

DATE: June 20, 1995 (revised)
TO: All Bridge Designers

FROM: A. J. Siccardi

SUBJECT: Technical Memorandum No. 2
Fracture Critical Bridges and Fracture Critical Members

The attached data, entitled Appendix A, contains excerpts from the FHWA Advisory and other literature relating to the referenced subject. The data is to serve only as a reminder that it is the unit leader, together with the designer, who is responsible for designating the Fractural Control Plan (FCP) to be used on the project. The data is intended to provide the basis for as nearly uniform an interpretation as is possible in assigning Fracture Control Members (FCMs) in a particular bridge design.

In all future designs the following will apply:

1. FCMs, should they exist, are to be clearly identified on the plans.
2. Design notes shall contain the supporting calculations and evaluation as to which members are designated FCMs and why they are so designated.
3. All members and/or details which are to receive non-destructive testing shall be clearly identified on the drawings.
4. All weld details are to be examined for alternative means of connection to tension components of FCMs and to tension components generally.

Each design is expected to be examined on an individual case basis. Where doubt exists, it is your responsibility to raise these doubts for discussion with the Preconstruction Engineer and/or the Bridge Engineer.

APPENDIX A

FHWA Technical Advisory - 1979 - set out the background regarding Control for Steel Bridges:

- Assure that specifications and design and construction procedures are adequate to:
- Preclude a catastrophic collapse, or
Preclude extensive reinspection, maintenance and/or repair.
- The need for concern developed as a result of:
 - Cracking and brittle fracture in steel bridges;
 - Cracking mostly associated with weld splices or welded connections.
- To reduce the risk of future cracking, the Advisory recommended that we:
 - Improve our methodology and control in the design, fabrication, inspection and construction of Fracture Control Members (FCMs) where fracture may cause collapse of the bridge.
 - Each designer develop for each project a Fracture Control Plan (FCP). The FCP to be commensurate with:
 - The particular design,
 - its details, and
 - degree of redundancy.
 - Factors to be considered in developing an FCP:
 - Damage tolerance limits of vital structural members;
 - Calculated and historical performance of the design details;
 - Inspectability and ease of fabrication;
 - Any supplemental quality control and quality assurance; and
 - Recognition of future preventative maintenance.

It is the responsibility of the designer to identify those Fractural Critical Members (FCMs) in the design. For the designer to specify that the FCP be applied to all bridge members, fracture critical or not, is wasteful and not good engineering practice. The following list contains those bridge members, seen by various designers, whose failure would result in a total collapse of the bridge:

- Two-girder systems in a simple span, or in the end span, or within one span of a roller expansion bearing, or in spans adjacent to a hinge or a link;
- Truss chords;
- Tension flanges of girders receiving their loads from floor beams;
- Steel cap of a single-or two-column structure;
- Stuctural steel C-type bent

The above list is not intended to be all inclusive.

Tension flanges in and of themselves are not fracture critical members absent some other feature which, if a crack were to develop in the tension flange, would result in total collapse. Any welds joining an attachment to a tension component of an FCM, whether the welds are parallel or perpendicular to the applied stress in the tension, must be considered part of the tension component and, therefore, considered fracture critical. Gusset plates welded to stiffeners which in turn are welded to the FCM provide an example of the type of detail which should be avoided where possible, so as to minimize the possibility of slow crack growth into a main load carrying tension member. Flaws in welds, which can go undetected even in the best of inspections, lead to crack propagation. Thus, it is emphasized that an FCP includes design, inspection, later reinspection (BRIAR), construction and maintenance or repair.