U.S. Department of Transportation
Federal Highway Administration

Georgia Division

61 Forsyth Street S.W.
Atlanta, Georgia 30303
404-562-3630
404-562-2703
GA.fhwa@dot.gov

December 16, 2013

In Reply Refer To:
HPE-GA

Mr. Keith Golden, P.E.
Commissioner
Georgia Department of Transportation
One Georgia Center
600 West Peachtree
Atlanta, Georgia 30308

Dear Mr. Golden:

We have reviewed the request to use proprietary items on the Bridge Replacement Project, BHF00-0151-01(006), PI 631570-, SR 225 at New Town Creek and Coosawattee River, Gordon County.

FHWA accepts the Certification provided by the Georgia Department of Transportation that the following items are essential for the proposed context sensitive design and that no equally suitable alternative products are available:

- Natina Steel Guardrail TP W-31 inch, 3900 LF
- Natina Steel Guardrail TP T including bridge connections, 168 EACH
- Natina Steel Guardrail TP 1 Anchorage, 5 EACH
- Natina Steel Guardrail TP 12 Anchorage, 3 EACH

Therefore, FHWA finds that it is acceptable to use the above listed items for the purpose of no equally suitable alternative products. This approval is only applicable to be used on Federal Project Number BHF00-0151-01(006), PI 631570-, Gordon County.

If you have any questions, please contact Vuong (Victor) Dang, Transportation Engineer, at (404) 562-3654.

Sincerely,

for Rodney N. Barry, P.E.
Division Administrator

Cc: Genetha Rice-Singleton, State Program Delivery Engineer
Cc: Dave Peters, Conceptual Design Group Manager
Cc: Chandria Brown, Project Manager

Keith Golden, P.E., Commissioner

GEORGIA DEPARTMENT OF TRANSPORTATION

One Georgia Center, 600 West Peachtree Street, NW
Atlanta, Georgia 30308
Telephone: (404) 631-1000

December 13, 2013

Mr. Rodney Barry – Division Administration
Federal Highway Administration
61 Forsyth Street, Suite 17T100
Atlanta, GA 30277
Attention: Melinda Roberson

Subject: Proprietary Items Usage
PI # 631570-; Project BHF00-0151-01(006)
Proposed Bridge Replacement – SR225 @ New Town Creek & Coosawattee River
Gordon County

Mr. Barry:

Please review the attached request for the use of proprietary products on the above project. The Department considers the use of the proposed proprietary items to be in compliance with 23 CFR 635.411 where no equally suitable alternative exists.

The proposed project is located in the New Echota Traditional Cultural Property, and the commitments in the approved environmental document require the use of context sensitive guardrail design. Since the use of weathering steel guard rail end terminals is no longer approved by FHWA, weathering steel could not provide a consistent appearance throughout the Traditional Cultural Property. The Natina coating would be added by the guardrail manufacturer prior to delivery to the project site, and the coating would add approximately $3.00 per linear foot to the cost of the guardrail (total estimated costs are provided in the attached document). GDOT's Office of Environmental Services concurred that the use of the Natina steel would satisfy the context sensitive guardrail design requirements.

Should you have any questions or concerns, please contact Dave Peters at 404-631-1738 or Chandria Brown at 404-631-1580.

Sincerely,

Brent Story, P.E.
State Design Policy Engineer

BAS:drp

Cc: Genetha Rice-Singleton, State Program Delivery Engineer
Attn: Chandria Brown, Project Manager
Glenn Bowman, State Environmental Administrator
Attn: Sam Pugh, NEPA Specialist

CDM Smith
3715 Northside Parkway, N.W.
Building 300, Suite 400
Atlanta, Georgia 30327
tel: 404-720-1400
fax: 404-467-4130

November 29, 2013

Ms. Chandria Brown, PE
Project Manager
Georgia Department of Transportation
Office of Program Delivery (25th Floor)
600 West Peachtree Street, NW
Atlanta, GA 30308

Subject: Use of Proprietary Items for
GDOT PI: 631570, Project number BHF00-0151-01(006)
Proposed Bridge Replacement – SR225 @ New Town Creek & Coosawattee River, Gordon County

Dear Ms. Brown,

Federal Highway Administration regulation in 23 CFR 635.411 provides the regulatory authority for FHWA's participation in the cost of a patented or proprietary product. For the Proposed Bridge Replacement – SR 225 @ New Town Creek & Coosawattee River Project, *PI 631570*, I request to use the items documented in this letter based on Federal Guidance where no equally suitable alternative exists.

635.411 Material or Product Selection

Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

1. Such patented or proprietary item is purchased or obtained through competitive bidding with equally suitable unpatented items; or
2. The State transportation department certifies either that such patented or proprietary item is essential for synchronization with existing highway facilities, or that no equally suitable alternate exists; or
3. Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.

The following guardrail types meet the Context Sensitive Design (CSD) requirement of this project, BHF00-0151-01(006), as part of the Conditions for No Adverse Effect for the New Echota Historic Site, Traditional Cultural Property, and National Historic Landmark:

Option 1: Steel-Backed Timber

Standard TP W -31 inch Galvanized Guardrail: $ 18.00/LF
Steel-Backed Timber Guardrail: $ 58.00/LF
Additional Cost of Steel-Backed Timber Guardrail Option = (58-18)*3900 LF = **$156,000**
Pros/Cons: High initial installation and maintenance cost.

Option 2: Weathered Steel

Standard TP W -31 inch Galvanized Guardrail: $ 18.00/LF
Weathered Steel Guardrail: $ 24.00/LF
Additional Cost of Weathered Steel Guardrail Option = (24-18)*3900 LF = **$23,400**
Pros/Cons: Safety concerns and high maintenance cost due to premature deterioration at the connections. Weathered steel anchorages are not allowed and using galvanized end units with weathered steel guardrails creates visually incomplete CSD.

