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Study on Stabilized Block Using Fly Ash, Construction & Demolition Waste

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Abstract: ***Thisstudyinvestigatesthedevelopmentofsustainablestabilizedblocksusingsandysoil,flyash,cement,andcrushed roof tile waste obtained from construction and demolition activities. The primary objective is to reduce the environmental impact and construction cost associated with traditional masonry units while utilizing industrial and construction waste effectively. Different mix proportions were prepared and tested for compressive strength, water absorption, and density after curing periods of 14, 21, and 28days. Theresultsshowedthat the mix M1containing 40% fly ashand 15% crushedroof tile waste achieved the highest compressive strength of 8.16 N/mm² after 28 days. Water absorption values remained below the permissiblelimit,confirminggooddurability.The studyconcludesthatflyashandrooftilewastecanbeeffectivelyutilizedin stabilized blocks to produce low-cost, eco-friendly, and sustainable construction materials.***

***Keywords**: Fly ash,stabilizedblocks, Constructionand DemolitionWaste,sustainable construction,compressive strength*

I. INTRODUCTION

The rapid growth of the construction industry has led to increased consumption of natural resources and environmental degradation. Conventional materials such as burnt clay bricks require high energy and contribute to pollution and resource depletion.Therefore,thereisagrowingneedforsustainableandeco-friendlyalternativesinconstruction.Stabilizedmudblocks (SMBs) have gained importance as a low-cost and environmentally friendly building material. These blocks can be produced usinglocallyavailablesoilalongwithindustrialandconstructionwastematerials.Flyash,aby-productofthermalpowerplants, is widely available but underutilized, while construction and demolition (C&D) waste creates disposal challenges. This study aimstoutilizeflyashandcrushedrooftilewasteintheproductionofstabilizedblocksandtoevaluatetheirperformanceinterms of compressive strength, water absorption, and density.

II. MATERIALS AND METHODS

A. MaterialUsed

The materials used for the preparation of stabilized mud blocks are sandy soil, class C fly ash, Crushed roof tile waste, Cement and water

1) Sandysoil

Sandy soil is used as the primary material for block preparation. It has good compaction characteristics and low plasticity,whichmakesitsuitableforformingstabilizedblocks.Thesoilusedinthisstudywasobtainedfromanearby location and was free from organic impurities.

2) ClassCfly ash

Flyashisanindustrialby-productobtainedfromthermalpowerplants.Inthisstudy,ClassCflyashwasuseddueto its self-cementing and pozzolanic properties. It reacts with water to form cementitious compounds, which improve the strength and durability of the blocks.

3) Crushedrooftilewaste

Crushedrooftilewastewascollectedfromconstructionanddemolitionactivities.Itwasusedasapartialreplacement material to improve particle size distribution and reduce voids. The inclusion of tile waste also helps in reducing environmental waste and enhances the density of the blocks.

4) Cement
Cement was added in a small quantity (5%) as a stabilizing agent. It helps in improving early strength and provides betterbondingbetweenthematerials.Thepresenceofcementacceleratesthestrengthgainoftheblocksduringcuring.

5) Water
Potablewaterwasusedformixingallmaterials.Cleanwaterensuresproperhydrationofcementandflyash,leading to better strength development. The amount of water added was controlled to achieve optimum moisture content.

B. MixProportions
Mixproportionadoptedforthis study are givenbelowinTABLE1:

TABLEIMIX PROPORTIONS

MIX	SOIL(%)	FLY ASH (%)	TILEWASTE(%)	CEMENT(%)
M1	40	40	15	5
M2	40	35	20	5
M3	40	30	25	5

C. Block Preparation
The preparation of stabilized blocks was carried out through dry mixing, wet mixing, and casting. Initially, sandy soil, fly ash, andcrushedrooftilewastewere drymixedthoroughlytoobtainauniformmixture.Cementwasthenaddedandmixeduniformly. Water was added gradually to achieve an optimum moisture content of approximately 16%, ensuring proper compaction. The mixture was thoroughly mixed to form a consistent mass.The prepared mix was then placed into cube moulds of size 70 mm× 70 mm × 70 mm and compacted adequately to eliminate air voids. The specimens were then removed from the moulds and prepared for curing. FIG shows the casting of cubes with dimension 70 mm × 70 mm × 70 mm.

Fig.1.Casting ofcubes

D. Curing
After casting, the blocks were cured for 7 to 28 days by regular water sprinkling. During curing, hydration of cement and pozzolanic reactions of fly ash occur, leading to the formation of cementitious compounds such as calcium silicate hydrate (C–S–H)andcalciumaluminatehydrate(C–A–H).Thesecompoundsenhancethestrength,bonding,anddurabilityofthestabilized blocks

III. TESTING OF BLOCKS

A. CompressiveStrengthTest
Compressivestrengthisthemostimportantpropertyforevaluatingtheperformanceofstabilizedblocks.Thistestdetermines the load-bearing capacity of the block. Strength increases with proper curing and compaction. Fig 2shows the compression strength testing of stabilized mud block in Universal testing machine (UTM).

