American Railway Engineering and Maintenance of Way Association
Letter Ballot

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

2. **Letter Ballot Number:** 30-22-21

3. **Assignment:** To review and update every section of the manual.

4. **Ballot Item:** Updates section 4.13 for turnout ties, much of which hasn't been updated since 1993.

5. **Rationale:** The updated wording aims to reflect current industry practices and bring to attention current issues, such as camber in longer ties.

SECTION 4.13 TIES FOR TURNOUTS

4.13.1 1 GENERAL (20231993)

a. Concrete ties used in turnouts are subjected to loadings and ballast support conditions considerably different from cross ties in standard track. The trackwork mounted on the ties, and the passage of rail traffic, especially on the turnout track, generate non-uniform dynamic loads which must be considered in the tie design.

b. The dimensions, and tolerances for manufacturing turnout ties are no more critical than standard track ties, but the calculations aregeometry is much more complex because they must be done precisely for each individual tie in the turnout must be specifically configured.

c. The specific provisions below for turnout ties are toshould be followed in addition to the regular requirements of Part 4, Concrete Ties. Where no specific provisions are stated, the general requirements for concrete cross ties are should be used.

4.13.2 LAYOUT (20231993)

4.13.2.1 Tie Orientation

a. Ties may be oriented at right angles to the straight track, per Figure 30-4-19, View A in which case the ties with cast in shoulders are different for left hand and right hand turnouts. Ties in sections having the rail fastened to a steel plate, and then the steel plate fastened to the tie, shall should be designed for interchangeable use in left and right hand turnouts.

b. Ties may be oriented in a fanned layout per Figure 30-4-19, View B in which case all of the turnout ties may be used for left hand, right hand, or equilateral turnouts. This minimizes the number of different ties which must be produced, and stocked, but the geometric calculations to accurately locate the fasteninginstallation of the ties in the fanned layout are considerably more complex.

4.13.2.2 Tie Spacing

Tie spacing in the switch section is usually determined by the location of the various switch mechanisms and connecting rods. Care must be exercised to ensure adequate ballast cribs for tamper tool operation. Satisfactory performance has been achieved where a minimum crib width of 7 inches (178 mm) has been maintained, but recesses may be required in the ties as discussed in Article 4.11.3. Beyond the switch section, 24 inches (610 mm)standard open track tie spacing can may be used. Some variations may be necessary to ensure correct tie placement at the frog, especially in the case of moveable point frogs.

4.13.2.3 Fastener Placement

a. To follow the curve of the turnout track, it is common for fasteners to require varying degrees of rotation in the ties. For rotation of the shoulders on ties with elastic fasteners, the method shown in Figure 30-4- 20 shall should be used since it allows the use of standard rail pads, and automatic clip application machines.

b. Track work plates shall be positioned parallel to the centerline of the tie, and the position of all inserts as well as cast in shoulders must be checked to ensure they do not contact the prestress tendons.

c. Consideration should be taken towards the placement and rotation of cast-in components and how they impact the prestressing tendon pattern. The uneven pattern of these components may conflict with the horizontal location of tendons, which may need to be deflected horizontally to accommodate the components. This is considered acceptable, provided flexural strength and concrete cover are unaffected.

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d. It is recommended practice to cap any inserts that do not utilize pre-installed bolts.

