Adapting European Pavement Tests to Prove Coating Performance on Steel Culverts

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Introduction / Objective

Buried steel structures must resist many environmental elements and maintain structural integrity throughout their design service life (DSL). For Canadian Bridges this exceeds 75 years. An innovative polymer coating on steel is expected to extend life to meet these requirements however it first must be tested in accelerated conditions that are representative of aggressive conditions that a highway culvert will face over its lifetime.

Statistical and Analytical Methods

Since it was invented in 1896 Corrugated Steel Pipe has seen a number of innovations in metallurgy and coatings. All have been the subject of extensive field and laboratory testing. Testing enables performance estimates over time in a variety of environmental conditions. A number of reports have been written and the conclusions have been published as predictive methods, text books, charts and tables available at www.cspi.ca

Many test procedures have been developed by the American Society for Testing and Materials (ASTM) and others to simulate accelerated materials performance. A number of these including ASTM B117 Salt Spray Test are seen as critical to assessing long term performance of steel structures in the Canadian Highway environment.

Unfortunately test methods and equipment that replicate the long term performance of culvert inverts in abrasive conditions are not readily available. The Corrpro equipment that generated the data (adjacent) is no longer available.

Based on European test methods for airport runways the Ministères des Transport du Québec (MTQ) has developed METHODE D ESSAI LC21-102 to test the abrasion resistance of pavements. Equipment for this test is available and used regularly at the MTQ laboratory in Quebec. Going beyond pavements, MTQ has effectively adapted this test procedure and established a method to review the effectiveness of various metallic and polymeric coatings on steel. By blasting wet Ottawa Sand over coated steel samples in a computer controlled pattern, many years of abrasion can be replicated in a few hours. MTQ has conducted testing on culvert steels with coatings of zinc, aluminum and polymer laminate (Trenchcoat) in the past. We were able to compare the results of these tests with the Corrpro test results from 2002 which looked at the same materials. From here we can then quantify expectations. Based on these findings it was deduced that if we retested the three known materials and added the new polymer coated structural plate material we could establish the relative performance of each and develop predictive abrasion models for the new polymer coating.

Large Polymer Coated Structural Plate Corrugated Steel Pipe on Vancouver Island in a Severe Level 4 Abrasion Environment Prior to Installation of Sacrificial Concrete Pavement and Fish Baffles

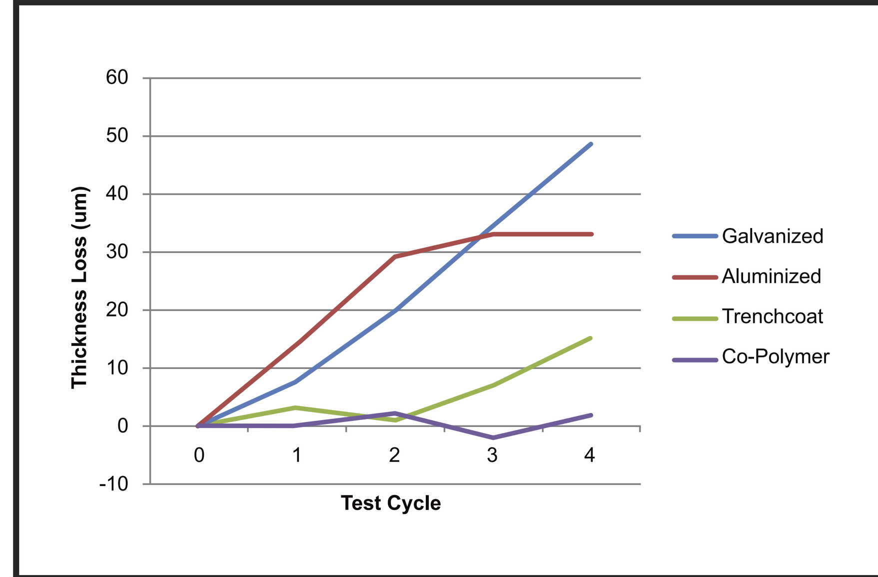
Accelerated Abrasion Test Apparatus used in Corrpro / NCSPA Study March 2002

Abrasion Level	Bedload Description	Anticipated Flow Velocity (m/s)	
		Minimum	Maximum
1	No bedload regardless of velocity. (Eg. Storm Sewer or Stormwater Detention Facility)	NA	NA
2	Minor bedloads of sand and gravel	0	1.5
3	Bedloads of sand and gravel	1.5	4.5
4	Heavy bedloads of gravel and rock	4.5	Above

Abrasion Level

1	2	3	4
Polymer Laminated	Polymer Laminated	Polymer Laminated	A sacrificial concrete pavement may be applied
Aluminized Type 2	Aluminized Type 2		
Galvanized	Galvanized		

Abrasion Level Charts and Limits Developed from the Corrpro Tests



Performance of coatings in sand blasting test.

