American Railway Engineering and Maintenance-of-Way Association
Letter Ballots 15-22-18, 15-22-19, and 15-22-20

**Assignment:** Replace ballot 15-21-18 which was withdrawn at the February 2022 meeting in Fort Worth, Texas. This ballot is submitted as the replacement ballot for forwarding to the full committee. Other minor changes to Articles 7.3.3.3 and 7.3.3.4 proposed by Letter Ballots 15-22-19 and 15-22-20 affected the Table numbering and are included in this "for publication" copy.

Revisions to Articles 7.3.3.3 and 7.3.3.4, and insertion of new Article 9.7.3.3.3.

**Rationale:** Ballot 15-22-18 is the replacement for the companion ballot in Subcommittee 1 (Ballot 15-21-24) concerning the changes in allowable stress for rating floorbeam hangers. The original ballot, 15-21-18 was withdrawn with the negative votes wanting consistency with both design provisions and existing language. The language has been modified in existing Table 15-7-2 for riveted bridges to permit the use of unreduced allowable stresses based upon a fatigue analysis being performed. Riveted connections with no fatigue check are limited to $0.40F_y$, not to exceed that for A36, or 14,400 psi on the gross section. The commentary states that this limit can be waived if documentation exists that shows a higher $F_y$.

Floorbeam hangers with bolts replacing rivets have de facto taken fatigue into account since the connection will act the same regardless of a formal fatigue analysis. No differentiation is shown for allowable stresses for bolted connections and will use the values of Table 15-1-11 for bolted hanger connections.

Existing Table 15-7-3 is modified from the first ballot to distinguish between gross and net area and the use of yield stress and ultimate stress. This conforms to the other instances of that language throughout the chapter. The table has been rearranged to organize it but the provision is the same as before. Included for change is the limit of 28,800 psi ($0.8F_y$) for steel above 36 ksi for connections using high-strength bolts. The change eliminates this limit since it is for A36 steel and does not take into account the use of 50 ksi steel which is commonplace in modern design, or the potential use of 70 ksi which is allowed in Section 1.2.

The limit for rivets is left the same in maximum rating, but the current value was developed with the 1961 fatigue provisions in mind. Since fatigue is not a factor for maximum rating, this restriction can be removed if desired by the committee, but it is left at its value of 21,600 psi at this time.

These changes are conformal to the language in this section during the period of ratings development required by the FRA Bridge Management Plan regulations, save for reduction of the allowable stresses based upon $F_u$ which is reduced in all tables in design and rating from $0.5F_u$ to $0.47F_u$.

Letter Ballots 15-22-19 and 15-22-20 converted some existing verbiage into tabular form, which inserted new Tables. Including all three ballots into one "for publication" document clarifies all the Table re-numbering.

Submitted by: Stephen Dick, Chair SC 5 (Rating)
Due Date: October 7, 2022

Make the following changes as shown (additions shown as **underlined bold red**, deletions shown as ~~**bold red strikethrough**~~, comments in brackets [ ] not part of final text):

**7.3.3 STRESSES (~~2021~~2023)[2]**

7.3.3.3 Allowable Stresses for Normal Rating

a. Allowable Normal Rating stress shall be based on either the minimum yield strength or the minimum ultimate tensile strength of the material as determined from tests or records. In the absence thereof~~:~~**, the ~~stresses~~ strengths shown in Table 15-7-2 shall be used.**

| ~~Material~~ | ~~Fy (psi)~~ | ~~Fu (psi)~~ |
|---|---|---|
| ~~Wrought iron~~ | ~~25,000~~ | ~~45,000~~ |
| ~~Bessemer steel~~ | ~~30,000~~ | ~~50,000~~ |
| ~~Open-hearth steel~~ | ~~30,000~~ | ~~60,000~~ |
| ~~Silicon steel~~ | ~~45,000~~ | ~~62,000~~ |
| ~~Nickel steel~~ | ~~50,000~~ | ~~90,000~~ |

