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Compressive Strength of Concrete Masonry Units with Plastic Bottle Sludge

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Abstract

Current design of concrete masonry emphasize compressive strength and application of green element. As the waste from water plastic bottle increased, therefore innovation of plastic bottle can reduced the cost of recycling and practice eco-friendly. This paper utilised the plastic bottle that filled with sludge as cores in concrete masonry with three arrangement of plastic bottles used which are (6x6), (5x5) and (4x4). However when dealing with material as additional material to the concrete it will be interact against with different behaviour respect to achieve the high strength properties. The purpose of this paper is to evaluate compressive loading capacity through compressive strength test. The compressive strength of concrete with different arrangement of plastic bottles were observed. The test showed the maximum compressive strength achieved at 24.2 N/mm2 and minimum strength at 8.7 N/mm2. In addition, the results meets the specification for concrete masonry unit strength. However the trend of strength decreased as the total number of bottles increased. It can be observed the less of bottle used as replacing the area of concrete, increased the compressive strength. Hence, the water absorption also observed. Determination of the compressive strength of the concrete masonry units with plastic bottle with sludge can be used further study to be implementing in Malaysia.

Key-word: - strengh, concrete, compressive, plastic, botle

1. Introduction

Concrete masonry units is one of the most popular alternative used in construction. These unit available in many shape and size also materials. However the size are con-trolled in the middle of block in order to help reduce weight and allow reinforced placed in the concrete if necessary (Shoubi,2013). Research conducted in this paper utilizes plastic bottle with DESA brand filled with sludge, and place as a cores in concrete. Plastic bottle is a bottle constructed from plastic. The advantage of plastics bottles over glass is their superior resistance to breakage, in both production and transportation (Golovinova, 2014). But, at the same time, they are non-degraded and cause environmental problems (Wan Noor Atimmi, 2010). Due to the relatively low value of the material and the required processing costs, much plastic ends up in aggregate where there is no environmental benefit. Sludge used is semi-solid slurry and can be produced as sewage sludge from waste water treatment processes or as a settled suspension obtained from conventional drinking water treatment and numerous other industrial processes .Usually the sludge will be end as waste. In this research, the bottle used are arranged with three matric arrangement which is (6x6), (5x5) and (4x4) before mixed with cement concrete. To form the concrete, plywood formwork are used to create concrete block masonry unit. The unit are

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measure to meet their properties on 7, 14 and 28 days. The water ratio used in this research is 0.45 and 0.7. Due to the ratio, the result can be analyses and the final result can be determined for effective mixing ratio. Testing of new concrete block masonry is necessary to determine the design meets the standard properties as one of building masonry. Universal Testing machine (UTM) used in this research and rate of water absorption also taken.

Lastly used the plastic bottle and sludge filled can be reduced energy consumption by eliminating the recycling process and can reduction of pollution by not releasing the toxic fumes of melting the plastics bottle. All the material used consist Green building concept, which is a building consisting of structures and the using of process that are environmentally responsible and resource-efficient start from material choosing and sitting to design, construction, operation, maintenance, renovation, and demolition . In other words, the design of concrete block masonry in these project involves a balance between home building and the environment and the practices to complement the classical building design concern of economy, utility, durability and comfort. In other way, it can reduce the Eco-house is the creative building and supportive infrastructure that reduce the use of resources, create healthier living environments for people and minimize negative impacts on local, regional and global ecosystem. The objective of this study are to study the strength of concrete block masonry through compressive strength test between 0.45 and 0.7 water-cement ratio and to identify relationship between water absorption of concrete block masonry and strength using 0.45 and 0.7 water-cement ratio.

2.0 Methodology

The methodology is explained on the unit, equipment and test procedures that have been used to achieve the objectives. In addition, this chapter describes the procedures for laboratory work carried out to obtain the desired results. Figure 1.0 below shows how the research mix design using sand cement at 1:6 proportional mix. The concrete being poured into the mould, measuring by 500mm length, 100mm width and 500mm height. The specimen formed cured with water through sprinkling. Curing ages are 7, 14 and 28 days. Then it subjected for water absorption testing and compressive strength test.

