FACTORS AFFECTING THE WORKABILITY OF CONCRETE INCORPORATING PFA

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Dedicated especially
to
my father,mother and siblings.

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ABSTRACT

Pulverized Fuel Ash or fly ash is industrial by product which can be very useful in the construction industries in Sarawak. In overseas, PFA have been used widely in concrete and also in other civil engineering field. By the researchs done in overseas, PFA is known as the admixtures that can improve the workability and strength of the concrete. Moreover, the water demand in concrete is decrease by the addition of PFA. However, in Sarawak PFA is a very new things and many research must be done before it can be used in the construction industries. The objective of the research is to define the characteristic of PFA which is produced by Sejingkat power station and its effect in concrete. Furthermore, from this research more researchs will be done to make the use of PFA in Sarawak to become a reality.

ABSTRAK

Pulverized Fuel Ash (PFA) atau *fly ash* adalah hasil sisa industri yang boleh menjadi produk yang berguna dalam sector pembinaan di Sarawak. Di luar negara *PFA* telah digunakan secara meluas dalam konkrit dan juga dalam sektor kejuruteraan awam yang lain. Melalui kajian-kajian yang dijalankan di luar Negara, *PFA* diketahui sebagai bahan tambahan yang boleh meningkatkan kebolehkerjaan dan kekuatan konkrit. Tambahan lagi, keperluan air di dalam konkrit boleh dikurangkan dengan penambahan *PFA*. Walau bagaimanapun, di Sarawak *PFA* adalah benda baru dan banyak kajian perlu dilakukan sebelum ianya boleh digunakan dalam sektor pembinaan. Objektif kajian adalah untuk mengenalpasti ciri-ciri *PFA* yang dikeluarkan dari Stesen Janakuasa Sejingkat dan kesannya ke atas konkrit. Tambahan lagi, melalui kajian ini, banyak lagi kajian-kajian lain akan dijalankan untuk menjadikan penggunaan *PFA* di Sarawak sebagai satu realiti.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The content of this thesis is mainly to describe the use of PFA (Pulverized Fuel Ash) in concrete and to test for workability. The report is present in few chapters which include introduction, literature review, research methodology, result and discussion and finally conclusion.

In chapter one which is introduction, the reader will know briefly about the objective of the research, PFA, and the importance of PFA to Sarawak construction industry.

In the chapter two which is Literature Review the reader will be bring more detail into the research. The PFA and its characteristic will be discussed through the chapter and also its roles in concrete workability, durability and also the comparison of PFA and some other concrete admixtures.

The experiment and laboratory work done in the research will be discussed in the chapter three which is the Research Methodology. Briefly, third chapter will explain on how the objective of the research can be obtained through the experiment and laboratory work done.

Chapter four which is result and discussion, include the result of the experiments done. Every results from the experiments present in tables and appropriate graphs and figures. With these tables and figures, it hopes to help the reader to understand more about the research.

Each result of the experiment will be discussed deeply and in more detail in the chapter five which is the discussion. The discussion were made from experience gained from the research and result of the experiment done. More figures will be shown to help the reader to understand more about the research and the characteristic of PFA.

In the last chapter, which is the conclusions, will discuss whether the objective of the research has been obtain or not. The objective whether PFA could be used in improving the concrete workability shall be included in the chapter.

1.2 Objective

The objective of the research is mainly to check the factors affecting workability of concrete incorporating PFA. This objective then can be divided into more small objectives by dividing it into the experiment that will be done which are:

- To investigate the paste consistency of cement plus PFA.
- To investigate the paste setting time of cement plus PFA.
- To study the workability of mortars with PFA using sand of different moisture content.
- To examine the effect of mortar workability due to different volumetric percentages of sand
- To find out the water requirement of mortar using PFA
- To find out the different in workability of Self Compacting Concrete(SCC) with Ordinary Portland Cement(OPC) concrete and OPC with PFA concrete.

From the objective it is easier to proceed with the experiment in the research as we know what experiment should be done.

1.4 Concrete with Pulverized Fuel Ash.

Construction work cannot be separated from the use of concrete. Wherever the construction work done there are always concrete being used. One of the main components of concrete is cement. When more concrete is needed it means more cements is used. That shows how much important the cement is in construction.

As a result of that we could find that the cement production is increased year by year. The production of cement involves using of raw materials. These means a lot of industrial waste will be produced. Thus, the environment is affected badly. How can we reduce the used of cement in making concrete? Changing certain amount of cement by other material is the answer. But from this answer we must answer the other question whether or not the material that we mix with cement in concrete production can achieve the required workability concrete.

