Synopsis:

Weathering steel is NYSDOT’s first choice for steel multi-girder bridges under most conditions. This decision has been made in part because of the cost savings that can be realized due to decreased painting and maintenance requirements. However, recent studies have shown that this may not always be the case. This presentation will discuss some situations where bridges with weathering steel are underperforming and whether or not the situation can be rectified for future applications.

About the Presenters:

Brian McMahon is currently the Regional Design Engineer for NYSDOT in Rochester. During his 19 year career at NYSDOT he has also served as a Regional Structures Engineer and Engineer-In-Charge. He has a B.S. degree in Civil Engineering from the University of Notre Dame, and an MBA in Management from Syracuse University.

Richard McFadden has been employed as an engineer for the New York State Department of Transportation for 21 years. He is currently on temporary assignment as the Assistant Resident Engineer for the Ontario/Wayne County Transportation Maintenance Residency. He has 8 years of experience as a highway designer and 13 years experience as a bridge design squad supervisor including time spent as Acting Regional Structures Engineer. He has had varied engineering design experience throughout his career including major interstate interchanges to lift bridge rehabilitations and major bridge rehabilitations and replacements. Mr. McFadden has a B.S. degree in Civil Engineering and Environmental Engineering from Clarkson University.
WEATHERING STEEL

WHAT IS IT?

– A high strength steel designed to form a tight, protective layer of rust (a.k.a. patina).

– Once the rust patina is formed, the base steel is protected from the environment. The future rate of corrosion is practically zero.

– Appears to be “weathered” – tan/brown in color.
WEATHERING STEEL

HISTORY

• 1910 - A steel containing copper is found to have twice the corrosion resistance of conventional steel.
• 1930’s - First major application - used in RR cars.
  - First brand - US Steel’s “Cor-Ten” steel.
• 1940’s -1960’s - Weathering steels evolve, using elements such as chromium, phosphorus, silicon, nickel.
• 1960’s – Widespread use begins in bridges & high-rise buildings.
• 1968 – A-588 spec issued - with 4x corrosion resistance.
WEATHERING STEEL

WHY USE ON BRIDGES?

• Cost effective even with the slightly higher initial cost.
  - No ongoing corrosion means less maintenance required and a longer bridge life; $$$$ saved.

• Typical w. steel bridge is unpainted. No paint means:
  – No unsightly rust when paint fails.
  – No $$$ spent on painting contracts.
  – No lane closures tying up traffic.
  – No environmental concerns (blasting, paint waste).
WEATHERING STEEL

GUIDELINES FOR USE

Patina will **not** form under certain conditions:

- Where steel is continually wet –
  - e.g., areas with excessive rain, humidity, fog.
  - In areas with minimal water clearance (8’ to 10’ minimum is recommended).
- Where exposed to harsh industrial fumes.
- Where subject to severe marine conditions.
WEATHERING STEEL

HISTORY of USE by NYSDOT

• 1970 - NYSDOT starts slowly.

• 1980 – Declared our steel of choice under most conditions.

• 1990 – Used in 95% of new NYSDOT steel bridges.

• 2000 - NYSDOT owns over 1200 weathering steel bridges.
WEATHERING STEEL

PROBLEM !!!

• 1997 – During a bridge washing contract along I-390, “something odd” was noticed.
• Excessive corrosion evident.
• Sheets of rust could be washed off.
• The steel had flaking, pitting, and delaminations present.
• The protective patina had not formed!
Albany..........we have a problem!!
WEATHERING STEEL

BRIDGE PERFORMANCE ISSUE?

NYSDOT Actions:
– Our Main Office took site visits and conducted a statewide survey.
– Several other Regions reported similar findings where the patina was not forming.
– Bottom line – our weathering steel was not performing as expected!
– NYSDOT contacts the steel industry. A Corrosion Advisory Group is established, with reps from the steel industry and academia.
WEATHERING STEEL
BRIDGE PERFORMANCE ISSUE

- Of special interest - the I-390 Corridor:
  - A very large population of our oldest weathering steel bridges
  - A harsh environment - very high volumes of high speed traffic.
- Decision was made to focus our studies on Moore Drive over I-390 (Rochester). The 2\textsuperscript{nd} span over the Erie Canal makes for a good control.
- Sampling, measurements and testing take place.
Moore Drive over I-390
Moore Drive over Erie Canal
WEATHERING STEEL

INITIAL STUDY CONCLUSIONS – MOORE DRIVE

• Yes, it is weathering steel.

• Over the driving lanes, the patina had not formed.

• Large quantities of Akaganeite found - a non-protective rust formed in presence of chlorides.

• Troubles blamed on the combination of road salt and traffic spray.

• Aesthetic issue – yes, Structural issue - ?
WEATHERING STEEL

SECTION LOSS RATES

• 0.1 mil/year – good environment
• 1.0 mil/year – expected at high Chloride environment
• Moore Drive: Over 20 year life, 60 mils section loss
  ====> 3.0 mil/year, or 30 times “good” rate
• 60 mils is 1/16” - roughly 4% section loss at web.

• We are concerned!! Further studies desired.
• Then a “funny” thing happened…..
60 to 0 mph in 2.8 seconds
WEATHERING STEEL

Next study phase – Moore Drive Specimen Racks & Sensors

• 3 Racks of “coupons” placed in September 2001
  – Coupons to be retrieved after 1, 2, 4 & 8 years
  – Section loss and chemical composition will be studied
  – When is the corrosion occurring, does it accelerate?

• 3 Monitors placed to continuously measure:
  – Atmospheric conditions
  – Electrical current over time
  – Variations in corrosivity
Specimen Rack
Specimen Rack
Specimen Rack
WEATHERING STEEL

NYSDOT ACTIONS

- Bridge Manual changes have been made
  - Commentary on lessons learned
  - Tightened guidelines for use
  - Recommends an over-design if close to any of the guidelines (use additional 1/16” thicker steel)
  - Recommends painting the beams at joints (for a length of 1.5 x beam depth)
  - Overall goal – raise awareness of issue
WEATHERING STEEL

NYSDOT ACTIONS

• New Bridge Washing Specification
  – New washing item introduced specifically for Weathering Steel bridges
  – Power wash all steel surfaces – 3000 psi minimum
  – Remove loose flakes and sheets of rust
WEATHERING STEEL

NYSDOT ACTIONS

• Bridge Inspection Manual Changes
  – Discussion and better guidance provided.
  – Goal: to insure consistent ratings.
  – Important that we know where our worst performers are so they can be addressed.
WEATHERING STEEL

NYSDOT ACTIONS

• Still searching for solutions!
  – Summer 2002: application of Weather-Act & Chlor-Rid at the Kendrick Broad bridge over I-390
WEATHERING STEEL

Summary

• Weathering steel bridges should not be considered 100% maintenance free.
• Owners should be aware of the issues, especially with bridges in harsh environments.
• We will continue to use weathering steel, but will monitor performance more carefully.
• Moore Drive - coupon evaluation is ongoing.
• Kendrick Road - coatings will be monitored.