Option 3: Painted Galvanized Steel

Standard TP W -31 inch Galvanized Guardrail: $ 18.00/LF
Painted Galvanized Steel Guardrail: $ 26.00/LF
Additional Cost of Painted Galvanized Guardrail Option = (26-18)*3900 LF = **$31,200**
Pros/Cons: High maintenance cost due to fading colors over time from sun exposure.

Option 4: Powder Coated Steel

Standard TP W -31 inch Galvanized Guardrail: $ 18.00/LF
Powder Coated Steel Guardrail: $ 40.00/LF
Additional Cost of Powder Coated Guardrail Option = (40-18)*3900 LF = **$85,800**
Pros/Cons: High initial installation and maintenance cost during the periodic replacement due damage.

Option 5: Stained (Oxidation Accelerator Applied) Galvanized Steel – Natina Steel Application

Standard TP W -31 inch Galvanized Guardrail: $ 18.00/LF
Oxidation Accelerator Applied Steel Guardrail: $ 21.00/LF
Additional Cost of Powder Coated Guardrail Option = (21-18)*3900 LF = **$11,700**
Pros/Cons: **Lowest** initial installation and maintenance cost. Utilizes the regular galvanized steel and creates a rustic look on galvanized surfaces without adversely affecting the protection offered by the galvanized layer. The accelerator solution can be applied at any galvanized steel guardrail production facility or after the installation.

We have performed market research on the oxidation accelerators to find similar products and applications for galvanized steel guardrails. However, the only product available in the market at this point is the Natina Steel produced by Natina Product, LLC. Recently Natina Products, LLC submitted Natina Steel to Georgia Department of Transportation's New Product Evaluation Program to be included in the GDOT's Qualified Products Lists. Currently GDOT is evaluating the Natina Steel product and performing laboratory and field testing program on Natina Steel products. In addition, Natina Steel product has been used to stain guardrails, handrails and 24" corrugated pipe for the Mountain Loop Project in Utah.

Based on the aforementioned information, the Natina Steel proprietary items are proposed for use for the Proposed Bridge Replacement – SR 225 @ New Town Creek & Coosawattee River Project, *PI#* 631570, BHF00-0151-01(006):

Manufacturer: *Natina Products, LLC*
Quantity in Project: *3900 LF*
Total Estimated Cost for *(item)*: $*81,900.00*

Model: *Natina Steel Guardrail TP W -31 inch*
Finish: *Weathering Galvanized Steel*
Color: *Earth-tone hues, medium to dark brown*

Manufacturer: *Natina Products, LLC*
Quantity in Project: *168*
Total Estimated Cost for *(item)*: *$9,408.00*
Model: *Natina Steel Guardrail TP T including bridge connections*
Finish: *Weathering Galvanized Steel*
Color: *Earth-tone hues, medium to dark brown*

Manufacturer: *Natina Products, LLC*
Quantity in Project: *5*
Total Estimated Cost for *(item)*: *$3,650.00*
Model: *Natina Steel Guardrail TP 1 Anchorage*
Finish: *Weathering Galvanized Steel*
Color: *Earth-tone hues, medium to dark brown*

Manufacturer: *Natina Products, LLC*
Quantity in Project: *3*
Total Estimated Cost for *(item)*: *$6,000.00*
Model: *Natina Steel Guardrail TP 12 Anchorage*
Finish: *Weathering Galvanized Steel*
Color: *Earth-tone hues, medium to dark brown*

The total estimated costs for materials listed above are based on recent construction bids on similar projects. These costs include materials, labor, tax, and freight.

The estimated total construction cost for the project is approximately *$7,000,000.00.* The total cost of *$100,958.00* for proprietary items represents *1.4%* of the estimated construction costs.

I, Umit Seyhan, do hereby certify that in accordance with the requirements of 23 CFR 635.411(a)(2), that these patented or proprietary items are essential for the proposed context sensitive design for the Proposed Bridge Replacement – SR 225 @ New Town Creek & Coosawattee River Project, *PI#* 631570, and that no equally suitable alternative products are available. The use of these products is essential to match the visual appearance of proposed context sensitive design facilities previously approved by the GDOT Office of Environmental Services and for compatibility with the GDOT Design Guidelines. Since the use of guard rail end terminals made from weathering steel in accordance with ASTM A588 is no longer approved by FHWA due to significant section loss within a short period of time, this patented or proprietary item consists of galvanized guardrails and end terminals with appearances similar to weathering steel A588. Utilizing these patented or proprietary items will eliminate non-matching end terminals along the project as well as increase the durability of the guardrails while reducing the periodic maintenance.

I, Umit Seyhan, respectfully request that the use of these proprietary products be approved. If you require any additional information, please let me know. I can be reached by email (seyhanu@cdmsmith.com) and office phone (404.720.1279).

Sincerely,

Umit Seyhan, PhD, MBA, PE
Project Manager

Attachments to include:

A. NATINA Steel Product Material Safety Data Sheet
B. NATINA Steel Applied Galvanized Steel Projects
C. GDOT's New Product Evaluation Report Sheet
D. Improved Corrosion-Resistant Steel for Highway Bridge Construction FHWA-HRT-11-061
E. Meeting Minutes for CSD on March 7, 2011

Material Safety Data Sheet

M.S.D.S.

Natina Products, LLC

Thermal, California

FOR CHEMICAL EMERGENCY SPILL, LEAK, FIRE, EXPOSURE, ACCIDENT: CALL CHEMTREC 1-800-424-9300

NATINA® STEEL

SECTION 1 Chemical Product and Company Information

Product and Trade Name:	Natina® Steel
Formulator:	Natina Products, LLC PO Box 4563 Palm Desert, CA 92261
Emergency Telephone:	CHEMTREC: 1-800-424-9300 (24 Hours)

SECTION 2 Composition/Information on Ingredients

Chemical Name:	Liquid Aesthetic Restorative Agent: Creates weather-aged color and patina on Steel Surfaces.
Chemical Family:	Blend of Organic Extracts and Sequestered Inorganic Salts.
Chemical Composition:	Soluble plant-derived organic matter and liquid sequestered iron, manganese, zinc, and copper sources.
Inert Ingredients:	Water
Note:	Oxidizes Galvanized Surfaces to create a rustic brown finish (medium - dark brown colors) without compromising the protection of the galvanized layer.

