HQ IMCOM centrally funded the initial research on a wooden crosstie replacement program report. This was necessitated by the large number of defective crossties encountered during inspections. It became apparent that installations needed support for creation of a crosstie replacement program as well as updated specification recommendations. The ADTIP/ERDC Railroad Track Evaluation Team inspects Army track every 5 years and communicates findings via reports to HQ IMCOM.

IMCOM sponsors a railroad resources management site available at

https://transportation.erdc.dren.mil/imcomadtip/rr_resources.aspx

Contact Us:
IMCOM ADTIP PM
210-466-0535
michael.r.andres.civ@mail.mil

ERDC POC
601-415-4524
Ethan.Russell@usace.army.mil

I-GRAM Army Dams & Transportation Infrastructure Program

Vol 9 01 September 2021

Current Specifications

Army specific standards for wooden crossties and switch crossties, used interchangeability in this document, can be found in UFC 4-860-01FA and UFC 4-860-03. UFGS-34 11 00 provides specifications that can be used when ordering crossties to ensure standards are met. Per AR 420-1, UFC 4-860-03 is to be used for routine maintenance and inspection. The following wood crossties replacement program recommendations will ensure that track is maintained IAW AR 420-1.

Wooden Crosstie Replacement Program Recommendations

Crossties maintain gage, surface, alignment, and distribute the load from the rail to the ballast. Unlike many forms of traditional infrastructure in the ADTIP program, crossties require continuous maintenance and should not be considered as a large capital project that does not need maintenance once completed. An involved and dedicated track manager and inspector is required for quality track that is capable of meeting Army mission requirements.

Standards. At a minimum, Army track is kept in accordance with UFC 4-860-03 chapter 5. DOD policy is to maintain its railroad track at a standard that exceeds FRA Class 2 safety standards and adhere to additional DOD speed restrictions as stated in UFC 4-860-03. All recommendations that follow are proposed program recommendations that attempt to meet standards.

UFC 4-860-03
13 FEBRUARY 2008

Summary of Standards

Item	Maintenance Standards: Deviation for Track Category A	Maintenance Standards: Deviation for Track Category B	Maintenance Standards: Paragraph Reference in UFC 4-860-03	Safety Standards: Restricted Operation 10 mph	Safety Standards: Close to Traffic	Safety Standards: Paragraph Reference in FRA TSS	Construction/ Repair Tolerances
Ties:						213.109	See 5-4.d.
Min. Nondefective Tie per 39 ft Tangent and LT 2 ° Curves 2 ° or GT	 Less than 12 Less than 13	 10 11	5-6.c.(1)	 Less than 8 Less than 10	 Less than 7 Less than 9	213.109 (c) and (d)	
Consecutive Defective Tangent and LT 2 ° Curves 2 ° or GT	 3 2	 3 2	5-5.c.(1)	 4 3	 5 or more 4 or more		0
Joint Ties:							213.109 (f)
No. of Nondefective Required – 24" C/L	2	1	5-5.c.(2)	1	0		2
Missing/Skewed	Tie missing or skew greater than 8 in. in 3 or more consecutive ties		5-5.d., 5-5.e., 5-5.f.		---	---	See 5-4.d.

Initial Program Development. The recommended crossties replacement program for Army installations is a cyclical spot crosstie replacement program supplemented by an initial larger general crosstie replacement. In many cases, Army installations have track that requires significant crosstie replacement to reach a level that can be maintained by a crosstie replacement program. If a track has more than 20% defective crossties, typically there will be a large number of consecutive defective crossties resulting in closed to traffic track. To start the program an initial 1 in 3, 1 in 4, or 1 in 5 crosstie replacement is recommended. After the installation has reached a point where the track is above the Army minimum safety standards, the crosstie replacement program can begin.

Crosstie Replacement Program. The crosstie replacement program will follow the following repair cycle. The repetition of each repair cycle will vary based on installation requirements. For installations with traffic density over 20 MGT per year or in the Decay Hazard Zones "high" or "severe" the process may need to be conducted quarterly whereas installations with a traffic density less than 10 MGT or Decay Hazard Zones "low" may need to conduct the repair cycle on 5 – 7 year rotations. Over time, installations will need to develop their ideal repair cycle timeline.

Procurement/Contracting Estimate >> Crosstie Inspection >> Procurement/Contracting Action >> Installation

*In an ideal situation a Crosstie Inspection is performed before the Procurement/Contracting Estimate. However, this is not always possible at Army Installations.

