North American Railway Bridge Inspection Practice
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ABSTRACT
The purpose of this paper is to illustrate the bridge inspection philosophy of certain large railways. North American railways are primarily public investor owned businesses and must show adequate financial returns to survive. Also, without adequate financial returns it is very difficult to secure the funding necessary to adequately maintain structures and provide the service to customers that generates sufficient profit.

Bridge inspection criteria are based primarily on ensuring safe and reliable operation, appropriate response and the information with which to provide adequate funding for maintenance and replacement.

Two different railway company philosophies are described. Of interest to the highway bridge community is how traffic volumes and structure load capacity influence inspection frequency and level of inspection. Items similar to FHWA bridge inspection criteria are not discussed.

The authors are, respectively, a former and the current Chairman of the Association of American Railroads Bridge Research Task Force and a former and the current Vice President – Structures of the American Railway Engineering and Maintenance-of-way Association (AREMA). Both authors are also past Chairmen of the AREMA Committee 15 – Steel Structures.
INTRODUCTION
The goal of railway bridge inspection is to provide, within the economic framework and with available tools and techniques, an accurate condition report of all railway owned and operated bridges to ensure safety of all rolling stock within authorized load limits and the public who are permitted to use these structures.

The main purposes of inspections are to:

- ensure structural integrity,
- note condition and/or change of condition,
- determine the need for action or more detailed inspection,
- provide information for the execution of repairs, strengthening, retrofit or replacement,
- provide information to determine the safe load the structure can support,
- establish future maintenance and capital requirements,
- assist in determining future cash flow requirements,
- gather and maintain the history of the structure,
- provide database information for the plant inventory system and/or bridge management system, and
- verify the accuracy of the information provided in the plant inventory system.

Clearly, inspection reports must contain sufficient information to achieve these purposes. How this is accomplished varies with the railroad, its organizational structure, its operating philosophy and the type, age and general condition of structures that it owns.

A railway with very robust structures in relation to the loads to be carried will inspect differently than one with structures of more marginal capacity, as will a railway with many standard spans as opposed to one with many structures built to individual designs. Inspections will also vary between railways depending on operating speeds and traffic volumes.

In any and all cases where an inspection of a bridge reveals a condition that, in the opinion of the inspector, may render the bridge unsuitable for carrying railway traffic at time table speeds; the necessary steps are taken to immediately safeguard train operations at that location through placement of slow order or stopping traffic as necessary.

All railways have procedures for informing appropriate decision makers. In the case of immediate need to cease operation over a structure, inspectors have direct radio or telephone contact with the railway dispatcher or rail traffic controller who controls the movement of all trains on that segment of the railroad.

All of the large North American railways also have Bridge Management Systems (BMS). Most of these BMS are computerized. Inspection Forms vary from simple check lists to very detailed input via wireless computer access devices.

Neither of the Railways reported in this paper has experienced a collapse due to regular train loading on a steel or concrete bridge in the last 65 years, possibly even longer. There have been some timber bridge failures in the industry, generally on small or short-line railroads. In the few instances where they have occurred, timber bridge failures under trains on the larger railroads have been attributed to excessive speed, poor train handling, faulty equipment including broken wheels and axles, or broken and loose rails that caused the train to leave the rail and impact the structure. None of the failures on the larger railroads were reported to be due to inadequate timber condition or strength.
A “one size fits all” approach to railway bridge inspection is not only inappropriate but wasteful of resources. Also, reliance on a minimum standards approach can be unsafe if the structures to be monitored do not meet the criteria on which the minimum standard was developed. It is the duty of the railway company’s Professional Engineers responsible for bridge inspection to determine the inspection protocol that strikes the appropriate balance. An inspection protocol for a railway with structures that are of conventional, well proven designs will be different from a protocol for unusual, innovative structures. Furthermore, inspection protocols need to change with time as structures age and problems start to appear.

This paper describes two different protocols both appropriate to the structures for which the protocol was developed. The details of each railway procedure described in this paper have been modified slightly to protect certain proprietary information.

