

Builder Perceptions of Wood and Non-Wood Products in the U.S. Top 20 Metro Housing Areas

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Abstract

This paper describes the preferences for structural wood products within the top 20 residential homebuilding markets in the United States. A survey of 945 homebuilders segmented across these markets provides the attributes demanded in structural floors, walls, and decking applications. In order to investigate materials substitution, the survey characterized the performance of wood, steel, and concrete on these attributes. This quantitative design was complemented with focus groups in four of these markets. Results show that wood products are challenged by concrete in wall and floor systems. While the basis for growth in the use of concrete was traditionally found in the U.S. South, the intended future use of concrete as a structural material was high in some Northern jurisdictions. However, the discussion sessions with builders tempered this trend. The survey shows that, according to homebuilders, concrete significantly outperforms wood on durability, strength/structural integrity, and acoustic performance. The first two of these attributes are among the three most important ones in floor and wall systems. For wood to remain competitive in walls and floors, these attributes should guide future product development. Plywood and OSB are thought superior to foam sheathing for strength, structural integrity, resistance to jobsite damage, environmental friendliness, and code acceptance. Foam is said to perform better than OSB or Plywood for both acoustics and energy performance. Accordingly, acoustics and energy performance in sheathing applications are valuable paths for product development. In decking applications, composite materials suit better the most demanded attributes, including durability, appearance, and longevity. Most generally, green labeling for building materials was not seen as very important. All suggested attributes of green labeling (sustainability, renewability, carbon neutrality, harvest legality, and formaldehyde safety) were rated equally.

Introduction

Past studies of wood use consistently revealed regional differences in consumption patterns and business practices. However, most studies provided these results at a large scale, where the U.S. was segmented into three or four regions and Canada into two regions (e.g., Eastin, et al. 2001, Fell 2001, Robichaud and Fell 2002, WPC 2005, WPC 2009). In spite of this, there is a sense that markets for wood products can vary widely from one city to another within the same regional segment. Past efforts to document the substitution trends in the U.S. South are an example of the interest for refined market knowledge (Lavoie 2008). As another example, a past survey of the top 100 largest builders (Robichaud and Lefaix-Durand 2004) revealed important differences in building practices between the cities of Chicago and Detroit. In the research field of forest products marketing, these two cities were historically included under the same market segment of the U.S. North-East. Trends toward the industrialization of homebuilding also have been shown to vary regionally (Lavoie et al. 2009). As a result, there is a sense that consumption and substitution patterns for wood may be better understood by looking at a smaller scale.

The intent of this project was to funnel down the market intelligence on wood products at the level of significant metro areas where housing starts are important. A primary focus was to explore builder perceptions of structural materials, and possible substitution trends between wood and other materials such as steel and concrete. Among the elements that are likely to show significant differences from a metro area to another, the consumption patterns for lumber, structural panels, engineered wood products and prefabricated components were key. Other important issues addressed in this study include

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Journal of Forest Products Business Research
Volume 7, Article No. 5

attributes demanded for lumber and panels, satisfaction with products and suppliers, green building and business constraints. This article reports on homebuilders that were randomly surveyed in the top 20 metro areas where homebuilding was significant in the U.S.

Background and Objectives

In North America, wood has been and remains the most used framing material in residential construction. Past studies have consistently revealed shifts in materials use and construction techniques. Some of the substitution of wood products are really shifts in wood use such as the adoption of engineered wood products (Fell et al. 2002). Real substitution of wood results from the adoption of alternative materials such as steel and concrete (Eastin et al. 2001, Lavoie 2008).

A decade ago, steel was the main contender for wood in residential construction. This was evidenced by the impressive growth in market share for steel studs in wall applications. Between 1994 and 1998, the proportion of U.S. homebuilders that tried steel framing at least once increased from 26.7% to 43.8%, while the overall market share for steel studs bounced from nothing to 8.8% (Eastin et al. 2001). However, the adoption of steel studs in interior wall framing came to a halt in subsequent years, as U.S. homebuilders relied less upon steel and more on engineered wood products and lumber (Robichaud 2003). Indeed, the overall

market share for steel studs in interior wall framing was further found to be 3.3% in the U.S. in 2001 (Fell and Robichaud 2002), 3% in 2002 (Robichaud 2003), 4.6% in 2003 (WPC 2005), and 5% in 2006 (WPC 2009). While steel studs were thought by homebuilders to perform much better than any other material for providing straightness in walls, steel was thought to lag significantly behind solid-wood lumber for structural integrity, availability, acceptance by the framing crew, acceptance by homebuyers, ease of installation and, especially, installed costs (Robichaud 2003). It has also been hypothesized that steel is used selectively on specific jobs, but less as a program (Fell and Robichaud 2002). Regionally, steel studs tended to be mostly used in the U.S. West (Fell and Robichaud 2002) and in eastern Canada (Robichaud 2003).

In recent years the use of concrete in structural floor and walls applications has spread to the detriment of wood. Table 1 documents that 60% of the total floor area built in the U.S. in 2006 used wood as a primary structural material, compared to nearly 70% in 1998. In exterior walls, the market share for concrete as a structural material has mostly remained steady between 11% and 12% during that period. Reliance on concrete as a structural material has been generally concentrated in the U.S. South (Robichaud et al. 2005). The increased reliance on concrete is thought to result from the perception, from the part of homebuilders and homebuyers alike, that the use of concrete provides better fire resistance, termite resistance, and insurance premiums than the use of wood (Lavoie 2008).

Table 1. Wood, steel, and concrete/masonry usage in U.S. single-family and apartment (1995, 1998, 2003, 2006).

	1995		1998		2003		2006	
	Usage	Share	Usage	Share	Usage	Share	Usage	Share
Floor Structure								
Wood, MMSF	1 538	62%	2 095	69%	2 293	64%	2 365	60%
Steel, MMSF	18	1%	13	0%	13	0%	21	1%
Concrete/Masonry, MMSF	915	37%	910	30%	1 301	36%	1 557	39%
Total, MMSF	2 471	100%	3 018	100%	3 607	100%	3 943	100%
Exterior Wall Structure								
Wood, MMLF	290	86%	357	88%	410	86%	444	89%
Steel, MMLF	1	0%	2	1%	2	0%	1	0%
Concrete/Masonry, MMLF	45	13%	48	12%	62	13%	53	11%
Total, MMLF	337	100%	406	100%	474	100%	498	100%
Interior Wall Structure								
Wood, MMLF	259	98%	310	95%	372	95%	392	95%
Steel, MMLF	6	2%	16	5%	18	5%	20	5%
Concrete/Masonry, MMLF	0	0%	2	1%	1	0%	2	0%
Total, MMLF	265	100%	327	100%	391	100%	414	100%
Roof Structure								
Wood, MMSF	2 628	100%	3 143	100%	3 757	100%	3 950	100%
Steel, MMSF	5	0%	9	0%	4	0%	10	0%
Total, MMSF	2 633	100%	3 152	100%	3 761	100%	3 960	100%

Source: WPC 2006.

In other words, the use of competing materials is not coincidental or strictly due to cost-competitiveness issues. Indeed, the use of structural materials is thought to depend on business constraints faced — and attributes demanded — by homebuilders. Past studies have shown that labour availability is an equal, if not greater, factor than product availability in the competition among building products and systems (Robichaud and Fell 2002). Builders increasingly look for easy to install, straight, and dimensionally stable products (Fell 2001). Speed of assembly also comes as a paramount requirement (Robichaud et al. 2005). Although attributes demanded by homebuilders are well documented, there remained a need and an opportunity to investigate how competing materials such as wood, steel, and concrete perform on these attributes. Such an investigation was necessary for a better understanding of the position of each product in residential construction.

In addition to product attributes, substitution has been explained by the characteristics of the business environment in which homebuilders evolve. Over years, there has been a consolidation trend through which homebuilders got larger, servicing vast regional markets or even the entire U.S. national market (Lefaix-Durand et al. 2006, Robichaud and Lefaix-Durand 2004). Historically, larger builders have been found to be more innovative and to be the earliest adopters of substitute materials (Fell et al. 2002). For instance, larger builders are more likely than smaller ones to replace solid wood with finger-jointed studs (Fell and Robichaud 2002, Robichaud 2003), on-site construction with prefabricated walls (Robichaud and Fell 2002), and structural sheathing with non-structural sheathing (Fell and Robichaud 2002). While long-term demographic trends support a sustained need for housing, it has been long held that the current demographic structure was responsible for the chronic labor shortages in the housing industry, at least prior to the recent slowdown in housing starts (Schuler and Adair 2003). In turn, labor shortages are thought to foster the adoption of industrialized, factory-built, solutions (Robichaud et al. 2005). Another driver for the adoption of substitute materials, including prefabricated components, is the need for reducing job-site waste (Schuler and Adair 2003). In the case of concrete use in the U.S. South, business factors related to the evolution of building codes, insurance premiums, and termite concerns were found to explain, at least in part, wood substitution (Lavoie 2008).

In response to the evolution of homebuilding practices, wood products have evolved either through engineered wood products (Fell et al. 2002) or prefabricated structural components (Lavoie et al. 2008, Robichaud and Fell 2002). This substitution effect, where wood is replaced by wood-based solutions, is apparent in the use of engineered wood products per square foot of floor area in residential construction. Between 1995 and 2006, the usage factor of engineered wood products per square foot of new home (including floor, wall, and roof systems) has doubled (WPC 2009). Meanwhile, the use of prefabricated wall panels has reached some 14% of market share in the U.S. on average and almost double that in the U.S. Northeast (Robichaud et al. 2005, USITC 2003).

Geographical patterns can then be established in mate-

rials substitution (e.g., Eastin et al. 2001, Robichaud 2003, WPC 2005). Generally, most studies of homebuilding practices have segmented the U.S. and Canada at the level of three or four regions for the U.S., and two for Canada (e.g., Eastin et al. 2001, Fell 2001, Robichaud and Fell 2002, WPC 2009). In the U.S., regional patterns have been summarized as a shift towards concrete in the U.S. Southeast, prefabricated wall panels in the U.S. Northeast, and steel studs and finger-jointed lumber in the U.S. Southwest (Robichaud et al. 2005). However, these patterns lack definition because homebuilding practices are thought to vary widely, even within the areas that are usually used. This lack of definition comes as another need that can be addressed by designing research efforts at the level of metropolitan areas. Within the top 20 metropolitan homebuilding markets in the U.S., the objectives of the project were to document:

- The most important attributes demanded in floors, walls, and decking systems;
- The performance of wood, steel, and concrete on demanded attributes; and,
- The importance of green labeling and green attributes.