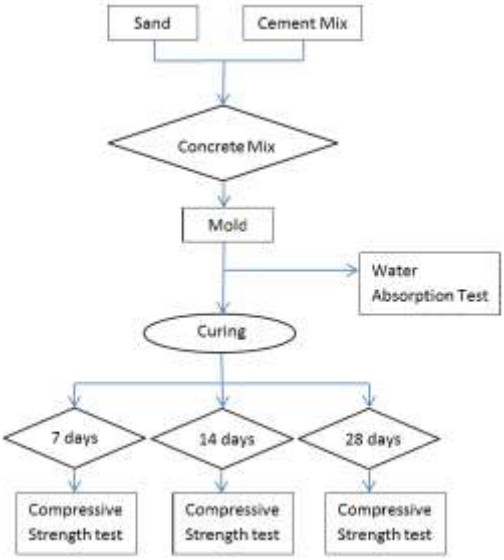


Figure 1 Conceptual framework

The distribution of megalithic culture in Negeri Sembilan and some part of Malacca shown the art of stone carving is valuable towards historical context which the variety shapes of Megalith such as sword shaped, rudder, spoon, tortoise, snake, baby deer and else (Abdul Halim, 1987). The art of stone carving is an invaluable heritage with the lasting historical and cultural importance.

i) Materials

The materials used for this research work include Portland cement, fine aggregate sand and water. For the mixing ratio, 1:6 (cement: sand) with water cement ratio of 0.45 and 0.7 was adopted. The wet mixture then poured in the mould

with sludge Plastic Bottle.Mixing ratio of these sample 1:6 which is cement propotion with sand. The amount of water depend on the weight of sample, and the w/c was choose to monitor relationship between the compressive strength of concrete mixture when deal with portion water.

ii) Curing

Curing was employed to maintain satisfactory moisture content and allow proper hydration and hardening of the sand concrete blocks. The blocks were cured for the whole period of the 28 days during which water is sprinkled on them for two weeks during curing. Sufficient curing is essential for a concrete to provide its potential performance .Then they were tested for their compressive strengths.

iii) Compressive strength

Compressive strength test was performed to obtain a sample of the panel. This test is performed by BS 5628 : Part 1 :1992. It also competes favourably, for example, with the minimum British Standard requirements of 2.8 MN/m^2 for precast concrete masonry units and load bearing fired clay blocks and of 5.2 N/m^2 for bricks.Maximum strengths described in N/mm2 are obtained by proper mixing of suitable material and arrangement also by proper com- pacting and curing [19]. In this research sample the block has reached age 7,14 and 28 days are tested for compressive strength using Universal Testing Machine (UTM) .

The compressive strength of each cube was calculated, by dividing the load causing failure of the specimen by the cross-sectional area as follow:

$$\text{Compressive strength } (N/mm^2) = \frac{\text{Load at failure (N)}}{\text{Cross sectional Area } (mm^2)}$$

There are 48 sample tested for compacting. The block masonry placed on the platform of the machine and the platform ensured clean and no impurities such as traces of broken concrete. The sample tested using UTM machine which is the easier way to identify strength of material.

Figure 1 A sample of concrete Plastic Sludge masonry

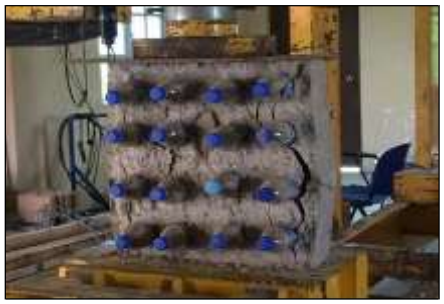


Figure 2 Compressive strength test using Universal Testing Machine (UTM)

iv) Water absorption test

Water absorption test is one test used to determine the percentage of water absorption on the concrete block masonry. This leach tests conducted more complicated than other tests because many steps must be followed. This test should be done carefully and follow the correct procedures so that there is no error that would affect the results of the readings taken. Furthermore, durability of concrete is mainly dependent on the capacity of a fluid to penetrate the concrete's microstructure, which was called permeability (Dolat Capital,2011).

