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## RECYCLING OF WASTE GLASS AS A PARTIAL REPLACEMENT FOR SAND IN CONCRETE HOLLOW BLOCK (CHB)

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### ABSTRACT

Reusing some non-biodegradable waste products as alternative ingredients in the manufacture of mortar is an endeavor to assure the sustainability of construction materials. Sand is a key component in the production of mortar, but using waste products like glass as a partial or full substitute will guarantee a decrease in the need to dredge for it, protecting the extremely valuable natural sand resources within the environment. Additionally, the use of crushed waste glass in place of sand in the creation of concrete hollow blocks (CHB) would guarantee that the stones are environmentally beneficial, removing the difficulties associated with the selective dumping of glass waste in landfills. The use of broken waste glass as a partial and full replacement is investigated in this study. The acquired results showed that the crushed/pulverized glass is very effective. The hollow block can be used as both a Load bearing and Non-Load bearing block since the minimum compressive strength is 5.41 MPa. This study makes it abundantly evident that used glass may be used to make environmentally friendly CHB, which will aid in the environmentally friendly disposal of glass trash.

**Keywords:** Concrete Hollow Block, Load bearing, Non-load bearing, glass, non-biodegradable

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### 1. INTRODUCTION

In the Philippines, Concrete Hollow Blocks (CHB) are one of the most often utilized walling materials. This is due, to their relatively low cost as compared to other materials and the rapidity with which semi-skilled laborers can install them ( Humanitarian Shelter Working Group, 2014). Hollow blocks were composed of cement, sand, and gravel. This saves cement in masonry work. Hollow block has special abilities like a thermal insulator due to its hollowness, has a small dead load, more compressive strength, durability, fire resistance, partial resistance to sound, ease of ventilation, etc. (Carbonell, R. 2022). Due to the uncontrollable demand of the CHB, the demand for the components increases. According to Spanne (2015) the earth was running out of sand. This is due to sand being an essential ingredient in the production of concrete. The U.S. Geological Survey said, "Sand and gravel use in construction alone accounts for about 30 billion tons a year globally. Combined with the sand and gravel used for land reclamation, embankments, concrete roadways, and industry, a conservative estimate for total annual consumption is around 44 billion tons." In addition, China, Indonesia, Malaysia, and Cambodia ban sand exports, citing these issues as a major factor (Vaughan, 2022). A study by Ismail et al. (2009) emphasized the physical and chemical similarities between scrap glass and sand. Additionally, a number of studies have been conducted to determine the influence and ideal percentage content of waste glass that can be used as an alternative to aggregate and cement in the production of mortar and concrete. Additionally, recycling wastes like used glass in concrete and mortar for buildings and other structural and non-structural engineering constructions helps to achieve sustainable buildings (Olofinnade, O. M., et al., 2019). Therefore, the goal of the current study is to determine whether broken waste glass may substitute sand in cement mortar to create environmentally friendly concrete hollow blocks.

### 2. METHODOLOGY

This study uses scientific method of obtaining data and results. The researchers ought to perform several tests that will validate the hypothesis and to determine the compressive strength of the mortar cubes that has different kind of mixtures of Cement-Glass-Sand and Cement-Glass. The researchers will compare and choose the ratio of the highest compressive strength of the cured and tested mortar cubes. The chosen ratio will be used as a mixture for the Hollow Block.

#### 2.1 Research Environment

The research was conducted in Civil Engineering Laboratory, University of Southeastern Philippines, BO Obrero, Davao City, Philippines.

