

# Performance on Used Iron Sand as Concrete Admixture

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**Abstract**— Malaysia construction industry is produced serious pollution to the environment and the pollution situation become more serious. The reason behind is Malaysia is having rapid development in the construction industry, because of vision 2020, therefore million tons of waste will be generated, one of the waste are iron sand that produce from the process of connecting or cutting the steel structure. The construction industry needs to find a method to reduce the landfill. It is very important to reuse, reduce and recycle the waste and one of the methods to reuse the iron sand is to mix with the concrete mixture.

In this study include the basic information of about iron sand as concrete mixture and carried out the experiment to determine the physical and the effect of iron sand concrete mixture and also will identify the suitable iron sand content to be added as concrete admixture. This will help to reduce the waste generated from the construction industry and produce an environmental friendly green product.

The method to complete this study is collecting the information from the Primary data which is an experiment and the secondary data, which is the literature review. Primary data, means that the experiment of the iron sand as a concrete admixture will be carried out, other than that, the secondary data also will be collected, which is the literature review, included the information from the journal, articles, books, internet or newspaper. After complete collected all the information, the information will be analyzed from primary data and secondary data, analysis and discussion will be carry out on what is different between the primary data and secondary data and lastly the conclusion and recommendation will be make base on the information collected.

**Keywords**— Waste Material, Environmental, Green Product.

## I. INTRODUCTION

CONCRETE in Malaysia has the advantages of low cost, high strength, weather resistances, high thermal insulation, high sound insulation, can form any shape require and other advantages. Concrete is a composite material, the material are cement, sand, water and aggregate, these few raw material is easy to obtain in Malaysia, therefore this is why concrete is popular in Malaysia.[1][2]

To obtain the high strength and good quality concrete, the proportion of the concrete is very important, different grade of the concrete can carry different load and have different proportion, a popular example is grade 25 concrete has the proportion of 1:1:2, with the arrangement of cement, sand and coarse aggregate [3] Other than that strength of concrete also might be affected by how dry is the concrete, the concrete can

only reach minimum required strength after 28 days, therefore extra care required when the concrete are not fully dry.[3][4]

Concrete is very common in Malaysia, its use for most of the high rise building, low rise building, bridge, drainages, dam, and others. Other advantages of concrete are it can last for many years. Furthermore the concrete also is a green product, it would not bring any negative effect to the environment, and it can be recyclable, but concurrently the when the building would not fulfill the user requirement or the land cost is more than building cost, it will be demolished, during demolish process, tons of waste are generating. If the waste does not handle properly, it would cause a lot of problems to us.[3][5]

In this study iron sand will be used as a concrete admixture to replace the fine aggregate, before carry out any experiment, knowledge and the concept of the concrete and iron sand must be understood to allow the experiment conduct smoothly.[6]

Every day, different sector, such as residential, commercial, industrial and others are generated millions of tons of waste, and the waste generates an increase annually, it was affected by the increasing of the population, normally the waste was being sent to disposal as landfill, some of this waste can reduce, reuse and recycle [5]. The benefit of reduce, reuse and recycle the waste, will help the environment to reduce the landfill, reduce the energy consumption and decrease the pollution. Other than that reuse, reduce and recycle the waste also can help to cost savings by reducing the use the new resources. But unfortunately Malaysia do not practice well in waste management to handle the landfill. [5]

Nowadays, Malaysia is the developing country, in order to achieve vision 2020, Malaysia will has undergone a rapid development in any industry including construction industry. Therefore a lot of building and infrastructure will be erect. In another word, there will also have plenty of steel structure will be carried out, such as portal frame, space frame roof, lattice frame and others. During the process of erecting this steel structure, it will produce a lot of iron sand; it is a waste that can be reused. By reusing the iron sand for the concrete mixture might not be helping much in the environment, but they're also another study studying how to reduce the other type of waste, and many a little makes a difference.

