COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

Producing and Inspecting Railroad Crossties

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Ultimately, a long-serving tie starts with a good piece of wood. Several types of structural wooden members are used in railroad track and related structures, but this article focuses on crossties—which are used to hold track in place at a defined gauge, or distance between rails—and their production and grading. This article describes what a good piece of wood looks like and how to recognize crossties with problems before they are placed in track. Understanding what tie inspectors look for will help tie producers make better ties and achieve a lower rate of tie rejection.

Crosstie Production

Tie Dimensions and Quality

The most common crosstie length in North America is 8' 6". Very few 8'-long ties are purchased (even though this is a standard length according to the published railroad tie specifications), but 9' ties are sometimes required. These lengths are finished lengths—sawyers need to allow several extra inches for trim when the tie is squared up and cut to length. Tie dimensions are discussed in more detail in the section about tie inspection, but a grade tie is identified according to its smallest dimension (its depth as laid in track) as either a 6" grade tie or a 7" grade tie. Crosstie dimensions are most commonly 7" x 9", but some 6" x 8" and 7" x 8" ties are also used. The wide dimension on a crosstie is referred to as a tie face, and the narrow dimension is called the side.

Ideally ties should be cut with the heartwood centered in the tie. Sapwood is more readily treatable than heartwood, and by putting the heartwood in the center of the tie a protective envelope of treated sapwood surrounds the heartwood, contributing to longer service life. The center of a log also tends to have heart checks, and if these extend to the surface because the tie was cut with the heart off-center it's possible that the surface with the heart checks might be turned upward during installation. Upward-facing heart checks will let rain into the unprotected heartwood and the tie will decay more quickly.

In terms of quality, crossties are categorized either as **grade** or **industrial grade** (IG) ties. IG ties—not good enough for a grade tie for a major railroad due to large splits or other defects, but not bad enough to cull entirely—are used in short line rail systems or freight yards. Grade ties need to be as sound as possible, especially in the area that supports the rails in track (the "rail-bearing area").

Purchasing

The path from tree to track can proceed through different channels:

- Many treating plants buy green ties directly from medium- to large-size sawmills. The treaters dry the ties, treat them with preservative, and sell them to a railroad.
- Smaller sawmills frequently cut ties and sell them to larger sawmills, who include them with their own tie production and resell them to a treating plant as described above.
- Sawmills also sell ties directly to railroads, in which case they first go to a railroad-owned staging and transport station (called a tie yard). At this point, ties will likely be inspected before being shipped to a treating plant for drying and treatment, but the rigor of the inspection is determined by the size of the tie yard, the number of available personnel, the kind of working relationship the tie buyer has with his suppliers, and the requirements of the treating plant.

Regardless of the level of quality control practiced at the sawmill or tie yard, every tie will be inspected at the treating plant. Ties that are rejected will not be paid for by the railroad; the fate of rejected ties is generally left up to the originating supplier.

In most cases, the contractual relationships between the treating companies and the railroads are stable and long-lasting. Railroads and the Railway Tie Association (RTA) work closely with tie suppliers to help assure the quality of the wooden ties in the pipeline.

Preparation for Treatment

Moisture Content

All wooden ties must be dried before they can be properly treated with wood preservatives. Water has to be removed before the preservative goes in, because two bodies can't occupy the same space at the same time! The maximum allowable moisture contents prior to seasoning vary according to species, due to differences in sapwood thickness, and are specified by the AWPA (American Wood Protection Association)[1] Standard T1-07, Commodity Specification C. (See Table 1.)

Table 1. Allowable moisture contents prior to treatment per Standard T1-07.

Species	Maximum Moisture Content Allowed (%)
Oak	50
Hickory	40
Mixed Hardwoods	40
Southern Pine	30

Note: Moisture contents are based on a 3" core cut into the narrow (sapwood) face.

Air Drying

It is not practical or cost-effective to dry crossties in dry kilns, so ties are dried in stacks on air-drying yards. Seasoning takes about eight to ten months for oak/hickory ties, and about five to six months for mixed hardwood ties; the length of time required depends on the species, the local climate, and the time of year in which the ties are set out on the drying yard. The final moisture content is checked before ties are pressure-treated with preservative. If ties are over-dried they take up an excess of preservative (which is costly and doesn't add significant protection to the crossties), so moisture control on the air-drying yard is essential. (See Figure 1 for an example of one common method of stacking crossties.)

Various types of defects can occur during drying. (See Figures 2-7).

Figure 1. *"German stacking," a common method of arranging ties for air drying in a tie yard. (The ties on the right could have been spread more uniformly for better air flow during drying, however.)*

Incipient Decay ("Stack Burn")

Because of high temperature and humidity conditions during much of the year, ties in the southern United States can air-dry slowly enough that incipient decay becomes a problem. This is especially true for susceptible species such as pine. Incipient decay is called "stack burn" by the industry, and can lead to significant losses due to ties being culled for rot if the drying yard is not closely monitored.

Figure 2. *Incipient decay ("stack burn") in a sweet gum tie.*

Seasoning Checks

Wood shrinks as it dries, so ties develop drying checks on the surface and on the ends. Ordinary seasoning checks are desired because they can increase the penetration of the wood preservative, and the checking pattern varies with the species. Most species have a grain pattern that is parallel with the tie, and checks are aligned in the longitudinal direction. Some species such as the gums, however, have interlocked grain patterns. These species have checking patterns that are much more irregular, and they are distinctive because of the way they tend to wander about.

