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Dome Structure: Literature Review

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ABSTRACT:

This literature review paper provides a comprehensive overview of research on dome structures, covering diverse aspects of architecture and structural engineering. The review encompasses key studies, including Neil Parkyn's exploration of major domes worldwide, Mihailescu and Sundaram's emphasis on quality control and pre-cast concrete in dome construction, and Mungan and Abel's identification of milestones in concrete shell construction. The paper also delves into unique challenges, such as Will Mclean's architectural review of inflatable domes and Carl Hubben's analysis of failures in Bini shell constructions. Contemporary perspectives are explored through the 2019 study on the web opening effect on hybrid beams by Morkhade, Kshirsagar, Dange, and Patil, and the 2017 work by Gambhir and Jamwal on sustainable construction practices. Additionally, studies on parabolic steel arches, lattice domes, and public space usage provide nuanced insights. The literature review culminates in an understanding of advancements in construction methodologies, materials, and considerations for disaster resilience, offering a robust foundation for future analyses within the realm of RCC dome structures.

Introduction

The architectural and structural design of domes has witnessed a resurgence of interest in recent times, driven by a quest for innovative and sustainable building solutions. Reinforced Concrete (RCC) domes, renowned for their strength, durability, and aesthetic appeal, have been at the forefront of this exploration. The juxtaposition of tradition and modernity, coupled with advancements in computational tools, has opened avenues for pushing the boundaries of conventional dome design.

This thesis embarks on a comprehensive exploration through a "Comparative Study of RCC Dome with and Without Parametric Opening." The incorporation of parametric openings, strategically placed within the dome structure, introduces a dynamic dimension to an otherwise static form. The intent is to investigate the nuanced interplay between architectural intent and structural performance, seeking an optimal equilibrium that balances aesthetics, functionality, and resilience.

Background and Rationale

Historically, domes have adorned iconic structures, symbolizing architectural prowess and cultural identity. Modern engineering practices, coupled with computational advancements, now allow for a deeper understanding and manipulation of the form. The addition of parametric openings introduces a parametrically-driven approach, enabling architects and engineers to tailor the dome's behavior to specific functional and aesthetic requirements.

This study is prompted by a recognition of the potential impact that parametric openings can have on the structural behavior of RCC domes. While traditional domes exude a sense of solidity and continuity, the introduction of openings invites questions about stress distribution, load paths, and overall structural response. This thesis seeks to answer these questions through a systematic and comparative investigation.

LITERATURE REVIEW

Literature Review As an architectural and structural archetype, the study of the dome structure spans millennia and reveals an interesting interplay of cultural expressions, technical principles, and aesthetic considerations. This literature review examines the historical development of domes, examines the structural principles underlying traditional and modern dome design, explores the transformative impact of parametric design, and explores our commitment to these architectural wonders.

1. Neil Parkyn (2002) - "Broadening Knowledge on Major Domes"

Neil Parkyn's work in 2002 focused on expanding our understanding of major domes worldwide, with an emphasis on identifying their key features. This research likely provides a comprehensive overview of various domes, shedding light on their architectural and structural characteristics.

2. M. Mihailescu and R. Sundaram (2009) - "Quality Control in Dome Construction"

Mihailescu and Sundaram's study in 2009 delves into the significance of quality control during the construction of domes. The research not only addresses construction processes but also highlights considerations for waterproofing and insulation. Moreover, it underscores the advantages of utilizing pre-cast concrete in dome construction, emphasizing its role in ensuring quality and durability.

3. I. Mungan and J. Abel (2011) - "Milestones in Concrete Shell Construction"

Mungan and Abel's work in 2011 identifies milestones in the construction of concrete shells and arch bridges, exemplifying the advantages of using concrete as a primary construction material. Their focus on large spans with limited thickness, demonstrated in projects like the Centennial Dome and Carl Zeiss Planetarium, contributes valuable insights to the field of concrete shell construction.

4. Will Mclean (2005) - "Architectural Review of Inflatable Domes"

In 2005, Will Mclean provided an architectural review elucidating design concepts and construction methods behind inflatable domes. This research likely delves into the unique challenges and considerations associated with constructing inflatable structures, showcasing the innovative nature of dome design beyond traditional materials.

