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Feasibility Study of Using Fly Ash Brick made from Reclaimed Sand Dust Waste

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Abstract. This Paper summarizes a project where we prepared six mixes of fly ash bricks, each with 18 samples, incorporating reclaimed sand dust waste, fly ash, sand, and cement. Mix 1 contained 0% waste, increasing by 10% in each subsequent mix, with a consistent 12% cement. The first three mixes had 38% sand and varying fly ash content (50%, 40%, 30%), while the next three had 0% sand and 58%, 48%, 38% fly ash, respectively. A 10% water content was added to all mixes. These proportions provided suitable strength to the fly ash bricks. We studied the history, significance, and problems of bricks, particularly fly ash bricks and reclaimed sand dust waste. Using past research, we evaluated feasibility and conducted compressive strength tests at 7, 14, and 28 days, achieving maximum strength. The water absorption capacity reached 27.82%, and the efflorescence test showed nil to slight salt deposition. Weight change was minimal, with slight variations in air-dry and oven-dry densities. In conclusion, this technique is practical and environmentally beneficial. We recommend further research to enhance its applicability and effectiveness.

Keywords: Fly Ash, Reclaimed Sand Dust Waste, Bricks.

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1. Introduction

Bricks have long been fundamental in constructing various structures, including buildings, houses, walls, and pavements. They are created by combining materials such as mortar into a cohesive mixture. Bricks come in different forms, types, and sizes, tailored to specific locations and historical contexts. Their production occurs on a massive scale to meet the needs of construction. One notable type of brick is the fired brick, known for its durability and strength, used since 4000 BC. Mud bricks, older than fired bricks, utilize straw as a binder.

History of Bricks

Bricks have been integral to construction for thousands of years, dating back to at least 7000 BC when they were first found in the south of Turkey near the ancient settlement of Jericho. Initially, bricks were formed in hot climates by sun-drying mud bricks, a technique prevalent in ancient Egypt where clay mixed with straw served as the binder. A significant development occurred around 3500 BC with the discovery of fired bricks, eliminating the need for sunlight and allowing brick production in colder regions. This innovation, often credited to the Romans, spread brickmaking techniques throughout Europe during the Roman era, gaining further popularity in the Renaissance and medieval periods. Following the decline of the Roman Empire, brick production waned in Europe, surviving primarily in the Byzantine Empire and Italy. However, the 12th century saw a resurgence of brickmaking in Germany and Italy, leading to the emergence of red clay bricks popularized during the Gothic period. During the medieval era, clay was shaped into bricks by laborers using wooden frames coated with sand or straw to prevent sticking. Notably, brickmaking in the United Kingdom saw modernization during Henry VIII's reign, and after the Great Fire of London in the 1660s, bricks played a crucial role in the city's reconstruction. In the 20th century, architects like Le Corbusier and Louis Kahn elevated bricks as a prominent construction material, further solidifying their importance. Today, in the 21st century, bricks remain a staple material in construction projects, testament to their enduring significance and adaptability to modern architectural needs.

Significance of Bricks:

Bricks are a prevalent building material due to their durability, strength, and environmental benefits. Their durability ensures structural integrity, resisting cracks that can weaken buildings over time. Additionally, bricks are eco-friendly, made from natural materials that do not harm the environment during production or use. One of the significant advantages of bricks is their ability to withstand high temperatures, eliminating organic matter like algae, bacteria, and fungi. This cleansing process enhances the bricks' strength and longevity by removing materials that could compromise their integrity.

Uses of Bricks:

Following are the uses of bricks:

- Bricks are used in floors as a paver for the internal flooring, which makes it attractive in look used for renovating old structures. These Floors are easily clean and looks significant.
- Bricks are used in external paving and clay brick paving is very long lasting and also it gives a prominent color.
- Bricks are used in making the interior of the walls and also the design of buildings that look attractive to people.
- Bricks also play an important role in making archies and archies made by brick gives a prominent attraction to the people and also it looks beautiful in structure.
- Bricks are used in the construction of underground structures such as sewage and tunnels as these have the tendency of water absorption so it has a high strength in underground structures.

2. Literature Review

This review includes all previous studies and research related to our paper title. It verifies how the project is feasible and beneficial for future trends, incorporating expert suggestions and conclusions to determine the project's applicability and potential benefits. The review compares the new venture with previous techniques, assessing its practical utility and identifying any drawbacks. We used Fly Ash Material and Reclaimed Sand Dust Waste. Fly Ash Brick is made from fly ash, a coal combustion product that is lightweight and often causes environmental issues when disposed of by construction industries. To address this, construction industries use fly ash with sand, cement, and waste material to create economical, environmentally friendly bricks. Metal casting processes generate several kinds of waste, with reclaimed sand dust being the primary waste. Regenerating this sand is crucial for environmental performance and sustainable development. In Pakistan, small and medium-scale metal casting industries have historically ignored this issue, but sand regeneration, recycling, reuse, and disposal are now essential for sustainable development. Quarry dust, a type of waste similar to reclaimed sand dust, is also used in the production of fly ash bricks.