Checks can become so wide and deep that they warrant downgrading or culling the tie. More information about this defect can be found in the section on tie inspection.

Figure 5. *Mechanically incised tie.*

Figures 3 and 4. *Compare the checking patterns on the sweet gum crosstie (above) to the white oak tie (right).*

Splits

Splits can occur in green ties because of defects or released growth stresses, and it is also possible for seasoning checks to develop into larger splits.

Endplating. Splits can often be repaired or prevented through the use of metal end plates (gang-nail plates) on the ties, but in general splits are considered to be defects. Some railroads ask for ties to be selectively end-plated; others may ask for all ties to be end-plated. End plating can be performed on both green ties and dry ties. Hydraulic pressure is often used to squeeze splits together before the end plate is positioned and subsequently pressed into the end grain.

Figure 6. *A platable split in an ash tie.*

Figure 7. *Some of these ties have been end-plated.*

Boultonizing

Green or partially-seasoned crossties can be boultonized to prepare them for impregnation without waiting for the final moisture content to be reached by air-drying. Boultonizing is a process in which ties are first placed into a treating cylinder and covered with the treating solution. The temperature is raised to about 190°F to 210°F and the ties are left to warm up for at least three hours. The pressure is then reduced in the cylinder until a 20-inch Hg vacuum is reached. The ties are left in the cylinder for about 6 to 10 hours. The reduced atmospheric pressure and the increased temperature causes the ties in the cylinder to dry, making them suitable for impregnation.

Boultonizing removes much more water from the sapwood than from the heartwood, but it doesn't work as well for species with thick sapwood due to the amount of water that has to be removed.

Pressure Treatment

Bethell or Full Cell Process

Pressure treating doesn't refer to treating wood with pressure; it refers to the fact that a wood preservative ("treating solution") such as creosote or copper naphthenate is forced into wood under pressure. In the simplest method, called the Bethell or Full Cell Process,

- Wood is placed in a closed vacuum cylinder, covered with a treating solution and heated. (Heat reduces the viscosity of creosote treating solutions, and it also sterilizes the tie.)
- The air is pumped out to create a vacuum in the cylinder; air bubbles out of the wood as the pressure is reduced, creating a vacuum within the wood as well.
- After the air is removed, the vacuum pump is turned off and the cylinder is opened to the atmosphere; the pressure differential between the vacuum inside the wood and the atmospheric pressure forces the hot treating solution into the wood.

This method of treatment is called the Full Cell Process because the wood cells are full of the treating solution at the end of the treatment cycle. This process is not used much because the large amount of preservative taken up adds cost and weight to each piece of wood treated.

Empty Cell Processes

Much more common than the Full Cell Process is a type of Empty Cell Process. This process leaves the wood cell walls coated with preservative, but the lumens remain empty. The Empty Cell Process has two variations: (1) the Lowry Process and (2) the Rueping Process. Empty cell processes result in good penetration, are very effective, and use less of the treatment chemical than the full cell process.

Lowry Process

In the Lowry Process:

- The wood and treating solution are introduced into the pressure cylinder and heated together. Unlike the Bethell process, air is not removed from the wood cells.
- The pressure is raised to force the solution into the wood.
- After about four hours the pressure is released and the solution that is not retained is pushed out by the air in the wood ("kickback").
- A vacuum is then applied to the cylinder for an hour to assist with tie cleanliness and drip control when they are removed from the cylinder.

The Lowry Process is commonly used for oak and hickory ties.

Rueping Process

The Rueping Process is very similar to the Lowry Process, except that air is forced into the ties under pressure before the treating solution is introduced into the cylinder. The cylinder is heated and pressurized, the pressure is released and a vacuum is applied for final clean-up similar to the Lowry Process. The addition of the forced air in the initial processing phase helps to push out the preservative and reduces the final amount of preservative retained by the tie. The Rueping Process is frequently used for Mixed Hardwood ties.

Retention and Penetration

The amount of preservative retained in a purchased tie is specified as some number of pounds of preservative per cubic foot of wood. More adverse conditions (as in marine immersion, for example) indicate a need for higher retentions. Different amounts of retention are specified for different treating solutions (e.g., creosote or copper naphthenate) because of their varying effectiveness.

The heartwood of some species is difficult for most preservatives to penetrate compared to sapwood, and different species take up different amounts of wood preservative. For example, white oak is much less permeable than red oak due to the abundance of tyloses. The AWPA requires oak/hickory crossties to be treated to a minimum retention of 7 pounds per cubic foot (pcf) (or to refusal) of creosote, while mixed hardwood charges (not including oak/hickory) must be treated to 7 pcf.[2]

In addition to retention, the minimum creosote penetration[3] is also specified and varies according to the species. For example, the minimum creosote penetration for an oak or hickory crosstie is 1½" or 65% of the annual rings, whereas for white oak the standard specification is for 95% of the sapwood to be treated. Mixed hardwood ties (excluding oaks and hickory) have to be treated to 1½" or 75% of the sapwood (and so forth).

Ties are bored at the center of the tie to check for adequate penetration because the wood in the center is not likely to treat as well as at the end where cross-sections of wood cells are directly exposed to the preservative. Ties are bored on the sides instead of the faces—because ties aren't square, the face of the tie is more likely to contain a thinner layer of sapwood, and borings taken there might appear to show inadequate penetration of the treatable wood. (See Figure 8.)