~~b.~~

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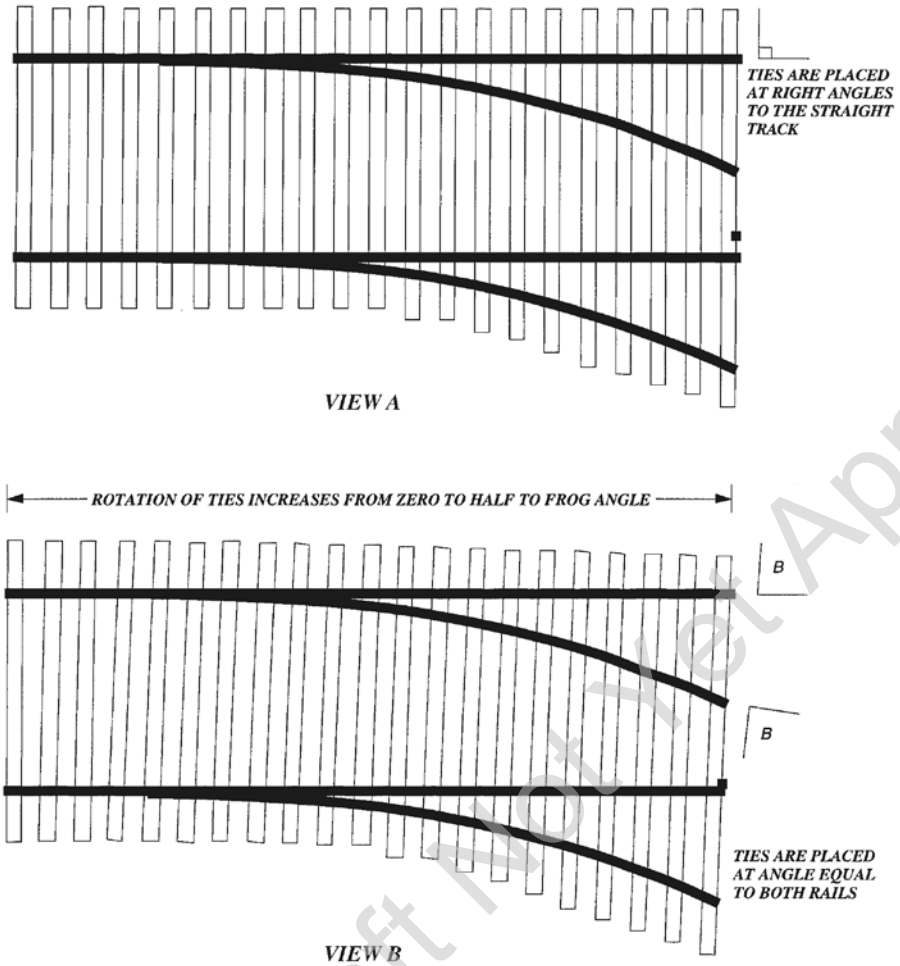


Figure 30-4-19. Tie Orientation

4.13.2.4 Ties in Crossovers

Where concrete ties are used in crossovers, either of the methods shown in Figure 30-4-21 may be used at the center portion of the crossover to support the closely spaced tracks. While long ties to span from track to track can be manufactured, ties split in the crossover track with long-tie connectors are preferrable for installation, maintenance and preventing excessive camber issues. Other methods such as interlacing and ties split without connectors is possible, provided both adjacent ties to a split are contiguous between track gauge and adequate bond length is achieved.

4.13.3 TIE DIMENSIONS (20231~~1993~~)

a. The turnout tie should have a constant cross section over the entire length. In some cases it may be

necessary to make recesses or chamfers to fit heaters, machinery, or other attachments. Recesses are

often needed in the sides of ties in the switch section, where temperature changes will cause the point rails, connecting rods, and all attached hardware to shift position.

b. The dimensions in Section 4.3, Tie Dimensions, Configuration and Weight are applicable except as noted in the following sections.

4.13.3.1 Length

The individual tie lengths are ~~calculated~~ determined based on the turnout geometry. The maximum tie length depends on the track geometry. The minimum tie length must be ~~calculated~~ determined based on track gage, distance from the rail to the outermost fastening in any tie, and the bond development length of the prestress tendons. Although "family-of-ties" consisting of incremental tie lengths may be used, lengths based on standard offset from gauge provide better efficiency and more uniform track support. Care should be taken to limit the use of ties longer than 18' as discussed in Article 4.13.2.4.

4.13.3.2 Minimum Depth

The minimum design depth of the turnout ties is governed by the design bending moments in Article 4.13~~1~~.5. ~~Satisfactory performance has been obtained with ties greater than 8.5 inches (216 mm) in depth.~~

4.13.3.3 Maximum Width

The maximum width of the turnout tie shall not be greater than 12 inches (305 mm). For tie widths greater than 11 inches (280 mm), extra care must be exercised to ensure adequate ballast cribs in the switch and frog sections where tie spacing may be reduced, and switch rods, baskets, etc., are located. These elements will also shift position in the cribs as temperature changes.