Within each market, the market shares for wood, steel, and concrete were computed in structural floor and wall applications. The market shares for sheathing and decking materials were computed too, as well as the percentage of new homes including a deck. However, for the sake of conciseness, this paper focuses on the drivers (attributes demanded, preferences, and satisfaction) that tend to explain these market shares.

Methods

The project was completed over a two-year time horizon. A quantitative research design was implemented in Year 1 (2008-2009), followed-up by a qualitative design in Year 2 (2009-2010). The quantitative design was implemented first in order to characterize potential substitution patterns for wood products based on market shares, attributes demanded, and materials performance. The qualitative design was meant to further explain those patterns.

For the quantitative design, a questionnaire probing current material usage, preferences, and perceptions was initially designed. The questionnaire covered homebuilding practices, geographical markets, type of foundations, structural floors, structural walls, sheathing materials, attributes demanded, performance of selected materials (wood, steel, and concrete), decking materials, and green issues. The questionnaire was randomly administered to a target of 50 respondents in the top 20 U.S. metropolitan areas based on housing starts, using data from the U.S. Census Bureau. Prior to implementation, the questionnaire was pretested among homebuilders for assessing survey length and evaluating the questions.

The survey was administered online by the National Association of Homebuilders Research Center (NAHBRC) among members and nonmembers of the NAHB. The survey was filled out online but invitations were done through two

¹Data from the U.S. Census Bureau for NAICS codes 236115, 236116, and 236117.

different mediums. NAHB members were contacted by email. Overall, 2,000 invitations were randomly sent among the NAHB members panel, which contained 5,000 entries. There were 351 respondents within the panel, for a response rate of 17.6%. Non NAHB members were contacted by postal mail. Overall, 16,000 postal invitations were sent, providing 594 usable responses for a response rate of 3.7%. At the time of the study, the population of residential homebuilders in the U.S. was estimated to be 98,067¹. All respondents were given a \$10 incentive and two reminders were sent after the first invitation. Nonresponse bias was tested by comparing early versus late respondents, as usually performed in the literature (e.g., Armstrong and Overton 1977). As no significant differences were found between these two groups, nonresponse bias is not thought to be an issue in this study.

Comparisons between metropolitan areas were done using analysis of variance (ANOVA) using a confidence level of 0.05. Least significant difference (LSD) post-hoc tests were performed to identify statistical differences between metro areas. However, only the most important differences are highlighted in this paper. The questionnaire used percentages to document market shares. Materials attributes were ranked on seven-point likert scales ranging from 1 (not at all important) to 7 (extremely important) with a mid-point of 4 (important). The performance of materials was also ranked on a seven-point scale ranging from 1 (poor performance) to 7 (excellent performance) with an average point of 4. Differences between the measured levels of attributes or performance ratings were made using the t-test. The segmentation between small and large builders was set at a volume of 40 homes per year. Generally, above this number, the volume of homes built by individual firms quickly rises (Robichaud 2003).

For the qualitative design, focus group sessions were held with homebuilders in four of the cities included in the quantitative design. These cities were Philadelphia, Chicago, Denver, and Phoenix. Focus group participants were invited through local material dealers. The incentive offered to participants was a lunch or a dinner. For each city, a concise discussion guide was prepared. The first page of the discussion guide was descriptive and included the market shares for products used in floors, walls, and decks. It also included preferences and a summary of the attributes most demanded within each jurisdiction. In addition to the introduction of the focus group and the presentation of participants, the discussion guide included five sections: floors, walls, decks, lumber suppliers, and green construction. For each of these topics, between five and eight questions were prepared to guide the discussion.

Philadelphia was investigated because of a high proportion of homebuilders indicating that the use of concrete would increase greatly or somewhat in both walls and floors applications. This observation was also true in Washington and New York, but to a lesser degree. In Chicago, substitution in wall sheathing was the most important among the 20 metro areas surveyed. In Denver, the market share for plastic

Table 2. Number of participants per metro area.

Metro Area	Number of Respondents	Percent
Atlanta	68	7%
Austin, San Marcos	39	4%
Charlotte, Gastonia, Rock Hill	47	5%
Chicago, Gary, Kenosha	50	5%
Dallas, Forth Worth, Arlington	47	5%
Denver, Boulder, Greeley	37	4%
Detroit, Ann Arbor, Flint	52	6%
Houston, Galveston, Brazoria	40	4%
Las Vegas	17	2%
Los Angeles, Riverside	44	5%
Miami, Fort Lauderdale	27	3%
Minneapolis, St. Paul	48	5%
New York, Northern New Jersey	78	8%
Orlando	51	5%
Philadelphia, Wilmington	60	6%
Phoenix, Mesa	31	3%
San Francisco, Oakland	36	4%
Seattle, Tacoma, Bremerton	34	4%
Tampa, St. Petersburg	48	5%
Washington, Baltimore	91	10%
Total	945	100%

composites in decking was the highest among all jurisdictions. As well, the market share for steel joists in floor systems was the highest in that area. In Phoenix, the high market shares for concrete slabs and for treated wood products were of interest. Focus groups were moderated by the researcher in charge of analyzing the results, as recommended in social science research (e.g., Edmunds 1999) using the transcripts of the sessions (Krueger and Casey 2000). The analysis focused on describing the current practices according to the discussion guide, and on the search of support (or lack thereof) to the quantitative observations.

Quantitative Results

Profile of Respondents

There were 945 participants in the study, for an average of 47.25 respondents per city, which is close to the target of 50. As shown in the repartition across metropolitan areas (Table 2) the average was reached with an uneven number of respondents per city because the target of 50 respondents was challenging to reach in some cases.

Most respondents were active homebuilders. During the year prior to the survey, 81% of respondents have built at least one home and 57% have been involved in the remodeling of existing homes. Some 25% of respondents have performed residential land development, 23% have done remodeling of light commercial building, 17% have built light commercial buildings and 7% have performed commercial land development.

Together, respondents built a total of 38,186 detached single-family homes (39% were starter homes; 43%, move-up and 18%, luxury). They further built 6,931 townhouses or duplexes and 11,135 condos or apartments. Per respondent, the average of single-family homes built was 40, with 7 townhouses (or duplexes) and 12 apartments or condos. On average, 53% of homes were custom built, 25% were semi-custom and 22% were production homes. Respondents have performed an average of 15 remodeling jobs in the 12 months preceding the survey. The majority of respondents were active in local markets (85%), while 12% served multiple markets in a region and 4% served multiple markets nationally.

Floor Systems

Respondents were asked their preference between a concrete slab foundation and a crawl space with a wood floor system when building a house without a basement. More than half of the respondents (52%) prefer a concrete slab while just over a third (34%) prefer a wood floor system. When asked to explain their preference, builders generally expressed that concrete foundations were better and easier to install. When looking at the future, almost two-thirds (65%) of respondents thought that the use of concrete as a structural

floor material (excluding basement and garage floors) would remain the same. One respondent in five indicated that concrete use would increase either greatly (5% of respondents) or somewhat (15%). Only 4% said it would decrease. Respondents expecting greater concrete use in the future are more numerous in the U.S. South (Figure 1). However, 20% or more builders also expect concrete use to increase in the West (San Francisco, Los Angeles) and in the North/Northeast (Washington, Philadelphia, Minneapolis).

Respondents were asked to rate the importance of several attributes of the structural floor materials they use. The evaluation was performed on a scale from 1 (not at all important) to 7 (extremely important), with a mid-point of 4 (important). For all areas together, Figure 2 indicates that *structural integrity*, *code acceptance*, *durability*, and *minimal callbacks*, were all significantly higher than the point 6 of the importance scale. *Price*, *occupant comfort*, *building-cycle time*, and *quietness* were deemed equally important between the points 5 and 6 of the scale. *Easy installation* and *home-buyer preference* ranked slightly over the point 5 while *energy bills* and *customer support* received a score of 5. The two lesser important attributes were *environmental friendliness* (4.75 out of 7) and *appearance while under construction* (3.83).

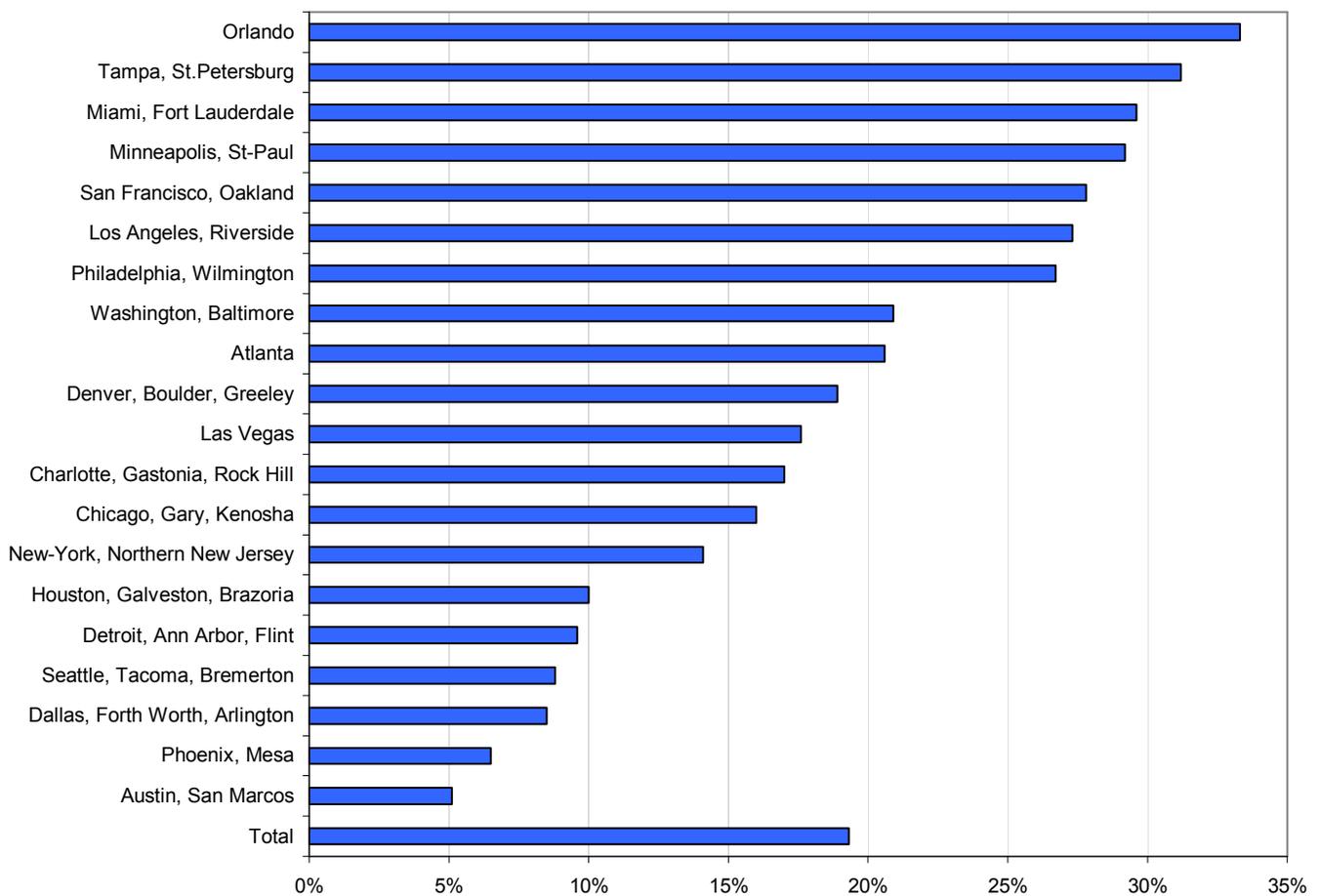


Figure 1. Proportion of builders indicating that concrete use as a structural floor material would increase greatly or somewhat.