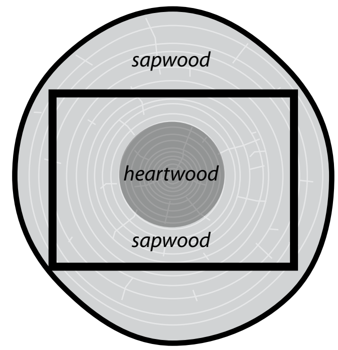


Figure 8. *An exaggerated sketch of how a crosstie might be cut from a round log. It illustrates how the tie sides are likely to contain thicker sapwood than the tie faces.*

Low permeability notwithstanding, it is possible to protect heartwood. Track trials conducted during the past twenty years have demonstrated that water-borne borates can diffuse even into white oak heartwood to protect ties. Borates can leach out of wood in wet conditions, so ties treated with borates must be additionally treated with a heavy oil-based preservative such as creosote for weathering protection ("dual treatment").

The Demand for Railroad Ties

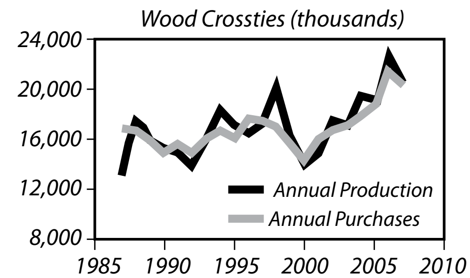
Because railroad ties take time to season and treat, the railroad tie industry tracks two related items: tie demand and tie production. Balancing the two helps to minimize the amount of inventory on tie yards at any given time. The RTA generates reports on a rolling total of the previous twelve months.

Railroad ties are much in demand at the present time, and at the end of 2007 both demand and production were running over 20 million ties per year on a rolling 12-month average.[4]

Tie prices vary by region across the United States, but historically untreated ties have been purchased by treating plants at around $20 per tie depending on transportation costs to the tie plant, market demand, and other factors. The number of ties required is subject to continual change (see Figure 9), and current local market prices should be consulted. The most current public information for tie production, demand, and inventory (and other statistics) is found on the RTA web site at http://www.rta.org/ProgramsandServices/IndustryStats.aspx.

There are three major players in the railroad tie treating industry today. Of the three, Koppers is the largest, with about half of the market share in North America. Tangent Rail and Burke-Parsons-Bowlby are generally ranked numbers two and three, but their combined market share amounts only to about 15–20%. Koppers is the world's largest distiller of coal tar, which is used to make creosote. Tangent Rail also manufactures coal tar products and creosote, with five treating plants for wood products. Burke-Parsons-Bowlby has five treating plants, including one in Stanton, Kentucky, and another in Fulton, Kentucky (opened in February 2007).

Figure 9. *Crosstie production and purchases. Data from the Railway Tie Association, current through December 2007.*



General Requirements for Crossties

Like other industrial products, wood railroad ties have to meet certain minimum specifications. These specifications may change from buyer to buyer according to the demands placed on the track by the rolling weight, frequency of use, and environmental conditions. All of the grading standards have evolved to ensure two essential things. Ties must be:

- Sound enough to support the weight on the track and to grip rail spikes
- Able to accept sufficient wood preservative

Railroads maintain gauge and distribute track loads by connecting the rails to the ties using steel tie plates and fasteners (see Figure 10). Four spikes or bolts are placed in each tie laid in a straight track section (called a tangent).[5] Wood defects within the two rail-bearing areas (the regions from 11" to 31" from each end of an 8' 6" tie) can cause serious problems.

Figure 10. *A section of railroad track showing tie plates and spikes.*

Switch ties are used where two tracks meet/diverge as trains transfer from one track to another, and can be from 10' to (occasionally) 20' long. (See Figure 11). These ties must be exceptionally sound throughout their length to hold the greater number of spikes used.

Understanding what tie inspectors look for in deciding whether to accept or cull a potential tie will help tie producers make better ties and achieve a lower rate of tie rejection. An inspector must determine whether the tie:

- Is of a species that will adequately accept wood preservative
- Has the correct dimensions
- Will have the mechanical strength to endure once placed in-track

Mechanical strength is largely determined by the wood species (because wood density is correlated with tie strength and hardness), and by the presence or absence of defects such as rot, holes and splits.

All defects are going to have the greatest consequence in the rail-bearing area, but some are potentially so deleterious to strength that they are disallowed in ties regardless of degree or location. Ties are inspected on all four sides and on both ends, using a mirror to examine the far end; this helps the tie grader catch defects and can assist with species identification. (See Figure 12).

Hardwood tie producers often group ties into categories for treatment, such as oak/hickory and mixed hardwoods, but separate sorts for species such as hickory may be performed at some yards. Local names may prevail for species identification; for example, in one southern facility "mixed hardwood" ties are referred to as "gum."

Figure 11. *The use of switch ties, where two sections of track are joined by one long wooden tie.*

Figure 12. *A hardwood tie as seen while being inspected by a tie grader. Notice the lights and mirrors aimed at the far end of the tie so the grader can look for holes and other defects.*

Crosstie Specifications

Quoted material from "Specifications for Timber Crossties and Switch Ties."

Keep in mind that the specifications for crossties, as described below, differ slightly from those for switch ties and for industrial grade ties. As the ultimate authority, refer to the RTA booklet entitled "Specifications for Timber Crossties and Switch Ties." It's available both in printed form and as an online publication at the RTA website (**www.rta.org**); as of this writing, the latest revision date is January 2003.

