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Performance of Interlocking Brick using Quarry Dust as Mixing Agent

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Abstract*: Sand demand is currently very high and constantly increased up to cause problems in the construction industry. In an effort to solve this problem, various studies have been conducted as an alternative to replace the use of sand and among them are the use of quarry dust as a substitute sand. In this study, quarry dust is used as a substitute of sand in the manufacture of interlocking brick cement-sand. However, it has raised questions about the ability of interlocking brick with quarry dust in terms of compressive strength and water absorption compared to interlocking brick with sand that are often used in construction. Interlocking brick made using an appropriate mixture of sand and quarry dust as the main components, cement as a binding agent. Providing 70 samples of interlocking bricks different mixing and all the interlocking brick dimensions are 250mm x 125mm x 100mm. The various percentages of quarry dust that to be used in the experiment. This percentage ratio is required to determine the appropriate percentage to be used in the production of brick in order to produce optimum strength. Interlocking brick will be tested using hydraulic machines for days 7 to days 28 for compressive strength and water absorption test. The results showed that the highest value of compressive strength test is from a sample of 70% quarry dust of 31.07 N/mm ² which consisted ratio of 1 cement: 1.8 sand: 4.2 quarry dust while for water absorption test, the highest reading was recorded by 0 % sample of quarry dust with a ratio of 1 cement mixture: 5.1 sand of 11.8%. As a conclusion, quarry dust content can affect the compressive strength of bricks, thereby increasing the compressive strength of brick and reduce the rate of water absorb.

***Index Terms*: Industrial Building System, Quarry Dust, Interlocking Brick,**

I. INTRODUCTION

Nowadays, in the modern industrialized world, construction usually involves the translation of designs into reality.

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A formal design team may be assembled to plan the physical proceedings, and to integrate those proceedings with the other parts of the design.

Normally, in construction companies will be prepared by a design team, including architect, structural engineers, civil engineers, planning consultant, electrical engineers, mechanical engineers, fire protection engineers, architectural consultants, and archaeological consultants to make sure their project will be a success [1].

Surveys such as that conducted by [2] have shown that, a variety of building construction techniques have been created to provide convenience to consumers. Creation of new construction techniques affects the construction processes amongst them expedite construction processes, save time and cost. It thus provides the option for users to select appropriate techniques. In the civil of the construction site, there are consist of two methods which are conventional and modern methods. Industrialized Building System (IBS) is a new technique of construction whereby the components are manufactured in a controlled environment, either on site or off site, placed and assembled into construction works. IBS product is Modern of Construction (MMC) one of a new alternative in site.

Structural work concerned with the structural analysis of buildings, structural design and other structures. Interlocking Brick is a new technology applied in the construction industry and a basis of 70 percentages of IBS which is introduced by the public sector [3]. It functions as an apprentice of the existing building where the interlocking bricks can save costs and construction time [4]. For the most part, have two types of bricks are delivered by utilizing machines to be specific cement bricks and clay bricks.

Quarry dust is a by-product resulting from the process of breaking large granite or natural aggregates and has no specific commercial value that specifically. It is appropriate material in replacing the sand in the interlocking brick because it has similar properties [5].

Normally, the interlocking brick is uses materials such as cement, sand and water. The ratio of these three mixtures is very important in ensuring the production of interlocking bricks that meet the requirements of brick for load-bearing walls. The demand for sand and cement for construction purposes is increasing day by day. The use of ordinary brick using a lot of employees to complete the work by binding to the bricks. The binding period also takes a long time to complete [6].

In addition, based on [7] studies, the sand mining activities can also cause ecological system at the river interrupted. For example, water pollution of rivers like Sungai Langat, Selangor, following there are industrial activities along the river, including quarries, cement plant, and mill wood. Quarry dust extraction is performed as an alternative measure to replace sand in brick work. Quarry dust, which is an inert material and useless waste to found from nearby quarries. A study on the optimum percentage of quarry dust that can replace sand will be done to overcome this problem.

A structure built of any material even need to be ascertained its stability to ensure the safety of the user structured. The unstable structure will cause economic losses and worse will involve the loss of life. Similarly, with structures constructed using brick, its ability to stabilize in bearing any load is a very important aspect to be ascertained and revised. The structures constructed using bricks, in many situations are exposed to compressive, shear and bending forces. These forces can cause failure to structures constructed from bricks.

In this research, the experiments carried out the replacement of sand to quarry dust into the mixture of interlocking bricks. Quarry dust is a useless wasted then recycled as an addictive or an alternative in the production of interlocking brick. This study will investigate the performance of the interlocking brick using different percentage of fresh and recycled quarry dust as the main material and the mix proportion consist of cement, sand and quarry dust.

