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Development and Study of Cow Dung Bricks

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Abstract:

The increasing global concern for sustainable and eco-friendly practices has led to the exploration of alternative construction materials. This study focuses on the development and study of cow dung and eco bricks as potential environmentally friendly alternatives to conventional bricks. Cow dung, an abundant agricultural waste product, and eco bricks made from recycled materials offer the potential to reduce environmental impact and promote sustainable building practices.

The study involved several phases. First, cow dung was collected and processed to remove impurities and enhance its binding properties. Various proportions of cow dung, along with additives such as clay, lime, wheat straw, and water were mixed to form a cohesive mixture suitable for brick manufacturing. The mixture was then molded into brick shapes and allowed to undergo drying. To assess the performance of the cow dung and eco bricks, compressive test was conducted. Comparative studies were also conducted against conventional bricks to evaluate their structural integrity and sustainability.

The findings of this study contribute to the growing body of knowledge on sustainable construction materials and provide insights into the potential applications of cow dung and eco bricks in the building industry. These alternative bricks have the potential to reduce environmental impact, utilize waste materials effectively, and promote sustainable practices in the construction sector, thereby contributing to a greener and more sustainable future.

Keywords **— Cow dung, eco brick, sustainable material, strength of brick**

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I. INTRODUCTION

The history of brick making in India is thousands years old, which reflecting the architectural heritage and cultural diversity. The use of bricks in Indian construction can be traced back to ancient civilizations, with significant developments occurring over time. One of the earliest instances of brick usage in India has been seen in the Indus Valley Civilization, which flourished around 2500 BCE. Excavations at sites like *Mohenjo-Daro* and *Harappa* reveal well-planned cities with intricate brick structures, including houses, public buildings, and drainage systems. The bricks used during this period were sun-dried mud bricks or fired bricks made from local clay. Not only this, The *Mauryan* Empire (*322 BCE - 185 BCE*) witnessed a major advancement in brick making techniques. Emperor *Ashoka*, known for his architectural endeavours, promoted the use of bricks in constructing pillars and monumental structures. The *Ashoka* pillars, with their intricately carved capitals and inscriptions, showcase the craftsmanship achieved with brick as a versatile medium.

During the medieval period, various dynasties and kingdoms in India left their architectural imprint using bricks. The *Chola* dynasty in South India (9th to 13th centuries) constructed magnificent temples with intricate brickwork.

The history of bricks in India is a testament to the enduring nature of this construction material. From ancient civilizations to contemporary architecture, bricks have played a vital role in shaping the diverse architectural landscape of the country, blending tradition with innovation.

A. *Indian Brick Industry:*

A China is the lead exporter of bricks in the world incurring about 37.2 million dollars of export value annually in the world. **India is the second largest producer of brick in the world** with 14% market share. India's construction industry was valued at over three trillion Indian rupees in fourth quarter of 2022. It will contribute 12-15% to the country's GDP by the year 2025. The Infrastructure in India is estimated to grow at a CAGR of approximately 7% during the forecast period. Government plans to invest a whopping amount in infrastructure projects by the year 2024-25. Clay fired bricks form the backbone of the construction industry which is valued at approximately US$ 70.8 billion. The brick sector in India, although unorganized, is tremendous in size and spread. The brick sector contributes nearly 0.7% to the country's GDP, offers seasonal employment generation to over 10 million workers. It is continuously expanding on account of a rapid increase in demand for bricks in infrastructure and housing industries. In order to meet this demand, over 150,000 brick units provide direct employment to more than 10 million workers and 74% of total production through BTKs and 21% through Clamps.

During the Ninth Five-year Plan period (1997-2002), the annual demand of 170 billion bricks per year was estimated to be generating revenues of over US$ 4.8 billion.

The brick industry is growing as the demand for bricks is increasing in the towns and villages due to the fast economic growth, urbanization and prosperity. It is alarming to note that 300 mm depth of fertile top soil in India will be consumed for burnt clay brick production in about 60 years. Usually, brick kilns are situated in rural and/or periphery of urban areas in the country. It is found that the process of making a brick has not changed much over the century's still 99% brick production done through hand molding. The bricks industries have challenges like rapid increase in brick production, environmental concerns, and use of large quantities of coal in brick kilns.

