



# Mechanical properties of high strength concrete that replace cement partly by using fly ash and eggshell powder

Ashraf Teara<sup>\*</sup>, Doh Shu Ing

College of Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Kuantan, Pahang, Malaysia

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## ABSTRACT

Global warming, climate change and greenhouse gases all these phrases are becoming an essential and significant topic to talk about in media in recent moments. One of the main and most elements that effect is carbon dioxide (CO<sub>2</sub>). Cement factories are the third higher producers of (CO<sub>2</sub>) after fossil fuels and land-use change. Cement factories emit in the atmosphere roughly about 5–7% of the total volume. Reducing the cement amount in concrete mixing is being a big challenge for researchers by replacing it with materials that are considered friendly to the environment or as waste. Possibilities of using waste materials for high strength concrete are the main aim for this research and to reduce the cement amount in concrete. Making concrete by replacing cement with green materials have been affected positively in our environment. Fly ash (FA) and eggshell powder (ESP) is the waste elements are using in this research by replacing them partly with cement in concrete mix. The percentages of replacement by weight are 5% and 10% of eggshell powder and 20%, 30%, 40% and 50% of fly ash class F. Property of all concrete mixes are tested for fresh and dried samples. Slump test, compressive strength test, flexural strength test and ultrasonic pulse velocity (UPV) had been done to all samples after curing in water until the day of test. The best results were for two mixes. The mixes 5% ESP with 30% FA and 5% ESP with 40% FA got the highest results compared to other mixes. 58.9 MPa and 56 MPa are the results for compressive strength, respectively. Replacing cement with green materials is possible to make high strength concrete and reducing the use of cement up to 45% in weight.

## 1. Introduction

The consumption of cement to make concrete or other mixes include cement becomes higher every year which will lead to draining the natural resources and also producing CO<sub>2</sub> in the environment and that is one of the main reason of climate change or global warming (Andrew, 2018). In Malaysia, there are eight factories for cement productions, which can make roughly in total about 40.2 million metric tons for the second quarter of the year 2017 (MyCC and Report, 2018). Compare to worldwide, about 4.1 billion metric tons of cement had been produced in the same year (statista, 2017). The construction industry is depending on the high usage of concrete. The essential material to make concrete is cement; to make one ton of cement all most one ton of CO<sub>2</sub> will be generated during its production (Pliya and Cree, 2015). As a result, all the emissions emitted by cement factories will be harmful to our environment, which leads to the ozone layer become thinner, and that will negatively affect global warming. Reducing the amount of cement has come to be a massive challenge to scientists and researchers to limit the

emission of CO<sub>2</sub> in the atmosphere and save natural resources.

Management for solid waste in Malaysia is one of the most significant environmental issues; the primary disposal method is landfilling to manage this continuously increasing. Stable waste future still not sure if there are potentials for different methods or ways to control and to reduce this type of waste. The difficulties related to the controlling of solid waste are complicated caused by several aspects such as the quantity and structure of waste produced, fast growth of urban zones, finance matters, quick technical improvement, moreover, limited energy and raw resources (Moh, 2017).

Cement is being replaced partly by numbers of waste materials such as palm oil fuel ash (POFA), slag, rice husk ash (RHA), fly ash (FA), and eggshells powder (ESP). Replacing fly ash (FA) instead of cement had a limitation, which is less than 50% (Atiş, 2003). Because of adding more percentage of (FA) in concrete or mortar, the mix will be weaker and not fit the purpose of using them in construction applications. The reason for fly ash is giving weak concrete could be the leak of calcium oxide (CaO) in the chemical component, which lesser than cement has. Eggshells

<sup>\*</sup> Corresponding author.

E-mail addresses: [a.alamen@gmail.com](mailto:a.alamen@gmail.com) (A. Teara), [dohsi@ump.edu.my](mailto:dohsi@ump.edu.my) (D. Shu Ing).

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