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"SUSTAINABLE AND COMPARATIVE STUDY ON BRICKS USING LOCALLY AVAILABLE MATERIALS (TILE WASTE & WASTE WATER)"

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Abstract-The civil engineering community has consistently struggled with how to implement building designs that are both economical and ecologically benign. The goal of the current project is to create novel masonry bricks that could increase the possibility of future low-cost building. A brick is a composite material made up of clay, water, and fine aggregate. However, researchers are more interested in discovering novel materials using waste products that are present naturally and are hazardous to the environment.

In this study, tile powder and waste water are used to partially replace clay and fresh water with Tile waste and waste water. In this study significant volume of waste water and tile waste are processed to some extent.

We must offer a material substitution or replacement in order to solve this issue. As a result, we have decided to use waste water and waste resources for our project, such as tile powder. As tile waste generated by the industry is accumulated over and over years. Tile powder offers higher Strength and Durability when compared to the qualities of traditional brick materials.

Key words: Tile waste, waste water, Ecologically benign, Sustainable, Conventional, Cost, Recycling.

I. INTRODUCTION

The amount of tile produced globally has surpassed 13 billion square meters at 13,552 million sq. India surpassed Brazil to overtake it as the world's second-largest producer and consumer of tiles in 2022. Ceramic tile output in India totals 1.08 billion square meters annually. The most promising center for making ceramic tiles in India is at Morbi in Gujarat. The amount of waste produced by the ceramic industry ranges from 15% to 30% of total output. Nowadays, it is difficult to recycle ceramic waste (Tile Waste). Although designated dumping zones have been established, the ceramic businesses continue to dump the powder in any nearby ditch or vacant place close to their production plant. The ecosystem encounters a number of issues as a result of this sort of ceramic waste disposal scenario, including.

The usage of materials is relatively low compared to their waste. By more usage of these materials, the waste levels are reduced. It can result in more usage of the tile powder and waste water. The bricks are made with composite mixture of tile powder as a partial replacement of sand. The bricks are made and are tested for their strength at various ratios. Then the bricks are tested for their strength and their optimum ratio is found.

This research is done to find a better material that has high strength compared to the normal brick and lighter weight. This also results in use of waste material in the brick which results in higher strength of the brick. The use of alternate material for fine aggregate in construction works need attention with respect to their availability and applicability. In these experimental studies were conducted to use tile powder to replace fine aggregate in brick.

II. OBJECTIVES:

- As the tile waste is abundant material is easily available.
- The main aim of this project to reduce the cost of building construction in a housing sector by adopting innovative materials and techniques.
- Finding out the locally available industrial waste material and utilizing the same in the Project.
- Last Longer and Require Less Maintenance.
- More Energy Efficient, Resulting in Lower Utility Bills.
- Provide Greater Protection Against Natural Disasters.
- Finding out the optimum % of replacement of material.
- Higher Rate than Traditional Homes.
- To find effective alternatives for conventional brick.
- Effective way of Mould preparation with variation in Temperature provided to bricks for firing.
- To test the strength and physical properties of brick with waste material and compare it with conventional brick.
- It can be Inflammable.
- To optimize the accumulated Tile Waste and can be Utilized as a recycling materials which also helps in reducing carbon foot prints.

III. LITERATURE REVIEW:

• Dr. Gyanendra Singh, Prof. Vinay Kumar Singh Chandrakar (2017) **-"Experimental Study of Waste Paper to Produce Environmental Ecofriendly Brick"** They have carried out experimental investigation of paper Crete Concrete, and concluded that the use of paper waste for producing a low-cost and light weight composite brick as a building material. An experimental investigation has been carried out to optimization of mix for paper Crete bricks depending upon the compressive strength, unit weight, and water absorption. Use of wastepaper as Paper Crete not only reduces the amount of cement but also makes environment friendly building materials.

•U. Kayalvizhi, M. Kathiresan, A. Ayyappan, K. Priya (2019) **- "Development Of Bio-Weeds Composite Bricks With Granite Powder"** In this research report, we looked into how granite powder and bio weeds together offer more benefits than traditional brick. As it decreases trash disposal and

increases consumption of bio weeds, It is also pollution-free and eco-friendly. Compared to regular brick, the bricks have a higher water absorption ratio. The brick's structure is likewise more fragile than that of regular bricks. A brick's compressive strength is greater than a brick that has been referred after 40% replacement after 7 days. In terms of strength and water absorption qualities, composite bricks are superior to traditional bricks. There is less sand needed.

