

THE INFLUENCE OF MORTAR THICKNESS AND STRENGTH ON THE MECHANICAL CHARACTERISTICS OF MASONRY BRICKWORK

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ABSTRACT

This study examines the impact of mortar thickness and strength on the mechanical properties of masonry bricks, with the goal of enhancing structural performance through optimised masonry construction procedures. The study investigates the impact of altering the thickness and compressive strength of mortar on the overall strength, durability, and load-bearing capability of brick masonry constructions. Various experimental tests were performed on masonry wall specimens that were built using varied mortar thicknesses and strengths. The specimens underwent standardised mechanical testing to assess their compressive strength, tensile strength, flexural strength, and durability in different climatic situations. The research primarily aims to determine the ideal mortar properties that improve the mechanical features of brickwork while maintaining construction efficiency and cost-effectiveness. The findings suggest that the thickness and strength of mortar have a substantial influence on the effectiveness of masonry brickwork. Increased thickness of mortar joints typically results in improved adhesion and distribution of loads, ultimately enhancing the compressive and tensile strength of the masonry. Nevertheless, an excessive amount of mortar might result in amplified shrinkage and the possibility of cracking. On the other hand, using stronger mortar enhances the ability of brickwork to withstand heavy loads and increases its resistance to damage, especially in buildings that are subjected to severe environmental conditions.

The study also examines the practical ramifications of these findings for the building sector. By optimising the thickness and strength of mortar, it is possible to create masonry structures that are more resilient and durable. This can potentially result in lower maintenance costs and a longer lifespan for buildings. The data indicate that achieving optimal masonry performance requires a balanced strategy that takes into account both mortar thickness and strength.

To summarise, this study highlights the crucial significance of mortar characteristics in maintaining the structural stability of masonry brickwork. Additional research is advised to improve the instructions for applying mortar and to investigate the durability of masonry structures with different mortar characteristics over an extended period of time.

Key Words: Mortar Thickness, Durability, Mechanical Performance, Bricks work, Compressive Strength

1. INTRODUCTION

Brickwork is a method of building that uses bricks and mortar to create things like walls, columns, and arches. It is a well-known and frequently used building technique that has been used for millennia all throughout the globe. Depending on the design and function of the building, brickwork may be used for both load-bearing and non-load-bearing walls. Individual bricks are laid in a predetermined pattern during the bricklaying process, and mortar is then used to bind the bricks together. Brickwork comes in a variety of styles, such as stretcher bond, English bond, and Flemish bond. Each bond has a distinct brick-laying pattern that is selected depending on the structure's intended purpose and design. From little homes to big office buildings, a diverse range of structures have been built using brickwork. The versatility of brickwork has made it a popular building material, and it continues to be used today despite the emergence of other building materials. Brickwork has several advantages over other construction methods. Here are some of the key benefits:

Durability: Brickwork is known for its durability and durability, making it a popular choice for buildings that need to withstand harsh weather conditions and other external factors.

Aesthetic Appeal: Brickwork can be used to create a wide range of textures, colours, and patterns, making it a versatile choice for both interior and exterior design. It also ages well and adds character to a building over time.

Fire Resistance: Brickwork is fire-resistant, which means it can help prevent the spread of fires and protect the building and its occupants.

Low Maintenance: Brickwork requires very little maintenance, which makes it a cost-effective choice over the long term.

Sustainable: Brickwork is an environmentally friendly option, as it is made from natural materials that are long-lasting and can be recycled. Despite its many advantages, brickwork also has some limitations. One of the main limitations is its weight. Brickwork walls are heavy, and require strong foundations to support them. This can make

brickwork more expensive than other building materials, particularly in areas with poor soil conditions or high seismic activity. Another limitation of brickwork is its susceptibility to water damage. Bricks are porous, and can absorb water, which can lead to the growth of mold and other fungi. This can cause damage to the walls and create health hazards for occupants of the building. All things considered, brickwork is a time-tested technique that has been used for centuries to create beautiful, durable, and long-lasting structures. Its benefits, including durability, aesthetic appeal, fire resistance, low maintenance, and sustainability, make it a popular choice for construction today. Whether you are building a new home or restoring an old one, brickwork is a technique worth considering for its craftsmanship and longevity. However, it also has some limitations, such as its weight and susceptibility to water damage.