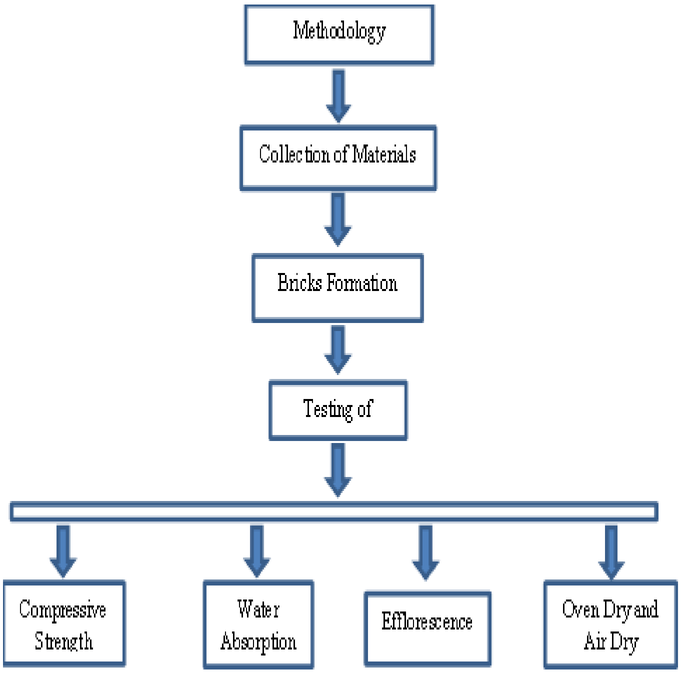
Ajay et al., (2017) found that using reclaimed sand dust waste in fly ash bricks increases strength by 20% and helps solve environmental pollution issues. Kumar et al., (2005) demonstrated that by 2005, fly ash utilization increased from 1 million to over 45 million tons per year, proving its viability for eco-friendly brick production. Kayali and Obada found that fly ash bricks have a strength of 40 MPa, high water absorption, excellent bond strength, and superior durability compared to normal bricks Zala and L. B., (2011) found that using the fly ash lime gypsum process produces economical bricks with greater compressive strength and safety compared to conventional bricks. Using a vertical rat trap bond saves 33% in masonry costs. Chamundeswari et al., analyzed that waste discharge causes storage, cost, and environmental issues. The study examines stone waste as a raw material for fly ash bricks, finding them safer, more economical, and stronger than conventional bricks. Recycling efforts are crucial for environmental protection in Pakistan. Fly ash bricks are eco-friendly, economical, and help prevent global warming compared to traditional clay bricks. Zhang et al., (2012.) noted that traditional clay bricks cause environmental problems, and making bricks from waste materials is more environmentally friendly, economical, and technically beneficial. Narayanasamy et. al., (2016) found that using glass waste in fly ash bricks reduces costs by 25% and increases strength compared to conventional fly ash bricks, benefiting the construction industry. Pitroda et al., (2016) found that using reclaimed sand dust waste in fly ash bricks prevents land damage and increases brick strength, benefiting agriculture and the construction industry by avoiding waste dumping. Gadling and Varma (2017). Gadling and Varma confirmed that using fly ash in brick production is eco-friendly. They found that using 70% to 80% fly ash increases compressive strength and durability, while reducing manufacturing costs. Suggesting its recycling into useful building materials to mitigate environmental problems and contribute to environmental control policies. Selvan & Kumar (2024) found that using waste materials in brick production helps control pollution and reduce carbon footprint. They suggest using foundry waste sand as a replacement for Fal-G bricks. Sudharsan et al., (2018) emphasizes utilizing waste materials in brick manufacturing to address environmental and sustainability challenges caused by raw material shortages and waste disposal issues, advocating for eco-friendly brick production to protect the environment.

3. Methodology

In our Methodology, we outline the steps and procedures taken to complete our research. First, we conducted a comprehensive literature review, examining previous studies and research by various authors and experts. This review verified the feasibility and future benefits of our project, ensuring it is applicable and beneficial for future trends. The literature review included expert suggestions and research indicating whether our project would provide lifelong comfort and utility compared to traditional methods. For our project, we explored various research papers to determine the potential outcomes of producing fly ash bricks using reclaimed sand dust waste. We aimed to assess whether this new technique would be superior to conventional clay bricks burnt in kilns. The review helped us analyze the useful impacts of using waste materials in brick production and whether it would positively influence public perception and market acceptance.