***Table 15-7-2. Typical Properties for Older Steels***

| Material (Note 1) | $F_y$ (psi) | $F_u$ (psi) |
|---|---|---|
| Open-Hearth Steel | 30,000 | 60,000 |
| ASTM A7 pre-1935 | 30,000 | 60,000 |
| ASTM A7 post-1935 | 33,000 | 60,000 |
| Wrought Iron | 25,000 | 45,000 |
| Bessemer Steel | 30,000 | 50,000 |
| Silicon Steel | 45,000 | 62,000 |
| Nickel Steel | 50,000 | 90,000 |

**Note 1: For other steels not shown, see Table 15-9-1**

b. Allowable unit stresses resulting from the loads and forces described in the preceding articles are shown in Table 15-1-11 as supplemented by Table ~~15-7-2~~ 15-7-3.

**Renumber existing Table 15-7-2 as Table 15-7-3**

***Table ~~15-7-2~~ 15-7-3. Supplemental Allowable Stresses for Structural Steel and Fasteners for Use in Normal Rating***

| Component | Allowable Stress (psi) |
|---|---|
| Tension in ~~gross section of~~ floorbeam hangers, including bending, using rivets, ASTM A307 bolts, or non-pretensioned high-strength bolts in end connections: | |
| If a fatigue evaluation is performed in accordance with Article 7.3.3.2c, d, e, or f, as applicable, | |
| Gross Section | $0.55F_y$ |
| Effective Net Area | $0.47F_u$ |
| If a fatigue evaluation is not performed in accordance with Article 7.3.3.2c, d, e, or f, as applicable, | |
| Gross Section | $0.40F_y$ |
| but not to exceed | 14,400 |

[Remainder of Table unchanged]



**7.3.3.4 Allowable Stresses for Maximum Rating**

a. Allowable Maximum Rating stress shall be based on either the minimum yield strength or the minimum ultimate tensile strength of the material as determined from tests or records. In the absence thereof, ~~Article 7.3.3.3a~~ the ~~stresses~~ strengths in Table 15-7-2 (or Article 7.3.3.3a) shall be used. Allowable stresses for these materials are shown in Table 15-7-4.

[continued]

***Table 15-7-4. Allowable Stresses for Structural ~~Older~~ Steels for Use in Maximum Rating***

| Material | $F_y$ (psi) | $F_u$ (psi) | $a_y$ | $a_u$ | K (psi) ($a_y \times F_y$) | $K_1$ (psi) ($a_u \times F_u$) |
|---|---|---|---|---|---|---|
| Open-Hearth Steel | 30,000 | 60,000 | 0.80 | 0.67 | 24,000 | 40,200 |
| ASTM A7 pre-1935 | 30,000 | 60,000 | 0.80 | 0.67 | 24,000 | 40,200 |
| ASTM A7 post-1935 | 33,000 | 60,000 | 0.80 | 0.67 | 26,400 | 40,200 |
| ASTM A36 | 36,000 | 60,000 | 0.80 | 0.67 | 28,800 | 40,200 |
| ASTM A709 (all), HPS | Note 1 | Note 1 | 0.80 | 0.67 | $0.80F_y$ | $0.67F_u$ |
| Wrought Iron | 25,000 | 45,000 | 0.80 | 0.67 | 20,000 | 30,150 |
| Bessemer Steel | 30,000 | 50,000 | 0.70 | 0.58 | 21,000 | 29,000 |
| Silicon Steel | 45,000 | 62,000 | 0.70 | 0.58 | 31,500 | 35,960 |
| Nickel Steel | 50,000 | 90,000 | 0.65 | 0.54 | 32,500 | 48,600 |

For weld steels, $K = 0.7F_y$, where $F_y$ is the lower value of yield strength between the base metal and the weld metal.

Note 1. See Table 15-9-1 for yield and ultimate strengths of ASTM A709 and HPS steels.

b. Allowable unit stresses resulting from the loads and forces described in the preceding articles are shown in Table ~~15-7-3~~ 15-7-5.

