UNIVERSITI TEKNOLOGI MARA

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

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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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LIST OF SYMBOLS

Symbols

A	Cross section area of specimen
A_s	Area of steel reinforcement
A_t	Area of textile reinforcement
F_c	Force in concrete compression
F_s	Force in steel tension
F_t	Force in textile tension
g/m^2	Gram/square milimeter
ε_{max}	Maximum strain
δ	Mid-span deflection of a beam
Δ_u	Ultimate deflection at mid-span of a beam
Δ_y	Deflection of steel at yielding of steel reinforcement
Δ_{max}	Ultimate deflection at when the material or member yield
Δ_u	Ultimate deflection at mid-span of a beam
P	Load
R_c	Compressive strength (prism)
R_f	Flexural strength (prism)

LIST OF ABBREVIATIONS

Abbreviations

AH	Aluminium Hydroxide
Al_2O_3	Aluminium Hydroxide
ASTM	American Society for Testing and Materials
BET	Brunauer/Emmet/Teller Nitrogen Absorption Test
BS	British Standard
BS EN	Eurocode Standard
$CaCO_3$	Calcium Carbonate
CaO	Calcium Oxide
CFRP	Carbon Fibre Reinforced Polymer
DOE	Department of Environment
FA	Fly Ash
FGM	Fine Grained Mortar
FLA-5-11	Type of Strain Gauge for Reinforcement Bar
FLA-5-3	Type of Strain Gauge for Shear Link
FRP	Fibre Reinforced Polymer
K_2O	Potassium Oxide
LOI	Loss of Ignition
LVDT	Linear Variable Differential Transformer

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