Our findings showed that fly ash bricks made with reclaimed sand dust waste are environmentally beneficial, as they utilize waste materials that would otherwise harm the environment. Traditional brick production in kilns generates significant smoke, causing health issues, whereas our method reduces these emissions. Additionally, the compressive strength of our fly ash bricks increased by 20%, making them stronger and more economical than conventional clay bricks.

These bricks also demonstrated a higher water absorption capacity, further highlighting their superior quality. Overall, our methodology confirmed that producing bricks from fly ash and waste materials is a viable and advantageous alternative to traditional methods.



4. Collection of Materials

After analyzing and studying the literature review, the next step that we followed is the collection of materials. In this step, we collect the materials which are our requirements for the project. As in our case the material which we want or require is the reclaimed sand dust waste. Reclaimed Sand Dust Waste is the material which is obtained by the casting of molding process of making machineries.

Before production we all have make an idea and quantities that how much brick we made. We made 6 mixes and each mix has 3 samples, so in a simple way each mix has 3 simples and, on each sample, we will test four tests which are compressive strength test, water absorption test, and efflorescence test and in last oven dry and air-dry density test. In this way we all estimate and collect the materials which are useful in our work and after the execution and access to all these materials we were able to execute our work forward.

Firstly, we all calculated that how much mixes we want then how much samples we required according to the mixes and then we calculate the ratios of each material such as fly ash material, cement, sand and the waste material which we purchased known as reclaimed sand dust waste. In the above table, we describe all the quantities that how much quantities we required for each mix and for each material, we can closely observe all the ratios and quantities of each material by weight or by volume. All proportions are discussed in the Table.1.

Table 1. Proportions of Various Materials by Weight or by Volume

IDs	Proportions (%)				Volume (m3)				Weight (kg)			
	FA	S	C	RSD	FA	S	C	RSD	FA	S	C	RSD
B-0%	50	38	12	0	0.02	0.01	0.00	0.00	13.29	23.37	6.56	0.00
B1-10%	40	38	12	10	0.02	0.01	0.00	0.00	10.63	23.37	6.56	6.45
B2-20%	30	38	12	20	0.01	0.01	0.00	0.01	7.97	23.37	6.56	12.91
B3-30%	20	38	12	30	0.01	0.01	0.00	0.01	5.32	23.37	6.56	19.36
B4-40%	10	38	12	40	0.00	0.01	0.00	0.02	2.66	23.37	6.56	25.82
B5-50%	0	38	12	50	0.00	0.01	0.00	0.02	0.00	23.37	6.56	32.27
									39.87	**140.24**	**39.37**	**96.82**

Here "FA" stands for "Fly Ash", "S" stands for "Sand", "C" stands for "Cement", "RSD" stands for "Reclaimed Sand Dust Waste". Density of all Material are given in Table 2.

Table 2. Densities of all Materials

Densities	kg/m^3
Density of fly ash, FA	700
Density of sand, S	1620
Density of cement, C	1440
Density of reclaimed sand dust, RSD	1700

Here as you closely observe all the quantities of 6 mixes and proportions are described by weight and by volume. The proportions in percentage of all materials such as fly ash, sand, cement and reclaimed sand dust waste all are making a 100% material and 4th 5th and 6th mix are nearest to some this 100%. We have used 10% water for all of the total material. So, here all the percentage proportions are clearly observed and these proportions are also measured in terms of volume and then in terms of weight. After considering all these aspects and calculations and estimation we made bricks of fly ash material with the replacement of reclaimed sand dust waste material.

4.1. Formation of Bricks

We prepared six mixes for brick formation, each containing fly ash, cement, sand, and reclaimed sand dust waste. The process involved mixing these materials thoroughly until they became as fine as sand. The mixing was done manually by laborers. In Fig. 1, you can see the reclaimed sand dust waste, which is fine and black in color. Once mixed, the materials were fed into the fly ash brick production machine. The machine produced bricks, which were then placed on wooden planks. Each mix produced 18 bricks, with 3 samples from each mix. The machine could produce 12 bricks at a time. Laborers collected the bricks as they were made. The mixed materials were placed into the fly ash brick production machine, which produced 12 bricks at a time. These bricks were then placed on a large wooden plank. The entire process continued until all bricks were made. Considering the densities and calculations of the materials, we produced greyish-colored fly ash bricks with proper dimensions. The production took place in Sheikhupura from April to May 2022. After one month, the completed bricks were transported to Multan for testing at the Institute of Southern Punjab's lab.

