American Railway Engineering & Maintenance-of-Way Association
Letter Ballot No. 15-22-08

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Assignment: At the February 2022 Meeting, a new letter ballot 15-22-08 was proposed. The letter ballot revised language in Article(s) 5.2.4, 5.5.5.3.1 in Part 5, Bearing Design and Construction of Chapter 15, Steel Structures.

Rationale: Currently the manual has an upper limit on the Basic Allowable Stress for polytetrafluoroethylene (PTFE) of 2,000 psi. It is understood that this was originally done to allow a simple swap of lubricated bronze for PTFE should the system fail; there was no evidence from owners that this was ever needed. Bearing manufacturers have expressed concern that keeping this value at 2,000 psi as opposed to the 3,000 psi used by AASHTO can artificially add size to certain bearing components.

A previous letter ballot was approved that revised the static coefficient of friction for lubricated and non-lubricated PTFE for the bearing pressures that were previously included in the manual; this ballot used assumed friction changes at the freezing point (via a power-function best-fit methodology) in lieu of a simple interpolation of the current AASHTO values. This previous revision generally made designs more conservative, but slightly inconsistent with straight interpolation.

This ballot will increase the limit of the allowable bearing stress on the net area to 3,000 psi and add the appropriate static coefficient of friction to tables in Article 5.5.3.1. Note that the maximum bearing stress is absolute, with dead load stresses (needed to calculate friction) obviously being below 3,000 psi. A revision to the static coefficient of friction has been made to some values in the previously approved tables, which will now consistently utilize a simple interpolation between AASHTO values, since no specific research was done on the specific material changes at the freezing point. Values for Zone 3 interpolate beyond -49^0 Fahrenheit based on the slope between -13^0 and -49^0.

References to the original research and summary of values used in the AASHTO manual are also proposed to be added.

Submitted by: William C Farrow III, Chair SC 7 Bearing Design and Construction

Due Date: April 29, 2022

Edit existing Article 5.2.4 and 5.5.3.1 (additions shown as **underlined bold red**, deletions shown as ~~**bold red strikethrough**~~). Editorial comments in brackets "[ ]" are not part of the new text. Existing text is shown as it appears in 2022 proofs.

SECTION 5.2 BASIC ALLOWABLE STRESSES

5.2.4 PTFE SLIDING BEARING SURFACES (~~2002~~2023) ~~R(2017)~~

For unfilled polytetrafluoroethylene (PTFE) bearing against stainless steel sliding surfaces (whether virgin PTFE resin, PTFE sheets, or woven PTFE fabric) the allowable stress in bearing on the net area shall not exceed ~~2,000 psi (14 MPa)~~ **3,000 psi (20MPa)**.

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SECTION 5.5 PTFE SLIDING BEARING SURFACE DESIGN

5.5.3 DESIGN (~~2022~~2023)[1]

5.5.3.1 General

a. PTFE sliding surfaces …#

b. Expansion bearings having …#

c. The minimum design static coefficient …#

Table 15-5-5. Static Coefficient of Friction for Non-Lubricated PTFE against stainless steel

Bearing Pressure for Non-Lubricated PTFE	Static Coefficient of Friction	
	Zone 1	Zone 2 & 3
500 psi (4 Mpa)	~~0.10~~ 0.18	0.20
1,000 psi (7 Mpa)	~~0.09~~ 0.16	0.18
2,000 psi (14 Mpa)	~~0.07~~ 0.12	0.13
3,000 psi (20 Mpa)	0.09	0.10

Table 15-5-6. Static Coefficient of Friction for Lubricated PTFE against stainless steel

Bearing Pressure for Lubricated PTFE	Static Coefficient of Friction		
	Zone 1	Zone 2	Zone 3
500 psi (4 Mpa)	~~0.05~~ 0.06	~~0.07~~ 0.08	0.11
1,000 psi (7 Mpa)	0.04	0.06	0.08
2,000 psi (14 Mpa)	~~0.03~~ 0.04	~~0.04~~ 0.05	~~0.05~~ 0.07
3,000 psi (20 Mpa)	0.03	0.04	0.06

[remainder unchanged]

[continued]

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9.5.5.3 DESIGN (~~2022~~2023)

9.5.5.3.1 General

a. The friction values presented herein are for PTFE on stainless steel (Reference 43a). Any other mating surface should be investigated by the engineer for a more appropriate friction factor.#

c. As presented in the tables in Article 5.5.3.1c the static coefficient of friction of a PTFE sliding surface varies with temperature and bearing pressure. The static coefficient is not applicable when live load is applied to the bridge due to vibrations creating a kinetic state of friction.

The friction values are straight-line interpolation based upon research by T.I. Campbell, W.L. Kong, and D.G. Manning (Reference 43a), as summarized in NCHRP Report 432 (Table H-26) (Reference 161). These are the same values used in the AASHTO LRFD Bridge Design Specification, 9th Edition.

The static coefficient of friction used in design should be the value that produces the worst-case loading for the component being designed. Depending upon the component being designed, the worst-case dead load bearing pressure may or may not include future loads (such as future ballast allowance).

The provision in Article 5.11.1c limits the as-constructed coefficient of friction of the PTFE sliding surfaces to a maximum of the listed values. This theoretically assures that Article 5.5.3.1b produces conservative loads for designing bridge components.

When calculating loads acting on other bridge components some railroads specify a higher coefficient of friction, such as 0.25, to accommodate future partially frozen bearings. Higher coefficients of friction should be accommodated at the discretion of the Engineer.

References

43a. Campell, T. I., Kong, W. L., and Manning, D. G. "Laboratory Investigation of the Coefficient of Friction in the Tetrafluroethylene Slide Surface of a Bridge Bearing." *Transportation Research Record 1275*. Washington, DC: Transportation Research Board, 1990. Cited in Article 9.5.5.3.1.

161. Stanton, J. F., C. W. Roeder, and T. I. Campbell. "High-Load Multi-Rotational Bridge Bearings." *NCHRP Report 432*. Washington, DC: Transportation Research Board, 1999. Cited in Articles 9.5.1.2b, 9.5.1.5a, ~~and~~ 9.5.1.5a(8)**, and 9.5.5.3.1**.