

Behavior of Arch Slabs Reinforced with FRP Bars under Concentrated Loads

Hind Salim Hamed Al-Shukeili

Abstract

Steel corrosion is a substantial problem in reinforced concrete structures located in wet areas. It may lead to structures deterioration and it needs high maintenance cost. The recommended alternative material of steel is Fiber Reinforced Polymer (FRP) reinforcement. FRP materials have been examined in many researches as rehabilitation materials for existing structures and as main reinforcement materials in some new structures like beams and columns. This research focuses on using FRP bars as reinforcing material in arch slabs. Six specimens have been constructed with 0.5m width, 0.975m maximum height, and 3.92m span. The thickness of the arch slabs varied from 100 mm at the middle to 175 mm at the ends. Test parameters included: type of reinforcing bars (Steel, Glass FRP, and Carbon FRP bars), reinforcement ratio (0.63%, 0.95% and 1.27%) and reinforcement configuration with hybrid reinforcement (top steel bars and bottom GFRP bars). All arches were pin supported at both ends and were tested using two concentrated loads. Measurements included cracking behavior, mode of failure, ultimate capacity, deflection and strains.

All tested arches showed good capacity ranges between 154kN and more than 250kN. The ultimate capacity of the steel-RC arch was slightly higher (16%) than the ultimate capacity of the GFRP-RC arch with the same reinforcement ratio, whereas the CFRP-RC arch had higher capacity (more than 8%) compared to the steel-RC arch. It was also found that increasing the GFRP reinforcement ratio from 0.63% to 0.95% and 1.27% enhanced the ultimate capacity of the GFRP-RC arches by 26% and 61%, respectively. Furthermore, the hybrid arch reinforced with steel bars at the top layer and GFRP bars at the bottom layer showed a slight improve in the ultimate capacity compared to the corresponding arch reinforced totally with GFRP bars. In conclusion, GFRP and CFRP bars are recommended to be used as reinforcing material in arch slabs in corrosive areas as they showed comparable behavior to steel-RC arches. In addition, GFRP bars can be used at bottom layer of RC arch slab (as it is more exposed to moisture) and steel bars at the top layer to get higher capacity.