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Failure Analysis Case Study

Failure Analysis of a Cable Support Strap due to Stress Corrosion Cracking

Keywords : Support Strap, Cracking, SCC

Material: Zinc

Introduction

10 straps were submitted to laboratory for failure analysis. These Zinc aerial cable support straps were on utility poles in a rural Ohio location. With no reported industrial sites for miles, these straps were found to be cracking within four months after installation. Visual examination, chemical and metallographic analyses was performed on the submitted strap sections to look for root cause of the failure.

Visual Examination

The fractures in all of the straps (0.012 inch by 3/4 inch) were essentially the sample: ie. complete fracture of the strap transverse to its length. In all cases the fracture had taken place in a relatively sharp bend in the strap. Visual and microscopic examination of the fracture surface showed them to be brittle in texture with no evidence of plastic deformation (thinning) adjacent to the fracture. All of the fractures, and indeed the surface of the straps, were covered with white corrosion products.

Chemical Analysis

Chemical analysis conducted on a composite sample from the straps resulted in the following composition:

	Result %	Required %
Cadmium	0.001	0.005 Max
Lead	0.004	0.005 Max
Iron	0.002	0.008 Max
Copper	0.88	0.7/0.9
Zinc	Remainder	Balance

The straps conform to the requirements for a 190 series rolled zinc alloy.

Microscopic Examination

Samples were cut from fracture surface and unused straps for metallographic examination. The microstructures of the failed and new samples were the same. It consisted of elongated (cold rolled) grains of zinc rich primary solid solution interspersed with small particles of a second phase, presumably a zinc—copper intermetallic compound. Figure 1 is a photomicrograph (500X) showing this microstructure. Figure 2 shows the fracture surface in cross-section. Branching of the main fracture is evident.

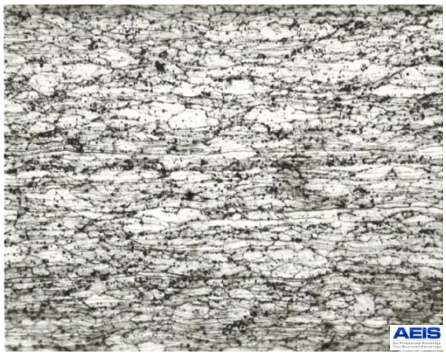

Fig 1 Microstructure of failed sample X500

Fig 2 Cross-section of fractured surface X500

An additional sample was cut from one of the fracture surface areas and used for scanning electron microscopic (SEM) study. The examination showed the fracture to be mainly transgranular. However, several areas of crack branching were observed. Figures 3 &4 are SEM photos showing two areas on the fracture surface examined. Note the presence of cracks going into the sample body (branching).

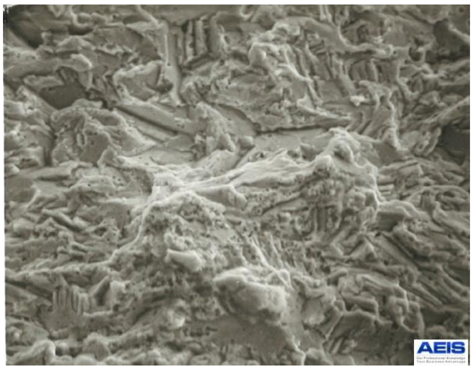

Fig 3 SEM of fractured surface X650

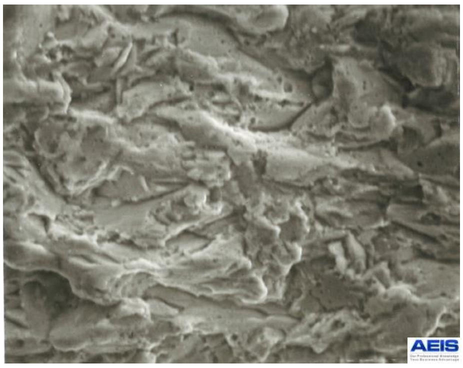

Fig 4 SEM of fractured surface X1000

Discussion

The evidence outlined above point to stress-cracking as the cause of failure. Specifically, the evidence of crack branching and the brittle nature of the fracture are typical of this mode of failure. Of particular significance is the britt1e behavior since this material is supposedly ductile in nature. As a check of this, an unused sample of strap was pulled in tension in an Instron testing machine. The fracture mode was decidedly ductile with severe thinning of the strip at the fracture. We thus have brittle failure in a ductile material; stress corrosion is one of the very few mechanism can cause this to come about. Stress corrosion will cause failure much faster than either stress or corrosion separately.

It should also be pointed out that stress corrosion of zinc is known to come about in the presence of warm potable water. It may be that rain water, collected in the inside of the bends in the straps and warmed by the sun, was the potential responsible corrosive.
In addition, the inside of the bends in the straps would be sites of residual tensile stress which is the second necessary condition for stress corrosion.

Conclusion

It is therefore concluded that failure of the zinc straps came about due to stress corrosion cracking.