CLOCK SPRING®

Effectiveness of dent and mechanical damage repair using Clock Spring®

Clock Spring® composite repair system can be used to reinforce dents in high-pressure pipelines. Fatigue testing indicates that Clock Spring® extends the fatigue life for dressed mechanical defects by an order of magnitude over grinding as the sole repair. (GRI Report No. GRI-97-0413 "Evaluation of a Composite System For Repair of Mechanical Damage in Gas Transmission Lines"). The repair is limited to smooth dents caused by inadvertent pipe contact with machinery or objects in the ditch or backfill. Stress concentrators in the dent must be removed in accordance with applicable codes and the dent area inspected for surface cracking.

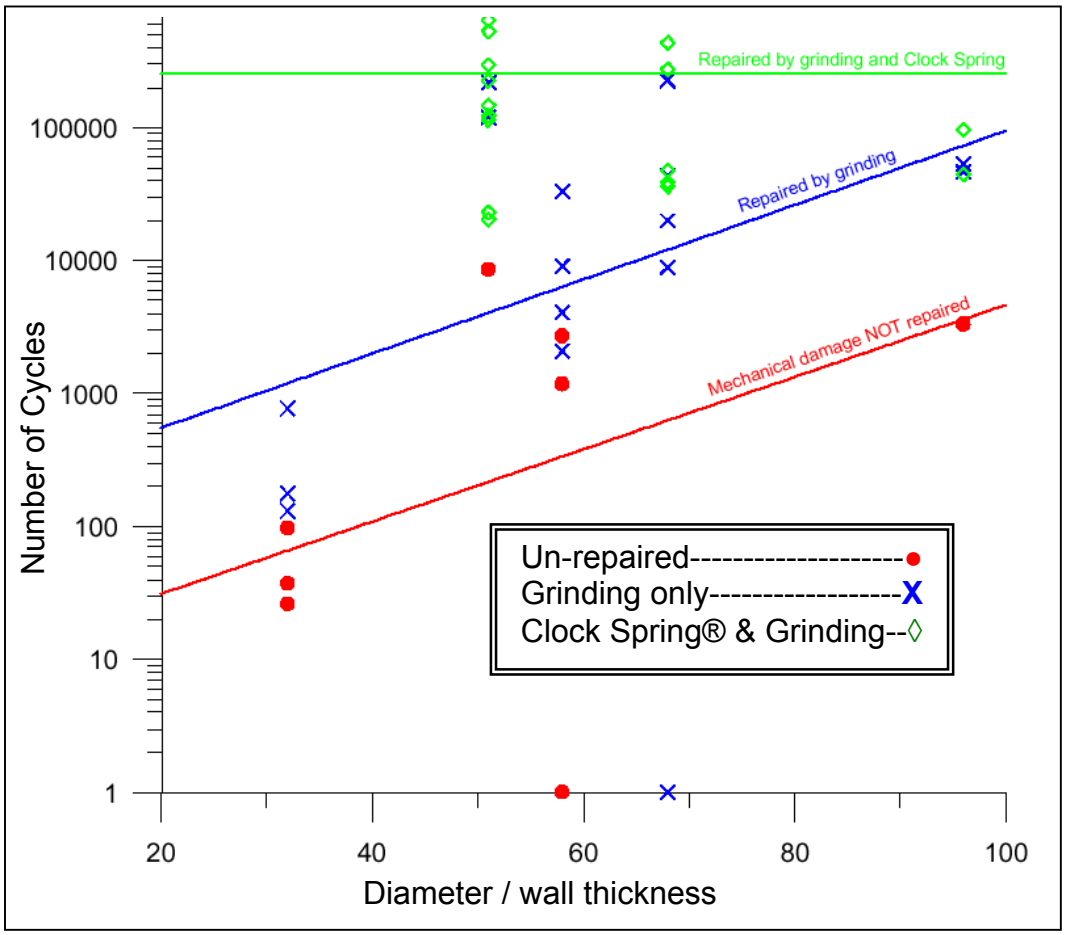


Figure 1.
Number of Cycles as a Function of Pipe Diameter to Wall Thickness Ratio

Three groups of data are plotted in Figure 1,

1. PRCI/GRI data for un-repaired dents with gouges (Lower)
2. GRI data for partially repaired defects (Grinding out stress riser)(Middle)
3. GRI data for fully repaired defects (Grinding plus Clock Spring®)(Upper)

Cycles to failure are plotted against Diameter / Wall thickness ratio (D/t). Analysis yields several observations.