## II. LITERATURE REVIEW

### A. Iron Sand

One of the challenges for the government is to reduce the waste material that is cause harmful to human being or environment from construction industry [13]. From the last decade, there are large demand of the building material

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industry and one of the building material is the concrete, one of the methods to reduce the waste material is by replacing the aggregate while manufacture the concrete [13]. The concrete has the ability to reuse the waste product, by replacing the aggregate with the industrial waste, and one of the industrial waste is the metal slag [13]. It is very important while choosing the type of aggregate, even the choices of aggregate can be industrial waste, but the characteristic of the waste product must not able to affect the durability and performance of the concrete.

The iron sand concrete mixture also known as heavyweight concrete, it is a high density concrete, which is the concrete have the density higher than 2600kg per meter cube [11]. Normally the concrete has the density of 2400 kg per meter cube, but the heavy weight concrete contains high density and having 5900 kg per meter cube, the maximum of the density of the iron sand, concrete can go to 8900 kegs per meter cube [11]. The high density of the concrete can be used for nuclear or medical radiation shielding, for example, radiation therapy units and also can be used for the ballast in offshore location, such as pipelines or similar structures [12].

#### *B. Physical properties of cement*

The properties of the cement can be categories in 4 few types, the reason to categories is to control the quality of the cement, and the quality of cement mostly depends on the chemical properties of the cement [3] [7].

First setting time is one of the properties of the Portland cement, there are some factor that will affect the time setting of cement which is the water content, proportion of the concrete, admixture added to the cement, a good property of the cement must not setting too fast or too slow [7]. The best time setting in concrete is 15 minutes after pour the concrete in the formwork system [7].

Besides that soundness of the Portland cement also is one of the factors, this is referring to the expansion of the cement. The concrete pour into the formwork system and maintain its volume, without any expansion [3] [7]. The reason will cause to the expansion is due to the chemical content in the cement, the lime, CaO and Magnesia, MgO contain in the cement will expand during the hydration process of cement[2]. A good cement property should not have major expanses, in other words, of the soundness is meant the stability of the concrete.

Next the fineness of the Portland cement mostly is influenced by the speed of the hydration of the concrete .The first seven days after the cement has set, the harden cement had shown the fineness of cement, the greater the fineness of cement, the stronger the cement obtain the strength [1] [4]. In other words the low fineness of harden cement will not long lasting and low strength. Therefore a good cement shall have a high fineness [4].

Lastly is the strength of the cement, the strength of the cement means the strength of the compression strength, tensile strength or flexural strength of the cement, the strength of the cement can be affected by the cement ratio, grading of the aggregate, curing conditions and others [14]. At most of the time the cement strength is good in compression strength and weak in tensile strength [4].

#### *C. Properties of Iron Sand*

Iron have the second great quantity in the world, in the iron contains hematite, magnetite, goethite and limonite, the main mineral in the iron is hematite, and its chemical formula is  $Fe_2O_3$ .

Iron is 8 times heavier than water, its density are 7.87, according to [3], it clearly state that the density of iron can reach 7800 kg/m<sup>3</sup>. When the iron attaches to the air, it will start to rust, the rust is the red powder on the surface of iron sand, in order to make the iron, stronger and less iron rusts produce, most of the time the manufacture will bine the iron with the carbon.

The iron also has high ductility, ductility is means that the electric current can flow through the iron easily, the iron melting point are 1535 Celsius [13]

### III. METHODOLOGY

#### *A. Introduction*

A few simple concrete tests were conducted at the site to investigate workability, strength of the concrete. For able to investigate the physical effect and performance of sea salt on the properties of concrete, two simple concrete tests will be conducted such as slump test and concrete cube test. Slump test is to determine the workability of iron sand concrete mixture. The concrete cube test of concrete cubes is to identify the change of compressive strength of sea salt concrete mixture. The following sections outline the materials and the test procedures by using different amount of iron sand added in the concrete.