ELEMENTS THAT IMPACT MASONRY STRUCTURES

Several factors may affect the masonry constructions' durability and lifetime. These elements include the mortar's thickness, the bricks' interaction with one another, and the mortar's ability to withstand compression. In order to design and build brickwork constructions that can endure external pressures and stresses and persist for many years without significantly deteriorating, it is vital to understand these variables.

Durability of Brick

Compression durability is a crucial aspect in defining the durability of bricks, which is the amount of force that a brick can withstand before it breaks. The durability of the bricks can be influenced by features such as the excellence of the raw ingredients the firing temperature, and the manufacturing process. The durability of numerous types of bricks was investigated in several experimental studies that included the construction of multiple masonry prisms. The findings indicated a strong Relationship among the brick's power and the mortar prisms' resultant compressive force .

Durability of Mortar

The entire longevity and durability of the constructions depend on the mortar's durability , which is a crucial component of masonry construction. Numerous factors, including the cement to sand ratio, the water to cement ratio, and the drying period, may affect the durability of the mortar. To form a solid bond without producing shrinkage or breaking, the cement to sand ratio must be properly regulated. The workability and durability of the mortar may be affected by the water-cement ratio, and if it is too high, it might damage the building. On the other side, the mortar mix could be challenging to deal with if it is too low. Last but not least, curing time is essential for ensuring that the mortar properly sets and hardens. According to research conducted by several authors on the impact of different binders on the overall durability of masonry, The compression durability of the brickwork and the compression durability of the mortar have a positive connection, meaning that when one durability rises, the other does too.

Thickness of Mortar

The thickness of mortar joints may have a big impact on how well masonry constructions operate. A weak and unstable construction might emerge from mortar joints that are too thin because they may not be able to adequately connect the bricks together. On the other side, if the mortar joints are overly thick, they may concentrate stress and weaken the brickwork as a whole. In arrange to maintain the overall potency of the brickwork constructions, it is crucial to use mortar joints with the proper thickness. The consequence of mortar thickness on brick structure can be explained in terms of stress circulation and load transfer mechanism. In a well-designed masonry structure, the load is transferred from one brick to another through the mortar joints. The mortar serves as an adhesive that bonds the bricks together and distributes the load evenly across the structure. When the mortar joints are too thin, they may not be able to provide enough bonding between the bricks, resulting in stress concentration and localized failure. Conversely, if the mortar joints are too thick, they may create a weak layer that is susceptible to cracking and failure under stress. The thick mortar joints may also create voids and reduce the actual cross-sectional area of the building, which can decrease its load-carrying capacity. Research has shown that the optimal thickness of mortar joints relies on several aspects, such as the size and shape of the bricks, mortar types, climate and environmental conditions, and the building method. Consequently, it is crucial to consider these factors when determining the appropriate thickness of mortar joints for a specific masonry structure.

Interaction between Mortar and Brick

The interaction among the brick-and-mortar is important for creating a strong and stable structure. The bond between the brick and mortar determines how well stresses are transferred between the units and can be influenced by the type of bond used in brickwork , such as the English bond or Flemish bond Lastly, it can be concluded that understanding the features that influence the durability and durability of brick structures is important for ensuring the longevity and stability of these structures. By paying attention to the quality of the materials used, the thickness of the binder, and the interface amid the brick and mortar, brickwork structures can be designed and constructed to withstand external forces and stresses.

SIGNIFICANCE OF THE STUDY

The mortar joints are an integral component of masonry structures as they provide bonding between individual units, distribute loads, and absorb differential movements due to shrinkage, thermal expansion, and other factors. Therefore, the properties of the mortar, including its thickness and durability, directly impact the overall structural integrity of the masonry structures. The appropriate thickness and durability of mortar are critical for ensuring that the structure can withstand the expected loads and stresses. If the mortar is too weak, or if the joints are too thin, the structure may be susceptible to failure under even normal loads. On the other hand, if the joints are too thick, they can create weak planes in the structure, and reduce the carrying capacity for loads of the masonry. As such, understanding how these factors influence the performance of the mortar can help identify best practices and design guidelines that can lead to stronger and more durable masonry structures. Overall, research on the thickness and durability of mortar is critical for advancing our understanding of masonry construction, and improving the safety and durability of masonry structures.

