

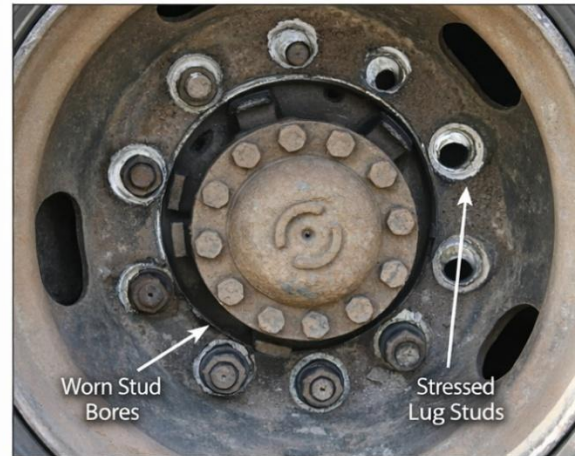
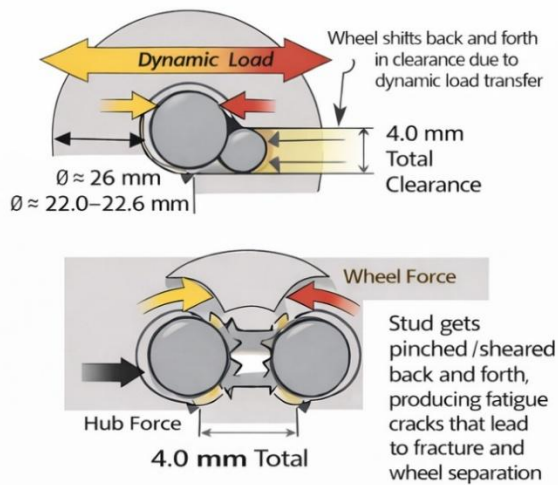


Figure 4 — Dynamic Clearance Activation and Stud Fatigue Mechanism

When clamp load decays below the friction threshold of the joint, the intentional clearance between wheel stud bores ($\approx 26 \text{ mm ID}$) and lug studs ($\approx 22.0-22.6 \text{ mm OD}$) becomes mechanically active. Under dynamic loading, the wheel may shift within this clearance until the stud contacts alternating sides of the bore. This produces repeated shear loading and bending stresses in the stud. Over repeated loading cycles, this motion can produce fatigue cracking and eventual stud fracture, which may lead to fastener loss and wheel separation. →

Figure 4 — Dynamic Clearance Activation and Stud Fatigue Mechanism

Figure 5 — Clearance-Activated Scissor-Shear Failure Mode.

After clamp-load decay and lug-nut loosening reduce frictional restraint in the joint, the wheel may shift under dynamic vehicle loads within the intentional clearance between the stud outer diameter ($\approx 22-22.6 \text{ mm}$) and the wheel bolt-hole inner diameter ($\approx 26 \text{ mm}$). This movement produces cyclic stud loading and scissor-like shear stresses that can lead to stud fatigue fracture and eventual wheel separation.