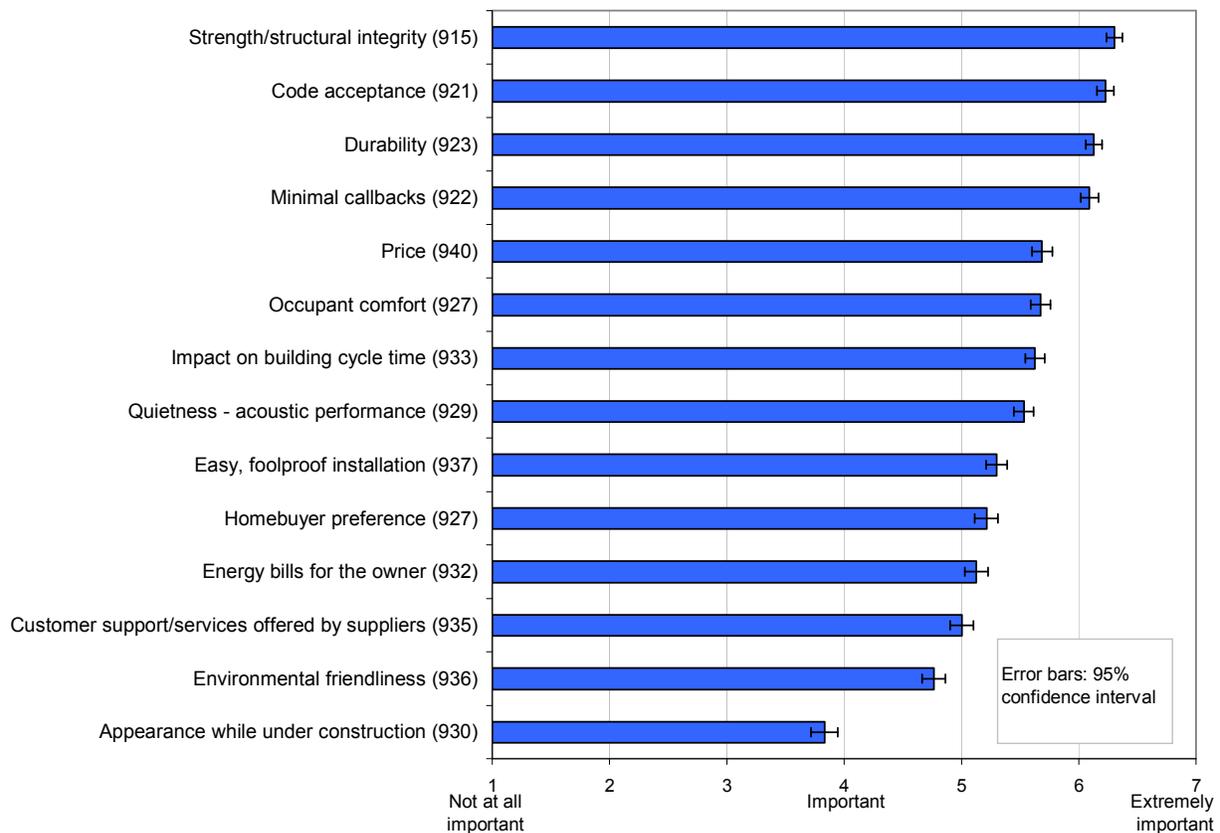


Figure 2. Attributes demanded for structural floor materials (number of respondents in parentheses).

For these attributes, respondents were asked to rate the performance of wood and concrete on a scale from 1 (poor performance) to 7 (excellent performance), with a mid-point of 4 (average performance). Figure 3 presents these results with the structural floors attributes ranking from the most important (*strength/structural integrity*) to the least important (*appearance while under construction*). For all attributes, performance reaches at least the point five on the seven-point scale. It is worth noting that the level of performance of both materials is higher when attributes are more important.

Taking Figure 3 as a baseline, it is possible to measure the difference in rated performance between wood and concrete. Figure 4 presents such a direct comparison for the selected attributes in structural floors. The comparison was done only for those respondents who have used both materials. Positive values point to an advantage for wood and negative values to an advantage for concrete. Wood was significantly deemed to perform better than concrete on *customer support*, *price*, *installation*, *occupant comfort*, and *appearance while under construction*. Concrete significantly outperforms wood on *durability*, *strength/structural integrity*, and *acoustic performance*. Two of these attributes (*durability* and *strength/structural integrity*) are among the top three important attributes for respondents in floor applications. Both materials fared equally for *cycle time*, *energy bills*, *environmental friendliness*, *homebuyer preference*, *code acceptance*, and *minimal callbacks*.

The dataset allows comparing wood and concrete for

each attribute in each metro area. While it would be too comprehensive to include these results in this article, some findings are worth noting. As structural integrity was found to be the most important attribute in floors, it is interesting to note where homebuilders favor concrete over wood for this specific attribute. The regions of Dallas, Miami, and Las Vegas were the ones where the performance of concrete was deemed the highest over wood. However, Northern jurisdictions (especially Chicago, Philadelphia, and New York) clearly evaluate concrete favorably against wood for this attribute, too. The second most important attribute in floors was *code acceptance*. With respect to this attribute, regions where wood lags (versus concrete) are mostly seen in the U.S. South. The areas of Austin, Dallas, Miami, Tampa, and Orlando especially perceived concrete to be significantly better code compliant than wood. Meanwhile, the areas of Denver, Seattle, and Chicago are where code compliance for wood was said to be the highest. In floors, *durability* was the third most important attribute. In all regions but Denver and Houston, concrete is said to be more durable than wood. Most jurisdictions in the U.S. South favor concrete and most jurisdictions in the North tend to favor wood. However, for *strength/structural integrity*, some areas in the U.S. North (Chicago, New York, and Philadelphia) indicate a stronger performance for wood. In floors, the performance of wood for *minimal callbacks* was the highest in Seattle and Denver. Concrete was preferred for this attribute in the Southern regions of Dallas, Austin, and Miami.

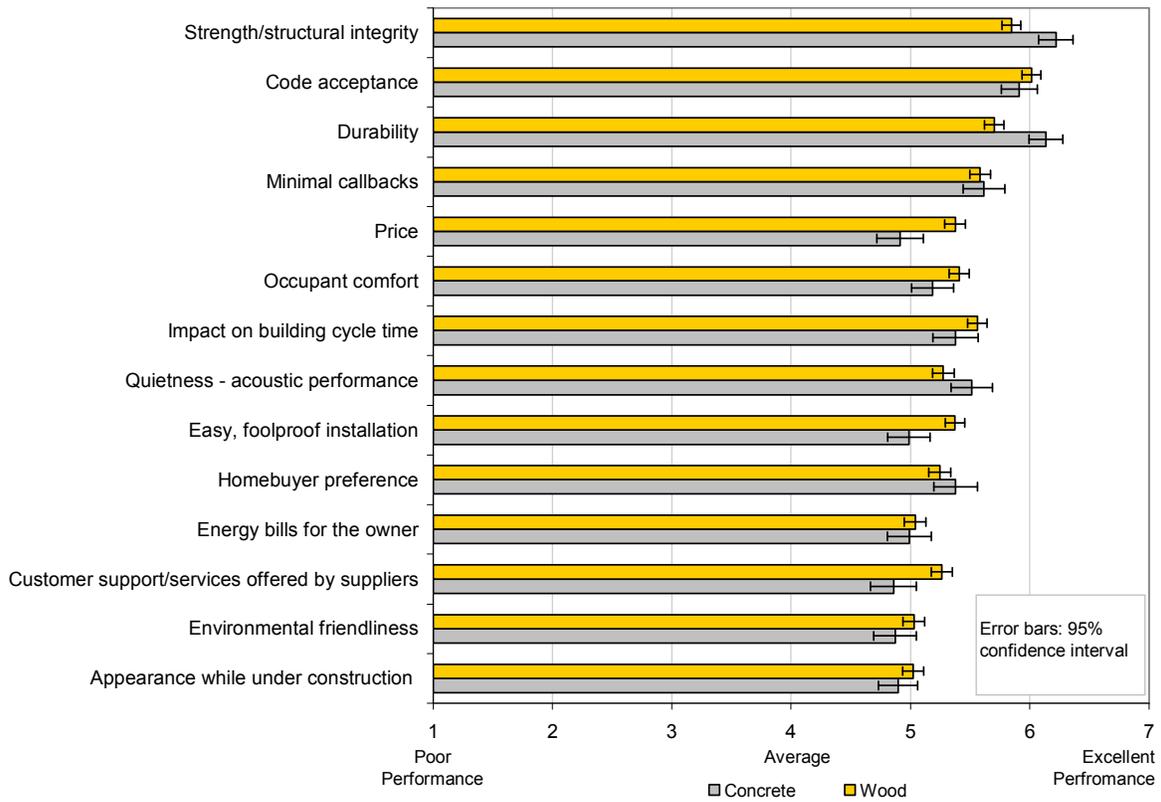


Figure 3. Wood and concrete performance on selected structural floors attributes.