Acceptable Tie Species

"Before manufacturing ties, producers shall ascertain which of the following kinds of wood suitable for crossties will be accepted:

Ashes	Gums	Oaks
Beech	Hackberries	Pines
Birches	Hemlocks	Poplars
Catalpas	Hickories	Redwoods
Cherries	Larches	Sassafras
Douglas-fir	Locusts	Spruces
Elms	Maples	Sycamores
True Firs	Mulberries	Walnuts

***Each railway will specify the kind of wood it wants to purchase, and other species will not be accepted unless specially ordered."**

Not every kind of tree makes a good tie. Some species are too soft, and some don't take preservative well enough. Ultimately, what is acceptable or unacceptable is up to the purchaser. Individual railroads and their inspectors conduct ongoing long-term tests to see how well different species and preservative treatments perform in the kind of environmental and service/load conditions for which they maintain track.

"Poplars" is a category that needs clarification; at one time this category included both cottonwood and yellow-poplar, but as cottonwood is no longer considered to be an acceptable species the word "poplars" in this list must be understood to be synonymous with yellow-poplar (and only yellow-poplar).[6] Very few yellow-poplar ties are actually produced in the United States.

Redwood is not commonly used anymore because denser softwood and hardwood species have taken its place in the tie market. Black walnut and cherry are rarely used for ties because the wood is generally more valuable for other items.

Dimensions

"Ties shall be 8′-0″, 8′-6″, or 9′-0″ long as specified by the customer. Thickness, width, and length specified are minimum dimensions for green ties."

The tie face and side dimensions need to be checked as well as the length. Crossties must be cut to meet or slightly exceed the minimum dimensions of the tie grade being purchased.

Wood shrinks as it dries, but green ties still have to meet a minimum size specification after seasoning (see below). Allowing a little extra all around is a better idea than cutting ties exactly to size when cutting a tie from green wood.

"Dry or treated ties may be ¼″ thinner or narrower than the specified sizes.

Ties exceeding these dimensions by more than 1″ shall be rejected."

As noted previously, 8′ 6″ long ties are most common. Hardly any 8′ crossties are needed, and very few 9′ long ties. The green length (as sawn) must be several inches longer than the minimum specification to allow the tie ends to be squared up. If a tie meets the minimum length requirement but the ends need to be squared up the tie may be rejected for being miscut.

One of the first things a tie inspector checks on a tie is its length. If a tie yard is only buying ties that are 8′ 6″ long (plus trim), ties that are 8′ 4″ long will be rejected. It is uncommon to find a tie that has been cut too short–but it happens nonetheless. Sometimes bundles of ties are presented for sale in which every tie is too short to make an 8′ 6″ tie.

Unless the buyer is purchasing 8' ties, these will be rejected for grade ties and the sawmill has wasted time, material and the trucking costs to get them to the buyer. He may even have to pay to get them returned to him! (Short ties may be acceptable as industrial grade ties for some buyers.)

Figure 13. *An example of a short pine tie that made it to a treatment plant. It should have been 8' 6" (102") long.*

Ties Must Be Sound

Ties are examined for a number of physical and handling defects, including wane, decay or incipient decay, holes, knots, shake, checks, splits, cross grain or slope of grain, bark seams, and splits.

As noted below, just the *presence* of some of these would be enough to cull a potential grade tie. Some of the requirements are relaxed for IG ties, however—see the RTA Specifications Booklet.

Very important! *All grade ties must meet the following minimum requirements (in addition to species):*

> **"Except as hereinafter provided, all ties shall be free from any defects that may impair their strength or durability as crossties, such as decay, large splits, large shakes, slanting grain, or large or numerous holes or knots."**

In other words, if a potential tie has decay, large splits, large holes, significant shake or a significant slope of grain–it won't make a grade tie. Knots may be permitted provided they aren't large and within the rail-bearing area (as described below).

It is rare that a defect-free tie is manufactured. The following sub-sections describe how severe the various defects have to be before the grade tie "candidate" has to be downgraded to an IG tie or culled entirely.

Wane

The width of the narrow side of the crosstie determines the grade (saleable size), and the amount and the position of wane (the absence of wood) can not exceed specified amounts without altering the tie performance. Now that ties are sawn instead of being hand-hewn, there is an unspoken expectation that wane will be held to a minimum.

> **"The grade of each tie shall be determined at the point of most wane on the top face of the tie within the rail-bearing areas. The rail-bearing areas are those sections between 20" and 40" from the center of the tie. The top of the tie shall be the narrowest face and/or the horizontal face farthest from the heart or pith center.**
>
> **All rail-bearing areas shall measure as follows:**
>
> **i) 7" grade crossties shall be 7" x 9" in cross section with a maximum of 1" of wane in the top rail-bearing areas.**
>
> **ii) A maximum of 20% of the ties in any given quantity (of 7" grade ties) may be square-sawn 7" x 8" in cross section with no wane in the rail bearing areas.**
>
> **iii) A 6" grade tie shall be 6" x 8" in cross section with a maximum of 1" of wane permitted in the top rail-bearing areas.**
>
> **iv) For both 6" and 7" grade ties, wane shall be permitted on the bottom face so long as it does not exceed 1" at any given point."**