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Fig.2.CompressionstrengthtestinginUTM

B. WaterAbsorptionTest

Thistestmeasurestheamountofwaterabsorbedbytheblocks,whichindicatesdurability.Lowerwaterabsorptionimpliesbetter resistance to moisture and longer service life.

C. DensityTest

Densityis calculatedas massperunitvolume.Higherdensityindicatesbettercompactionandimprovedstrengthofthe blocks.

IV. RESULTS AND DISCUSSION

Theperformanceof stabilizedmudblockswasevaluatedbasedoncompressivestrength,water absorption,anddensity.The experimental results obtained for different mix proportions are presented and discussed below.

TABLEIICOMPRESSIVE STRENGTHRESULTS

Mix	14Days(MPa)	21Days(MPa)	28Days(MPa)
M1	3.16	4.73	8.16
M2	2.65	4.61	7.14
M3	2.14	3.81	6.12

The results indicate that the compressive strength of stabilized mud blocks increases consistently with curing time for all mix proportions. At 14 days, Mix M1 shows the highest strength (3.16 MPa), followed by M2 (2.65 MPa) and M3 (2.14 MPa). A similartrendisobservedat 21daysand28days,whereM1achieves4.73MPaand8.16MParespectively,whicharehigherthan the corresponding values ofM2 andM3. The increasein strength with curing period isattributed to the continuoushydration of cement and pozzolanic reaction of fly ash, leading to the formation of cementitious compoundssuch as calciumsilicate hydrate (C–S–H), which enhances bonding between particles. Among the mixes, M1 exhibits the highest compressive strength at all curing periods, indicating better compaction and an optimum combination of soil, fly ash, and tile waste. Mix M2 also shows good strength development but remains slightly lower than M1. Mix M3 records the lowest strength due to its higher tile waste content, which reduces cohesion and increases voids within the matrix.

TABLE IIIWATERABSORPTION RESULTS

Mix	WaterAbsorption (%)
M1	13.47
M2	13.62
M3	16.31

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ThewaterabsorptionresultsindicatethatMixM1showsthelowestwaterabsorption,followedcloselybyM2,whileM3exhibits the highest value. Lower waterabsorption indicates better resistance to moistureand improved durability. The increase inwater absorption for M3 is due to higher tile waste content, which leads to increased porosity. The presence of fly ash and proper compaction in M1 and M2 helps in reducing voids and improving resistance to water penetration

TABLE IVDENSITY RESULTS

Mix	7 Days(kg/m^3)	14 Days(kg/m^3)	28 Days(kg/m^3)
M1	1557	1644	1860
M2	1516	1626	1831
M3	1510.2	1615	1761

The density results show that Mix M1 exhibits the highest density, followed by M2, while M3 has the lowest density. Higher densityindicatesbettercompactionandimprovedstructuralintegrity.ThedecreaseindensityinM3isduetothehigherproportion of tile waste, which affects the compactness of the mix.

The results clearly demonstratethat theinclusion of flyashandcrushed roof tilewastesignificantly influences theproperties of stabilized blocks. Compressive strength increases with curing time due to hydration and pozzolanic reactions, while water absorption is affected by porosity and compaction. Among the mixes, M1 provides the best overall balance between strength, durability, and material efficiency, making it the most suitable mix for stabilized block production

V. CONCLUSIONS

The present study demonstrates that stabilized mud blocks incorporating fly ash and crushed roof tile waste can be effectively used as a sustainable alternative to conventional building materials. The experimental results clearly indicate that compressive strength increases with curing time due to continuous hydration and pozzolanic reactions, while water absorption is influenced by the porosity and compaction of the mix. Among the different mix proportions, Mix M1 exhibited the highest compressive strength (8.16 MPaat 28days)and maximum density, indicating superior load-bearing capacityand compaction characteristics. However, Mix M2 showed a more balanced performance with adequate strength (7.14 MPa), relatively low water absorption (13.62%),andefficientutilizationofmaterials.Theresultsalsorevealthatincreasingcrushedrooftilecontentbeyondanoptimum level(as inM3)leads toa reductioninstrengthanddensityduetoincreasedporosityandreducedcohesion.The inclusionoffly ash significantly contributed to strength development through pozzolanic reactions, while crushed tile waste improved particle packinguptoanoptimumlimit.Therefore,consideringoverallperformance,materialefficiency,andsustainability,MixM1can be considered the optimum mix, more suitable for applications requiring higher strength. Overall, the study confirms that the utilization of industrial and construction waste materials in stabilized mud blocks not only enhances engineering properties but also promotes eco-friendly, cost-effective, and sustainable construction practices.

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