II. PREPARATION OF MATERIAL

The materials and equipment involved has been identified earlier before starting the experiment in the laboratory to ensure that everything is available in the laboratory and instead the pre-emptive arrangement can be made. The use of quarry dusts will require the extraction of the material from nearby quarries. The material ingredients have been tested to ensure that the material is in accordance with the required specifications. Materials to be used in the interlocking brick mixture will be weighed by the amount that has been calculated.

A. Properties of Quarry Dust

Physically, quarry dust is the material shaped end of sharp and long gray. The surface of the quarry dust texture is rough from sand. Theoretically, the smooth surface of the aggregate coarse texture will be a bonding material stronger than the smooth texture of sand surfaces. Fineness of the quarry dust can be defined as particles that are retained on sieve 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm [8]. The size of the different quarrying dust, which is produced by 20% - 25% of the total production in each unit of the crusher is left as a quarry dust waste material [9].

B. Interlocking Brick

According to [10], a semi-mechanized stationary type machine used to produce interlocking bricks. The other creation frameworks are-manual forms that require hand packing, a portable semi-automated egg-laying machine and fully mechanized system that combined compression and manually filling in the mold. The machine can compact and consolidates the mix so that the bricks are uniform in measure and attain desired physical properties.

The bricks are cured for a minimum period of 14 days, before they are prepared to utilize. A high quality machines are going to propose according to the feedback and need from the developer for this project. Control samples have been prepared in advance to determine the ratio of mixture by preparing with a sample of 70 of interlocking bricks. All the brick sizes are 250mm x 125mm x 100mm dimensions as shown in Figure 1. All the interlocking brick is generated using pressure machines in the same laboratory. The ratio of replacement sand with different mixture which is 0%, 15%, 30%, 50% and 70% by 1:6 ratios (cement: sand).

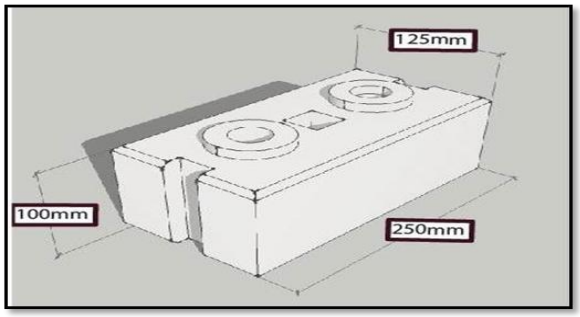

Fig. 1 Sample of Interlocking Brick

C. Ratio Mixture

There are 4 ratio of mixture used which are cement and mixtures rate with 0%, 15%, 30%, 50% and 70% (cement: quarry dust). There is no additional ratio of quantity of cement which is used same as original quantity. Contents of water used in the manufacturing of bricks has 0.5% to 0.55% with ratio 1:6 of (cement: sand). Table 1 shows the quantity of materials based on the ratio of the mixture.

Table. 1 Quantity of Materials According to the Ratio

Materials	15%	30%	50%	70%
Cement	0.86 kg	0.86 kg	0.86 kg	0.86 kg
Sand	4.37 kg	3.6 kg	2.57 kg	1.54 kg
Quarry Dust	0.77 kg	1.54 kg	2.57 kg	3.6 kg

III. RESULT AND DISCUSSION

The test has been done to find the ratio of mix material for the interlocking standard bricks and physical properties of the interlocking quarry dust bricks using two test which are:

A. Compression Strength Test
B. Water Absorption Testing

A. Compressive Strength Testing

The compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Testing for compressive strength test was based on BS 3921:1985 (Testing Bricks - Specification for Compression Testing Machine for Bricks). A test for a strength of concrete was performed. This test is conducted to determine the strength of the interlocking where the brick of the imposed compressive loads until failure.

The compressive strength is the main characteristic that should be evaluated in determining the quality of a concrete building. The interlocking bricks tested their compressive strength on day 7 and day 28.

Each ratio of interlocking brick tested randomly were selected by 3 of bricks. The average of the compression strength on day 7 and day 28 were compared as shown in Figure 2.