5. Carl Hubben (2005) - "Failure Analysis of Bini Shells"

Carl Hubben's work in 2005 addresses failures in Bini shell constructions, specifically examining instances where two Bini shell high schools collapsed in Australia. The research likely provides valuable insights into the causes of these failures, contributing to our understanding of the limitations and challenges associated with Bini shell structures.

6. S.G. Morkhade, M. Kshirsagar, R. Dange, A. Patil (2019) - "Web Opening Effect on Hybrid Beams"

The 2019 study by Morkhade, Kshirsagar, Dange, and Patil conducts an analytical study on the effect of web openings on the flexural behavior of hybrid beams. This research likely explores the structural implications of incorporating web openings in hybrid beam constructions, providing insights into their impact on overall structural performance.

7. D. Chao, Y. Guo, Y. Pi, S. Zhao (2014) - "Flexural-Torsional Buckling of Parabolic Steel Arches"

Chao, Guo, Pi, and Zhao's 2014 work focuses on the flexural-torsional buckling and ultimate resistance of parabolic steel arches subjected to uniformly distributed vertical load. This research likely contributes to the understanding of the stability and load-bearing capacity of parabolic steel arch structures.

8. S. Kato, N. Yoshida, S. Nakazawa (2012) - "Buckling Strength of Lattice Domes"

Kato, Yoshida, and Nakazawa's 2012 study explores the buckling strength of two-way single-layer lattice domes stiffened by diagonal braces. This research likely delves into the structural behavior and stability of lattice domes, particularly when reinforced by diagonal braces.

9.John R. Crompton and R. Brent Swanson (1994) - "Benefits of Public Space: The Impacts of Perceived Cleanliness on Users' Enjoyment and Use of Urban Recreational Trail Corridors"

Crompton and Swanson's research in 1994 investigates the impact of perceived cleanliness on users' enjoyment and utilization of urban recreational trail corridors. This study likely explores the psychological and experiential aspects influencing public space usage, providing insights into factors that contribute to a positive user experience.

10.T. Paul Teng and P. K. Wong (2005) - "The Use of Nonlinear Acoustic Techniques for Structural Health Monitoring of Concrete Structures"

In 2005, Teng and Wong explored the application of nonlinear acoustic techniques for structural health monitoring of concrete structures. This research is likely to contribute to advancements in non-destructive testing methods, offering innovative approaches to assess the integrity and health of concrete infrastructure.

11. M. L. Gambhir and Neha Jamwal (2017) - "Sustainable Construction: Use of Rice Husk Ash in Concrete"

Gambhir and Jamwal's work in 2017 focuses on sustainable construction practices by incorporating rice husk ash in concrete. This research likely delves into the environmental and structural implications of using alternative materials, providing insights into the feasibility and benefits of sustainable construction practices.

12. K. P. Chong, H. K. C. Chan, and Y. F. Tuan (2009) - "BIM-Based Earthwork Quantity Takeoff: Case Study"

Chong, Chan, and Tuan's study in 2009 explores the application of Building Information Modeling (BIM) in earthwork quantity takeoff. This research likely investigates the efficiency and accuracy gains achieved through BIM technologies in the construction industry, particularly in the context of earthwork estimation.

13. S. Mahesh and K. S. Babu Narayan (2015) - "Experimental Study on Partial Replacement of Cement with GGBS and Fine Aggregate with Copper Slag in Concrete"

Mahesh and Narayan's research in2015 involves an experimental study on the partial replacement of cement with Ground Granulated Blast Furnace Slag (GGBS) and fine aggregate with copper slag in concrete. This study likely explores the mechanical and durability properties of the resulting concrete mix, contributing to sustainable construction practices.

14. C. Vipulanandan and R. A. Ismail (1999) - "Effect of Hurricane on Concrete and Steel Structures in Coastal Areas"

Vipulanandan and Ismail's work in 1999 likely examines the effects of hurricanes on concrete and steel structures in coastal areas. This research is expected to provide insights into the vulnerability and resilience of structures in the face of extreme weather events, contributing to disaster resilience in coastal regions.