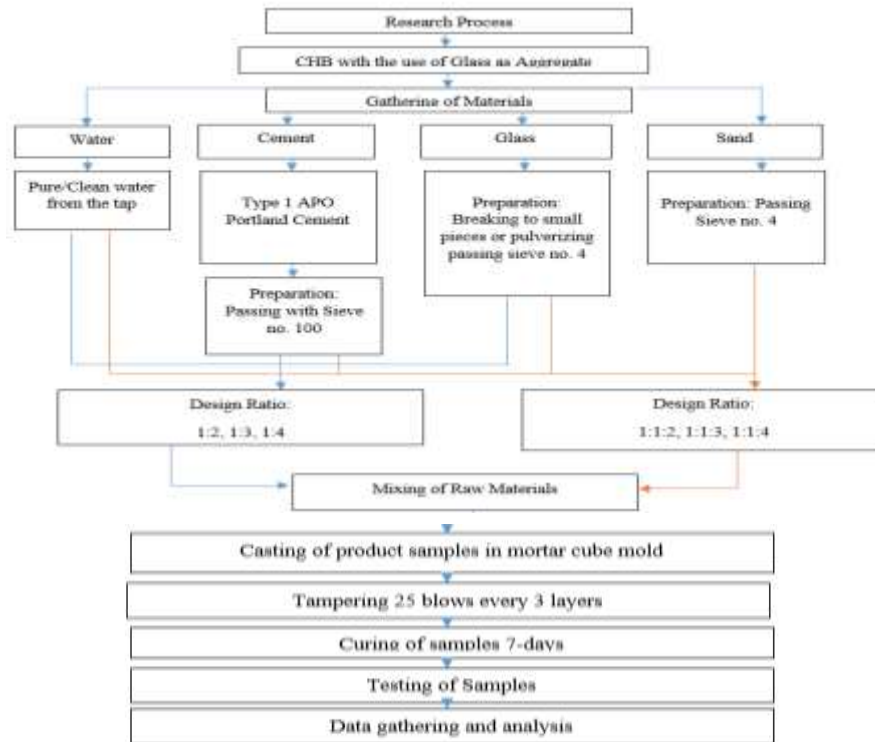
#### 2.2 Research Materials

The Glass used in the study was collected from the Storage Room of our residence. The sand was purchased from Diaz Sand and Gravel, Davao City. The Portland cement (APO Portland cement type 1) was purchased from Citihardware, Bajada, Davao City. The water used is from the tap water from the research environment.

### 2.3 Research Instruments

The instruments used in the study are Cube mold, tamper rod, trowel, container, Cylinder, Sieve no. 4, Pan, and UTM. In the gathering of the data, the Universal Testing Machine (UTM) is used to test the compressive strength and tensile strength of different kinds of materials. The equipment is used in determining the compressive strength of the cured mortar cubes of the study.

### 3. MODELING AND ANALYSIS



### 4. RESULTS AND DISCUSSION

Table 1: Summary of results

Ratio	14-Days Curing	KN	N	mm <sup>2</sup>	Mpa	Average
1:02	28-Nov	41.4	41400	2580.64	16.04253	17.2567
		47.1	47100	2580.64	18.25129	
		45.1	45100	2580.64	17.47628	
1:03	29-Nov	35.3	35300	2580.64	13.67878	15.03503
		40.2	40200	2580.64	15.57753	
		40.9	40900	2580.64	15.84878	
1:04	1-Dec	26.5	26500	2580.64	10.26877	10.61752
		28.7	28700	2580.64	11.12127	
		27	27000	2580.64	10.46252	
1:01:02	5-Dec	36.6	36600	2580.64	14.18253	15.3192
		38.9	38900	2580.64	15.07378	
		43.1	43100	2580.64	16.70128	
1:01:03	6-Dec	27.8	27800	2580.64	10.77252	11.49586
		28.6	28600	2580.64	11.08252	
		32.6	32600	2580.64	12.63253	
1:01:04	7-Dec	25	25000	2580.64	9.687519	9.403352
		23.4	23400	2580.64	9.067518	
		24.4	24400	2580.64	9.455019	

Table 1 shows the different average strength of the mortar cubes in Column 7. Column 1 is the ratio of different mixtures, column 2 is the date when the sample was tested and in Column 3 in the Force results in the UTM in KN and N in Column 5. Column 6 is the area of the sample. Column 7 is the Compressive Strength computed of the mortar cubes.

**Table 2:** Average of Mixtures

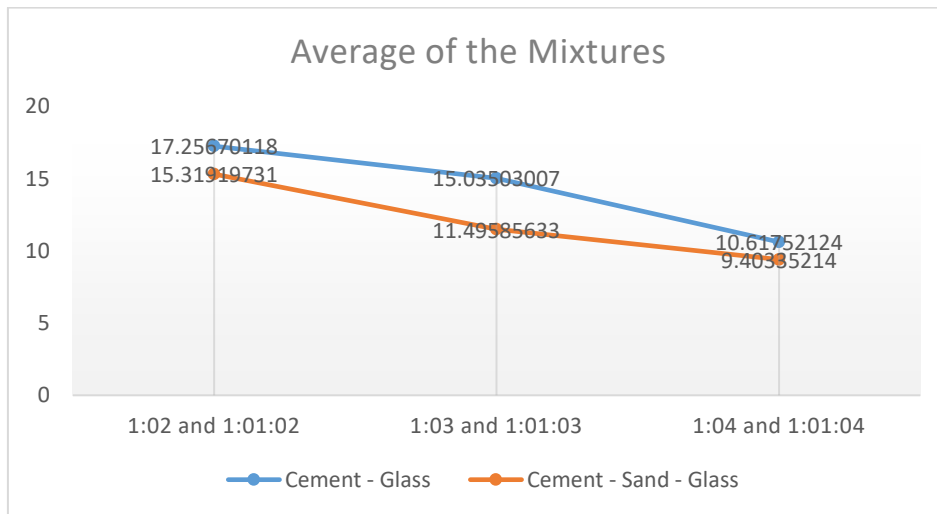


Table 2 shows the average result of the mixture Cement-Glass (Blue Line) and the Cement-Sand-Glass (Orange Line). Note that the 1:02, 1:03, and 1:04 are Cement-Glass mixture while the 1:01:02, 1:01:03, and 1:01:04 are Cement-Sand-Glass mixture.

