2.5.2.1.1 Materials

WEATHERING STEEL SELECTION CRITERIA
The purpose of the office standard is to provide guidelines to the engineer for the proper application of uncoated weathering steels and to make recommendations for maintenance to ensure continued performance of the steel. This criteria is taken from the FHWA Technical Advisory "Uncoated Weathering Steel in Structures", T5140.22, dated October 3, 1989.

DESIGN
Selection Criteria

1. Environmental considerations where weathering steel may not be used.
    - High rainfall, high humidity or persistent fog.
    - Industrial areas where chemical fumes may drift onto the structure. If the sulfur trioxide level is greater than 2.1 mg/100 cm^2/day average, weathering steel shall not be used. This would apply near fertilizer plants, such as the FMC Plant in Pocatello, Potlatch Plant in Lewiston, etc.
2. Geometrics and location
    - Grade Separations - The so-called "tunnel effect" is produced by the combination of narrow depressed roadway sections between vertical retaining walls, narrow shoulders, bridges with minimum vertical clearances and deep abutments adjacent to the shoulders as are found at many urban/suburban grade separations. These roadway/bridge geometrics combine to prevent roadway spray from being dissipated by air currents and can result in excessive salt in the spray being deposited on the bridge steel. Figure 1 shown below is representative of situations where use of uncoated weathering steel should be avoided where winter deicing salt use is significant.

    NOTE: There is no evidence of salt spray causing excessive corrosion in cases of narrow bridges with wing walls parallel to the over crossing road.

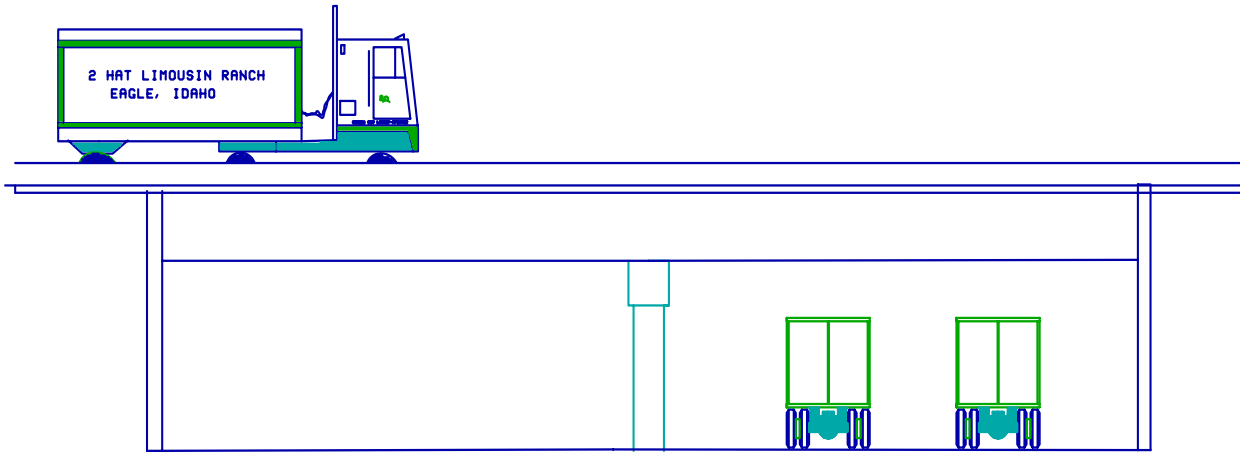

Figure 1 DEPRESSED ROADWAY TUNNEL EFFECT

    - Low Level Water Crossings - Sufficient clearance over bodies of water must be maintained so that spray or condensation or water vapor does not result in prolonged periods of wetness of the steel. Clearance to bottom flange of at least 10 feet over sheltered, stagnant water and at least 8 feet over running water is recommended.
3. Method of Selection
    - The Bridge Engineer, in cooperation with the Group Leaders, will make the selection. The selection will be based on stress, economics, environmental considerations, and aesthetics.
    - The selection will be made at the preliminary design stage.

Design Details

When weathering steel is used, the following design details should be utilized.

1. Controlling Roadway Drainage

   This is the first line of defense against localized corrosion by eliminating the exposure of the steel to contact with drainage from the roadway above, especially in areas where roadway salts are used.

   a. Joints:
      - To the extent possible, bridge joints should be eliminated. Virtually every bridge with joints has problems (corrosion, rideability, maintenance) attributable to the joint.
      - Extensive experience has shown that obtaining a permanent water-tight bridge joint is an elusive goal. Therefore, when joints are necessary, the assumption should be that the joints will leak and that drainage will contact the steel. Therefore, all steel within a minimum distance of 1 1/2 times the depth of the girder from the joint should be coated. In addition, Finger Joints shall not be used with weathering steel bridges unless given prior approval of the Bridge Engineer.
      - Drip bars on the top and bottom of the lower flanges can be effective in intercepting drainage and preventing it from running long distances along the flange and causing corrosion of the uncoated steel. However, welding of any attachment to the tension flange should be considered only after a thorough analysis of the impact of the attachment on fatigue life of the member.