OBJECTIVES

This research aims to investigate the impact of mortar depth and durability on the mechanical properties of brick structures. The necessity to improve brick constructions' structural performance and endurance is what drives the research since they are so often utilized in construction across the globe. To realize this objective, a comprehensive investigational curriculum is planned and implemented, which involves testing various types of brickwork samples subjected to different loading conditions. A comprehensive review of the literature was conducted prior to delineating the specifics of the study. The conclusions of this review are presented in Chapter 2. The following are the primary goals of this research:

- 1) To determine how various kinds of mortar affect the durability of clay brickwork
- 2) To determine how clay brick masonry's durability is affected by the junction thickness of mortars.
- 3) To assess the brickwork's stress performance

2. LITERATURE REVIEW

a study of the literature is a crucial part of any research project, as it provides a comprehensive overview of the existing knowledge on a particular topic. The purpose of this literature review is to recognize the current advances in the field of masonry and related areas, and to highlight the research gaps that this study aims to address. To achieve this goal, a thorough review of the literature has been conducted, covering a wide range of topics related to brickwork. The literature review covers the recent research on the consequence of mortar thickness and durability on masonry.

The purpose of the dissertation is to look at how grout durability and width affect the axial and fracture rigidity of masonry.

This is an important area of investigation because it has significant practical implications for the design and brickwork development. tensile durability in compression of masonry is critical to its ability to withstand vertical loads, while the shear durability is important for resisting lateral forces, such as wind or seismic loads. Despite the importance of mortar properties in masonry construction, there is still a lack of consensus on the optimal thickness and durability of mortar for different types of masonry structures. This has caused a substantial variance in the design and construction practices used in the industry. There is therefore a need for a comprehensive review of the existing literature upon the extent that the cement affects and durability on masonry's compressive and shear force. An extensive overview of the current masonry structures research is given in this chapter's literature review. The literature is systematically reviewed and the methodologies and findings of each study are evaluated. This allows for the identification of any gaps or inconsistencies in the existing research and a deeper knowledge of the variables affecting the efficiency of brick constructions.

BRICKWORK

The durability and longevity of the brickwork are influenced by the quality of the bricks and mortar used. The load-bearing capacity of building material constructions is determined by the compression durability of the bricks, but the mortar's quality impacts the bricks' adhesion and cohesion. The thickness of the mortar joints is also crucial for the brickwork's overall durability. How bricks and mortar interact determines how effectively masonry constructions function."

Bricks

Zengin and Kocak (2017) Several bricks and two mortars were examined, including The results showed that the properties of masonry walls are significantly influenced by the kind of brick used in such walls. The walls' compression durability increased along with the bricks' compression durability. The walls' modulus of elasticity

increased in a similar manner to how the bricks' did[8]. Both the kind of brick and the type of mortar used were shown to have an impact on the walls' ability to absorb water.

Mortar

Haach et. al. (2010) examined how various mortar types affected the compression durability of concrete masonry prisms. Prisms were tested with various mortars in the research to compare their compressive behavior. "The findings demonstrated that the kind of mortar used had a substantial impact on the prisms' compressive behavior, with stronger mortars producing greater compression durability [10]. The research comes to the conclusion that choosing the right mortar is crucial when planning and building masonry constructions.

El-Dakhakhni and El-Sheikh (2021) investigated how the seismic behavior of masonry walls was affected by the properties of the mortar. A total of 12 full-scale masonry walls constructed with different kinds of mortars were used in the investigation. The walls' performance was evaluated in terms of durability, stiffness, and ductility after being placed through a series of cyclic loading tests. The results of the research showed that masonry walls' seismic behavior is significantly influenced by the kind of mortar that is utilized. In comparison to walls built using low-durability mortars, high-durability walls showed greater durability, stiffness, and ductility. The research also revealed[11] that the way masonry buildings respond to earthquakes is significantly but only somewhat influenced by the The grout connections' width. The durability and ductility of walls with thicker mortar joints were lower than those with thinner mortar joints.

