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Potential for Expanding Small-Diameter Timber Market

Assessing Use of Wood Posts in Highway Applications

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Abstract

Because of a combination of circumstances, there is an overabundance of small-diameter timber available in the United States. There is low demand for this material because it has low value. One way to increase the value, and therefore the demand, for this material is to develop or expand markets where the material can be used. We looked at markets where little or no machining would be required before use because this would make it more feasible to use small-diameter material. One such market is that of wood posts in highway applications. In this study, we gathered information on the current use of posts, both wood and those made from other materials, used in highway applications. Information was gathered using a survey of Department of Transportation engineers from across the United States. We then analyzed the information to assess the possibility of increasing the use of small-diameter timber in the highway application market. We found many opportunities for ways this market could be expanded, but we also found challenges to increasing this market.
Keywords: small-diameter timber, small-diameter trees, small trees, wood post, guardrails

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Assessing Use of Wood Posts in Highway Applications

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Introduction and Research Rationale

Ample supply of small-diameter timber (SDT) will probably continue for the foreseeable future due to a host of circumstances (timberland practices, land ownership patterns, government regulations, fire prevention measures, and various environmental and political scenarios). Because the current and forecasted supply of SDT far exceeds demand, this study explored a possible market for increasing use of SDT.

According to Wolfe (2000), the value of SDT in roundwood form (that is, not machined or minimally machined) can be twice that of SDT machined to dimensional form (square) and nine times that of wood chips made from SDT. This means that for applications that don't require a great amount of processing, SDT still in the round form can be a more economical choice than machined SDT. This study explored the use of SDT as wood posts in the highway industry, both in the roundwood form and machined to a square form.

Researchers at the University of Washington (Seattle) and the USDA Forest Service, Forest Products Laboratory (Madison, WI), collaborated to assess the current and future use of wood posts, relative to alternative materials, in highway applications in the United States. Posts are widely used for guardrails, signage, and fencing for highways. Types of posts include aluminum, steel, plastic, concrete, and wood. The information from the assessment was then used to analyze the market for possible increased use of SDT for posts in these highway applications. Until recently, it was common for wood posts to be sawn from large-diameter timber, but reduced supply and high costs of large-diameter timber have increased the demand for a substitute. An overview of post products, pricing, and distribution is presented in Appendix 1.

To gather information on the use of posts in highway applications, we designed a questionnaire to be sent to engineers in the Department of Transportation in each state of the United States. Questions were asked about the use of posts in general, the use of wood posts, the use of preservatives in wood posts, and demographic information. The information gathered from the questionnaire was used to analyze the current and future market of SDT used as posts in highway applications.

Methods

Questionnaire

The questionnaire used in this study (Appendix 2) was based on a review of the SDT and post literature (Appendix 3) as well as three in-depth interviews with state Department of Transportation (DOT) supervisors. The preliminary draft of the questionnaire underwent two pretests. For the first pretest, the questionnaire was sent to six academic scholars, and for the second pretest, it was sent to eight transportation sector employees. The questionnaire was then revised to increase validity, clarity, and comprehensiveness. The questionnaire consisted of four sections. The first asked general questions about using highway posts to provide an overview of all types of posts including wood, steel, plastic, and aluminum. The second section asked about current use of wood posts and attitudes and opinions about future use of wood posts. The third section asked about preservative treatments, one of the perceived obstacles to increasing the use of wood as posts. The last section gathered demographic information on questionnaire respondents and their respective DOT agencies.

Sample

For our sample, we wanted to select all DOT engineers in each state that are responsible for making decisions about posts for highway applications. Sample selection began by sending a letter to the director of each state DOT asking for the name of the engineer(s) responsible for making these decisions. Fourteen states have one engineer responsible for purchasing posts used in guardrail and sign applications, but most states (36) indicated that two different engineers are responsible for posts, one for guardrails and barriers and another for signage. Therefore, the selected sample was 82 DOT engineers. They were sent an explanatory cover letter that ensured confidentiality and a four-page questionnaire, and 62 completed questionnaires were received for a response rate of 76%. Each of the 50 states is represented by at least one engineer, so the effective response rate on a per DOT agency basis is 100%.

Respondents are construction and design engineers (40%), traffic and transportation engineers (35%), as well as research, supervising, and standards engineers (25%). They oversee decision making about posts and/or specification in highway signage (39 engineers), guardrails (33), fences (24), median barriers (21), rest areas (8), and bridges (5). These engineers have been DOT employees from 5 to 44 years, with an average employment period of 21 years.

The DOT agencies participating in this study are responsible, on average, for 19,000 miles of state highways, with a reported minimum of 970 miles to a maximum 77,000 miles. Annual budgets range from a low of $380,000 to a high of $8.6 billion (billion = $\times 10^9$), with an average of $1.3 billion.

Results

Post Types

Before asking questions about wood posts, it was important to learn what post types are substitutes or compete with SDT. When asked about the types of posts used in highway applications, DOT engineers said that steel, wood (round and square), aluminum, concrete, and plastic (composite and poly-lumber) posts are used in a variety of highway applications. As Figure 1 shows, steel is used most often for all highway applications. It ranks first in use for signs, guardrails, fencing, barriers, and bridges. Square wood is used, in order of most to least, for guardrails, signs, fencing, barriers, bridges, and walls. In order from most to least, roundwood is used for fencing, guardrails, signs, barriers, bridges, and walls.