• Rautray, Priya brata (2019) **"Bio-Brick Development of Sustainable and Cost Effective Building Material"-** The current study investigates the possible use of "agro-waste" as a component of sustainable alternative building materials in the form of bricks, including hay or straw stubbles, residual timber, etc. These bio-bricks may be changed to fit the local market and building construction styles based on the components that can be made from agro-waste. The use of agro-waste as a building material has the potential to reduce both the use of natural resources and energy.

• Shehbaz Ahmad, Mansoor Ul Hassan Shah, Aamat Ullah (2021) **"Sustainable Use 0f Marble Waste In Industrial Production Of Fired Clay Bricks And Its Employment For Treatment Of Flue Gases"-** For the purpose of making lightweight burned clay bricks and for the treatment of flue gases, waste marble powder was used in this study. According to recent study, adding waste marble to clay bricks causes the bulk density to drop as the amount of waste marble increases. When calcined waste marble is utilised instead of uncalcined waste marble, the compressive strength values increase. For a 10% addition of waste marble to clay bricks, the compressive strength value is 8.5 and 10.2 MPa for uncalcined and calcined waste marbles respectively.

• Dr. Vishal Puri (2022) **"Development Of Eco-Friendly Bricks For Sustainable Construction" -** Four distinct innovative brick production processes were presented in this study. These bricks made use of the brick-making possibilities of waste materials such straw, PET, polythene, and recycled aggregates. These bricks have been shown to be 15–25% less expensive than traditional bricks. Even after using such wastes, the size and form were observed to be ideal with sharp edges. Additionally, it was found that these bricks were 20–30% more energy efficient than standard bricks.

• Surbhi Jain (2022)**"Scientists Create Bricks From Wastewater"-** The authors of this study compared clay bricks manufactured using groundwater using the conventional method to burnt clay bricks developed utilizing wastewater. The experimental investigation included both destructive and non-destructive experiments, which were completed and evaluated. It was shown how wastewater affected the durability and growth of burnt clay bricks. When compared to ground surface water bricks, the results from wastewater bricks were 19% better. The testing findings of wastewater bricks were 15–25% better than those of clay bricks burnt in groundwater.

IV.METHODOLOGY

4.1 MATERIALS USED:

Collection of materials is basic and important step in any project. Also the materials used should be Eco-friendly, hence in this project usage of Waste material is given the priority.

Property	% (By weight)
Alumina or Clay	20 to 30
Silica or Sand	50 to 60
Lime	4 to 6
Iron Oxide	4 to 6
Magnesia	1
SO_3	1.7

Table 1 : Properties of Clay

As Tile Waste is mostly made up of ceramic, usually glazed, materials including glass, cork, stone, and other composites.

Property	% (By weight)
SiO_2	21.8
Al_2O_3	6.89
Fe_2O_3	4 to 6
Fe_2O_3	3
Magnesia	1
Calcium	1.7
Passing	1.18mm

Table 2 : Properties of Tile Powder

Parameters	Values
p^H	7.4
Alkalinity	62mg/L
Acidity	50mg/L

Hardness 1.calcium hardness 2. Magnesium hardness	180mg/L 64mg/L
Chlorides	120mg/L

Table 3 : Parameters of Tested water sample

4.2 OTHER BONDING MATERIALS ARE:

1. Rice Husk
2. Rice Husk Ash

4.3 PHASES OF MANUFACTURING

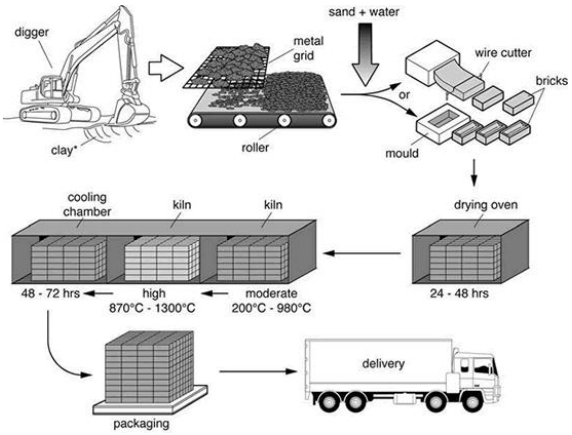

Fig 1: Phases of Manufacturing

4.3.1. Mining and Storage: There are six processes in the preparation of clay for the manufacture of bricks: cleaning clay of dirt For the creation of bricks, pure clay is required. The clay in the top layer of soil, which is roughly 200 mm deep, is discarded because the top layer of soil may contain pollutants. Unsoiling is the term for this. Digging the clay is extracted from the ground and scattered on the bare ground once the top layer has been removed. Cleaning The clay is cleansed of stones, plant materials, etc. during this step. If there is a significant amount of particle matter, the clay is cleaned and screened. With the use of earth crushing rollers, the clay lumps are reduced to powder.

