American Railway Engineering & Maintenance-of-Way Association
Letter Ballot 15-23-20

Edit Articles 1.14.2, and 9.1.14.2, edit Glossary, and add Reference as shown (deletions in **~~bold red strikethrough~~**, new text in **red bold underline**, explanatory text in brackets [ ] are not part of final text):

1.14.2 DEFINITIONS (~~2020~~2025)[2] [insert new 1.14.2b and 1.14.2c]

a. FCMs (fracture-critical members) are defined as those tension members or tension components of members whose failure would be expected to result in collapse of the bridge or inability of the bridge to perform its design function as determined by the Engineer. Tension components of steel bridges include all portions of tension members and those portions of flexural members subjected to tension stress.

b. Fracture control (FC) practice, for the purpose of this Chapter, is the collection of practices required for FCMs. The fracture-critical provisions of this Chapter shall apply to members designated as requiring FC practice.

c. The fracture-critical provisions of this Chapter shall apply to members designated as nonredundant steel tension members (NSTMs).

~~b~~**d**. Any attachment welded to a fracture-critical member as defined in paragraph a, except for bearing sole plates, shall be considered an FCM when any dimension of the attachment exceeds 4 inches in the direction parallel to the calculated tensile stress in the FCM.

9.1.14.2 DEFINITIONS (~~2022~~2025) [insert paragraph lettering and new text]

a. It is important to recognize that in many cases, the entire member need not be classified as an FCM but rather only the component(s) in tension. For example, in welded built-up girders in a two-girder bridge, the tension flange and the portion of the web in tension should be classified as FCMs. In contrast, the compression flange and the portion of the web only in compression need not be classified as FCMs.

The responsibility of defining "the bridge's design function" lies with the Engineer and it should not be approached lightly. Generally, for a tension member or tension component of a member to be considered fracture-critical, its failure must significantly reduce the overall load-carrying capacity of the structure, result in unacceptable deflections, or result in some other major hindrance to the safe operation of trains. For example, on one hand, failure of one girder in a two-girder bridge would result in significant loss of load capacity and the tension elements of the girders, therefore, should be considered FCMs. On the other hand, it is unlikely that floorbeams that are spaced very closely, or even knee braces in through girders, would be considered FCMs since their failure likely would not significantly reduce the load capacity of the span. More guidance on identifying FCMs can be found in Reference 53.

Compression members and member components in compression may be structurally important but should not be classified as FCMs. Compression components do not fail by crack formation and extension but rather by yielding or buckling. Similarly, riveted and bolted members, even though in tension, may not necessarily be classified as FCMs provided that their individual components provide sufficient internal redundancy.

The AASHTO/AWS D1.5 Fracture Control Plan provides for enhanced material properties and increased care in the fabrication and use of the materials in FCMs to lessen the probability of fracture of tension components from crack formation and extension.

b & c. At the time of this publication (2025), terminology related to fracture-critical members and other less-redundant structure types is in a period of change within the steel bridge community, with newer terminology introduced in some documents but not others. For the purpose of this Chapter, "FCMs", "NSTMs", and "members requiring FC practice" are to be treated as equivalent. For more information on the evolving terminology, see Reference 53a.

d. A welded attachment is designated as fracture critical when any dimension of the attachment exceeds 4 inches in the direction parallel to the calculated tensile stress in the FCM. This is due to the component having a sufficient length to actively participate with the overall member. A similar behavior was observed for Category E and E' welded attachments with connection lengths greater than 4 inches. Experimental research in Reference 72 demonstrated that a decrease in fatigue strength occurs as the attachment length is increased in the direction of stress. An attachment length of 4 inches was found to be long enough to increase active stress participation with the member and produce a significant stress raiser at the end of the weld.

Bearing sole plates welded to the tension flange are exempted from the requirements for FCMs because they are located in regions of low tensile stress. By extension, welded bearing components and bearing components welded to the sole plate are likewise exempted.

Chapter 15 Glossary

Abbreviations

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FAST	Facility for Accelerated Service Testing (Pueblo, CO)
FC	**fracture control**
FCM	fracture-critical member

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NSBA	National Steel Bridge Alliance
NSTM	**nonredundant steel tension member**
OSHA	Occupational Safety and Health Administration

NSBA

National Steel Bridge Alliance, a division of American Institute of Steel Construction (AISC). www.steelbridges.org. Term cited in Part 3.

Nonredundant steel tension member (NSTM)

See Fracture-critical member.

Open deck structure

A railroad bridge having the track ties supported directly by beams, stringers, or girders. Term cited in Parts 1, 6, 7, 8 and 9.

References

53a. Connor, R. J., H. Gilmer, J. B. Lloyd, R. Medlock, and E. Wasserman. "Implementation of Redundancy Terms under 2022 NBIS". National Steel Bridge Alliance. https://www.aisc.org/globalassets/nsba/technical-documents/redundancy/b012-23.pdf. Cited in Article 9.1.14.2.