SECTION 3 Hazardous Identification

Health Hazards: Extremely low. Natina Steel is both non-toxic and non-hazardous to users and the environment.

SECTION 4 First Aid Measures

Ingestion:	Harmful if swallowed. Obtain medical attention.
Inhalation:	Remove the affected individual or individuals to fresh air.
Eyes:	Promptly flush eyes with clean, cool water for at least 15 minutes. Obtain medical attention
Skin:	Wash from skin with soap and water

SECTION 5 Fire Fighting Measures

Flash Point:	Not Flammable
Flammable Limits:	Not Applicable
Fire Extinguisher Media:	Not Applicable (Product not considered flammable)
Firefighting Procedures:	None (Product not considered flammable)
Explosion Hazard:	None

SECTION 6 Special Use and Protection Information

Avoid breathing product mists during application. Avoid prolonged or skin contact. Avoid eye contact with this product. Use a NIOSH particulate respirator if respirable mist generation occurs or is anticipated during product application. Use protective equipment (protective coveralls, nose masks, gloves, goggles, hats, etc.) as required or indicated by conditions of product use.

SECTION 7 Cautionary Statements for Persons Handling this Product

CAUTION:

- May be harmful if swallowed in quantity. Do not ingest.
- Product may irritate the eyes. Use goggles.

- Mists may irritate the respiratory system. Nose masks are recommended.
- Prolonged product contact may irritate the skin. Wash exposed skin area thoroughly after handling or applying.
- Avoid product contact with strong oxidizers and/or strong acids.
- Keep this product out of reach of children

Work/Hygiene Practices: Do not eat, drink, or smoke when handling this product. After handling, always wash hands before eating, smoking, drinking, using the toilet, or applying cosmetics or topical medications.

SECTION 8 Physical and Chemical Properties

Boiling Point:	Approximately 250° F @ 1 atmosphere	Miscibility in water:	Completely miscible
Specific Gravity:	1.1 to 1.2	Reaction with water:	No reaction compounds
Flashpoint:	Not Applicable	Solid Content:	36%
% Volatile by Volume:	Negligible	Weight/Gallon:	9.2 lbs
Salting Out Temperature:	<32°F		
Appearance/Odor:	Medium brown/amber color, with slight fertilizer-like odor.		
pH:	1.0 – 2.0*		
Note regarding pH:	Natina Steel contains soft, buffered, organic acids that are completely harmless to users and the environment (including: humans, soil, waterways, animals, plants, etc.). The organic acids that this product contains are very different than inorganic acids (i.e. sulfuric) and are not harmful in any way. These acids are similar in nature to lemon juice and, when used as recommended, will not harm the environment whatsoever.		

SECTION 9 Material Storage Information

Store this product in a cool place, away from sources of high heat.

SECTION 10 Spill, Leak and Disposal Procedures:

Notify management of any spills or leaks.
Spills and leaks should be absorbed, swept up, and disposed of according to non-hazardous chemical use.

SECTION 11 Reactivity Information

Stability:	Stable	Conditions to Avoid:	Excessive heat
Hazardous Decomposition Products:	Carbon Dioxide		
Hazardous Polymerization:	Will not occur		

SECTION 12 Transportation Information

Non -hazardous substance. Natina® Steel is not hazardous under UN or I.A.T.A. regulations.

SECTION 13 Regulatory Information

SARA TITLE III HAZARD CATEGORY:	IMMEDIATE:	Y	FIRE:	N	SUDDEN RELEASE	
	DELAYED:	N	REACTIVE:	N	OF PRESSURE:	N

SUBSTANCES REGULATED UNDER SARA, TITLE III, SEC. 313: None Listed

DATE OF ISSUE: 8/15/2010
UPDATED: 4/10/2012

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NATINA

World's Best Staining Technology

Contact Natina 877.7.NATINA (877.762.8462)

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Mountain Loop Project

The Federal Highway Administration used Natina Steel to stain the guardrail, handrail, and 24" corrugated pipe on this project in Utah and everything turned out perfect.

NATINA

World's Best Staining Technology

Contact Natina 877.7.NATINA (877.762.8462)

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Caltrans-Central Fence

Natina Steel beautifies guardrails, and just about any other type of galvanized surfaces, by creating a rustic brown color that will not fade from UV over time.

NATINA

World's Best Staining Technology

Contact Natina 877.7.NATINA (877.762.8462)

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Caltrans - Santa Cruz

Natina Steel has now been approved by a number of states for use on guardrails and just about any other kind of galvanized surface you can think of!

Natina News

El Dorado County Completes Wall Parapet & Guardrail Replacement & Enhancement Project!

General Contractor: *C.C. Myers, Inc.*

Agencies Involved: *Caltrans & TRPA*

Product Manufacturer & Application Specialists: Natina Products, LLC
(A.K.A. Natina Desert Varnish Solutions)

Before

After

Rustic Brown Guardrails that Blend with Nature

The California Department of Transportation (Caltrans) in conjunction with the Tahoe Regional Planning Agency (TRPA) and C.C. Myers, Inc. (General Contractor) recently completed work on the Highway 50, Echo Summit Wall Parapet Replacement and Water Quality Improvement Project (Contract No. 03-1E14U4). Work was performed to replace the existing 18-inch rock wall found at a scenic viewpoint in the Lake Tahoe Basin. The barrier wall, built in 1939 and located in El Dorado County from Echo Summit eastbound to Johnson Pass Road, was deteriorating in several locations due to both natural occurrences (i.e. falling rocks, weather conditions, etc.) and through interaction with snow removal equipment and, occasionally, vehicle crashes.

