for selecting the optimum span

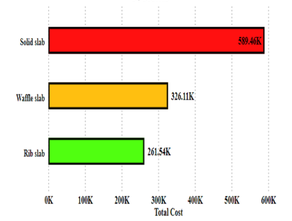

Figure 12: Comparing costs of different Structural systems.

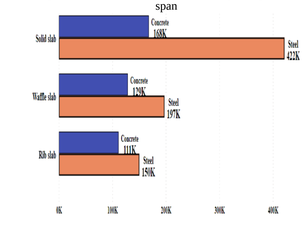

Figure 13: Comparing materials costs of different Structural systems.

Dome Analysis & Design

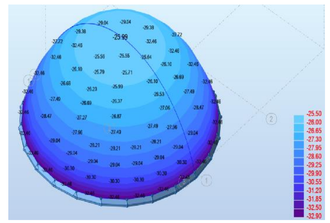

Figure 14: meridian force analysis by Robot structural analysis

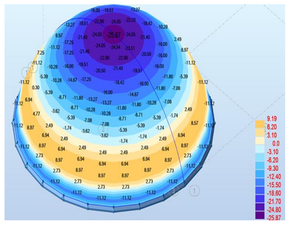

Figure 15: Ring force analysis by Robot structural analysis

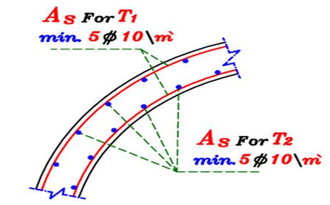

Figure 16: Cross-Section of dome

Table 1: Detailed cost of dome

DOME COST	
Concrete Volume (m^3)	30.56399
Cost of concrete (SR)	6331.637
Amount of Steel (KG)	3826.942
Cost of steel (SR)	12580.81
Total Cost of dome (SR)	18912.44

Optimum Model

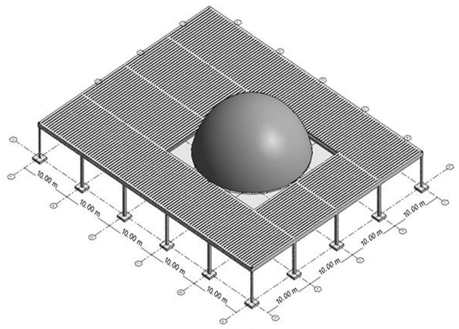

Figure 17: 3D model of optimum system

Table 2: Optimum model information

Optimum Model		
General	Area	2000 m^2
	Span	10 x 10 m
	Height	13 m
	No. of worshippers	3000
	Structural system	One-way Ribbed slab
Cost (SR)	263,355.84	

Recommendations

- We recommend adding a dome and ring beam because it gives an aesthetic addition, gives a long span in the middle of the mosque, and will not increase costs.
- A one-way joist system will be a more economical structural system for spans of 8–12 m.