Overall, the findings suggest that wood (round and square combined) and steel are the most commonly used materials in all types of highway applications. The most common uses for square wood are guardrails (more than 60% of respondents)

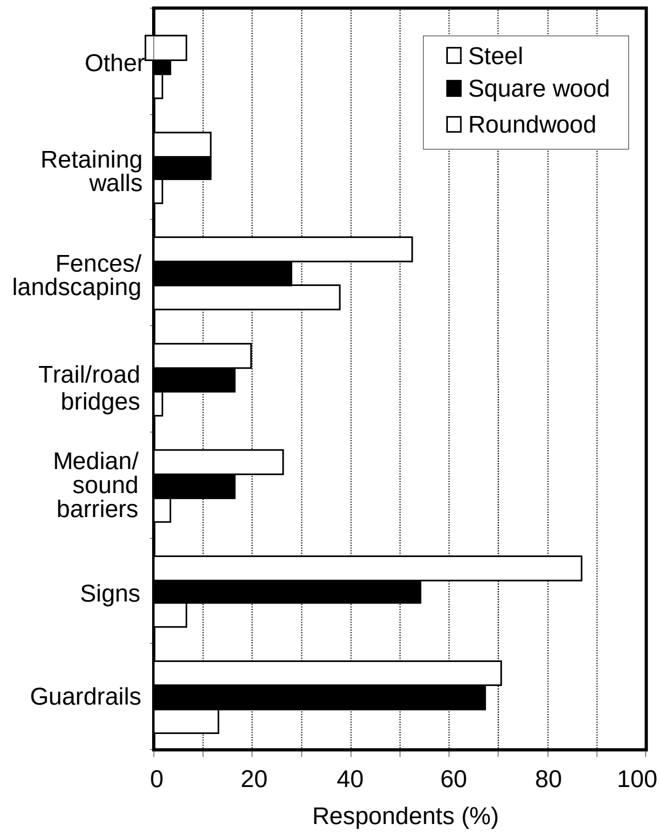

Figure 1—Types of posts used in highway applications.

and signs (more than 50%), whereas roundwood is used most for fencing and landscaping (almost 40%) (Fig. 1).

Recent Changes in the Types of Posts Used

To assess the degree of substitution among different post types, engineers were asked about changes in the past three years in DOT use of different post types. Response categories ranged from 1, or using “much less” of the type in question, to 7, or using “much more” of that type. Figure 2 shows average responses, ranging from 3.7 (slight decrease in use of concrete) to 4.3 (slight increase in use of plastic composite). This suggests fairly stable or unchanging patterns in the type of post used. Post types experiencing increased use are plastic composite (4.3), steel (4.2), and other post types (4.2, specified as square hollow steel and fiberglass). Plastic poly-lumber (4.0) appears to have stable or unchanging usage. The remaining post types have experienced a very slight decrease in usage, including square wood (3.9), roundwood (3.9), aluminum (3.8), and concrete (3.7).

To summarize, there has been little change in the post types used during the past three years. This implies that newer post materials like plastic composites and poly-lumber may not compete directly against wood in highway post applications, and this suggests a stable market situation for SDRT.

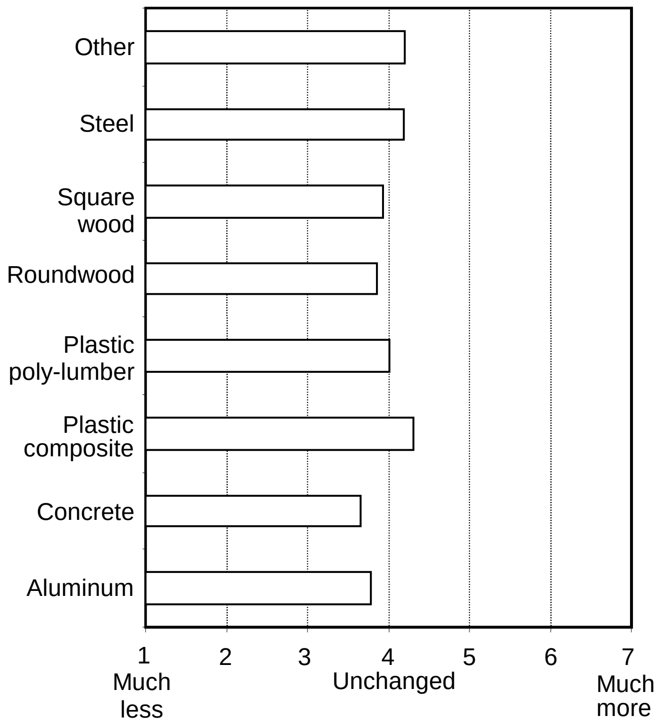

Figure 2—Changes in the types of posts used during the past three years.

