

A novel surface preparation method for existing metallic structures in harsh environments prior to coating

Existing metal structures are pre-engineered steel buildings like garages, barns, or warehouses, as shown in Figure 1. However, harsh site environmental conditions (e.g., marine environment) cause extensive corrosion of structural materials such as steels and aluminum alloys. Advanced polymeric coatings have thus been developed to serve as a physical barrier to significantly hinder corrosive electrolytes from attacking metals. To maximize the protective efficiency of these coatings, proper metal surface preparation such as a thin, robust pretreatment film is often required prior to coating application to provide excellent adhesion between the coatings and the metal surface.



Figure 1. An example of existing metal structures

Funded by DOD-MDA STTR Phase I program in 2015, this research is aimed at developing a robust, high-performance pretreatment based on SILSBOND technology. Metal substrates tested included cold-rolled steel, hot-rolled steel (A36) and extruded AA 6061 aluminum alloy. Harsh site environmental conditions (e.g., marine environment) were simulated. SILSBOND pretreatment products were sprayed onto metal substrates without post water rinse (spray on - dry in place). We tested 2 types of spraying methods: 1) wand spray in the ambient environment and 2) hydro-blasting in a humid environment.

1) Wand spraying of SILSBOND pretreatment solutions in the ambient environment

Figure 2. shows abrasive-blasted A36 (Hot Rolled Steel, HRS) panels sprayed with SILSBOND solutions and dried in place. Figure 2(a) shows the two rust-free panels sprayed with a high pH SILSBOND solution (pH11) and Figure 2(b) are the panels with a SILSBOND solution (pH 8.0) showing red-brownish flash rust.

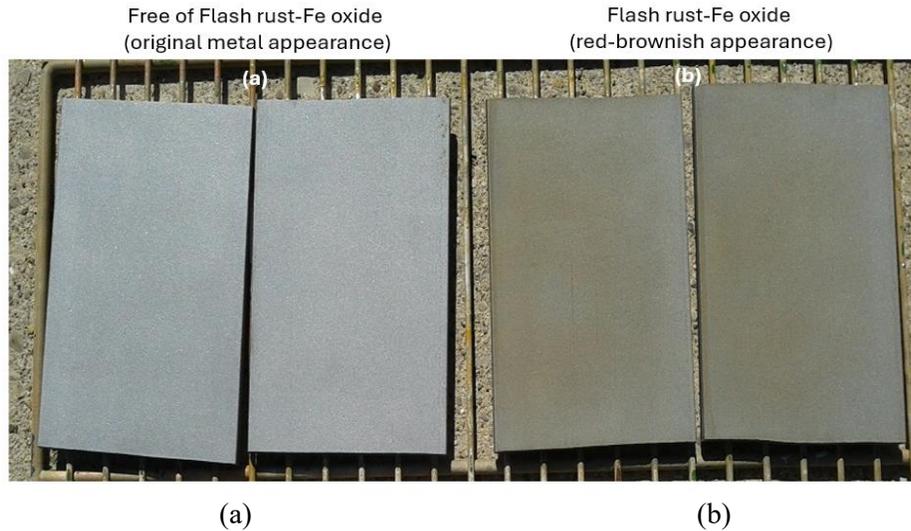


Figure 2. shows abrasive-blasted A36 (Hot Rolled Steel, HRS) panels sprayed with SILSBOND solutions and dried in place (Fairfield, OH)

Figure 3 shows the epoxy coated HRS panels after 500 hrs of SST. The panel in Figure 3(b) was pretreated with SILSBOND (pH11) before coating while the one in Figure 3(a) without pretreatment shows significantly paint loss in the scribes. Clearly, the SILSBOND treatment can effectively enhance the anticorrosive coating performance.

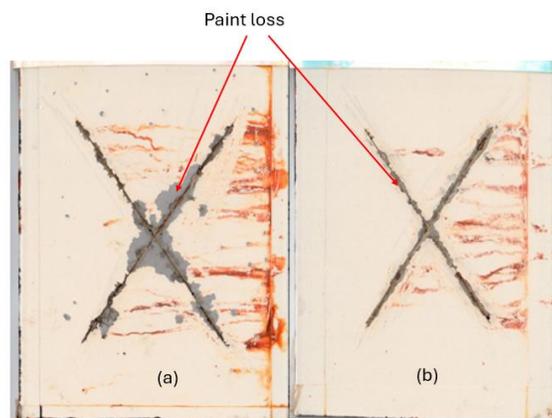


Figure 3. Epoxy coated A36 HRS panels after 500 hrs of SST; (a) no pretreatment and (b) pretreated with SILSBOND (pH11)

2) SILSBOND application using hydro-blasting method in a humid environment

In this test, a hydro-blasting method was used to remove mill scales (thick metal oxides) from the A36 hot roll steel panels and to pretreat the freshly cleaned panel surfaces with SILSBOND in one step. Two SILSBOND solutions with different pHs, pH 11 and pH 5.5, were used here. Figure 4 shows the hydro-blasted A36 hot rolled steel surfaces pretreated with different SILSBOND solutions. Figure 4(a) shows a mill scale free and rust-free surface after hydro blasting at 50,000 psi. However, at lower pressure (25,000 psi), the hydro-blasted surface still has some mill scale, as shown in Figure 4(b). When the oxide-free panel surface is treated with an acidic SILSBOND solution, a uniform layer of yellow rust forms immediately, as illustrated in Figure 4(c).

