Finite element simulation for steel tubular members strengthened with FRP under compression

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Tubular steel sections are widespread all over the world because of their strength and aesthetic appearance. Tubular steel members may exhibit local buckling such as elephant foot or overall buckling under extreme compression load. Recently, external bonding of fiber reinforced polymers (FRP) sheets for strengthening these members has been explored through experimental research. This paper presents three-dimensional nonlinear finite element analysis (FEA) to investigate the structural behavior of strengthening tubular steel members with FRP against local and overall buckling phenomena. Out-of-roundness and out-of-straightness imperfections were introduced to the numerical models to simulate the elephant foot and overall buckling, respectively. The nonlinear analysis preferences such as the integration scheme of the shell elements, the algorithm for solution of nonlinear equations, the loading procedure, the bisection limits for the load increments, and the convergence criteria were set, appropriately enough, to successfully track the sophisticated buckling deformations. The agreement between the results of both the presented FEA and the experimental research was evident. The FEA results demonstrated the power of the presented rigorous FEA in monitoring the plastic strain distribution and the buckling phenomena (initiation and propagation). Consequently, the buckling process was interpreted for each mode (elephant foot and overall) into three sequential stages. Furthermore, the influence of FRP layers on the nonlinear analysis preferences and the results was presented.