Grain Car Axle Failure Analysis

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Overview

- Description of broken axle
- Non-destructive testing of axle
- Axle failure mechanism
- Cause of the axle failure
Fractured Axle

Mating fracture surfaces

Internal void
Non-Destructive Testing of the Axle

- Wheel Seat Location
- Internal void
- Additional void indication
- Additional void indications

- 3.5 - 4.25”
- 13”
- 1.5”
- 2.25 - 3.25”
- 2.75”
- 1.5” (10%)
- 5”
Axle Fracture Surface

- Two distinct fracture regimes
  - Fatigue
  - Overstress
- Crack propagation from inside void to outside
- Heavy batter and post-fracture damage
Formation of Internal Voids

Mold Side View

Mold Top View

Liquid cooling

Freezing starts

Freezing finishes

Solidification

Solid cooling

Temperature vs. Time
Formation of Internal Voids

Steel ingot

Casting voids

Steel axle

Void in axle
Summary

• The wheelset axle fractured from fatigue
  • Crack initiated at an internal solidification void
  • Crack propagated toward outside surface of axle
• Void was created during initial ingot casting
• Proper ultrasonic testing should have detected void
  • Performed at manufacture
  • Performed at rework