In this study, novel type shot peening applications such as severe shot peening (SSP) and dual step peening - DSP- (severe shot peening followed by re-peening -RP-) have been applied to AISI 4340 railway axle steel. Microstructural and mechanical properties are compared with conventionally shot peened (CSP) ones. The new treatments influence thicker surface layer and improve mechanical properties (microhardness and fatigue) by the way of Almen intensity enhancement. Disadvantageously, SSP increase surface roughness to the values that can be hazardous to the expected fatigue life of critical machine parts. However, DSP reduces the values and new approaches could be designed for making surface roughness values comparable with CSP in the aspect of the experimental outputs.