Decreasing Bolt and Bearing Failures on Process Rolls

For Vibration Institute
Piedmont Chapter

Ken Singleton
Bob Bracher
Outline

1. Background

2. Review of Roll-Shaft Reliability Problem Areas

3. Detection
   - Vibration
   - Modal Analysis
   - Rotor Modeling
   - Bump Testing

4. Correction

5. Results of the reliability efforts.
The focus of this case study was the Failures of Shaft-Roll Bearings and Bolts of shaft-roll assemblies in a fiber manufacturing plant.

The project was initiated because bolt and bearing failure rates were considered too high and the unexpected failures were having a major impact on plant production and reliability of the operating equipment.

A review was made to identify the root cause of the bearing and bolting failures.
Shaft Roll Reliability Problem Areas

1. Bolts & Joint Integrity
Bolts & Joint Integrity

The rolls were bolted to the end of the shafts using 16 - 1 ¼ inch SOHC Bolts.

Analysis of bolt failures indicated cyclic fatigue failures were the most common.

This bolting failure allowed the roll to drop off the shaft during operation.
Bolts & Joint Integrity

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12 of the 16 1 ¼” Socket Head Bolts failed at the head.

It appeared that bolt 16 failed 1st, then bolts 13 & 14.

Bolts 3 thru 8 failed last.

Note fretting damage on the shaft face. Fretting was often observed on the shaft and roll mating faces indicating extended operation with a loose joint allowing relative motion.
Bolts & Joint Integrity

This bolt failed at the surface of the shaft. Note loss of shaft material around the tapped hole indicating cyclic loading.

The mating surfaces of the shaft and roll were designed to be clamped by 16 1 ¼ bolts preloaded to about 120,000 lbs each. The design clamping force calculated to 1,920,000 lbs.

Fretting corrosion and bolt failure in fatigue indicated that the bolts were not seeing the design loading.

Contributors to Failure: Shallow tapped holes in the shafts Incorrect thread lube Failure to use a lubricant Inadequate torque Rough machined clamping surfaces
The shaft failed in cyclic fatigue in bending.

The stress riser was caused by a sharp machined corner on the shaft OD.
Bolts & Joint Integrity

Nine bolts failed on this shaft-roll.
Bolts & Joint Integrity

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  - Using various torque values
  - Use and non-use of anti-seize on bolt threads and under the heads
  - Bolt binding due to hole location inaccuracy and hole angularity error (machining errors).
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The inside surface of roll ends, which a bearing plate clamped, was often very rough.

The bearing plate mating surface had approximately 125 to 250 rms finish. A 32 finish was called out on the drawing.

Compression of the material in the high tool mark ridges during normal operation could be a contributor to the bolted joint loosening.
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- Many shaft bolt holes were tapped too shallow which caused the bolts to bottom, preventing adequate clamping of the joint and stretching of the bolt thus causing bolt fatigue failure.
In this case of a loose roll, the bolt threads were deformed the last 1/2 \( \text{``} \) indicating the holes were not tapped deep enough with fully formed threads.

The **lack of design preloading** of the bolt resulted in insufficient joint clamping force.
Shaft Roll Reliability Problem Areas

1. Bolts & Joint Integrity
2. Bearings