Manufacturing of Bricks from Pumice, Fly Ash and Waste Lime from Fertilizer Industry Multan

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Abstract. Lime has been used for construction since Mughal Era. These days, brick making has been incorporated in the policies for low-cost houses. Lime use for bricks has been increased globally due to its availability from industrial waste. One of the largest components of the Lime from Multan Fertilizer waste is "Lime chalk calcium carbonate ($CaCO_3$, 87.5%)". Reuse of refused Lime from Multan Fertilizer waste for the production of bricks is a suitable solution. This project is focusing to utilize lime for making bricks. "Lime chalk, calcium carbonate ($CaCO_3$, 87.5%)", was mixed with sand replacement Pumice and fly ash in fixed proportions. Those mixtures were then used to cast the cylinder (10×3 inches). Compressive strength, heat resistance, and water absorption tests were performed on those blocks, and results were analyzed and compared with those of conventional concrete blocks and clay bricks. Conventional concrete blocks absorb about 9.5% of the water while water absorption of the Lime from the Multan Fertilizer block is only 0.24%.

Keywords: Fly Ash; lime chalk; Multan Brick; Pumice, Brick; Sugarcane Bagasse

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1. Introduction

The objective of the research is to develop a methodology for making lime from Multan Fertilizer waste. The author aims to simulate the compressive strength, heat resistance, and water absorption of Lime from Multan Fertilizer bricks. Another objective is to compare the properties of blocks made of lime from Multan Fertilizer with conventional concrete blocks. The scope of this project is to utilize lime from Multan Pak Arab Fatima Fertilizer for the manufacturing of blocks. Only Lime from the Fertilizer industry is used in this project. This Lime will be mixed with pumice, Sanawa sugarcane bagasse fly ash & cement in different ratios.

2. Literature Review

This section elaborates the literature review for making blocks out of Lime from the Fertilizer industry. The literature review aims to highlight the usage of Lime from Fertilizer mixed with the Fly Ash and Pumice materials to manufacture different blocks and to test their respective properties. The fertilizer industry has been growing remarkably in terms of diversity, quality, and production volume in recent times (Caruso et al. 2021). Due to the extensive amount of Fertilizer Lime availability over the year in Multan, it is considered one of the most important block fillers these days (Nshimiyimana et al., 2021). Nshimiyimana et al. (2021) studied Durability simulations of Compressed Earth/ Clay Blocks Stabilized with Agricultural By-Product Binders which included Rice Husk Ash, Lime from Multan. Fertilizer is semi-crystalline, semi-transparent, and has higher tensile strength, chemical resistance, and suitable thermal stability. Huge quantities of Lime are used in the filling sites. The company is producing 320 million tons of Lime from Multan Pak Arab Fatima Fertilizer every year and Sanawa Industrial Area at the same time. Around 8 billion tons of Lime from Multan Pak Arab Fatima Fertilizer has been produced since 1950 as revealed by Abbas et al (2017). Out of 8 billion, only 9% is recycled,

while the total production capacity of Lime is 64,400 kilotons per year in 2018. Lime from Multan Fertilizer accounted for 30.3% of the total production of Lime. Unlike natural lime that is a non-degradable lime in the natural environment, other limes are leading to environmental pollution when they are discarded after their usage (Siuda et al., 2021). Some common characteristics of lime are high strength and durability. Most of the Lime from Multan Pak Arab Fatima Fertilizer is disposed of at landfill sites which also leads to serious environmental issues (Liu et al. 2021).

2.1. Experimental Program simulation procedure

The methodology follows a sequence of activities to achieve the desired objectives. At first, the block specimens were cast, and then tests were performed. The casting of the blocks involves several activities i.e., mixing, pouring in mold, de-molding, and testing. Moreover, the block specimens were tested for water absorption, heat resistance, and compressive strength (Fig. 1).

Table 1. Comparative analysis of cylinder

		Water Absorption (%)				
		Type 1	**Type 2**	**Type 3**	**Type 4**	**Type 5**
Mean	SD	9.13	9.18	9.35	9.2	9.3
		9.1	9.85	9.9	9.8	9.9
		10.5	10.25	10.8	10.95	10.7

3. Lime from Multan

The collected waste Lime from Multan Fertilizer, Pumice, and Fly Ash are taken in a proportion of 1: 1:1.5 (1 Lime from Multan Pak Arab Fatima Fertilizer: 1 Pumice: 1.5 Fly Ash) by weight and are mixed to get a homogenous mix and then poured into the molds of 12 inches high and 6-inch diameter cylinder size. After setting in for 12 hours in the mold, the simulated specimens were demolded and immersed in water for 28 hours before being removed for testing (Doğan-Sağlamtimur et al., 2021).