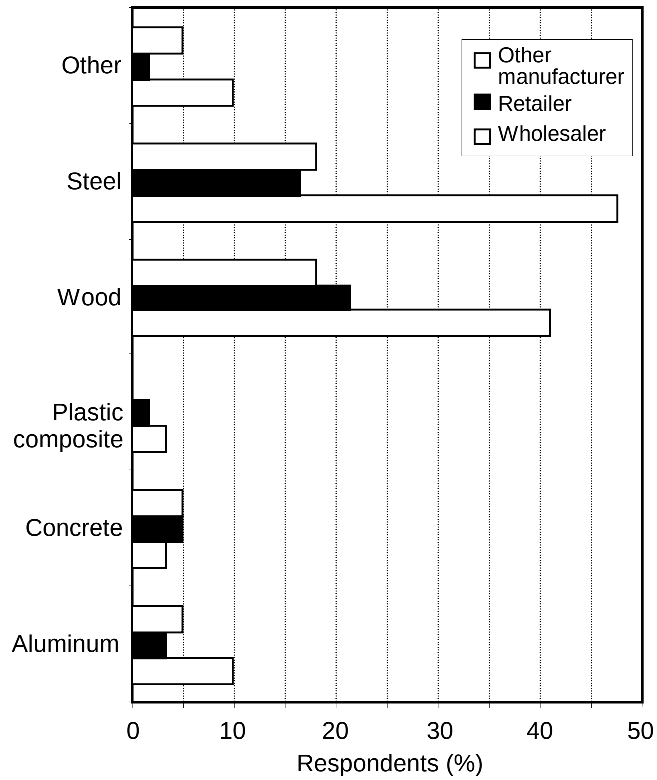

Figure 3—Type of post suppliers used by DOT.

Post Suppliers

Engineers use a broad range of suppliers for posts. Wholesalers, retailers, state DOT agencies, other state agencies, and manufacturers are used. Wholesalers are the most common supplier of posts for DOT agencies. Most striking is that wholesalers are used extensively for steel (41%) and wood (36%) purchases. However, a more heterogeneous group of suppliers, thus competitors (that is, wholesalers, retailers, and manufacturers), are used for aluminum, concrete, and plastics (Fig. 3).

Cost of Posts

Only one-third of the respondents provided information on the cost of posts, indicating and often stating that post specifications and decision making is a separate function from bidding and purchasing. The cost data that we collected is broken down into a cost-per-post basis (Table 1). The cost data that was provided varied widely and should not be considered comprehensive or reliable for comparison purposes. At best, this cost data should be interpreted only in terms of the range of prices paid. The least expensive post cost reported is $2 for round and square wood. The highest cost reported is $495 for a steel W-beam post. No data was received for the cost of concrete posts. This may have been because such posts are sometimes made on site by DOT employees.

Table 1—Cost of posts

Post type	Lowest cost ($ per post)	Highest cost ($ per post)
Aluminum	25	31
Concrete	No data	No data
Plastic composite	30	135
Plastic poly-lumber	No data	No data
Roundwood	2	20
Square wood	2	162
Steel	8	495

Beneficial Attributes of Posts

To discover how SDT might be best positioned and promoted to the marketplace, perceived benefits associated with SDT were explored. The possible benefits examined included easy installation, handsome appearance, very durable, low maintenance, high impact resistance, good price, and no concerns environmentally. Respondents were asked to rank these benefits, on a scale of 1 (strongly disagree with the stated benefit) to 7 (strongly agree) with 4 representing a neutral position. Summary means for these ratings are provided in Table 2 and shown in Figures 4 through 6.

Table 2—Mean ratings of benefits of different types of posts[a]

Post type	Handsome appearance	Easy installation	Low maintenance	Very durable	High impact resistance	No concerns environmentally	Good price
Aluminum	4.9	4.7	5.6	5.4	3.5	5.5	3.6
Concrete	4.0	3.3	4.9	4.8	4.0	5.3	4.0
Plastic composite	4.1	4.7	3.9	3.8	3.0	4.9	3.1
Plastic poly-lumber	4.0	4.4	4.5	3.7	3.8	5.2	2.7
Roundwood	4.0	4.1	4.1	3.7	3.2	4.1	4.5
Square wood	4.5	4.3	4.7	4.4	3.7	4.4	4.7
Steel	4.5	5.4	5.6	5.9	5.0	5.4	5.0

[a]Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing a neutral position.

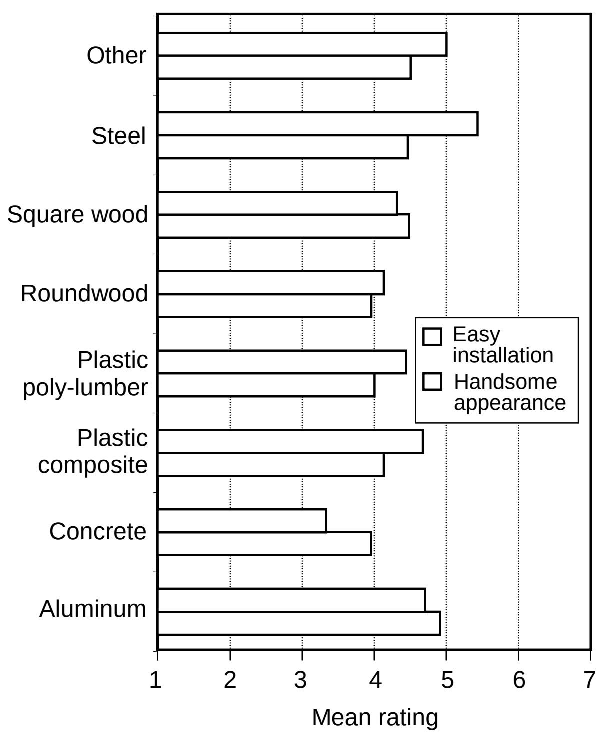

Figure 4—Appearance and ease of installation ratings of post types. (Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing a neutral position.)