RAILWAY “A”
Railway has many bridges of fairly robust design and relatively good carrying capacity where bridge inspection policy is relatively straightforward. Except at locations requiring skewed, curved, long spans or other a typical bridges, this railway was originally constructed utilizing standard spans integrated into the crossing openings.

This railway uses procedures more closely following the AREMA Manual of Recommended Practice (1) recommended by the Federal Railway Administration Guidelines (2).

All bridges are inspected by a Professional Engineer or qualified inspector. Bridge inspection qualification is defined through technical training and/or experience and/or certification through recognized training such as that by AREMA (3).

Note that visual inspections are carried out annually and at these inspections the need for more detailed review is determined.

Regular Scheduled Bridge Inspection - Annual
The basic purpose of annual inspections is to determine condition and work required, if any, to maintain bridges in a safe operating condition.

An annual inspection must be carried out on all bridges for the purpose of:

- ensuring structural integrity,
- noting condition and/or change of condition, and
- determination of need for periodic and/or detailed inspection(s).

The annual inspections are carried out with due consideration of previous annual inspections and recommendations, all of which are maintained in an electronic database. Track mounted bridge inspection vehicles (with articulated booms) are used in order that inspectors may gain close access to the majority of the bridge under inspection.

Regular Scheduled Bridge Inspection - Periodic Inspections
The basic purpose of periodic inspections is to monitor conditions deemed as needing regular scheduled examination, in addition to scheduled annual inspections.

These inspections are carried out on particular bridges at intervals determined by the Professional Engineers; considering such factors as condition, age, flow regime and traffic volumes. The periodic inspections are for the purpose of:

- monitoring physical condition and change of condition
determination of underwater conditions

Soundings or inspections by qualified divers at intervals deemed appropriate, depending on river velocity, bridge configuration, presence of upstream structures, are also considered as periodic inspections.

Reports and recommendations are reviewed by Professional Engineers who, if required, take immediate action to effect necessary repair work.

**Detailed Bridge Inspections**

These inspections are carried out under the direction of the railway’s chief bridge engineer to determine capacity, repair requirements and condition, as required following Regular Scheduled Inspections (annual or periodic) of specific bridges, or as deemed necessary by the railway’s chief bridge engineer. Detailed inspections are carried out after Regular Scheduled Bridge Inspections when the bridge:

- requires an assessment of strength (i.e. requires rating and/or fatigue life cycle analyses), and/or
- is in a condition which requires a detailed inspection in order to adequately assess repair and/or reconstruction requirements.

**Emergency Bridge Inspection**

In cases where a bridge has sustained damage through contact by railway equipment, road vehicles, debris flow or other such event, a qualified inspector must immediately inspect the structure. In cases where the structure has sustained damage, which, in the opinion of the inspector, may adversely affect the capacity of the bridge; a Professional Engineer or qualified representative must inspect the bridge. The inspector will assess the damage and make recommendations (repairs and/or traffic restrictions).

**Underwater Inspections**

**TABLE 1 : Railway “A” Underwater Inspection Matrix**

<table>
<thead>
<tr>
<th>Bridge Crossing Conditions</th>
<th>Bridges with substructures in watercourses</th>
<th>Substructures in poor condition and/or susceptible to scour</th>
<th>Critical scour conditions</th>
<th>Flood or vessel impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection frequency:</td>
<td>5 years</td>
<td>2 years</td>
<td>1 year</td>
<td>Emergent</td>
</tr>
<tr>
<td>Inspection Type:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine:</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Detail:</td>
<td></td>
<td>D</td>
<td>M</td>
<td>D</td>
</tr>
<tr>
<td>Tactile inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Routine:</td>
<td>D</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Detail:</td>
<td></td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

Legend:

- **M** – Mandatory. Must be performed at prescribed intervals by qualified personnel.
- **D** – Discretionary. To be performed subject to findings of Routine Visual Inspection or Routine Detailed Inspection. Conditions warrant further inspection by more detailed means.
Underwater inspections are classified in accordance with type and frequency as shown in Table 1.

