ECOTRAX™
COMPOSITE RAILROAD TIES

MECHANICAL PROPERTIES

Test and Standard	Property	Value
Specific Gravity ASTM D6111	Specific Gravity	0.85 – 0.90
	Density	53 – 56 lb/ft³ (849 – 897 kg/m³)
Compression ASTM D6108	Compressive Strength (parallel to grain)	3,081 psi (21.2 MPa)
	Compressive Strength (perpendicular to grain)	1,240 psi (8.5 MPa)
	Permanent Deformation Under Load (30,000 lb. / 13,608 kg)	0.013 in (0.033 cm)
	Modulus of Elasticity (compression)	177,937 psi (1,227 MPa)
Flexural AREMA Chapter 30 ASTM D6109	Ultimate Load	19,164 lbs (857 kN)
	Modulus of Elasticity (in bending – center negative – MOE)	314,059 psi (2,165 MPa)
	Shear Strength (calculated)	1,500 psi (10.3 MPa)
	Modulus of Rupture (in bending – center negative – MOR)	3,954 psi (27.3 MPa)
	Plate Compression (MOE)	25,600 psi (176.5 MPa)

Thermal Expansion ASTM D696		Increase Length from 78º F – 160º F (25.6 °C – 71.1°C)	Decrease Length from 160º F – 0º F (71.1°C – -17.8°C)	Increase Length from 0º F – 78º F (-17.8 – 25.6 °C)	Coefficient of Thermal Expansion
	Average	0.2019 in (0.5128 cm)	-0.3503 in (-0.8897 cm)	0.1661 in (0.4219 cm)	0.000041 in/inºF (0.000074 cm/cm/ºC)

Slip Resistance ASTM F609	Average Coefficient of Friction (Dry Condition)	Average Coefficient of Friction (Wet Condition)
	0.60	0.62

Cyclic Load AREMA Chapter 30 – TTCI

21,000 lb (9,525 kg) load rotated between gage side and field side

Lateral Railhead Displacement

Cycles	Railhead Displacement	Tie Displacement	Total Railhead Displacement*
	Static Gage Load	Static Gage Load	Static Gage Load
500,000	0.2 in (5.08 mm)	0.158 in (4.01 mm)	0.042 in (1.07 mm)
1,000,000	0.176 in (4.47 mm)	0.101 in (2.57 mm)	0.075 in (1.91 mm)
1,500,000	0.136 in (3.45 mm)	0.102 in (2.59 mm)	0.034 in (0.86 mm)
2,000,000	0.139 in (3.53 mm)	0.096 in (2.44 mm)	0.043 in (1.09 mm)
2,500,000	0.179 in (4.55 mm)	0.086 in (2.18 mm)	0.093 in (2.36 mm)
3,000,000	0.18 in (4.57 mm)	0.085 in (2.16 mm)	0.095 in (2.41 mm)

NOTES: There was no abnormal workout of the cut spikes.
*Total Railhead Displacement = Railhead Displacement - Tie Displacement

Tie Plate Cutting

	Field	Center	Gage
Top	0.022 in (0.56 mm)	0.021 in (0.53 mm)	0.025 in (0.64 mm)
Center	0.014 in (0.35 mm)	0.018 in (0.46 mm)	0.042 in (1.07 mm)
Bottom	0.025 in (0.64 mm)	0.027 in (0.69 mm)	0.023 in (0.58 mm)

NOTES: No cracking developed in the rail-seat area.

