Due to increased traffic volumes, demand for heavier semi-freight loads, deterioration from corrosion or components fatigue and even pavement widening, the deck system of movable bridge requires periodic rehabilitation or replacement. Several alternative deck replacement systems such as adhesively-bonded pultruded fiber reinforced polymer (FRP) deck system, aluminum extrusions deck system were proposed and investigated previously. However, some concerns like shear strength estimation for economic design and heavy self-weight of the system remained. A potential solution is to use ultra-high performance concrete (UHPC) in passively-reinforced beams without any shear reinforcement to bring down the self-weight of the deck significantly as well as increase the system strength. To accurately estimate shear strength of UHPC, each of the shear contribution components such as aggregate interlocking, concrete in compression zone and dowel action, need to be taken into consideration individually. In addition, the serviceability check is of important for both live load deflection as well as the fatigue behavior under moving loads. Finally, a 17 psf high strength steel (HSS) reinforced deck system is considered as qualified system suggested by Florida Department of Transportation (FDOT). Hence, in current dissertation, three main issues will be proposed and discussed. The first one is to identify appropriate dowel action contribution to shear resistance to adequately capture the strength behavior of UHPC related structure while respecting the tents of future economic and safe designs. The second one is to investigate the tensile fatigue influence on UHPC component and estimate the number of cycles upon failure based on different level of loading. The last one is to check the serviceability issues for both “UHPC-HSS” system and “UHPC-CFRP” system which include but not limited to strength, deflection, crack widths, reinforcing bar strength attribution ratio and shear reduction factor.