Figure 1. Fly Ash Brick Making Process

4.2. Testing of Bricks

To investigate the various aspects and features of our fly ash bricks, we conducted four tests: compressive strength, water absorption, efflorescence, and oven dry and air-dry density. For the compressive strength test, fly ash bricks were immersed in water at room temperature for periods of 7, 14, and 28 days. After each period, the bricks were taken out, wiped with a moist cloth, and stored in moist jute bags for three days before being placed in a compression testing machine. The bricks were positioned with flat faces horizontal and mortar-filled faces upwards. The load was then applied, and the presence of cracks indicated weak strength, while the absence of cracks indicated good compressive strength. For the water absorption test, we first took the dry weight of each brick, known as M1, before immersing them in water for 24 hours. After this period, the bricks were removed, wiped with a damp cloth, and their wet weight was taken, known as M2. The water absorption percentage was then calculated using the relevant formula. The efflorescence test involved selecting bricks randomly and partially immersing them in water to a depth of less than 2.5 cm. The bricks were placed in a warm room with limited ventilation, and distilled water was added as needed until all the water was absorbed and evaporated. The bricks were then inspected for any efflorescence marks. For the oven dry and air-dry density test, the air-dry density of the specimens was first calculated by measuring the volume and weight of each brick. The bricks were then placed in an oven for 24 hours. After this period, the bricks were removed, and their volume and mass were measured again to calculate the oven dry density. This process highlighted significant changes in the mass of the samples, allowing us to determine the densities accurately. These tests demonstrated the strength, water absorption capacity, efflorescence resistance, and density changes in fly ash bricks, providing valuable insights into their quality and suitability as a sustainable construction material.

4.3. Results and Analysis

we will discuss about the results and analysis on the brick samples to check the characteristic nature of the fly ash brick. To ensure the suitability of fly ash bricks for construction, it is crucial to conduct tests to analyze their characteristics. These tests determine whether the bricks are strong, durable, and fit for use. Firstly, strength tests are performed by applying loads to the bricks to assess their load-bearing capacity and resistance to cracking. This is essential to verify if the bricks can endure the stresses of construction. Secondly, water absorption tests measure changes in the brick's weight after immersion in water, indicating how well they can maintain strength and integrity when exposed to moisture. Additionally, efflorescence tests evaluate the brick's tendency to develop salt deposits after water exposure, which can affect its appearance and durability. Lastly, density tests, both air-dry and oven-dry, are conducted to determine the brick's density before and after drying, providing insights into its material properties. Conducting these tests ensures that the fly ash bricks meet necessary standards and perform well in construction applications.

4.4. Compressive Strength Test

We have total 18 Mixes for compressive strength test, six mixes for 7 days samples, six mixes for 14 days samples and six mixes for 28 days samples. Each mix consists of 3 samples and we have performed all these samples one after another according to its duration. We have tested all samples one after the other in a compression testing machine Shown in Fig. 2 and apply a load on it to check its strength.

4.5. Compressive Strength Test on 7 days Samples

In the Table.3, we have calculated the compressive strength of fly ash bricks after 7 days of curing. Following this curing period, we measure the compressive strength of the bricks and then compute the average compressive strength, providing results in both MPa and psi for clearer elaboration. However, our primary calculations are in MPa. The area considered for these calculations is 22,500 mm^2. As clearly shown in the graph Fig. 3, the 7-day curing results indicate the compressive strength of fly ash bricks. It demonstrates the compressive strength gained by various mixes. The graph shows that, after 7 days of curing, the 4th mix of B3-30% has achieved the highest strength with a value of 13.8074 MPa. This is attributed to the balanced use of all materials in this mix. The graph also indicates that increasing the material proportions beyond this optimal mix results in a loss of strength.

4.6. Compressive Strength Test on 14 days Samples

In the Table.3, we have calculated the compressive strength values of fly ash bricks by placing them in water for 14 days. After this 14-day curing period, we measured the compressive strength and its average compressive strength primarily in MPa, but also in psi to provide a comprehensive understanding. This process is similar to the 7-day curing method. In the same manner, we have calculated the compressive strength of bricks after the 14-day placement. As you can see in the graph Fig.4, it clearly demonstrates the compressive strength of all 6 mixes after placing them in water for 14 days of curing. After this 14-day period, we took the bricks out of the water and tested them to find their compressive strength. The results show that mix 4, B3-30%, has the highest strength with a value of 16.0444 MPa. This mix gains the maximum strength compared to the other mixes. Additionally, the graph indicates that the longer curing period significantly increases the strength of the bricks, as evidenced by the higher values achieved compared to the 7-day curing period.

