American Railway Engineering and Maintenance of Way Association
Letter Ballot

1. **Committee and Subcommittee:** Committee 30 – Subcommittee 4

2. **Letter Ballot Number:** 30-22-13

3. **Assignment:** D4-3-15: Research tie pads and ballast pads and include in Chapter 30. Ongoing assignment.

4. **Ballot Item:** Introduction of testing procedures for determination of under tie pad dynamic stiffness

5. **Rationale:** This ballot introduces to the manual the second testing procedures for component characterization of under tie pads. It included recommended methods and procedures for the determination of the dynamic stiffness of the component, allowing comparison of different under tie pad products and estimation of in-track performance. The material included is highly based on the already established procedures set forth by the European Committee for Standardization while considering North American-specific parameters (e.g., loading magnitudes).

   Note: Only modification from Spring 2021 ballot document is on Section 6.c. that now requires the same time between consecutive tests.

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2.10.1.2 Low-frequency Dynamic Bedding Modulus

a. Test Purpose:

Determine the dynamic bedding modulus of an under tie pad (UTP) for frequencies between 2 – 30 Hz. Typical test frequencies are 5±1 Hz and 10±1 Hz, with optional tests at 20±1 Hz and/or 30±1 Hz for high-speed applications.

b. Test Frequency:

Initial qualification and routine testing required. Routine testing frequency shall be agreed upon between supplier and client.

c. Test Procedure/Setup:

(1) Samples: Three (3) samples of the UTP material shall be tested for initial product qualification. Number of samples for routine testing shall be agreed upon between supplier and customer. Sample dimensions and characteristics should follow recommendations presented in 2.10.1.1.c.1.

(2) Test temperature: Samples should be tested at 74±10 °F. Tests at additional temperatures may also be requested. Additional recommended temperatures are 0±5 °F, 32±5 °F, and/or 105±5 °F.

(3) Test setup: In accordance with 2.10.1.1.c.3 and 2.10.1.1.c.4. See ***Figures 30-2-15*** and ***30-2-16***.

(4) Measurement equipment:

(a) Actuator capable of applying $0.44F_{max}$ at the required test frequencies.

(b) Force measuring device compliant with ASTM E4.

(c) Displacement gauges (minimum of three) compliant with ASTM E2309 Class B.

Note: All equipment should be capable of recording data at a rate of at least 20 times the loading frequency.

(5) Applied Load: Load magnitudes (F_{min} and F_{test}) shall be determined based on sample area (A) and the pressures (p) given in ***Table 30-2-1*** for the intended application loading environment as follows:

$$F_{min} = p_{min} \times A$$

$$F_{test} = 0.4p_{max} \times A$$

(6) Procedure:

(a) Measure initial temperature of all components (GBP, Loading Plate, UTP) to ensure the required test temperature is achieved.

(b) Place UTP (or UTP on concrete block) centered between loading plate and GBP with a tolerance of ⅛ in. as shown in ***Figures 30-2-15*** and ***30-2-16***. All components placed above the sample (GBP, Loading Plate, etc.) must be attached to the loading head so that their weight is accounted for in the force applied.

(c) Loading: Apply a cyclic force from F_{min} to F_{test} at the specified frequency (f) for 100 cycles (or 10s for frequencies above 10 Hz) ensuring the maximum amplitude of loading (i.e., F_{min} to F_{test}) is reached within 50 cycles (or 5s for frequencies above 10Hz). Record load and displacement data for the last 10 cycles and obtain values of F_{min}, F_{test}, d_{min}, and d_{max} for each cycle (see ***Figure 30-2-18***). If displacement value from any instrument differs by more than 20% from the average measurement, check alignment of load application to ensure loading is centered and repeat test.

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- If running procedure directly following another test, loading procedure should be started 60 ± 5 seconds after the end of the preceding test with a constant static load held over the specimen in between tests. Constant load shall be $0.7F_{min}$ if following a static bedding modulus test or F_{min} if following another dynamic bedding modulus test.

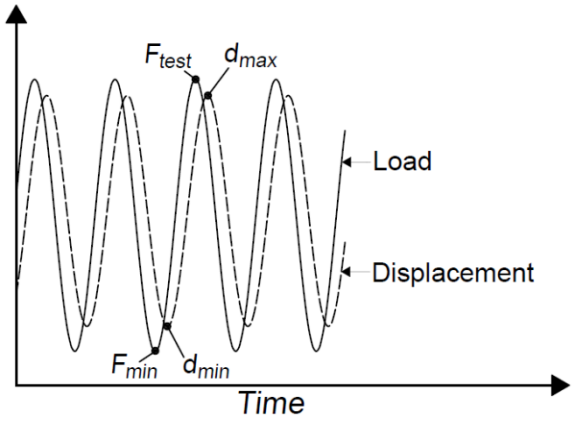

Figure 30-2-18 Example time-history data for dynamic bedding modulus determination

(d) The dynamic bedding modulus ($C_{dyn,f}$) for a frequency f shall be calculated from the 10 cycles of data recorded as follows:

$$C_{dyn,f} = \frac{1}{10}\sum_{i=1}^{10}\frac{\sigma_{test} - \sigma_{min}}{d_{max} - d_{min}}$$

where, $\sigma_{test} = \frac{F_{test}}{A}$

$\sigma_{min} = \frac{F_{min}}{A}$

d_{max} = average maximum displacement from all sensors

d_{min} = average minimum displacement from all sensors

(e) The dynamic-to-static stiffness ratio (or stiffening coefficient) shall be calculated as follows:

$$\kappa_{dyn,f} = \frac{C_{dyn,f}}{C_{stat}}$$

d. Test Criteria:

To be agreed upon by the purchaser and supplier.

(1) The following information shall be recorded and reported:
- (a) Sample temperature
- (b) Sample area (A)
- (c) Test loading frequency (f)
- (d) Magnitudes of F_{min}, F_{test}, d_{min}, and d_{max}
- (e) Dynamic bedding modulus ($C_{dyn,f}$)
- (f) Dynamic-to-static stiffness ratio ($\kappa_{dyn,f}$) (if C_{stat} already obtained)
- (g) Mean load-displacement curve (if requested)

NOTE: Additional testing procedures for UTPs are currently under development. In the interim, it is suggested that the recommendations put forth by the most recent European Standard EN16730 be followed.

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