- At a D/t of 60, the fatigue life for partially repaired defects is approximately one order of magnitude greater than the fatigue life of un-repaired defects.
- The fatigue life of fully repaired defects is approximately two orders of magnitude greater that un-repaired defects.
- Fatigue life of un-repaired and partially repaired defects increases with increasing D/t. There is not enough data to estimate the trend line for fully repaired data so it is shown flat.

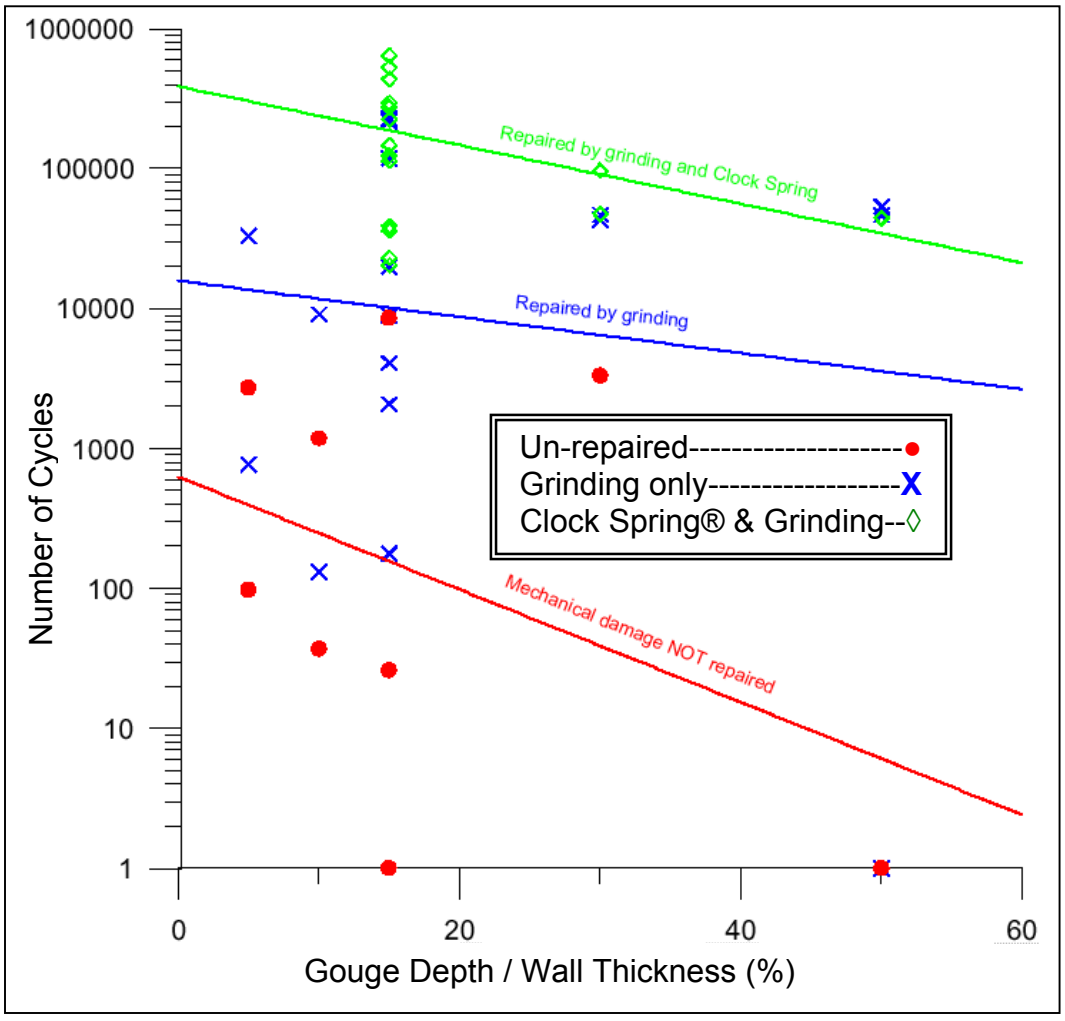


Figure 2.
Number of Cycles as a Function of Gouge Depth

Figure 2 provides data plotted with the gouge depth being the variable of interest. As with figure 1, the following data groups are presented,