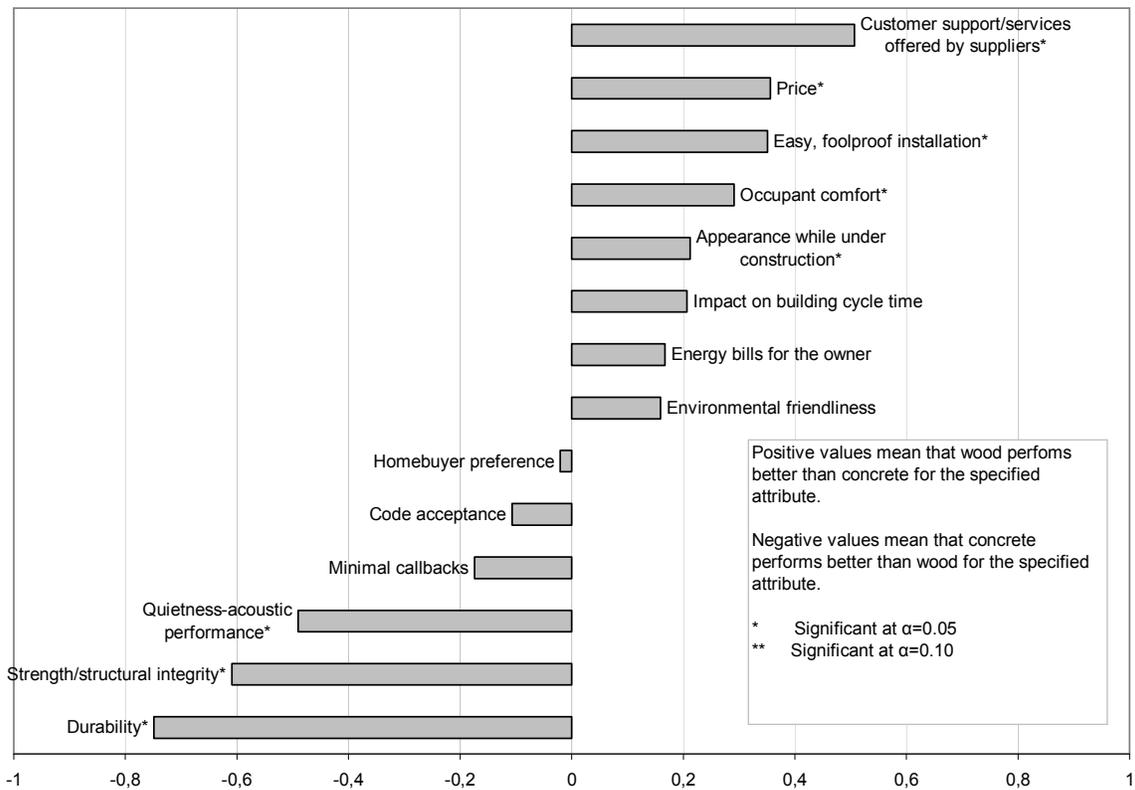


Figure 4. Wood performance versus concrete performance for structural floor attributes.

Wall Systems

Respondents were asked to rate the importance of several attributes of the structural wall materials they use. The evaluation was performed on a scale from 1 (not at all important) to 7 (extremely important), with a mid-point of 4 (important). For all areas together, Figure 5 shows that *code acceptance* and *strength/structural integrity* were the two most important attributes with a score above 6 on the importance scale. *Durability* was the third most important attribute with a score of 6. A group of attributes were then ranked between 5 and 6 on the importance scale (*minimal callbacks*, *price*, *cycle time*, *occupant comfort*, *acoustic performance*, *installation*, *energy bills for owner*, and *homebuyer preference*). Among this group, *minimal callbacks* and *price* were the closest to point 6 on the scale. The three least important wall materials attributes for homebuilders were *appearance under construction* (a score between 4 and 5), *environmental friendliness*, and *customer support* (scores of 5).

For the attributes that are found in Figure 5, respondents were asked to rate the performance of wood, steel, and concrete on a scale from 1 (poor performance) to 7 (excellent performance), with a mid-point of 4 (average performance). Figure 6 presents the structural wall attributes in the same ranking as Figure 5, with the most important wall attributes in the upper portion and the least important attributes in the lower portion. For most attributes, the performance of steel was rated lower than wood and concrete. The higher confi-

dence intervals for steel reflect the lower number of respondents and users of that material. Generally, the level of performance of all materials is higher when attributes are more important. Looking at the most important attributes, wood and concrete were rated equally with a score of 6 on the performance scale for *code acceptance*, beyond steel with a score of 5. The performance of concrete surpassed 6 for *strength/structural integrity*, and received a score of 6 for *durability/low maintenance*. For those two attributes, wood had a lower score, between 5 and 6 on the performance scale.

Taking Figure 6 as a baseline, it is possible to measure the difference in rated performance between wood, steel, and concrete. Figure 7 presents such a direct comparison for wood and concrete. The comparison was done only for those respondents who indicated the selected materials, thus explaining the small differences between the averages measured in Figure 6. Positive values point to an advantage for wood and negative values to an advantage for concrete or for steel. Significant results at $\alpha=0.05$ and $\alpha=0.10$ were identified, the latter as an indication of potential differences. Wood was deemed to perform significantly better than concrete on *installation*, *price*, and *customer support*. Concrete significantly outperforms wood on *durability*, *strength/structural integrity*, and *acoustic performance*. Two of these attributes (*durability* and *strength/structural integrity*) are among the top three most important attributes for walls. Both materials fared equally for the remaining attributes.

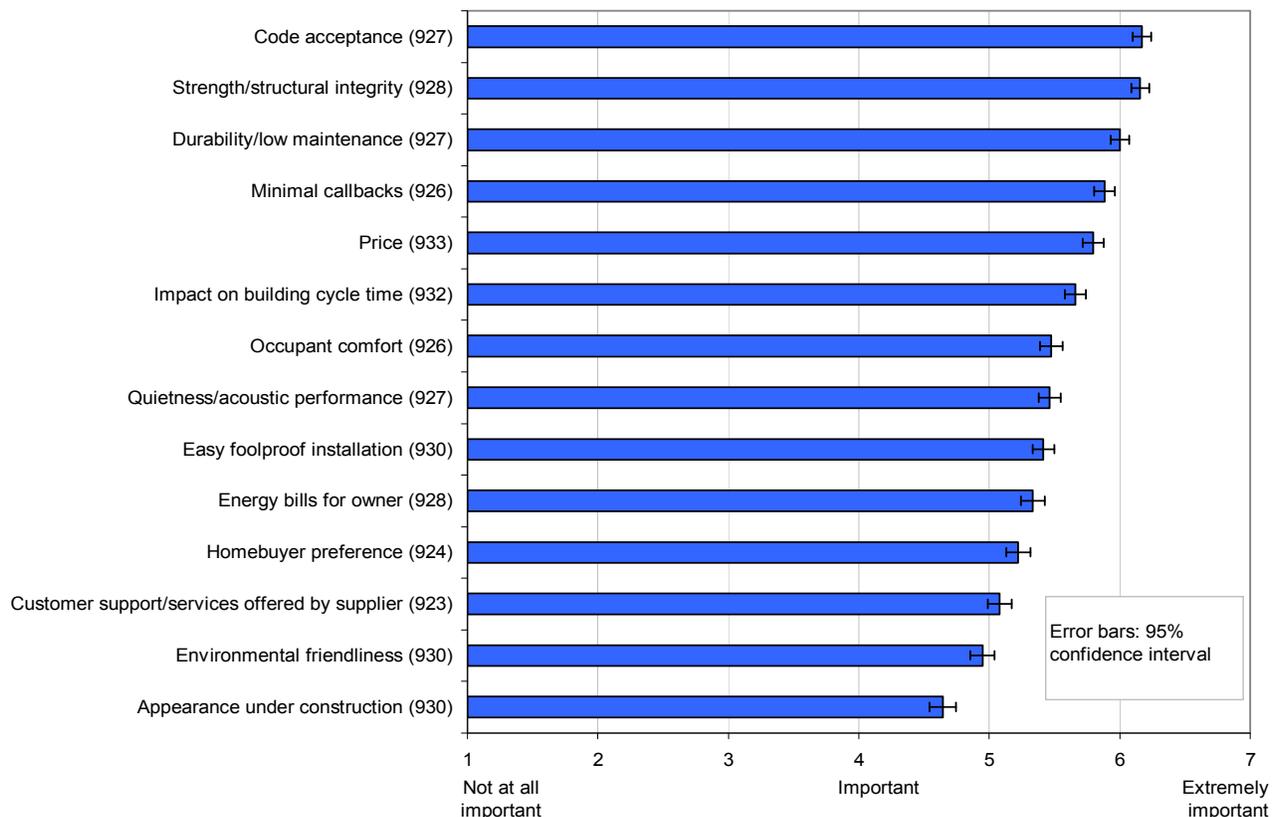


Figure 5. Attributes demanded for structural wall materials (number of respondents in parentheses).