4.3.2. Moulding clay for Manufacturing: prepared clay is mold into brick shape into proper shape in two types a) Hand moulding and machine moulding. We can use hand moulding if brick production is done on a small scale and labour costs are low. The rectangular moulds are constructed of steel or wood and have openings at the top and bottom. The bricks required are in large quantity, and then machine molding is economical and also saves ore time.

4.3.3. Forming: Weathering and Tempering are the two steps in the forming process, produces a homogeneous, plastic clay mass. Usually, this is achieved by adding water to the clay in a pug mill, a mixing chamber with one or more revolving shafts with blade extensions. After pugging, the plastic clay mass is ready for forming. There are three principal processes for forming brick: stiff-mud, soft-mud and dry-press.

4.3.4. Drying: Wet brick from molding or cutting machines contain 7 to 30 percent moisture, depending upon the forming method. Before the firing process begins, most of this water is evaporated in dryer chambers at temperatures ranging from about 100 ºF to 400 ºF (38 ºC to 204 ºC). The extent of drying time, which varies with different clays, usually is between 24 to 48 hours. Although heat may be generated specifically for dryer chambers, it usually is supplied from the exhaust heat of kilns to maximize thermal efficiency. In all cases, heat and humidity must be carefully regulated to avoid cracking in the brick.

4.3.5. Hacking: Hacking is the process of loading a kiln car or kiln with brick. The number of bricks on the kiln car is determined by kiln size. The brick is typically placed by labors or mechanical means. Brick placed face-to face will have a more uniform color than brick that are cross-set or placed face-to-back.

4.3.6. Firing: Brick are fired between 10 and 40 hours, depending upon kiln type and other variables. There are several types of kilns used by manufacturers. The most common type is a tunnel kiln, followed by periodic kilns. Fuel may be natural gas, coal, sawdust, methane gas from landfills or a combination of these fuels.

4.3.7. Cooling: After the temperature has peaked and is maintained for a prescribed time, the cooling process begins. Cooling time rarely exceeds 10 hours for tunnel kilns and from 5 to 24 hours in periodic kilns. Cooling is an important stage in brick manufacturing because the rate of cooling has a direct effect on color.

4.3.8. De-hacking: De-hacking is the process of unloading a kiln or kiln car after the brick have cooled, a job often performed by labors. Bricks are sorted, graded and packaged. Then they are placed in a storage yard or loaded onto rail cars or trucks for delivery.

Fig 2: Manufacturing of Bricks.

V. EXPERIMENTS CONDUCTED

1. Compressive Strength Test
2. Water absorption Test
3. Dimensionality Test
4. Efflorescence Test
5. Hardness Test
6. Soundness Test

VI. RESULTS AND DISCUSSION

As the results are been compared with conventional brick (Standard brick) with Tile waste brick with varying % of Tile waste replacement with clay and results are as follows.

5.1. COMPRESSION TEST:

This test is also known as the crushing strength of brick, determines the compressive strength of brick by applying pressure to a brick specimen until it breaks. Typically, three brick specimens are brought to the lab for testing and tested one at a time and average of three has been tabulated.

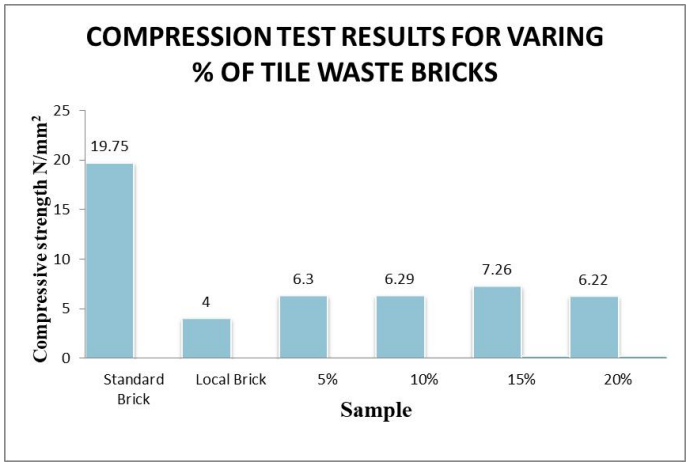

Fig 2: Compressive strength in N/mm^2.

It has been observed by the readings there is significant variation with Compressive Strength as the % in tile waste increases, there is gradual increase in the strength. However at 20% addition of tile waste there is decrease in the strength of the brick.

