Fit

• Advance
  – New publication: NSBA White Paper for I-girder fit
    • Describes fit and customary practices
Skewed and Curved Steel I-Girder Bridge Fit

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This is a stand-alone summary that is complimentary to a larger guide document on fit being published by the NSBA.

What is Fit?

The "fit" or "fit condition" of an I-girder bridge refers to the deflected girder geometry associated with a specific load condition in which the cross-frames or diaphragms are detailed to connect to the girders. Consideration of the fit condition is important since the geometrical relationship between the girders and cross-frames changes for different loading conditions.

In all bridge systems (trusses, arches, etc.), the steel components change shape between the fabricated condition, the erected condition, and the final condition. Therefore the associated relationship, or fitting, of the members also changes. When the changes are small, the fit choice can be inconsequential, but when the changes are large, the proper fit choice is essential for achieving a successful project.

The question, then, is in what condition should an I-girder bridge be detailed to fit? Certainly, the final condition is of great interest: to perform effectively in service, girders and cross-frames need to be in place, properly connected and properly supporting the roadway and traffic. Therefore, one might infer that bridges should be detailed simply to fit in their final constructed condition. For some bridges fitting the cross-frames to the final condition is fine and indeed may be the best choice; however, for others, fitting to the final condition significantly increases the internal cross-frame forces and can potentially make the bridge unconstructable. For every bridge, the fit condition must be selected to effectively manage the structure's constructed geometry and internal forces, and to facilitate the construction of the bridge.

It should be noted that, in practice, I-girder bridge fit is accomplished by the choice the detailer makes in setting the "drops" for the cross-frame and connection plate fabrication. The drop is defined as the difference in elevation on either side of a cross-frame. Since the fit choice directly influences the cross-frame fabricated geometry, as well as the bridge constructability and subsequent internal forces, the fit choice should be selected by the designer, who knows the loads, with proper consideration of the bridge erection. To facilitate an informed decision, the designer can discuss their bridge with experienced fabricators, detailers, erectors, and contractors.

Common Fit Conditions

The fit of an I-girder bridge is influenced by the difference in deflection between the sides of the cross-frames: the greater the skew, the sharper the curve, the greater the variation in the girder lengths, and the greater the span lengths, the greater this differential deflection will be. In fact, a quick way to evaluate potential constructability issues is to note the differences in the deflections across the width of the bridge at each stage of loading.

Given that dead loads cause deflections, and differences in girder deflections affect fit, it follows that the common fit conditions are associated with different bridge dead load conditions. These are shown in Table 1. Designers tend to be more familiar with names associated with loading conditions; fabricators tend to be more familiar with terms associated with stages of construction. The setting of drops discussed in the "Practices" column of the table refers to the detailer establishing the relative position of each cross-frame to each girder.
Differential deflection

Deflected position at steel deadload

Deflected position at full deadload
Deflected position at steel deadload

Deflected position at full deadload

Differential deflection
Differential deflection

Deflected position at steel deadload

Deflected position at full deadload
Fit

• **Advance**
  
  – New publication: NSBA White Paper for I-girder fit
    • Describes fit and customary practices
    • Provides recommendations
      – Straight square bridges: any fit condition
      – Straight skewed bridges: SDLF or TDLF
      – Curved bridges (up to ~ 250’ span): SDLF, then NLF

• **Need**
  
  – Improved understanding of fit and implications for construction
Phased Array Ultrasonic Testing (PAUT)

Advance

• New Annex in D1.5 (pending T-17 ballot)
  – Allowable alternative for traditional UT with current acceptance criteria
45 degree

linear scan

35-70 degrees

sectorial scan
Traditional UT
PAUT
Phased Array Ultrasonic Testing (PAUT)

**Advance**
- New Annex in D1.5 (pending T-17 ballot)
  - Allowable alternative for traditional UT with current acceptance criteria
  - Can be encoded
    - Owner may allow in lieu of RT
  - New D1.5 annex: qualifications, scan plan requirements, calibration
  - Consider hybrid approach: PAUT first then UT or RT if defect is found

**Need**
- Fit-for-service, PAUT-oriented acceptance criteria – NCHRP is looking at this
Digital Radiography

Advance

• Digital RT is ready and in limited use
Digital Radiography

Advance

• Digital RT is ready and in limited use
  – Eliminates film
  – Facilitates e-exchange and storage
  – Faster shots
  – Same acceptance criteria, image quality indicators (IQIs)

Need

• Guidance in D1.5
“Virtual Assembly”

Advance

• CNC equipment and modeling reduce the need for assembly
“Virtual Assembly”

Advance
• CNC equipment and modeling reduce the need for assembly

Need
• Better understanding in the community
  – Fabricator’s means of ensuring fit vary
  – Assembly needs vary from bridge to bridge
  – Models and assembly of models are often are not needed to reduce assembly
Bridge Information Modeling (BrIM)

Advance

• Digital project information flow facilitates faster and more accurate information exchange and storage
Design Software

Design Drawings

Detailing software

CNC equipment - cutting, drilling, welding, marking

Shop Drawings

Shop Floor

Approval
Design Software

Design Drawings

XML Translator / Creator

XML File

XML Translator

Detailing software

CNC equipment - cutting, drilling, welding, marking

Shop Drawings

Shop Floor

Approval

XML Translator / Creator

XML File

XML Translator

Final Bridge Information Model

XML File
PennDOT I-81/Rt 22

95 Calendar Days
NTP to Complete
Steel Erection
Bridge Information Modeling (BrIM)

Advance
• Digital project information flow facilitates faster and more accurate information exchange and storage

Need
• Digital workflow to replace plan set
• Digital tools
  – Project definition in XML
  – Translators
• Collaborative workflow
Metalizing

Need

• Widely-accepted specification to standardize requirements for pull-off strength and mill thickness
• When metalizing, use galvanizing for smaller components (like cross frames)
Two-Coat Zinc Coating

Advance

• Two-coat paint provides faster, more cost-effective coating

Need

• Broader use, acceptance
Summary

• Fit
• Phased array UT
• Digital RT
• Virtual assembly
• BrIM
• Metalizing
• Two-coat paint system