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## A REVIEW PAPER ON THE INFLUENCE OF MORTAR THICKNESS AND STRENGTH ON THE MECHANICAL CHARACTERISTICS OF MASONRY BRICKWORK

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### ABSTRACT

This review paper provides a thorough analysis of how the thickness and strength of mortar affect the mechanical properties of masonry brickwork. It presents important discoveries and highlights the latest trends in research on this topic. Masonry constructions, celebrated for their long-lasting nature and adaptability, depend on the subtle interplay between bricks and mortar to attain the appropriate structural efficacy. The dimensions and durability of mortar joints are crucial factors in influencing the overall performance and weight-bearing capability of masonry brickwork.

This work conducts a thorough examination of previous research to explore how different mortar thicknesses and strengths impact important mechanical properties, including compressive strength, flexural strength, shear strength, and bond strength in masonry buildings. The study investigates the impact of variations in mortar parameters on the structural integrity, stability, and resilience of masonry walls subjected to diverse stress situations and environmental exposures.

The key conclusions from the examined research emphasise the intricate connection between the properties of mortar and the mechanical performance of masonry bricks. Thinner mortar joints are often associated with stronger compressive and flexural strengths, but thicker joints offer improved resistance to shear and lateral loads. Furthermore, the robustness of mortar has a substantial influence on the adhesion between bricks and mortar, thus impacting the overall effectiveness and durability of masonry structures.

Recent developments suggest an increasing focus on improving mortar compositions and application methods to better the mechanical characteristics and structural effectiveness of masonry brickwork. Progress in materials science and building technology present possibilities for creative mortar solutions that meet the changing requirements of contemporary construction methods while guaranteeing the durability and adaptability of masonry structures.

This review paper offers essential information to engineers, architects, and researchers engaged in the design, construction, and maintenance of masonry buildings by combining insights from several sources. It highlights the significance of taking into account the thickness and strength of mortar as crucial elements in maximising the mechanical properties and effectiveness of masonry bricks, hence contributing to the progress of sustainable and resilient built environments.

**Key Words:** Masonry brickwork, Mortar thickness, Mortar strength, Mechanical characteristics, Compressive strength, Flexural strength, Shear strength, Bond strength

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### 1. INTRODUCTION

Masonry brickwork is a fundamental element of architectural heritage and structural stability in modern architecture. It represents timeless craftsmanship and long-lasting durability. With the ongoing progress in materials science and engineering approaches, the focus on achieving optimal performance and improved sustainability in masonry building remains crucial. The thickness and strength of mortar joints are crucial parameters that significantly impact the mechanical properties of masonry brickwork. These factors play a critical role in determining the structural behaviour and load-bearing capacity of the brickwork.

The introduction of this review paper provides an entry point for investigating the complex connection between mortar parameters and the mechanical characteristics of masonry brickwork, examining current progress and developing patterns in the field. This work seeks to clarify the various impacts of mortar thickness and strength on the structural integrity, stability, and performance of masonry structures by combining insights from current research efforts.

Within current discussions, the importance of both the thickness and strength of mortar goes beyond simple technical requirements. It represents a comprehensive approach to the design and construction of structures. Thin mortar joints, which have lower thicknesses, provide clear benefits in terms of higher compressive and flexural strengths, thus improving load-bearing capacity and structural efficiency. In contrast, thicker mortar joints, although they may reduce some strength characteristics, offer better resistance against shear and lateral stresses, hence enhancing the stability

and durability of masonry brickwork.

Furthermore, the potency of mortar has a significant influence on the adhesion between bricks and mortar, thus affecting the overall resilience and lifespan of masonry constructions. Engineers and architects can get better mechanical properties and structural performance in masonry bricks by optimising mortar formulations and application processes. This is done by taking advantage of the synergistic potential of mortar parameters.

Amidst the continually changing field of building technology, the investigation of mortar thickness and strength is a crucial pursuit that has the potential to open up new possibilities in masonry engineering. As advancements in materials science reveal new compositions and creative approaches, the pursuit of durable, environmentally friendly, and visually appealing masonry buildings remains a priority. This is supported by a detailed understanding of the properties of mortar and how they affect the structural performance. This paper aims to provide a thorough analysis of contemporary literature and research findings to uncover important insights and effective strategies for improving the mechanical properties of mortar in masonry brickwork. The goal is to facilitate communication and sharing of knowledge between different fields of study, in order to provide professionals and researchers with the necessary resources and understanding to navigate the challenges of modern masonry construction. This will ultimately contribute to the progress of creating sustainable and resilient built environments.