MASONRY PRISM TEST

Compression durability of a building block prism is a crucial parameter in the building of masonry buildings. It is the maximum compressive load that a brick prism can withstand before failing. Numerous variables, such as the kind of brick used, the building process, the depth of the connections, and the mortar's durability affect the compression durability of brickwork. Several academic scholars examined the brick prism's compression durability and reported their results in peer-reviewed journals. The next section goes on prior research on brickwork prisms' compressive toughness.

Jagadish et al. (2016) did a test on a sample of masonry using different mortar mixtures to see how the mortar mix affected the brickwork's compression durability. Compression durability of the samples The equipment for compression testing is then used to assess durability. The results of the investigation show that the mortar mixture significantly affects the compression durability of brickwork. According to the study's findings, adding more cement to the mortar mixture increased the brickwork samples' compression durability [3]. A 1:4 cement-sand mortar mix provided greater torsional durability as a cement-to-sand ratio of 1:6 the investigators also found.

Joshi and Jain (2013) studied the unreinforced clay-based masonry's tensile response. Masonry compression durability is an important attribute to consider while designing, repairing, or retrofitting masonry buildings. The paper includes a description of the testing technique as well as the experimental findings for bricks, mortar, and brickwork prisms. The experimentally determined average compression durability of bricks matches the BIS value for the Maharashtra area. The prism test yielded an average compression durability of masonry of 0.781 MPa, which was compared to the findings obtained by other studies. The experimental results were confirmed by comparing the basic compressive the prismatic testing tension to the fundamental stress fracture derived from IS1905:1987[12].

Thamboo and Dhanasekar (2019) investigated the masonry's tensile durability and deformed properties pursuant to unilateral compression. While prisms and wallettes are commonly used for testing, there is a lack of established correlation between these methods. Despite the fact that data for calculating compression properties using either approach is included in the current brick design regulations, the process of creating these standards has received little attention. Researchers built and tested fifty prisms and forty wallettes using various unit types and mortar mixtures in an attempt to close this gap. "The findings revealed that wallettes consistently had lesser compressing durability than prisms." The durability of the compressive of the prismatic and the wallette were discovered to be linearly related. Furthermore, To correspond, a condensed scientific paradigm was suggested. deformation characteristics between prisms and wallettes[13]. This study sheds light on important considerations for masonry design standards and provides valuable insights for future research in this field.

Chen et. al. (2021) examined the use of MOSA mortar (modified oyster shell ash mortar) to reinforce old brickwork constructions in China. The paper details laboratory research on how lime-clay mortar was replaced with MOSA mortar to enhance the flexural behavior of brickwork masonry. The findings show that the suggested method's reinforced brickwork samples' compression durability satisfies the design criteria. The study also discovered a formula to ascertain the masonry compressive stability reinforced by altering mortar, and the predicted and observed values matched [14]. The stress-strain relationship of the tested samples under axial compression was simulated using

a parabolic model, which was found to be consistent with the experimental results. The paper concludes that more experimental research is required to show the efficacy of this brickwork durability ening strategy in real-world applications.

TRIPLETS TEST OF BRICKWORK

Brickwork failure is frequently related to shear failure of the brick- mortar bond, which has been recognized as one of the most common failure types. Previous study has suggested that a masonry wall's brick-mortar junction might break due to insufficient binding durability . Consequently, the shear bonding capability of brickwork is an important metric that must be carefully considered. This section provides a survey of the literature on this subject.

Alecci et. al. (2013) examined the direct prediction of masonry shear durability , which entails conducting Consequently, an increased bonding capacity of... accordance with diagonal compression testing on panels in accordance. The article describes the findings of an experimental study on brickwork walls built with various types of mortar using these two methods. The paper compares the masonry shear durability values obtained by laboratory tests on shear triplets to those obtained by three equations [16]. The paper concludes by highlighting the importance of such experimental tests for accurate prediction of masonry shear durability .

