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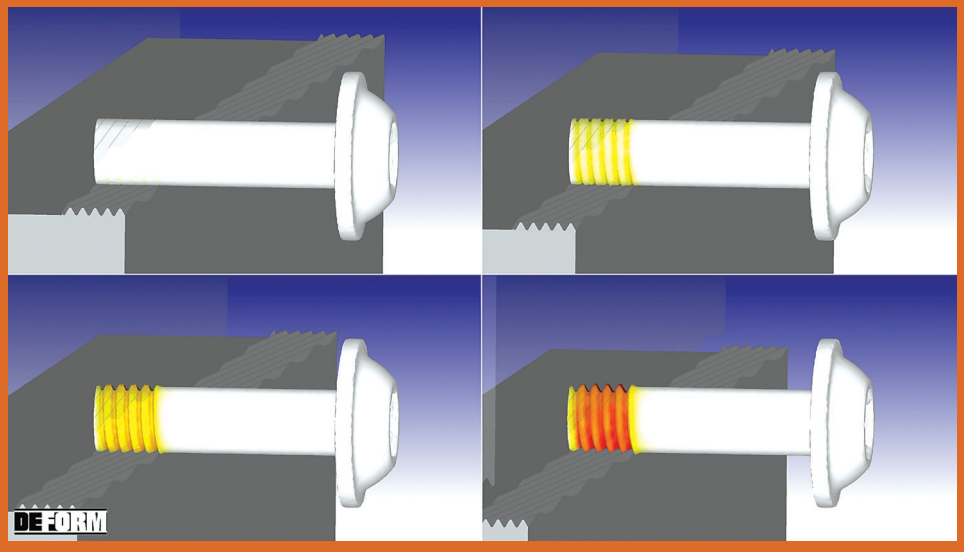

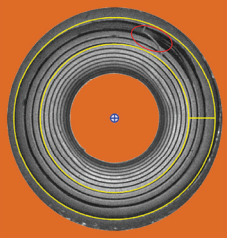

INTERNATIONAL FASTENER EXPO 2021

Failure Analysis of an Irrigation System

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A Case Study

EMPHASIS: Fastener Failure

Figure 1 is a view of a typical center pivot agricultural irrigation system, which is essentially a water pipe with drive wheels that rotates about a fixed pylon. The pipe is supported with wire cables attached to struts that hold the pipe in a curved shape. Equally spaced are electric, motor driven, wheels that turn slowly allowing the system to walk around the pivot, delivering water to the crop. In Figure 1, a failure of the water delivery pipe has occurred as indicated by the arrow. This has caused the pipe and support structure to collapse, making irrigation impossible.

Figure 2 is a side view of the irrigation pipe at the area where the failure occurred. This is an eight bolt flange. Rust patterns suggest that this flange connection had been leaking over time.

Figure 3 is a close-up of the failure origin. There was a ductile fracture at the lower area of the pipe with an origin approximately at the right arrow, just outside the weld fillet. The left arrow points to pipe flanges that are severely deformed and nearly touching at the bolt locations. The bending of the flanges is a result of excessive bolt compression around a gasket that only seats in the circular section of the pipe. Since the bolts are not equipped with cylindrical spacers, there is no limitation as to the degree of travel of the nut along the bolt. This has caused excessive stress in the vicinity of the right arrow, initiating a crack and final fracture.

When flange connections such as the one shown in **Figure 3** leak, the tendency is to tighten the connection hoping that further compression of the gasket will stop the leak. In this case, excessive torque has caused the bolt shafts to bend as seen in **Figure 3**. It is not clear that the deformed flanges actually stopped the leak since it appears that a gap has developed in the flange to gasket area between bolts.

A better design here would be to install spacers in order to limit the amount of bolt compression delivered to the flanges so they remain planar and do not strain the weld fillet area that attaches the flange to the pipe. If tightening a flange set up with spacers does not stop the leak, then the gasket should be replaced.

An instruction to limit the flange bolt torque in the installation manual would also be helpful, but the spacers would surely prevent flange deformation from excessive bolt torque. In this case, the root cause of the failure is excessive torque being applied to the flange bolts.

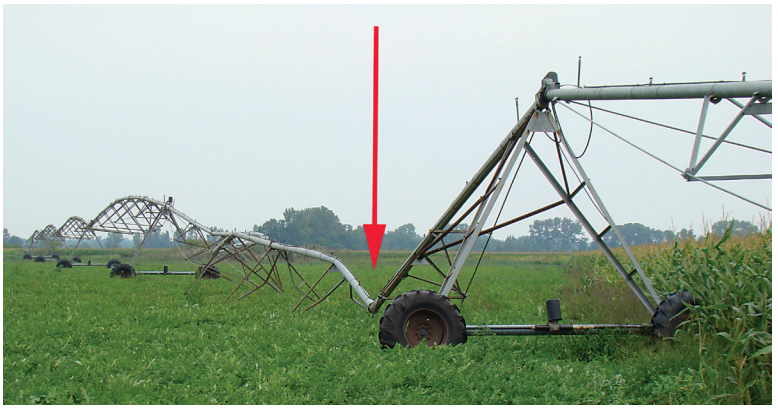

Fig. 1 — Typical center pivot agricultural irrigation system showing a failure of the water delivery pipe.

Fig. 2 — side view of the irrigation pipe at the area where the failure occurred.

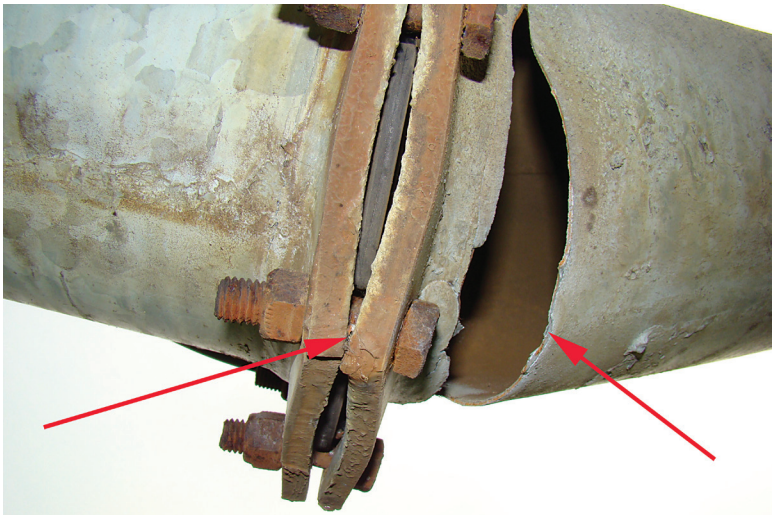

Fig. 3 — Close-up of the failure origin showing ductile fracture at the lower area of the pipe with an origin approximately at the right arrow, just outside the weld fillet.

For additional discussion with the author on fastener failures, send email to: *ccr@croberts.com* or visit *www.croberts.com.*

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