

MEMO

TO: The Winnipeg Blue Bombers Entertainment Group (WBBEG)

FROM: David Amorim – Architect of Record
Amorim & Amorim Architecture (AAA)

DATE: March 25, 2015

PROJECT No.: 0001.2015IGF

SUBJECT: *Evaluation of Structural Steel Coating Alternatives and Final Recommendation*

This memo is to inform The Winnipeg Blue Bombers Entertainment Group (WBBEG) of Amorim & Amorim Architecture's (AAA) recommendation to proceed with a **Duplex** system for use on the exposed structural steel for the proposed Winnipeg Blue Bombers stadium. A duplex system will be less expensive over the life of the stadium and will offer drastically improved resistance to corrosion.

1.0 BACKGROUND

The Winnipeg Blue Bombers of the Canadian Football League (CFL) have long been referred to as the “*Blue and Gold*”. The blue and gold colours are part of the Blue Bomber brand and play a significant role in marketing the team. The Canad Inns Stadium (Figure 1), opened in 1953, has been the Blue Bombers home field to present day. As can be seen in Figure 1, exposed structural steel has been painted in either blue or gold, reinforcing the importance of these colours to the team's identity.

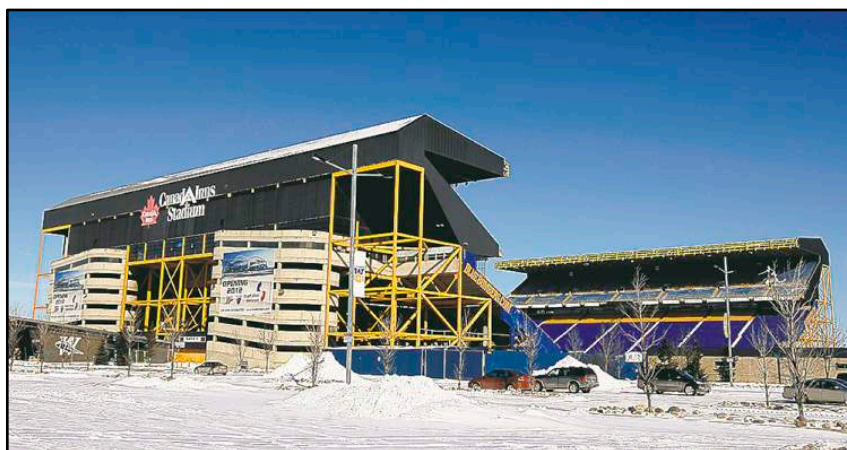


Figure 1 – Canad Inns Stadium [1]

Due to a fan's accidental death at the stadium in 2006, a major review of the Canad Inns Stadium was completed and a final report was issued in 2008 by local structural engineering firm Crosier Kilgour & Partners Ltd (CKP) [2]. The report published by CKP discussed the general condition of

the stadium and provided a professional opinion on the probable costs to address any identified issues.

While AAA understands that WBBEG desires the use of a traditional paint system (TPS) for the exposed structural steel elements (as shown in Figure 2) to maintain the *Blue and Gold* brand, special attention should be paid to the 2008 report issued by CKP. In particular, CKP retained Canadian Structural Inspection Services (CSIS) to conduct a thorough structural steel inspection – it was ultimately reported “*there are numerous areas throughout the facility where exposure to the elements has caused advanced deterioration. Three principal conditions must be addressed: loss of strength, loose material in danger of falling, and tripping hazards. Since there is limited redundancy in the frames which comprise the structure, deterioration must be addressed diligently*”. The expected repair cost (excluding professional fees and contingencies) was estimated at \$2,300,000 [2].



Figure 2 – Proposed Investors Group Stadium Concept [3]

While there are a number of other code compliance issues with the Canad Inns Stadium leading to the decision to replace the current stadium with the proposed [2], the cost to repair the structural steel damage is not insignificant. AAA stresses that WBBEG consider the fact that the current specified paint system for the proposed Investors Group Field does not vary drastically from that applied to the deteriorated Canad Inns Stadium. Therefore, AAA has considered the use of a duplex paint system (hot-dip galvanized (HDG) steel combined with paint) as an alternative. The following *Alternatives* section provides the rationale behind the final recommendation.

2.0 ALTERNATIVES

TRADITIONAL PAINT SYSTEM (TPS)

1. Background and Mechanism of Protection

A typical TPS, such as that used in the existing deteriorated Canad Inns Stadium, provides resistance to corrosion predominantly through barrier protection [4]. In other words, the paint layer effectively acts as a physical barrier providing resistance

to corrosion inducing materials from coming in contact with the structural steel. Typical TPS's generally consist of several layers as shown in Figure 3.