In general, accordance with Table 1, bridge substructures within watercourses and the watercourse bed conditions should be inspected at intervals not exceeding:

- After Flood or Extreme Flow Conditions: All bridges require foundation and watercourse bed inspection after flood conditions. Flood conditions, which would typically precipitate an inspection, may be due to unusual spring snowmelt, high rainfall events and/or ice conditions in the waterway.
- 1 Year: Critical bridges (bridges which cross waterways with extreme flow velocities, bridges with historical scour and/or flood experience, bridges with spread footings on erodible streambeds, bridges which collect ice and/or debris).
- 2 Years: Bridges with deteriorated or exposed footings, deteriorated scour protection works; or with substructures in unstable channels with known scour potential (scour due to flow direction and/or velocity, debris and sediment build-up, propeller wash, ice formation, recent flood discharges).
- 5 Years: All bridges with substructures in watercourses.

**Bridge Inspection Reporting**

The general nature of the typical items in Table 2 to consider during bridge inspections are supplemented by the railway’s BMS, which specifically outlines components and details to inspect. Note that Railway “B” (see later in paper) has 36 detailed pages of items to be checked.

**TABLE 2: Railway “A” General Inspection Guidelines**

<table>
<thead>
<tr>
<th>General</th>
<th>Deck Condition</th>
<th>Bearing/bridge seats</th>
<th>Clearances (ballast wall - steelwork etc..)</th>
</tr>
</thead>
<tbody>
<tr>
<td>general behavior of structure under load (if practical)</td>
<td>- size, spacing</td>
<td>- expansion bearing condition</td>
<td></td>
</tr>
<tr>
<td>- deflection</td>
<td>- condition of timbers, guard rails/timbers</td>
<td>- bed plate position and anchor bolt conditions</td>
<td></td>
</tr>
<tr>
<td>- vibration</td>
<td>- walkways/railings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- lateral movements of superstructure</td>
<td>- ballast and waterproofing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- movements of substructure (subsidence, sway)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steelwork</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- condition and straightness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- eybar and truss counter slack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- damaged components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- cracks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- stringer connection clip angles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- flanges at bearings (girder, stringer, truss chords)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- truss hangers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- welded structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pin connection plates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- fillets of angles (beam flanges, truss posts, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- cover plate ends</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- lateral bracing &amp; gusset plates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- rivet conditions (loose, corrosion)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- floor connections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pin and hole wear (observe under traffic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- corrosion loss of section, or build-up causing distortion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- paint conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concrete/Masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td>- cracking</td>
</tr>
<tr>
<td>- spalling</td>
</tr>
<tr>
<td>- delamination</td>
</tr>
<tr>
<td>- rebar exposure</td>
</tr>
<tr>
<td>- footing conditions (scour, exposure)</td>
</tr>
<tr>
<td>- surface conditions</td>
</tr>
<tr>
<td>- joint conditions</td>
</tr>
<tr>
<td>- plumbness</td>
</tr>
<tr>
<td>- bridge seat condition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>- sizes</td>
</tr>
<tr>
<td>- decay (increment boring)</td>
</tr>
<tr>
<td>- wear</td>
</tr>
<tr>
<td>- checks &amp; splits (stringers, caps)</td>
</tr>
<tr>
<td>- connection conditions (loose bolts etc..)</td>
</tr>
<tr>
<td>- crushing at points of bearing</td>
</tr>
<tr>
<td>- pile condition (hollowness, ground line and cap areas)</td>
</tr>
</tbody>
</table>

**Post Earthquake Bridge Inspection**

To minimize the potential consequences of an earthquake on train operations Railway A has adopted an Earthquake Response Protocol (EQRP). The purpose of the EQRP is to reduce the consequences of an earthquake by stopping or slowing rail traffic until the right-of-way can be assessed and deemed, or made safe for rail traffic. Experience has demonstrated that some of the elements most vulnerable to damage during a significant
earthquake include: track, signals, level crossings, structures, liquefaction susceptible soils, rock fall areas, and landslides. Therefore, once an earthquake has occurred it is prudent to stop or slow trains until bridges can be assessed to assure that trains can...

