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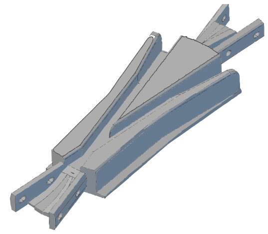
SHOULD STAINLESS STEEL ALLOYS BE USED AS BUFFER LAYERS ON AMS FROG REPAIR?



Examination of a failed frog reveals that 312 Stainless Steel buffer layers can lead to catastrophic failures.

Layer(s) of stainless is sometimes referred to as a "butter" or "buffer" layer. They all serve the same purpose.... to blunt cracks.

It is not uncommon for railroad maintenance shops to utilize 312 or 307 Stainless Steel welding electrodes or wires to seal cracks in Austenitic Manganese Steel (AMS) frog repairs before a build-up procedure with AMS welding electrodes or wires. Some shops have taken this a step further by applying a complete buffer layer of Stainless Steel weld metal deposit prior to the AMS buildup procedures (see Fig. 1). Stainless steel weld deposits are incredibly versatile in mending flaws and cracks, etc., so it stands to reason that a complete layer would certainly be helpful and ensure the integrity of the frog repair. Or is it? A recent study by Postle Industries, Inc. may suggest otherwise.

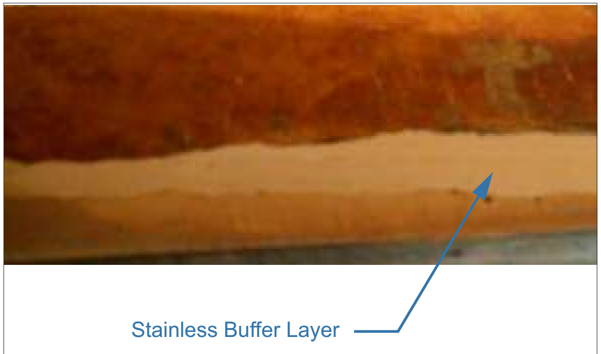


Fig 1. Stainless Buffer Layer identified by the Frog Owner.

In November 2015, a frog with a severe breakout of the point was field sectioned and shipped to the lab for analysis. Upon arrival in the lab, the broken out section was further sectioned for microscopic analysis. Fig 2 shows a distinct crack running lengthwise along the frog section. Its distinct color indicated that this deposit was not the typical AMS welding electrode/wire deposit. Further investigation with the frog owner confirmed our suspicions that this deposit was in fact a 312 Stainless Steel electrode applied buffer layer (see Fig. 3). The crack appeared to run on the fusion line between the AMS frog base metal and 312 Stainless weld metal and occasionally ran along the fusion line between the 312 Stainless buffer layer and the AMS build up wire deposit. Photomicrographs in Fig 4 confirmed this observation. Upon further investigation under high magnification, small chromium carbides were noted along the fusion zones base metal and AMS buildup. It was determined that these chromium carbides were a major contributor to the frog failure. Chromium carbides are the result of carbon and chromium combining into a very angular hard compound, known as a chromium carbide, which can be helpful in abrasion resistance, or in this case, a very harmful source of cracking. But where did they come from?

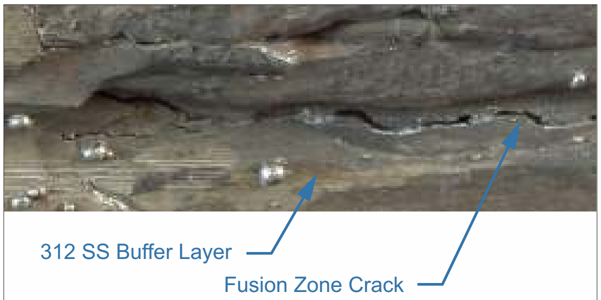


Fig. 2 Crack in the frog point occurring at 7 layers below the surface and running adjacent to a 312 Stainless steel buffer layer.

Obviously chromium carbides need chromium and carbon elements under the right conditions to form. Examination of the source materials involved reveals some indication of what happened.

- ✓ There is no chromium in the AMS frog chemistry.
- ✓ There is about 1% carbon in the AMS frog chemistry.
- ✓ There is about 30% chromium in 312 Stainless Steel chemistry.