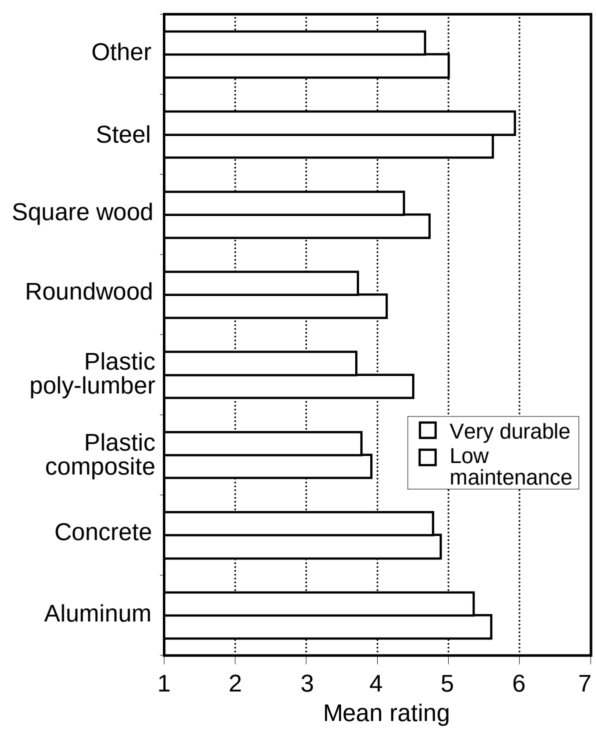

Figure 5—Durability and maintenance ratings of post types. (Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing a neutral position.)

Appearance

Aluminum was thought to be the most attractive type of post, followed closely by square wood and steel posts. Interestingly, roundwood posts were viewed as being less attractive than square. Other post types rated lower were concrete and plastic. Given that square wood posts were considered more handsome than other post types, promotional messages could communicate this benefit.

Ease of Installation

By a wide margin, steel posts were the easiest to install, followed by aluminum, plastic composite, and plastic poly-lumber. Square and roundwood posts were considered to be slightly difficult to install while concrete posts were the most difficult. Steel and aluminum were the easiest to install. Use of wood posts may be increased by any measures taken to assist buyers in simplifying (perceived or real) the installation task.

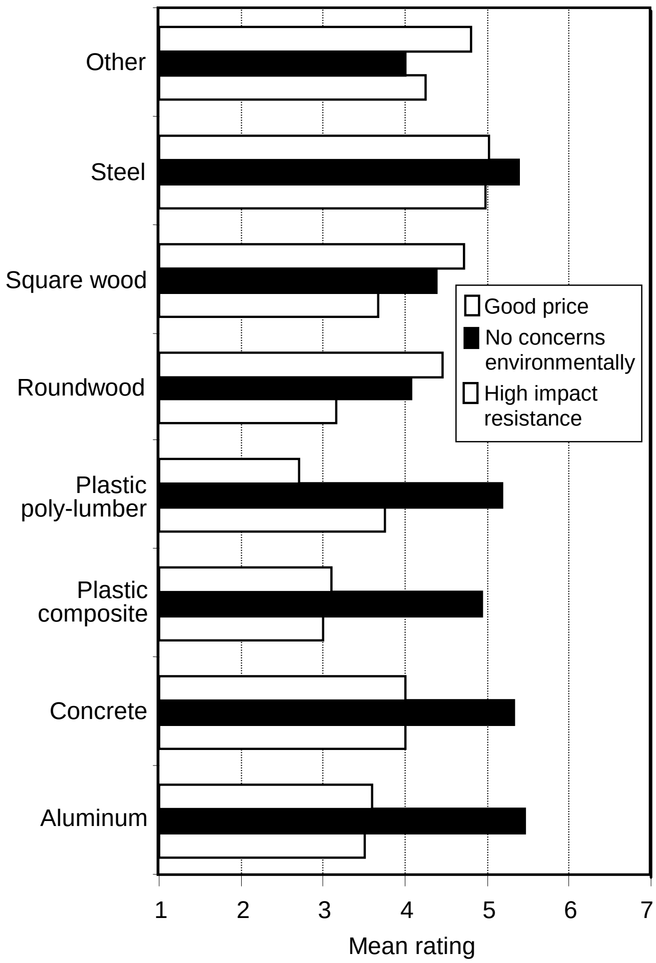

Figure 6— Impact resistance, environmental concerns, and cost ratings of post types. (Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing a neutral position.)

Maintenance

Steel and aluminum posts were thought to require the least maintenance, followed by concrete, square wood, and plastic poly-lumber. Roundwood posts received a neutral maintenance score as did plastic composite posts, suggesting that an average amount of maintenance is necessary. From a marketing perspective, it would be wise to promote SDT for applications that require less maintenance, such as interior uses or uses protected from the elements (for example, rest or picnic areas with pavilions).

Durability

By a huge margin, steel was considered the most enduring post type. Aluminum, concrete, and square wood posts were also considered durable. On the other hand, roundwood, plastic poly-lumber, and plastic composite posts were not considered very durable. There could be an interrelatedness between the maintenance and the durability. In other words, it may be that roundwood and plastic posts were thought to require more maintenance than other post types, and in the absence of effective maintenance, durability is compromised. Because roundwood posts received the lowest rating for durability, SDT should be positioned for applications that are not subjected to extreme conditions.

Impact Resistance

Only one post type, steel, was thought to have high impact resistance. Concrete was rated neutral, suggesting some impact resistance. However, plastic poly-lumber, square wood, aluminum, roundwood, and plastic composite posts were not associated with high impact resistance. Because wood posts were not thought to be impact resistant, careful thought should go into options for reinforcing wood posts in strength-dependent applications like guardrails. On the other hand, SDT could capitalize on the many sign applications requiring breakaway specifications (that is, low impact resistance) for safety purposes.