B. *Different Type of Bricks Used in Construction in India*

In Indian construction, bricks play a significant role as a primary building material. They have been used for centuries due to their durability, availability, and cost effectiveness. Indian construction practices feature various types of bricks, each with its unique characteristics and applications. Burnt clay bricks are the oldest and most widely used in construction. Burnt clay bricks are the oldest and most widely used construction material. Here are some of the different types of bricks commonly used in Indian construction; Traditional Fired Bricks, Fly Ash Bricks, Concrete Bricks, Hollow Bricks, Porotherm Bricks, Autoclaved Aerated Concrete (AAC) blocks and Interlocking Bricks.

C. *Market Segmentation of Indian bricks*

Bricks market of India includes clay bricks, fly ash and concrete bricks and blocks, where **clay bricks dominate the bricks** market despite close down and conversion of clay brick kilns to newer technology due to government interventions in reducing air pollutions from red clay brick kilns. Fly Ash and concrete blocks are still not running to their full capacity due to shortage of fly ash, higher cost of concrete blocks compared to traditional red clay bricks.

D. *Brick Classification on Basis of Strength in India*

In India, bricks can be classified based on their strength and composition. The strength of bricks is

determined by various factors such as the type of material used, manufacturing process, and curing methods. Here are some common classifications of bricks based on strength in India; clay bricks mainly categorized as sun dried bricks or un-burnt bricks, burnt brick, first class bricks, second class bricks, third class bricks, Sand Lime or Calcium Silicate Bricks, Concrete bricks, Fly ash bricks, Engineering bricks and fire bricks.

E. Manufacturing Processes of Clay Bricks

In The manufacturing process of clay a brick typically involves several processes for manufacturing i.e. mining and preparation of clay, mixing, shaping, drying, firing, cooling and sorting-packaging.

F. Challenges & Issues in the Indian Brick Sector

The traditional kiln unit itself occupies considerable land area and is subjected to high temperature making it unfit for agricultural activities (after the site is abandoned).

The large coal consumption of the brick industry is the cause of significant air pollution in terms of carbon dioxide (CO2), carbon monoxide (CO), Sulphur dioxide (SO2), nitrogen oxides (NO2) and suspended particulate matter (SPM). The large amounts of coal used for brick firing also leave behind bottom ash as residue. The air pollution and bottom ash generated cause considerable health problems, especially related to respiratory health, while also causing damage to property and crops.

The seasonal nature of brick production generates employment for a limited period of six - seven months in a year. Majority of the workforce has no option, but to engage as labourers (generally as agricultural labourers) for the rest of the year.

The workers in the brick industry are subjected to extreme working conditions and poor remuneration. Currently in India, brick manufacturing is a labor-intensive sector, with crude techniques causing considerable worker drudgery. They are also exposed to high concentrations of Repairable Suspended Particulate Matter (RSPM), during monitoring and regulating the fire, as the furnace chamber is covered with ash (ash acts as insulator)

G. Problem Statement

It has been observed that traditional bricks from kiln is costly and causes pollution. The Cow Dung can be used to manufacture bricks which are eco-friendly and much cheaper. To overcome this, an innovative approach of cow dung as brick ingredient and its feasibility should be checked when mixed with wheat stubble, lime, fly ash & clay.

H. Advantage of Cow Dung Bricks over Conventional Bricks

Cow dung bricks, also known as "gobar bricks" or "cow dung patties," have gained attention as a sustainable alternative to conventional bricks. Some advantages of cow dung bricks over conventional bricks are eco-friendly, high thermal mass, low cost, natural pest repellent and anti-radiation property.

II. REVIEW OF LITERATURE

The cow dung bricks are composed of with cow dung, clay, wheat straw/rise husk in different proportions. The review of literature of cow dung brick is done and the experimental treatments were finalised.

A. Feasibility of Cow dung Bricks as Insulator in Cavity Wall

A Cow dung brick with 65% cow dung (mix 1) gives adequate strength. The strength of the cow dung mixture decreases as the percentage of cow dung content increases. Along with it they perform other test to check feasibility of cowdung bricks. The temperature test gives them positive result which shows that temperature drop to 31.1°C from 32°C after using cow dung bricks. They burnt their bricks for 15 minutes which does not get fire easily but after 1 hour it turns to ash. So it is less fire resistance as compared to normal brick. Cavity Walls give Good Insulation against Sound, it makes the room Soundproof nearly 2-3db drop observed at several points taken during experiment.