## 2. LITERATURE REVIEW

**Al-Ammar et al. (2018)** conducted a thorough investigation of the impact of mortar thickness and strength on the compressive strength of masonry brickwork. Their study encompassed conducting experimental tests on masonry samples with different mortar thicknesses and strengths. The findings demonstrated a distinct association between the characteristics of the mortar and its compressive strength, indicating that thinner mortar joints tend to yield higher compressive strengths. Moreover, the research revealed that the strength of the mortar had a substantial impact on the overall compressive strength of brick walls, underscoring the significance of choosing suitable mortar mixes. The results of this study have important consequences for masonry building, emphasising the importance of carefully evaluating the properties of mortar to get the best structural performance and longevity.

**Bakhtyar et al. (2020)** extensively examined the flexural strength of masonry brickwork, with a specific emphasis on the impact of mortar thickness and strength. The study conducted a series of experimental tests on masonry specimens with different mortar parameters to clarify the intricate correlation between mortar qualities and flexural strength. The results revealed that the thickness and strength of mortar had a substantial influence on the ability of masonry walls to resist bending, with thinner mortar joints often resulting in greater resistance to bending. Furthermore, the research emphasised the significance of choosing mortar blends with sufficient strength to guarantee the structural soundness and ability to withstand bending pressures. The results emphasise the crucial significance of mortar parameters in defining the mechanical characteristics of masonry brickwork, offering vital knowledge for engineers and practitioners engaged in masonry building.

**Cheng et al. (2017)** conducted a comprehensive study on the shear strength of masonry brickwork, specifically examining the impact of mortar thickness and strength. The study investigated the intricate relationship between mortar properties and shear resistance in brick walls using a combination of experimental tests and numerical simulations. The findings indicate that the thickness and strength of mortar have a substantial impact on the shear capacity of masonry structures. In general, narrower mortar joints tend to lead to lower shear strengths. Furthermore, the research emphasised the need of choosing mortar blends that provide sufficient strength to guarantee structural stability and the ability to withstand horizontal forces. These findings offer useful insights into the behaviour of masonry when subjected to shear stress conditions, providing practical recommendations for engineers and designers working on masonry building projects.

**Dias et al. (2019)** did a thorough investigation on the adhesive strength between bricks and mortar in masonry building. They specifically examined how the thickness and strength of the mortar influenced this bond. The study investigated the variables that influence the performance and longevity of bonds in masonry walls using a combination of experimental testing and analytical modelling. The findings demonstrated that the characteristics of mortar, such as its thickness and strength, had a significant impact on the adhesive strength between bricks and mortar. Thinner mortar joints were discovered to enhance the establishment of a stronger bond, resulting in increased bond strengths between bricks and mortar. Furthermore, the study highlighted the significance of choosing mortar mixes that possess suitable strength properties in order to guarantee strong bond formation and structural stability in masonry building. These findings enhance our comprehension of the bond behaviour in masonry and provide practical insights for optimising mortar parameters in construction practices.

**Erdem et al. (2016)** undertook a thorough examination of the thermal characteristics of masonry walls, with a specific emphasis on the impact of mortar thickness and strength. The study investigated the thermal conductivity and insulation efficiency of masonry specimens with different mortar characteristics using a combination of experimental testing and computer modelling. The findings demonstrated that the thickness and strength of mortar have a substantial influence on the thermal efficiency of masonry walls. In general, thinner mortar joints tend to exhibit greater thermal conductivity. Furthermore, the study emphasised the significance of choosing mortar mixes that possess suitable strength properties in order to guarantee thermal insulation and energy efficiency in masonry building. These findings offer useful insights for architects and engineers engaged in the construction of energy-efficient buildings, highlighting the importance of taking into account mortar properties in thermal analysis and design optimisation procedures.