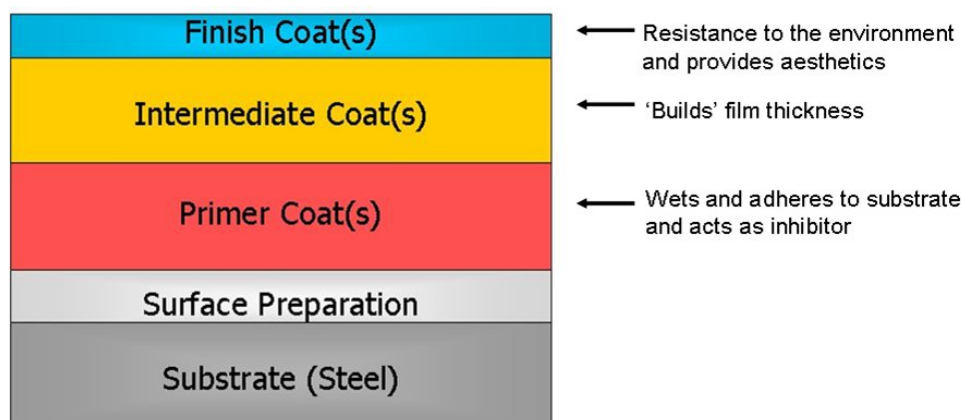


Figure 3 – Schematic Diagram of a Typical Traditional Paint System [4]

As with other corrosion protection systems, preparation of the steel surface is extremely important [4]. The *Steel Structures Painting Council* defines various levels of surface preparation that the Engineer may specify prior to the application of a typical paint system. Once the substrate surface has been adequately prepared, a primer coat followed by both an intermediate and final finishing coat are typically applied.

Manitoba Infrastructure and Transportation (MIT), the governing department of transportation, has published *Specification 1070(I) – Specifications for Coating Structural Steel* [5]. While this specification is written for coating systems applied to highway bridge girders, it is the only structural steel coating specification found to be prepared by local departments and is therefore of importance; should WBBEG decide to pursue the use of a TPS, *MIT Specification 1070(I)* would be invaluable in providing guidance with respect to several approved paint systems, application processes, guarantee guidelines, etc.

2. Cost

The typical TPS costs approximately \$1.60/ft² [6]. A comparison between a TPS and a duplex system can be found in the *Life Cycle Cost Analysis* section.

3. Advantages

An advantage to simple paint systems is the general familiarity of the system by local contractors. This system has been frequently used over the years in Manitoba and there is no shortage of local contractors able to provide this product. Additionally, a paint only system is less expensive upfront (capital cost); while this may be perceived as an advantage, AAA stresses that the overall lifecycle costs must be considered when comparing the two alternatives.

4. Disadvantages

The most serious disadvantage of a TPS is that once the physical paint barrier is compromised, deleterious substances are free to attack the unprotected steel and begin corroding the member [6]. This corrosion can be difficult to spot as it can sometimes progress underneath the otherwise visually satisfactory paint coating. Once corrosion has begun, costly repairs will likely be required to halt the corrosion process and ensure the continued structural integrity of the member.

Additionally, *MIT Specification 1070(I)* states that:

“A written guarantee from the supplier of the coating system within fourteen (14) days of completion of coating operations stating that the product will perform satisfactorily for a minimum period of five (5) years from the completion date... The supplier shall guarantee the replacement of the coating, including any surface preparation, touch-ups, and final overcoats, at no cost to the Department in the event that the coating system does not perform satisfactorily over the five (5) year guaranteed time period. [5]”

Given that the proposed stadium has been designed for a 75-year design life, specifying a corrosion protection system guaranteed for only 5 years by the coating supplier does not seem sensible.

DUPLEX PAINT SYSTEM

1. Background and Mechanism of Protection

A duplex paint system is essentially a combination of a hot-dip galvanized (HDG) system with a painted system overtop. It is well known that HDG systems provide excellent protection against chloride attack due to sacrificial (cathodic) action. Zinc oxide initially forms upon exposure of HDG to dry air. With moisture, zinc oxide is converted to zinc hydroxide that further reacts with carbon dioxide to form zinc carbonate, ultimately protecting the steel from the environmental conditions. During corrosive conditions, the steel member becomes an electrochemical cell; the protected steel becomes a “cathode” while the zinc coating becomes an “anode”. Since the anode corrodes at a quicker rate, the zinc is “sacrificed” to protect the steel members [7]. Thus, the primary mechanism of protection is an electrochemical mechanism. Further, the HDG coating also serves as a physical barrier against deleterious substances. In addition, the paint system overlaying the HDG further provides a physical barrier. This synergistic effect between the HDG and paint is specifically what makes a duplex system advantageous.