Environmental Concerns

None of the posts types were viewed as imposing serious environmental concerns, although roundwood posts were seen as being the most worrisome. More will be said about environmental concerns in a subsequent section.

Price

Again, steel received the highest rating for good value or pricing, but square wood and roundwood posts followed closely behind. Concrete had a neutral rating. However, aluminum, plastic composite, and plastic poly-lumber posts were thought to be expensive. Clearly, this perceived cost advantage could be used to promote use of SDT in highway applications rather than other post types, perhaps placing an emphasis on total or life cycle costs.

Shapes of Wood Posts

In the questionnaire, engineers were asked about the shape of posts used, round versus square, for guardrails, signs, fencing, bridges, medians, and various rest area applications. Fencing was the only application where roundwood posts were used by a majority of the respondents (50%). Other applications had far less use of roundwood posts. Roundwood posts were used for bridges by 20% of the respondents and for guardrails by17% of the respondents. Square wood posts were used much more frequently in highway applications. Square wood was used for guardrails, rest areas, median barriers, and signs by the majority of the respondents (75%, 72%, 68%, and 66%, respectively). The percentages of respondents using wood posts for different applications are shown in Table 3.

Table 3—Percentage of respondents that used wood posts of different shapes in different applications

Highway application	Round post usage (%)	Square post usage (%)
Bridges	20	43
Fences	50	38
Guardrails	17	75
Median barriers	12	68
Rest areas	11	72
Signs	10	66

Table 4—Sizes and frequency of use of wood posts of different shapes

Round post		Square post	
Diameter (in.)[a]	Frequency of use (*n*)[b]	Dimensions (in.)[a]	Frequency of use (*n*)[b]
2–3	6	4 by 4	31
4–5	15	4 by 6	25
6–7	13	5 by 6	3
8–9	7	5 by 7	1
10–11	2	6 by 6	18
12–13	3	6 by 8	39
14–16	2	7 by 9	0
17–19	3	8 by 8	14
20–22	1	8 by 10	5
>22	1	10 by 10	8
		10 by 12	2
		12 by 12	3

[a]1 in. = 2.54 cm.
[b]*n* = number of times used.

Size of Wood Posts

To discover the degree to which SDT can be used in existing highway applications, engineers were asked how often they use roundwood posts of different diameters and square wood posts of different dimensions. Table 4 shows that the reported diameters ranged from a low of 2 in. to more than 22 in. Table 4 also shows the frequency of use for each diameter range reported and each square post dimension used. Most roundwood posts fell within the 2- to 9-in. diameter range, clearly a good sign for SDT market potential. Of these small-diameter posts, the majority fell within the 4- to 7-in. diameter range. The range of dimensions for square wood posts is from 4 by 4 in. to 12 by 12 in. Square wood posts that are 4 by 4 in., 4 by 6 in., 6 by 6 in., and 6 by 8 in. are most commonly used in highway applications. The most often used square wood posts are 4 by 4 in., 4 by 6 in., 6 by 6 in., and 6 by 8 in.

Table 5—Mean ratings for unfavorable characteristics of wood posts

Unfavorable characteristic	Mean[a]
Splitting and cracking	4.58
Environmental concerns	4.08
Overpriced	3.77
Difficult to install	3.76
Poor decay resistance	3.76
Short life	3.68
High maintenance	3.66
Weak impact resistance	3.62
Below performance standards	3.35
Mold and fungi discolorations	3.30
Inconvenient to obtain	3.06

[a]Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing neutral.

Perceptions About Wood Posts

The questionnaire probed the degree of unfavorable opinions held by engineers in regards to round and square wood posts. The possible unfavorable characteristics investigated were overpricing, high maintenance, poor decay resistance, poor performance, short life span, weak impact resistance, poor availability, difficult installation, mold and fungi discolorations, splitting and cracking, and environmental damage. Engineers were asked to rate on a scale from 1 (strongly disagree) to 7 (strongly agree), the unfavorable characteristics listed in Table 5 and shown in Figure 7.

Out of the eleven unfavorable characteristics, only one appeared to be associated with wood posts, and that is splitting and cracking damage. On the other hand, problems least associated with wood posts were ample supply, mold and fungi discolorations, and poor performance. The remaining characteristics received less than neutral mean scores, suggesting that engineers do not associate these problems with wood posts. Mean ratings for the characteristics are provided in Table 5 and shown in Figure 7.

Wood Preservative Treatments

Preliminary interviews suggested that the main obstacle to using more SDT in highway applications was a concern about the environment due to the use of preservatives.

Wood Preservatives Used

To learn more about the state of wood preservative, we asked engineers which wood preservatives were used in the posts they purchased. Chromate copper arsenate (CCA) was the most commonly used preservative, with more than half of the responding engineers (54%) claiming purchase of CCA-treated posts. Other preservatives used to treat wood posts