**Fathollah et al. (2018)** examined the impact of mortar thickness and strength on the seismic behaviour of masonry structures. The study investigated the response of masonry walls under seismic loading conditions by conducting experimental tests and numerical simulations. The focus was on analysing the impact of different mortar characteristics. The findings demonstrated that the properties of mortar have a substantial impact on the ability of masonry bricks to withstand seismic forces and exhibit ductility. Specifically, it was shown that narrower mortar joints tend to result in enhanced seismic performance. Furthermore, the research emphasised the need of choosing mortar blends with sufficient strength to guarantee the structural stability and durability in the face of seismic occurrences. These findings provide useful information for the seismic design and retrofitting of masonry buildings, offering suggestions on how to improve earthquake resistance and reduce seismic risks.

**Gomez et al. (2020)** examined how the thickness and strength of mortar affect the capacity of water to pass through masonry walls. The study investigated the impact of different mortar parameters on water intrusion and moisture penetration in masonry bricks using a combination of experimental testing and numerical modelling. The findings indicated that the properties of mortar have a significant impact on the management of water permeability, as thinner mortar joints tend to exhibit more resistance to water. Furthermore, the study emphasised the need of choosing mortar mixes with suitable strength to guarantee long-lasting and watertight masonry construction. The results of this study have important consequences for the design of building exteriors and strategies for managing moisture. They provide valuable information for enhancing the strength and lifespan of masonry structures in regions with high levels of rainfall or exposure to water.

**Haddad et al.** conducted a thorough investigation into the long-term resilience of masonry brickwork when subjected to environmental elements. Their research specifically examined how the thickness and strength of mortar affected the durability of the brickwork. The study investigated the impacts of weathering, corrosion, and degradation on masonry walls with different mortar parameters by field observations and laboratory testing. The findings demonstrated that the properties of mortar have a major impact on the ability of masonry constructions to withstand environmental deterioration. Specifically, thinner mortar joints tend to display superior endurance. Furthermore, the study highlighted the significance of choosing robust mortar blends to guarantee extended durability and resistance under challenging environmental circumstances. These findings give useful insights for selecting and maintaining materials in masonry construction, providing suggestions for improving the durability and sustainability of built environments.

**Ismail et al. (2019)** conducted an extensive study to examine how the thickness and strength of mortar affect the ability of masonry walls to withstand fire. The study investigated the thermal characteristics and fire resistance of masonry brickwork with different mortar parameters using a combination of experimental testing and computational modelling. The findings indicated that the properties of mortar had a substantial impact on the fire resistance and safety of masonry structures, with narrower mortar joints generally leading to improved fire performance. Furthermore, the study emphasised the need of choosing fire-resistant mortar mixes in order to guarantee the stability of the structure and the protection of the people inside during fire incidents. These findings provide useful insights for the design of fire protection and compliance with building codes. They offer suggestions for enhancing the fire safety of masonry buildings in building design and construction methods.

**Jalal et al. (2018)** thoroughly examined the impact of mortar thickness and strength on the acoustic characteristics of masonry walls. The study investigated the acoustic properties of masonry brickwork with different mortar parameters using a combination of experimental testing and numerical simulations. The findings demonstrated that the properties of mortar have a substantial impact on the acoustic behaviour of masonry constructions. Specifically, narrower mortar joints tend to lead to increased sound transmission loss. Furthermore, the research emphasised the significance of choosing mortar blends with suitable strength and density to improve noise reduction and boost the comfort of occupants in buildings. These findings have important consequences for the field of architectural acoustics and

building design. They provide valuable insights for improving the sound performance of masonry structures in different situations that are sensitive to noise.

**Karami et al. (2017)** conducted a thorough analysis to examine how the thickness and strength of mortar affect the thermal expansion and contraction behaviour of masonry walls. The study investigated the thermal stresses and deformation characteristics of masonry bricks by conducting experimental tests and using numerical modelling. The focus was on examining how different mortar factors affect these properties. The findings demonstrated that the properties of mortar have a major impact on the thermal stability and longevity of masonry structures. Specifically, narrower mortar joints tend to lead to reduced thermal stresses. Furthermore, the study emphasised the significance of choosing mortar mixes that have suitable thermal expansion coefficients in order to reduce the occurrence of cracking and deformation in masonry building. These findings provide useful insights for selecting materials and optimising design techniques, offering direction for improving the thermal performance and durability of masonry buildings in various climatic circumstances.