~~Where:~~

~~E = modulus of elasticity of the material, psi~~

~~$F_y$ = yield strength of the material, psi~~

~~$F_u$ = ultimate tensile strength of the material, psi~~

~~For open-hearth steels (including A7, A36 and similar subsequent steels), High Performance Steels (HPS), and wrought iron:~~

~~$K = 0.8 F_y$~~
~~$K_1 = 0.67F_u$~~

~~For Bessemer, silicon and high-strength steels other than High Performance Steels (HPS):~~

~~$K = 0.7 F_y$~~
~~$K_1 = 0.58 F_u$~~

~~For nickel steel:~~

~~$K = 0.65 F_y$~~

~~$K_1 = 0.54F_u$~~

~~**For weld steel:**~~

~~$K = 0.7\ F_y$~~

All other nomenclature is as defined in Part 1 Design, Article 1.4.1 and Article 1.3.14.1.

*Table ~~15-7-3~~ 15-7-5. Allowable Stresses for Maximum Rating*

| Type **of Stress** | Pounds Per Square Inch |
|---|---|
| Axial tension, structural steel, gross section | K |
| Axial tension, structural steel, effective net area (See Article 1.6.5) | $K_1$ |
| Axial tension, structural steel, effective net area at cross-section of pin hole of pin-connected members | 0.82 K |
| Tension in floorbeam hangers, including bending, gross section: | |
| Using rivets, ASTM A307 bolts or non-pretensioned high-strength bolts in end connection | 0.75 K |
| but not to exceed | 21,600 |
| Using high-strength bolts in end connection | K |
| ~~**but not to exceed**~~ | ~~**28,800**~~ |
| **Tension in floorbeam hangers, including bending, on effective net area:** | **$K_1$** |
| Tension in floorbeam hangers, including bending, effective net area at cross-section of pin hole of pin-connected members: | 0.60 K |
| but not to exceed | 17,300 |
| ~~**Tension in floorbeam hangers, including bending, on effective net section:**~~ | ~~**$K_1$**~~ |

[Remainder of Table unchanged.]

c. Members subject …
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~~**For nomenclature, see Paragraph (b) above.**~~

d. For members subject to both axial tension and bending, the total of the axial tensile stress and the combined bending tensile stresses about both axes shall not exceed K. However, the compression stresses, if any, in the extreme fibers of flexural members resulting from the combined bending compressive stresses about both axes and the minimum simultaneous axial tension stress shall not exceed the values allowed ~~**by the formulas of paragraph b above**~~ **in Table 15-7-5**.

e. Secondary stresses due … [unchanged]

[continued]

## 9.7.3.3 STRESSES (~~2021~~2023)

### 9.7.3.3.3 Allowable Stresses for Normal Rating (2023)

**The stresses shown in Table 15-7-3 are used in addition to the stresses shown in Table 15-1-11.**

**For floorbeam hangers, the allowable tension stress using rivets is based on whether a fatigue analysis per Article 7.3.3.2b, c, d, e, f, and g is performed. If this analysis has been performed, the allowable stress for a riveted connection is higher than for riveted hangers without a fatigue analysis. The limit of $0.40F_y$ on the gross section is based upon the 1961 implementation of 14,000 psi on the net section used for floorbeam hangers in an attempt to limit fatigue damage. These provisions were in place prior to the development of existing fatigue provisions.**

**If a fatigue analysis is not performed, the limiting stress is the lower value of $0.40F_y$ or 14,400 psi on the gross section. The limit of 14,400 psi on the gross section is based upon an assumption of $F_y$ = 36,000 psi at the time riveted construction was changed to either bolted or welded construction (1960s).**

**The application of the fatigue provisions in Article 7.3.3.2 obviates the need for a limiting stress, if the fatigue analysis is performed. It should be recognized, however, that the use of the limit of $0.40F_y$ will not prevent fatigue failures in hangers as riveted members have a Variable Amplitude Fatigue Limit (VAFL) of 6.0 ksi. Stresses in hangers are generally above the VAFL level and create accumulative fatigue cycles which can result in fatigue failure.**