2. Cost

The typical duplex system costs approximately \$3.68/ft² [6]. A comparison between a traditional paint and a duplex system can be found in the *Life Cycle Cost Analysis* section.

3. Advantages

The synergistic effect of a duplex system **results in a 1.5 to 2.3 times longer lifetime** for a duplex system compared to the sum of the individual lifetimes of the HDG and paint coatings. This lifetime is further extended with regular maintenance [7]. Further, aesthetics is not sacrificed as the exact blue and gold finish can be achieved with a duplex system.

4. Disadvantages

Compared to a TPS, a major perceived drawback of duplex systems is the cost. Unfortunately, many owners only consider the capital costs of the steel coating system and choose to ignore the fact that a duplex system is likely less expensive over the life of the structure.

Some owners that have realized the impressive corrosion resistance advantage of a duplex system during the planning stage have been disappointed with the final duplex product; this is due to a lack of knowledge by both the client in specifying an appropriate duplex system and by the fabricator in being unfamiliar with duplex systems; it is not due to duplex systems being inferior to TPS's. **Just as with a TPS, HDG surface preparation is essential to ensure the satisfactory performance of the overall duplex system** [7]. Therefore, to ensure that WBBEG will be completely satisfied with the end product, AAA will produce a *Duplex System Special Provision* which shall be included in the contract tender document. A rough draft of the Special Provision is included in this memo. Please note, this Special Provision would be elaborated on significantly prior to tendering.

3.0 LIFE CYCLE COST ANALYSIS

The proposed stadium will require approximately 60,000 ft² of structural steel coating. Over the 75-year design life, it is reasonably assumed that the chosen coating system will require routine maintenance consisting of repainting or touch-ups as shown in Table 1. Assuming a conservative 3% inflation rate and a 5% discount rate, the life cycle costs of the two systems listed in the net present value (NPV) are shown in Table 1. It can be seen that even though the duplex system's capital cost is double that of the TPS, the life time cost for the duplex system is actually lower, due to less expected maintenance. It should be stressed that these costs are only the tangible material/labour costs and do not incorporate intangible costs such as loss of revenue due to stadium closures for routine maintenance. With only three maintenance projects for a duplex versus twelve for a TPS system, the period of time the stadium is closed and losing revenue is significantly reduced.

Table 1 – Life Cycle Cost Analysis of Structural Steel Coating Options

Traditional Paint System¹							
Year	0	6	12	18	24	30	36
Unit Cost	\$1.60	\$1.91	\$2.28	\$2.72	\$3.25	\$3.88	\$4.64
Quantity (ft²)	60000	20000	20000	40000	20000	20000	60000
NPV	\$96,000.00	\$28,512.65	\$25,405.34	\$45,273.35	\$20,169.74	\$17,971.64	\$48,039.29
Year	42	48	54	60	66	72	
Unit Cost	\$5.54	\$6.61	\$7.89	\$9.43	\$11.26	\$13.44	
Quantity (ft²)	20000	20000	40000	20000	20000	20000	
NPV	\$14,267.99	\$12,713.07	\$22,655.20	\$10,093.12	\$8,993.18	\$8,013.10	
TOTAL =	\$358,107.67 2015 Dollars						

Duplex System²				
Year	0	20	40	60
Unit Cost	\$3.68	\$6.65	\$12.00	\$21.68
Quantity (ft²)	60000	10000	10000	10000
NPV	\$220,800.00	\$25,049.92	\$17,051.59	\$11,607.09
TOTAL =	\$274,508.60 2015 Dollars			

¹Minor touch-ups (20,000 ft²) have been assumed to be required at years 6, 12, 24, 30, 42, 48, 60, 66, 72.

¹Major touch-ups (40,000 ft²) have been assumed to be required at years 18 and 54.

¹A full repaint has been assumed to be required at year 36 (approximately half the design life); since the structure is only designed for a 75 year design life, a full repaint is not provided at year 72.

²Minor touch-ups (10,000 ft²) have been assumed to be required every 20 years.

