Assessment of Different Reinforced Concrete Slab Systems in High-Rise Structures

Ali Alqarni

March 15, 2024

Assessment of Different Reinforced Concrete Slab Systems in High-Rise Structures

Ali Alqarni[1]

[1]Department of Civil Engineering, Kansas State University, Manhattan, KS 66506, USA

March 13, 2024

Abstract

This research is centered on examining high-rise reinforced concrete residential structures, specifically integrating three distinct slab systems: solid slab (SS), flat slab (FS), and hollow block slab (HB). The scope of the study expands to include the evaluation of a tall building comprising 60 floors, comparing the three slab systems in terms of base shear, moment, and maximum displacement in both directions under lateral loads. The comparison adheres to the requirements outlined in the American Concrete Institute's ACI 318-11 code.

1 Introduction

The objective of this study is to cultivate a comprehensive understanding of structural engineering principles through the meticulous design and analysis of low, mid, and high-rise buildings. By delving into the specifics of various slab types, including solid, flat, and hollow block slabs of the building that was design by Sayed and Ali [1, 2], participants will gain insights into the complexities of creating structures that are both sturdy and efficient. A significant emphasis is placed on designing buildings capable of withstanding the forces exerted by natural phenomena such as earthquakes and wind, ensuring that they meet the highest standards of safety and durability. Furthermore, this study will explore the practical application of the CSI structural package, utilizing advanced software tools like SAP2000 and ETABS, to model and analyze the proposed designs. This initiative promises a holistic approach to learning, equipping participants with the knowledge and skills to design buildings that are not only aesthetically pleasing but also robust, resilient, and compliant with contemporary engineering standards.

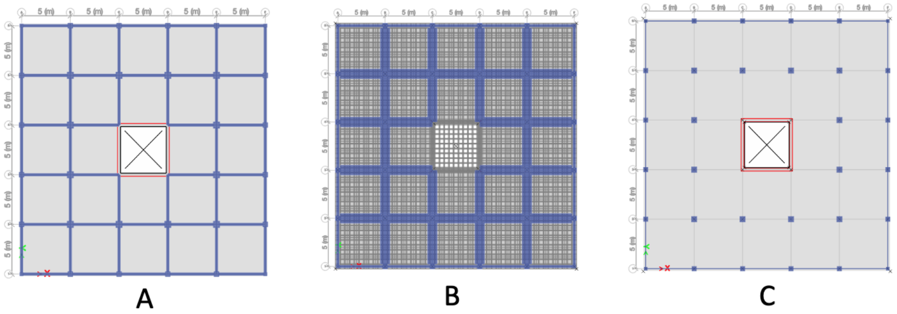

Figure 1: (A) Soild Slab [SS]; (B) Hollow Blocks [HB]; (C) Flat Slab [FS]

2 Results & Discussion

Throughout the study, a comprehensive exploration of the intricacies of reinforced concrete building designs, varying in height and structural systems, was embarked upon. This exploration equipped us with the necessary skills to identify and implement the most appropriate footing systems, designed to support specified loads efficiently. Our capabilities were further enhanced by our ability to analyze the performance of various structural systems when exposed to lateral forces, such as earthquake loads.

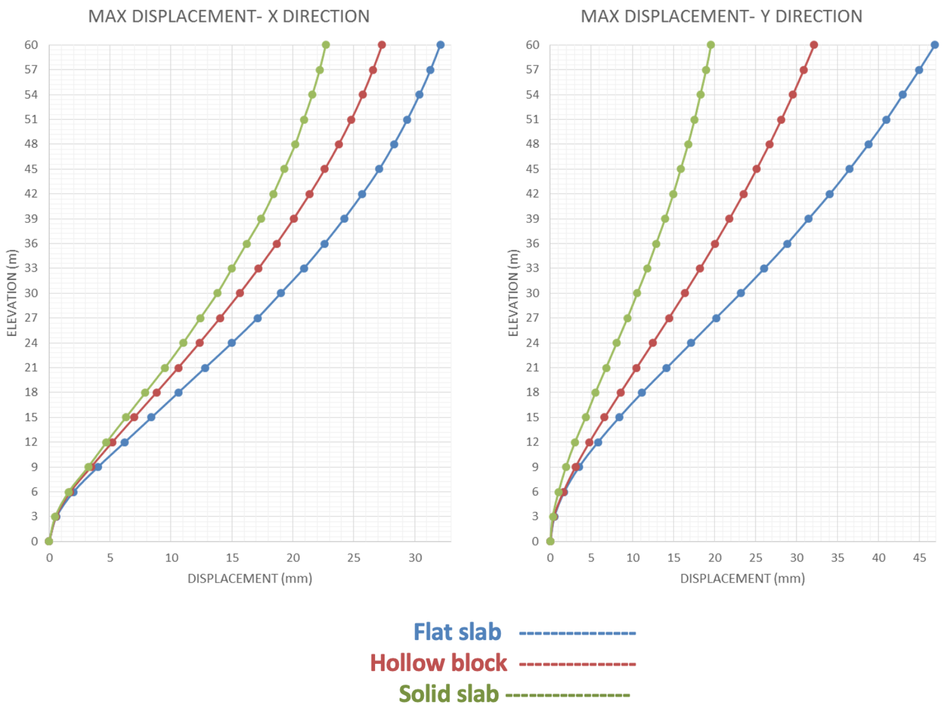

Figure 2: The floor's Displacement (mm)

