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SUMMARY OF DOCTORAL THESIS

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Title: Evaluation of Using ECC and CFRP for Strengthening of Concrete Structures

コンクリート構造物補強にECCとCFRPを適用した場合の評価

The current thesis is a step towards better evaluation of the current condition of concrete structures as well as utilizing some modern materials for the purpose of repair and strengthening of the deteriorated structures. It is thought that this thesis could help in enhancing of the old and deteriorated structures as well as extending their life time to a further longer period. At the beginning, new approach for identifying the crack size and location in concrete members by utilizing readings from the ultrasonic pulse velocity (UPV) test was conducted. The new method was successfully able to identify artificial cracks created in concrete specimens having flat and arched soffit. Strengthening of concrete members was conducted by using combinations of the ductile engineered cementitious composites (ECC) alone or with the high modulus carbon fiber reinforced polymers (CFRP) sheets. First, beams in sound and cracked conditions were repaired using ECC. It was noticed that ECC was capable to bridge the forces in between the gap of the crack. It was also noticed the enhancement in concrete strength and ductility was proportionally increased with the increase in ECC depth. CFRP was also pasted over ECC substrates and the induced shear stresses was observed; it was observed that the bonding between ECC and CFRP was much better that of concrete and CFRP. This suggested the use of thin ECC layer to replace the inferior layer in concrete beams before strengthening with CFRP. It was noticed that the undesirable interfacial debonding mode of failure was avoided or delayed. The study was also extended to use CFRP for strengthening of scaled down arched specimens similar to those used in Egypt. The study showed enhancement in both sectional loading capacity and ductility. Soffit strengthening was better in achieving high loading capacity while sides' strengthening was better in achieving high ductility. Combination between using both soffit and sides' strengthening was capable to achieve both high section capacity and ductility at the same time. Finally, the thesis ended up with strengthening of rectangular columns containing grooves with CFRP. The columns loading capacity and ductility were enhanced. New expression for predicting the ultimate loading capacity of grooved columns was also suggested. The overall conclusion of the thesis was therefore, the ability to repair and strengthen different structural concrete members was successfully done using combinations of ECC and CFRP.