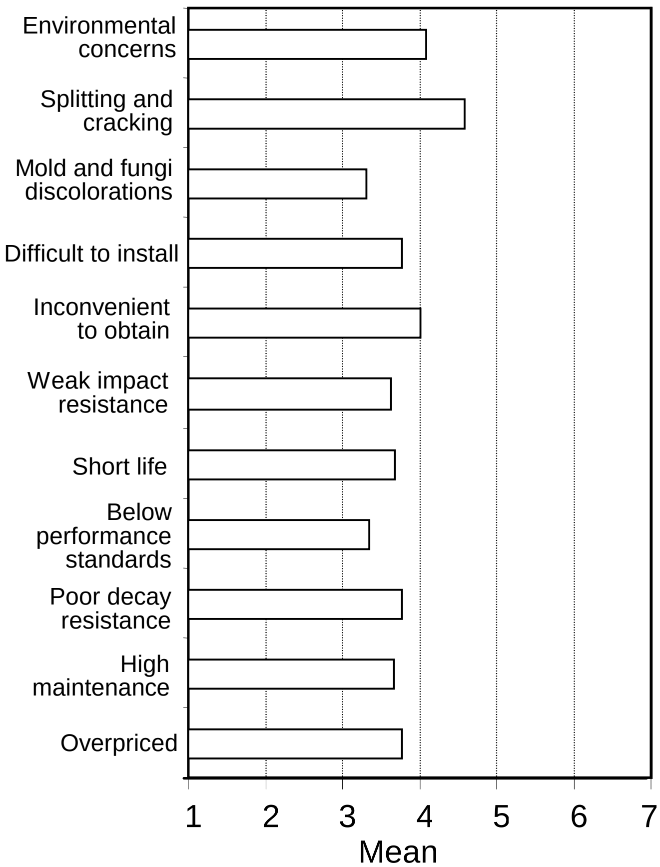

Figure 7—Ratings for unfavorable characteristics possibly associated with wood posts. (Ratings were on a scale of 1 (strongly disagree) to 7 (strongly agree), with 4 representing neutral.)

included pentachlorophenol (43%), creosote (25%), ammoniacal copper zinc arsenate (16%), and copper napthenate (10%). (Values in parentheses are percentage of responding engineers that claimed purchase of posts treated with that preservative.)

Life Expectancy and Alternative Preservative Treatments of Wood Posts

Another alternative to extending the life of wood posts is pressure treating. To explore attitudes about the relative effectiveness of pressure preservative treating compared with not treating, engineers were asked to estimate respective life spans. The mean response for the life span of untreated wood posts was 3.5 years. According to the engineers, preservative-treated wood posts had a mean life expectancy of 5.7 years, 63% higher than that of untreated posts. Pressure-preservative-treated wood posts received the highest mean response, 5.9 years, 69% higher than that of untreated posts.

Table 6. Mean ratings for concerns about preservatives

Concerns	Mean[a]
Water contamination	3.18
Impact on strength properties	3.07
Cost of preservative treating	2.98
Soil contamination	2.91
Impact on human health	2.91
Impact on wildlife	2.69
Unpleasant odor	2.14
Unattractive appearance	2.02

[a]Ratings were on a scale of 1 (no concerns) to 7 (strong concerns).

Maintenance and Preservative Retreatment of Wood Posts

The questionnaire probed the respondents for the degree of wood post maintenance or retreating performed. More than 90% of all wood posts are never retreated. Only two engineers reported retreatment. These two reports included annual retreatment of signs and retreatment of bridges after 20 years of service.

Preservatives and Environmental Concerns from Wood Posts

On average, the respondents did not have strong concerns about environmental impacts, cost, and performance of wood post preservatives (Table 6). Highway engineers were most concerned about the impact of preservatives on water contamination, though the concern was mild with a mean of 3.18. This was an unexpected finding because interviews with industry engineers suggested that there were environmental concerns associated with wood preservatives (for example, human health and safety, water contamination, wildlife and fishery health, and reproductive concerns). It may be that environemntal concerns are about contamination at treatment facilities and not the environmental impact of a treated post in a particular location. Also, this study did not probe potential concerns about disposing of treated wood.

Summary

Opportunities: Findings that Suggest Small-Diameter Timber Market Could be Increased in Highway Use

- Wood (round and square combined) and steel were the most commonly used posts in all types of highway applications. This means that wood posts occupy a substantial amount of the current market.

- Square wood was used by more than 50% of the respondents for guardrails and signs. Given the relative small circumference of signposts, this application may offer a sizeable SDT market opportunity.

- Roundwood was used by almost 40% of the respondents for fencing and landscaping posts, so the fencing post replacement market offers an opportunity for SDT.

- The type of posts used the past three years has changed little. This implies that newer post materials like plastic composites and poly-lumber may not be considered effective substitutes and might not compete directly against wood posts.

- The competitive market for SDT is mainly wholesale, and this may represent a simpler business environment compared with the shared influence, multichannel competitive market for other types of posts, such as aluminum posts.

- Except for steel posts, square wood posts were considered more handsome than other types. Promotional messages could communicate this benefit.

- There appear to be very few concerns about possible negative characteristics of wood posts, such as negative impacts of preservative treatments including environmental impacts.

- Most roundwood posts used are within the 2- to 9-in. range, which clearly shows potential for increased SDT use.

- The majority of square wood posts used are within four sizes that can be supplied by SDT: 4 by 4 in., 4 by 6 in., 6 by 6 in., and 6 by 8 in.

- Users did not appear to have environmental concerns about wood post preservatives.

Challenges: Findings That Suggest Unfavorable Market Potential for Small-Diameter Timber

- Roundwood posts were not considered attractive compared with other types of posts, including square wood posts. Promotional messages, then, should not make such a claim for roundwood post applications.

- Square and roundwood posts were thought to be slightly difficult to install while steel and aluminum were easiest. Any measures that can be taken to assist buyers in simplifying wood post installation will enhance market share.

- It may be most effective to promote SDT in applications requiring less maintenance, such as interior uses or uses protected from the elements, so as to minimize concerns about more than average maintenance being necessary.

- Roundwood posts received the lowest rating for durability. As with the maintenance concern, SDT should be marketed for applications that are not subjected to extreme conditions.