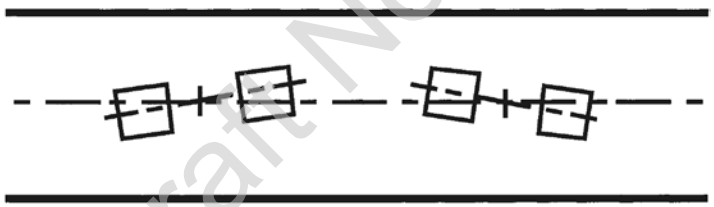
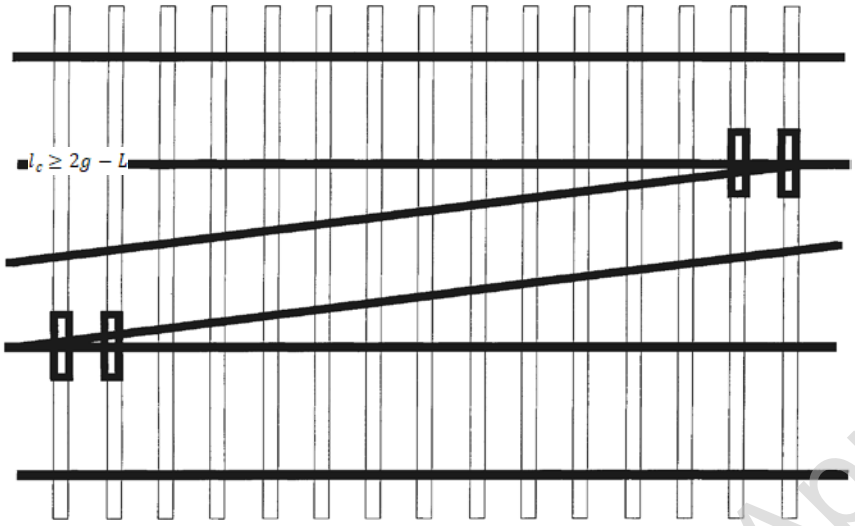
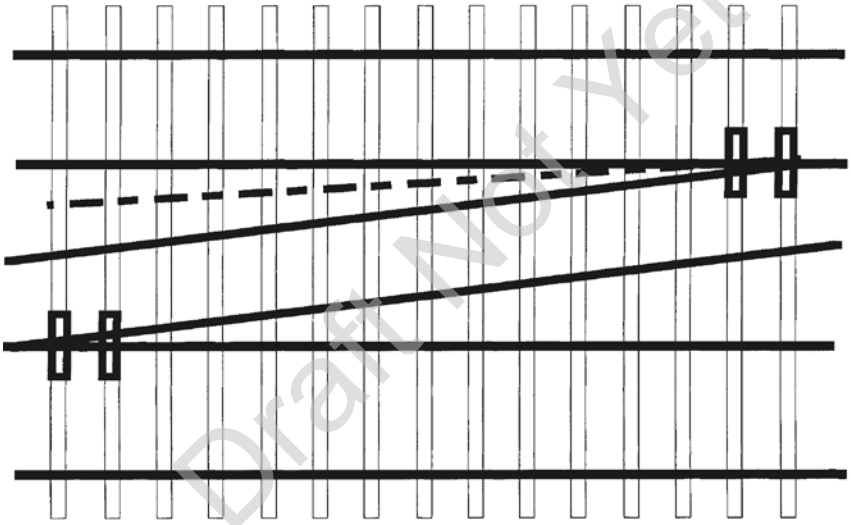


Figure 30-4-20. Preferred Rotation Method for Shoulders in Turnout Ties



VIEW A: LONG TIES SPAN UNDER ALL TRACKS



VIEW B: SHORTER TIES ARRANGED TO CARRY TRACKS SEPARATELY

Figure 30-4-21. Ties in Crossovers

4.13.3.4 Rail Cant

The turnout ties normally provide for no rail cant. Where a transition must be made to ties with rail cant, it can be achieved through the use of special trackwork plates, special cast ties, elastic fastening systems, or pre-~~-~~twisted rails. A common practice is to install one or more 1:80 cant transition ties between flat turnout ties and 1:40 open track ties.