Lourenço et. al. (2004) “Consequently, it can be said that stack-bonded masonry, which is largely used for aesthetic reasons, has a regular pattern that makes it possible to insert reinforcement in joints. However, there hasn't been much discussion of how stack-bonded brickwork responds to shear pressure. An experimental research program with aligned joints filled with micro-concrete was carried out to contribute to this field. Effective analysis of the shear behavior of stack-bonded masonry with microconcrete joints produced typical failure modes that adhered to the Coulomb friction law[17]. It is important to note that the masonry panels looked at in this research had continuous vertical seams because, in contrast to the typical running bond with discontinuous vertical joints, they are meant to be used to build reinforced masonry shells.”

DIRECT DIAGONAL SHEAR TEST

Ghasemi et. al. (2022) deliberate the result of various mortar kinds and thicknesses on masonry shear durability . The research was carried out on a total of 12 full-scale masonry walls that were built using various types of mortars and thicknesses. The walls were put through a series of direct diagonal shear tests, and their performance was measured in terms of shear durability . The study's findings revealed that the kind of mortar has a considerable impact on the shear potency of brickwork. Walls built with high-durability mortars have greater shear durability than walls built with low-durability mortars[18]. The study also discovered that the thickness of mortar joints has a tiny but substantial influence on masonry shear durability . Shear durability was lower in walls with thicker mortar joints than in buildings with thinner mortar joints.

Bustos-García et. al. (2019) assessed how mortar type and thickness affected the masonry's diagonal shear durability . The experimental examination includes direct diagonal shear testing on masonry samples with various mortar types (cement-lime and cement-sand) and thicknesses. According to the findings, masonry shear durability increases with thickness and is significantly influenced by the kind of mortar[19]. Shear durability is stronger in cement- sand mortar samples than in cement-lime mortar samples . The paper also includes regression equations for predicting masonry diagonal shear durability depending on mortar type and thickness.

El-Dakhkhni and El-Sheikh (2017) reported an experimental analysis of unreinforced masonry walls' direct shear behavior. The experiment included evaluating 20 brick walls with varying aspect ratios, thicknesses, and mortar kinds. The walls were loaded in shear until failure, and the shear durability , deformability, and failure modes were analyzed. The results showed that the shear durability of the walls was significantly affected by the thickness, aspect ratio, and mortar type. The walls with thicker and wider cross-sections exhibited higher shear durability s than the thinner ones. The walls constructed with stronger mortars showed higher shear durability s and less deformability than the ones with weaker mortars[20]. The failure modes observed were diagonal splitting, shear sliding, and tensile failure of the masonry units.

3. METHODOLOGY

This work comprises a series of experiments that aim to explore the mechanical properties of materials. The mechanical properties of interest include dimension tests, water absorption, efflorescence, compression durability , and bond durability . This chapter provides a comprehensive account of the experimental program carried out, encompassing the description of the constituent materials employed, the fabrication of test samples, the apparatus utilized, and the experimental procedures implemented. This investigation's main goal is to provide an in-depth analysis of the materials' mechanical behavior.

PROBLEM FORMULATION

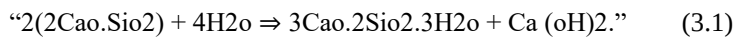
The compression durability of the bricks and mortar, the kind of bonding used, and the thickness of the mortar joints are only a few of the factors that have an impact on the mechanical behavior of brickwork. This study uses experimental testing to investigate the effects of joint width or mortar durability on the mechanical behavior of brickwork. Investigating the components of masonry was done during the experimental testing phase. The preparation of examples, such as masonry prisms, brick triplets, and masonry walls, was then completed. Following a 28-day curing period, the samples underwent testing. These tests aimed to measure various characteristics such as compressive and shear durability, and diagonal tension. The data acquired from tests provided insights into the performance of masonry structures and the factors that influence their durability and durability.

MATERIALS USED

Various materials, including bricks, cement, and sand, were employed to build test samples as part of the experimental endeavour. In this study, bricks were employed as both the test sample and the unit material for creating masonry assemblages such as prisms and triplets. Mortar also included the use of cement and sand.