   b. Drains
      - The spacing between drainage scuppers should be maximized in accordance with established hydrologic and hydraulic design. The FHWA Publication HEC 21, "Bridge Deck Drainage Guidelines", provides sound recommendations in this regard. Refer to Bridge Design Manual Article 2.6.6 for a design procedure. As scupper spacing increases, the volume of water required to pass through each scupper increases, thus creating velocities high enough to flush outlets clogged by deposits from low volume rainfalls.
      - Scupper downspouts should be designed and placed such that drainage will not contact the steel surface. However, details used to connect scuppers to drain pipes have often created more problems than they have prevented. Do not use flat runs of piping and elbows which clog or connections that separate. Careful detailing is critical.
      - Scupper drain pipes should not be routed through closed box sections where leakage inside of the box is possible, and may go undetected for long periods of time.

2. Other Features

   a. Water Traps
      - All details must be designed to provide natural drainage. Small copes in corners of plates or small drain holes are easily plugged, and should not be relied on to provide drainage.

   b. Box Sections
      - Box sections that are too small to provide for adequate visual inspection and access for maintenance personnel should be painted and weep holes to allow proper drainage and circulation of air should be provided.
      - Larger boxes should be detailed to minimize the entrance of water, debris and dirt that can promote corrosion. They must also provide for natural drainage of water that may enter and adequate access for inspection, cleaning and maintenance when necessary. Precautions should include:
        1. Locked covers or screens over access holes to prevent the entry of animals and birds or unauthorized personnel. Covers over manholes should be on hinges and provided with a lock to allow easy access by inspection personnel.
        2. Provision of positive drainage and adequate ventilation to minimize the wetting of the interior surfaces from water or condensation.
        3. Painting of the inside of the box members should be considered. Weep holes should also be provided to allow for proper drainage and air circulation.

   c. Concrete Surfaces

      After passing over uncoated weathering steel, drainage leaves dark, non-uniform and often unsightly stains on concrete surfaces. This problem can be mitigated, if desired, by using one or more of the following approaches:
      - Wrapping the piers and abutments during construction to minimize staining while the steel is open to rainfall.
      - Allowing/requiring the contractor to remove staining with a commercial solvent after completion of construction.

- Applying epoxy or some other material to coat and/or seal the concrete surfaces against staining.

d. Overlapping surfaces
If water is allowed to flow over overlapping joints, capillary action can draw the water into the joint and cause "rust-pack" to form. Therefore, the contact surfaces of overlapping joints must be protected from intrusion of rainfall and runoff. This applies to non-slip-critical bolted joints as well as to overlapped joints such as those in tapered high mast lighting poles. The faying surfaces should be painted or sealed to prevent the capillary penetration. In slip-critical bolted splices, "rust-pack" should not occur when the bolts are spaced as per AASHTO specifications.

e. Fascia Girders
There is no evidence that coating the entire fascia girder will add to the service life of an otherwise uncoated bridge. Therefore do not paint exterior girder except in the area of expansion joints.

MAINTENANCE

Effective inspection and maintenance programs are essential to ensure that all bridges reach their intended service life. This is especially true in the case of uncoated weathering steel bridges. The following maintenance actions should be done routinely:

Inspection

Implement inspection procedures that recognize the unique nature of uncoated weathering steel and the conditions resulting from excessive corrosion damage. Develop inspection guidelines that highlight the structural features to be inspected and also illustrate the difference between the desired oxide coating and excessive rust scaling. Measurements of the oxide coating thickness should be taken during each bridge inspection and recorded in the bridge inspection reports.

Controlling Roadway Drainage To the extent feasible the following should be done:

- Divert approach roadway drainage away from the bridge structure.
- Clean troughs of open (finger) joints and reseal "watertight" deck joints.
- Maintain deck drainage systems (scuppers, troughs, etc.) in order to divert deck drainage away from the superstructure steel and substructure units.
- Periodically clean and repaint all steel within a minimum distance of 1 1/2 times the depth of the girder from bridge joints.

Other Maintenance

- Remove dirt, debris and other deposits that hold moisture and maintain a wet surface condition on the steel. In some situations, hosing down a bridge to remove debris and contaminants may be practical and effective. Some agencies have a regularly scheduled program to hose down their bridges.
- Maintain screens over access holes in box sections to prevent entrance by animals and birds.
- Remove growth of nearby vegetation that prevents the natural drying of surfaces wet by rain, spray or other sources of moisture.

Commentary

FHWA Technical Advisory T5140.22 can be found at http://www.fhwa.dot.gov/legsregs/directives/techadvs/t514022.htm

HEC-21 can be found at http://www.fhwa.dot.gov/bridge/hec21.pdf