The panel weighted before immersed. The through pores allow air to escape in the 24 hour absorption test (BS 3921). The 24 hours immersion test allows water to be absorbed in pores which are easily filled under cold condition. The effects of masonry absorption property is due to variable raw materials used. Furthermore, the high surface water absorption only decreased compressive strength of cover concrete. The whole strength of concrete depends on both surface and internal structures. So, strength of concrete cannot be evaluated by water absorption. The water absorption by immersion gives an estimation of the total (reachable) pore volume of the concrete, but gives no indication on the concrete permeability, which is more important with regard to durability.

Figure 3. Concrete block masonry are weighted before soaked in the water

3.0 Result and analysis

From this experimental study based on 48 specimen with replacement of Plastic Bottle sludge to the area of concrete mix from (6x6), (5x5) and (4x4), the objective of this research obtained and shows good agreement and promising effect to the bottle sludge effect on concrete masonry properties.

Testing the specimens is classified according to the curing age and water content of the concrete as on the seventh, fourteenth and twenty-eighth days.

Table 1. Average of Compressive strength for concrete masonry w/c 0.45

No.	Details	Specimen (Water content 0.45)			
2	Area (mm^2)	100 x 500 = 5000	500 x 100 = 5000	100 x 500 = 5000	100 x 500 = 5000
3	Mix ratio	1:6	1:6	1:6	1:6
4	Mass (kg)	41.9	43.5	49.0	49.8
5	The Maximum load (kn)	125	121	51.5	54
6	Compressive Strength (N/mm^2)	25	24.2	10.3	10.8

Table 2. Average of Compressive strength for concrete masonry w/c 0.7

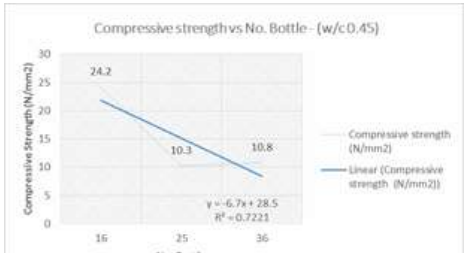
No.	Details	Specimen (Water content 0.45)			
2	Area (mm^2)	100 x 500 = 5000	500 x 100 = 5000	100 x 500 = 5000	100 x 500 = 5000
3	Mix ratio	1:6	1:6	1:6	1:6
4	Mass (kg)	41.9	43.5	49.0	49.8
5	The Maximum load (kn)	125	121	51.5	54
6	Compressive Strength (N/mm^2)	25	24.2	10.3	10.8

Under the compressive strength test the specimens were cracked and reach ultimate strength recorded by machine as showed in table 1 and table 2 above.

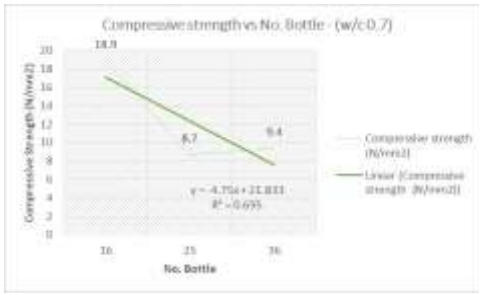
Table 3. Compressive strength for concrete masonry w/c 0.7 and 0.45

Sample of Bottle	w/c 0.45		w/c 0.7	
	load (kN)	Compressive strength (N/mm2)	load (kN)	Compressive strength (N/mm2)
16	121	24.2	94.5	18.9
25	51.4	10.3	43.5	8.7
36	54	10.8	47	9.4

From the graph it shows, the relationship of compressive strength between number of bottles used and water content influence the strength of concrete masonry for 7,14 and 28 days of curing age. The result shows the specimen with using 16 (4x4) bottle get higher value compared to specimen with 25 (5x5) and 36 (6x6) of bottle. It slightly decrease from 24.2N/mm^2, 10.3N/mm^2 then increase 10.8N/mm^2 for specimen with w/c 0.45 and from 18.9N/mm^2, 8.7N/mm^2 then increase at 9.4N/mm^2 for specimen 0.7 w/c. . More replacing area of cement sand by sludge bottle, reduce the strength of specimen. Nevertheless, increasing of water content from 0.45 to 0.7 reported decreasing the strength of specimen sequent.



