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Experimental study of fly ash density effect to the mortar compressive strength with recycled fine aggregate

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Abstract

Massive production of fly ash and recycled concrete aggregate from various sources such as industries, demolished buildings and so on has been seen as a threatening environmental waste from the conservative material engineering perspective. However, in recent years, the utilization of waste materials in mixed concrete have been turned upside down to become an alternative in producing eco-friendly construction materials. Therefore, this study is aimed to observe the mortar compressive strength that consists of cement, water, recycled fine aggregate and specifically fly ash whose amount is determined based on the packing density method. Several mixing variations are used to derive the correlation between fly ash density and mortar compressive strength. Three different fly ash percentages, which are 25% (loose), 35% (completely) and 45% (over) are used in the laboratory test with the variations of mixing ratios of 0.2, 0.35, and 0.5. The mortar under completely packaged condition delivers the highest compressive strength in any mixing ratio, which are found at 27.02 MPa, 30.26 MPa, and 32.15 MPa for respectively 0.2, 0.35 and 0.5 mixing ratio. Conclusively, this particular pattern indicates the suitability of packing density method usage as the basic to determine the optimum fly ash amount in mortar mixing.

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*Keywords:*Fly Ash; Recycled Concrete Aggregate; Packing Density; Compressive Strength; Mortar Mixing.

1. Introduction

Innovations in civil engineering field have developed quite significantly in recent years. These innovations are mostly contributed by material research developments which are the most interested area in green building concept.

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One of these developments leads to the use of fly ash in mortar as a substitute to a part of cementitious materials. The use of this material is expected to reduce the contributing wastes which are byproducts of coal power plants. Moreover, this material can be a better filler than common fine aggregates. This is due to the fact that it has a smaller particle sizes that averaged at 0.075 mm [1]

Although several concrete code like ACI (American Concrete Institute) and SNI (Indonesian National Standard) have provided the value of fly ash that can be added in concrete mix as pozzolan material which at 15%-25% [2], it doesn't govern the behavior of fly ash beyond these percentages. Considering the behavior of fly ash from the previous research [3], the fly ash would be considered as fine aggregate in mortar mix for this study.

Aside from the use of fly ash, reducing the waste material in constructions can also be achieved by using recycled fine aggregate in mortar mix. Although the use of these materials would likely to produce a significantly smaller compressive strength [4], it can be overcame with decent researches in this field. Recycled fine aggregate used in this study have particle size with the range 0.6 mm – 4.75 mm.

The objective of this study is to find an optimum percentage for fly ash in recycled aggregate concrete mortar mix and to observe the relation between packing density of mortar mix and its compressive strength. This percentage would be obtained by observing the relation between the packing density of mortar mix with the percentage of fly ash in that mortar mix. This relation is predicted to have a similar figure as seen in Fig. 1 [5]. With the increasing percentage of fly ash (filler aggregate), the packing density would increase until it reached an optimum point (point 3). The value of packing density would decrease beyond this point.

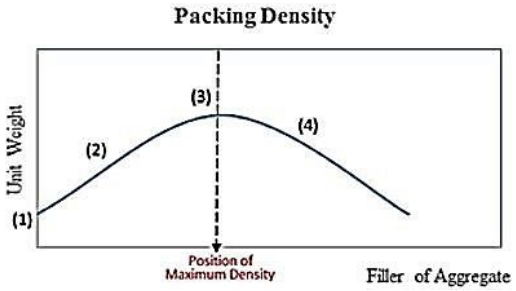

Fig. 1. Packing density prediction

2. Experimental

2.1. Packing density method

Mortar's mix packing density with a variety of fly ash percentage are tested to obtain the effect of fly ash percentage in the mix to its packing density. For each percentage of fly ash, the mortar's mix packing density is tested with the increments of 5 percent until it reached a few point beyond the optimum. It is compacted directly in a mold using a bar and rubber hammer. These result of present study can be seen in Fig. 2

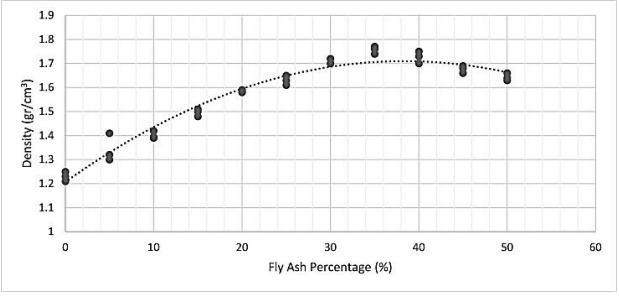

Fig. 2. Packing density testing