

Hot Topics in Steel Bridge Design:

Fracture-critical Members & Live-load Deflection Criteria

Dennis R. Mertz

**University of Delaware's
Center for Innovative Bridge
Engineering (CIBrE)**

Fracture-critical Members (FCM's)

**“tension members or tension
components of members whose
failure would be expected to result
in collapse of a bridge”**

***AASHTO Manual for Condition
Evaluation***

Many similar definitions in other documents (AASHTO, AWS, FHWA, etc.).

Some speak only of specifically “steel” members, others speak of collapse of a “portion of or the entire bridge.”

**In any case, the definition
is problematic.**

- **Steel only?**
- **Failure?**
- **Expected?**
- **Collapse?**

**Should the concept be limited
to steel bridges?**

**Florida recently implicitly
designated segmentally
constructed concrete box girders
with only two tendons as FCM's.**

FCM requirements:

- **Greater fracture toughness,**
- **Greater fatigue resistance (in *Standard Specifications*),**
- **Additional fabrication inspection, &**
- **Additional in-service inspection (apparently most onerous due to maintenance and protection of traffic).**

New light shed on FCM's:

- FHWA proposes that States create FCM inspection plans, &**
- High-performance steel (HPS) offers inherently greater toughness.**

FHWA Workshop on Fracture Critical Bridge Members

November 10 - 12, 2004

Orlando, Florida

**approximately 25 attendees
representing FHWA, States,
consultants, and the academy**

Workshop Objective: Work towards developing a modern and cost effective Fracture Control Plan for steel bridges through integration of technologies.

Target Outcomes:

- Define redundancy
- Identify updates necessary for the existing Fracture Control Plan (FCP).
- Develop immediate changes needed to take advantage of new technologies.
- Identify short-and long-term studies/research needed to modernize the FCP.
- Prepare a report to capture the findings and recommendations.

High-performance Steel

**West Virginia & FHWA recently
waived some FCM requirements for
a steel tied-arch with an HPS tie-
girder.**

NCHRP 20-5, Task 35-08
Inspection and Management of
Bridges With Fracture Critical
Members

PI's: Robert Dexter, University of
Minnesota & Rob Conner, Lehigh
University

Soon to be finalized.

**What do our bridge-design
colleagues around the world
do with regard to FCM or non-
redundant members?**

Nothing special?

**Summary of FCM issue:
New thinking may be on the
way!**

Live-load Deflection Criteria

- Included in the *Standard Specifications*,
- Optional in the *LRFD Specifications*
(all 50 States to use a form of the
criteria),
- LRFD mimics SS.

**Legendarily,
based upon the crying of a baby
being pushed across a bridge in a
stroller on the bridge's sidewalk**

**Theoretically,
controls human perception of
motion due to adjacent traffic
(thus, more severe criteria for
“bridges with sidewalks”).**

**But this perception is a function of
acceleration not deflection (A
gradual deflection is not readily
perceived.).**

**Practically,
it provides a “comfort level”
based upon defining a minimum
gross stiffness.**

Introduction of HPS triggers renewed interest in the LL deflection criteria.

HPS cost study by HDR Engineering, Inc. in conjunction with the University of Nebraska at Lincoln (UNL) demonstrates that the LL deflection criteria may govern some HPS designs.

NCHRP 20-7, Task 133 Improved Live Load Deflection Criteria for Steel Bridges

**PI's: Charles Roeder, University of
Washington & Karl Barth, West
Virginia University**

***The 50 States seem to have 50 ways to
apply the LL deflection criteria (SS)
with various interpretations of load
and resistance.***

NCHRP 20-7, Task 133 Improved Live Load Deflection Criteria for Steel Bridges

The correlation between excessive deflection and premature deterioration is difficult to make.

Summary of LL deflection criteria issue:

**Work by the steel industry
continues to develop a rational
approach to limiting bridge
flexibility!**

Thank you.
Questions?

**Presentation available on the
University of Delaware's Center for
Innovative Bridge
Engineering's website
www.ce.udel.edu/cibre**