B. Effect of Cow Dung and Coir in Strengthening of clay bricks

The study was conducted to investigate the effect of cow dung, coir and lime in strengthening of clay bricks for the construction of environment friendly buildings. Coir is a abundantly available natural fiber and is extracted from the husk of coconut fruit. coir is used to act as reinforcement in the ratios, 5% and 10%. Mixing cow dung to clay improves plasticity, reduces green breakage, and act as internal fuel in fire bricks thereby reducing firing cracks. The various ratios of cow dung used are, 5%, 10%, 15%, 20%, and 25%. The compressive strength of the clay brick increases with the addition of cow dung, coir and lime. The maximum strength obtained is 25.63 N/mm2 for the 5% coir and 25% cow dung ratio. As per IS 1077:1992, it is of the class 25. The normal strength of the un-burnt clay bricks are 7.9 N/mm2 which is much less than the strength obtained from the ratio 5% coir and 25% cow dung.

C. *Development of Eco Brick and Concrete with the partial Replacement of Cow Dung*

The study was done on Development of Eco Brick and Concrete with the partially replacement of cow dung. They used 10%, 20% and 30% of Cow dung brick and 10%, 20% and 30% of Cow dung ash in concrete, and obtained maximum strength at 10 % replacement.

As per study, the compressive strength decreases from 6.3(N/mm²) at 0% cow dung to 1.75(N/mm²) at 20% cow dung. There is also decrease in flexural strength from 4.5(N/mm²) at 0% cow dung to the 3.75(N/mm²) at 20% cow dung. Whereas, the water absorption capacity increases from 23.2 at 0% cow dung content to the 45.19 at 30% cow dung content. The highest value of workability value is recorded for 20% cow dung.

It is concluded that on increasing the cow dung quantity, strength decreases simultaneously whereas water absorption capacity increases

D. *Replacement of Cement in Concrete by Cow Dung Ash*

The cement replaced by cow dung ash in concrete. The Cement was partially replaced with four percentages (5%, 10%, 15%, and 16%) of cow dung ash by weight. A Consistency limits and chemical composition of ordinary Portland cement (OPC), cow dung ash and OPC mixed with cow dung ash were determined. The compressive strengths of the mortar and concrete specimens were determined at 7, 14 and 28 days respectively. Test results indicated that the consistency limits increased up to an optimum content and decreased further with increase in percentage of CDA in cement. The compressive strength is increased when the cement is replaced by 5% of CDA and decreased with the increase in the cow dung ash content. It is concluded that the 5% cement can be replaced with CDA in mortar. The compressive strength of the concrete is reduced with the increase in CDA and in strength increase with the increase in curing days. As observed in mortar, 5% of cow dung may be used as a partial replacement to cement in concrete. This study observed that during hydration, the Calcium Hydroxide (CH) produced reacts with the silica from CDA over time to form the more stable Calcium Silicate Hydrates(C-S-H) which can be responsible for the appreciable strength gain. It has been reported by several researchers that incorporation of pozzolanic materials into cement reduces the CH formation (which promotes micro cracking) and enhances formation of C-S-H, which promotes later strength gain.

III. MATERIAL AND METHODOLOGY

A. *Fresh cow dung*

Fresh Cow dung has been used as the basic raw material for making bricks collected from the Cattle breeding farm, JAU, Junagadh in 4 plastic drum in the morning nearly 7 AM. As per the study more than 40kg of Fresh Cow Dung has been used in the process of making bricks. (Refer to Plate no.1)

Cow dung, additionally referred to as cow pats, cow pies or cow manure, are the waste product (faces) of bovine animal species. Cow dung is the undigested residue of plant depend which has surpassed thru the intestine of cow. It is wealthy in minerals like Potassium, Magnesium, Sodium and Manganese and is created from natural matters. Cow dung has been utilized in India for lots of

years with inside the fields of agriculture or farming. The manufacturing conventional bricks from kiln is luxurious. In growing countries, maximum of the population cannot manage to pay for traditional constructing blocks made with the sand-cement mixture. In addition, those blocks do now no longer offer thermal consolation and feature an excessive embodied power as compared to vernacular substances. Cow dung, which is mostly a darkish brown color, is regularly used as manure (agricultural fertilizer). Dung can also be accumulated and used to provide biogas to generate energy and heat. The fuel line is wealthy in methane and is utilized in rural regions of India and Pakistan and some other place to offer a renewable and stable supply of energy.