TABLE 3: Railway “A” Earthquake Response Protocol

<table>
<thead>
<tr>
<th>Observable Results and Effects (Mercalli Scale) ordered by increasing severity</th>
<th>Magnitude (Richter Scale)</th>
<th>Earthquake Response Level</th>
<th>Radius impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full range below</td>
<td>Unknown</td>
<td>1</td>
<td>200 miles</td>
</tr>
<tr>
<td>Hanging objects sway People feel movement Parked cars may rock Doors, windows, and shelves may rattle</td>
<td>0 to 4.9</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Light furniture moves Pictures fall off walls Objects fall from shelves Everyone feels movement Light furniture falls over Windows may crack</td>
<td>5.0 to 5.9</td>
<td>3</td>
<td>40 miles</td>
</tr>
<tr>
<td>Some people fall over Walls may crack Heavy furniture falls over Some walls crumble Many people panic Some buildings collapse</td>
<td>6.0 to 6.9</td>
<td>3</td>
<td>110 miles</td>
</tr>
<tr>
<td>Railroad lines are bent Most buildings are damaged Roads crack Bridges collapse Buried pipes break Most buildings collapse All structures are destroyed</td>
<td>&gt; 7.0</td>
<td>3</td>
<td>170 miles</td>
</tr>
</tbody>
</table>

Legend:
0 - Resume track speed. The need for continued inspection to be determined by the engineering officers of the company.
1 - Rail traffic controllers and train dispatchers notify all trains within radius of to operate at restricted speed. Inspection of track, structures, signals, and communications is initiated. Structures are inspected in accordance with the guidelines below.
2 - Trains reduce speed to restricted speed until signals, track, and structures have been inspected. Structures are inspected in accordance with the guidelines below.
3 - Trains stop until track confirmed safe. Trains may only move to provide access to emergency vehicles and to move out of a hazardous location.
proceed safely. The EQRP documents the protocol to limit train movements following a significant earthquake.

The government geological services organization provides notification of the magnitude and location of the earthquake. The information is provided within about 12 to 20 minutes of the event, 24 hours a day, seven days a week. A summary of the railway’s EQRP process is shown in Table 3.

The inspection guidelines for post earthquake inspection are summarized as follows;

- Overpasses are inspected for;
  - Reduced support for span at bearings
  - Column damage
  - Damage to any span restraint system

- Bridges carrying railway traffic are inspected for;
  - Deck
    - Kinks or shifts in track
    - Misalignment – vertical or horizontal especially at ends of each span along length of bridge
    - Track and rail anchorage condition
  - Steel Superstructures, Towers & Bearings
    - Displaced or damaged bearings
    - Stretched or broken anchor bolts
    - Deformation in viaduct towers
    - Buckled columns or bracing
    - Tension distress in main members or bracing
    - Straightness of top chord of trusses or top flanges of girders
  - Concrete Superstructures & Bearings
    - Displacement at bearings
    - Cracks in superstructure
  - Timber Trestle Bridges
    - Line, surface and cross-level of track
    - Displaced timbers, particularly in framed bents
    - Bent bolts or drift bolts
  - Movable span bridges
    - Damage to counterweight guides
    - Open draw span shifted on pivot pier
    - Relative movement of piers that prevent opening or closing, including mis-alignment of track girders and segmental girders of rolling lift span
    - Alignment of rail locks and of wedges at ends of span
  - Substructures
    - Concrete Abutments and Piers
      - Displacement
      - Cracks – vertical or horizontal
    - Masonry Abutments and Piers
      - Dislodged stones
      - Cracks in stones
    - Timber
• Misaligned in posted piles, sills and cap beams
• Spilt or broken piles, posts
• Broken or disconnected post or pile bracing

• Approaches at abutments
  o Cracks, hanging ties, loss of shoulder
  o Settlement of fill behind or under abutment, differential movement and displacement of abutments

RAILWAY “B”
This railway has many structures that are marginal, but adequate, to carry projected loads and must be very diligent to ensure safe and uninterrupted operations. The railway is an amalgamation of many railways, and it seems that each bridge was a unique design to the extent that two bridges built by the same owner within a one-year time frame, 100 meters apart have different flange thicknesses and depths for the same span lengths.