4.7. Compressive Strength Test on 28 days Samples

In the Table.3, it also shows the compressive strength test readings of fly ash bricks after placing them in water for 28 days of curing. After this 28-day curing period, we took the bricks out of the water and calculated their compressive strength, along with their average compressive strength, primarily in MPa, as done for the previous 7-day and 14-day periods. For clear observation of the results, we have also calculated the values in psi, similar to the readings from the previous curing periods. As you can see in the graph Fig.5, it shows all the values of the mixes for the compressive strength test after 28 days of curing. In this aspect, we calculated the compressive strength, and in this case, mix 4 (B3-30%) gained the maximum compressive strength compared to the other mixes, with a value of 17.9111 MPa. This mix achieved the highest value in MPa compared to the 7-day and 14-day curing periods, indicating that the longer the curing time, the greater the strength of the bricks.

4.8. Average Compressive Strength Values in (MPa)

Table.3 shows the values of average compressive strength of all 7 days, 14 days and 28 days curing respectively in MPa. Hence, you can see that the values are increasing according to the time of curing in which we noted that normal values are in 7 days then the values are increasing after 14 days curing and the values are more increasing after 28 days curing. Therefore, it is clearly observed that more the days of curing more it will gain strength.

Figure 2. Compressive Strength Test on Brick

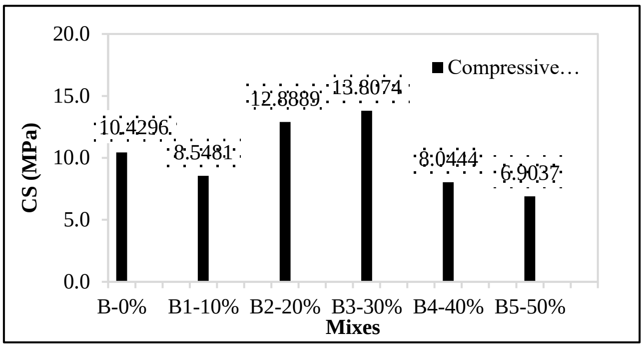


Figure 3. Showing Compressive Strength Values in (MPa) for 7 Days Curing

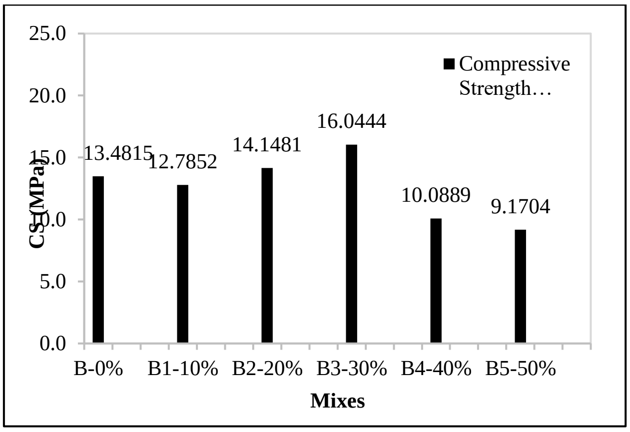


Figure 4. Showing the Compressive Strength in MPa for 14 days curing

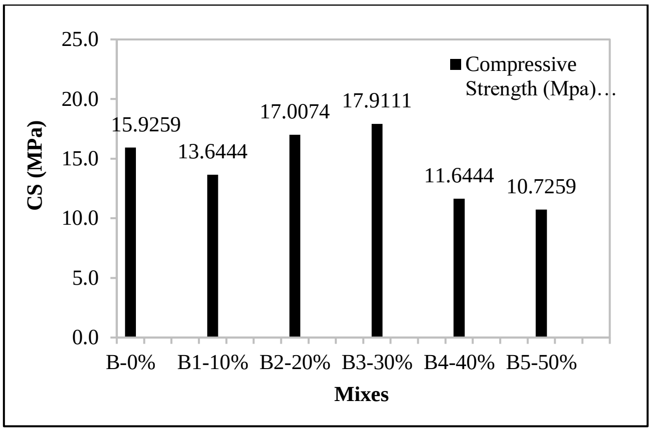


Figure 5. Showing the Compressive Strength in MPa for 28 days curing

Table 3. Compressive Strength Test values and their averages for 7-, 14- and 28-Days Curing

