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THE EFFECT OF WASTE PAPER SLUDGE ASH (WPSA) AS CEMENTITIOUS MATERIAL TO THE PROPERTIES OF CONTROLLED LOW STRENGTH MATERIAL (CLSM) CONTAINING RECYCLED CONCRETE AGGREGATE (RCA)

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ABSTRACT

It is known that the construction industry, on a daily basis, uses quite a sum of natural resources to fulfil their occupational duties. Some examples to these resources are timber, cement, aggregate and water. Most of the aforementioned materials are non-renewable and may decrease in the near future. However, there is an alternative to ensure lower usage of natural resources and that is to reuse current waste as a construction material. Evidently, certain waste materials can be used to reduce the usage of cement altogether. Waste Paper Sludge Ash, or in short, WPSA, happens to be one of the industrial wastes that has been in demand as of late. Reason being, it can be used as a replacement for cement due to its considerable high amounts of alumino-siliceous materials. WPSA also helps in reducing several problems on disposal. This research presents the results of a parametric study on the Controlled Low Strength Material (CLSM) using WPSA from a mill plant named MNI Mentakab in the state area of Pahang. Prior to this research, it has been expected that WPSA can serve as a cementitious material substituting cement and thus reducing the exploration of natural resources. The CLSM properties that have been investigated are divided into two properties which are; plastic properties and hardened properties. In plastic properties, several tests were conducted and they are, the slump test, the flowability test, the time set, and the heat of hydration. Hardened properties on the other hand, conducted tests on the compressive test at the age 7, 14, 28, 56 and 90 days, the absorption rate and the porosity parameter. The CLSM mix was designed based on a previous study which uses a 1.3 water-cement ratio. These CLSM mixtures were casted into moulds with the size of 100 mm × 100 mm x 100 mm. Every ratio was prepared in 28 cubes with different WPSA and OPC percentages corresponding to the total of 336 specimens. The aims of this research are first, to evaluate the potential of WPSA as a cementitious material to produce CLSM containing RCA, then, to formulate an optimum mix proportion of CLSM containing WPSA as a replacement binder material and RCA, and finally, to analyse and assess the effects of WPSA to the CLSM properties containing RCA. It has been found that the best design mix that achieves all CLSM properties is on S3 which is WPSA reacts as a replacement binder material containing RCA.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

ACI 229R (2013) has defined Controlled Low Strength Material (CLSM) as a self-compacted and cementitious material used primarily as a backfill in places of compacted fill and was known as flowable fill, unshrinkable fill, flowable mortar, flowable fly ash, fly ash slurry, plastic soil-cement, and soil cement slurry.

ACI 116R (2000) classified CLSM as materials which have a compressive strength of 8.3 MPa or less. Most CLSM applications needed the unconfined compressive strength of 2.1 MPa and less for future excavations of CLSM in ACI 229 (1999). CLSM can also be formed as anticorrosion fills, thermal fills, and durable bases. Besides, CLSM cannot be considered as a low strength concrete but as a self-compacted backfill material that can be used in compacted fills. ACI 230.1R-09 (2009) claimed that no compaction is needed in CLSM due to its capability of self-compacting and no curing process is needed to achieve its strength.

There are some benefits of using CLSM in construction especially for backfills and compacted fills. CLSM is easy to place regardless of type and location of the void due to its properties as a self- levelling material. It may need a little or no compaction to fill the void which can speed up the construction time and reduce labour requirements on site. In addition, CLSM is a strong and durable material due to its load-carrying capacities which is higher than other compacted soils or granular fills. CLSM has shown to be less permeable thus it can resist erosion better than soil according to ACI 229 (1999).

CLSM is not prone to undergo settlement compared to the soil especially when it is not consolidated properly for example pavement which leads to the formation of cracks and dips on the road surface. This is due to CLSM properties since no void is formed during placement and settlement is not occurred under loading. This is due to compressive strength of CLSM in between 0.3 to 0.7 MPa that can be excavated for the future excavation when needed. This strength of CLSM is strong enough for most backfilling applications by ACI 229 (1999).