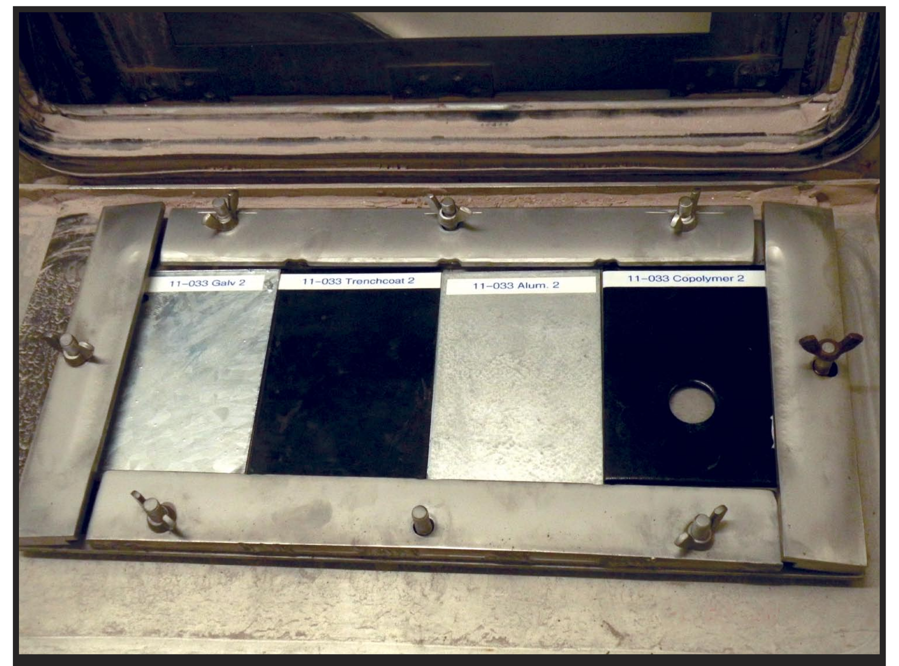
Abrasion Condition Coating Options

1 Non	2 Low	3 Moderate	4 Severe
Polymer Coated Plate	Polymer Coated Plate	Polymer Coated Plate	
Galvanized Plate	Galvanized Plate		
Alternate Structure[1] - Composite Systems[2]	Alternate Structure[1] - Composite Systems[2]	Alternate Structure[1] - Composite Systems[2]	Alternate Structure[1] - Composite Systems[2]

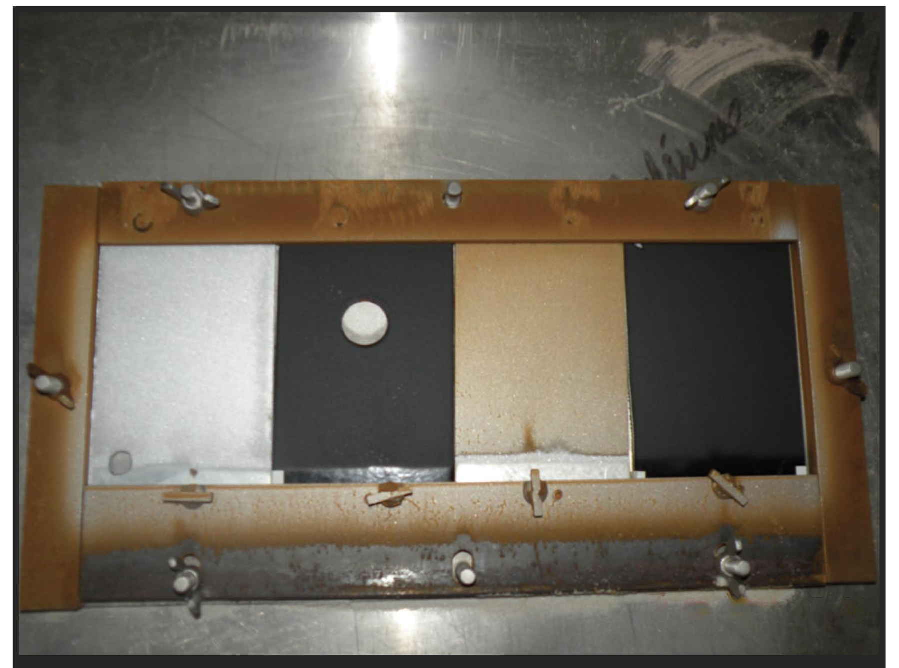
Predictive Abrasion Model for Polymer Coated and Hot Dip Galvanized Steel

Comparative testing of polymer coated structural plate has been performed by Transports Québec, Service des Matériaux Infrastructures in accordance with Méthode LC 21 102, "Aggregates Resistance to Polishing: Sand Blasting Method." The test involves subjecting test panels to abrasive impact from Ottawa sand. The sand was blasted on the surface at a rate of 570 g/minute for four cycles at 43.3 minutes per cycle. The graph shows the measured coating thickness loss during the course of the testing. As can be seen, the EAA copolymer on the corrugated plate product outperformed the Trenchcoat. Both EAA materials out performed the metallic coatings (galvanized and aluminized).

