Midwest Guardrail System with Round Timber Posts


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Introduction

• National Fire Plan after 2000 Fire Season
• Fuel management as fire prevention technique
• Controlled burns consume small-diameter forest thinnings (SDTs)
• Cut SDTs for product use w/ proceeds to offset removal costs
• SDTs for posts in guardrail systems
• Need structural properties of SDTs for round posts in longitudinal barriers
24 million ft (4,500 miles) of guardrail is sold in the US per year.
Which translates into 3.8 million post (of some type).
A lot of thinnings could be utilized if thinning material is shown to perform adequately as guardrail posts.
Round post can be twice the value of rectangular and nine times the value of chips.
Longitudinal Barriers

- Strong-post, W-beam guardrails
  - 12-gauge rail
  - spacer blocks – wood, steel, & recycled materials
  - evenly spaced posts – wood and steel
- Round wood posts economical
- Large-scale implementation mostly in Texas
  - prior TTI research
- Opportunities for increased round post use in W-beam guardrails
  - options needed for wood species
Midwest Guardrail System (MGS)

- Developed in 2000 & meets TL-3
- 1,905-mm post spacing
- 787-mm mounting height
- Splices at midspan locations
Research Objectives

• Dynamic structural properties for round posts (DF, PP, and SYP)
• Post diameter, embedment depth, and grading specification for each species
• Round wood posts in MGS
• TL-3 evaluations to NCHRP 350
• Installation manual and standard CAD plans
Wood Sampling

• Initial post diameters
  ▪ SYP – 184 mm (7.25”) from TTI testing
  ▪ DF – 190 mm (7.5”) using tabulated strengths
  ▪ PP – 216 mm (8.5”) using tabulated strengths

• Wood highly variable – strength can differ by:
  ▪ species, ring density, knot size, moisture content, & region

• Three control groups using ring density & knots
  ▪ LRD-SKN
  ▪ LRD-BKN
  ▪ HRD-SKN
Wood Sampling (Cont.)

- Post categorized by ring density, knot frequency, and knots
  - LRD - \( \leq 4 \text{ rpi} \)
  - HRD - \( \geq 6 \text{ rpi} \)
  - SKN -\(<38 \text{ mm (1.5”)}
  - BKN - \( >64 \text{ mm (2.5”)}\)

- Component testing to evaluate post properties for 3 categories & random population
Post Specimens

- Wood posts acquired from multiple sources
- Graded by experts
- Weighed, measured, documented, and knot mapped
- SWMOE estimation
  - rank and sort posts
- Random selection
Phase I Component Testing

- Target load capacity – 9.5 to 10 kips
- Cantilevered rigid sleeve testing (450 tests)
  - round 1 (initial sizing)
    - 45 dynamic tests
    - 180 static tests
  - round 2 (modified sizing)
    - 45 dynamic tests
    - 180 static tests
- SWMOE, MOR, & Peak Load tabulated
- Post sizes modified for Phase II testing
Phase II Component Testing

- Cantilevered soil testing (18 tests)
- Evaluated 37 and 40 in. embedment depths
- Results showed need to increase post sizes & capacity
- 37-in. embedment depth preferred
- Nominal post sizes at groundline [+0.75”/-0.25”]
  - SYP – 190 mm (7.5”)
  - DF – 184 mm (7.25”)
  - PP – 203 mm (8.0”)

[Logos and emblems]
Post Grading Criteria

• Knots & RPI
  ▪ SYP: ≤64 mm (2.5") & ≥4 rpi
  ▪ DF: ≤38 mm (1.5") & ≥6 rpi
  ▪ PP: ≤89 mm (3.5") & ≥6 rpi
  ▪ tight spec. - reduce diameter
  ▪ loose spec. - allow high percentage to qualify

• Additional criteria
  ▪ post manufacture, size, scars, shape & straightness,
    splits & shakes, decay, holes, slope of grain,
    compression wood, and preservative treatment
Test Requirements & Plan

• TL-3 of NCHRP Report No. 350
  ▪ 820-kg small car @ 100 kph & 20 degrees
  ▪ 2000-kg pickup truck @ 100 kph & 25 degrees

• Small car test unnecessary

• SYP MGS testing unnecessary

• 2000P crash tests on MGS w/ DF & PP posts
Dynamic System Test
Douglas Fir MGS – Test MGSDF-1

E.D. = 37 in.
4,450-lb GMC Pickup
62.1 mph & 25.5 degrees
D.D. = 60.2 in.
W.W. = 60.3 in.
7 fractured posts
Ponderosa Pine MGS – Test MGSPP-1
4,464-lb GMC Pickup
62.3 mph & 25.5 degrees
D.D. = 37.6 in.
W.W. = 48.6 in.
4 fractured posts
Conclusions and Recommendations

• Round timber posts for MGS
  ▪ two TL-3 pickup truck tests under NCHRP 350 – DF & PP
  ▪ SYP using component testing, similarity, & prior work
  ▪ 37-in. post embedment depth

• Round-Post Option for MGS
  ▪ new market for SDTs
  ▪ reduces risk for forest fires
  ▪ aids U.S. and state timber industries
  ▪ reduces MGS cost

• Grading specification, installation manual, & CAD plans
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