Metallurgical Evaluation of Cracked In-Service Heavy Duty Pile Bonnets

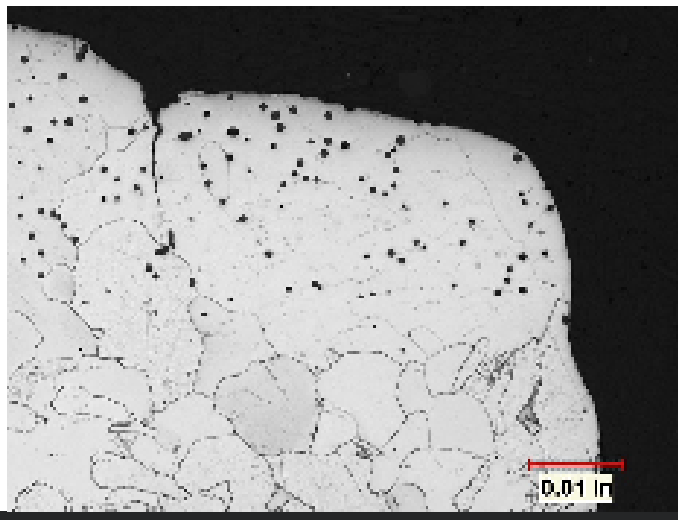
CTLGroup was retained by an industrial construction company in order to determine the cause for multiple in-service failures of heavy-duty pile bonnets. The fractured bonnets were reportedly purchased new from an offshore supplier and were considered to have failed well short of anticipated service life.

The pile bonnets were reportedly made from cast carbon steel; and the inner cushion receptacles and pile insert receptacles were machined flat for maximum energy transfer during service.

Fractures appeared to progress along significant portions of the pile bonnet perimeter, and penetrated full cross-sectional thickness for a significant portion of the crack propagation path. Examination of the fracture within the pile insert receptacle cavity revealed that the fracture path propagated through the toe of the casting radius formed at the cushion receptacle, adjacent to the pile insert receptacle cavity wall.

DPA revealed that the cracking resulted from multiple origin fatigue fractures, which initiated around the entire circumference of the cast surface of the pile internal insert cavity wall. At some point during the pile bonnet operational lifetime, primary fatigue cracking was arrested, and secondary fatigue was re-initiated at the arrest locations of the primary fatigue propagation.

Metallographic specimens revealed the presence of a significant layer of oversized MnS and SiO2 inclusions at the primary fatigue origins. CTLGroup determined that the observed microstructural anomalies, which are indicative of poorly controlled foundry practices, compromised the functional integrity of the pile bonnets and resulted in premature failure of the units.



Services

- Metalurgical evaluation
- Field investigation and examination

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