1. PRCI/GRI data for un-repaired dents with gouges (Lower)
2. GRI data for partially repaired defects (Grinding out stress riser)(Middle)
3. GRI data for fully repaired defects (Grinding plus Clock Spring®)(Upper)

Several observations can be made,

- The fatigue life of a dent with a gouge decreases with increasing gouge depth.
- The fatigue life of partially repaired defects is greater than un-repaired defects by two orders of magnitude at the 15 % gouge depth.
- The fatigue life of fully repaired defects is greater than un-repaired defects by three orders of magnitude at the 15% gouge depth.

Clock Spring® repair system is effective in increasing the fatigue life of mechanical defects (dents). Stress concentrators or gouges must be removed prior to Clock Spring® installation

In an article in Oil and Gas Journal, September 2002, Mr. Michael J. Rosenfeld, Vice President of Kiefner and Associates outlines the factors that govern evaluation of mechanical damage to pipelines.

Where gouges exist, the operator is cautioned to make repairs as soon as possible and to reduce pressure to provide a safety factor for the workers.

"Several repair options are available to the operator. Steel sleeves designed for pressure containment are always an appropriate repair method. And composite wrap repairs are acceptable, provided the following steps are taken.

- *The scrape or gouge is ground down to a smooth contour.*
- *The damaged area is inspected to verify that any cracks have been removed.*
- *The residual indentation is filled with a hardenable material under the sleeve.*

The safe length and depth of grinding may be determined from:

$$L \leq 1.12*((D*t)*(((a/t)/(1.1*(a/t)- 0.11))^2-1))^0.5$$

Note: See next page for equation as it appears in the article.

Where: L = Length of grind
a = Depth of grind
D = Pipe diameter
t = Pipe wall thickness

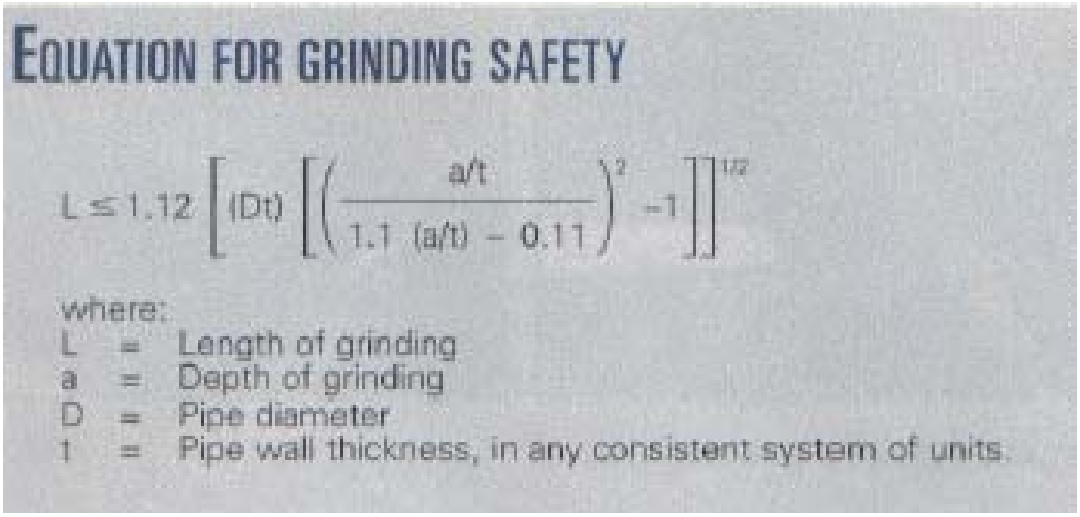
The maximum safe depth for grinding is 40% wall thickness."

The article goes on to say;

"Rock-induced damage can be repaired by a number of methods, including:

- *Welded steel sleeves, either designed for internal pressure, or with the ends left unwelded (a hardenable filler in the dent space being recommended in either case).*
- *Composite wrap repair with hardenable filler in the dent space.*
- *Repair to the coating only (appropriate for gas pipelines)."*

Clock Spring® is an effective repair alternative for mechanical defects in pipelines.



Simply the smartest pipeline repair decision you can make!

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