Lime

Lime is a commonly used binder in construction, particularly in masonry and plastering applications. The process of creating lime involves burning limestone and then slaking it with water to produce a powder that hardens when exposed to air. For this particular work, hydrated lime was used, as described in IS:1540(Part I)- 1980[29]. The supplier provided in sequence on the features of the binder ingredients, which is summarize in Table 3.1. The chemical process of hydraulic lime reacting with water, known as hydration, can be expressed using Equation 3.1.



Belite (C2S) + Water $\Rightarrow$ Calcium Silicate Hydrate + Portlandite

Cement

Ordinary Portland Cement (OPC) is a common construction binding material. It is made by burning limestone, clay, and other elements at high temperatures to produce a powder that hardens when mixed with water. In this experiment, 53-grade OPC, as described in IS:269-2015[31], was used. Table 3.1 summarizes the features of the binder ingredients as given by the dealer.

Table 3.1. Properties of Binders

Properties	Hydrated lime	OPC-53
Chemical Composition (%)		
SiO ₂	13.1	24.42
Al ₂ O ₃	0.7	4.85
Fe ₂ O ₃	2.81	3.80
CaO	66.3	66.16
MgO	0.5	1.85
K ₂ O	0.15	0.4
LoI	16.44	1.17
Physical Properties		
Specific Gravity	2.6	3.12
Fineness(cm ² /gm)	3750	3000
Color	White	Grey

Sand

In this study, natural sand was obtained from a local supplier, and its characteristics were analyzed. A sieve analysis was conducted in accordance with IS 2116-1980[32] to evaluate the particle size distribution of the sand. Additionally, the bulk density of the sand was calculated to be 1750 Kg/m³.

These measurements provide important information on the suitability of the sand for use in construction and can be used to determine the optimal mix ratios for mortar or concrete.

Bricks

Bricks are a widely used building material that provides durability, durability, and fire resistance to structures. They are made from clay that is molded and fired in a kiln to harden them. The quality of bricks depends on the properties of the clay and the firing temperature used during the manufacturing process. Bricks are available in different shapes, sizes, and colors, and are used for various construction purposes such as walls, pavements, arches, and columns. Bricks are an essential component of masonry construction, and it is crucial to test their quality before using them in construction projects. Brick testing can help ensure that the bricks are strong, durable, and capable of withstanding the stresses and loads imposed on them in construction. There are several tests that can be performed on bricks to determine their quality, including dimensions tests, compression durability, water absorption, efflorescence, and soundness tests. These tests can provide information about the physical and mechanical characteristics of the bricks, such as their durability, durability, porosity, and resistance to weathering.

PREPARATION OF SAMPLES

This research includes brick, mortar, and masonry samples. The samples included five brickwork prisms, three brick-high stacks bonded triplets, and a wall for diagonal shear testing. The brickwork prisms were prepared by bonding the bricks with mortar, with each prism consisting of 10 brick units. The triplets were prepared by stacking three brick units and bonding them with mortar. The wall for diagonal shear testing was constructed by bonding 27 brick units with mortar in a stretcher bond pattern. Table 3.2 shows the Total number of samples prepared for complete work.

Calculation of Samples for testing

Table 3.2. Number of samples for each test

Tests	Lime Mortar			Cement grout			Total
	13 mm	20 Mm	27 mm	13 mm	20 mm	27 mm	
Compression durability (Prism)	3	3	3	3	3	3	18
Shear Durability (Triplet)	3	3	3	3	3	3	18
Diagonal Shear Durability (Wall)	3	-	-	3	-	-	6

After conducting thorough testing on various thicknesses of mortars, it was evaluated that the maximum shear durability for the triplet occurred at a thickness of 13 mm for both types of mortar. As a result, further testing and analysis were focused solely on this thickness for diagonal shear testing, and for this, only 6 samples were prepared for the diagonal shear testing.

Brick

In this study, standard-fired clay bricks were utilized as the prime building material. The bricks were sourced from a reliable supplier and were of uniform size and quality. The dimensions of the bricks had been two hundred and twenty millimeters in length a thickness of 110 mm in width and seventy-five millimeters in depth. The durability at compression and water absorption of the blocks were evaluated through testing, efflorescence, and dimensional accuracy in accordance with relevant standards to ensure they met the required specifications for use in construction.

