A Study of Recycle Cellular Lightweight Concrete as Coarese Aggregates in Concrete Bricks.

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Abstract.

This research aims to apply the aggregate material in concrete blocks with Cellular Lightweight Concrete (CLC), which is a waste from CLC manufacturing. Even though, this type of lightweight concrete has less compressive strength than ordinary concrete block. But it has advantageous properties such as heat insulation, Sound insulation, light weight, and ability to trimmed. Moreover, recycling the waste can reduce the impacts on environment. By experiment the ratio of CLC concrete fragment in concrete blocks as a coarse aggregate. The researchers compared the properties of ordinary concrete blocks with CLC mixed concrete blocks according to the non-load-bearing concrete standards (TIS 58-2533) [1]. The results show that dry unit weight is inversely variation to specimens (1) ordinary concrete block, (2) concrete block with CLC passed sieve no. 4 and (3) no. 8 respectively. Compressive strength is directly variation to dry unit weight. And water absorption is inversely variation to dry unit weight. Finally, the specimens that passed the standard criterias are ordinary and mixed CLC passed sieve no. 4. There are samples also can be improved in construction technology and reduce environmental impact.

Keywords. concrete block, lightweight concrete, recycled material, cellular, CLC

1. INTRODUCTION

Lightweight concrete is a concrete that has less unit weight than general concrete. Lightweight concrete is a new product manufactured from natural raw materials as portland cement, lime sand, gypsum, water, air entraining admixtures and design admixtures in a unique formula. Normally, the concrete has a unit weight around 2300 kg/m3 in dry conditions. But lightweight concrete such as Cellular Lightweight Concrete (CLC) has dry unit weight between 600 - 1600 kg/m3. [2]

Cellular Lightweight Concrete (CLC) is now widely used in construction engineering. Because it has better properties than general concrete such as heat insulation, sound insulation and lightweight. For these reasons, CLC concrete is more widely accepted in

modern construction than general concrete. In addition, many manufacturing processes of CLC yield that significant CLC concrete waste.

For this reason, the researchers realized the importance of recycling the concrete fragment as coarse aggregate materials used in concrete blocks to bring the benefits of CLC to develop new concrete blocks as an alternative for construction materials.

2. METHOD

This study compares the properties of concrete blocks and CLC mixed concrete fragment. The specimen's dimension of tested specimens is specified as a cube with the size of 15 cm × 15 cm × 15 cm. The specimens of concrete block have admixture ratio as cement per sand per stone equals to 1: 1: 1. And the sample with CLC have admixture ratio as cement per sand per stone per CLC fragment equal to 1: 1: 1: 1. Water cement ratio of both specimens is 0.4. Mixed samples are separated into 2 cases with the size remaining on sieve no. 4 and no. 8. Then all specimens be compared with the non-load-bearing concrete standards (TIS 58-2530), to confirm that the concrete block passed the standard criteria for construction.

Table 1 Compressive strength of non-load-bearing concrete standards (TIS 58-2533)

Minimum of Compressive strength Mpa. (ksc.)	
Averrage from 5 block.	For each block.
2.5 (25.5)	2.0 (20.4)

Table 2 Water absorption of non-load-bearing concrete standards (TIS 58-2533)

Long side shrinkage percent	Maximum humidity Percentage of water absorption (Average 5 concrete blocks)		
	Average annual humidity percent		
	<50	50≤ W ≤75	75 <
≤ 0.03	35	40	45
0.03 < L ≤ 0.45	30	35	40
0.45 ≤	25	30	35

2.1. The manufacturing process of concrete block.

1 Mixing cement, sand, stone and water with the specified ratio.

2 Grinding CLC fragment with the Los Angeles Abrasion Machine. Then sieve the fragment to select the remaining fragment on sieve number 4 and 8.

3 Producing CLC foam from foaming agent with foam generator machine and air pump. Immediately leaving the generator, the smooth foam must be used rapidly since deterioration after mixed exposure to the environment.

Figure 1 CLC fragment recycled remain on the sieve.

4 Mixes admixture together as specific ratio. For general concrete block used ratio 1: 1: 1. And for mixed CLC concrete block used ratio 1: 1: 1: 1.

5 After a proper mixing. the concrete is casted into the formwork and finishing the surface with a trowel. Then surface is sealed with plastic to prevent water evaporation.

6 Curing CLC in the formwork for 24 hours. Then remove from formwork. And curing the samples in water.

7 By the age 7 days old, the specimens were brought out of the water. Wiping the skin to dry, then the specimens were weighted. Then baked for 24 hours to completely dry. And measure the size on both sides of the length with the vernier caliper and then tested to compressive strength.

2.2. Water absorption

The specimens were brought out from curing then drying the skin and weighted the samples to collect the saturated condition weight. Then drying the samples in the oven for 24 hours to completely dry and collect the absolute dry condition weight. After that calculating the water absorption from the formula below.

$$\%\mathrm{W} = \left[\frac{SW - DW}{DW}\right] \times 100\% \quad (1)$$

- SW : Saturated weight, kg

- DW : Dry weight, kg
- %W : Water absorption, %

2.3. Compressive Strength

1 Measuring samples in width, length and height by vernier caliper.

2 Weighing samples and taking notes.

3 installing samples into the concrete compression testing machine.