Inspectors are extensively trained in-house with emphasis on noting small incremental changes. Inspectors must have good climbing ability and are directly supervised by Professional Engineers whose sole responsibility is prioritizing and preparing appropriate responses to inspection findings.

Railway B plans inspection frequency based on Million Gross Tons (MGT). For ease in interpreting the term MGT over a certain segment of track, an average weight train run daily would represent about 2 MGT annually. On an annual basis, a typical heavy North American unit train moving daily would represent about 6.6 MGT and the returning empty unit train about 1.2 MGT for a total, including the empty return unit train, of 7.8 MGT (4). For bridge purposes the MGT is per track.

On this railway, all bridges, except non-core lines with traffic < 5 MGT, no passenger and no unit trains must be observed under traffic as often as possible but at the very least once every 5 years with the type of train noted. The details of each type of inspection are outlined below.

TYPES OF INSPECTIONS
Detailed Inspections includes measurements and documentation of the defects and deterioration of all the components of the structure. It also includes observations of the surroundings for the purpose of ensuring the integrity of the structure and to obtain accurate information for determining carrying capacity and/or required repair or replacement needs.

Visual Inspections
Full Visual Inspection is a periodic inspection between detailed inspections to ensure the integrity of a structure and to note any condition or change that requires investigation or attention. Visual inspections include looking at all the critical components of the structure and comparing with the previous detailed inspections. The inspector must get close enough to each component and connection of the structure to view it clearly. This usually means close enough to touch the component under observation.
Cursory Visual Inspections
Cursory Visual Inspection or “Bridge Visit” is the occasional check by a Professional Engineer or an officer designated by the Bridge Engineer to insure the integrity of the structure and that there is no visible damage to the deck, superstructure or substructure. At a minimum this requires an observant walk over and a similar walk under the structure to comply with FRA annual inspection criteria.

Emergency Inspections
Emergency Inspection is a visual inspection to ensure the integrity of the structure as a result of an emergency situation such as a derailment, accident, or local failure and entails a detailed inspection of the components damaged by the incident. This is to assess any damage and the need for emergency repairs and /or replacement to ensure the safety and serviceability of the structure.

Special Inspections
Special Inspection is conducted under special circumstances. This may include inspections to allow dimensional loads including very heavy loads, to verify existing information in the field or to develop detailed work plans. Special inspections may be required after a reported earthquake or other such circumstances.

Follow Up Inspections
Follow up Inspection is carried out at intervals as warranted by the situation (as directed by the Engineer) to note the changes in the development of defects that have already been detected.

Underwater Inspections
All bridges where the structural condition of the submerged members cannot be determined with certainty, require an underwater inspection at least once every 5 years, or as determined by the manager Bridges and Structures.

INSPECTION FREQUENCY
Inspection frequencies on this railway are governed by the tonnage moved and the importance of the line. These criteria may be increased or decreased by the head of the railway’s bridge department acting on behalf of the Chief Engineer.

Core Line – Traffic over 100 MGT
These are lines typically carrying over 13 unit trains daily or 50 average trains daily, or combination thereof, adding up to 100 MGT annually per track over a structure. Detailed Inspections are required annually. Visual Inspections every ½ year.

Core Line > 50 MGT
These are bridges on lines that typically 25 average trains daily or 8 unit trains daily, or combination thereof, adding up to 50 MGT annually per track. Detailed are required every 2 years, and Visual Inspections every year.
Core Line > 30 MGT + Minimum Rating < 110% of authorized Load
Typically 15 average trains daily or 4 unit trains daily, or combination thereof, adding up to 30 MGT annually per track. Note that the capacity of the weakest component in the structure is less than 110% of the stress (or stress range) caused by the loads authorized in regular service on that line.

Detailed inspections are required every two years and Visual Inspection every year.

All Remaining Core Lines
Visual inspections are required annually.
Detailed inspections are:
- For structures with the weakest component rating less than 100% of authorized load, every 2 yrs or more frequently as the situation warrants.  
  Note that the railways have a Normal Rating (used by this railway for regular service traffic on most high tonnage core lines) and a Maximum Rating (1) for use with occasional loads, most non-core lines and on lines slated for eventual closure. The actual application depends on the railroad, similar to Inventory and Operating Ratings used by Highway Administrations.
- All other structures require a detailed inspection once in 5 years.

