CATEGORY: JOURNAL BREAKAGE

TYPE: BENDING FAILURE

AFFECTS: WORK ROLL AND BACK UP ROLL

CHARACTERISTICS

Journal failure by bending can be identified by a full cross sectional fracture that is typically at a tangent to the rolls axis. The journal fracture is typically located at the journal to barrel face radius and may extend into the end of the barrel.

EXAMPLE

Example 1
Journal failure of a back up roll due to excessive bending stress. Failure initiated at the barrel to journal radius and then propagated instantaneously across the barrel diameter.

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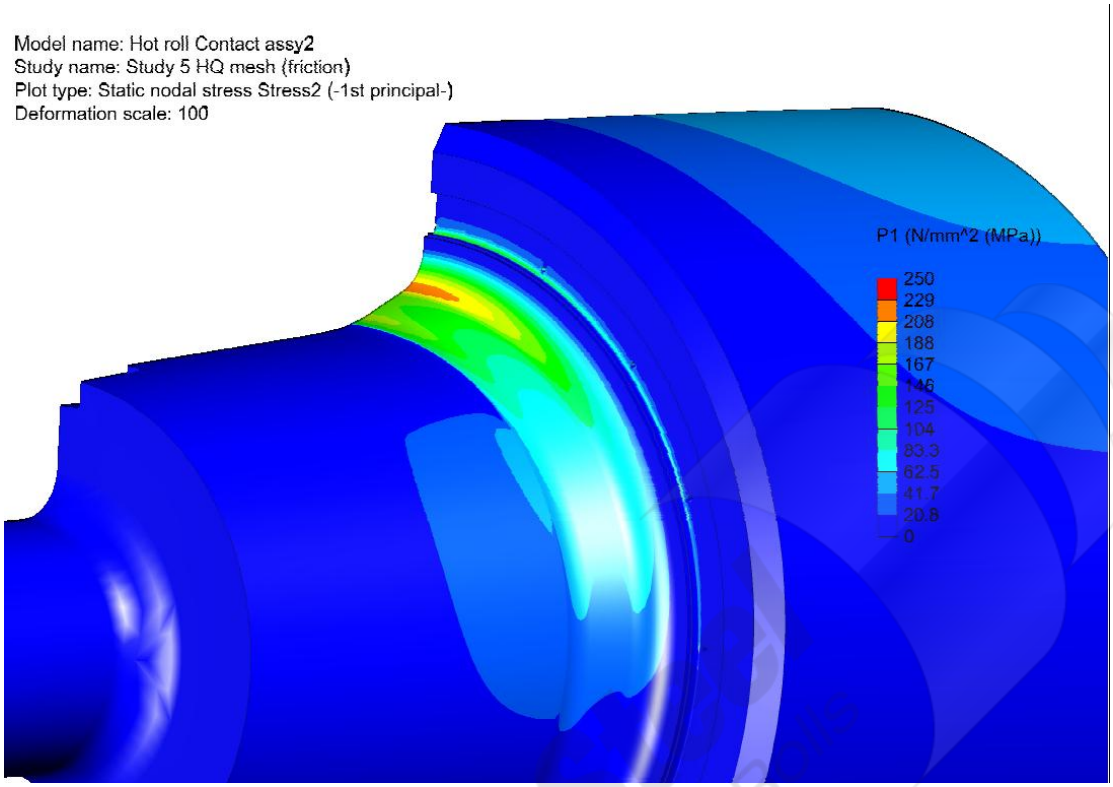

FEA plots showing a typical example for the location and depth of peak bending stress developed in a back up roll