TRPA is a bi-state agency, created in 1969 by California and Nevada, and ratified by Congress, to protect the environment of the Lake Tahoe Region. As such, and since the existing rock parapet and the associated retaining wall are eligible for the National Register of Historic Places, TRPA required that special measures were taken to maintain the aesthetics of the current structures and surrounding areas. For instance, the new barrier was required to mimic the original wall in color and texture, although some modifications to the new design were needed for motorist safety, in order to preserve its visual characteristics. To accomplish this, the design of the new barrier was poured using elastomeric formliner that was designed to match the previous barrier wall. The new barrier now replicates the shape, colors and bonding pattern of the historic parapet to the greatest practical extent while still being able to meet motorist safety requirements. Steps, like these, taken to preserve both the

NATINA STEEL

at a glance

Uses: *Permanent color enhancement for galvanized surfaces.*

Color: *Rustic brown finish (earth-tones ranging from medium to dark brown).*

Application: *Customized self-contained spray rig or pre-treatment at an off-site location.*

Natina Products, LLC
P.O. Box 4563
Palm Desert, CA 92261
Phone: (877)7NATINA
Fax: (866)420-1708
www.natinaproducts.com

historic and scenic beauty of the Lake Tahoe region are certainly appreciated by visitors and residents alike who continue to enjoy the Lake year in and year out.

Another enhancement to the project was to replace old metal guardrail with new metal guardrail and use a product called Natina Steel to create a rustic brown appearance on the otherwise shiny galvanized guardrails and end terminals. This environmentally safe solution (composed wholly of natural oxidizers found in soil and soft organic acids) is applied directly to a number of galvanized surfaces including but not limited to: guardrails, steel posts, sign posts, culvert markers, mile markers, grates, and isolation casings. Natina Products, LLC, based out of Coachella, CA, began applying their patent pending solution on August 3rd and finished in just 2 days.

Once applied, Natina Steel immediately reacts with the zinc found in galvanized surfaces and quickly (over the following 5 – 21 days depending on sunlight and heat intensity) forms a rustic brown finish similar to A588/Weathered Steel (A588 Steel has been found to be unsafe by a number of transportation agencies so its use was not allowed) without compromising the protection offered by the galvanized layer. So, rather than having shiny metal surfaces that contrast harshly with the surrounding landscape, Natina Steel is able to create a beautiful rustic finish that blends with the natural environment.

The best part is that since Natina Steel contains no color pigments, but instead develops its color through the oxidation process, the color will not fade from sun exposure. So, these beautiful rustic brown guardrails will look great for many years to come with little to no maintenance or their associated expenses! The final inspection of the newly colored guardrails along this stretch of scenic roadway was recently completed and everyone is very pleased with the results.

> ***"Natina Steel is able to create a beautiful rustic finish that blends with the natural environment. "***

This Caltrans project was funded in part by the American Recovery and Reinvestment Act of 2009. The general contractor on the project was C.C. Myers, Inc. of Rancho Cordova, California.

Natina News

Los Angeles County Completes Guardrail Replacement & Enhancement Project

Lance Grindle
Assistant Division Head, Design Division
Los Angeles County Public Works

Project Contractor:
Ace Fence Company

Product Manufacturer & Application Specialists: Natina Products, LLC
(A.K.A. Natina Desert Varnish Solutions)

Before

After

Guardrails That Complement Nature

Los Angeles County Public Works (County) completed work on their Guardrail Replacement Project (Contract #RDC0014180) shortly after the beginning of the New Year. The goal of the project was to replace guardrails at 37 separate locations along Mulholland Highway in the unincorporated communities of Cornell and Monte Nido. As the existing guardrails were approaching the end of their useable life, and since roadway safety is of the utmost concern to the County, this project is one that the County and local residents took very seriously.

One of the goals laid out by the County in their Countywide Strategic Plan is to "provide improved infrastructure to better serve the public and enhance the quality of life in the affected communities." So as not to detract from the beauty of the surrounding landscape, the County decided to implement weathering steel, conforming to ASTM A588, for the guardrails on this stretch of scenic coastal highway. A588 is a type of steel that quickly develops a layer of rust on the outermost surface and is typically used for aesthetic purposes as many prefer their rusty appearance when compared to the shiny metal appearance of a galvanized guardrail.

Unfortunately, the County found out from the guardrail manufacturer, Trinity Highway Products (Trinity), that end terminals (the last piece of each guardrail section ranging up to 50' in length) made from A588 steel are no longer approved for use by the Federal Highway Administration and were therefore unavailable. This created a problem for the County as they did not want to have the rusty looking guardrails alongside non-matching, shiny galvanized, end terminals.

Fortunately Trinity was able to refer the County to Natina Products, LLC (A.K.A.

NATINA STEEL

at a glance

Uses: *Permanent color enhancement for steel surfaces.*

Color: *Earth-tone hues ranging from tan to very dark brown.*

Application: *Customized self-contained spray rig.*

Natina Products, LLC
P.O. Box 4563
Palm Desert, CA 92261
Phone: (877)7NATINA
Fax: (866)420-1708
www.natinaproducts.com

Natina Desert Varnish Solutions). They offer their technologically advanced and patented product, called Natina Steel, which is applied directly on top of galvanized surfaces and is able to achieve a look similar to A588 steel without adversely affecting the protection offered by the galvanized layer. Lance Grindle, the Assistant Division Head of Design Division at the County said that "in order to make sure that the best solution was used for the job, the County took a look at various options and eventually selected Natina Steel for its longevity and ease of periodic maintenance." In the end, in order to create a more uniform appearance, the County had Natina Products, LLC apply Natina Steel not only to the galvanized end terminals but to the guardrails as well.

> ***"The County took a look at various options and eventually selected Natina Steel for its longevity and ease of periodic maintenance."***
> ***Lance Grindle***

Natina Products, LLC started applying their patented formula and finished this entire project in just 6 days. Natina Steel is an environmentally safe solution that is composed of natural oxidizers (found in soil) and soft, buffered organic acids. Once Natina Steel is applied to galvanized surfaces it quickly reacts with the zinc layer and forms a rustic brown finish over the following 5 – 21 days (depending on sunlight and heat intensity). The best part, according to Ryan Morey of Natina Products, LLC "is that because Natina Steel contains no pigments but instead develops its color through the oxidation process itself the color will not fade from sun exposure." So, these beautiful rustic guardrails will look great for many years to come with little to no maintenance and their associated expenses!

