The usage of fibers in concrete segmental tunnels has led to considerable structural and durability improvements. In seismic regions, structures are designed to resist earthquake effects and maintain their functionality. Therefore, it is necessary to specifically study the structural behavior and response of Fiber Reinforced Concrete (FRC) segmental tunnels for their reliable implementation in seismically active zones. Recent research efforts in this regard show the favorable performance of FRC under earthquake loadings. Yet, further research is required to better understand the various aspects of FRC segmental tunnel performance under seismic loading and develop a seismic design framework.

Keywords: Fiber reinforced concrete; Segmental tunnel; Seismic performance
performance, a hybrid SFRC mix containing both micro and macro fibers, with a higher content of microfibers over macro ones, is a technically preferable option for the design of segmental lining tunnels in seismic zones.

In another study by Jamshidi Avanaki et al. [22], the performance of segmental joints, i.e. the joints connecting to adjacent segments in a ring, under seismic loads was studied. The results showed that the SFRC mixes enhance the seismic performance of the joint compared to plain concrete (no rebar) or traditionally reinforced (with rebar) concrete. Finally, equations were proposed to estimate the joint’s moment demand/capacity ratio and rotational ductility for seismic design. In an experimental study by Xin et al. [23], a series of shaking table tests was conducted using scaled tunnel specimens with plain concrete, steel reinforced concrete and polypropylene FRC under increasing seismic intensities loadings. Their results displayed the advantageous behavior of the polypropylene fiber to change the brittle behavior of plain concrete, change the damage patterns of reinforced concrete with rebar, reduction in the number of initial micro cracks, postpone the appearance of new cracks, prevent the propagation of macro cracks and relieve the stress concentration at the ends of fibers.

In an effort to facilitate the seismic design of SFRC segmental tunnels, Jamshidi Avanaki [24] investigated the seismic ductility properties of such tunnels and derived R-factors for their seismic design.

Conclusion

The advantageous aspects of incorporating fibers in full or partial replacement of conventional rebar have been proven in many previous research efforts. Research conducted so far is focused on normal loading scenarios experienced in the lifespan of a tunnel. Yet, tunnels located in seismically active regions should be capable to perform in a favorable manner under earthquake effects. The seismic performance of FRC tunnels is a subject which despite recent efforts, requires much further research and investigation to ensure a safe and feasible design.

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