B. *Lime*

Lime is a calcium-containing inorganic mineral composed on the whole of oxides, and hydroxide, commonly calcium oxide and/ or calcium hydroxide. It is likewise the call for calcium oxide which happens as a made from coal-seam fires and in altered limestone xenoliths in volcanic eject. The phrase lime originates with its earliest use as constructing mortar and has the experience of sticking or adhering. The rocks and minerals from which those substances are derived, usually limestone or chalk, are composed on the whole of calcium carbonate. They can be cut, crushed, or pulverized and chemically altered. Burning (calcinations) of those minerals in a lime kiln converts them into the rather caustic cloth burnt lime, unsliced lime or quicklime (calcium oxide) and, via next addition of water, into the much less caustic (however nonetheless strongly alkaline) slaked lime or hydrated lime (calcium hydroxide, Ca(OH)2), the manner of that is referred to as slaking of lime. If excessive compressive strengths are undesirable, lime content material may be elevated and the belongings specification used.

C. *Fly ash*

Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel and has considerable pozzolonic activity. As per the study, more than 20 kg of fly ash collected from the local vendor of *Bhesan Chowkdi*, Junagadh, Gujarat, India.

Fly ash improves the workability, strength and durability of bricks. This national resource has been gainfully utilized for manufacture of pulverized fuel ash-lime bricks as a supplement to common burnt clay buildings bricks leading to conservation of natural resources and improvement in environment quality. Pulverized fuel ash- lime bricks are obtained from materials consisting of pulverized fuel ash in major quantity, lime and an accelerator acting as a catalyst.

Fly Ash s the inorganic mineral residue obtained after burning of coal/lignite in the boilers. Fly ash is that portion of ash which is collected from the hoppers of ESP's and pond ash is collected from the ash ponds. Bottom ash is that portion of ash which can be collected from the bottom portion of the boilers. The characteristics of fly ash depend upon the quality of lignite/coal and the efficiency of boilers. India depends upon primarily on coal for the requirement of power and her power generation is likely to go up from 60,000MW in the year 2010, while generation of power from bituminous sources is on increase. The generation of fly ash is also likely to increase. The fly ash generation in India Thermal Stations is likely to shoot up to 170 million tons in 2010 from the present level of 100 million tons.

D. *Fly ash*

The Clay is regarded as one of the most abundant natural mineral materials on earth. Clay help to maintain the shape after forming bricks. For the study purpose more than 20 kg of clay has been purchased from the Sabalpur Chowkdi Vendors, Junagadh. The Clay used for brick manufacturing has plasticity, which permits them to shaped and molded when they are mixed with water. The Clay types (surface clay, shale clay, fire clay) have similar chemical compositions but differ in their physical characteristics. The manufacturer minimizes these variations by mixing clays from locations and sources in the same pit. The brick

from the same manufacturer may have slightly different properties in subsequent productions. Clay bricks have a set of properties which are important in governing the strength and durability of bricks.

E. Wheat stubble

Wheat stubble refers to the remaining plant material left in the field after wheat harvest. It is consider as the by-product of wheat crop which is collected from Wheat Research Station, Junagadh.

As per study, during brick making process 5 kg of pulverized wheat stubble were use. It consists of the stalks, leaves, and other above-ground parts of the wheat plant that are left behind once the grain has been harvested.

Wheat stubble is typically composed of dry and fibrous plant residues. The cow dung provides the binding properties while the wheat stubble adds strength and durability to the bricks. The ratio of cow dung to wheat stubble may vary depending on the desired characteristics of the bricks and the availability of materials.

By incorporating wheat stubble into the cow dung mixture, the eco bricks benefit from the added strength and durability of the fibrous material. This combination of cow dung and wheat stubble helps to create sustainable and environmentally-friendly building materials and promote utilizing agricultural waste products.