On February 24, 2011 the County, along with representatives from Ace Fence Company (the guardrail installer) and Natina Products, LLC, completed their final inspection of the newly colored guardrails along Mulholland Highway and everyone is very pleased with the results. Now, and for many years to come, this stretch of scenic coastal highway will be enjoyed by tourists and residents alike.

Georgia Department of Transportation

NPE Status Report --- Listed Alphabetically by Company Name

NPE#	Manufacturer	Product Name / Description	Estimated Time for Lab/Field Evaluation	Contact Info	Fee Paid	Status / Progress Report
1002-1	NAEX Corp.	"Firecide"	--	Complete	--	No Application
1303-3	Natina Products, LLC	"Natina Steel"	Fee / See Comments	Office of Materials and Testing-Brennan Roney-broney@dot.ga.gov Office of Materials and Testing-Brad Young-byoung@dot.ga.gov		Lab & Field Test
0505-5	NDS, Inc.	"Gravelbag, Snakebag 4, Snakebag 6, & Drain Donghnut" - Snake Bag-UV Monofilament Gravel Bag. UV Monofilament Fabric, Heat bonded at the seam	--	Complete	--	No Application
0606-2	Neenah Foundry Company	"Neenah Lift Mate" - Circular cast iron frame and platen lid, employing a patent pending ball and socket feature.	--	Complete	--	Accepted
9602-1	Neptco, Inc.	Arbortape (Staking and guying trees)	--	Complete	--	Accepted
7905-1	Neville Chemical Company	PaveBrite	--	Complete	--	No Status
0505-6	Newton Construction	"Jiffy Clip" - Plastic re-bar fastener. Nylon and Poly Propylene.	--	Complete	--	Accepted
0307-5	Nilex Corporation	"GeoRidge" A permeable plastic berm used in sediment control.	--	Complete	--	No Application
0707-1	Nordloh Industries LLC	"AutoBlanket® Staple" -	--	Complete	--	No Application
0605-15	North American Green	"SedimentSTOP" - Composed of 70% straw and 30% cononut fibers evenly distributed between two jute nettings.	--	Complete	--	No Application
0511-4	North American Green	"P550" - Permanent, ultra high strength, three-dimensional matting structure incorporated with a 100% polypropylene fiber matrix, swen together on 1.5 inch centers.	--	Complete	--	Accepted
0302-3	North American Green	"P550 Composite Turf Reinforcement Mat"	--	Complete	--	Accepted
9408-2	North American Green	North American Green C350 (Channel liner for erosion control and turf reinforcement.)	--	Complete	--	Accepted
0010-6	Northwest Pipe	Poz-Loc Slip Base , Socket System	--	Complete	--	No Application
0010-5	Northwest Pipe	SQ Post galvanized slip-base system	--	Complete	--	Accepted
0704-5	NPC	"Flex-Rib Frame-Chimney Seal" - Rubber sleeve and stainless steel bands are expanded into place between the manhole frame and cone forming a permanent monolithic, watertight, flexible seal, effectively blocking all infiltration.	--	Complete	--	Withdrawn/No Action
0910-3	NUCOR Steel Marion, Inc.	"+NU-GUARD™ 27"	--	Complete	--	Accepted

TECHBRIEF

Improved Corrosion-Resistant Steel for Highway Bridge Construction

FHWA Publication No.: FHWA-HRT-11-061

FHWA Contact: Paul Virmani, HRDI-60, (202) 493-3052, paul.virmani@dot.gov

This document is a technical summary of the Federal Highway Administration report, *Improved Corrosion-Resistant Steel for Highway Bridge Construction* (FHWA-HRT-11-062).

Introduction

Plate girder bridges are usually fabricated from painted carbon steels or unpainted weathering steels. Weathering steels, including the modern high-performance steels, offer the lowest life-cycle cost (LCC) over the design life of the bridge because, in most service environments, ongoing maintenance due to steel deterioration is not necessary. However, where the bridge is subject to high time-of-wetness or high chloride exposures—coastal areas and areas that use large quantities of deicing salt—weathering steels are not effective because the protective patina does not develop and the steel has a high corrosion rate.[1] In these conditions, structural stainless steel ASTM A1010 (UNS S41003) provides sufficient corrosion protection so that painting is not necessary and the bridge structure is maintenance free over its design life.[2] The initial cost of stainless steel is more than twice the cost of carbon or weathering steel. Reducing the cost of stainless steel would improve the LCC of bridges in severe corrosion service conditions. This study identifies steels with lower potential cost than ASTM A1010 that could be candidates for bridge construction while still providing low corrosion rates.

Approach

The alloy steel design selected to reduce the cost of ASTM A1010—that contains 11 percent chromium (Cr)—was to reduce the Cr content to 9, 7, and 5 percent. To compensate for the diminished corrosion resistance from lower Cr, additions of 2 percent silicon (Si), 2 percent aluminum (Al), or a combination of 2 percent Si plus 2 percent Al were made in the lower Cr experimental steels. After making and hot rolling the steels, the resulting plates were heat treated. These were tested for strength and impact resistance to determine which steels can meet the steel specifications for steel bridges.[3] The corrosion resistance of the alloyed steels was studied in the laboratory using accelerated test methods. In addition to measuring the corrosion rates, the corrosion products that developed on each of the steels were identified. Several steels were studied further by exposing them for 1 year on an existing weathering steel bridge that has a high corrosion rate due to deicing salt use.

Additionally, a LCC analysis was conducted to examine the benefits of using maintenance-free, corrosion-resistant steel in place of regularly repainting conventional steel. Both deterministic and probabilistic LCC

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
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analyses were conducted for a bridge intended to have a 125-year service life.