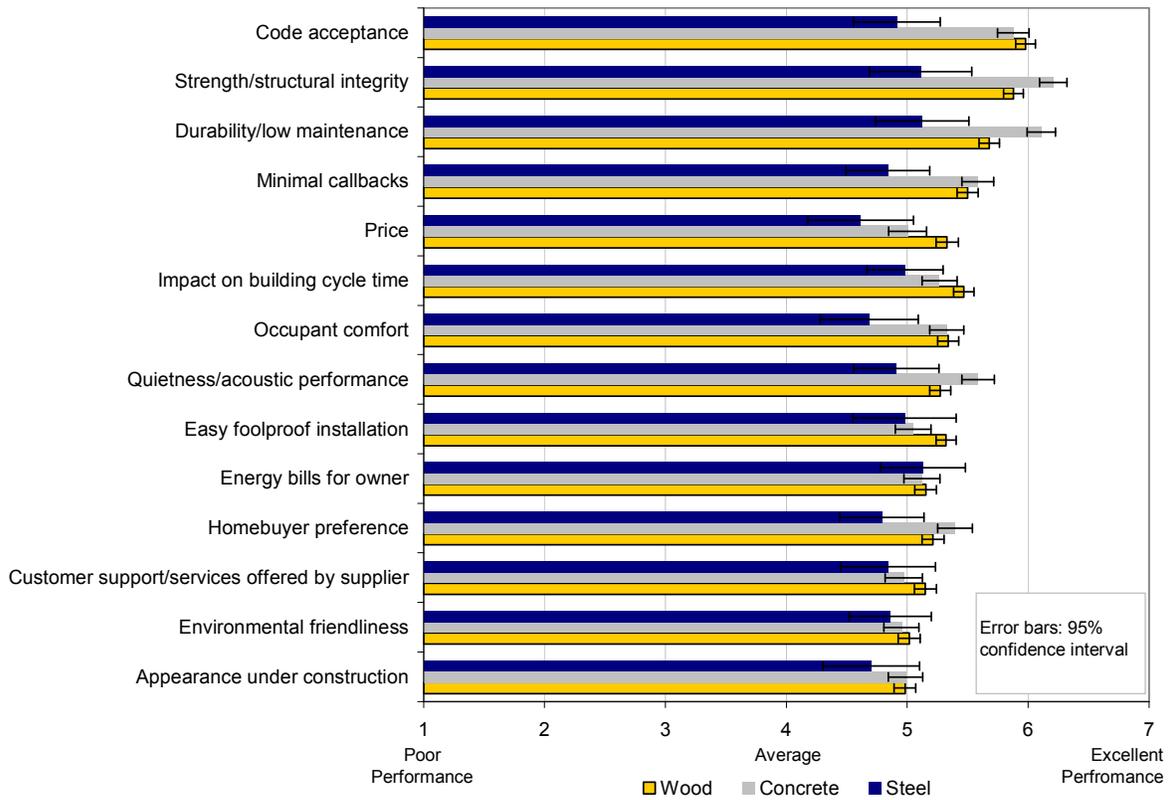


Figure 6. Wood, concrete, and steel performance on selected structural wall attributes.

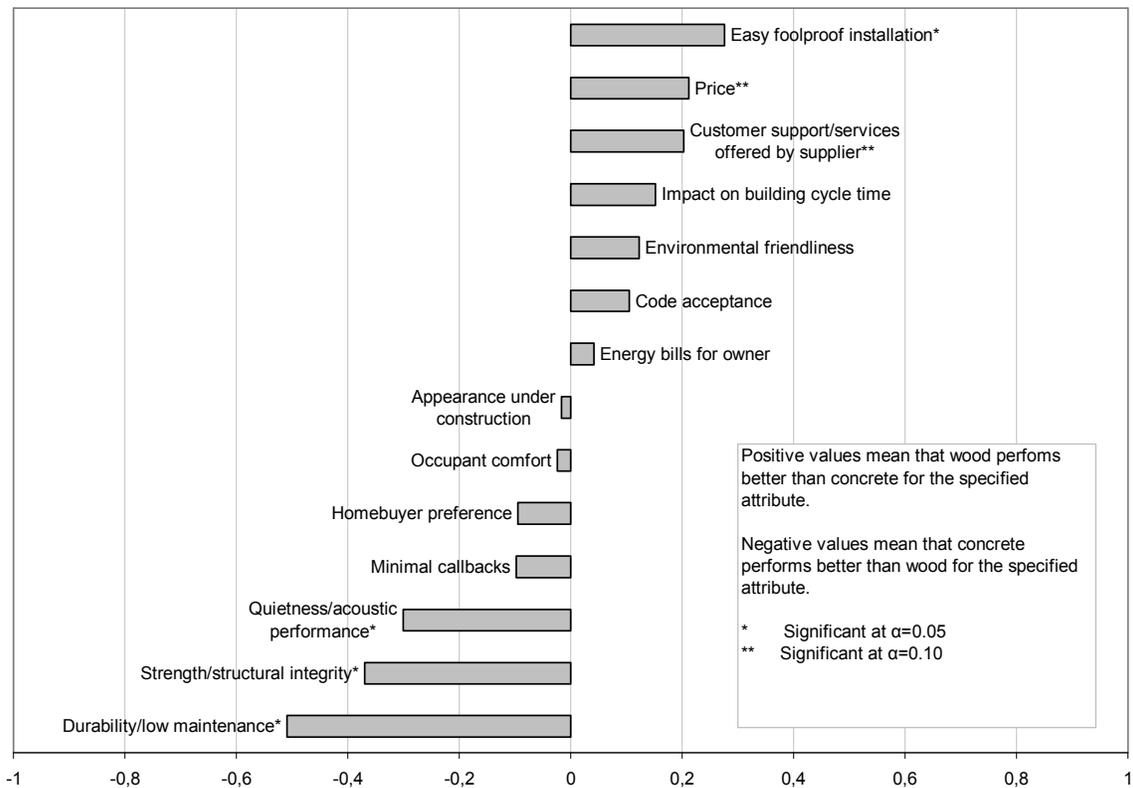


Figure 7. Wood performance versus concrete performance for structural wall attributes.

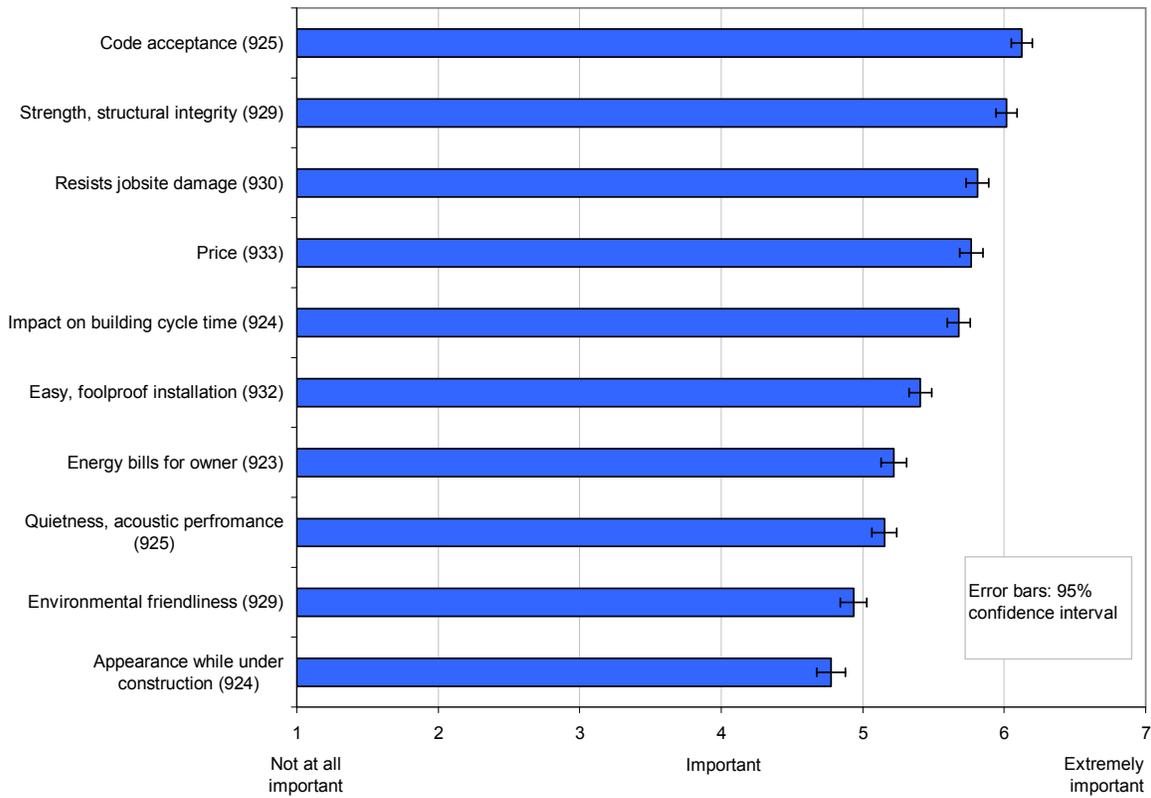


Figure 8. Attributes demanded for wall sheathing materials (number of respondents in parentheses).

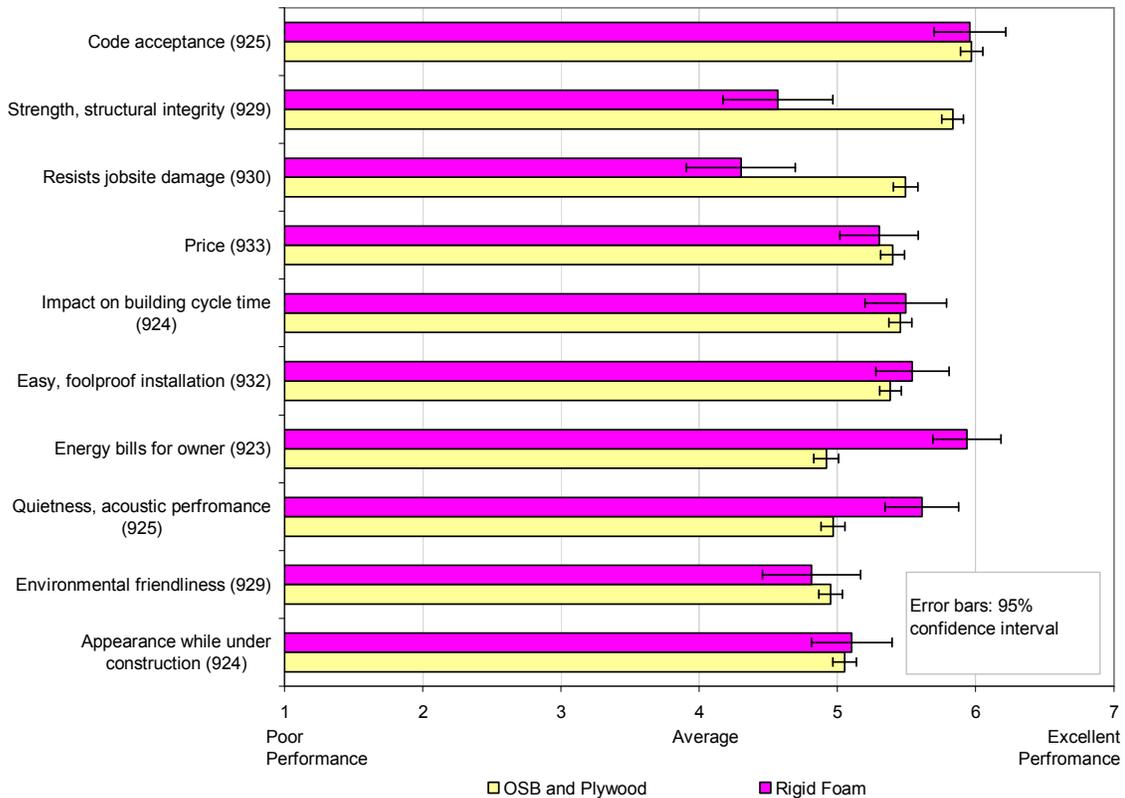


Figure 9. The performance of OSB and plywood compared to foam on selected wall-sheathing attributes.

