Adapting European Pavement Tests to Prove Coating Performance on Steel Culverts

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. Anumber 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 pave-

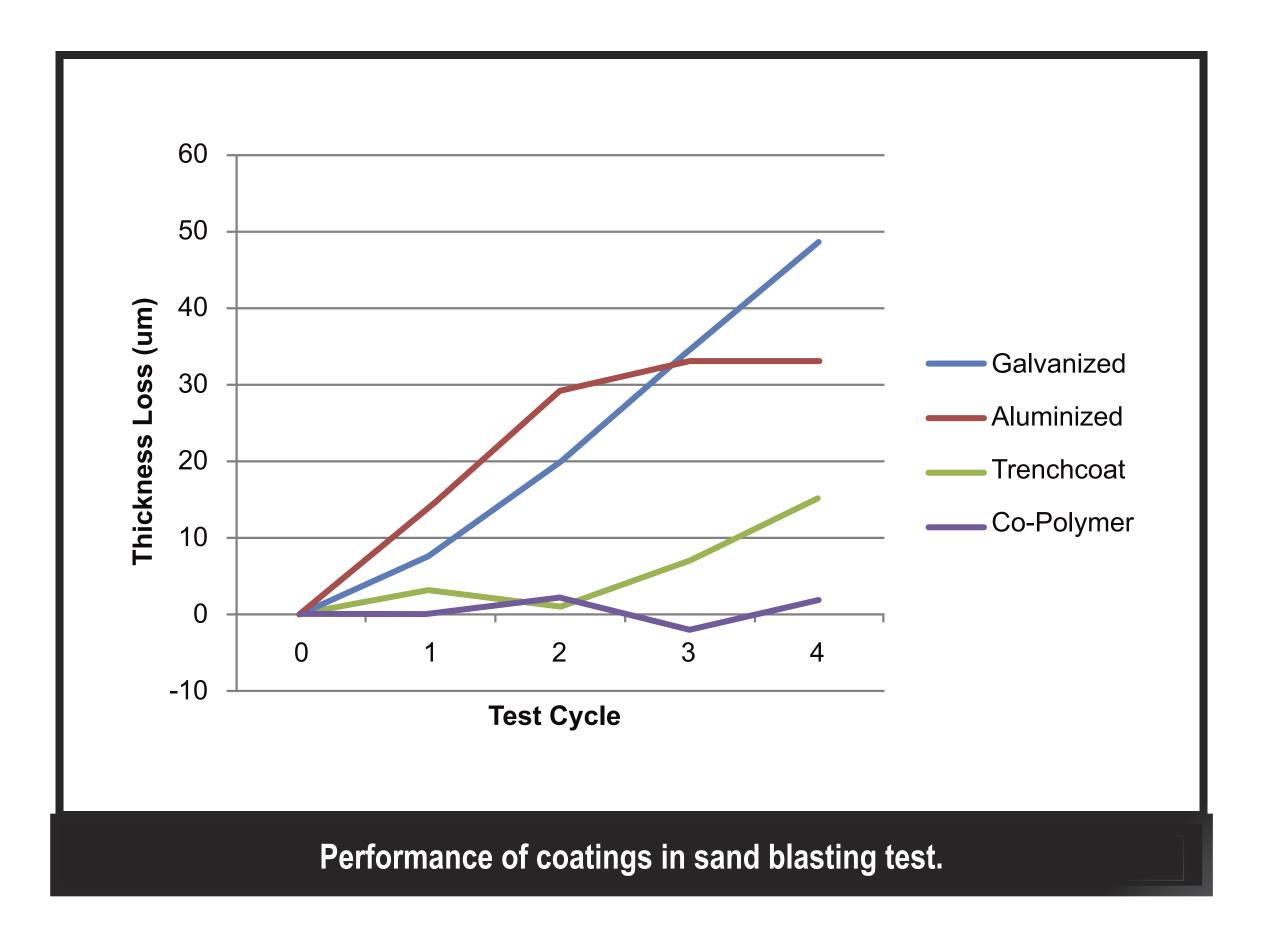


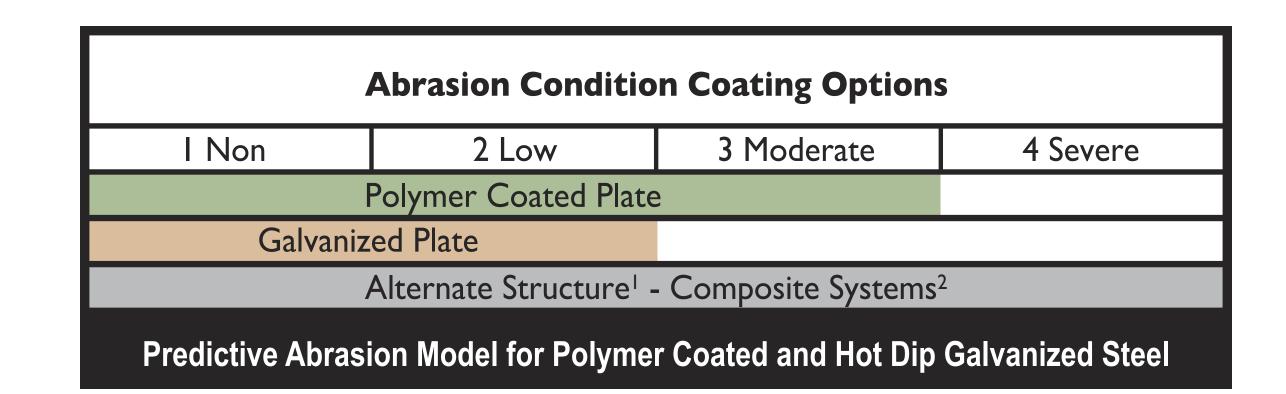
Large Polymer Coated Structural Plate Corrugated Steel Pipe on Vancouver Island in a Severe Level 4 Abrasion Environment Prior to Installation of Sacrificial Concrete Pavement and Fish Baffles