Fig. 3 Mounted cross section of the failed frog showing a crack running in the fusion zone of AMS frog and 312 Stainless steel buffer layer.

- ✓ There is very little carbon in the 312 Stainless Steel chemistry.
- ✓ There is about 3% chromium in AMS buildup wire chemistry.
- ✓ There is about 1% carbon in the AMS buildup wire chemistry.
- ✓ There is plenty of opportunity for carbon and chromium to join and form chromium carbides.

So how did the formation come about to cause such a catastrophic failure? We know that carbon, being quite small in size, likes to migrate, especially when heat is applied to the base and weld metal, to areas that are void of carbon. We also know that the carbon will cross fusion zones to get where they are going, but they will also link up with chromium almost instantly if any is encountered in the migration. Keeping these things in mind, imagine that a layer of 312 Stainless deposit is a buffer layer on top of the broken out AMS frog (see Fig. 5). Through the dilution with the AMS frog base material, a large volume of carbon now exists in the 312 Stainless Steel buffer deposit. In addition, carbon from the AMS Frog and AMS build-up migrates into the 312 Stainless steel buffer layer, aggravating the situation. The carbon migration is further enhanced by the successive layers of AMS build-up applied during the build up procedure. Keeping low interpass temperatures below 500°F (260°C) helps to retard, but not eliminate this migration and formation of chromium carbide as well as other harmful carbides. It was also noted that once the 312 Stainless deposit ended further back on the point, the crack also ended, suggesting further that the crack is associated with the 312 Stainless buffer layer.

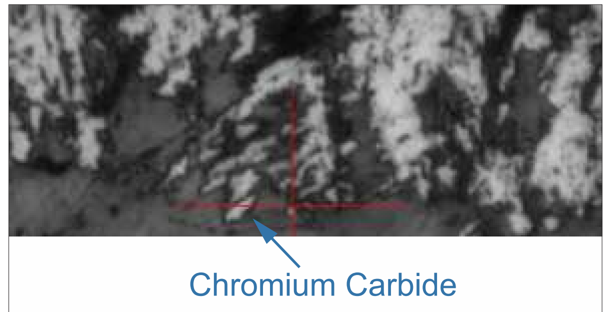


Fig 4. Chromium Carbide on the fusion zone of the AMS Buildup and 312 Stainless buffer layer.

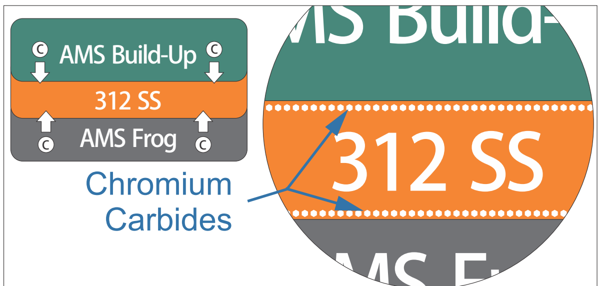
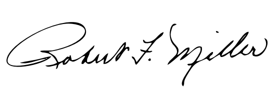


Fig. 5 Upper left graphic shows Carbon diffusing into the 312 SS. Upper right graphic shows the formation of Chromium Carbides in the fusion zone.

Summary

While depositing a 312 Stainless steel buffer layer prior to AMS welding electrode or wire buildup may appear to be beneficial, the consequences of using it as a buffer layer may result in a catastrophic failure. This actually applies to any type of Stainless steel weld deposit used as a buffer layer. Visual and microscopic examination of a spalled AMS frog point suggests that carbon migrated or diluted into the 312 Stainless steel deposit and caused formation of chromium carbide along fusion zones associated with the AMS frog and AMS buildup, and ultimately led to the spalling, requiring repair or the complete scrapping of the frog. The use of 312 Stainless or any type Stainless electrode or wire should be confined to crack repair and not for the deposition of a buffer layer. While carbon migration does occur in the stainless crack repair deposits, it is far less damaging than a buffer layer.

Should stainless steel alloys be used as buffer layers on AMS frog repair? All stainless steels contain high volumes of chromium which contributes to the formation of chromium carbides and its use is not recommended by Postle Industries, Inc.



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