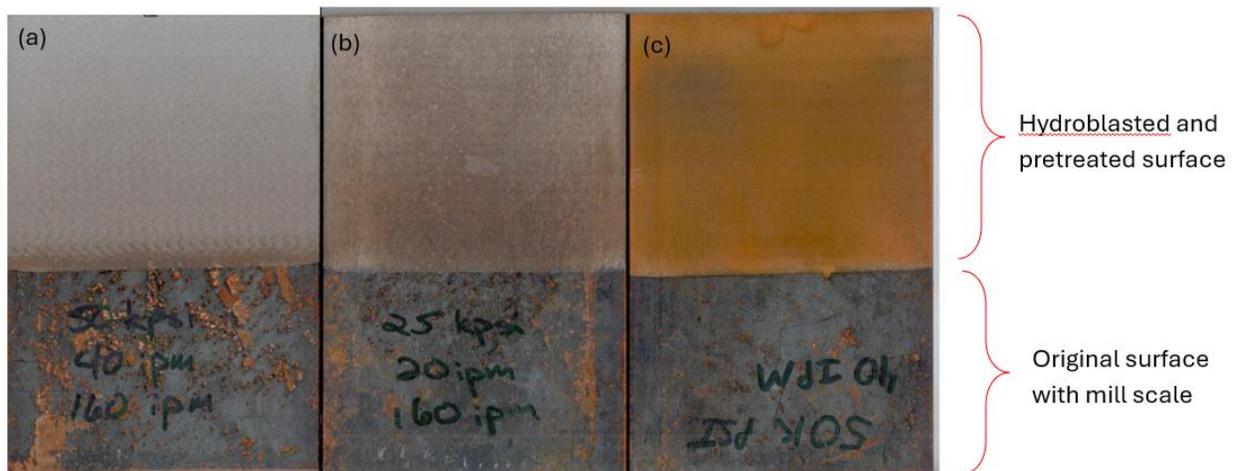
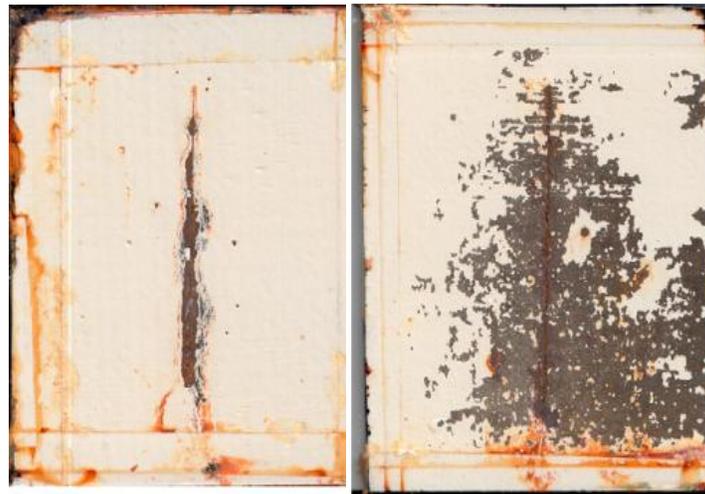


Figure 4. hydro-blasted A36 hot rolled steel surfaces pretreated with SILSBOND solutions; (a) hydro-blasting at water pressure of 50,000 psi, pretreated with SILSBOND (pH 11), (b) hydro-blasting at water pressure of 25,000 psi, pretreated with SILSBOND (pH 11) and (c) hydro-blasting at water pressure of 50,000 psi, pretreated with SILSBOND (pH 5.5)

The panels that underwent hydro-blasting and SILSBOND pretreatment (see Figure 4(a) and (b)) were coated with an epoxy primer and subjected to SST for 500 h. The outcomes are presented in Figure 5. Panel 5(b) experienced total paint removal after testing, likely caused by residual mill scale on its surface. In contrast, the panel in Figure 5(a) demonstrated excellent anticorrosive properties of the coating.



(a)

(b)

Figure 5. 500-hour SST results for epoxy primer-coated A36 panels: (a) hydroblasted at 50,000 psi with SILSBOND pretreatment; (b) hydroblasted at 25,000 psi with SILSBOND pretreatment.

Remarks:

- 1) SILSBOND pretreatment with alkaline pH prevents flash rusting on steel surfaces and greatly improves coating corrosion resistance by providing strong paint adhesion to metal substrates.
- 2) SILSBOND pretreatment with hydro-blasting is a new method that cleans and preps metal surfaces in one step prior to coating.