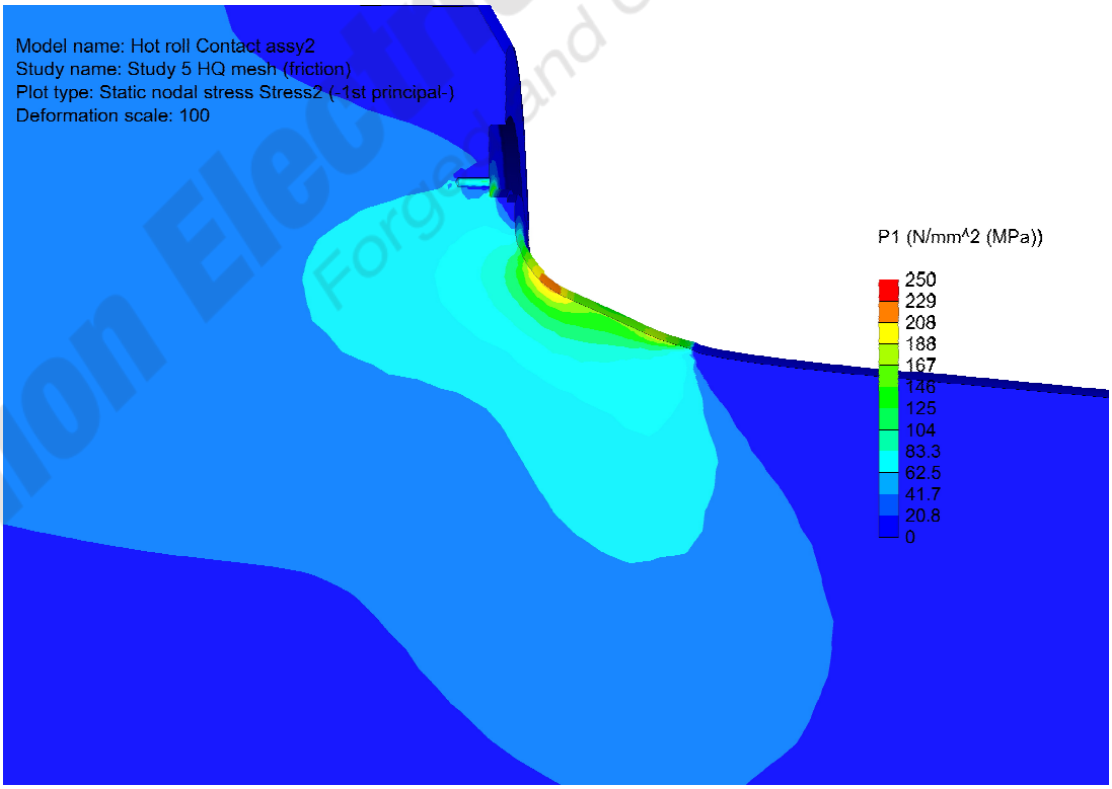

Figure 2
Failure of a work roll journal that occurred due to excessive bending load.

Figure 3

MECHANISM

The separating force applied by the bar to the rolls generates a bending stress within the journal between the barrel end face and the bearing. As the roll rotates, this area of the journal cycles between alternating states of tensile and compressive stress. If the peak stress applied exceeds the strength of the roll journal then an instantaneous fracture will occur.

If the applied stress exceeds the fatigue strength of the roll material at a given location then a crack will be initiated when the critical number of cycles is reached. Once present a crack will propagate during rolling across the journal cross-section in a fatigue mode gradually reducing the effective journal cross section. Once the bulk strength of the journal is exceeded by normal applied bending stress then an instantaneous fracture across the remaining cross section occurs.

Journal failures under bending should not be encountered during normal rolling where the roll design applied has sufficient safety margin to meet the expected operational parameters. However several factors can reduce this safety margin.

The presence of stress concentration points, such as created by improper repairs or by insufficiently radiused corners, notches or corrosion pitting (see section IV.C) at the journal surface can all initiated a failure under bending load.

Insufficient material strength due to grade selection or because of improper material properties within the journal such as that from excessive porosity, poor structure or off centre shrinkage cavities may also result in crack initiation and ultimate failure from the journal centre outward.

PREVENTION

- Avoid excessive bending loads during rolling above that of the roll design limits.
- Ensure the roll material has sufficient strength for the application
- Protect the form radius area from corrosion.
- Remove notches or tooling marks and ensure all corners are properly radiused.
- Implement routine inspection of the journal form radii when a known problem exists.
- Do not carry out repairs to journals in the area between the barrel face and bearing (see section IV.E).