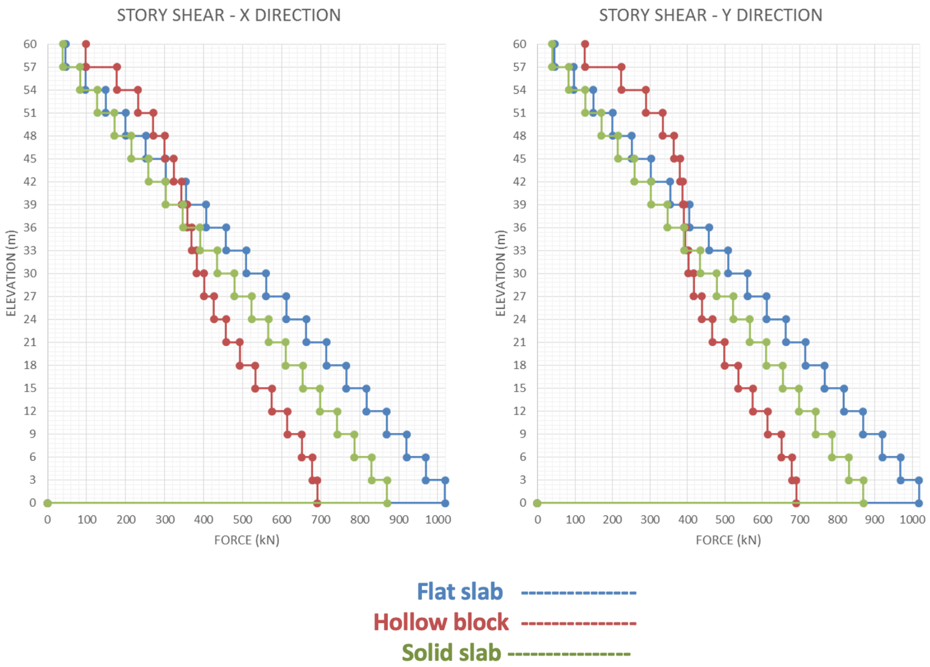

Figure 3: The floor's Shear (KN)

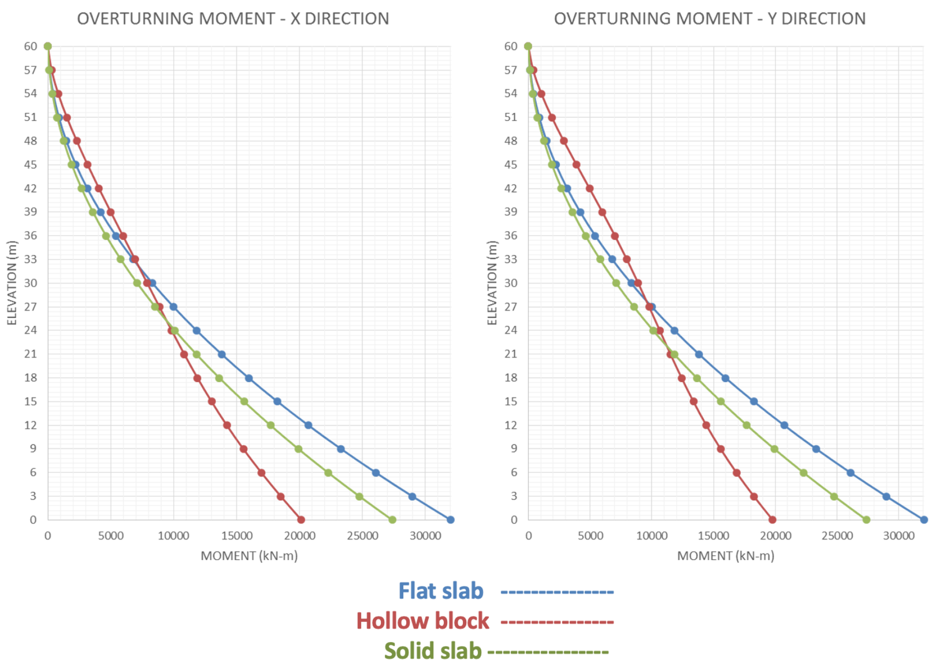

Figure 4: The floor's Moments (KN-mm)

The process also involved detailed quantity take-offs, further enriching our practical understanding. A significant aspect of our learning journey was the adept use of structural software packages for modeling and designing diverse structural components. Engaging with real-life engineering challenges, our theoretical knowledge was rigorously applied, particularly during the various phases of the real-life project. This hands-on experience has not only solidified our understanding but also prepared us for the practical demands of the civil engineering field. Sincere acknowledgements are extended to all those who have guided and supported us throughout this educational endeavor.