Non-Core Lines
Non-core lines are lines that could be abandoned or sold without seriously impacting the main railway core business or seriously change the overall profit of the railway.

For lines with traffic >10 MGT treat as Core Line
For traffic between 5 and 10 MGT or Traffic < 5 MGT but carrying Passenger or Unit Trains.  These are lines typically carrying three to five average trains daily, or one unit train daily, or combination thereof, adding up to the annual tonnage.

If the minimum Maximum Rating is less than 1.2 times the authorized loading treat as a Core line of similar tonnage for inspection purposes.

If the minimum Maximum Rating is greater than 1.2 times the authorized loading then a visual inspection is required every 2 years, and a cursory Inspection annually to meet FRA criteria.

Non-Core line < 5 MGT, no passenger and no Unit trains except Seasonal Grain
These are structures that carry less than 3 average freight trains daily.

A cursory Inspection annually to meet FRA criteria.

If the minimum Maximum Rating is less than 1.1 times the authorized loading, then a Visual Inspection is required every two years, and a Detailed Inspection every ten years.

If the minimum Maximum Rating is greater than 1.1 times the authorized loading, then a Visual Inspection is required every 3 years and a detailed inspection as directed by the Engineer as required.

Unused Bridges
Require a Cursory Inspection every 3 yrs or as directed, essentially to ensure sufficient integrity to protect the railway from lawsuits.
Overhead Bridges
If the railway is responsible for maintaining the structure, then a Visual Inspection is required annually with Detailed Inspection as required. If the Railway is not responsible for maintenance then a Cursory Inspection is required annually and a Detailed Inspection as directed by the Professional Engineer responsible.

Special Structures
This refers to what could be called monumental structures with replacement values exceeding 0.5 billion US dollars. Inspection frequency is determined by special studies. One such structure has a recommended 10-year Detailed Inspection frequency.

Report of Outages
Whenever a structure is out of service for any period of time, the head of the railway’s bridge department must receive a report outlining the details of the problem that caused the outage.

Post Earthquake and other Similar Incidents
Post earthquake and other natural disasters have procedures that are different depending on the severity and geographical location. This railway has a direct reporting service that informs the relevant train dispatcher of an earthquake occurrence that exceeds Richter intensity of 3 or more. All trains within a radius of 50 to 400 miles are immediately advised to reduce to restricted Speed (speed that allows stopping within half the range of vision) until the actual magnitude and epicenter has been determined by proper authority. Generally no train movement is permitted for earthquakes with severity exceeding 5 on the Richter scale without inspecting track and structures at radii from 50 to 400 miles depending on the earthquake severity and location. The detailed procedures are similar to those shown for Railway “A” in Table 3.

There are similar procedures for extreme water events.

Bridge Inspection Reporting
This railway has 36 pages of details (compare to Railway “A”) as to what must be checked in any visual or detailed inspection and uses wireless technology to automatically send the report to the various appropriate levels in the organization. Software is programmed to send a telephone message 24/7 for structures that are reported as critical to the dispatcher and the Local Planning and Inspection Engineer for immediate action.

CONCLUSION
Bridge inspection is the poor man’s insurance and the successful bridge owner’s first line of protection. In the North American bridge railway industry inspection is tailored to fit the needs of the structures in service on the railway property concerned.

Two examples were illustrated, one on a railway with many bridges of fairly robust design and relatively good carrying capacity where bridge inspection policy is relatively straightforward, and the other on a railway where great care has been taken to
Sweeney, Unsworth.

concentrate inspection resources on weaker though adequate structures based on traffic volumes and bridge component capacity.

Both policies have been successful on the properties concerned although clearly they are not interchangeable.

Similar criteria might be of interest to other bridge owners.

REFERENCES
2. FRA Guidelines, FRA 49,CFRPart 213, Appendix C., Federal Railroad Administration, Office of Bridge Safety, Washington, DC.
3. AREMA Bridge Inspection Course, under revision, Landover, MA.