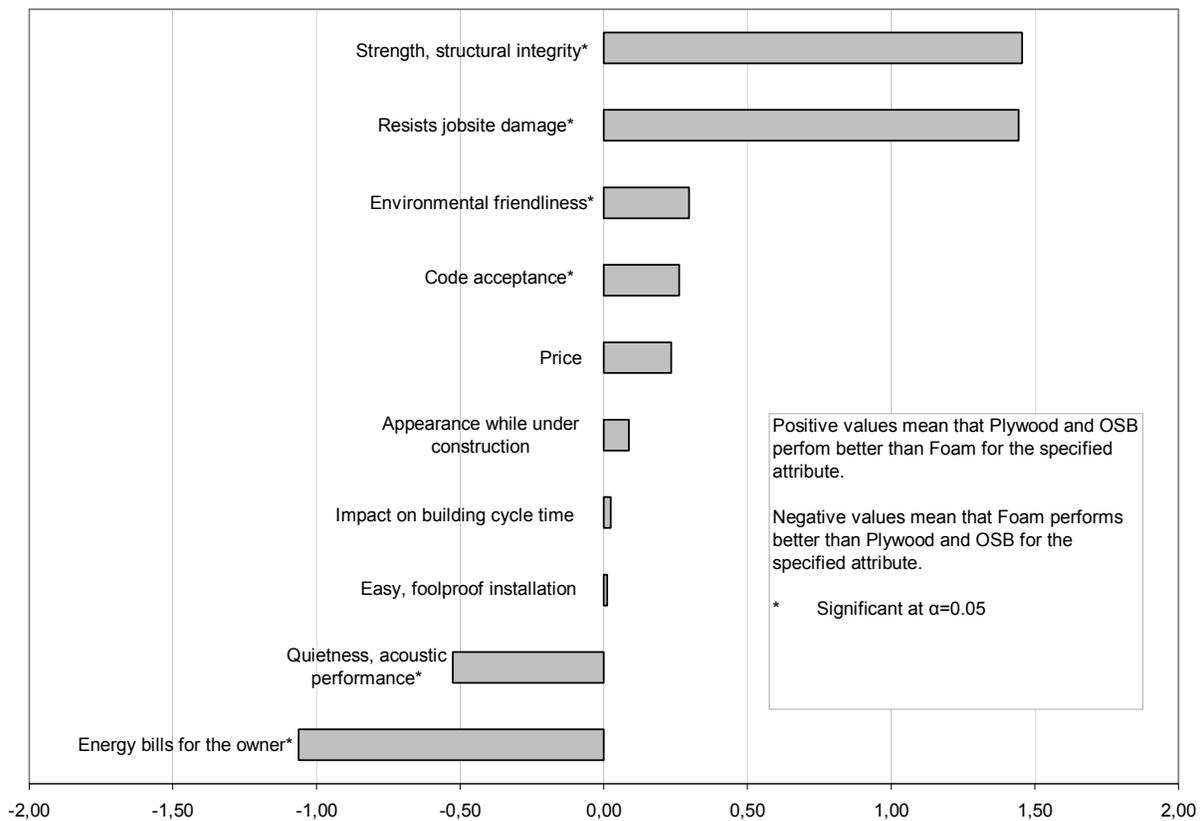


Figure 10. Attributes demanded for wall sheathing materials (number of respondents in parentheses).

For walls, *code acceptance* was chosen as the most important attribute by homebuilders. In Charlotte and Houston, concrete fared significantly better than wood for this attribute. Wood was thought to be better than concrete especially in Austin and Washington, and Denver. The second most important attribute for walls was *strength/structural integrity*. In Denver, New York, Washington, San Francisco, Detroit, and Chicago, wood was said to perform better than concrete for this attribute. However, the reverse was found in all other areas, but especially in Orlando, Seattle, Tampa, Las Vegas, and Miami. *Durability* was ranked as the third most important attribute for walls. Such as in floors, most areas favor concrete. Again, Southern areas (Orlando, Tampa, Las Vegas, and Houston) strongly favor concrete for *durability*. Some Northern areas (especially Seattle, Minneapolis, and Philadelphia) have also shown a preference for concrete because of its *durability*. The fourth most important attributes for walls was *minimal callbacks*. On this attribute, concrete was found to be superior to wood in Seattle, Tampa, Los Angeles, Atlanta, and Orlando. In Austin, Denver, and Charlotte, wood was found to be superior to concrete. For most wall attributes, wood was deemed to perform significantly better than steel. This was especially the case for *price*, *code acceptance*, *customer support*, *minimal callbacks*, *installation*, and *homebuyer preference*. For all other attributes, there were no statistically significant differences between wood and steel.

For wall sheathing materials, respondents had to indi-

cate the importance of several attributes within their purchase decision (Figure 8). On a scale from 1 (not at all important) to 7 (extremely important) with a mid-point of 4 (important), the two most important attributes were *code acceptance* (slightly over 6 on the scale) and *strength/structural integrity* (6). *Resistance to jobsite damage*, *price*, and *cycle time* followed with a value between 5 and 6 (closer to 6), on the importance scale. Three other attributes in that range, closer to point 5 were: *installation*, *energy bills for owners*, and *acoustic performance*. *Environmental friendliness* was rated at 5 and *appearance while under construction* rated slightly lower.

Keeping the same ranking of attributes as those in Figure 8, the performance of plywood and OSB was compared with the performance of foam sheathing (Figure 9). For the most important attribute, both materials fared equally with a high rating of 6 on the performance scale. For the two other most important attributes (*strength/structural integrity* and *resistance to jobsite damage*), wood-based materials fare better than foam.

In sheathing applications, *code acceptance* was the most important attribute. When comparing wood sheathing to foam sheathing by metro area, differences for this attribute are small and generally in favor of wood. With respect to *code acceptance*, the performance of wood was ranked the highest in Washington. In sheathing applications, *strength/structural integrity* was found to be the second most important attribute. In all areas where plywood/OSB and foam sheathing are used, the former combination was deemed better than the latter.

Resistance to jobsite damage was ranked third for sheathing attributes. Except in Austin, all other areas where plywood/OSB and foam are used strongly prefer wood based panels for this attribute. *Price* was the fourth most important attribute for wall sheathing applications. While wood-based panels are thought to perform better than foam on *price* in Washington, the reverse was found in Houston.

Decking Materials

For the decking material that they use the most, homebuilders were asked to indicate their level of satisfaction ranging from “*very dissatisfied*” to “*very satisfied*.” Satisfaction was rated the highest by users of tropical hardwoods and composite/plastic lumber (Figure 11), both exceeding significantly the “*somewhat satisfied*” anchor. Respondents using untreated lumber or a combination of decking materials were somewhat satisfied. Builders using treated lumber or other decking materials were the least satisfied, as their satisfaction ranged between “*neither satisfied nor dissatisfied*” and “*somewhat satisfied*.”

Respondents were also asked to rate the importance of selected attributes when purchasing decking materials (on a scale from 1 = *not at all important* to 7 = *extremely important*, with a mid-point of 4 = *important*). Figure 12 shows that three attributes scored higher than point 6 on the scale and were statistically equal: *durability*, *appearance*, and *longevity*. *Structural integrity*, *minimal callbacks*, and *low main-*

tenance reached 6 on the seven-point scale. Four attributes then ranged between points 5 and 6 of the importance scale (*homebuyer preference*, *installation*, *price*, and *customer support*). *Environmental friendliness* was the least important attribute with a score of 5.

With respect to deck surfacing, respondents were asked whether materials made of wood are better, about the same, or worse than other decking-surface products not made of wood. Overall, 58% of respondents thought that wood was worse, 31% that wood was about the same, and 12% that wood was better. Figure 13 indicates that in Denver, Washington, Detroit, Philadelphia, Miami, Phoenix, and Orlando, 60% and more respondents actually think wood is worse. Overall, there are 15 regions out of 20 where more than 50% of respondents indicated that wood was worse than other materials. Best scores for wood being better than other materials were reached in Las Vegas, Atlanta, and New York. In these three areas, a proportion of 24%, 22%, and 22% of respondents, respectively, found that wood was better than other materials.

Green Issues

Most generally, green labeling for building materials was not seen as very important (Figure 15). The greatest importance of such labeling was found in three areas: Denver, San Francisco, and Phoenix. All suggested attributes of green labeling (*sustainability*, *renewability*, *carbon neutrality*, *harvest legality*, and *formaldehyde safety*) were rated equally.