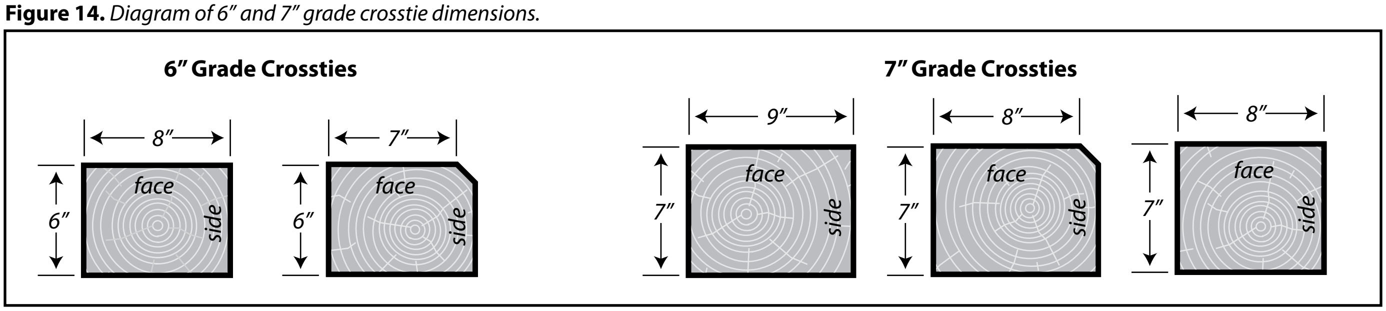
Because it's not intuitive to think of ties as having "top" and "bottom" faces when they're out of track, I'll repeat the definition from above: "The top of the tie shall be the narrowest face and/or the horizontal face farthest from the heart or pith center."

The requirement for less than 1" of wane at any point on the bottom side of the crosstie is to assure secure embedment of the tie in the rock ballast. Since tie placement in track (top up or top down) is random, it's not good for there to be more than 1" of wane at any point on either face.

Note that 7" x 8" crossties cannot have any wane in the rail-bearing area. This is different from the requirements for other sizes of ties.

Wane is not used to downgrade a 7" grade tie to a 6" grade tie. The standard states that a 7" grade crosstie must be 7" x 9" in cross-section, but wane is ignored when the side dimension is measured. (See Figure 14.)

Figure 14. *Diagram of 6" and 7" grade crosstie dimensions.*



Redrawn from AREMA Manual for Railway Engineering.

Figure 15. *Wane outside the rail-bearing area. Would this be acceptable?*

Figure 16. *Would you cull this 7" x 9" red oak tie for wane?*

Decay

"Decay is the disintegration of the wood due to the action of wood-destroying fungi. "Blue stain" is not decay and is permissible in any wood."

Soft, discolored areas indicate the presence of decay fungi. Decay is a defect that warrants culling the tie. It won't get fixed in the treating cylinder; in fact, if a tie with decay doesn't get properly sterilized in the treating cylinder the decay might even spread to inadequately treated heartwood once it's laid in track. This can be a real problem for non-decay-resistant or moderately-decay-resistant heartwood.

Figure 17. *Heart-rotted maple tie after only five years in track.*

Figure 18. *Decay in an air-dried crosstie.*

Holes

Ties with large holes cannot support the stresses placed on the track, therefore they cannot be placed into service. Insect damage is a common cause of holes in trees.

"A large hole is one more than ½" in diameter and 3" deep within, or more than ¼ of the width of the surface on which it appears and 3" deep outside, the sections of the tie between 20" and 40" from its middle.

Numerous holes are any number equaling a large hole in damaging effect. Such holes may be caused in manufacture or otherwise."

Fire scars are also problems to watch out for because of holes and other problems. (See Figure 20.)