Curing	7days			14days			28days		
IDs	Crushing Load (kN), "P"	Compressive Strength (MPa) CS= P/A	Avg CS (MPa	Crushing Load (kN), "P"	Compressive Strength (MPa) CS= P/A	Avg CS (MPa)	Crushing Load (kN), "P"	Compressive Strength (MPa) CS= P/A	Avg CS (MPa)
B-0%	229	10.1778	10.4296	302	13.4222	13.4815	365	16.2222	15.9259
	240	10.6667		301	13.3778		360	16.0000	
	235	10.4444		307	13.6444		350	15.5556	
B1-10%	199	8.8444	8.5481	290	12.8889	12.7852	304	13.5111	13.6444
	192	8.5333		284	12.6222		308	13.6889	
	186	8.2667		289	12.8444		309	13.7333	
B2-20%	285	12.6667	12.8889	322	14.3111	14.1481	390	17.3333	17.0074
	290	12.8889		317	14.0889		375	16.6667	
	295	13.1111		316	14.0444		383	17.0222	
B3-30%	310	13.7778	13.8074	369	16.4000	16.0444	401	17.8222	17.9111
	312	13.8667		363	16.1333		398	17.6889	
	310	13.7778		351	15.6000		410	18.2222	
B4-40%	172	7.6444	8.0444	225	10.0000	10.0889	250	11.1111	11.6444
	189	8.4000		235	10.4444		265	11.7778	
	182	8.0889		221	9.8222		271	12.0444	
B5-50%	145	6.4444	6.9037	208	9.2444	9.1704	240	10.6667	10.7259
	156	6.9333		201	8.9333		245	10.8889	
	165	7.3333		210	9.3333		239	10.6222	

4.9. Water Absorption Test

We have calculated the Water Absorption Capacity of our Fly Ash Bricks by initially we calculated the Dry weight (W1) of all samples of the mix and after calculating the Dry Weight then we placed all the samples in water for 24 hours. And after 1 day we take out all the samples from the water and then we calculate the wet weight (W2). Now by applying formula we will calculate its water absorption. Average Water Absorption Capacity of Fly Ash Bricks should not more than 20%.

4.10. Water Absorption Test for 24 Hours

In the Table.4, it is shown all the values of Water Absorption by placing the fly ash bricks in water for 24 hours and before curing we noted the dry weight and after curing of 1 day, we noted the wet weights of all the samples and in the end, we noted the Average Water Absorption in (%) of all the mixes respectively. In this Graph Fig.6, all mix values are described clearly. It clearly indicates all the mixes are described in an appropriate way and all the values are explained clearly that in which value it has a maximum water absorption value, mix 4 (B3-30%) have a value in which it clearly shows a maximum water absorption capacity have a value of 27.820%, and all others have a normal and low water absorption capacity so it clearly shows that due to the standard ratio or proportion of mix 4 it has the highest and greatest water absorption capacity.

Table 4. Water Absorption Test of Fly Ash Bricks for 24 Hours

Mix	Dry Weight (W1), kg	Wet Weight (W2), kg	Water Absorption, WA (%)	Average WA (%)
B-0%	3.234	3.796	17.378	17.649
	3.236	3.846	18.850	
	3.194	3.728	16.719	
B1-10%	2.978	3.588	20.484	20.893
	2.966	3.566	20.229	
	3.05	3.72	21.967	
B2-20%	2.131	2.432	14.125	16.769
	3.098	3.69	19.109	
	3.21	3.758	17.072	
B3-30%	2.578	3.286	27.463	27.820
	2.55	3.3	29.412	
	2.648	3.352	26.586	
B4-40%	2.012	2.341	16.352	19.975

	2.674	3.296	23.261	
	3.072	3.696	20.313	
B5-50%	3.27	3.87	18.349	21.859
	2.512	3.22	28.185	
	3.266	3.888	19.045	

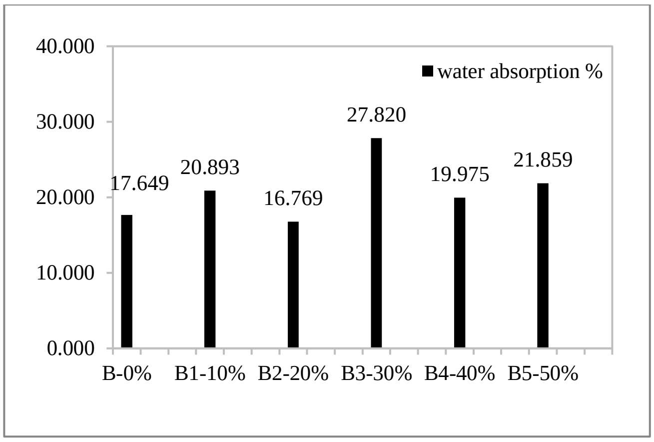


Figure 6. Representing Water Absorption Values of all Mixes

4.11. Efflorescence Test

We have done an efflorescence test on our bricks as we have 6 mixes of bricks and each mix contains about 3 samples, so we test on all these 3 samples and we place the end point of every brick in a water below the depth of 2.5 cm in every case and we placed each sample of the brick in distilled water and we continue to put the distilled water into it when the bricks were looks dried and we checked until the water is fully absorbed or dried and it was continued about 3 days and after second time we dried we check the efflorescence in it and there was no salt deposition was seen in the brick so it has a "NIL" Result. The Table.5 in the above clearly determines all the presence of salt deposition whether it is present or not or if present than at to which extent it is shown.