Abrasion Level	Bedload Description		Anticipated Flow Velocity (m/s)		
			Minimum	Maximum	
I	No bedload regardless of ve (Eg. Storm Sewer or Stormy Detention Facility)		NA	NA	
2	Minor bedloads of sand and	gravel	0	1.5	
3	Bedloads of sand and gravel		I.5	4.5	
4	Heavy bedloads of gravel an	d rock	4.5	Above	
Abrasion	Level				
	Polymer Laminated			rificial	
ŀ	Aluminized Type 2			concrete pavement may be applied	
	Galvanized				
I 2		3		4	

ments, 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.

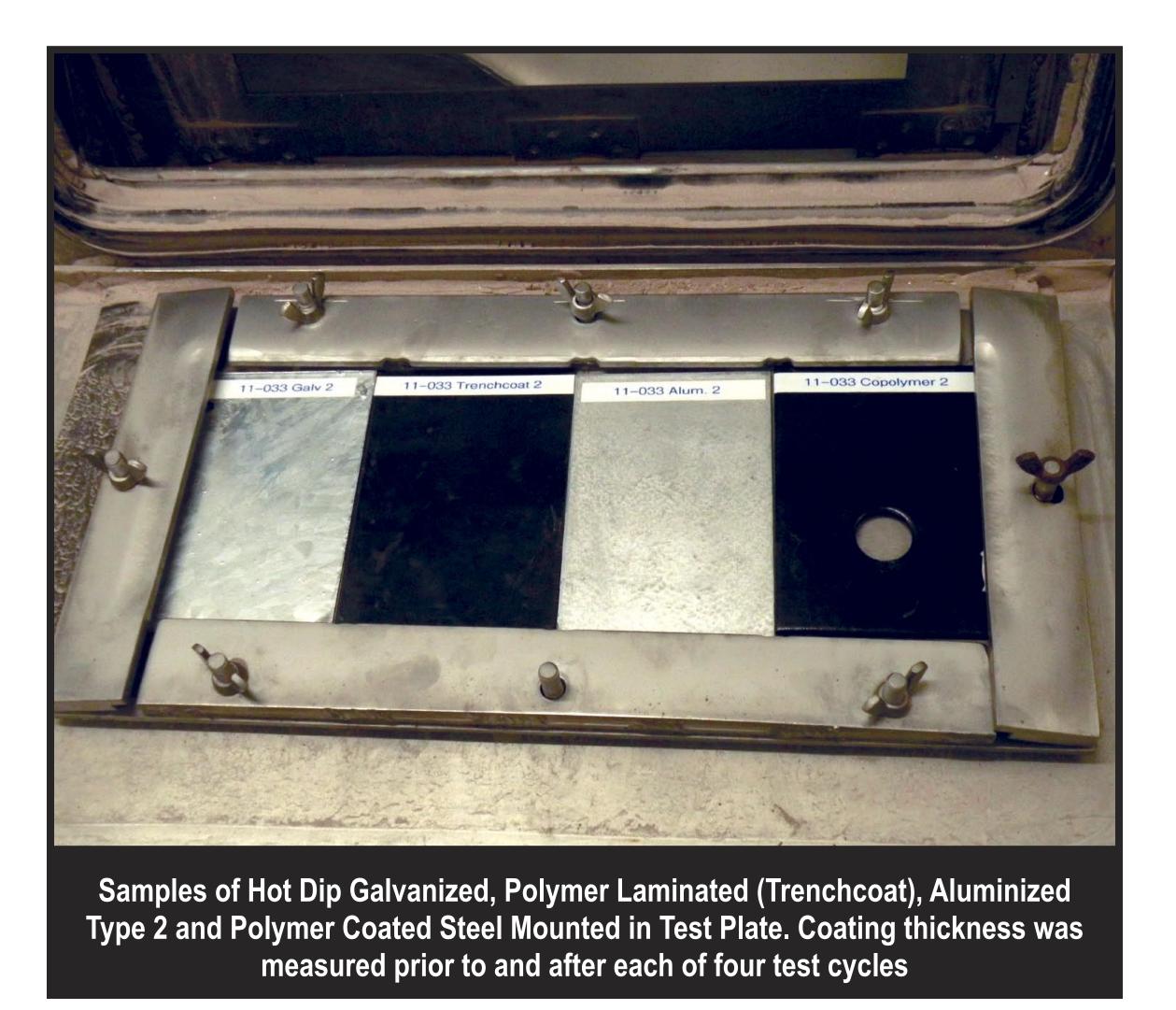




Comparative testing of polymer coated structural plate has been performed by Transports Québec, Service des Matériaux Infrastructures in accordance with Méthode LC 21 102, "Aggregates Resistance to Polishing: Sand Blasting Method." The test involves subjecting test panels to abrasive impact from Ottawa sand. The sand was blasted on the surface at a