#### *B. Iron Sand Concrete Mix Design*

In this study, the iron sand will be used to replace the fine aggregate, the percentage of iron sand will replace the fine aggregate are 5%, 10% and 15%. The slump test, compaction factor test and cube test will be carry out in order to obtain the information require to achieve the objective. The table 1 shows the weight of raw material for the test. The grade 15 concrete will be used to compare the different between with the iron sand concrete mixture, the normal grade 25 concrete which is shows in the table is not replace by any iron sand which is 0% replace of the fine aggregate. 1 meter cube of the concrete will have 2406 kg, and grade 15 concrete proportion are 1:2:4 with 0.6 water ratio, according to the cube test, it require 3 of 150mm x 150mm x 150mm of the iron sand concrete mixture for each percentage iron sand concrete cube, due to each concrete cube need to be test in day 7, day 14 and day 28, therefore there are total 9 iron sand concrete cube, each cube will have  $2406.15 \text{ kg} \times 0.15\text{m} \times 0.15\text{m} \times 0.15\text{m} = 8.12\text{kg}$ , it mean that the iron sand need to prepare for this project are  $(0.1 \text{ kg} + 0.2 \text{ kg} + 0.31 \text{ kg}) \times 3 = 1.83\text{kg}$ .

TABLE I  
MIX PROPORTION DESIGN

Percentage	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Iron Sand (kg)	Total (kg)
0%	2.03 kg	2.03 kg	4.06 kg	0 kg	8.12kg
5%	2.03 kg	1.93 kg	4.06 kg	0.406	8.526
10%	2.03 kg	1.83 kg	4.06 kg	0.812	8.932
15%	2.03 kg	1.72 kg	4.06 kg	1.218	9.338

IV. RESULTS AND DISCUSSION

A. Comparison of Compressive Strength

From the fig.1 shows that the compressive strength of the control mix is 15.54, and as mention in the early time, the fig.1 has indicate that the strength of the control mix concrete shall have around 15 N/mm<sup>2</sup> of the strength. The result from the compression test show are slightly better from what is expected, it means that the control mix has carry out in a proper way and the data obtain for compressive strength in these laboratory experiment are reliable and believable.

The reason of why of the occur are this happen is the most suitable content of iron sand added to the concrete are 5%, furthermore if the iron sand added more than 5%, the compressive strength of the concrete will start decreasing, during carrying out the laboratory experiment, when the iron sand added the iron sand actually act as a water retarded, the fresh concrete become very dry and low workability, therefore while casting the for the concrete cube, iron sand concrete mixture are hardly to compact and cause the concrete are not fully compacted, it will cause the concrete cube having the air void in the concrete and cause the concrete become weaker.

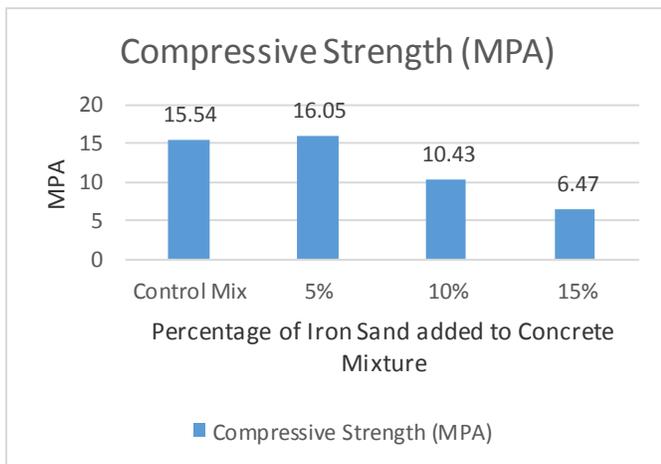


Fig.1 Comparison of Compression Strength between Different Ration of Iron Sand Concrete Mix Design

B. Comparison of Slump Values

From the fig.2, it show that the control mix have low workability which the slump drop until 20mm, but after added 5% of the iron sand to the fresh concrete, the fresh concrete become very low workability which is only 4mm of slump drop, the more iron sand added to the fresh concrete the lower the workability of the concrete are until 10% of the iron sand

is added, the slump did not have any collapse, which is 0mm and remain the shape of the mould, 15% of the iron sand added into the fresh concrete also have the same situation as 10% of iron sand added to the fresh concrete, It means that the workability of the fresh concrete are very low according which is the table to identify the workability of concrete from slump test. The reason is similar to the discussion for compression strength, the iron sand make the fresh concrete dry and cause the fresh concrete become hard and elastic.

