BORETEST

Automatic Ultrasonic Inspection System For The Inspection Of Hollow Train Axles
Axles, like the wheels are critical structural elements on all trains but especially on high speed trains. Therefore, the quality standards and international standards applied require rigorous periodic implementation to ensure quality control.
OBJECTIVES

Replace manual procedures and provide an automated system based on quality control using ultrasound, which can be verified with the greatest reliability and analyse the structural state of the shaft, thus preventing possible in service failures and their consequences.
AXLES

The structural complexity of the shafts

2 basic types:

- Motor Axle

- Trailer axle
AXLES

Tecnical Data of the Motor Axle:
• Maximum Static load 17t
• Bend force from the Wheel 136 kN
• Lateral force (cornering) 58 kN
• Maximum running speed 350 km/h
• Ambiente temperatura -30º C hasta +50º C
• Weight without additional elements 1.306 kg aprox.
• Weight with added elements (with gearing) 1.626 kg aprox.

Tecnical Data of the Trailer Axle:
• Maximum Static load 17t
• Bend force from the Wheel 131 kN
• Lateral force (cornering) 50 kN
• Maximum running speed 350 km/h
• Ambiente temperatura -30º C hasta +50º C
• Weight 927 kg aprox.
• Weight with the brake discs attached 1.343 kg aprox.
AXLES

- Both types of shaft are exposed to possible damage from impact, load, material fatigue stress in the areas of the fillets, etc.
Acoustic velocity is generally a constant characteristic for each given material (dependent on the properties of the medium), independent of frequency or wavelength (although it could be affected by pressure and temperature, especially in liquids and gases).

**Velocity of Longitudinal Waves:**

\[
v = \sqrt{\frac{E}{\rho} \frac{1-\mu}{(1+\mu)(1-2\mu)}}
\]

- \( E \) = Young's Modulus (linear elasticity module)
- \( \rho \) = Density
- Poisson's Coefficient = \( \frac{1-\mu}{(1+\mu)(1-2\mu)} \)
  (ratio between lateral and axial strains)

Lead (Pb): 2160 m/s  Aluminium: 6320 m/s

**Velocity of Transversal Waves:** \( V_t \approx \frac{1}{2} V_L \)

Transverse waves have shorter wavelengths than the longitudinal at the same frequency, and therefore have greater sensitivity to small reflectors.
ULTRASONIC INSPECTION

- Using oil as a coupling medium (less dense than water but more viscous), the inspection is carried out in one pass, with up to 10 x 4 MHz transducers grouped in an Ogive:

Of these, 8 are angle transducers of 45°, 70°, 38°, 39.4° (oriented in 4 different directions). The objective is to detect both longitudinal and transverse defects in the external surface of the axle.

- Generating transverse or shear waves at about 3280 m/s (shear waves do not propagate in liquids or gases)
INSPECCION POR ULTRASONIDOS

2 transducers of 0°. Detect defects in the volumen of the axle and continuously monitors the coupling between the Ogive and the axle.

- Generates longitudinal or compression waves in the material at 5920 m/s.
SYSTEM CHARACTERISTICS

- Access to the system is controlled by a user name and password, allowing different levels of access:
  - Operator, Inspector, Supervisor, Maintenance, etc.:

- The status of the main parts of the machine are visible at all times:
SYSTEM CHARACTERISTICS

There is also a screen that shows the status of the whole machine (Easy Maintenance)
SYSTEM CHARACTERISTICS

- A programmable system of maintenance is also provided, with a record of use and maintenance.

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SYSTEM CHARACTERISTICS

- To define new axle profiles is both easy and intuitive.
SYSTEM CHARACTERISTICS

- Real time visualization of the Ogive within the axle:

- C-Scan information of any anomaly that occurs during the inspection, color indicates transducer.
SYSTEM CHARACTERISTICS

- Real time visualization of the A Scan of each transducer during the inspection
SYSTEM CHARACTERISTICS

- It is possible to filter out geometric anomalies (Fillets) and automatic numbering of the defects that have been encountered.
SYSTEM CHARACTERISTICS

- There is a complete system provided for the train fleet management
SYSTEM CHARACTERISTICS

- All stored data from previous inspection is easily accessible for comparison and reporting:
SYSTEM BENEFITS

- **Portable and robust**: A compact, rugged system and a standard battery operated pallet truck allow easy movement.
- **Autonomy (UPS)**: More than 30 mins of battery in case of power cuts.
- **Rapid**: Inspecting 100% of the axle from one side of the train.
- **Versatile**: Adaptable to different type of axles.
- **Precise**: Covers all geometry of the axle by probes of different angles.
- **Data Analysis and Reporting**: Generates various kinds of reports, which can be analyzed in real time during inspection and automatically stored in a database for further analysis and reporting.
- **Easy to use**: Easy calibration of the Ultrasonic system, with a minimum of learning.
- **Customized Design**: To meet the requirements of the customer or local regulations, the mechanic, electronic and software are easily adaptable.
- **Standards**: Complies with both National and International Standards, for example, the Deusche Bahn.
THANKS FOR YOUR ATTENTION!

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