Wheat straw, rice straw, and corn straw are the most abundant lingo cellulosic biomasses among agricultural residues in the world (Kim and Dale, 2004), used mainly as feed for livestock or agricultural supplements. Wheat straw consists mainly of cellulose (28%–39%), hemicelluloses (23%–24%), lignin (16%–25%), and fewer contents of ash and protein.

F. Water

Water plays a crucial role in the process of making cow dung bricks. It is important to use the right amount of water during the brick-making process to ensure proper consistency and compaction. Excessive water content can lead to weak bricks or prolonged drying times, while insufficient water can make the mixture difficult to work with. Here are some ways in which water is used in the production of cow dung bricks; softening of cow dung, mixing with other materials, moisture adjustment and compaction.

G. Acquisition of material

The raw materials refer to the practice of sourcing or obtaining necessary materials or resources from external suppliers or vendors rather than producing them internally. It involves the delegation of the procurement process to a third party. The raw material has been collected from different source ie. Cow dung acquired from cattle Breeding Farm, Wheat stubble from Wheat Farm, Wheat Research Station, JAU, Junagadh, Lime from M/s Jay Cement, Dolatpara, Junagadh, Fly ash from brick manufacturer, Bhesan Chowkdi, Junagadh and clay from brick manufacturer, Sabalpur Chowkdi, Junagadh

H. Apparatus used

A pulverizer is a mechanical device that is used to grind, crush, or pulverize materials into fine particles or powders. It is commonly used in various industries such as mining, construction, pharmaceuticals, and food processing. Pulverizer typically consists of a rotating drum or cylinder that contains grinding media, such as steel balls or hammers. The material to be pulverized is fed into the cylinder, and the grinding media inside the cylinder crush and grind the material into smaller particles.

Shredder: A shredder machine is a mechanical device or equipment designed to cut, tear, or shred materials into smaller pieces. It is commonly used to destroy or reduce the size of various items, such as paper documents, plastic materials, metal objects, or organic waste. The primary purpose of a shredder machine is to ensure the secure disposal or recycling of materials. By shredding items into smaller fragments, it makes them more manageable, reduces their volume, and prevents unauthorized

access to sensitive information. Shredder machines are widely used in various industries, businesses, offices, and households for different purposes. Shredders typically consist of a motor-powered mechanism with rotating blades or cutting elements that interact with the material being shredded. The design and configuration of shredder machines can vary depending on the specific application. Shredder machines for wheat stubble have been developed to address these concerns. These machines are equipped with rotary blades or flails that effectively chop the stubble into smaller pieces, facilitating its incorporation into the soil or its use as mulch. By breaking down the stubble, these machines help speed up the decomposition process and enhance soil health.

Universal testing machine: A Universal Testing Machine (UTM), also known as a Universal Testing Instrument (UTI), is a versatile mechanical testing device used to evaluate the mechanical properties and behaviour of various materials. It is widely used in industries, research laboratories, and educational institutions for testing the strength, elasticity, ductility, and other mechanical characteristics of materials. The Universal Testing Machine typically consists of a load frame, grips or fixtures for holding the specimen, and a force or load-measuring system. The load frame is a robust structure that applies controlled forces or loads to the specimen, allowing for the measurement of its response to stress. The grips or fixtures securely hold the specimen in place during the testing process, ensuring accurate results. The force or load-measuring system typically incorporates a load cell or hydraulic system to measure the applied force or load accurately. It provides data such as tensile strength, compressive strength, bending strength, modulus of elasticity, and other mechanical properties of the tested material.

Gravity Convention Oven: Gravity convection ovens are designed for applications where a fan or other air flow would disturb the thermal process, such as processing of lightweight materials or powders. Gravity Ovens are designed for applications that require less temperature uniformity than other types of mechanical convection ovens Gravity convection ovens offer many industrial uses such as drying and baking. Each gravity oven model generates a natural air convection supply through perforated shelves to achieve temperature uniformity without blowers.

Sieve Shakers: Sieve shakers are devices designed to help promote particle movement through a stack of sieves, facilitating accurate particle separation. As the particle separate, they are retained on the various sieves depending on their size, providing insight into the average particle size of the sample. A sieve shaker automates the agitation of particles for particle separation and sizing distribution for a range of materials to meet quality control and quality assurance requirements.

