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Use of Glass Dust to Improve Concrete Strength on Offshore Platform Installations

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Abstract*: The primary aim of this study is to investigate the influence of using glass dust as an additional in conventional concrete material on the properties of fresh and hardened concrete. Soil pollution happen when non-biodegradable materials disposed into land. However, the used of this non-biodegradable can do wonder for construction purposes. This is due to the non- biodegradable materials which cannot be broken down to simple organic molecules by micro-organisms. Glass dust is one of the example of non- biodegradable. Nowadays, the used of this dust becoming more popular due to its properties. In this study, the glass dust which consist of silica has being used as an additional ingredients to concrete cement. The concentrations of the glass has being varies to determine the mechanical properties e.g. compressive strength of M35 grade concrete. The variation of glass dust are from 10, 20 and 30%. The compressive strength of concrete cubes is tested after 7 and 14 days. The outcomes of the study are presented in tables and graphs.

***Keywords* : Offshore, Glass Dust, Platform**

I. INTRODUCTION

Offshore platform structures is a huge construction normally in the middle of the sea consists of a complete hydrocarbon facilities from drilling raw hydrocarbon until ready to deliver it to shore by pipe line or tankers. The construction or structure which complete with accommodation is an expensive investment, however, in return the profit is very wealthy. This expensive cost are due to it complicated interrelated 'system to system' interlink with high standards of construction process. This is because the sea water is an aggressive agent of corrosion. Not dealing with this corrosion properly will jeopardies the whole activity including life. Thus, the structure of the platform not only must be strong, it also can withstand the impact of the wave and surrounding weather.

Concrete is one of the oldest and most common construction materials in the world. Cost is one of the main reason of its popularity. Other factors are availability, durability, and ability to sustain extreme weather environments such as open sea. Compare to steel and polymers as other construction materials are more expensive with similar range strength.

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The concrete in principal is a brittle material that has high compressive strength, but low tensile strength. Knowing it disadvantage, reinforcement of concrete is a must in order to overcome this stress. Since, it is used for various purposes in the construction as well as marine industry i.e airport runways, road pavements, water pipelines, fencing posts, subways and tunnels and water tanks.

Concrete platforms are becoming more popular lately. According to Fernandes and Pardo [2] this popularity are due to less maintenance and reduce in fatigue resistance compare to other materials. Since all the maintenance of the platform must be done in situ, less or free maintenance is essential. Most of this concrete platforms are self-floating and it all started with a first unit in 1976. Though, there is disadvantage of the concrete platform in tensile strength. Study still actively carry out on it to improve the outcome [1]. One of the method is using glass dust as additional mixture material to the concrete.

Concrete with glass dust as an additional mixture is an innovation for having better strength for the platform. Glass dust or glass powder, better known as glass aggregate in industrial term. It is a pure glass that crushed to powder shape. The colours of the power highly depend to waste glass provided. The partical size varies depending on the chemical composition of the glass and method of production and crushing.

A proper glass crush will look like sand. Interestingly, it carry the same coefficient of permeability to the sand as well. It is due to silica property. Among its characteristic is low water absorption. As the glass dust is in powder in shape, it give advantage for proper mixture of concrete. Thus, it give a better cohesive and stable mixture.

The offshore platform has evolved as the hydrocarbon reserve has moved from shore to ultra-deep water. Thus, the requirement to new concept as well as technologies. This including facilities to support this changers. All the facilities and systems are proven technology and being used worldwide. State of the art design is necessary in order to complement drilling platform for more than 3000 meters. This depth is a huge challengers to the engineers and technologist [3, 4].

II. EXPERIMENTAL

There are two experiments were applied, which are (1) Slump test and (2) Compressive strength test.

i. Slump test:

The concrete slump test or slump cone test is to determine the workability or consistency of fresh mix prepared concrete before it sets.

The freshly made concrete is ease to flows, thus, it can also be used as an indicator to check the uniform quality of concrete during construction. The test is popular due to the Simplicity involves low cost and provides immediate results. This procedure mentioned in ASTM C143 in the United States, IS: 1199 – 1959 in India and EN 12350-2 in Europe.

The test is carried out using the equipment as shown in figure 1.

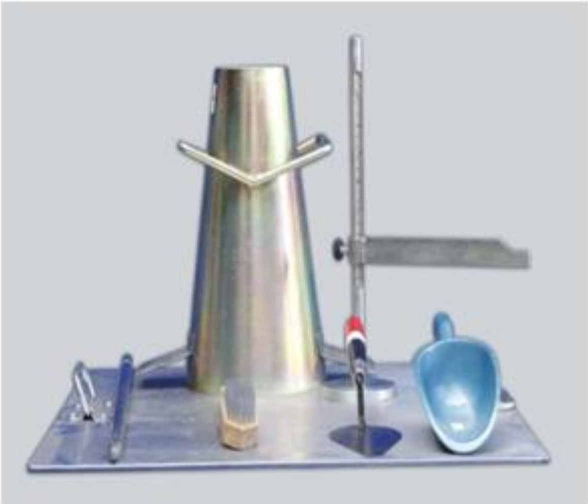

Fig. 1 Concrete Slump Test Set

The procedure of slump test is show in figure 2.