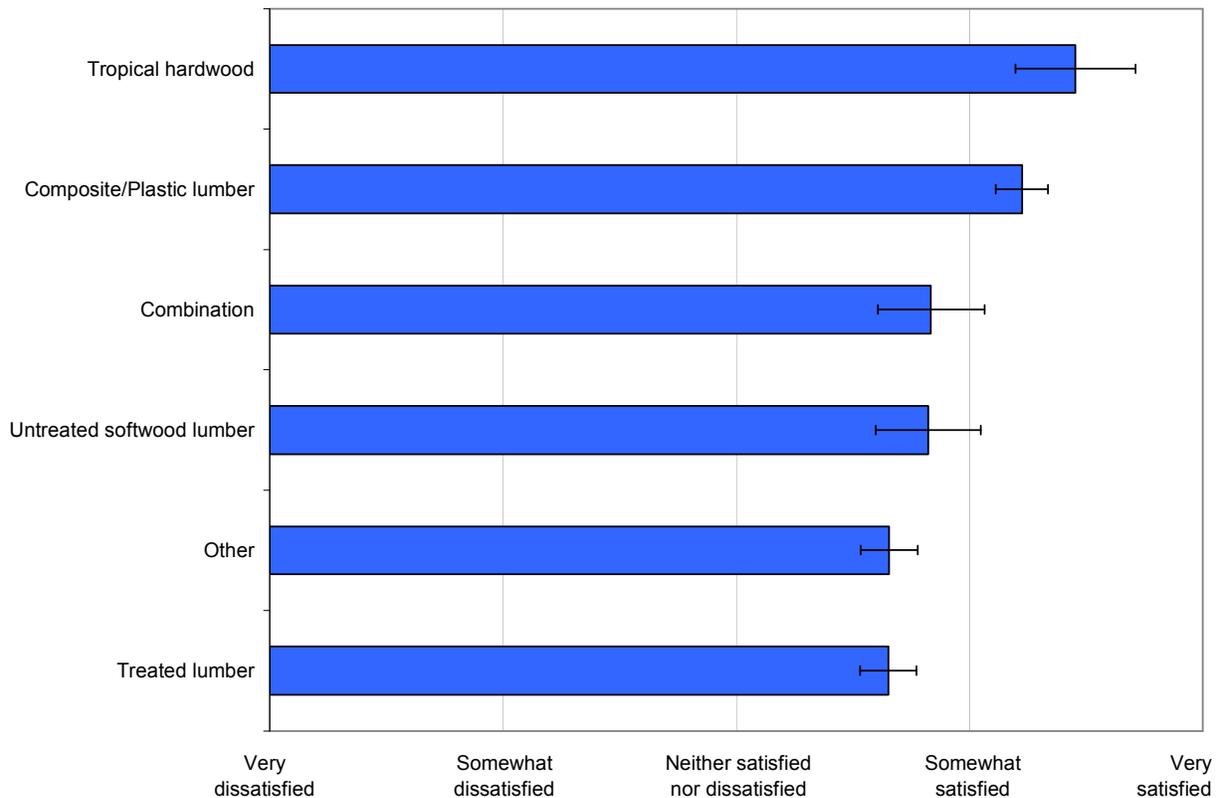


Figure 11. Builders satisfaction with the decking material mostly used.

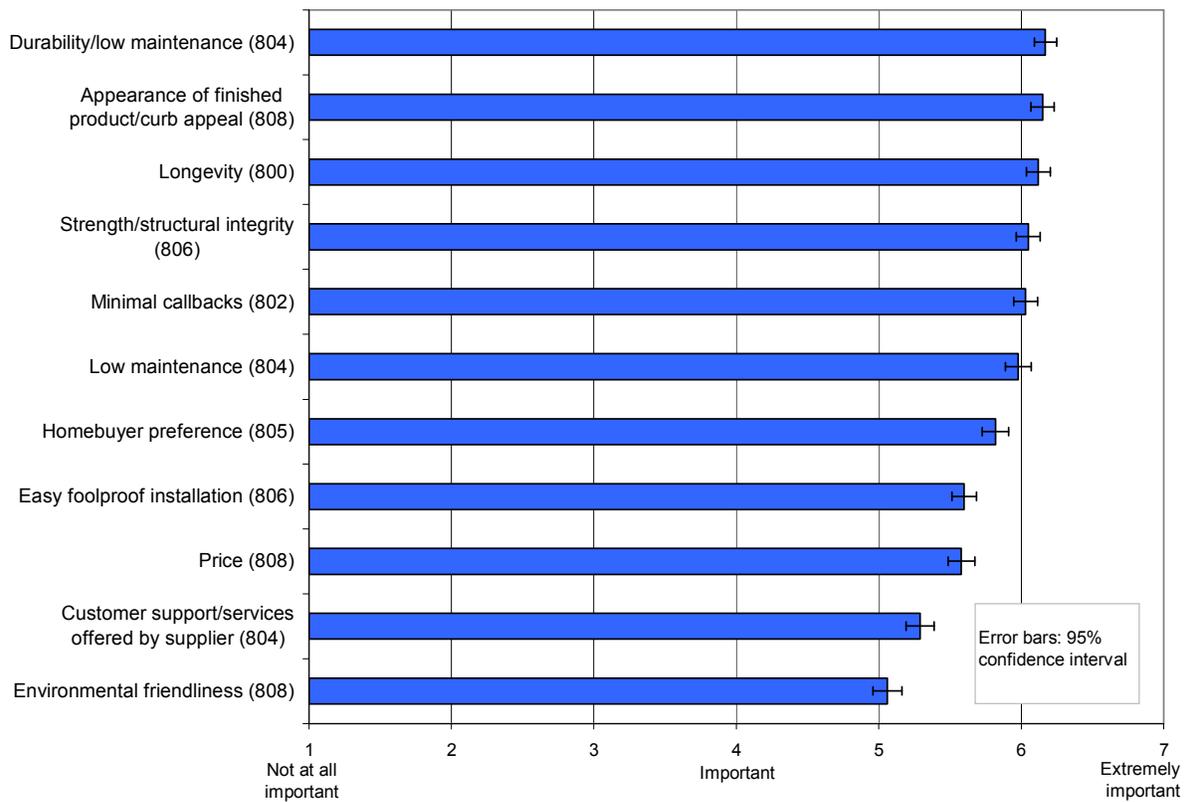


Figure 12. Attributes demanded in decking material purchases.

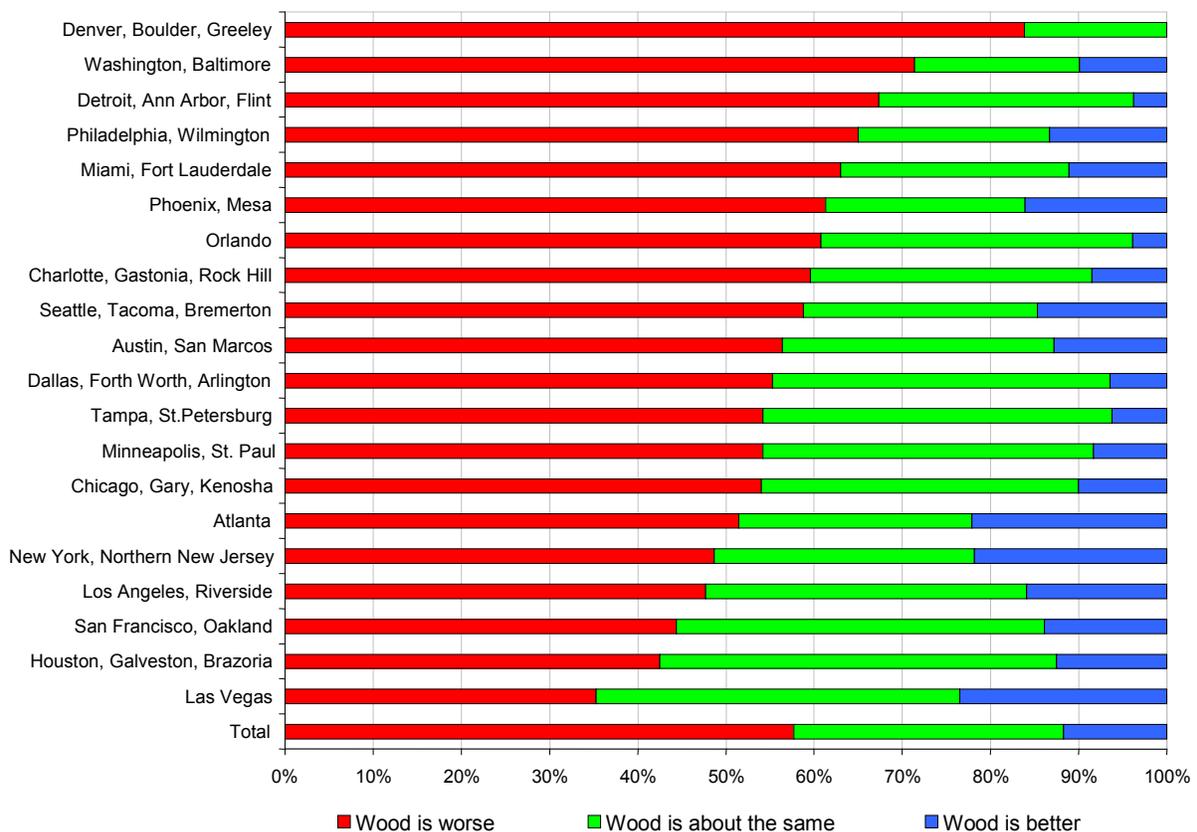


Figure 13. Evaluation of wood versus non wood materials for decking surfaces.

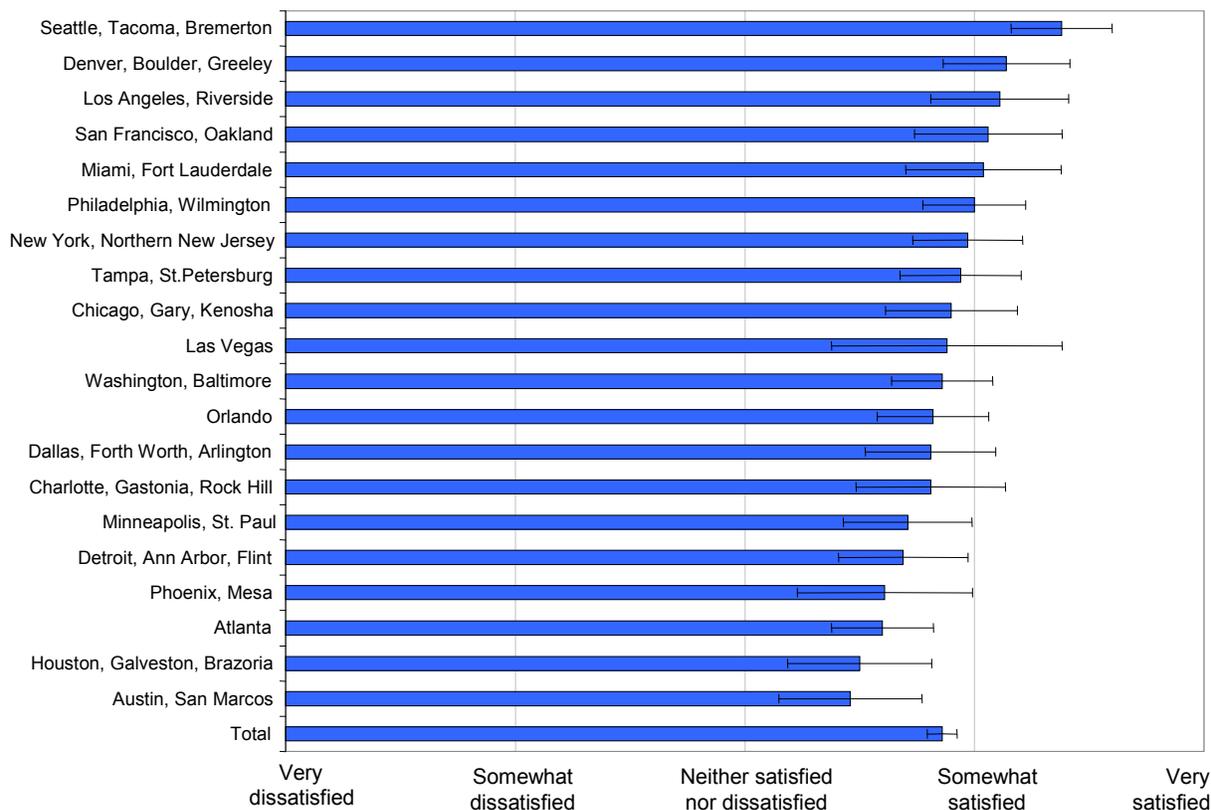


Figure 14. Satisfaction with decking materials by metro area.