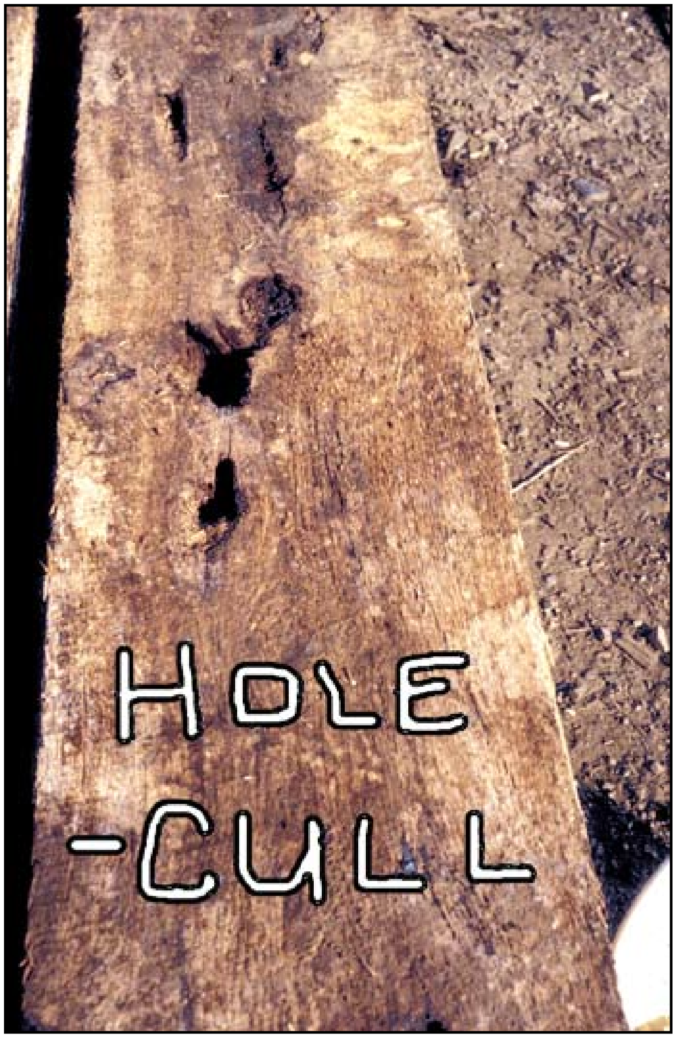


Figure 19. *Holes in a crosstie that would warrant culling the tie.*

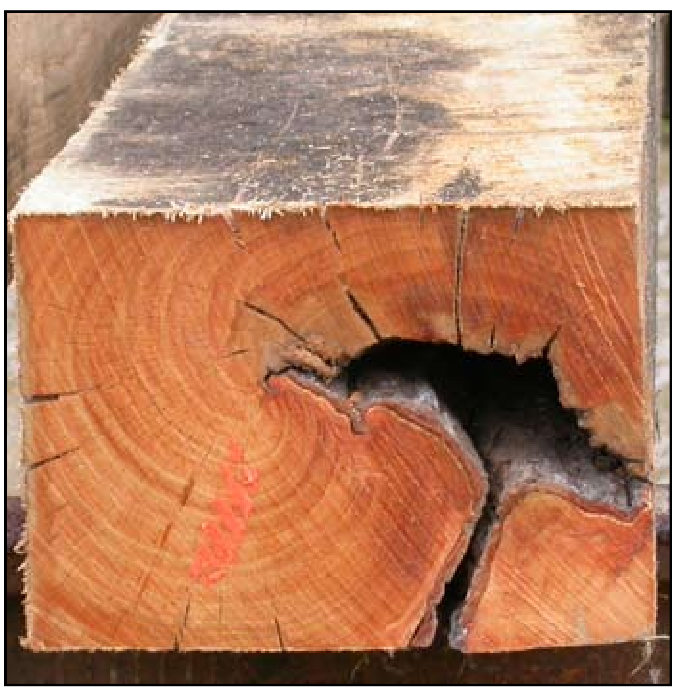


Figure 20. *Fire scar in sycamore.*

Knots

Knots are problesm in ties for a couple of reasons. First, knots contain sloped grain—and sloped grain is weaker than straight grain. Second, knots may contain bark that prevents proper penetration of preservative. Knots can also contain decay. Small knots are not significant problems, but large knots are reasons to reject a tie.

> **"Within the rail-bearing areas, a large knot is one having an average diameter more than ⅓ the width of the surface on which it appears, but such a knot will be allowed if it is located outside the rail-bearing areas. Numerous knots are any number equaling a large knot in damaging effect."**

Knots on either the face or the side of a crosstie can cause it to be rejected. On a 7" x 9" tie, for example, any knot wider than 3" on the 9" face within the rail-bearing area would cause the tie to be culled. A smaller knot that is only 2½" in diameter would cause this tie to be culled if it were located on one of the sides of the tie (because 2½" is greater than ⅓ of 7", or 2⅓"). (See Figure 21.)

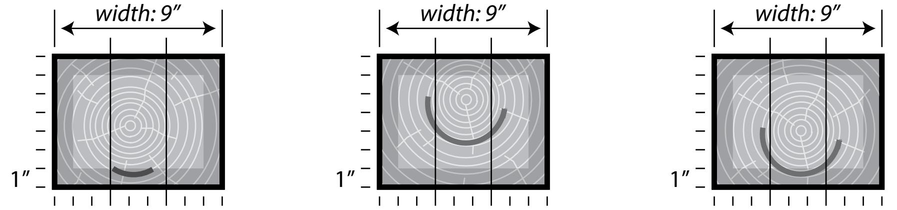
Figure 21. *This large knot in the rail-bearing area is 3½" in diameter. Its size alone causes this tie to be culled, but notice that there is also some significant slope of grain associated with this knot. Even without the knot, the slope of grain would have to be examined as a potential reason to cull this tie.*

Shake

> **"Shake which is not more than 1/3 the width of the tie will be allowed, provided it does not extend nearer than 1" to any surface."**

Shake is a separation of the wood between annual rings. Shake is not allowed in ties because it often leads to failure of the wood after it has been repeatedly stress-loaded in service. It doesn't always take a lot of time for the tie to fail! (See Figures 22-25.)

Figure 22. *Examples of ties to cull for shake, with the reasons(s) given below each illustration.*



Cull for surface proximity: *Shake is within 1" of the surface.*	**Cull for width:** *Shake is wider than one-third of the beam width.*	**Cull for both surface proximity and width.**