Results

Experimental Steels

Melting of six experimental steels was performed in an induction furnace under vacuum. The aim compositions of all heats was 0.015 percent carbon (C), 1.29 percent manganese (Mn), 0.022 percent phosphorus (P), 0.004 percent sulfur (S), 0.08 percent copper (Cu), 0.43 percent nickel (Ni), 0.24 percent molybdenum (Mo), 0.020 percent vanadium (V), and 0.0150 percent nitrogen (N). Table 1 shows the nominal compositions of each experimental steel.

Heats weighing 100 lb (45 kg) were poured into iron molds. The resulting ingots measured approximately 5 x 5 x 13 inches (125 x 125 x 350 mm). The ingots were heated one at a time in an electric furnace to 2,300 °F (1,260 °C) and hot rolled to 0.5625-inch (14.3-mm)-thick plates. These plates were normalized by heating to 1,650 °F (900 °C) and then cooling in air.

Mechanical Properties

The results of standard Brinell hardness tests on the as-normalized plates are presented in table 2. Most of the experimental steels exhibited the desired dual-phase or martensite microstructure, but the two Al-containing steels had an all ferrite microstructure, and they were relatively soft.

In the as-normalized condition, martensitic and dual-phase steels exhibited relatively high hardness, tensile strength, and yield strength. It was necessary to determine the temperature at which each steel needed to be tempered to achieve the two targeted yield strength levels of 50 to 65 ksi (344.5 to 447.9 MPa) and 70 to 85 ksi (482.3 to 585.7 MPa). This was accomplished by systematic heat treatment studies for each experimental steel using hardness testing and tensile testing. All the steels could be normalized and tempered to achieve the targeted 50 to 65 ksi (344.5 to 447.9 MPa) yield strength range representative of ASTM A709 50W, except 5Cr2Si2Al. All the steels could be normalized and tempered to achieve the ASTM A709 70W target yield strength of 70 ksi to 85 ksi (482.3 to 585.7 MPa), except 5Cr2Si2Al and 7Cr2Al.

The Charpy V-notch (CVN) impact test is specified for bridge steels.[3] Figure 1 presents the results of this test for the experimental steels. At the 50 ksi (344.5 MPa) strength level, only 11Cr, representing the ASTM A1010 steel, exhibited sufficient impact toughness to be a candidate for bridge construction. Similar behavior was observed for the 70 to 85 ksi (482.3 to 585.7 MPa) yield strength plates. The impact toughness results for the experimental steels are disappointing, but they may be explained by the optimum dual-phase microstructure of 11Cr with fine grain size compared to the other steels.

Table 1. Compositions of experimental steels.

Steel (Wt Percent)	Cr	Si	Al
11Cr (ASTM A1010)	11.4	0.5	—
9Cr	9.0	0.5	—
9Cr2Si	9.0	2.0	—
7Cr2Al	7.0	0.5	2.0
7Cr2Si	7.0	2.0	—
5Cr2Al2Si	5.0	2.0	2.0

— No (zero) aluminum present in these steels.

Table 2. As-normalized hardness and microstructures.

Steel (Wt Percent)	HBW	Microstructure
11Cr (ASTM A1010)	285	Dual-phase ferrite plus martensite
9Cr	313	All martensite
9Cr2Si	256	Dual-phase—more ferrite than 11 percent Cr
7Cr2Si	258	Dual-phase—more ferrite than 11 percent Cr
7Cr2Al	154	All ferrite
5Cr2Si2Al	200	All ferrite

HBW = Brinell hardness number (ASTM recognized).

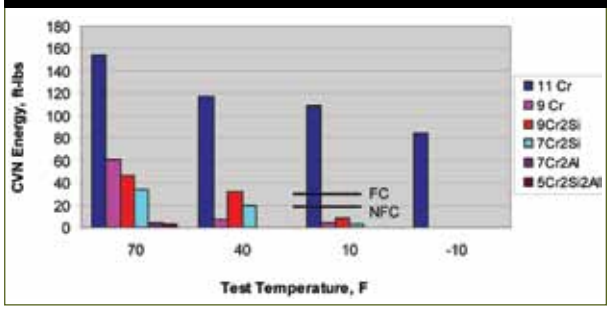
Laboratory Corrosion Evaluation

The atmospheric corrosion of bare structural bridge steels in chloride environments was simulated with the standard SAE J2334 cyclic corrosion test, consisting of 1-day cycles for 100 days.[4] Sets of coupons were run with a 5 percent sodium chloride (NaCl) spray solution, and another set of coupons was run with 3 percent NaCl solution to determine if a less severe chloride content in the spray solution might change the thickness loss rates from corrosion for any of the steels.[5] Thickness loss of test coupons and x-ray spectroscopic analysis of the corrosion products were both determined. Conventional ASTM A588 steel coupons representative of ASTM A709 50W bridge steel and ASTM A1010 coupons were tested along with the experimental steels.

The effect of yield strength on the thickness loss was measured for the 11Cr, 9Cr2Si, and 7Cr2Si steels. There was no significant difference in thickness loss for the two different yield strengths of the three steels. It was concluded that the corrosion behavior of these steels was not influenced by the steel yield strength.

The comparative corrosion behavior of the steels is presented in figure 2. As the number of corrosion cycles increased, the total thickness loss increased

Figure 1. Average CVN absorbed energy values for experimental steels tempered to achieve yield strength greater than 50 ksi (344.5 MPa).



5*(F-32)/9 °F = °C
FC = Fracture Critical; NFC = Non-Fracture Critical

for all the steels. The experimental steels, as well as the control ASTM A588 weathering steel, experienced thickness loss at a relatively constant rate per cycle. This behavior demonstrates that the protective patina responsible for providing reduced corrosion rates for weathering steels does not form when the test is conducted with 5 percent NaCl. Similar behavior was observed using 3 percent NaCl.