The four actions listed oversimplify the process; however, they provide a basic starting point for an effective crosstie replacement program. This I-Gram is intended to provide the building blocks for an installation to start its own crosstie replacement program. It is not standard operating procedure and is meant to be adjusted to fit the needs and experiences of individual installations.

Additional Reference Material. Trade and professional organizations are excellent resources: American Railway Engineering and Maintenance-Of-Way Association (AREMA) (https://www.arema.org/), Railroad Tie Association (RTA) (https://www.rta.org/), and the American Wood Protection Association (AWPA) https://awpa.com/info/. The Army has the following reference documents: AR 450-1 Army Facilities Management, DA-PAM 420-1-3 Transportation Infrastructure and Dams, UFC 4-860-01 Railroad Design and Rehabilitation, UFC 4-860-03 Railroad Track Maintenance & Safety Standards, UFGS 34 11 00 Railroad Track and Accessories (specification resource), FRA Track Safety Standards, TM 5-627 (Out of date resource for maintenance on Army track). Which can be found at IMCOM Railroad Resources Site https://transportation.erdc.dren.mil/imcomadtip/rr_resources.aspx

Policy: Army G-9 – Mike Dean Arden.m.dean.civ@mail.mil
Execution: Army IMCOM – Michael Andres michael.r.andres.civ@mail.mil
Inspection: USACE ERDC – Jeremy Beasley thomas.j.beasley@usace.army.mil
Design: USACE TSC – Andy Fanciullo Andrew.P.Fanciullo@usace.army.mil
Repair: MCAAP Rail Services – Ryan Crabtree ryan.c.crabtree.civ@mail.mil

HQ IMCOM centrally funded the initial research on a wooden crosstie replacement program report. The large number of defective crossties encountered during inspections necessitated this. It became apparent that installations needed support for creation of a crosstie replacement program as well as updated specification recommendations. The ERDC Railroad Track Evaluation Team inspects Army track every 5 years and communicates findings via reports to HQ IMCOM.

IMCOM sponsors a railroad resources management site available at

https://transportation.erdc.dren.mil/imcomadtip/rr_resources.aspx

Contact Us:
IMCOM ADTIP PM
210-466-0535
michael.r.andres.civ@mail.mil

ERDC POC
601-415-4524
Ethan.Russell@usace.army.mil

I-GRAM Army Dams & Transportation Infrastructure Program

Vol 9 01 September 2021

Procurement/Contracting Estimate

In many installations procurement must be done in advance. The best method to determine the procurement or contracting estimate for a replacement cycle is a crosstie only inspection where the total number of defective crossties are marked and recorded. If this is not possible, the following outlines an initial methodology to estimate a rough yearly crosstie replacement.

Steps:

1.0: Determine Hazard Decay Zone. Locate the corresponding Hazard Decay Zone using Figure 1.

2.0: Determine Estimated Crosstie Life (T_{avg}). Locate the estimated crosstie life based on Figure 2. Note: For low tonnage routes with dual treated crossties, the estimated average crosstie life was adjusted to account for the decreased mechanical wear.

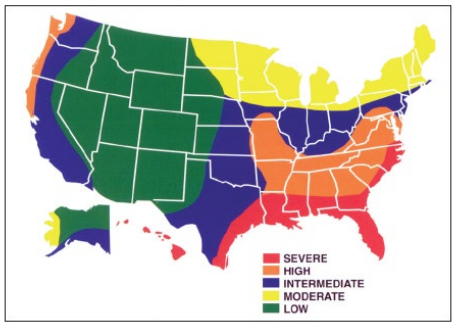


Figure 1: RTA Decay Hazard Map. Source: Railway Tie Association (Tie Report #1).

	Est. Average Crosstie Life (Yr.)		
Hazard Decay Zone	Creosote Only	Dual Treated	Dual Treated (Traffic Density > 5 MGT Per Yr.)
LOW	43.3	43.3	43.3
MODERATE	39.9	39.9	39.9
INTERMEDIATE	35.9	44.9	39.9
HIGH	30.7	44.9	39.9
SEVERE	18.1	38.6	38.6

Figure 2: Average Crosstie Life for Creosote and Dual Treated Crossties. Based on modified data from RTA Report "Determination of Effect of Introduction of Dual Treatment (Borate-Creosote) Ties on Average Tie Life and Wood Tie Life Cycle Costs"

3.0: Determine Estimated Number of Crossties on Track. For estimation purposes, the calculation can be done for the total track system, track, or track segment. Determine using the following equation:

$$N_{Tie} = \frac{L_{Miles} * 63,360 \frac{in}{mile}}{S}$$

N_{Tie} = Total number of crossties on the track system, track or track segment.
L_{Miles} = Length of track system, track, or track segment (miles)
S = Crosstie Spacing (in). Typically 19 in-22 in