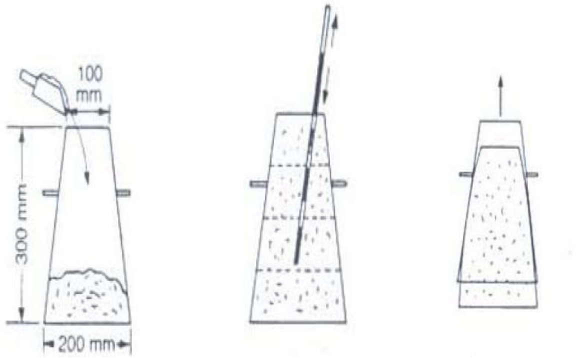

Fig. 2 Procedure for slump test

In simple the test procedure can be shown in figure 3.

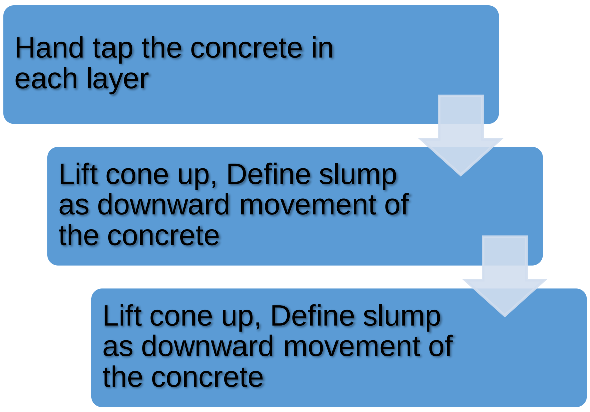

Fig. 3 Flow chart of slump test

Figure 4 shows the measurement of the slump.

Fig. 4 Slump measurement

The shape of the concrete after slump test is very important to interpret the condition of the mixture. Sample of the shape shown in figure 5.

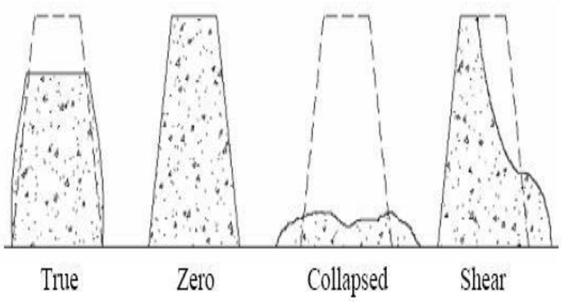

Fig. 5 Types of Slump Test Results

- True Slump – The end product will follow the shape of the mould (cone). The reading taken as shown in figure-4.
- Zero Slump – The end product will follow the shape of the mould perfectly. This indicate dry mixture (very low water-cement ratio).
- Collapsed Slump – The end product will not follow the shape of the mould. This indicate wet mixture (very high water-cement ratio). The slump test is not appropriate.
- Shear Slump – The end product will not follow the shape of the mould. The result is incomplete, and required to retest.

ii. Compressive strength test:

The Compressive strength test is measured by breaking a cylindrical or cubical concrete specimen of known dimensions in a compression testing machine. The strength of the concrete highly depends too many factors, i.e. water-cement ratio, cement strength, quality of concrete material and quality control during production of concrete. The aim of the test is to check for any crack on its surface as well as deflection.

Measured by considering failure under the action of a uniaxial compressive force. Under uniaxial compression, the failure pattern is such that the cracks are approximately parallel to the applied load through some cracks form at an angle to the applied load as shown in the figure 6. There are two types of cracks i.e.

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parallel and inclined. The parallel cracks appear in normal direction to compression load at local tensile stress. Meanwhile, inclined crack progress from shear planes that cause collapsing.

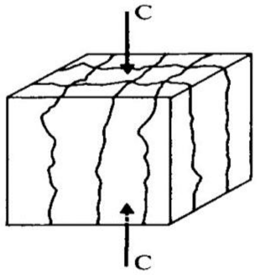

Fig. 6 Directional for compressive load

Compressive strength of concrete is tested by the testing cube. Cube of size (150 mm X 150mm X 150mm) concrete specimens were casting using M35 grade concrete. Specimens with normal or standard concrete and glass dust concrete were cast. During casting the cubes will compacted using tamping rods. The cubes will be remain in the mould for 24 hours before it being removed. Then, the cubes will be exposed to sea water for 7 and 14 days. Later, the specimens were tested for compressive strength using a compression testing machine as shows in figure 7.

Fig. 7 Compressive Strength Machine

III. RESULT AND DISCUSSION

For checking the workability of concrete slump cone method is used. Table and graph show the results of workability of concrete with cement replacement by glass powder in various percentages ranging from 10% to 30%.

Size of slump cone.