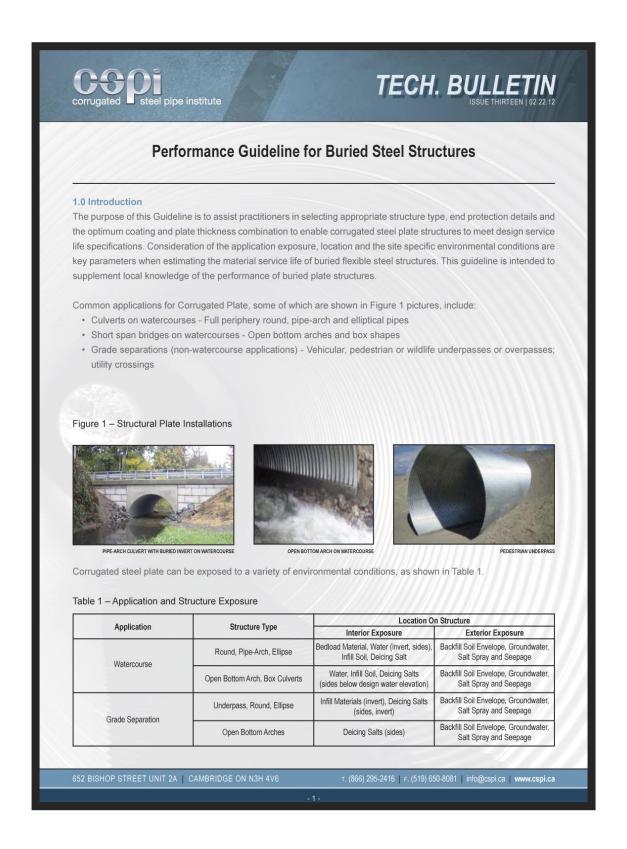
rate of 570 g/minute for four cycles at 43.3 minutes per cycle. The graph shows the measured coating thickness loss during the course of the testing. As can be seen, the EAA copolymer on the corrugated plate product outperformed the Trenchcoat. Both EAA materials out performed the metallic coatings (galvanized and aluminized).



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.



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



	Durability of Structural Plate Corrugated Steel Pipe and Deep Corrugated Structural Plate Structures, February 27, 2012		
	White Paper		
Performance Guideline for Buried Steel Structures			
1	ntroduction		
r	distorically, structural plate corrugated steel pipe structures have been fabricated from galvanized steel. Galvanized steel has a history of long life when installed in proper environments; however durability emains a concern in installations with more challenging environmental conditions. Since 1974, orrugated metal products have been manufactured from polymer coated sheet in order to improve lurability in these challenging installations. Recently, similar polymer coatings have been applied to tructural plate corrugated steel pipe and deep corrugated structural plate.		
	The Corrugated Steel Pipe Institute (CSPI) developed a Guideline to assist practitioners in selecting ppropriate structure type, end protection details and the optimum coating and plate thickness ombination to enable corrugated steel plate structures to meet design service life specifications. Consideration of the application exposure, location and the site specific environmental conditions are sey parameters when estimating the material service life of buried flexible steel structures. The udeline is intended to supplement local knowledge of the performance of buried plate structures.		
2	his white paper provides technical data and assumptions which support the Estimated Material Service ife (EMSL) approach presented in the CSPI Guideline. The EMSL approach uses established models to estimate metal loss in soil, water and atmospheric environments. Models considered and selected for each of the environments are discussed in the following sections of this white paper.		
	This white paper was prepared by Elzly Technology Corporation under contract to CSPI. Elzly is a consulting engineering firm specializing in corrosion and corrosion control for civil works, industrial tructures and military equipment. Their experience includes more than 20 years studying the durability of corrugated metal structures and the benefits of various coatings. Elzly has a broad technical berspective on the use of protective coatings, metal plating, corrosion resistant metal alloys and hemical corrosion inhibitors.		
E	stimated Material Service Life (EMSL) Approach		
F	The Canadian Highway Bridge Design Code ¹ does not dictate a specific durability estimation procedure. Aather, the code provides minimum corrosion protection requirements and references a variety of Iurability estimation procedures in the commentary. The commentary discusses coatings, cathodic protection, engineered backfill and increased metal thickness as approaches to improving structural Iurability. For durability estimation, the commentary refers the reader to the California Method ² and		
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Polymer Coated Deep Corrugated Structural Plate Arch at the St. Lawrence River, QC