- Wood posts were not thought to be impact resistant. Careful thought should go into options for reinforcing wood posts in strength dependent applications like guardrails. On the other hand, SDT could capitalize on the many sign applications requiring breakaway specifications (that is, low impact resistance) for safety purposes.

- Wood posts were reported to be very easy to obtain, and this implies that SDT suppliers face a competitive market.

Acknowledgments

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Appendix 1—Overview of Products, Pricing, and Distribution of Wood Posts

The post industry is a fairly competitive market with a large number of sellers, none of which possesses sufficient market power to influence price or supply. Jackson and Jackson (1989) found that the economic health of agribusiness is the most important influence on post sales. Other factors include, in order of most influence to least, geographic location of the post manufacturing plant, freight rates, highway activity, housing construction, and advertising.

Product

Converting timber to posts first involves debarking to accelerate drying, facilitate preservative treatments, and allow visual inspection for quality assessment. Drying green timber to a 15% moisture content, compared with 40% initial moisture content, is the second step (Carino 1986). This is done to substantially reduce shipping weights and associated freight rates, enhance preservative treatment, reduce pest susceptibility, and increase strength properties. Treating posts, to reduce the likelihood of damage by decay and insects, is the last step in the production process (Brennan 1993).

There are three levels to consider for a product: core benefit, actual product, and augmented product. The core benefit is the primary benefit that consumers seek, and for posts this might be safety, privacy, or containment. For example, guardrails protect vehicle occupants by transmitting impact energy into the ground. The actual product is built around the core benefit using branding, labeling, and design. Knowing who made the post increases awareness and perhaps loyalty to the manufacturer. Branding delivers a manufacturer's promise for a specific set of features and benefits. A post may be branded with a tag that offers descriptive information on the post such as the tree species used, specifications, preservative method, manufacturer location and name, and production date. Also, branding can be used to communicate unique product characteristics. Environmentally conscious consumers have contributed to the rising popularity of certified forest products (that is, wood from certified sustainable forests) (Hansen 1997, Ozanne and Vlosky 1996). Post manufacturers create an augmented product by offering additional buyer services and benefits. Brand equity is considered an important strategic asset in today's marketplace where it is estimated that it costs six times more to sell to a new customer than selling to an existing customer. Post manufacturers are using various types of customer services to gain competitive advantage. For example, offering a toll free phone number is a low cost way to provide customer service. Potential buyers can inquire about prices, grades, installation, or problem-solving help.

Pricing

The price of a post from SDT is a major factor influencing a buyer's purchase, so managing pricing well is important to post manufacturers and those organizations (such as the USDA Forest Service) that market timber resources to post producers. Pricing decisions are influenced by many factors such as costs, specifications, and structure of the organization. Of particular importance in the context of this research are the costs of acquiring the SDT for making posts. Costs are either fixed and variable. Fixed costs (for example, salaries for supervisors and workers) are stable throughout an area of production, whereas variable costs (for example, raw materials like timber) are directly related to the volume of posts produced. Therefore, variable costs tend to play a more important role in manufacturing and pricing. Prices vary with diameter, preservative treatment, and degree of processing needed (for example, peeling, pointing, drilling, and doweling).

Distribution

Posts are generally sold through distribution channels from manufacturers to buyers. In these channels, post manufacturers identify customers as wholesalers, retailers, or end users. End users are classified as industrial buyers (industry and government) or consumers (homeowners). Three types of distribution channels exist in the post industry. The first is direct marketing in which there is no intermediary, and wood posts are sold directly from manufacturers to end users such as homeowners or industrial buyers. For example, some post manufacturers sell direct through the Internet. In the second type of distribution channel, a retailer exists between the manufacturer and the end user. The retailer buys posts from manufacturers and resells to end users through retail yards or warehouses. In the third distribution channel, the wood post manufacturer sells to a wholesaler who in turn sells to a retailer who then sells to the end user.

Jackson and Jackson (1989) found that the volume of posts produced by a manufacturer usually determines the distribution channel. Smaller manufacturers tend to sell directly to end users, most likely because this type of selling is simpler, prices can be kept lower, and these manufacturers usually do not market a substantial amount of posts. In contrast, for larger manufacturers, two-thirds of the posts by volume are sold to wholesalers. In general, direct sales to retailers constitute the smallest proportion of posts sold from all manufacturers. As a seller of the SDT resource, the USDA Forest Service should be familiar with SDT markets to increase the use of SDT by current and future post manufacturers.

Appendix 2—Posts In Highway Applications Questionnaire

(Response categories are shown only for those questions where it is meaningful for the reader.)

Post Use in General

1. What types of posts are used in the following highway applications?

	Guardrails	Signs	Median/sound barriers	Trail/road bridges	Fences/ landscaping	Retaining walls	Other use __________
Aluminum posts	❑	❑	❑	❑	❑	❑	❑
Concrete posts	❑	❑	❑	❑	❑	❑	❑
Plastic composite posts	❑	❑	❑	❑	❑	❑	❑
Plastic poly-lumber posts	❑	❑	❑	❑	❑	❑	❑
Roundwood posts	❑	❑	❑	❑	❑	❑	❑
Square wood posts	❑	❑	❑	❑	❑	❑	❑
Steel posts	❑	❑	❑	❑	❑	❑	❑
Other type __________	❑	❑	❑	❑	❑	❑	❑