Mortar

Mortar is an essential material in construction that is used to bind individual masonry components together. It is typically made by mixing cement or lime with sand to create a smooth paste. For this study, hydraulic lime mortars with a binder-to-aggregate ratio of 1:3 were selected. This type of mortar is often used in historic masonry conservation projects due to its ability to allow walls to naturally breathe and thus improve long-term performance. Alternatively, cement is now the most efficient binder available, and OPC-53 mortar was used in this study due to its effectiveness. The ratio of binder to aggregate in this mortar is also 1:3, which is a common ratio used in construction. The durability of the mortar is an important factor in determining the compression durability of brickwork. In this study, the durability values of the designed brickwork mortar were computed using mortar cubes with a face area of 50 cm². The mortar cubes were prepared using the same ratio of binder to aggregate as used in the brickwork construction, which was 1:3. The cubes were then cured under standard conditions for 28 days before being tested for compression durability.

Masonry Wall for Diagonal Test

A direct diagonal test is used to find the diagonal tensile durability of masonry walls (Fig. 3.4). For this test, a masonry wall was built with the bricks and mortar being tested, with the bricks arranged in a stretcher bond pattern. A load was then applied to the wall in a diagonal direction until failure occurs. The load was measured, and the diagonal

tensile durability is calculated based on the dimensions and properties of the wall. The test method is described in ASTM E488-96[38].

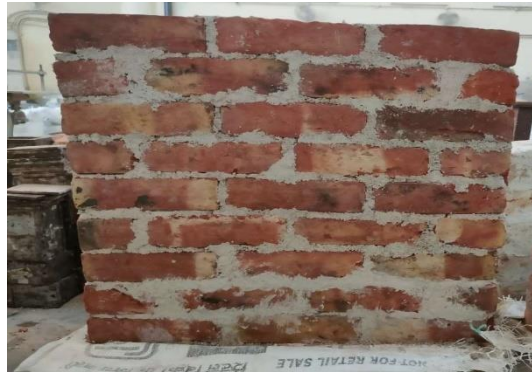


Figure:1 - Masonry Wall for Diagonal Testing

4. RESULT

The outcomes of the tests conducted to ascertain the mechanical characteristics of masonry samples are presented in the Results and Discussion chapter. This chapter seeks to provide a thorough analysis and explanation of the experimental results. Each part of the chapter focuses on a different mechanical characteristic of the brickwork examples. To help the reader comprehend the data, the findings are provided as tables, graphs, and figures with supplementary descriptive statistics. The findings are critically analyzed in the discussion section, which also discusses the advantages and disadvantages of the experimental techniques used and their implications for masonry building. A review of the major discoveries and their relevance in relation to masonry building is provided in the chapter's conclusion.

TESTS ON BRICK

For the construction of walls, pavements, and other buildings, bricks are often utilized. To assure the quality and longevity of the buildings, it is crucial to ascertain their mechanical qualities. Bricks' size, water absorption, efflorescence, compression durability, and shear durability are all evaluated by a variety of tests. These tests help in assessing the performance of bricks and ensuring their suitability for specific construction applications. In this section, we will discuss the different tests conducted on bricks to determine their mechanical properties.

Dimensions Test

Bricks are typically rectangular in shape and have a variety of dimensions.(Length x depth x height). The dimensions of a brick can vary depending on the type of brick, the manufacturer, and the country in which it is made. However, it should be noted that not all of the bricks possess exact and precise measurements. The various brick samples are referred to as B1, B2, B3, B4, and B5. The measurements of these samples are shown in Table 5.1.

