



BONAXLE® | product specification

BONAXLE® is our innovative solution that enhances safety, service life and reliability while significantly reducing life cycle costs (LCC). It has the potential to drive a paradigm shift in railways across Europe and beyond. GHH-BONATRANS has advanced the already well established in Japanese technology by adapting it to European conventional geometries and steel grades. This innovative technology increases strength of all types of axles along their entire length without altering their geometry or steel composition.

Key features

- Enhanced safety with lower life cycle costs (LCC) and carbon footprint
- Extended non-destructive testing (NDT) intervals due to higher resistance to crack initiation
- Impact resistance prevents axle damage during operation
- No seizures during maintenance operations - assembly and disassembly of wheels, wheel centers, gears, brake discs, and bearings
- Enables older platforms to comply with current safety requirements

Seizure prevention

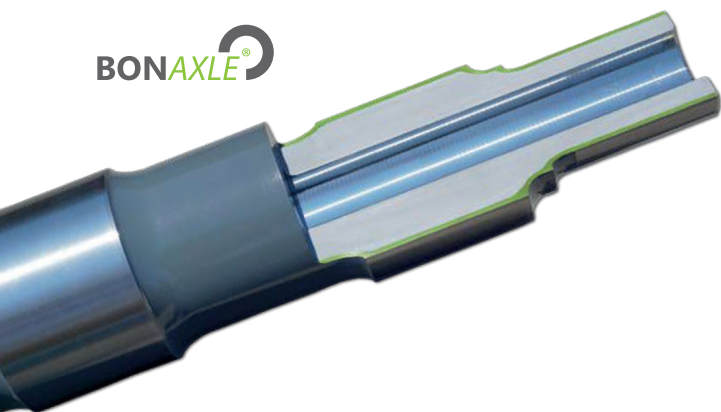
The homogenous hardened layer, with hardness of approximately 490 HV30, reaches to approximately 6 mm below the axle surface. Its high hardness, along with high yield and tensile strengths, prevents seizures during wheel assembly and disassembly (the same applies to other axles seats and surfaces).

Resistance to crack initiation and propagation

The axle has proven resistance to ballast impacts, as confirmed by testing. Crack propagation tests have shown that it is virtually impossible for cracks to propagate in induction-hardened axles. While cracks typically propagate at the stress of 100 MPa in common axles, **BONAXLE®** can withstand up to 300 MPa without any crack propagation. Even with an artificial notch in a critical position, the **BONAXLE®** fatigue strength still exceeds the EN 13261 requirements for an axle without a notch.

LCC reduction

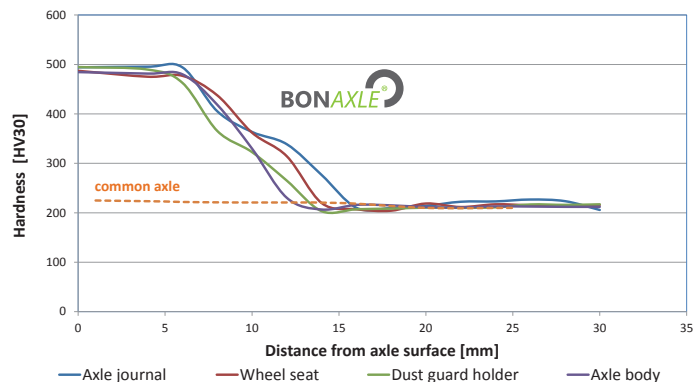
Thanks to high safety margins, service intervals – particularly for NDT for crack detection – can be extended and synchronized with maintenance schedules for other wheelset and bogie components. This significantly reduces life cycle costs (LCC). In addition, **BONAXLE®** eliminates the need for costly thick-layer coatings, protective casings, or repairs to damaged coatings.



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BONAXLE® is manufactured in full compliance with EN 13261.

In addition, the entire length of the axle, including all diameters and transitional sections, undergoes surface induction hardening. It has been fully validated for EA4T, EA1N, and EA1T steel grades.



Axle for the entire service life of rolling stock

The fatigue limit is several times higher than that of a common axle. Despite increased surface hardness, the notch sensitivity remains unchanged, with the q parameter meeting the requirements for the common (EA4T) steel.

| EN 13261 | R_{fL} [MPa] | R_{fE} [MPa] | $q = R_{fL}/R_{fE}$ [-] | R_e [MPa] | R_m [MPa] |
|-----------------|----------------|----------------|-------------------------|-------------|-------------|
| Required | ≥ 350 | ≥ 215 | ≤ 1.63 | ≥ 420 | 650-800 |
| BONAXLE® | 660 | 420 | 1.57 | 852 | 1,563 |

The fatigue limit of **BONAXLE®** has been significantly enhanced, increasing from 240 MPa for a common EA4T axle to 450 MPa or higher:

| EN 13261 | Local stress [MPa] | Nominal stress – F1 [MPa] | Stress in joint area – F3, F4 [MPa] | Number of cycles |
|-----------------|--------------------|---------------------------|-------------------------------------|------------------|
| Required | - | ≥ 240 | $> 145 - F3$ $> 132 - F4$ | 10,000,000 |
| BONAXLE® | 410 | 352 (+46%) | 235 (+78%) | 10,000,000 |
| | 450 | 416 (+74%) | 274 (+88%) | 10,000,000 |