- Bottom diameter: 200 mm
- Top diameter: 100 mm
- Height: 300 mm

Table. 1 Result for slump test

Cube Markings (mixture)	Slump (mm)	Degree of workability
Normal mix	45	MEDIUM
10% glass dust	99	HIGH
20% glass dust	95	HIGH
30% glass dust	90	HIGH

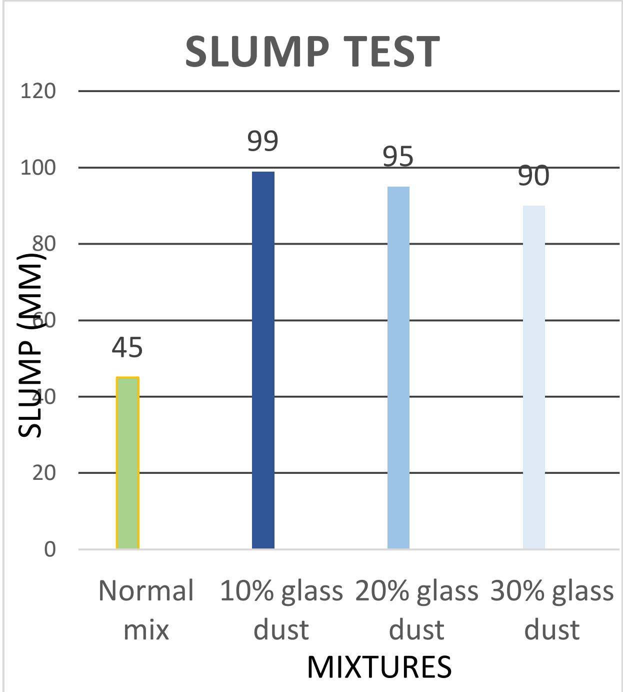

Fig. 8 Graph for Slump Test

From the graph 8, the slump value of conventional concrete is in the range of 45 mm to 50 mm. The workability of concrete with different percentage of glass dust has been determined. It showed workability of concrete increased with increasing the percentage of glass dust in concrete. In addition, workability of concrete with 10% glass dust increased and the highest among the additional 20% glass dust and 30% glass dust. Workability of concrete with glass dust still remain above 90m. So, workability of concrete with different percentage of glass dust is suitable for high reinforcement and heavy structure.

There are many factors influence the slump test, among them are: Material properties, air contain and temperature.

The results will reflect these factors.

Compressive test results:

Table. 2 Result of compressive strength for 7 and 14 days

Compressive strength (cube) no.	Type of specimen	Compressive strength (7 days) (N/mm2)	Compressive strength (14 days) (N/mm2)
1	Conventional	44.88	48.44
2	10% glass dust	49.10	56.88
3	20% glass dust	51.11	60.44
4	30% glass dust	58.66	63.11

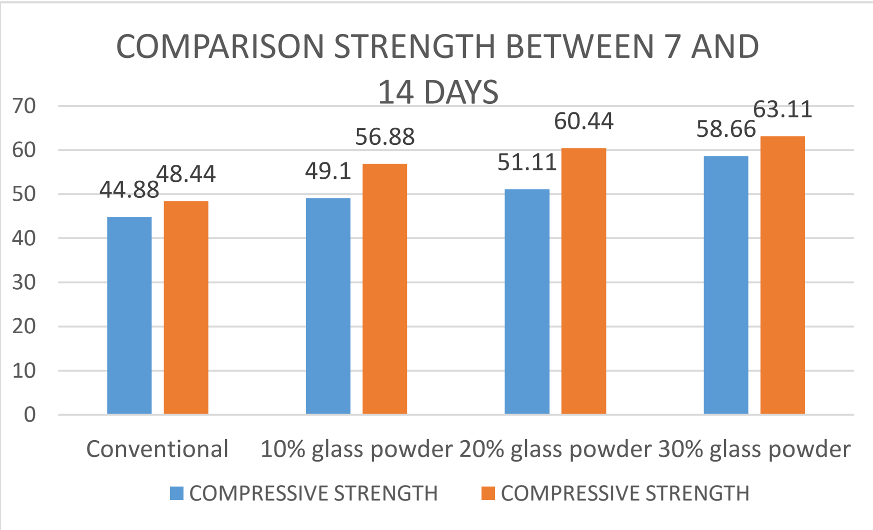

Fig. 9 Graph for Compressive Test for 7 and 14 days

The table 2 and figure 9 shows the compressive strength of the concrete cube after 7 and 14 days.

From that, this analysis extends our knowledge of the development of concrete with glass dust as an additional mixture has been successfully completed and the results were presented and analyze in the previous chapters. Use of glass dust in concrete can prove to be economical as it is non-useful waste and free of cost.

For conventional or normal concrete without glass dust, the workability decreases. When the rate of glass powder increases, despite its zero absorption. This phenomenon could be explained with developed by the finesses and high surface area of this powder, which captures a required amount of water for consistency. Workability of concrete mix with glass dust increases with increase in glass dust content. Concretes of grade 35 recorded the highest workability of up to 99 mm slump for 10% glass dust. This very high values could be useful in very heavy and congested reinforcements such as a concrete platform.

The 30% replacement of fine aggregates by glass dust showed a 7% increase in compressive strength at 14 days. The increase of 7 % in the 14 days cube compressive strength of glass dust concrete was compared to conventional concrete. Both at the age of 7 days and 14 days, maximum compressive strength occurred at 30% of glass dust.

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