All the reduced Cr experimental steels had significantly less corrosion resistance than the ASTM A1010 control sample and its laboratory analog, the 11Cr steel. As the Cr content of the experimental steels decreased from 11 to 5 percent Cr, the corrosion rate (thickness loss) increased. However, all the experimental steels exhibited better corrosion resistance than the ASTM A588 control sample. Adding 2 percent Si to the 9 and 7 percent Cr steels was detrimental to corrosion resistance. This is shown in figure 2 by comparing 9Cr to 9Cr2Si. Substituting 2 percent Al for 2 percent Si in the 7 percent Cr steel had a strong positive effect on the corrosion rate. Figure 2 shows that the 7Cr2Al steel had the same corrosion performance as the 9Cr steel, suggesting that 2 percent Al is equivalent to 2 percent Cr for cyclic corrosion resistance.

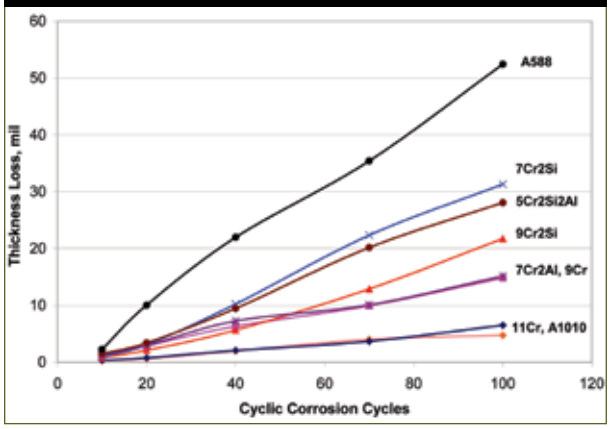
Since the corrosion rates in the cyclic corrosion tests appear to be linear, a regression equation was calculated for thickness loss as a function of cycles for each steel. The results of this analysis are presented in table 3. The values for the coefficient of determination (R^2) were all greater than 0.97, confirming that the corrosion rates of all the steels are linear with cycle number.

Under the conditions of the 5 percent NaCl cyclic corrosion tests, the corrosion rate of the ASTM A1010 steel is one-tenth that of ASTM A588, implying it will take 10 times longer for the same amount of thickness loss from ASTM A1010 as from ASTM A588.

Field Corrosion

In a field corrosion test site on the Moore Drive Bridge over I-394S in Rochester, NY, various steel coupons

Figure 2. Summary of 5 percent NaCl cyclic corrosion test results.



1 mil = 25.4 µm

Table 3. Linear regression equations for thickness loss in 5 percent NaCl cyclic corrosion tests.

Steel	Coefficient, Mil Per Cycle	Predicted Life Versus ASTM A588
ASTM A1010	0.050	10.4
11Cr	0.056	9.3
9Cr	0.147	3.5
9Cr2Si	0.197	2.6
7Cr2Si	0.304	1.7
7Cr2Al	0.152	3.4
5Cr2Si2Al	0.275	1.9
ASTM A588	0.519	1.0

1 mil = 25.4 µm

were exposed on racks mounted to the lower flange of the bridge.[6] The Moore Drive Bridge is in a location of high deicing salt use on interstate highway I-394S passing beneath the bridge. Following 4 years of exposure, ASTM A588 coupons experienced thickness loss of 10 mil (254 µm) or a rate of 2.5 mil per year (mpy) (60 µm per year), 10 times the generally accepted maximum rate for weathering steel of less than 0.25 mpy (less than 6 µm per year). At the same time, ASTM A1010 stainless steel coupons exposed for 2 years showed a corrosion rate of 0.58 mpy (14.7 µm per year).

The experimental steels selected for exposure on the Moore Drive Bridge were 9Cr, 7Cr2Si, and 7Cr2Al. After 329 days of exposure on the bridge, thickness loss of the steels was determined. The corrosion rate of each of the three developmental steels was 1.07, 1.11, and 1.20 mpy (27, 28, and 30 µm per year), respectively. These rates are less than one-half the 2.5 mpy (64 µm per years) of ASTM A588 weathering steel. The rust composition was similar for all three of the experimental steels: Akaganeite was the most abundant oxyhydroxide, followed by goethite and

lepidocrocite. Notably absent was maghemite, which was abundant on the cyclic corrosion test coupons. It was concluded that the cyclic corrosion test protocols used in this study were fundamentally different for Cr-containing steels than actual field environments for bridges exposed to deicing salts. It is likely the high time-of-wetness of the cyclic corrosion test promotes the formation of maghemite.

LCC Analysis

A LCC analysis examined the benefits of using a maintenance-free, corrosion-resistant steel in place of regularly repainting conventional steel. Deterministic LCC comparisons for a 125-year life span bridge girder made of painted carbon steel versus ASTM A1010 steel showed ASTM A1010 was more economical. Probabilistic LCC analysis determined that starting in about year 12 the probability that an ASTM A1010 steel girder costs less than a painted steel girder increases rapidly; the 50 percent probability occurs at year 15. By year 20 of service, the probability is over 90 percent that the ASTM A1010 steel girder is less expensive, and it becomes certain that the ASTM A1010 steel girder is less expensive than a painted conventional steel girder after year 40.

Summary

The efforts to develop a less costly but equally corrosion-resistant bridge steel than currently available ASTM A1010 were unsuccessful because the combination of strength and impact toughness required for steel bridge members could not be achieved with the lower Cr steels. The experimental steels were more corrosion resistant than ASTM A588. However, because ASTM A588 and other weathering steels do not develop a protective rust patina in the presence of high-salt exposure, bridges made from weathering steels or carbon steel must be painted and maintained by repainting at certain intervals for those service environments. Its corrosion resistance makes ASTM A1010 capable of lasting in structures for long periods of time—125 years, as considered in this study—without the need for initial painting or maintenance (i.e., repainting). Accordingly, the economic benefit of ASTM A1010 is gauged on its lower LCC compared to that of a conventional painted bridge steel.

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Researchers—This study was performed by ArcelorMittal in conjunction with Old Dominion University and Lehigh University.