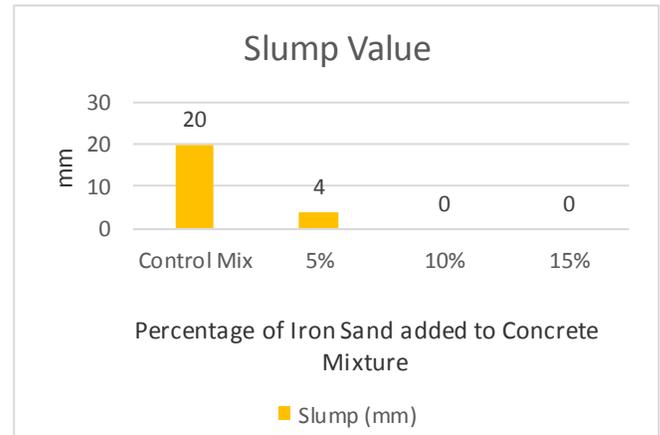


Fig.2 Comparison of the Slump Value

C. Comparison of Compaction factor values

From the fig.3, it shows that the comparison between different ration of iron sand added to the concrete mix design. There are similar to what happen in the slump test, the workability of the concrete are decreasing according to the more iron sand is added to the concrete, but it decrease dramatically in 5%, and subsequently it only slightly decrease. The iron sand concrete mix is become weaker after the iron sand is added to the fresh concrete, the compaction factor can be reach 0.70, if 15% of the concrete is added to the fresh concrete.

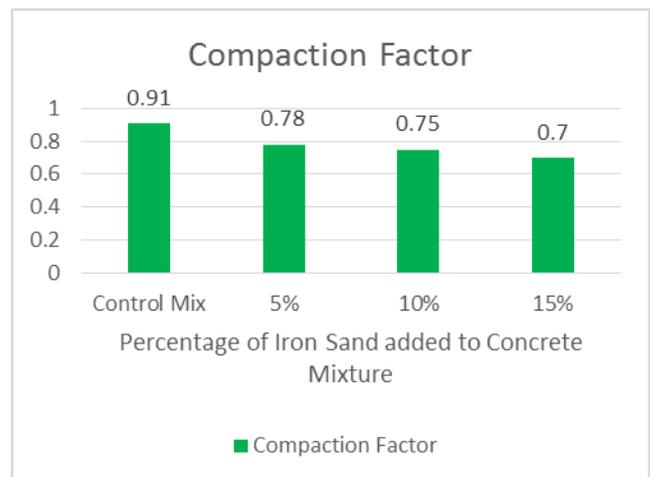


Fig.3: Comparison of the Compaction Factor

## V. CONCLUSION

According to the laboratory test of compression test, slump test and compaction test, the conclusion for the physical properties of iron sand concrete mixture can be made is the concrete will slightly increase its strength after 5% of the iron sand is added, but if the iron sand is continued to add after 5% of iron sand to the concrete, the concrete will become weaker and weaker due to the iron sand has acted as water repeller making the concrete difficult to compact and mix and cause the concrete has low workability. The low workability of the concrete has made the concrete weaker.

Effect of the iron sand to the concrete mixture as it has acted as water repeller to the concrete cube and made the fresh concrete harden and difficult to mix, it will cause the fresh concrete has the low workability properties. The concrete which has low workability will affect and decrease the strength of the concrete cube while carrying out the compressive strength. From the result of the slump test and compaction factor test, the conclusion can be made is the more iron sand added to the fresh concrete, the lower the workability of the concrete.

The suitable content of iron sand to be added as a concrete mixture can be categorized in 2 types, which is compressive strength or workability, it means that the purpose of adding the iron sand is to increase the compressive strength or increase the workability.

If the iron sand is added in purpose to increase compressive strength, the suitable iron content is 5%. From the laboratory test result, it shows that by adding the iron sand will slightly increase the compressive strength. In another case, if the iron sand is added for purpose to increase workability, the suitable content of adding iron sand is 0%, which means the fresh concrete are not suitable to add the iron sand as concrete admixture, because the iron sand will only make the fresh concrete become harder and difficult to mix.

In my opinion, the fresh concrete are not suitable to add any iron sand, which is 0% of iron sand added, because by adding 5% of iron sand will slightly increase the compressive strength but will seriously affect the workability of the fresh concrete.

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