4.0: Determine Estimated Number of Crossties Needed. This will provide an estimated number of crossties needed per year; if the replacement cycle is not yearly, the calculation can be adjusted as required. Because this estimate is for crossties that will become deficient in the year an additional number of already deficient crossties should be added based on the most recent inspection. If the status quo is acceptable, this additional number will be 0. For installations with a significant number of defective crossties, it is recommended to divide the number of additional crossties needed over a 5-year period.

$$R_{Tie} = \frac{N_{Tie}}{T_{avg}} + D_{Tie}$$

R_{Tie} = Annual estimated number of crossties needed for the track system, track or track segment.
N_{Tie} = Total number of crossties on the track system, track or track segment.
T_{avg} = Estimated crosstie life (Yr.)
D_{Tie} = Deficient number of crossties from last inspection of the track system, track, or track segment.

5.0: Calculate Procurement/Contracting Estimate. This estimate is based on the local cost for ordering crossties, labor, equipment, etc. If an installation uses contract labor, the local cost should be used for calculation. When ordering crossties, it is recommended to follow I-Gram "Wooden Crosstie Recommendations".

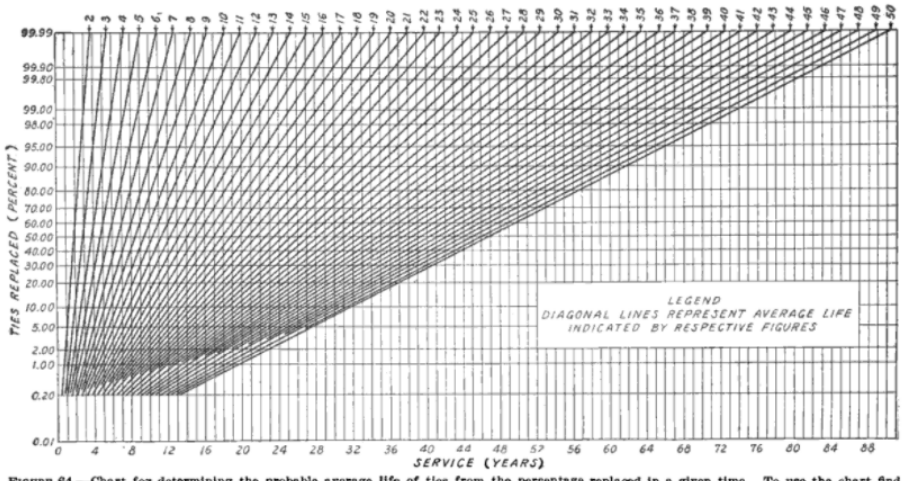


FIGURE 64.—Chart for determining the probable average life of ties from the percentage replaced in a given time. To use the chart find the percentage-renewal figure at the left, follow this line horizontally until it intersects the vertical line corresponding to the number of years the group of ties has been in service, then follow the nearest heavy diagonal line to the upper edge of the chart where the probable average life of the group of ties in years will be found.

Figure 3: Chart to determine probable crosstie life. (Forest Product Laboratory, Wood Handbook 1940)

Alternative Step 1.0 and 2.0: tonnage, axle loading, speed, track geometry, rail weight, ballast and track support, jointed or welded rail, fastener types, environmental factors, biological activity, wood type, and crosstie treatment influence the crosstie life expectancy. Therefore, individual installations need to determine average crosstie life expectancies based on in-track conditions. If crosstie replacement is properly tracked, Figure 3 can be used to calculate an expected average crosstie life expectancy. It is recommended to track the average expected life expectancy for the track system, tracks, and track segments. Note: The RTA has sponsored research on an updated Forest Products Laboratory Tie Life Curve; however, Figure 3 was not updated. For Army installation needs, Figure 3 is acceptable for average crosstie life expectancy.

I-GRAM Army Dams & Transportation Infrastructure Program

Vol 9 01 September 2021

HQ IMCOM centrally funded the initial research on a wooden crosstie replacement program report. The large number of defective crossties encountered during inspections necessitated this. It became apparent that installations needed support for creation of a crosstie replacement program as well as updated specification recommendations. The ERDC Railroad Track Evaluation Team inspects Army track every 5 years and communicates findings via reports to HQ IMCOM.

