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(57) Abstract :

A system and method for wear and fatigue resistance in a railway rail structure (1) is disclosed. The rail structure (1) comprises a high wear resistance hardened outer layer (10), a ductile transition layer (20), and a tough inner core layer (30), metallurgically bonded to form a multilayer configuration. The outer layer (10) provides high resistance to abrasive and adhesive wear, the ductile transition layer (20) introduces compressive residual stresses to retard crack initiation and propagation, and the inner core layer (30) delivers high fracture toughness and structural strength. The layers (10, 20, 30) are produced using differential heat treatment, surface quenching and tempering, laser cladding, additive bonding, or hot rolling. The structure (1) achieves reduced rolling contact fatigue, lower crack growth rate, decreased rail wear, and reduced maintenance under high-speed and heavy axle load operating conditions.

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