I 0.45



0.7

From graph figure 5 and 6 above shows analysis of standard deviation for compressive strength against water content of 0.45 and 0.7. The correlation build to determine the strength correlation between different variable. From the results, correlation of strength and w/c 0.45 give the highest positive value 0.7221 and 0.695 for w/c 0.7. This is gives strong evidence which the value of 0.7221 which is near to 1, was a better correlation between combination water content (w/c) and number of bottle used and compression strength behaviour of concrete masonry tested. It also shows that using 0.45 w/c is better in this research because rate of data change is looked normal not to drastic rather than using 0.7 w/c. As overall from the value of R both value R^2 is above 0.5 shows the model suitable to be used as a method of research [4]. Below is the result of water absorption of specimens of two w/c.

Table 4. (a),(b) Percentages of water absorption

No. of Bottle	w/c - 0.45
16 (4x4)	$\frac{(45.6-45.2)}{45.6} \times 100 = 0.87\%$
25 (5x5)	$\frac{(49-48.8)}{49} \times 100 = 0.41\%$
36 (6x6)	$\frac{(51.2-51.0)}{51.2} \times 100 = 0.39\%$

No. of Bottle	w/c - 0.7
16 (4x4)	$\frac{(51.0-49.6)}{51.0} \times 100 = 2.75\%$
25 (5x5)	$\frac{(52.2-50.4)}{52.2} \times 100 = 3.45\%$
36 (6x6)	$\frac{(46.4-46)}{46.4} \times 100 = 0.86\%$

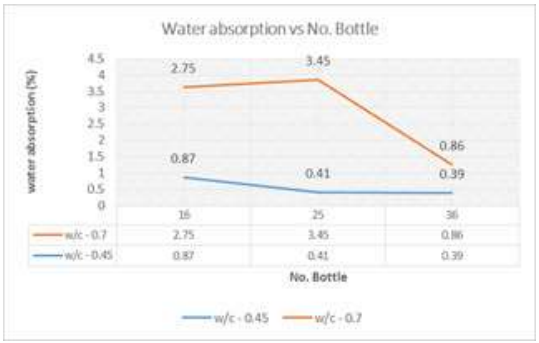


Figure 7. Water absorption graph versus number and arrangement of bottle.

The graph shows that the water absorption will be de- creasing not constant when we replace the area of concrete with bottle. By referring to the table 7, it showed that the rate of water absorption not influenced the strength of concrete. Other than that, the low percentages of water absorption which is less than 20%, proved than this invention of concrete masonry unit is good enough to be implement in construction. However in can be conclude that the strength of concrete influent of amount of cement used and water content.

4.0 Discussion and conclusions

From the above findings, it can be concluded that masonry unit using Plastic Bottle Sludge are suitable to be used as a partial of replacement for area in concrete mix. At the same time, by used waste material such as sludge and plastic bottle in this research it can help to reduce pollution, cost of recycling and processing.

From the result, it also showed that concrete grad M10 until M20 can be archived for this invention. Further re- search should be carried out to improve the result by implementation the in situ wall using bottle and test it with compressive strength method. However, this technique still needs some modification for better result. For example, the using of cement can be further reduced by replace the amount mortar using clay with adequate amount of water or any other suitable materials.

In term of strength, bottle effect the high deflection with low loading strength. However water cement ratio are more influence in mixing the mixture, because the high of cement content will increasing more strength of concrete. Nevertheless, new investigations can be performed to better understand the role types of cement used and ratio of water linked to the compressive strength. Lastly, the proposed of using bottle is suitable to used and implement in construction, and at the same time the used of waste material such as sludge will help to reduce the environment pollution.

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