UNIVERSITI TEKNOLOGI MARA

# FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAMS STRENGTHENED WITH TEXTILE FINE GRAINED MORTAR

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Thesis submitted in fulfillment
of the requirements for the degree of
**Doctor of Philosophy**
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# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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# ABSTRACT

Recently a new repair and retrofit method have been develop and used to extend the service lives of reinforced concrete (RC) structures. One of the most common reinforcement techniques for RC members involves the use of fibre reinforced polymer (FRP) composites. However, the disadvantage which mainly associated with the use of epoxy resins with high cost, poor performance in high temperature and on wet surface and incompatibility with substrate materials. In an attempt to alleviate the problem arising from the use of epoxies, this research have suggested the replacement with inorganic (mortar) matrix namely fine grained mortar (FGM). Therefore, textile fine grained mortar (TFGM) offers a new innovative technology to strengthen or repair concrete structures. TFGM is comprised of thin layered of FGM and textile reinforcement made of alkali glass resistant (AR glass). Less than 2 mm of mortar thickness is needed between the TFGM layers due to the small maximum grained size of fine sand that is 600 μm. The FGM was designed with three different mix cementitious materials (pozzolans) to determine the optimum compressive strength consisting of fly ash (FA), palm oil fuel ash (POFA) and rice husk ash (RHA) as cement replacement material. The replacement percentage consists of 10%, 20%, 30% and 40% of the weight of the cement. The binder to sand ratio also varies from 1:2, 1:2.5 and 1:3. Studies of using FA as a cement substitute in FGM have been reported by previous researchers. It has demonstrated that inclusion of FA in the FGM improved the strength of the resulted mortar. However, research on use of agriculture wastes namely POFA and RHA as FGM's cement replacement is still lacking. The optimum mix proportion of FGM made of three different pozzolans was selected as a FGM to form composite binder TFGM. Then, the fresh TFGM consisting of two, four, six and eight layers was applied to the surface of plain concrete prism which has no bar reinforcement with dimension of 100 mm x100 mm x 500 mm. Meanwhile, four and eight layers of TFGM have been selected to strengthen RC beams with beam dimensions of 150 mm x 200 mm x 2500 mm. In this research, the lamination method was used to strengthen the plain concrete prism and RC beams. The strengthened plain concrete prism was gone through three point bending test. While for the RC beam specimens were tested under four point bending testing. Finite element analysis using ATENA software was used to verify the experimental work. The result for the FGM mix proportion shows that replacement with 20% FA, 10% POFA and 20% RHA for binder to sand ratio of 1:2 produced an optimum compressive strength. The FGM was then selected and used as a strengthening binder for the plain concrete prism and RC beams. Strengthening with eight layers of TFGM containing POFA on the plain concrete prism increased the load carrying capacity of the latter about 36% compared to the unstrengthened specimen. While for the RC beams with eight layers TFGM containing POFA increased the load carrying capacity about 38% compared to the theoretical load of 30 kN. The load carrying capacity also increased by 33% compared to the unstrengthened specimen of 31 kN. Finally, the prediction of the ATENA software was examined and compared with the experimental results.

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