Finite Element Analysis of R.C. Arches with Openings Strengthened by CFRP Laminates

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ABSTRACT

The main objective of this research is to present an analytical study to investigate the behavior and performance of reinforced concrete arches with and without openings , un-strengthened and strengthened (externally by CFRP laminates or internally by steel reinforcement and comparison with experimental results. Twelve tested reinforced concrete semi-circular arches with and without web openings were analyzed with cross-section of (150*250mm) and inner diameter (1500mm) and outer diameter (2000mm).The variables considered in this research included: curvature forces , location of opening through profile of arch, and type of strengthening.

ANSYS computer program (version 11, 2007) was performed throughout this study. Full bond was assumed between the CFRP and concrete and between steel reinforcement and concrete. Brick elements SOLID 65 and SOLID 45 was used to represent concrete element and steel plate, respectively. While LINK8 and SHELL 41 were used to represent steel reinforcement and CFRP laminates, respectively. In general, a good agreement between the finite element and experimental results has been obtained concerning load – deflection response and mode of failure , where cracking and ultimate loads with average difference about 5.83% and 3.92%,respectively.

REFERENCES

[1] M.A. Mansour "Design of Reinforced Concrete Beams with Web Openings" , *Proceeding of the 6th Asia-Pacific Structural Engineering and Construction Conference*, Kula Lambur, Malaysia 5-6 September (2006).

[2] K.H. Tan and M.A. Mansour *"Design Procedure for Reinforced Concrete Beams with Large Web Openings"*, ACI Structural Journal, Vol.93,No.3, (1996).

[3] ACI Committee 440, *"Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening of Concrete Structures",* Michigan, USA, (2002).