Table 5. Efflorescence Test of All Brick Samples

Mix	Samples	Efflorescence
B-0%	1	NIL
	2	NIL
	3	NIL
B1-10%	1	SLIGHT
	2	SLIGHT
	3	SLIGHT
B2-20%	1	NIL
	2	NIL
	3	NIL
B3-30%	1	NIL
	2	NIL
	3	NIL
B4-40%	1	NIL
	2	NIL
	3	NIL
B5-50%	1	SLIGHT
	2	SLIGHT
	3	SLIGHT

4.12. Oven Dry Density and Air-Dry Density Test

To perform this test, we have taken 1 sample from each mix and test it on it. First we take each sample of fly ash brick from each mix and then we calculate its volume by calculating length, width and height and then we calculate volume and then we calculate weight of each brick and note the density by formula: Density = Mass / Volume, by doing the same process of each sample we calculate the Air Dry Density of each fly ash brick and then we placed them in an Drying Oven for 24 hours (1 day) let them dried completely and after completion of 24 hours we took them out and calculate its density which is Oven Dry Density and major change which we notice is the slightly change in weight. The Table.6 shows the reading of Oven Dry and Air-Dry Density in which we have collected one sample from each mix and first we have calculated its air-dry density and then after the placement in oven for 24 hours we have calculated its oven dry density and it shows not so much but a slightly change in the weight as compared to the weight of air-dry density and therefore, it also shows slight change in densities also.

Table 6. Air Dry Density and Oven Dry Density

Samples	Air Dry Density (kg/m^3)	Oven Dry Density (kg/m^3)
A	1.1437	1.1350
B	1.0416	1.0343
C	1.1036	1.0912
D	0.88905	0.8795
E	1.01094	1.0043
F	1.2598	1.2518

4.13. Comparison between Fly Ash and Normal Clay Brick

As we compare all the fly ash bricks with normal clay bricks, we found that the fly ash bricks are economical then as compared to normal clay bricks and also it has an achievable strength as compared to the clay bricks and also fly ash bricks have a great water absorption capacity as compared to the normal bricks and have less salt deposition can be seen rather in conventional clay bricks. And other thing that we notice that bricks placed for 7 days curing have less strength and not have precise value rather than the bricks placed for 14 days curing. 14 days curing bricks have a good strength as compared to 7 days curing bricks; it means the strength is higher as the curing duration increases. In regard to this, it is also noted that the price of normal conventional brick is higher than fly ash bricks and fly ash bricks are economical and have easy to access and the main reason is that the strength of fly ash bricks is much better than the normal clay conventional brick and also it has the capability to bear the strength and also the main positive reason which makes it different from the normal brick is that it is made by environment friendly process with the utilization of waste materials so to avoid any air pollution which can be spread through smoke though kilns in the production of normal clay bricks.

5. Conclusions

- We have tested the compressive strength, water absorption, efflorescence and air dry and oven dry density tests on fly ash bricks and it gives a reasonable performance in terms of strength and absorption capacity.
- First, we check the salt deposition of the brick that after absorption of water rather it shows salt deposition or not, in this case there is a "NIL" and "SLIGHT" condition where the 2nd mix B2-10% and last mix B5-50% shows SLIGHT salt deposition of efflorescence while other 4 mixes have a NIL salt deposition on fly ash bricks.
- After efflorescence, we have tested the water absorption test on our fly ash bricks to check the absorption capacity of fly ash bricks for 24 Hours, as we have six mixes of 18 samples each in which the mix 4 (B3-30%) have given the highest water absorption of 27.820%, the reason is that the mix 4 have an equal and stable proportions of all the materials from which the fly ash brick is made and it gives satisfactory results in all aspects.
- After water absorption, we have calculated the compressive strength of fly ash bricks for 7 days, 14 days and 28 days respectively. Results of this test had also given us the reasonable performance and in this case mix 4 (B3-30%) have gave us the highest strength of all 7, 14 and 28 days respectively. We have achieved a value of 13.8074 MPa for 7 Days Curing and 16.0444 MPa for 14 Days Curing and 17.9111 MPa for 28 Days Curing, hence it shows that if we increase the time period of curing, we will achieve highest strength as you can see it gives a higher value in MPa for 28 days Curing as compared to 7 days and 14 days correspondingly.
- After Compressive Strength, we have performed air dry and oven dry density test in order to check the change in the weight that whether the weight changes when we placed in an oven for 24 Hours and we first calculate air dry density randomly and after 24 Hours placement in an Oven we calculated the oven dry density and we notice a sudden or slight change in the weight appears and also it creates a slight difference in density also.