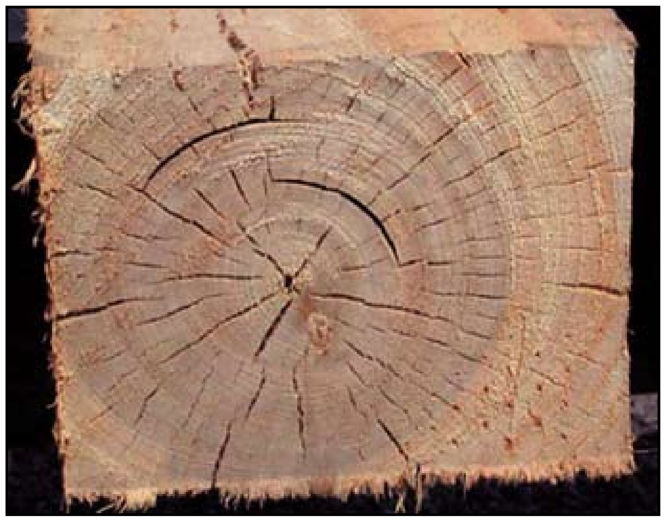
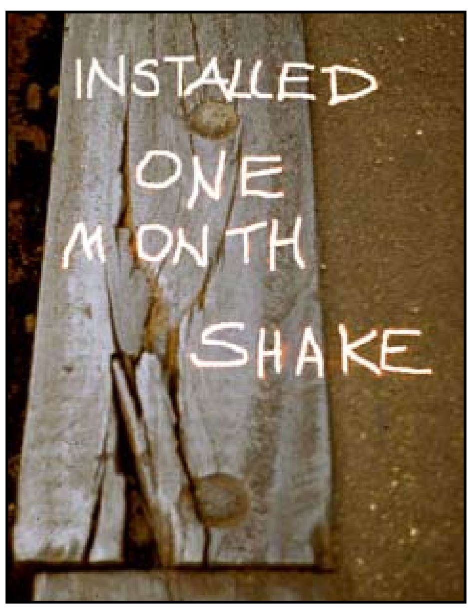
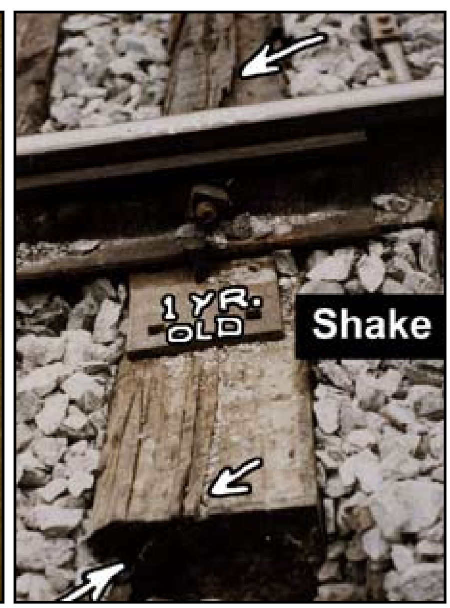


Figure 23. *The combined width of these two ring shakes is 4", which causes rejection under a 9" face width.*





Figures 24 and 25. *Early failures due to shake, one month old and one year old, respectively. The photo on the left is at a road crossing.*

Checks

The difference between checks and splits needs to be clearly understood. A check is found on one surface only, but a split is a separation of the wood extending from one surface to another surface.

> **"A check is a separation of the wood due to seasoning which appears on one surface only. Do not count the end as a surface.**
>
> **Ties with *continuous* checks whose depth in a fully seasoned and/or treated tie is greater than ¼ the thickness and longer than ½ the length of the tie will be rejected.**
>
> **Season checks greater than 2" deep or ¾" wide shall be rejected as industrial grade ties."**
>
> *(Italics added for emphasis.)*

In other words, if you are grading a 7" x 9" tie that is 8' 6" long (102" long), any check deeper than 7/4" (1¾") or longer than 51" would cause the tie to be rejected for all uses. Checks are different from splits. If a separation doesn't extend to another surface, it's a check—not a split. (See Figure 26.)

Railroads can exercise their own judgment when it comes to making grading decisions more restrictive. For example, one company specifies that heart checks cannot be more than ½" wide in the rail-bearing area.

Figure 26. *This tie would be rejected because the long check in the middle of the tie is over half the length of the tie, and it is 1¾" deep.*

Splits

> **"A split is a separation of the wood extending from one surface to an opposite or adjacent surface.**
>
> **In *unseasoned* crossties, a split no more than ⅛" wide and/or 4" long is acceptable.**
>
> **In a *seasoned* crosstie, a split no more than ¼" wide and/or longer than the width of the face across which it occurs is acceptable. End plates may be required by the railroad.**
>
> **Do not count the end as a surface when measuring the length of a split."**
>
> *(Italics added for emphasis.)*

Splits can often—but not always—be fixed by end-plating. Splits that are noticeable in a green tie will only get worse with seasoning.

The common practice is not to attempt to "fix" splits wider than ¾" and/or longer than 10" by end-plating. Look at the following illustrations to see examples of salvageable and non-salvageable timber. (See Figures 27-30.)

Figure 27. *This split is acceptable as-is for an air-dry tie. It is less than ¼" wide and shorter than the 9" face where it appears. (Remember that the tie end doesn't count as a surface.)*

Figure 28. *This tie could be saved with an end plate. Single "through splits" that equally divide the end are perfect for end-plating.*

Figure 29. *This tie has a split that is over one inch wide, and it's not salvageable.*

Figure 30. *End plates can't salvage every tie.*

Bark Seams

"A bark seam or pocket is a patch of bark partially or wholly enclosed in the wood. Bark seams will be allowed provided they are not more than 2" below the surface and/or 10" long."

Most railroads will not allow any bark seams in the rail-bearing area, and some restrict the width and length of the bark seam. Included bark means that there is a mechanical and structural defect in the wood, and the bark also prevents preservative from penetrating beneath the bark surface. (See Figure 31.)

Here's a case to consider: If one end of a crosstie was cut through the crotch of a tree it will contain a bark seam that may be centered in the tie. (See Figure 32.)

This tie might be thought to be unacceptable according to a strict reading of the standard because of the bark seam depth; it's apparent from the end that the bark seam extends more than 2" below the surface, even though it's only barely visible (if at all) on either of the tie faces. In practice, however, bark seams like this are generally shallow defects that do not extend into the rail-bearing area. They might be considered to be short splits and judged accordingly because tie ends don't count as surfaces for splits.

