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# Investigation of fatigue behavior for UIC coupling system: conception of predictive maintenance model

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Most freight trains use a pneumatic braking system that does not ensure synchronised braking between different wagons. This lack of synchronisation results in significant in-train forces during emergency braking, which is sometimes triggered by the railway infrastructure when certain speed thresholds are exceeded. The magnitude of these forces depends on several factors, including train length, mass, load distribution and the specific braking operation being performed, e.g. after acceleration or from coasting conditions. Excessive compressive in-train forces can lead to wagon derailment, particularly when light wagons are travelling through curves with small radii. Conversely, excessive tensile forces can compromise the integrity of the coupling system, leading to premature fatigue failures, interrupting train service and requiring the recovery of separated train sections. In the light of the above framework, and to increase the applicability of the results, this study carries out an investigation of the fatigue behaviour for the International Union of Railways (UIC) unified coupling system, using load spectra generated by the UIC TrainDy software. The calculated trains are statistically generated and have the same mass and length in order to provide a significant variability for the load spectra used by the finite element analysis. The aim is to develop a maintenance model that is capable of predicting the extent of damage to the screw couplings of freight wagons during their service life. Based on a systematic and automated analysis of realistic load cycles, the model will allow the optimisation of maintenance strategies and, at the same time, the improvement of railway efficiency.

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