Digital Weight Machine: A digital scale is a measuring device that reads and displays the weight of an object. Unlike an analog balance scale, a digital scale is a high-quality scale that gives a more correct weight reading.

Hand Gloves:A glove is a garment covering the hand, with separate sheaths or openings for each finger and the thumb. Gloves extending past the wrist are called gauntlets. Gloves protect and comfort hands against cold or heat, damage by friction, abrasion or chemicals, and disease; or in turn to provide a guard for what a bare hand should not touch. We used rubber gloves during the mixing of raw materials.

I. Methodology

Batching: The process of measuring ingredients or materials to prepare brick is known as batching. Batching can be done by two methods,

- Volume batching
- Weight batching.

Batching should be done properly to get quality material mix. The proper and accurate measurement of all the material used in brick making is necessary to ensure uniformity of proportions in succeeding batches. As per the study, weight batching has been adopted initially but it seems to be difficult to manage the proportions exactly by weight and it is time consuming affecting the end product of the

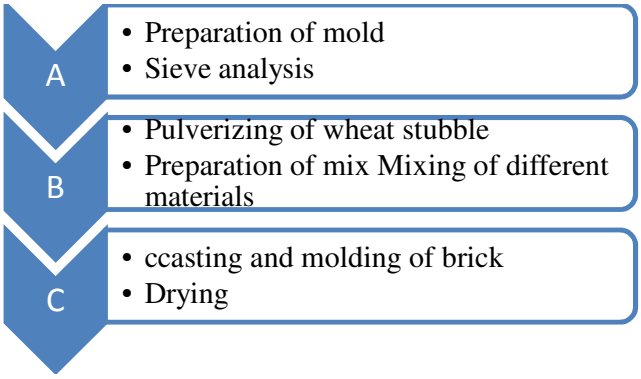
project. So as to make the process easy and viable volume batching method adopted.

In the context of brick manufacturing, volume batching refers to the process of combining specific quantities of raw materials in predetermined proportions to create a batch of bricks. The raw materials typically include clay, wheat stubble, water, and sometimes additives like fly ash or lime.

Volume batching: In volume batching, materials are measured on the basis of volume. It is less precise method of batching. Measurement boxes or gauge boxes of known volume (807.5 cm^3) having dimension (8.5x9.5x10 cm) are used to measure materials. A Gauge boxes are generally deeper and contains narrow top surface and they are made of timber or steel or iron Volumes of different sized fine aggregate and coarse aggregate are measured. The gauge box was used to measure cow dung, lime, wheat stubble, fly ash and clay. The Volume batching is a technique used to improve efficiency, reduce costs, and optimize resource utilization by processing similar items or tasks together as a batch rather than individually. Volume batching concrete mix gives low to high slumps. Volume batching since it is difficult to find the exact volume of granular materials because of their voids. Volume batching does not require skilled workers but weigh batching, as our project is small, A volume batching has been adopted for said study. We prefer volume batching for most of samples.

Weight batching: In this method, Materials are measured on the basis of weight. It is accurate method of batching. Weigh batchers or other types of weighing equipment are used to measure weight of materials. Only a few samples are done by weight batching (i.e. M1, M2, and M3). Weigh batchers used are available in two types namely mechanical weigh batcher and electronic weigh batchers. In mechanical weigh batchers, weights are measured using spring and dial gauge arrangement and it is widely used equipment in weigh batching. In electronic weigh batchers, electronic scales and load cells supported by hoppers are used to measure the weight of ingredients of concrete. Moisture content presence in the aggregate should also be considered while batching. In case of fully automatic weigh batching it can be considered but volume batching is not suitable in such cases. Compressive strength of same concrete mix at 7 days and 28 days is higher for weigh batching concrete mix than volume batching concrete mix.

Process of making of cow dung eco bricks:



Making different composition of Cow Dung, Fly Ash, Lime, Wheat Stubble and Clay

As in the said study volume batching method has been adopted. Different composition samples material collected at a place to mix it further. Total of 48 different proportioned brick samples made using volume batching method.