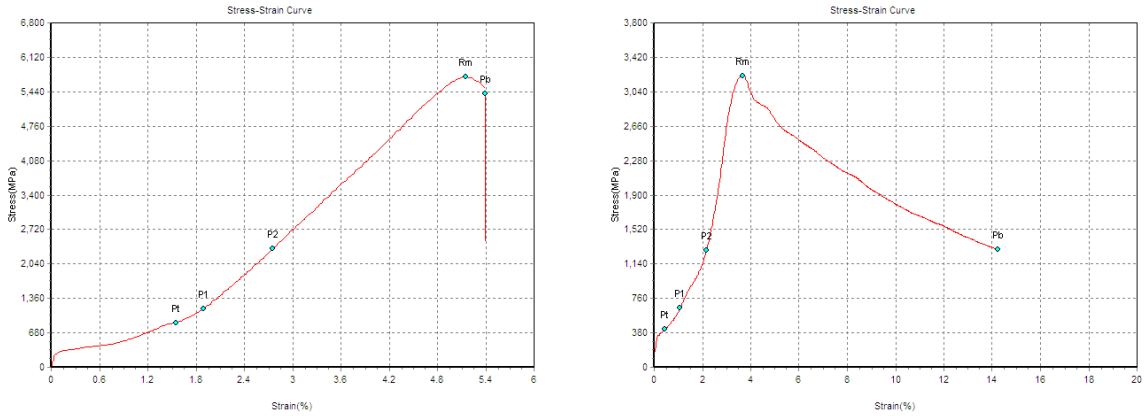
3.1. Pumice

The collected Lime from Multan Fertilizer was brought to the site and plant of the Institute of Southern Punjab. The Lime from Multan Fertilizer, fly ash from Sanawa power plant and pumice from Chaghi (Baluchistan) were taken in proportion by weight and Fly Ash. Accordingly, they were mixed thoroughly using a rod and trowel before it hardened.

3.1.1 Fly Ash

The mixture is then homogeneously poured into the cylindrical mold and then is compacted with the aid of steel rod and surface is finished using trowel. Before pouring the mix into the mold, the walls of the mold are oiled for smooth removal afterword, Gupta (2021), as shown in Table 1 and Fig. 2.

Fig. 1 Prepared Specimens using Various Materials



(a) Deformation profile Pumice

(b) Deformation profile Fly Ash

Fig. 2 Model output training data for the comparative analysis of cylinder casted on 1st May 2021

Table 2 Mix proportion for trials

Block Type	No. Of Samples	Lime Weight	Sand Weight	Fly Ash Weight	Pumice Weight
Sand	4	1.96 kg	5.6 kg	-	-
Fly Ash (15%)	4	1.96 kg	4.76 kg	0.84 kg	-
Fly Ash (20%)	4	1.96 kg	4.48 kg	1.12 kg	-
Fly Ash (25%)	4	1.96 kg	4.2 kg	1.4 kg	-
Pumice (15%)	4	1.96 kg	4.76 kg	-	0.84 kg
Pumice (20%)	4	1.96 kg	4.48 kg	-	1.12 kg
Pumice (25%)	4	1.96 kg	4.2 kg	-	1.4 kg

4. Conclusions

The first objective of this research was to develop a methodology for making Lime from Multan Fertilizer block. The Lime was extracted from Multan Pak Arb Fatima Fertilizer waste. From the experimental results of the study, the following conclusions have been summarized: Proper methodology for the making of Lime from Multan Fertilizer block was formulated economically. Different ratios of lime Fly Ash Sanawa and Pumice from Chaghi were taken under consideration to compare their properties with each other and to opt for the optimal level of ratio.

The second objective as mentioned above of this project was to determine the compressive strength, heat resistance, and water absorption of Lime from Multan Fertilizer block. The mix lime and 25% replacement of aggregate with pumice Fly Ash generate the best result in compressive strength i.e., 2027 psi. The mix of lime and 25% replacement of aggregate with pumice by Fly Ash give the most resistance to heat. The mix of lime and 25% replacement of aggregate with pumice by fly ash absorb the least waster i.e., 0.24%.

The third objective was to compare the properties of manufactured Lime from Multan Fertilizer block and conventional concrete block. The compressive strength of conventional concrete blocks is about

725 PSI. The compressive strength of Lime from Multan Fertilizer is thrice compared to conventional concrete block. Conventional concrete blocks absorb about 9.5% of the water while water absorption of the Lime from Multan Pak Arab Fatima Fertilizer block is only 0.24%. After analyzing the results in terms of compressive strength, water absorption, and heat resistance, we recommend the use of these blocks instead of concrete blocks in the construction of houses. The use of these blocks will help to reduce the 'carbon footprint' along with Lime waste. Since the surface of the block is at 40% Lime from Multan, it is quite smooth that does not require any plaster. Only finishing polish is required to be utilized as tiles. Water absorption behavior of the Lime from Multan for the block was closely observed, and it was concluded that Lime from Multan Pak Arab Fatima Fertilizer block can also be used for constructing UGWT and OHWT.

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