4.13.4 DESIGN CONSIDERATIONS (2023~~1993~~)

a. Article 4.1.6.2 recommends that continuous welded rail be used on concrete tie track. For turnouts with concrete ties it is also recommended to fully weld the rails to the points and frog, and to locate any joints which may be required over a ballast crib, rather than over a tie.

~~b. Field instrumentation may be used to verify loadings in pilot installations, especially in cases where open flangeway frogs are used, or speeds are higher than usual. Instrumentation can also be used to verify support conditions, and the need for maintenance after accumulated tonnage.~~

~~c. The minimum pre-compressive stress at any vertical cross section should be 1,000 psi (69 MPa) after all losses and without any applied load.~~

4.13.5 FLEXURAL STRENGTH (2021)

The flexural capacity of the turnout ties should be taken as 30% higher than the design bending moments determined per Section 4.4 using the equivalent tie length. The equivalent tie length should be taken as the rail centerline to rail centerline dimension (60" or 1524 mm for standard gauge) plus two times the rail centerline to end of tie dimension. The ties should be tested in accordance with the Rail Seat Vertical Load Test described in Article 4.9.1.4, with distance 2X/3 taken as 14 inches (356 mm) for this test. The maximum turnout bending moments based on Class I axle loads (82 kips or 365 kN) should be taken as shown below:

Minimum Positive Moment Capacity ..... 390 inch-kips (44 kN-m)
Minimum Negative Moment Capacity ..... 300 inch-kips (34 kN-m)

NOTE: The maximum capacities shown above have been in use since the late 1980's and have shown to be sufficient for North American track conditions.

4.13.6 SUPPORT CONDITIONS (~~1993~~2023)

a. Special care must be given to the support conditions for concrete ties in turnouts to ensure that bending moment capacities are not exceeded. There are many ties where four railseat sections must each have ballast tamped beneath them, and this can cause large negative bending moments when a train passes on any two of the railseats.

b. Frequently the trackwork in the switch and frog sections covers a substantial portion of the ties, and care must be taken to ensure that ballast is adequately tamped under all ties. Hand tamping may be necessary in some cases to tamp around plated tie sections, heater ducts, or other equipment.

c. Ties oriented in a fanned layout per Figure 30-4-19, View B will require more time for proper surfacing than ties oriented at right angles to the mainline track per Figure 30-4-19, View A.

~~d. At the option of the Engineer, serrations may be considered in the sides or bottom of the tie to increase lateral resistance in the ballast.~~

~~e.~~d. Some mechanical equipment may be unable to properly lift and surface the increased weight of concrete ties in turnouts, and assistance with hand jacks may be needed. Also, some mechanical equipment may not be capable of, or may not be set up to tamp ties more than 8 inches (203 mm) deep, and this may cause spalling on the edges of ties. Equipment with sufficient reach must be used to surface concrete turnout ties.

~~f.~~e. The extra length, and stiffness of concrete turnout ties causes a large increase in vertical track modulus. It is recommended that concrete track ties be used at the three entrance points to concrete tie turnouts, so that the change in track modulus is minimized.

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4.13.7 TOLERANCES (~~2021~~2023)

4.13.7.1 Camber

Vertical camber in the ties should be measured either at 28-days after manufacture or before shipping. Only ties with 3 or more rail seats need to be checked for camber. Camber should not exceed 1/1,000 of the tie length. Ties should be stored according to manufacturer's ~~recommendations~~recommendations; improper storage support conditions can induce camber on the tie ~~prior to checking camber~~. Though camber can be one condition that affects track cross-level, other contributors to cross-level issues include tolerance stack-up, differences in fastening systems (plated vs elevated rail seats vs standard rail seats), damaged components (i.e. bent plates), ballast support, etc.

4.13.7.2 Fastenings

Cast-in inserts and shoulders for fastening systems should be located within ±1/16 inch (1.6 mm) of the position shown on the drawing. Angular tolerance should be within 0.5 degree of the rotation specified.

4.13.7.3 Tie Spacing

Ties should be spaced within ±1/4 inch (6 mm) of the accumulated distance from the point of switch.

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4.13.7.4 Prestress Tendon Placement

Tendons may need to be deflected horizontally to accommodate the cast-in components. This is considered acceptable, provided flexural strength and concrete cover are unaffected.

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