Figure 31. *This bark seam is greater than 2" deep, and it's also longer than 10". (Look how the bark seam extends from the face and down the side.) It fails to meet the minimum tie specifications.*

Figure 32. *A bark seam that would probably be acceptable.*

Manufacturing Defects

Ties need to be bark-free, free of warp, and cut squarely. Sometimes ties will warp or twist after cutting due to the release of growth stresses present in the living tree. Ties with these defects are not acceptable. (See Figures 33-34.)

> **"All ties must be straight, square-sawn, cut square at the ends, have top and bottom parallel, and have the bark entirely removed. A tie will be considered straight when a straight line from a point on one end to a corresponding point on the other end is no more than 1½" from the surface at all points."[8]**

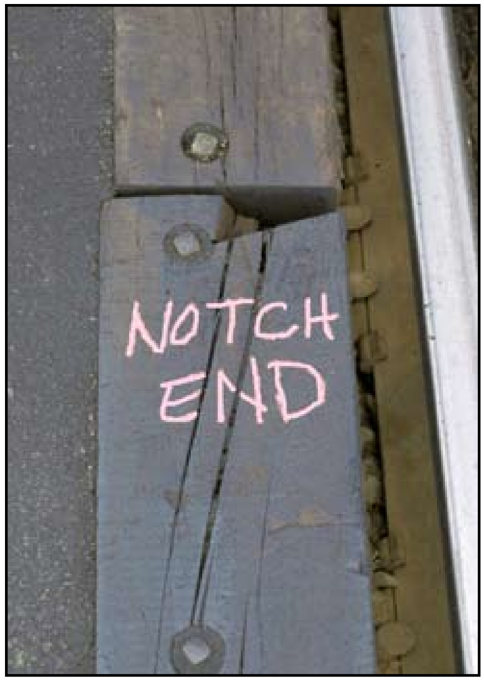


Figure 33. *The miscut end should have caused this tie to be culled. This cut is from the felling notch in the woods.*

Figure 34. *One of these crossing ties is obviously not the right thickness!*

Slope of Grain (Crossgrain)

It's important to minimize crossgrain because it diminishes the amount of load that any piece of wood will support. Slope of grain can occur in a tie due to the way the sawyer positioned the log on the carriage, or maybe the tree grew with some crook. No matter how it's cut, a crooked tree will never make a straight-grained tie. Crossgrain could also occur due to localized grain deviation around knots, etc. (See Figures 35-37.)

"Except in woods with interlocking grain, a slant in grain in excess of 1 in 15 will not be permitted."

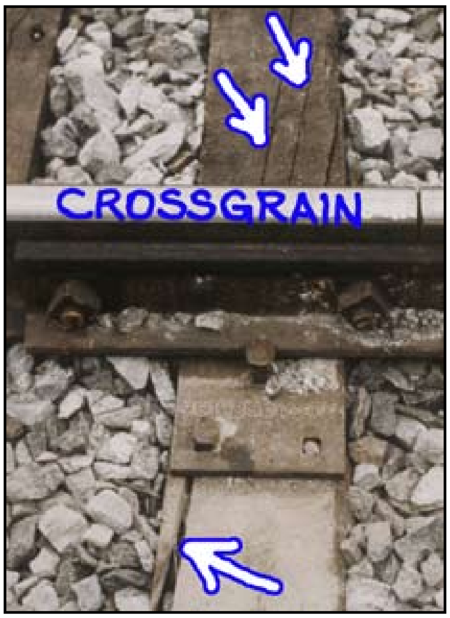


Figure 35. *Crossgrain in this tie caused it to fail prematurely.*

Figure 36. *A crossgrain problem with this tie was caught before treatment—it broke when it was dropped!*

Figure 37. *Since sweet gum normally has interlocking grain, the evident slope of grain in this tie would be acceptable. Figure 3 showed a good example of a sweet gum tie with interlocking grain, so it's repeated here. The shake would have to be looked at too.*

Notes

1. The American Wood Protection Association, the organization responsible for this standard, was called the American Wood-Preservers' Association until the end of 2007. The association goes by the AWPA acronym in any case.
2. AWPA Standard U1-07. 2007. Use Category System: User Specifications for Treated Wood. Commodity Specification C: Crossties and Switch Ties, Part 3.0.
3. AWPA T1-07. 2007. Use Category System: Processing and Treatment Standard. Section 8.3: Crossties and Switch Ties.
4. Demand peaked in January 2007 at 21.7 million ties per year. As of December 2007, demand was 20.3 million ties per year. Peak production was in September 2006 at 22.6 million ties per year. As of December 2007, tie production was 20.7 million ties per year.
5. Eight spikes per tie are used on curves.
6. Personal communication with Jim Gauntt, Executive Director of the RTA, August 2007.
7. This corresponds to the length of tie that is between 11" and 31" from each end of an 8' 6" tie.

References

AWPA. 2007. Standard U1-07. Use Category System: User Specifications for Treated Wood. Commodity Specification C: Crossties and Switch ties, Part 3.0.

AWPA. 2007. Standard T1-07. Use Category System: Processing and Treatment Standard. Section 8.3: Crossties and Switch ties.

Railway Tie Association (RTA). January 2003. "Specifications for Timber Crossties and Switch Ties" booklet. www.rta.org.

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Photo/Figure Credits

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Figures 1-8, 10-13, 16, 20, 36, 37

Railway Tie Association
Figure 9

AREMA Manual for Railway Engineering
Figure 14

RTA Visual Guide to Tie Specifications
Figures 15, 21-23, 26, 27, 28, 29, 31

Jim Watt
Figures 17, 18, 19, 24, 25, 30, 32-35

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