**Table 3:** Difference of the Average of the Mixtures by Category

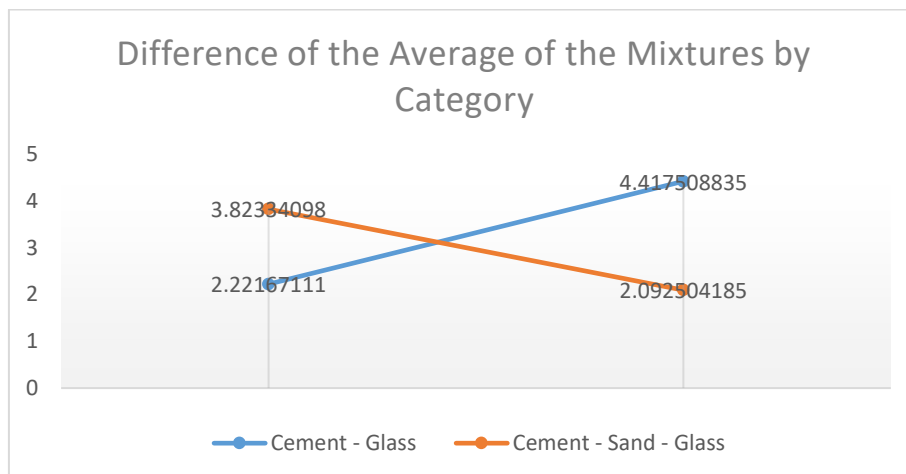


Table 3 shows the difference of the average of the mixture for the Cement-Glass (Blue Line) 1:02 subtracted by 1:03, and 1:03 subtracted by 1:04. While the mixture Cement-Sand-Glass (Orange Line) 1:01:02 subtracted by 1:01:03, and 1:01:03 subtracted by 1:01:04.

**Table 4:** Difference of with sand and w/o sand

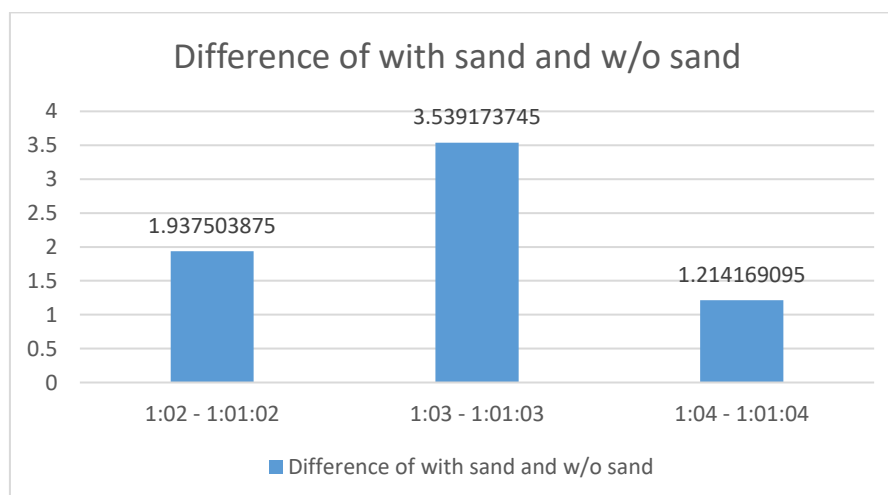


Table 4 says that comparing the mixture with sand and without sand there is a big difference in 1:03 – 1:01:03 mixture followed by the 1:04 – 1:01:02 mixture and the less difference in strength is 1:01:04.

**Table 5:** Prices of CHB with different mixtures

	<b>Price</b>			
	<b>Cement</b>	<b>Sand</b>	<b>Glass</b>	<b>Pesos</b>
<b>1:02</b>	34.125		0	<b>34.125</b>
<b>1:03</b>	25.59375		0	<b>25.59375</b>
<b>1:04</b>	20.475		0	<b>20.475</b>
<b>1:01:02</b>	25.59375	0.06	0	<b>25.65375</b>
<b>1:01:03</b>	20.475	0.048	0	<b>20.523</b>
<b>1:01:04</b>	17.71875	0.04	0	<b>17.75875</b>

Table 5 states the different prices of the different CHB mixture. Since Glass is free there is no charge for glass in the pricing only Cement and Sand. In the table, the more glass, the price is lesser but the strength is not high. The highest price of CHB has the highest strength while the lowest price has the lowest strength.

## 5. CONCLUSION

Based on the results, as there is an increase in Glass, the compressive strength will decrease. From Table 3, there is a huge difference between the mixture Cement-Glass and the Cement-Sand-Glass mixture. It would only mean that the compressive strength of the mixture Cement-Sand-Glass is closer every time the glass will be added compared to the Cement-Glass. In Table 4, the two mixtures (Cement-Glass and Cement-Sand-Glass) with the semi-same ratio of their components' Compressive strength were compared. The least difference was the 1:04 and 1:01:04 ratio and their results are closer. When breaking crushing/pulverizing the glass, the glass' surface must not be smooth so that there is a great bond between the cement and glass. The cement can hardly stick to a smooth surface compared to a rough surface.

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