Abrasion Testing Chamber



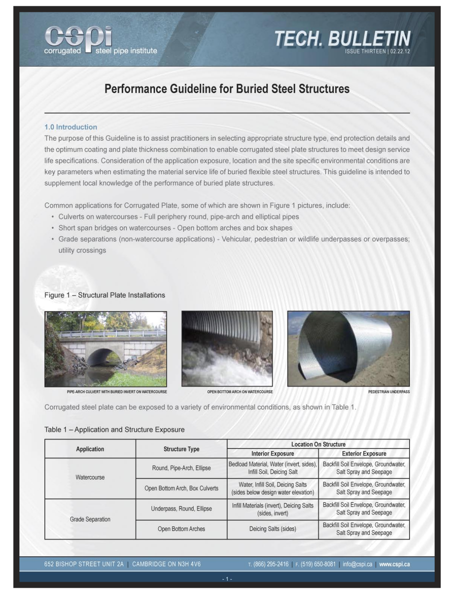
Samples of Hot Dip Galvanized, Polymer Laminated (Trenchcoat), Aluminized Type 2 and Polymer Coated Steel Mounted in Test Plate. Coating thickness was measured prior to and after each of four test cycles

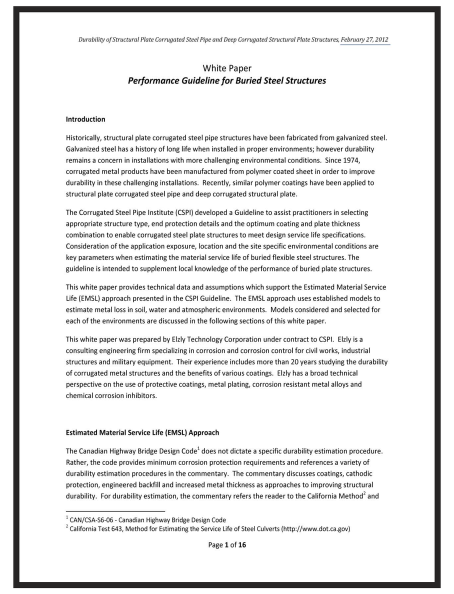


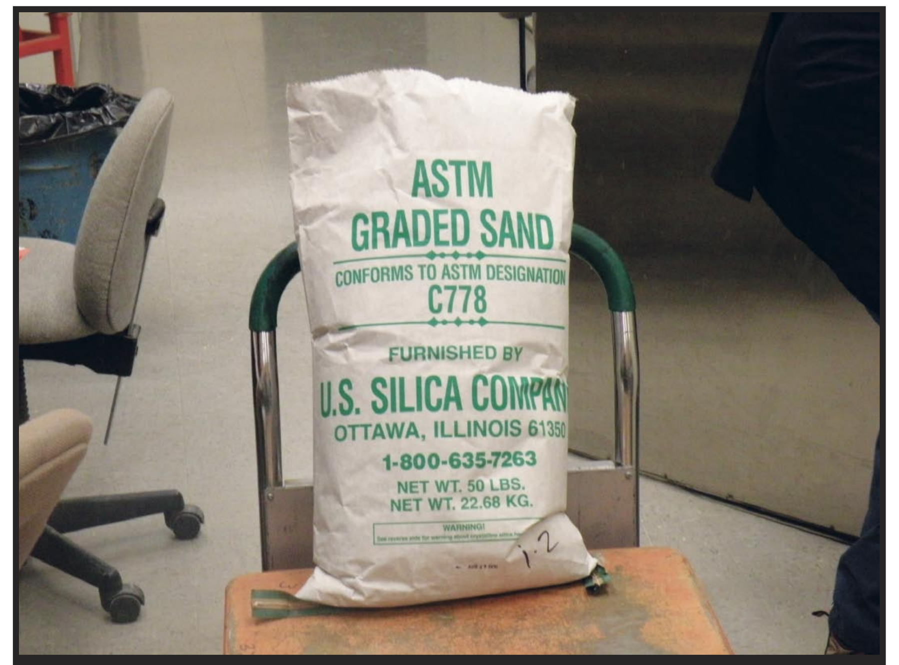
The Four Materials after four cycles of Abrasion Testing

Conclusions

Polymer coated structural plate performed well in aggressive abrasion tests conducted at the MTQ laboratory. The results support tests and review by a number of other agencies. The innovative test methods adapted and developed at MTQ have established a level of confidence in Polymer Coated Structural Plate that will lead to an earlier use and acceptance of the product. Through analysis of all test data and an extensive literature review by a qualified Corrosion Engineer it is possible to develop predictive models as they relate to the long term field performance of the product. These models and analysis are captured in the "Performance Guideline for Buried Steel Structures" and the supporting "White Paper" www.cspi.ca.







Aluminum Oxide (Al203) is used in Pavement Testing while Wet Ottawa Sand Provides a Test that is more Representative of Culvert Abrasion

Examples of Pavement Abrasion Test Samples at the MTQ Facility

Polymer Coated Deep Corrugated Structural Plate Arch at the St. Lawrence River, QC

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