Using PFA as the material that replace certain part of cement in concrete production is one of the objective of this research. Checking the characteristic of fresh concrete produced in term of it workability and compare it with the Ordinary Portland Cement (OPC) concrete is the main objective that hope to obtain.

Making concrete with PFA is not a new thing in the construction world. In Europe, many countries have applied this technology and it became a successful effort to reduce the use of cement. The properties of PFA varies accordingly to the type of coal used for burning. In Sarawak, PFA is a by-product of the Sejingkat Power Station. In this research, the experiments to make concrete with PFA will be done to check whether it is good or not to use Pulverized Fuel Ash in concrete making in context of Sarawak

Figure 1.1 Coal

The workability of OPC concrete is different with OPC plus PFA concrete. Comparing this workability of two different type of concrete and to find whether PFA improves concrete workability is the main objective of this research to be made.

From this comparison, we could know many things like the advantages and disadvantages of using PFA in concrete. The research may help the industry to reduce the cement usage in construction and also reduce the construction cost. It also

advantages to use PFA which is an industrial by-product, in making concrete and reduce its harmful effects on the environment. This will help whether it is good or not to use concrete with PFA in Sarawak.

There is a need to do research in this matter. The PFA characteristic is different accordingly to the place where the coal is mined. A research of using PFA that succeed in one place may not be similar in result in other place. Beside PFA, other concrete components like cement and aggregate also influent the concrete.

1.4 Pulverized Fuel Ash.

PFA which stand for Pulverized Fuel Ash is the industrial waste product that produced by electric power station. Coal that is used to generate the electricity produced a waste product which is called Fly Ash or PFA. This research is done to find the roles of Fly Ash in making concrete and the compare with that using the OPC.

Sejingkat Power Station is using coal to generate the electric power. The coal is brought to the station from Marudi. In one hour 60,000 tonnes of coal is used to generate electric power. 3,000 tonnes of PFA per hour is produced during the operation and the ash is collected by using Electrostatic Precipitation (ESP) machine in the station. However 10 percent of the ash cannot be collected by the equipment due to its fineness and released in the air. The PFA collected have three different sizes ranging from coarse to fine.

Figure 1.2 Sejingkat Power Station

The PFA are the industrial waste product and harmful to human. Immediate action need to be made to make sure that there will not be too many PFA around in the environment. The company that collected PFA from Sejingkat power station are trying to find ways to use back the PFA (Pulverized Fuel Ash) in the industry but not much positive results are found. At present, the PFA is treated by conveying it to the pond near the station.

In Kuching, the used of the PFA blended cement production is still in the infant phase. Cahaya Mata Sarawak Bhd, the main company that produced cement in Sarawak, is still making the research such cement are intended for Bakun hydro electric project. The use of PFA in massive concreting like dam has the advantage of reducing the heat of hydration. If the temperature of concrete is not properly controlled then cracked will be formed and this dangerous for the dam structure. Using PFA as the main component in concrete will become common in the future.

1.5 Summary.

The research objective hoped to develop more new alternatives for construction in Sarawak. Using PFA in construction had achieved successful result in other countries and hopefully we can use this technology too in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Ordinary Portland Cement and Pulverized Fuel Ash concrete.

There are different cementing materials usually used in concrete which is OPC only and OPC plus PFA concrete. OPC concrete is ordinary concrete that used in construction. The component of the OPC concrete is cement, fine aggregate, coarse aggregate and water. OPC plus PFA concrete is different in the component where part of cement is substitute with PFA. Other components which are fine aggregate, coarse aggregate and water is same with the ordinary concrete.

However, using PFA as the part of the component make some changes into the properties of the concrete itself. The properties of the concrete which is fresh properties and hardened properties will changes as the result of the adding of PFA in the concrete. Further, these different in properties of concrete; also influence the using of PFA or Fly Ash in the world of construction.

This research will cover the differences of OPC concrete PFA concrete in their workability. Several workability tests will be done to check the different of PFA concrete and OPC cement. The result of these tests will give us a rough indication of the use of PFA in construction.

2.2 Components of Concrete.

According to Dhir R.K. (1996), concrete generally can be described as the material that composed by cement, water, aggregate and the additional material known as admixtures. Cement which is the part of the concrete constituent is a chemically active but only react which the presence of water. Aggregate played the roles as the filler material with good resistance to any volume changes which happen within concrete after mixing.

OPC concrete differ with OPC plus PFA concrete in term of the concrete component. OPC concrete is composed from cement, water and aggregate, but OPC plus PFA concrete have also PFA as one of its components.