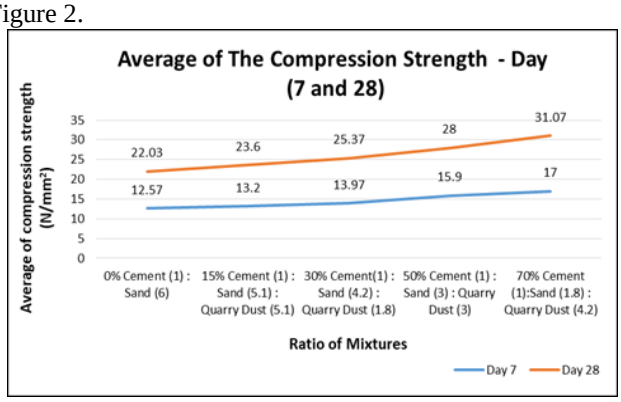

Fig. 2 Average of Compression Strength on Day 7 and 28

Based on the values obtained, the strength of the bricks is increase follows by the percentage of quarry dust. The data showed that the strength of bricks value is high when compared with the use of a mixture using sand. On days of 7, the average strength of bricks is 17 N/mm^2. And on the day of 28, the average bricks mixed is the highest 31.07 N/mm^2. Almost 90% of strength value increase between days 7 and days 28. It can be concluded that all concrete strength tests for days 7 and 28 are significant increase of the ratio of mixtures. For the ratio of mixture, the most suitable sample was 70% because it had a higher compressive strength and it shows that the used of quarry dust can affect the performance of the bricks in term of their strength.

B. Water Absorption Testing

The water absorption test is a test where the absorption of water rate is known. In this test, the total of 15 bricks with different levels of mixed quarry dust and sand have been used. This test was conducted as per the specifications of BS 3921: 1985 (Method for determination of water absorption in Brick). This method was known as 'water immersion method'. The size of bricks specimens used was 250mm × 125mm × 100mm.

Fig. 3 Process of Water Absorption

The test was carried on three specimens to achieve average value, taken from each mix and cured in water for 28 days the age of the testing. For this experiment the result was taken under 28 days of curing period only. The specimens were left immersed for 5 hours before their removal from the tank as shown in Figure 3. The surfaces of the specimens were wiped with a clean cloth and were weighed again to obtain the wet weight (WW) of the specimens.

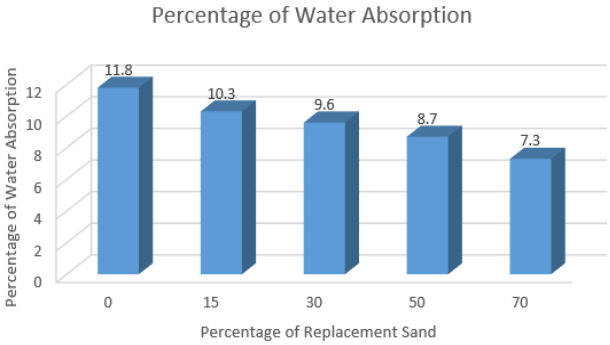

Fig. 4 Average Percentages of Water Absorption

From this experimental test, the absorption rate is reduced by the addition of the quarry dust percentage where the relationship between the parameters is directly proportional to each other. When the volume of quarry dust increases, the absorption rate of the water decrease. This also shows that when there was more quarry dust in the mixed of bricks, the amount of water absorbs are decreasing as shown in Figure 4.

This is because the amount of the proportion of natural quarry dust can absorb water in minimal possible. The specific gravity of stone blast is more or less equal to the aggregate the quality of stone dust. The quality of stone dust is depending upon the crushers running time and the quality of rock which then lesser the percentage of finer particle thus made it more suitable for the replacement of sand of stone dust.

IV. CONCLUSION

The use of quarry dust as replacement materials in interlocking bricks proves that the continuity of the increasing performance in term of strength of interlocking brick when using quarry dust. Therefore, quarry dust is one of a suitable wasted material for use as alternate materials in interlocking bricks. A total of 70 interlocking bricks has been prepared in carrying out for this study and all the objectives of this study have been achieved through the results obtained and the analysis of the data has been made. Thus, the conclusion that can be made in relation to the purpose of using the quarry dust in concrete are:

-The compression test for bricks was done in the days of 7 and 28. After compressive testing, it was found that the optimum strength to replace sand using the quarry dust is amounted to 70% with an average compressive strength of 31.07 N/mm^2. On the day of 28, where this level strength of interlocking brick that used quarry dust is the highest value recorded.

-The strength of the sample obtained is directly proportional to the density.

It is proven when the sample of interlocking brick is in low density value, the strength of the sample is low. And when its density level is high, the sample has a higher strength.

-On the day of 28, the water absorption test on interlocking brick samples can be concluded that by increasing the percentage of quarry dust in the interlocking brick mixture, the percentage of water absorption will be decreased. With quarry dust percentage replacement towards sand cause the interlocking brick will be denser and this cause brick function in less absorbing the water.

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