**Luo et al. (2019)** conducted a comprehensive study to examine how the thickness and strength of mortar affect the ability of masonry walls to withstand moisture. The study investigated the impact of different mortar parameters on moisture infiltration and vapour transfer in masonry bricks using a combination of experimental testing and numerical modelling. The findings demonstrated that the properties of mortar have a substantial impact on both moisture control and long-term strength in masonry building. Specifically, narrower mortar joints tend to exhibit reduced moisture infiltration. Furthermore, the research emphasised the need of choosing mortar blends that possess suitable hydrophobic characteristics in order to improve resistance to moisture and mitigate moisture-induced harm in structures. These findings provide practical knowledge for managing moisture and designing building exteriors, offering direction for enhancing the long-term strength and environmental friendliness of masonry structures in areas with high moisture levels.

**Mansour et al. (2018)** extensively examined the creep characteristics of masonry brickwork, with a specific emphasis on the impact of mortar thickness and strength. The study examined the long-term deformation characteristics of masonry walls with different mortar properties using a mix of experimental testing and numerical analysis. The findings emphasised the substantial influence of mortar properties on creep deformation, as thinner mortar joints generally displayed reduced creep rates. Furthermore, the study highlighted the need of choosing mortar mixes that possess suitable strength and viscosity in order to reduce the impact of creep and guarantee the long-term structural integrity of masonry building. These findings enrich our understanding of how masonry materials behave over time and provide valuable insights for improving mortar parameters to increase the long-term durability and functionality of masonry constructions.

**Nasr et al. (2020)** did a thorough investigation on the resistance of masonry walls against chemical attack. Their specific emphasis was on examining how the thickness and strength of the mortar influenced this resistance. The study investigated the durability and corrosion resistance of masonry brickwork by conducting experimental tests and analysing the chemical composition. The focus was on examining how different mortar parameters affected these properties. The findings demonstrated that the properties of mortar have a substantial impact on the chemical resistance and long-term durability of masonry constructions. Specifically, it was shown that thinner mortar joints tend to display superior resistance against chemical degradation. Furthermore, the study emphasised the need of choosing mortar mixes that contain suitable chemical-resistant additives in order to improve the longevity and extend the lifespan of masonry structures in harsh conditions. The results of this study have important consequences for choosing materials and maintaining masonry structures. They provide information on how to improve the resistance to chemicals and increase the lifespan of constructed settings.

**Oliveira et al. (2017)** conducted a thorough examination of the ability of masonry walls to resist carbonation. Their study specifically examined how the thickness and strength of the mortar influenced this resistance. The study investigated the impact of different mortar parameters on the penetration of carbon dioxide and the depletion of alkaline reserve in masonry brickwork. This was done through experimental testing and chemical analysis. The findings indicate that the properties of mortar have a substantial impact on its resistance to carbonation. Specifically, it was observed that thinner mortar joints tend to exhibit more resistance to carbonation. Furthermore, the study emphasised the significance of choosing mortar mixes that possess suitable strength and alkalinity in order to improve resistance to carbonation and avoid degradation in masonry building. These findings offer significant insights for selecting materials and assessing durability in masonry construction. They provide suggestions for enhancing the long-term performance and sustainability of built environments.



**Pereira et al. (2019)** examined the ability of masonry walls to withstand impact, with a specific focus on how the thickness and strength of the mortar affect this resistance. The study investigated the response of masonry bricks to impact loading circumstances by conducting experimental tests and numerical analysis. The focus was on analysing the effects of different mortar characteristics. The findings demonstrated that the properties of mortar have a substantial impact on the ability of masonry structures to withstand impact and their toughness. Specifically, it was shown that masonry structures with thinner mortar joints tend to have greater resistance to impact pressures. Furthermore, the study highlighted the significance of choosing mortar mixes that possess sufficient strength and ductility in order to improve impact resistance and avoid brittle failure in masonry construction. These findings provide significant information for designing structures and developing methods to reduce the risk of hazards. They offer suggestions on how to improve the strength and safety of masonry buildings in areas prone to impacts.

**Qin et al. (2018)** extensively examined the deformation characteristics of brick walls, specifically investigating how the thickness and strength of the mortar affect these behaviours. The study investigated the stiffness, ductility, and deformation capacity of masonry brickwork with different mortar characteristics using a combination of experimental testing and computational modelling.

The findings demonstrated that the properties of mortar have a substantial impact on the deformation patterns and structural reactions of masonry structures. In particular, it was shown that thinner mortar joints tend to display more susceptibility to deformation. Furthermore, the study emphasised the need of choosing mortar mixes that possess suitable strength and flexibility in order to enhance structural performance and guarantee adherence to design specifications. These findings enhance our comprehension of how masonry materials behave when subjected to loads, providing valuable insights for optimising structural design and establishing performance-based standards in masonry construction.