Plate Area Compression AREMA Chapter 30 – TTCI	Railhead loaded to 100,000 lbs. (45, 359 kg) in 20,000 lb. (9,072 kg) increments 30-60 seconds between increments	Elastic deformation at 100,000 lbs. (45,359 kg)	0.153 in (3.89 mm)
		Permanent deformation at recovery after release of 100,000 lb. (45,359 kg) load within 1 minute	0.043 in (1.09 mm)

Spike Pullout and Spike Lateral Restraint AREMA Chapter 30 – TTCI	Cut Spike Insertion and Extraction Inserted/extracted at 2 in/min (51 mm/min)	Insertion Force *4.5 in (11.4 cm) depth (average of 8 spikes)	5,906 lbs (26.3 kN)
		Extraction Force *4.5 in (11.4 cm) depth (average of 8 spikes)	2,541 lbs (11.3 kN)
	Lateral Resistance	Force to deflect spike 0.2 in (5 mm) laterally *cut spike inserted to depth of 4.5 in (11.4 cm)	1,849 lbs (8.2 kN)

Screw Spike Pullout ASTM D6117	Mechanical Fastener Screw Spike Pullout 11/16" (17.5 mm) screw, 14 mm nominal diameter hole, 97 mm clip	7,103 lbs (31.6 kN)
Single Tie Lateral Push AREMA Chapter 30 – TTCI	Single Tie Lateral Push (newly installed)	2,750 lbs (12.2 kN)

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ELECTRICAL PROPERTIES

Dielectric Strength ASTM D149-09	Thickness	Volts/Mil (VPM)	Breakdown Voltage
	0.1396 in (3.546 mm)	> 358	> 50,000
ARC Resistance ASTM D495-99	Time (seconds)	Current (mA)	ARC Resistance (seconds)
	0-240	10	124.6 (average of five samples)

Inclined Plane Tracking ASTM D2303-97	Flow Rate (mL/min)	Voltage (kV)	Series Resistance (k) ohms	Time to Track (minutes)	Time to Track (minutes)
	1.5	2.5	10	20	34 (max)

Volume and Surface Resistivity ASTM D257-07	Volume Resistivity (ohms-cm)	Surface Resistivity (ohms)
	1.0×10^{16} (avg)	1.1×10^{17} (avg)

Electrical Impedance AREMA Chapter 30 – TTCI	Ten volts AC 60 hertz applied between two running rails for 15 minutes before and after 6-hour soak in water	BEFORE 6-hour soak	current	0.002 milliampere (mA)
			impedance	5 megohms
		AFTER 6-hour soak	current	0.004 milliampere (mA)
			impedance	2.38 megohms

FLAMMABILITY AND COMBUSTION PROPERTIES

Flame Resistance UL 94HB	Specimen	Flame front to 25 mm mark?	Burn time after 25 mm mark (sec.)	Damaged length between 25 and 100 mm	Flame front to 100 mm mark?	Linear Burning Rate (mm/min.)
	Average	Yes	246.0	75.0	Yes	20.4

NOTE: ECOTRAX material met the passing criteria for UL HB classification.

Toxic Gas Generation BSS 7239		Specimen 1	Specimen 2		
	Weight (g)	124.7	126.2		
	Gas	**Corrected PPM**	**Corrected PPM**	**Average PPM**	**Std. Deviation PPM**
	Carbon Monoxide (CO)	150	100	125.0	35.355
	Hydrogen Cyanide (HCN)	1	1	1.0	0.000
	Sulfur Dioxide (SO_2)	5	5	5.0	0.000
	Hydrogen Chloride (HCL)	0.5	0.5	0.5	0.000
	Hydrogen Fluoride (HF)	0	0	0.0	0.000
	Nitric Oxide (NO)	60	60	60.0	0.000
	Nitrogen Dioxide (NO_2)	1	1	1.0	0.000

Specific Optical Density of Smoke ANSI/ASTM E662	**Optical Density Test Result Summary**		
		Non-Flaming	Flaming
	Ds @ 1.5 Min. (average)	0.4	2.7
	Ds @ 4 Min. (average)	2.8	33.6
	Dm (corr.) (average)	16.9	266.3

Surface Flammability ASTM E162	Average Flamespread Factor (Fs) = 6.34	Average Flamespread Index (Is) = 147.43
	Average Heat of Evolution (Q) = 23.61	Flamespread Index Range (Is) = 129.78 to 175.92