4 Applying the compression to the specimens at a constant rate in the range of 0.14 - 0.34 Newton per square millimeter per second to the point of failure. And collecting compressive strength data to calculate compressive stress from formula below. (TIS 409-2525)[3]

Calculation

$$\sigma = F/(L \times W) \tag{2}$$

- W : Width of the sample(cm.)
- L : Length of the sample(cm.)
- H : Height of the sample (cm.)
- F : Compressive force (kg.)
- σ : Compressive strength (ksc.)

Figure 2 General concrete block specimen.

2.4. Analysis results

From the experiments, the properties were compared with concrete block criteria (TIS 58-2533). Specimens which pass the standard shall be considered for engineering construction.

3. RESULT AND ANALYSIS

From the testing results, the density of specimens show that density is inversely proportional to percentage of foam.

Table 3 Comparison of properties of concrete specimens.

Average properties		General	CLC sieve no.4	CLC sieve no.8
Dry Unit Weight	kg/m3	1870.65	1579.52	1406.83
Comp. strength	ksc	75.44	36.36	10.50
Water absorption	%	4.05	9.91	12.24

From table 3, the weight of the samples containing CLC decreased. Because the aggregate mass added has a pore structure inside that make the concrete block has more lightweight than general.

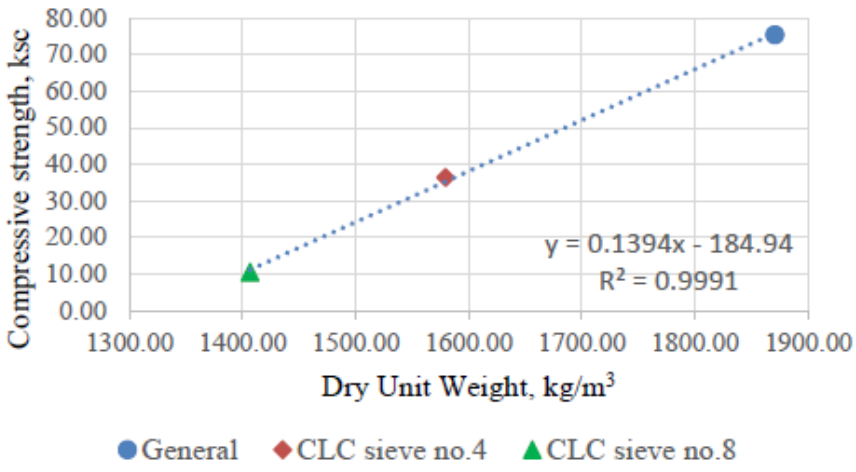

Figure.3 Relationship between dry unit weight and compressive strength

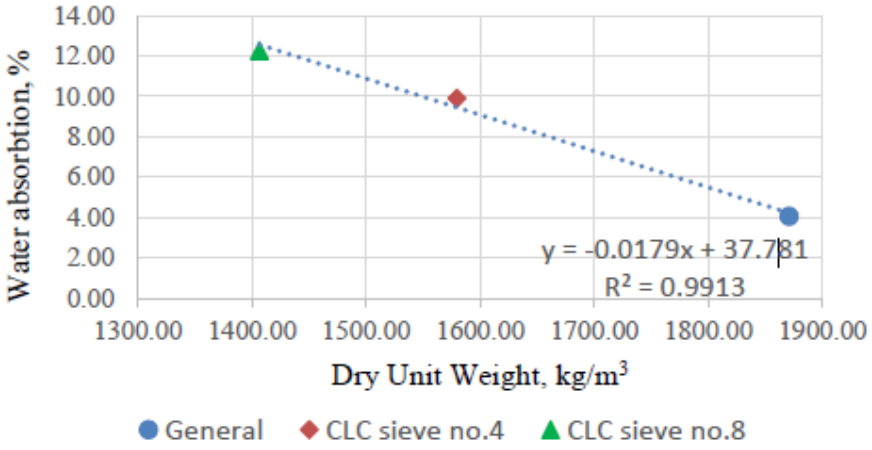

Figure 4 Relationship between dry unit weight and water absorption

From Figure 3 compressive test show that, the weight of the concrete is reduced because the combination of CLC and the compressive strength. The compressive strength of concrete blocks decreases varies with decreasing of weight. From concrete blocks with compressive strength 75.44 ksc. To only 10.50 ksc. In the case of mixed with CLC passed sieve no.8.

From Figure 4 water absorption test show that, water absorption is inversely proportional with dry unit weight. Concrete block with CLC passed sieve no.8 specimen has more pore structural than the other. That cause this sample has the most water absorption (12.24%).

4. CONCLUSION

The specimens which passed all criteria can be classified in non-load-bearing concrete standards. From the analysis, general concrete block has average compressive strength at 75.44 ksc being above the standard. For specimens with CLC passed sieve no.4 is 36.36 ksc that higher than the compressive standard.

Moreover, water absorption test of all specimens has water absorption under the standard criteria (from table 2 the lowest value is 25%). Every samples pass this criterion.

However, concrete block with CLC passed sieve no.8 has compressive strength under criteria value (from table 1 minimum average compressive load is 25.5 ksc.). Because this admixture has too much pore structure and reduced compressive strength.

Finally, the specimens pass the standard criteria and can be an optional of construction are ordinary concrete block and concrete block with CLC passed sieve no.4.

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