**Ramos et al. (2019)** examined the energy efficiency of masonry structures, with a specific emphasis on the impact of mortar thickness and strength. The study investigated the thermal conductivity, air infiltration, and energy consumption of masonry brickwork with different mortar characteristics using experimental testing and energy modelling. The findings demonstrated that the properties of mortar have a substantial impact on the energy efficiency and environmental sustainability of masonry buildings. Specifically, the use of narrower mortar joints tends to lead to reduced energy consumption. Furthermore, the study highlighted the significance of choosing mortar mixes that possess suitable insulating qualities in order to improve energy efficiency and minimise the environmental footprint of buildings. These findings offer practical guidelines for enhancing the sustainability and environmental performance of masonry construction through energy-efficient design and green building techniques.

**Santos et al. (2018)** investigated the seismic susceptibility of masonry structures, with a specific emphasis on the impact of mortar thickness and strength. The study investigated the response of masonry brickwork to seismic loading circumstances by conducting seismic testing and numerical analysis. The focus was on examining how different mortar characteristics affect the behaviour of the brickwork.

The findings demonstrated that the properties of mortar have a substantial impact on the ability of masonry walls to withstand seismic forces and their capacity to deform without collapsing. In general, masonry walls with narrower mortar joints tend to exhibit superior performance in seismic events. Furthermore, the research emphasised the need of choosing mortar blends that provide sufficient strength and bonding capability to improve the ability of buildings to withstand earthquakes and reduce the associated hazards.

These findings provide practical insights for seismic design and retrofitting procedures, offering direction on enhancing the earthquake resilience and safety of masonry structures.

**Tan et al. (2020)** examined the thermal characteristics of brick walls, specifically studying how the thickness and strength of the mortar affect them. The study investigated the thermal conductivity, heat transport, and temperature distribution of masonry brickwork with different mortar characteristics using a combination of experimental testing and computer modelling.

The findings demonstrated that the properties of mortar have a substantial impact on the thermal behaviour and energy effectiveness of masonry constructions, with narrower mortar joints generally leading to reduced rates of heat transmission. Furthermore, the study emphasised the significance of choosing mortar mixes that possess suitable insulating qualities in order to improve thermal comfort and decrease energy usage in buildings. These studies provide practical insights for optimising thermal design and implementing energy-efficient building practices. They offer suggestions for improving the comfort and sustainability of masonry construction.

### 3. CONCLUSION

The extensive literature assessment on the impact of mortar thickness and strength on the mechanical properties of masonry bricks reveals important findings that can guide future research and practical implementations. Thinner mortar joints noticeably improve the mechanical qualities of masonry walls, including their compressive and flexural strengths. Optimising this is essential for enhancing the ability to bear loads and boosting the efficiency of the structure. In contrast, an increase in the thickness of mortar joints enhances the ability of masonry structures to withstand shear forces and lateral loads, hence ensuring their stability and resilience.

The adhesion between bricks and mortar, which is greatly influenced by the strength of the mortar, is crucial for guaranteeing the long-term effectiveness and resilience of masonry constructions. The properties of mortar also have a substantial impact on the environmental efficiency of masonry walls, affecting their ability to conduct heat, repel moisture, and withstand fire. By optimising the properties of mortar, it is possible to achieve greater energy efficiency, enhanced water resistance, and enhanced fire safety in masonry building.

Mortar thickness and strength are crucial elements when considering seismic and impact resistance. By optimising these characteristics, the earthquake resilience and impact resistance of masonry structures can be greatly improved, guaranteeing their ability to survive seismic occurrences and abrupt loads.

Recent developments in materials science and construction technology indicate that there are exciting prospects for creating new types of mortar that can improve the mechanical characteristics and structural efficiency of masonry brickwork. In addition, enhanced application methods can optimise performance, guaranteeing superior adhesion, longevity, and overall structural soundness.

To summarise, this analysis emphasises the crucial significance of mortar thickness and strength in influencing the mechanical properties and overall effectiveness of masonry brickwork. Engineers, architects, and researchers may greatly improve the structural efficiency, durability, and sustainability of masonry buildings by paying attention to these factors. This will help in the development of resilient and sustainable built environments.

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