5. Recommendation

- First, we recommend to those people firstly who are interested to work on this project that you should make a proper arrangement of all the availability of materials and make your possible resources before starting the work on your project so that in case of work it will not create any difficulty for you to analyze all the proceedings.

- After that, we recommend that you should clear all the tests procedures to enhance all the tests in a corrective way.
- First you select all the tests that you want to perform and then analyze all of their procedures in a thoroughly manner and then estimate which test is suitable or possible in recent time and which is not.
- After clearing all these aspects then you start your work on project and also for the materials availability make sure we recommend you to make some accountable resources, so that you do not find any difficulty in getting these materials.
- After this, who wants to work in this project we recommend that you can perform tests other than this, if you want and you can experiment those tests in order to give a validity of contribution to this research and study.
- We have used a reclaimed sand dust waste as a waste material we recommend you to test any other waste materials rather than this one, in order to widen the research of fly ash bricks which are made up of waste materials in order to make it possible for an easy access to the market and construction industry as a replacement of traditional and normal brick made up clay.
- We recommend that you can use any waste other than this to increase the knowledge in this research in order to give the access to other ones so they can go through to this study and it increases the awareness among society to use the brick with the production of waste material is feasible for the public and environment also.

6. References

Andodariya, (2017). 'Feasibility study of using Fly Ash Brick made from Reclaimed Sand Dust Waste and Quarry Dust Waste', MOJ Civil Engineering, 3(3).

Case Studies in Construction Materials, Priyadarshini and Jyoti Prakash Patnaik.

Chamundeswari, J. et al. (no date). 'Experimental Research on Fly Ash Brick'. International Journal of Engineering Trends and Technology [Preprint].

Fırat, S. et al. (2012) 'Utilization of marble dust, fly ash and waste sand (Silt-Quartz) in road subbase filling materials', KSCE Journal of Civil Engineering, 16(7), pp. 1143–1151.

Gadling Pravin P, Varma MB. (2017). A Review of Ecofriendly Bricks by Using Fly Ash. Journal of Construction Engineering, Technology & Management; 7(2): 35–40p.

J. Mater. Environ. Sci., (2019). Volume 10, Issue 11, Page 1062-1073).

Journal of Cleaner Production 17S0959-6526(19) 31965-110.1016/j.jclepro.2019.06.017. JCLP 17186)

Kayali, O. (no date) 'High Performance Bricks from Fly High Performance Bricks from Fly Ash'.

Kumar, Mathur and Sinha, (2005). A Case Study: Manifold Increase in Fly Ash Utilization in India', Fly Ash India, (1), pp. 1–8.

Narayanasamy, S. (2016) 'FEASIBILITY OF USING WASTE GLASS POWDER IN FLY', (May).

Pitroda, J., Gudhka, Y.G. and Kanazariya, R.M. (2016) 'A Critical Review on Techno-Commercial Study of Reuse of Reclaimed Sand Dust in Brick

Manufacturing', International Journal of Constructive Research in Civil Engineering, 2(5).

Sudharsan and Palanisamy, Sudharsan, N. and Palanisamy, T. (2018) 'A comprehensive study on potential use of waste materials in brick for sustainable development', Ecology, Environment and Conservation, 24(September), pp. S339–S343.

Tamil Selvan, T., Kumar, M. Analysis of a stochastic epidemic model driven by bilinear incidence rate with two different transmission mechanisms. *J Anal* **32**, 509–527 (2024). https://doi.org/10.1007/s41478-023-00665-5

Waheed, A., Azam, R., Riaz, M.R. et al. (2022). Mechanical and durability properties of fly-ash cement sand composite bricks: an alternative to conventional burnt clay bricks. Innov. Infrastructure.

Yousuf et al., J. Mater. Environ. Sci., (2020). 11(6).

Zala, L.B. (2011). 'Fly Ash Bricks Masonry: An Experimental Study.

Zhang et al., (2012). This study was supported by the Scientific and Technological Research Council of Turkey (TUBITAK, Project No: 111M694), Construction and Building Materials, 47.