IMCOM sponsors a railroad resources management site available at

https://transportation.erdc.dren.mil/imcomadtip/rr_resources.aspx

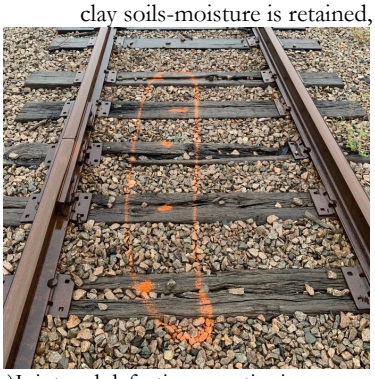
Crosstie Inspection

Current Required Inspections. Per AR 420-1, UFC 4-860-03 is to be used for routine maintenance and inspection. USACE ERDC, sponsored by HQ IMCOM, hosts the Railroad Track Standards and Maintenance Course (PW-1213). This two-week course provides the necessary training to conduct a Safety Inspection, Detailed Track Inspection, and Special Safety Inspection. In addition, the class outlines the topics of which a Continuous Operator Inspection needs to be aware. The USACE ERDC is the SME on Railroad Track Inspection and Research. The POC of the ERDC Railroad Track Evaluation Team is T. Jeremy Beasley thomas.j.beasley@usace.army.mil.

In all of the inspections listed above, defective crossties are noted. The Safety Inspection, Detailed Track Inspection, and Special Safety Inspection are completed at varying intervals depending on traffic frequency or period. The Special Safety Inspection is done based on factors that require it. Each of these inspections highlight the number of defective crossties as well as the number of maintenance and safety standards deficiencies.

Common Closed to Traffic (CTT) Defects. The ERDC Railroad Track Evaluation Team inspects Army Track on a 4- to 5-year rotation. Because of the repeated inspections over a long period of time, ERDC inspectors have noticed specific crosstie deficiencies that are found on almost all Army track systems. Figure 4 provides photo examples of the noted defects. Those anecdotal defects are listed below:

- Joint Crossties: Per UFC 4-860-03 there must be at least 1 nondefective crosstie within 24" of the center of the joint. The measurement is taken from the centerline of the crosstie.
- Defective Crossties in a Row: Per UFC 4-860-03, there is a maximum number of allowed consecutive defective crossties in a row before restriction and no operation of the track.
- Poor drainage and fouled ballast: Poor drainage resulting in pooling or extensive water contact with crossties will decrease the life expectancy of the installed crossties. In track with fouled ballast-especially with organic, silt, or clay soils-moisture is retained, resulting in a decrease in life expectancy of the crossties.



a)Joint and defective crossties in a row.

b) Poor drainage and fouled ballast.

c) Fouled ballast.

Figure 4. Examples of common defects found by the ERDC Railroad Track Evaluation Team on Army Track.

Crosstie Inspection for the Crosstie Replacement Program. It is recommended that for every crossties replacement cycle one crosstie only inspection is performed. This crosstie inspection should mark all defective crossties in accordance with UFC 4-860-03. The Crosstie Inspection can be divided into two parts that can be performed concurrently or separately.

Defective Crossties

Purpose: Know the current number of defective crossties on the track system.

- Total number of defective crossties.
- Locations of restricted and CTT defects.
- Identify defective crosstie by nail plate/label.
  - See Figure 5.

Crossties to be Replaced

Purpose: Mark replacement crosstie locations based on the number of crossties in the procurement/contracting estimate.

- With a separate marking device, mark defective crossties to be replaced in the installation repair cycle.

Figure 5 shows a sample tracking sheet for crossties. Installations should develop their own tracking system based on best practices. The goal of the tracking is to determine the behavior of crossties that have been installed on track in order to plan more effectively for future replacement and to estimate average crosstie life expectancy for the Procurement/Contracting Estimate. The industry is developing and has already developed new technology systems that can track individual crossties behavior over time; however, for most Army installations there is not enough economy of scale to justify procurement of these systems. Because tracking failure of crossties can be difficult and time consuming, installations should track failures to the best of their abilities. In some cases, installations have purchased "tacs" with information such as manufacture date, location, and treatment to improve record tracking. If record keeping is maintained, it is also possible to track each crosstie with a unique identification number, on a "tac" which can be associated with required tracking information.

Crosstie Behavior Tracker												
Identification			Installation				Crosstie Information					
Track System	Track	Track Segment	Install date	Install Location	Install Pattern	Notes	Manufacture date	Treatment Location	Species	Dimensions and Quality	Treatment	Anti-Splitting Device	Notes

Failure *Update after each inspection.		
Defective Date	Average Defect	Notes

Figure 5. Example tracking sheet for installed crossties.