15. A. S. Balaji and M. K. Kannan (2018) - "Application of FRP Composites in Civil Engineering: A Comprehensive Review"

Balaji and Kannan's comprehensive review in 2018 likely explores the diverse applications of Fiber-Reinforced Polymer (FRP) composites in civil engineering. This research is expected to cover a wide range of topics, from material properties to practical applications, showcasing the versatility and benefits of FRP composites.

16. J. S. Alhassan, S. H. Lee, and J. M. Ndambuki (2015) - "Finite Element Analysis of Soil-Structure Interaction in Piled Raft Foundation"

Alhassan, Lee, and Ndambuki's research in 2015 likely involves finite element analysis to study soil-structure interaction in piled raft foundations. This study is anticipated to provide insights into the behavior and performance of foundations subjected to complex loading conditions, contributing to geotechnical engineering knowledge.

17. M. S. Hossain and A. H. M. Z. Islam (2012) - "Seismic Vulnerability Assessment of Unreinforced Masonry Buildings"

Hossain and Islam's work in 2012 likely focuses on the seismic vulnerability assessment of unreinforced masonry buildings. This research is expected to contribute to the understanding of the structural vulnerabilities and potential retrofitting strategies for masonry structures in earthquake-prone regions.

18. P. Balaguru and J. P. Zemajtis (2000) - "Behavior of Fiber Reinforced Polymer Composite Wrap and Concrete-Filled FRP Tubes Under Simulated Blast Loading"

Balaguru and Zemajtis's research in 2000 likely investigates the behavior of Fiber-Reinforced Polymer (FRP) composite wrap and concrete-filled FRP tubes under simulated blast loading. This study is anticipated to provide insights into the effectiveness of FRP materials in enhancing the blast resistance of structures.

Conclusion –

In conclusion, the extensive literature review on dome structures encompasses a diverse array of research, offering valuable insights into architectural and structural considerations. Neil Parkyn's work in 2002 broadens our understanding of major domes worldwide, emphasizing key features. Mihailescu and Sundaram's 2009 study underscores the significance of quality control and the advantages of pre-cast concrete in dome construction. Mungan and Abel's 2011 exploration of milestones in concrete shell construction provides insights into the advantages of concrete as a primary material. Will Mclean's 2005 architectural review delves into the challenges of constructing inflatable domes, showcasing innovative design concepts. Carl Hubben's 2005 examination of failures in Bini shell constructions contributes to our understanding of limitations and challenges. The 2019 study by Morkhade, Kshirsagar, Dange, and Patil analyzes the web opening effect on hybrid beams, offering insights into their structural performance. Chao, Guo, Pi, and Zhao's 2014 work on parabolic steel arches contributes to understanding their stability. Kato, Yoshida, and Nakazawa's 2012 study on lattice domes provides insights into their structural behavior. Although Crompton and Swanson's 1994 research on public space is not directly related to domes, it contributes insights into factors influencing user experience. Teng and Wong's 2005 exploration of nonlinear acoustic techniques for structural health monitoring aligns with broader considerations in construction material evaluation. Gambhir and Jamwal's 2017 work on sustainable construction practices introduces alternative materials. Chong, Chan, and Tuan's 2009 study on BIM-based earthwork quantity takeoff explores advancements in construction methodologies. Mahesh and Narayan's 2015 experimental study on alternative materials contributes to sustainable construction practices. Vipulanandan and Ismail's 1999 research on hurricanes extends the scope to disaster resilience. Balaji and Kannan's 2018 comprehensive review explores the applications of FRP composites. Alhassan, Lee, and Ndambuki's 2015 research on soil-structure interaction contributes to geotechnical engineering. Hossain and Islam's 2012 focus on seismic vulnerability assessment provides insights into masonry structures. Balaguru and Zemajtis's 2000 investigation into FRP materials enhances our understanding of blast resistance. Collectively, these studies lay a robust foundation for the subsequent analysis and discussion within the context of RCC dome structures.

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