IV. TESTING AND EVALUATION

A compression test of cow dung bricks is a laboratory test conducted to determine the load-bearing capacity and structural strength of bricks made from differently proportioned cow dung. This test assesses how much load or pressure the bricks can withstand before they deform or fail. It helps evaluate the bricks' performance and suitability for use in construction applications. During the compression test, a cow dung brick is placed in a Universal Testing Machine (UTM) which applies a gradually increasing compressive load on the brick until it reaches its maximum load capacity or fails. The UTM measures the load applied and the corresponding displacement or deformation of the brick.

$$\text{Compresasive strength} = \frac{\text{load in N}}{\text{Area in mm}^2}$$

$$\text{strain} = \frac{\text{change in length in mm}}{\text{original length in mm}}$$

The compression test for cow dung bricks involves assessing their load-bearing capacity and mechanical strength. The test is typically conducted using a Universal Testing Machine (UTM) to apply a gradually increasing load until the brick fails or reaches the desired load capacity. A step-by-step description of the compression test for cow dung bricks is as follows:

Prepare standardized cow dung bricks of uniform size and composition. Ensure the bricks are thoroughly dried before testing.

Calibrate the UTM and clean the platen surfaces to avoid any contamination.

Place a steel plate on the lower & upper platen of the UTM to distribute the load evenly.

Position a cow dung brick centrally on the lower platen, making sure it is aligned to receive an even load distribution.

Carefully place the movable crosshead of the UTM on top of the brick without exerting any load initially.

Set the test parameters on the UTM software, including the compression speed and the desired load range.

Start the test, allowing the UTM to gradually apply an increasing load on the cow dung brick.

Monitor the load and displacement data recorded by the UTM during the test.

Continue the test until the brick fails or until it reaches the desired load capacity, whichever comes first.

Record the maximum load and displacement values obtained during the test.

Analyze the data to calculate the compressive strength of the cow dung brick. Divide the maximum load by the cross-sectional area of the brick to obtain the compressive strength value.

Repeat the compression test for all cow dung bricks.

Data Analysis:

Plot a load vs. Elongation graph, to visualize the behaviour of the cow dung eco bricks during the compression test.

To calculate the compressive strength of brick, the maximum load obtained during the compression test was divided by the cross-sectional area of the brick.

V. RESULT AND CONCLUSION

The project was carried out in the civil engineering wing under Department of Renewable Energy Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, Gujarat.

As per the said study, volume batching and weight batching method has been taken into account. Initially the weight batching was the primary method for the making the bricks like M1, M2, M3. But so as to make the process easy, volume batching arise as the alternative option. As per the data concluded it is observed that the weight batching method is the best optioned method for making the cow dung eco bricks. In weight batching method, account for the cow dung proportion percentage varying from 0% - 15% in the study.

While the volume batching method have cow dung proportion percentage ranging from 10% - 45% mostly above 15% have a large quantity of cow dung which leads to the decrease in the load bearing capacity and decrease in the mass of bricks.

The volume batching method also affects the quantity of Lime. As per the observation a total of 13 samples in range of 5% - 10% lime, 9 samples in range of11% - 15%, 9 samples in range of 16% - 20%, 7 samples in range of 21% - 25%, 3 samples 26% - 30%, 3 samples in range of 31% - 40%.

The Wheat Stubble quantity in bricks are described as the 13 samples have 0%, 5 samples in range of 5% - 10%, 6 sample in 11% - 15% range, 6 sample in 16% -20% range, 8 sample in 21% - 25% range, 4 samples in 26% - 30% range & 1 sample for more than 30%.

Following conclusion were made based on test results:

It is clearly observed from the graph that increase of volume ratio of cow dung more than 1 results significant fall in Load Bearing Capacity of the brick.

Cow Dung brick weight is nearly 30 % lesser than clay bricks which results in significant decrease in structural cost of building.

Cow dung bricks are highly compressible material as they have a very high elongation value and it is difficult to denote the peak load of the bricks.

Study signifies that the cow dung bricks are Less Heat Resistance. As per said study the overheating can cause deduction in strength of the bricks. So it is preferred to do sun drying for nearly 5-7 days instead of oven drying method.

Further study is required for lesser cow dung volume ratio less than 1 & increasing wheat stubble volume ratio by 2 with adding one more cementing material and eco-friendly reinforcement material like bamboo fiber and jute fiber.

It is concluded from significant elasticity of cow dung bricks, that it is suitable for Lumina elements like acoustic sheets and thermal insulation sheets.

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