TECHNICAL SUMMARY

Measurement of Adhesion Properties between Topcoat Paint and Metallized/Galvanized Steel with Surface Energy Measurement Equipment

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Introduction

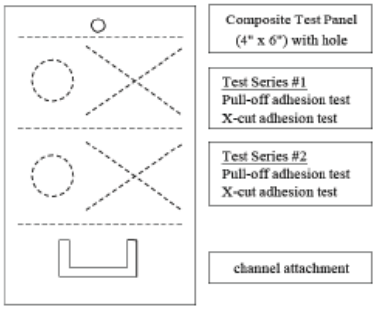
For many highway transportation steel structures, a zinc coating is applied to the surface of the steel for corrosion protection. Zinc is applied to steel in three ways: by zinc-primer paint, by metallizing(where hot zinc is sprayed onto the steel surface), or by hot-dip galvanizing (where the steel part is immersed in a molten zinc bath and a zinc layer metallurgically forms on the steel). Paints are often applied to the zinc-on-steel surfaces for additional corrosion protection and an aesthetic color finish (the duplex system). The frequent sight of peeled off paints on galvanized posts and other highway structures lead to a general impression that it is harder to achieve a good paint adhesion on metallic zinc-coated steel surface than that on the bare steel surface.

Objective

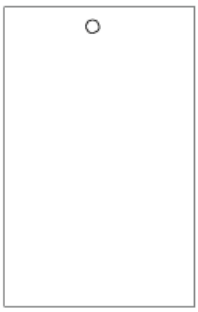
The objectives of this research project are: (1) Compare the adhesion properties of NEPCOAT-approved topcoat paint over metallized or galvanized steel. Use "surface-energy" measuring technique to characterize the wetting properties of the liquid paint on the profiled zinc surfaces. Explore correlation between the adhesive strength and the liquid paint wetting properties. As control, the adhesion properties of topcoat paint over zinc primer painted steel substrates will also be measured. (2) Investigate various factors affecting the adhesion of topcoat paint over galvanizing. (3) Report and recommend practices that produce the best adhesion of NEPCOAT-approved topcoat paints over metallized and particularly galvanized steel surfaces.

Methodology

The researchers prepared four different types of test panels coated with five different commercial paint systems. The paint systems include four systems adapted from the NEPCOAT list of intermediate and top paints qualified for bare steel, and one system of epoxy sealer for metallized surface. Four types of substrates were used for fabricating the test panels: (1) galvanized steel with mechanical grinding to produce rough surface, (2) galvanized steel with blast profiling to produce rough surface, (3) galvanized steel stored indoor for two weeks before blast profiling and painting, and (4) metallized steel with inherent roughness due to the thermal spray process. The researchers recorded, as a function of time, the contact angle of droplets of freshly prepared liquid paints on the replicas of the substrate used for spray painting. The cured test panels were subject to pull-off strength tests according to the ASTM



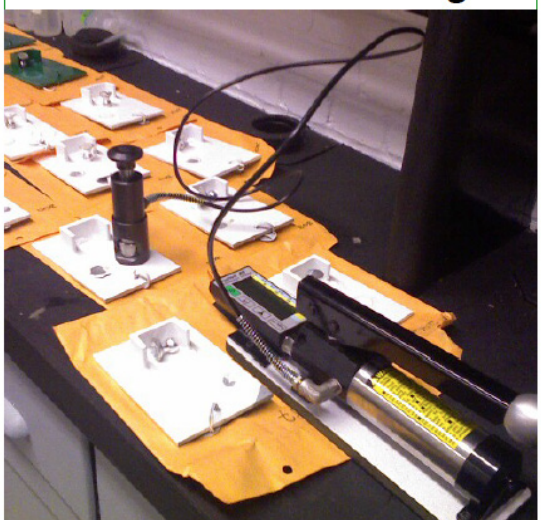
Type A Test Panel Configuration for Facility to paint



Type B Test Panel Configuration for NETC PI "surface energy" measurements

D4541 standard, and the X-cut tape tests according to Method A of ASTM D3359 standard. Images of the pull-off test break surfaces were photographed and examined.

Pull-off strength measurement of coatings



Contact Angle of paint droplets on profiled surface

Conclusion

The researchers analyzed the correlation between the pull-off strengths and the contact angles. The correlation provided insight on the relative adhesive strengths of the different paint-substrate pairs. The researchers concluded that (1) the NEPCOAT paints could be used for galvanized and metallized steel to obtain comparable adhesion performance as that of the zinc-rich organic primer coated steel, (2) although the NEPCOAT intermediate paint on the metallized surface has adequate pull-off strength to pass the inspection, it is highly recommended that the state DOT specification of the use of sealant is strictly followed, (3) although the exposure to atmosphere after galvanizing is commonly recognized as a problem for paint adhesion, the researchers found that a time delay of two weeks between galvanizing and profiling/painting is permissible if the galvanized steel is stored in the normal indoor dry atmosphere, (4) a refined quantitative correlation between pull-off strength and contact angle could be useful for optimizing the paint-to-substrate match.

Recommendations

There is a good chance that the ranking of the pull-off strength could be changed in a long-term accelerated weathering and corrosion test. The pull-off strength for the dry coatings may be different in a coating exposed to salt-fog tests. Although the test panels include welded U-channels to emulate welding joints in a real structure, the researchers could not sample the coated paint immediately next to the joint because the pull-off strength tester could not be fit into an area next to the welded joint. The researchers recommend that a study of the salt-fog spray test to be done on the test panels fabricated and tested for this study, to yield additional information on the question of profiling and paint adhesion.

New England Transportation Consortium

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COMPLETE REPORT

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