4.0 DUPLEX SYSTEM SPECIAL PROVISION (DRAFT FOR TENDER DOCUMENT)

General

This Special Provision shall apply to any Works involving the use of paint over hot-dip galvanized coating (HDG), otherwise known as a duplex system, for coating structural steel. The Fabricator is advised that many post treatments are known to complicate application of the paint system. The Fabricator shall submit a written outline of the galvanizing process including all treatments to be provided with approximate timelines for approval by the Engineer prior to commencing the Works.

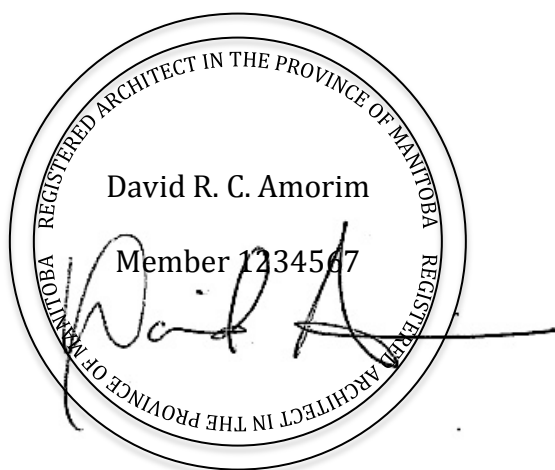
Paint System

The Fabricator shall use an acrylic powder coat system found on the approved products list appended to this document. The Fabricator may opt to utilize a different paint system, such as epoxy-polyamides or latex-acrylics, pending the approval of the Engineer. Prior to commencing the Work, the Fabricator shall prepare trial members demonstrating to the Engineer the overall process to be used, including the HDG surface preparation, application of paint, and final colors on the fully cured member. The Fabricator is advised that he shall not begin the painting process until the Engineer has inspected the HDG surface of each member.

Surface Preparation

The Fabricator shall follow *ASTM D6386-10 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting*.

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5.0 WORKS CITED

- [1] Christian Cassidy. (2008, April) Winnipeg Stadium. Photograph.
- [2] Crosier Kilgour & Partners Ltd. (2009, December) Update of January 2008 Briefing Document on Structural Condition and Required Remediation. Final Report.
- [3] ChrisD. (2011, August) An artist's rendering of the future Winnipeg Blue Bombers stadium at the UofM. Rendering.
- [4] SteelConstruction.info. Paint Coatings. [Online]. http://www.steelconstruction.info/Paint_coatings
- [5] Manitoba Infrastructure and Transportation. (2010, March) Specification 1070(I) - Specifications for Coating Structural Steel. Interim Specifications.
- [6] American Galvanizers Association. Duplex Systems - Painting Over Hot-Dip Galvanized Steel. Final.
- [7] American Galvanizers Association. (2012, Unknown) Hot-Dip Galvanizing for Corrosion Protection: A Specifier's Guide. Guide.

Word Count (not including words in tables or figures, Works Cited or this page)
1983/2000

DISCLAIMER: Please note that Amorim Consulting is a fictional architectural firm and The Winnipeg Blue Bombers Entertainment Group is a fictional client commissioning this project. However, the Winnipeg Blue Bombers are a real CFL team located in Winnipeg, Manitoba, Canada. Figure 1 is a real picture of the old Canad Inns Stadium, now demolished; CKP is a real firm which was responsible for the condition report referenced in the background of this essay; Investors Group Field is the real name of the stadium ultimately built to replace the deteriorated Canad Inns Stadium. It should be noted that Figure 2 is of a real concept proposed by the architect of record but the final constructed stadium ultimately differed from that shown. The architect's seal is not real and the author is in no way, shape, or form, suggesting that he is a licensed architect; the seal is simply for effect given the nature of this essay. Ultimately, this essay is submitted for consideration for the AGA Edgar K. Shutz Memorial Scholarship and shall not be interpreted as anything other than simply a fictional educational work.

My name is David Amorim and I am an Engineer in Training and a Graduate Student at the University of Manitoba in Winnipeg, Manitoba, Canada. I'm currently completing my Masters of Science in Structural Engineering. With the ambition of becoming a respected leader in the field of bridge engineering, I'm always eager to expand on my technical knowledge. Having worked on several large bridge projects with a local consulting firm throughout my studies, I'm a believer of the almost limitless possibilities of structural steel granted that the proper system, such as a hot-dip galvanized system, is incorporated into the design to ensure the continued success of the structure throughout its lifetime. I love working with steel and I am thankful that organizations such as the American Galvanizers Association exist to provide industry professionals with a wealth of technical knowledge and tools to improve our work.

Thank you for the consideration for the Edgar K. Shutz Memorial Scholarship.



David Amorim