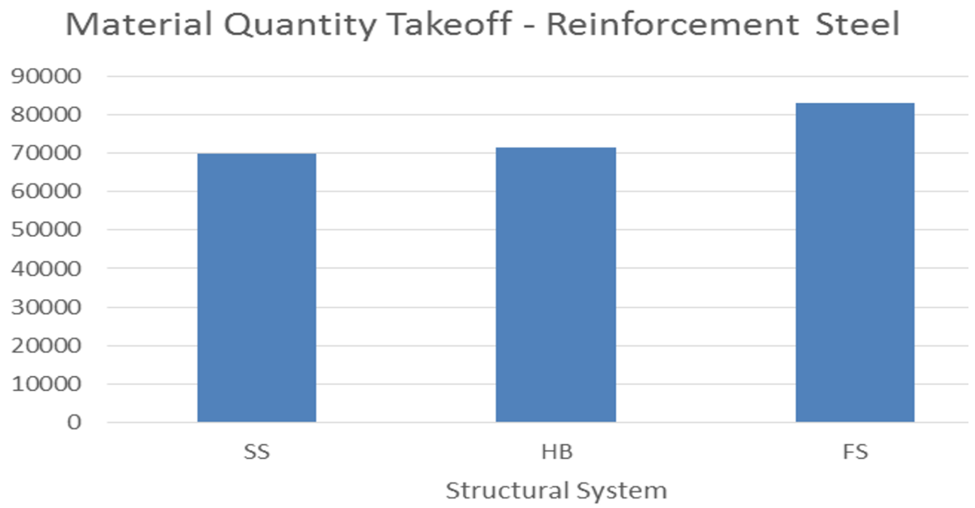

Figure 5: Material Quantity Takeoff - Reinforcement Steel (in Kg)

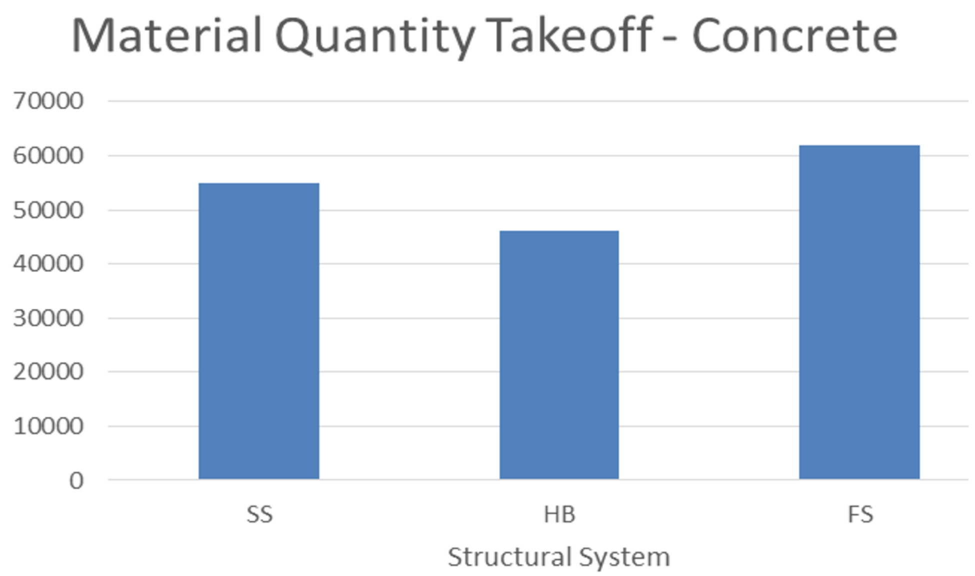

Figure 6: Material Quantity Takeoff - Concrete (in KN)

3 Conclusion

In summary, the comparative study of slab systems in high-rise reinforced concrete buildings reveals distinct differences in performance and cost. The flat slab system exhibits the highest top displacement and base shear values, suggesting it is less stiff but incurs higher costs due to greater steel usage. In contrast, the solid slab system demonstrates lower displacement, indicating better stiffness, while the hollow block system offers the lowest cost due to reduced concrete consumption. These findings emphasize the importance of carefully selecting a slab system that balances structural efficiency with economic feasibility.

References

[1] A. Alqarni, ”Influence of Concrete Floors on Buildings Near Fault Regions,” Master's thesis, University of Dayton, OhioLINK Electronic Theses and Dissertations Center, 2020. http://rave.ohiolink.edu/etdc/view?acc_num=dayton1608378695834876.

[2] S. Mahmoud, A. Alqarni, J. Saliba, A. H. Ibrahim, and H. Diab, ”Influence of floor system on seismic behavior of RC buildings to forward directivity and fling-step in the near-fault region,” Structures, vol. 30, pp. 803-817, 2021, Elsevier. https://doi.org/10.1016/j.istruc.2021.01.052.