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# Parametric Analysis of the Static Behavior of Long Cylindrical Concrete Thin Shells under Self-Weight Loading

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**ABSTRACT**

In this study, a comprehensive parametric investigation of the static behavior of long cylindrical concrete thin shells subjected to self-weight loading is presented. The analysis was conducted using the ANSYS software, and the effects of three factors, namely span, central angle, and thickness, were systematically examined. It was observed that the central angle, thickness, and span significantly influenced the shells' performance. Specifically, larger central angles led to increased deflection under loading, and thicker shells demonstrated enhanced resistance to buckling. Furthermore, the shell's span was found to have a notable impact on its overall behavior, with longer shells exhibiting greater deflection compared to shorter ones. The obtained results were compared with a numerical model from previous research, showing a difference of less than 5%. This close agreement lends credence to the study's conclusions and interpretations. The findings of this investigation contribute valuable insights to the field of cylindrical concrete thin shells, providing a solid foundation for future research and practical applications.

## 1. INTRODUCTION

Concrete structures are extensively employed in modern construction, and comprehending their behavior under various loading conditions is vital for ensuring their safety and longevity. One type of concrete structure that has attracted significant attention in recent years is the long concrete thin shell, often utilized in the construction of large-span structures such as roofs, domes, and vaults. The behavior of these structures is intricate, and their structural performance is heavily influenced by their geometric and material properties.

Cylindrical reinforced concrete shells are a common choice for covering expansive spaces, with long ($L/R \geq 2.5$) and short ($L/R<2.5$) shells being the two primary types [1]. Long shells are typically used for factory roofs, while short shells are suitable for aircraft hangars. As the L/R ratio decreases, the ultimate load capacity of reinforced concrete shell models increases; however, short shells exhibit less ductile behavior compared to long shells [2].

In recent years, numerous researchers have investigated the static behavior of cylindrical concrete thin shells using finite element analysis. This paper presents a review of recent studies in this area, their respective methodologies, and limitations. Lu and Jing [3] explored the structural feasibility of an arched shell roof structure system for a warehouse measuring 36m×20m. Numerical simulations were performed using the ANSYS finite element method for an arched shell roof structure with a thickness of 150mm. The results demonstrated that the deformation and stress met specification requirements, indicating that the selection of an arched shell roof system is feasible. Lende and Talikoti [4] conducted a parametric study by analyzing multiple cylindrical shells for different parameters using the computer analysis program SAP 2000. They examined two-dimensional models with span lengths of 10m and 12m and a length-to-width ratio of 3, altering the radius and shell thickness. The study concluded that the structural behavior differed across the dimensional models.

David [2] presented a nonlinear finite element analysis of reinforced concrete cylindrical shells and investigated their behavior under monotonically increasing loads. The three-dimensional model of six small-scale experimental shells with length-to-radius ratios ranging from 0.84 to 5.0 was analyzed using the ANSYS computer code. The nonlinear response was traced throughout the entire load range up to failure, revealing that cracking occurs at working load levels, with a subsequent reduction in shell stiffness. Increasing loads led to varying failure modes, from beam failure in long shells to combined longitudinal and transverse cracking in intermediate-length shells and abrupt diagonal with limited transverse cracking in short shells.

Sharei et al. [5] performed an experimental investigation on the load-bearing behavior of lightweight, textile-reinforced concrete barrel vault shells and compared test results with nonlinear finite element simulation results. Do et al. [6] conducted an ANSYS numerical simulation study to examine the stress and strain states of double-layer doubly curved concrete shell roofs. They changed initial parameters, such as layer thickness, the location of the steel fiber concrete layer within the structure, and the steel fiber content contained in the concrete shell for a 3000×3000 mm shell. The experimental and simulation results were verified against each other, and it was found that the optimal bearing capacity of the curved shell roof was achieved when the steel fiber concrete layer was placed below the normal concrete layer, the percentage of steel fibers contained in the concrete was 2%, and the thickness was