Contact Us:
IMCOM ADTIP PM
210-466-0535
michael.r.andres.civ@mail.mil

ERDC POC
601-415-4524
Ethan.Russell@usace.army.mil

I-GRAM Army Dams & Transportation Infrastructure Program

Vol 9 01 September 2021

HQ IMCOM centrally funded the initial research on a wooden crosstie replacement program report. The large number of defective crossties encountered during inspections necessitated this. It became apparent that installations needed support for creation of a crosstie replacement program as well as updated specification recommendations. The ERDC Railroad Track Evaluation Team inspects Army track every 5 years and communicates findings via reports to HQ IMCOM.

IMCOM sponsors a railroad resources management site available at

https://transportation.erdc.dren.mil/imcomadtip/rr_resources.aspx

Procurement/Contracting Action

Purchase of Crossties or Contracting Action. Procurement and contracting are different for each Army installation. If an installation installs and orders their own crossties, it is important to have strong specifications. I-Gram "Wooden Crosstie Recommendations" provides recommended requirements for Army crossties. If a contracting action is required, and contract labor is hired, the contract needs to include strong crossties specifications as well as provisions for surfacing and tamping after completion. In either situation, it is important to "Trust but Verify" any contracting action with a quality QA/QC plan. There have been instances of Army installations receiving untreated crossties or incorrectly dimensioned crossties.

Record Keeping. Any crossties to be installed on track need to be properly recorded. This is required in order to assess average crosstie life and track crosstie performance over time. Information requirements include: Crosstie manufacturer, treatment plant, species, dimensions and quality, treatment, anti-splitting device, and treatment date. Records should be kept for the entire life of all purchased crossties.

General Recommendations. The following are general recommendations during the procurement/contracting action:

- TM 5-627 recommends that installations keep the following stocked on-site:
  - One hundred tie plates sized to fit each section of rail in use.
  - One hundred crossties (7 inches by 9 inches by 8 feet-6 inches). Note: Installations should vary this number based on track miles and best practice. All crossties in storage will age if exposed to climate conditions.
  - Five hundred tie plugs to fit 5/8- by 6-inch spike holes.
  - Two kegs of track spikes (5/8 by 6 inches).
- In general, the industry is honest and will provide good crossties. To ensure this, specifications need to be clearly stated and encompass all requirements.
- Over time, maintaining records of crossties ordered, deficient crossties, and crossties installed will allow for procurement that is more accurate/contracting estimates, but this is only accomplished by maintaining records.

Installation

General Recommendations. The following are general recommendations during installation:

- Storage
  - Protect crossties from the elements by covering with a tarp or overhead structure. Once treated, crossties will begin to decay from environmental impacts; exposed crossties will begin to decay at rates similar to installed crossties.
  - For checking, epoxy can be used to fill the check (i.e., SPIKEFAST *trade name-not endorsement*)
  - Additional recommendations on crosstie storage are found in TM-627
- Installation
  - Kerf marks should be installed facing up. An ideal crosstie has a boxed heart; however, if this is not possible the bark should be installed facing up (rings facing down). On manufacture kerf marks are placed to note the ideal installation.
- MISC
  - Flipping crossties already installed on track is not recommended. If initially installed correctly, this will lead to the incorrect side facing up as well as exposing the previously buried section of the crosstie. This leads to an increase in environmental decay in comparison with plugging the crosstie.
  - Plugging crossties with epoxy is acceptable and is typically quick and more effective than wood plugs (i.e., SPIKEFAST *trade name-not endorsement*).
  - Borate or copper naphthenate treated hardwood plugs can be used to reduce the effect that creosote has on the installer.
  - Crossties should be tamped after installation. If economy of scale is possible, track can be surfaced an aligned as well.

Closing Remarks

The most effective way to ensure that installations have crossties that meet Army Safety Standards is a dedicated track inspection and maintenance team that understands that wooden crossties and the track system as a whole, and also requires continuous inspection and maintenance over time. Best practices need to be developed by maintenance personal at the installation over time. In order for a crosstie replacement program to be successful, there needs to be a specific crosstie only inspection allowing the inspector to inspect the crossties without distraction. Frequency of inspections needs to be based on the individual installation requirements. Projected future crosstie requirements require knowing the percentage of defective crosstie per mile and adjusting as required over time. A true prediction cannot be created, because there are too many factors that can affect crosstie life. The only exact method to determine the number of deficient crossties is to walk track and create a prediction of crosstie life over time. In order to create that prediction, the installation needs to keep track of installed crosstie locations and characteristics.

Thank you to all SME that supported the development of these recommendations.

Contact Us:
IMCOM ADTIP PM
210-466-0535
michael.r.andres.civ@mail.mil

ERDC POC
601-415-4524
Ethan.Russell@usace.army.mil