Steel flexes. Add in heavy trucks and welded members and the potential for fatigue cracking increases. Unaddressed cracking can lead to structural issues compromising bridge safety.

ODOT maintains 389 steel bridges constructed between 1908 to 2016. The list includes many of Oregon’s well known bridges like the McCullough Bridge in Coos Bay, the St. John’s Bridge in Portland and the Astoria/Megler Bridge in Astoria. ODOT regularly inspects these bridges and timely repairs are done as needed to ensure they remain structurally sound. Over $1 million a year is spent on fatigue repairs and strengthening of old steel bridges.

Q | Where do fatigue cracks come from?

A | Fatigue cracks develop in steel bridge components from normal truck traffic loading even when the loading is within acceptable levels. The cracks can develop very slowly over time, and may not be visible during their early growth stage. However, the cracks can eventually become a serious concern as they can result in the component failure. Most bridges are designed so if one component fails the load will be redistributed to other components. However, there are bridge types where if one component fails, additional components will then fail, resulting in a partial or total collapse.

Q | What bridges are affected?

A | Fatigue can be an issue for any steel bridge component, however, bridges that were constructed starting in the 1950’s, when welding became widespread, are the most susceptible; older bridges built with riveted or bolted connections are much less susceptible. Any point where a weld begins or ends is a potential location for a fatigue crack to form. Welds may also have defects that are inherent to the welding process. The state-of-the-art in the 1950’s, both from a welding procedure standpoint, as well as shop inspection techniques that were available, make it very likely that defects are present in older welded structures. Also, the bridge designers of that era did not fully appreciate how details such as intersecting welds and other design details are affected by repeated loading cycles.

Fatigue crack noted on the Winchester Bridge.
Q | How are fatigue cracks identified?
A | Fatigue cracking on steel bridges is a national concern. Welds are evaluated based on appearance including surface defects, craters and undercutting. However, some defects may not be detected through visual inspection so the design details that contribute to fatigue cracking have been identified and ranked according to how prone they are to cracking. While all bridges are inspected at least every two years, bridges that have design details that could lead to fatigue cracking are scheduled for additional in-depth inspections. The bridge inspectors closely examine each detail that is prone to developing fatigue cracks, and document the results. Bridges that are in danger of a partial or total collapse if one component were to fail are given greater attention than other bridges.

Q | How are fatigue cracks addressed?
A | Some fatigue cracks grow very slowly and are simply monitored closely during each inspection cycle to identify any change in crack length. Other fatigue cracks need to be repaired. Sometimes, new connection details designed to modern standards are used to replace older details that have fatigue cracks. Other times, a simple fix such as drilling a hole at the end of the crack to reduce the stress concentration and installing a high-strength bolt and tightening it is sufficient.

Q | Are we keeping up with fatigue cracking repairs?
A | For now, we are keeping up, however, our aging bridges are supporting higher traffic volumes and heavier loads. Steel bridge fatigue cracking is the primary focus of the Bridge Section Senior Mechanical Engineer who works with ODOT Bridge Crews to modify connection details to reduce the risk of fatigue cracking. Some older highway bridges with steel superstructures will likely require strengthening at some point in their service life to accommodate higher loads. As long as we have steel bridges in the inventory, we will continue to maintain vigilance in regards to monitoring and repairing fatigue cracking.

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Resources
- ODOT Bridge Section 2016 Bridge Condition Report
- ODOT Bridge Inspection Coding Guide