2. Over the past three years, have there been changes in the type of posts used?

	Much less			Unchanged			Much more	Don't know	Don't use
Aluminum posts	1	2	3	4	5	6	7	❑	❑
Concrete posts	1	2	3	4	5	6	7	❑	❑
Plastic composite posts	1	2	3	4	5	6	7	❑	❑
Plastic poly-lumber posts	1	2	3	4	5	6	7	❑	❑
Roundwood posts	1	2	3	4	5	6	7	❑	❑
Square wood posts	1	2	3	4	5	6	7	❑	❑
Steel posts	1	2	3	4	5	6	7	❑	❑
Other type __________	1	2	3	4	5	6	7	❑	❑

3. Where does your agency obtain posts?

	Wholesaler	Retailer	Made by our agency	Other state agency	Other manufacturer	Don't know	Don't use
Aluminum posts	❑	❑	❑	❑	__________	❑	❑
Concrete posts	❑	❑	❑	❑	__________	❑	❑
Plastic posts	❑	❑	❑	❑	__________	❑	❑
Wood posts	❑	❑	❑	❑	__________	❑	❑
Steel posts	❑	❑	❑	❑	__________	❑	❑
Other type __________	❑	❑	❑	❑	__________	❑	❑

4. Approximately, how much do you pay for posts?

	Post cost (specify unit)	Maintenance & installation	Don't know	Don't use
Aluminum posts	$ ______ /_________ unit)	$ _____ /__________ unit)	❑	❑
Concrete posts	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Plastic composite posts	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Plastic poly-lumber posts	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Roundwood posts (untreated)	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Square wood posts (untreated)	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Roundwood posts (pretreated)	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Square wood posts (pretreated)	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Steel posts	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑
Other type __________	$ ______ /_________ unit)	$ ______ /_________ unit)	❑	❑

5. To what degree do you view the following to be attributes of each post type?
(1 = "strongly disagree" to 7 = "strongly agree")

	Handsome appearance	Easy installation	Low maintenance	Very durable	High impact resistance	No concerns environmentally	Good price
Aluminum posts	____	____	____	____	____	____	____
Concrete posts	____	____	____	____	____	____	____
Plastic composite posts	____	____	____	____	____	____	____
Plastic poly-lumber posts	____	____	____	____	____	____	____
Roundwood posts	____	____	____	____	____	____	____
Square wood posts	____	____	____	____	____	____	____
Steel posts	____	____	____	____	____	____	____
Other type _________	____	____	____	____	____	____	____

Use of Wood Posts

6. What shape of wood posts is used?
7. What size wood posts are used?
8. To what degree do you associate wood posts with the following?

	Strongly disagree			Neutral			Strongly agree	Don't know	N/A
Overpriced	1	2	3	4	5	6	7	❑	❑
High maintenance	1	2	3	4	5	6	7	❑	❑
Poor decay resistance	1	2	3	4	5	6	7	❑	❑
Below performance standards	1	2	3	4	5	6	7	❑	❑
Short life	1	2	3	4	5	6	7	❑	❑
Weak impact resistance	1	2	3	4	5	6	7	❑	❑
Inconvenient to obtain	1	2	3	4	5	6	7	❑	❑
Difficult to install	1	2	3	4	5	6	7	❑	❑
Mold and fungi discolorations	1	2	3	4	5	6	7	❑	❑
Splitting and cracking	1	2	3	4	5	6	7	❑	❑
Environmental concerns	1	2	3	4	5	6	7	❑	❑

Wood Posts and Preservatives

9. What type(s) of preservatives are used to treat your wood posts? (check all that apply)

    - ❑ Chromated copper arsenate (CCA, also called green treated)
    - ❑ Ammoniacal copper zinc arsenate (ACZA, also called chemonite)
    - ❑ Ammoniacal copper quat (ACQ, also called ACQ Preserve)
    - ❑ Pentachlorophenol (PCP)
    - ❑ Copper naphthenate
    - ❑ Creosote
    - ❑ Other (specify)_______________

10. In your opinion, what is the average life span of these posts?

	One year	2-3 years	4-6 years	7-10 years	11-15 years	16-20 years	21-30 years	31-40 years	>40 years	Don't know
Untreated	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Pressure treated	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Preservative treated	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

11. How often is a maintenance coating (retreatment) applied to posts in these applications?

	Once a year	2-3 years	4-6 years	7-10 years	11-15 years	16-20 years	21-30 years	31-40years	Never treat	Don't know
Guardrails	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Signs	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Fences	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Bridges	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Rest area facilities	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Median barriers	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Other type _______	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

12. When using treated wood posts, what concerns may arise in your agency?

	No concerns						Strong concerns	Don't know	N/A
Soil contamination	1	2	3	4	5	6	7	❑	❑
Impact on human health	1	2	3	4	5	6	7	❑	❑
Impact on wildlife	1	2	3	4	5	6	7	❑	❑
Unpleasant odor	1	2	3	4	5	6	7	❑	❑
Unattractive appearance	1	2	3	4	5	6	7	❑	❑
Impact on strength properties	1	2	3	4	5	6	7	❑	❑
Water contamination	1	2	3	4	5	6	7	❑	❑
Cost of preservative treating	1	2	3	4	5	6	7	❑	❑

Background Information

13. What is your job title?

14. How long have you worked for your organization?

15. What post application(s) are you responsible for?

❑ Bridges ❑ Fences ❑ Guardrails ❑ Median barriers ❑ Rest areas ❑ Signs

16. Approximately how many miles of roads does your agency oversee?

17. Overall, what is the annual budget of your agency?

Appendix 3—Literature

Post

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