Table 5.1. Dimensions of bricks

Specimen no.	Dimensions(mm)
B1	220*110*76
B2	221*110*75
B3	223*110*75
B4	221*110*73
B5	220*110*75

Water Absorption of Bricks

The water absorption test is a common test performed on bricks to evaluate their porosity and the amount of water they can absorb. This test is important as it helps in assessing the durability and weather resistance of the bricks, which are crucial factors in their selection for construction purposes. The water absorption of the brick samples was calculated using Equation (5.1).

$$\text{Water Absorption (\%)} = \frac{M_2 - M_1}{M_1} \times 100 \quad (5.1)$$

Table 5.2. Values of water absorption

Samples	Wt. after oven-dry(M1) (Kg)	Wt. after 24 hours in water(M2) (Kg)	Water absorption (%)	Avg. Water absorption (%)
B1	2.99	3.29	10.03	11.08
B2	3.02	3.37	11.59	
B3	3.11	3.44	10.61	
B4	3.13	3.46	10.54	
B5	3.01	3.39	12.62	

The results of the water absorption test for the brick samples in this study are presented in Table 5.2. This table provides information on the water absorption characteristics of the different brick samples, which can be used to evaluate their suitability for specific applications. After conducting the test on the samples, the average water absorption was determined to be 11.08%. According to Indian standards, “when tested in the manner described, the average value should not surpass 20% by weight for Class 12.5, and 15% by weight for higher classes”. This is because excessive water sorption can outcome in structural damage including cracking, warping, and deterioration of the brick. Consequently, it is essential to monitor the characteristics of bricks and ensure they meet the appropriate standards for the specific class of brick being used.

Efflorescence Test of the Bricks

The efflorescence test was performed on the units to evaluate the presence of soluble salt deposits. The results indicated that the efflorescence was below 4% (Table 4.3), which is within the permissible limit set by IS 3495:1992. This standard specifies that for Class 12.5 bricks, the allowable efflorescence limit is less than or equal to 10%, while for higher classes, it should be less than or equal to 5%. Since the efflorescence of the bricks in this study falls well within the specified limits, it can be concluded that the bricks meet the required standards and are suitable for use in construction.

Table 5.3. Efflorescence Test Result

Test	As per IS 3495:1992	Experimental Result
Efflorescence	10% or less for Class 12.5 bricks and 5% or less for Higher Classes of bricks	Below 4%

5. CONCLUSION

The various conclusions drawn from the above studies are given below:

- The durability in compression disparity among lime grout and cement grout is estimated to be around 270%. This variation in compressible resistance between mortar mixes has been instrumental in determining the influence of grout power on construction a prismatic and block triplets.
- The compressive value of mortar composed of concrete lenses is notably higher than that of mortar made from lime prisms, highlighting the significant effect of durability on the compression characteristics of brickwork. It can be deduced that there exists a direct correlation between the compressible capacity of the cement employed and the compression durability of the brickwork.
- The triplets made with mortar made of cement exhibit a shear durability that is roughly 255% higher than that of the triplets with the lime mortar. This discovery indicates that the breaking durability of brickwork is significantly influenced by the compression durability of the mortar.
- Upon increasing the width of the grout to thirteen millimeters to twenty millimeters and subsequently to twenty-seven mm, the compressive property of both samples of mortar demonstrated a roughly increase of thirteen percent in the former case. However, in the latter case, the compression durability of the stone a prism dropped by approximately 21% for cement mortar and 26% for lime mortar. The aforementioned findings indicate that a first rise in the thickness has a positive impact on compression durability. However, surpassing the ideal thickness limits results in an ensuing decrease in the breaking force of the mortar prism. This implies that there exists an ideal vary for mortar thickness that optimizes the compression durability of construction prisms.
- The results indicate that a rise in grout width from 13 millimeters to 20 millimeters and subsequently to 27 millimeters resulted in a reduction of the shear durability by around 35 for both lime as well as cement cement

triplets. However, for cement cement triplets, a significant decrease of roughly 85% in shear durability was observed, while for lime mortar, the reduction in shear asset was around 26 percent. These findings demonstrate that as the thickness of mortar increases beyond a certain point, there is a significant reduction in shear durability for both mortar types, albeit to a greater extent in cement grout .

- The diagonal tension test was conducted on both lime mortar and cement grout with a mortar thickness of 13 mm. Specifically, the shear stress recorded for the cement grout wall was approximately 250% higher than that of the lime mortar. These findings indicate that in the case of 13 mm mortar thickness, cement grout demonstrates significantly greater shear durability compared to lime mortar.
- Increased diagonal tension durability helps to enhance the overall stability and structural integrity of brickwork . It improves the ability of the masonry structure to resist lateral forces, such as wind loads or seismic forces.

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