5.2. WATER ABSORPTION TEST

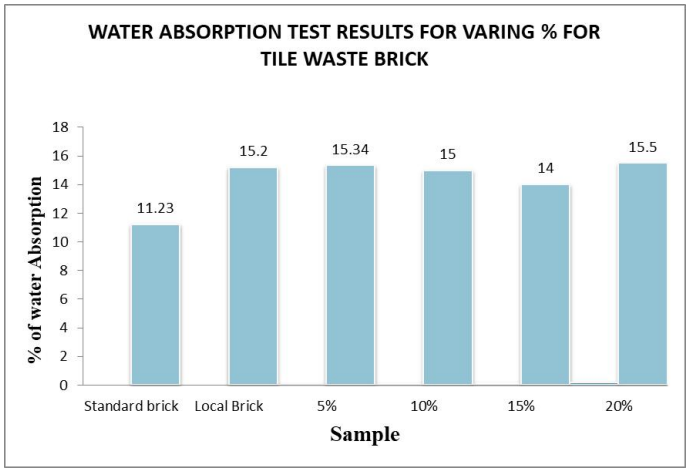

Fig 3: % of Water Absorption (24 hours)

As per IS-3495:1992 Water absorption for bricks should not be more than 20%. In our tile waste bricks the water absorption seen not more than 20%. However at 15% tile waste brick has shown lesser water absorption as compared to other % of tile waste bricks.

5.3. DIMENSIONALITY TEST

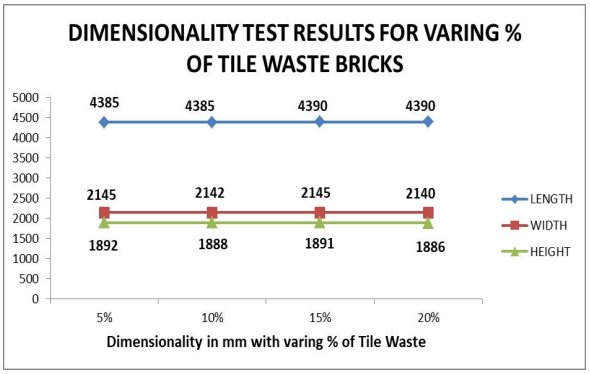

Fig 3: Dimensionality in mm.

Dimension tolerance test on bricks is done as per IS-3495:1992 and IS-1077 results obtained are in-between(Length=4310-4590mm, Width = 2130-2260mm, Height = 1760-1890mm).

5.4. EFFLORESCENCE TEST:

As per the IS: 3495(Part-3):1995 the liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious'. We have found the Nil results as there is no perceptible deposit of efflorescence seen.

5.5. HARDNESS TEST:

In this test a scratch is made on brick surface with a hard thing. If that doesn't left any impression on brick then is good quality brick.

5.6. SOUNDNESS TEST:

In this test to bricks are held by both hands and struck with one another. If the bricks give clear metallic ringing sound and don't break then those are good quality bricks.

VI. CONCLUSION

As per the results obtained the following conclusions were made:

1. The most important property of brick is its compressive strength. Significant variation with Compressive Strength as the % in tile waste increases, there is gradual increase in the strength. However at 20% addition of more tile waste there is decrease in the strength of the brick.

2. As per IS-3495:1992 for Water absorption of bricks should not be more than 20%. In the observed results of Tile waste bricks the water absorption seen is not more than 20%. In our tile waste bricks the water absorption seen not more than 20%. However at 15% tile waste brick has shown lesser water absorption as compared to other % of tile waste bricks.

3. Dimension tolerance test on bricks is done as per IS-3495:1992 and IS-1077 results obtained are in between (Length=4310-4590mm, Width = 2130-2260mm, Height = 1760-1890mm).

4. As per the IS: 3495(Part-3):1995 the liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious'. We have found the Nil results as there is no perceptible deposit of efflorescence seen.

5. In this test a scratch is made on brick surface with a hard thing. If that doesn't left any impression on brick then is good quality brick.

6. In this test to bricks are held by both hands and struck with one another. If the bricks give clear metallic ringing sound and don't break then those are good quality bricks.

The Tile waste brick can be utilized for pavement construction, Load bearing walls and also used in heavy construction as the weight of the brick is 3.5kg.

VII. FUTURE SCOPE

- To promote the tile waste and waste water from localities as a useful product.
- Establishing the industries locally.
- Decrease the water absorption capacity.
- Increase fire resistance capacity.
- Ultimately reduced Tile Waste amount.
- Decreases in the carbon footprint of the house.
- To manage the disposal of waste product into construction raw material.
- To encourage the waste product as ecofriendly material.
- To dispose the waste safely.
- To conduct cost analysis and find cost effectiveness to any structure by bricks with waste material.
- Can improve the bricks by varying Tile Waste.

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