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HRDI-60/07-11(600)E

SR 225 at New Echota
GDOT Project BHF-151-1(6), PI 631570
Gordon County

March 7, 2011, 11am

Attendees:

Chandria Brown, OPD
Stanley Hill, OPD
Ben Rabun, Bridge Design
Ben Buchan, Engineering
Heather Mustonen, Environmental Services
Matthew Kear, Environmental Services
Sam Pugh, Environmental Services
Tom Tran, Wilbur Smith Associates

Meeting Minutes:

The purpose of the meeting was to discuss the SR 225 project at New Echota (BHF-151-1(6), PI 631570) in relation to the Context Sensitive Design (CSD) efforts as part of the Conditions for No Adverse Effect for the New Echota Historic Site, Traditional Cultural Property, and National Historic Landmark. The goal was to address concerns raised over possible maintenance issues associated with the CSD preferences and how they may best be accounted for. A summary of the discussion surrounding each topic is below:

1. **Guardrail:** The different types of guardrail proposed for the design were discussed along with the concerns associated with each choice. Heather Mustonen noted that Weathered Steel guardrail was the original preference; however powder-coated or painted guardrail were preferred due to safety concerns with the weathered steel. Powder-coated was recommended because of its durability over painted. Ben Rabun raised concerns over the use of powder-coated guardrail and stated a preference for painted guardrail. He stated that guardrail will require periodic replacement due to damage and it would therefore be a better choice to use painted guardrail (ie. don't install guardrail with a 20 yr lifespan aesthetically that will only last 7 yrs due to damage, etc.). He suggested that colored guardrail be included in the plans and then allow the contractor to obtain the guardrail to meet the spec (most likely painted). Two additional guardrail options were discussed: cable barrier and wooden guardrail.
    - Cable barrier was discussed as another option to reduce the visual impact of the guardrail in the design. It was noted that the cable barrier would require a greater area of reflection, may affect the landscape plan, and would be dependent on the shoulder width. Ben Rabun also raised the question of how the cable barrier would be attached to the bridge end posts and stated that the use of steel as a transition to the bridge approaches would be preferable because there is precedent for it. It was

also stated that cable guard rails are typically used on medians with very flat slopes since they are designed for an area of reflection/movement of 12'.

- Ben Buchan inquired about the use of wood guardrail if the aesthetic was important to the design. Heather Mustonen indicated that that was the initial preference for guardrail noted by consulting parties in 2008. At the time, Wilbur Smith evaluated the feasibility of using steel-backed timber guardrail and noted that while it was crash tested to TL-3, it would likely have high construction and maintenance costs associated with it and recommended against its use. Ben Buchan stated that these reasons should not necessarily exclude the steel-backed timber guardrail from consideration.
- Ben Buchan also inquired about the necessity of guardrail throughout the project length and stated that the slopes should be reevaluated and adjusted to remove the need for guardrail where possible. *Update - Tom Tran provided the following information as a follow-up to the meeting:
  - *This project is on a fairly high fill embankment and requires guard rails in lieu of flatter slopes at different locations along the project for the following reasons:*
    1. *Reduce the construction limits to minimize the impact to New Echota Historic Site and Park.*
    2. *Reduce the construction limits to minimize the impact to the golf course.*
    3. *Reduce the construction limits to minimize the impact to stream buffers and other Environmentally Sensitive Areas such as wetlands, archaeological resources, and cultural resources.*
    4. *Reduce the construction limits along the high fill embankment section to lower the right-of-way acquisition cost by minimizing the required right-of-way,*
    5. *Reduce construction cost along the high fill embankment section by increasing the slope and minimizing the required volume of fill materials.*

    We will investigate in Final Design, ways to reduce the amount of guardrail and still have an economical impact to the project.

2. **Bridge Design:** The incorporation of a Cherokee basket weave design into the bridge barrier was discussed.
   - Stamping was proposed on the interior bridge barriers with the use of stain to provide contrast and make the pattern visible to traffic. Issues with weathering of the stain were discussed and it was stated that the use of stain should be avoided.
   - It was suggested that other state DOT's be contacted for their experience in this type of CSD.
   - The option of a plain bridge barrier with a stone veneer was presented as an option.
   - Heather Mustonen suggested that a compromise could be the use of a Kansas Corral bridge barrier and the incorporation of stamping into the wing walls and end posts instead of the barrier. This would reduce the maintenance concerns with the bridge

barrier and reduce the amount of specialized stamping that would be necessary while still providing the desired aesthetic.
    - Sam Pugh suggested that instead of staining the basket weave design, different textures could be used in the formliner to create the visual contrast that is desired. This would remove the potential for maintenance issues related to staining.
    - Any special pattern will need to be provided very specifically in the design/spec and can't be proprietary so as to restrict the contractor to a specific vendor.
3. **Signage:** The movement and elevation of the New Echota entrance sign was briefly discussed. It was determined that plans for this relocation do not need to be sent to Bridge Design for review. Wilbur Smith will need to include the detail for the construction of the sign in the plans and it will need to be reviewed and approved by DNR, however no special review by Bridge Design is required.
4. **General Comments:** It was stated that replacement and repairs to guardrail and bridge barriers will never completely match due to weathering, etc. Maintenance would be conducted by the District based on available budgets and this may include the temporary placement of unpainted steel guardrail. It was also stated that paint will likely be the method of repair whether the guardrail was painted or powder-coated. Ben Rabun stated that durability and cost should be considered when deciding which option of CSD guardrail to incorporate into the design.
    - It was decided that a cost comparison of the different CSD options should be presented.
    - Ben Buchan noted that CSD is not an end product; it is a process and the end result may end up saving money in the long run.

<u>Action Items:</u>

1. Heather Mustonen and Matthew Kear will transmit the preferences for the bridge designs to WSA for cost estimates. *See accompanying document
2. Wilbur Smith will examine the need for guardrail along the length of the project and whether or not the slopes can be adjusted and therefore minimize the overall amount required. *See update above
3. Heather Mustonen will contact other state DOT's to inquire about their CSD work.