These conclusions were not dependent on builder size. These results indicate that homebuilders may expect some proof of green building benefits. Future work may investigate how quantifiable green aspects, especially energy savings and energy performance, may support the marketing of green products among homebuilders.

Qualitative Results

This section presents the findings that apply to the four markets studied. Discussions focused on potential wood substitution in floors, walls, decks, lumber suppliers, green building, and housing conditions. However, in line with the objectives of the project, the results presented focus on wood substitution and omit other topics that may be of lesser relevance to the study.

Philadelphia

There were nine homebuilders taking part in the discussion in Kulpsville (PA) at the northern periphery of Philadelphia on September 13, 2009. There was a mix ranging from small custom homebuilders building a few homes a year to large builders completing up to 2,500 units per year. The product mix was focused on single-family homes but included multi-family homes, townhouses, and vacation homes.

A rationale to choose Philadelphia and its surroundings for conducting focus groups was the high proportion of

homebuilders indicating a will to use more concrete in the future to build structural walls and floors. This finding was not confirmed at all by the discussion. When asked if they anticipate steel and concrete increasing in market share in the future, none of participants was aware of a single builder considering turning to these techniques. One participant reported that builders in the area who have tried steel stopped because the framing crews are reluctant changing from wood.

Indeed, products used in floor systems by participants were all engineered wood products (EWPs) and solid wood. It was further mentioned that concrete would probably not be used for a while in floor applications because of low lumber prices. The choice between EWPs and solid wood in flooring is much dictated by the span, where EWPs become more attractive at spans greater than 14 and 16 feet. So far, this market continues to rely more on solid wood than on EWPs.

As a participant said: *“There is much going in sheathing applications but it is very difficult to adopt new products.”* There was a consensus among participants about the interest of energy performance. One participant has tried foam sheathing in the past but discontinued use of the product because it was too subject to jobsite damage, and it also expands more. It was also more difficult to seal the house. Participants noted that large, national builders were more likely to use products such as Thermoply, foam sheathing, etc.

According to the prodealer servicing the participants, five years ago, the composite decking market was virtually non-existent, and now it’s growing substantially. Meanwhile,

the treated-lumber business has remained the same. Because most of the participants use very little or no composites, it is hypothesized that some — if not much — of the composites go into remodeling. Overall, respondents felt that the composite decking industry has evolved from the first generation of products, but that it is still not a mature industry. Increasingly, maintenance is a big issue in materials selection for decking. With that said, this market seems to continue being quite price sensitive for decking surfaces.

Homebuilders agreed that customers typically look more for energy efficiency than for green products. Participants agreed that it was easier and more profitable for them to sell an energy-performing home than a green home. Especially, some participants noted that energy savings are quantifiable, which makes them easier to achieve and demonstrate. There was a consensus on the challenge of defining what is green, especially for the customers. A participant indicated that the cost of green building was an issue: *“Everybody wants green but they don’t want to know the cost.”* Another added: *“They talk about green but their expectations is it’s too expensive and that they can’t afford it.”* Some participants insisted on the ability to demonstrate potential cost savings because this is a language that customers understand. Most generally, third-party certifications were seen as one of the best ways to reassure and inform the customer.

The workforce was seen as shrinking. With the downturn, many subcontractors have lost their employees to other sectors or regions, and there is uncertainty as to whether the labor base will return once the housing crisis subsides. There is a sense that there will be more industrialization of homebuilding if labor issues continue being important. Participants generally agreed that they will have to look at prefabricated (prefab) wall panels at some point because framers will continue to face labor shortages. Competition for the labor coming from other industries was seen as problematic.

Phoenix

The discussion session was held in Phoenix on October 10, 2009. There were 10 participants. Two were vice presidents (VPs) for one of the top 10 national homebuilders in the U.S. There was also another large builder (custom homes, multi-family, hotels), one developer for high-end custom homes, a small builder of high-end custom homes, and five people from one of the most important truss manufacturers in Arizona. The latter firm was also a framing contractor.

The Phoenix market is much oriented towards slab-on-grade construction. EWPs and floor trusses are also used for floor framing. In general, EWPs (or open web floor trusses) are preferred over solid wood because of the possibility for longer spans. All participants agreed when a builder commented: *“I haven’t built a house or multi-family house with solid sawn in 20 years.”* In this market, the preferred technique for the ground level is thus slab-on-grade, and EWPs (or open web floor trusses) when another story is needed. The truss manufacturer was prompt to add that he has some success and foresees more to come with open-web floor trusses. This is because it allows use of recycled material for

webbing, and it also eases the installation of air conditioner ducts. The fact that solid-sawn products are somewhat non-existent in the flooring market is reportedly due to the properties of EWPS including dimensional stability, low or no shrinkage, and straightness.

The floor sheathing market appeared dominated by OSB (1 1/8”) among respondents. It seems that the change from plywood to OSB was much driven by the engineers involved in home design. Currently, the residential market is near 90 to 95% OSB while the commercial sector is still important for plywood. In wall systems, most respondents have extensively relied on FJ lumber in the past, while using more solid sawn these days. The interest in FJ studs was that it helped reduced the callbacks and was more stable dimensionally. According to a participant: *“It was more economical for us to pay a little more to buy FJ studs versus the solid sawn.”* Reportedly, there is less FJ lumber in the market currently because of higher price and lower quality. In sheathing, there is quite a lot of OSB, but also some amount of plywood in shear-wall applications. Sheathing is preservative treated in high moisture areas, but moisture is not a big issue in that market.

Looking at future building techniques, it seems that steel is and will be increasingly used in the area. Participants further felt that structural insulated panels (SIPs) were not likely to increase in market share while prefab panels using solid-sawn studs may well become prevalent depending on participants. While one participant clearly thought that prefab panels cannot compete with stick building because of panel inventories and changes on the construction site, others were more enthusiastic about these products. Especially, it was thought that prefab panels reduce cycle time and that they are more ecological because they reduce jobsite waste, which is an important aspect of the green rating systems such as LEED.

Because of termites, most decking materials are made of composites or concrete. According to participants, there is no wood use in decking and patio applications in Arizona. In addition, the need for shade in this desert area is important, so the need for large patios or decks is accordingly less important. Maintenance, for decking but also for the house as a whole, was seen as becoming increasingly important.

Most of the homes built in the Phoenix area are certified to Energy Star standards according to participants. This was true for all builders at the session but one. One of the participants further does the NAHB green building certification. However, participants noted some confusion in the market about the nature of green construction: *“I don’t think anybody can tell you what green is.”* Overall, participants were very reluctant about green building schemes, as noted in some comments:

“It’s really chic to build green now, but if you don’t have a lot of money to pay for that, then nobody wants it.”

“They probably give you more points in here for landscaping than for FSC.”

“It all depends on the system. You get more points here for your windows, glass, air handlers, landscaping, and all the other things than wood.”

Nevertheless, a builder insisted on the fact that homebuyers really enjoy hearing about green construction and elements such as low-VOC paint, low energy-consumption air conditioners, etc. Homebuyers also seem to be much interested in energy efficiency, which translates into increased sales of solar panels. The demand for energy efficient homes would also depend on the market point, as a builder noted: *“The first timers (homebuyers) are after price.”* Another added: *“The move up are looking for their pension funds and where they are going to put their money.”* That said, a builder noted: *“60% of homebuyers are willing to pay more for the radiant barrier; they are embracing those things when they know they’ll get a return on it”.*

There was a sense that, when the housing market stabilizes, there will be a labor shortage. According to participants, entry costs to build a home are becoming prohibitive (design reviews, tax fees, etc.). A participant even suggested: *“Fees amount to the value of the lumber in the house.”* In terms of construction, the most important change to come in the next five years was not seen in building techniques, but in the business environment. Especially, it was noted that builders are under a lot of pressure by outside entities to do the right thing. Participants felt that certification and regulations would be the biggest issue and would go much further than Energy Star.

Chicago

The discussion was held in the Gary (Indiana) area, some 30 miles south of Chicago. While Gary was included in the quantitative phase of the study as part of the greater Chicago area, it turned out that the Gary market differs from Chicago at least in wall sheathing applications². The main rationale to investigate the Chicago area was due to a relatively high proportion of foam sheathing in wall systems used instead of plywood and OSB. However, only after the session was scheduled was it discovered that foam sheathing is much less used in the Gary area than in Chicago. With that said, some participants were literate on foam sheathing and the session proved valuable. It was attended by eight homebuilders. Most were small, building anywhere from one to 15 homes per year, generally at the higher end. One was a larger builder who had as many as 150 new housing starts prior to the downturn. All have seen a reduction of their housing starts by 50 to 75% since the downturn.

Most participants were using OSB for floor sheathing, and I-Joists for framing. For some respondents, solid-sawn joists were reserved for those homes built on a tight budget. The few respondents using more solid-sawn joists intended to use more engineered-wood floor joists in the future. All participants were stick framing their walls. For some, using panels would not make sense because every single home is different. Interestingly, a participant stated: *“We have done it (prefab walls) for years, 20 years or so, it worked well, but*

we switched back – really for cost, it was better to have our own guys frame it. And then especially if there is changes. That was too difficult changing walls onsite.” Another builder commented that he has thoroughly compared the cost of prefab panels with stick framing, and found that *“definitely framing onsite is more economical and more desirable.”* There was a consensus on the fact that there are no major labor issues or difficulties finding framers in the area.

When asked whether they use products such as foam or kraftboard sheathing instead of OSB and plywood, two participants had experience with those alternative products. The switch back to wood-based panels was done for strength and waviness issues. Especially with vinyl siding, *“you would see a lot more of the waviness in the foam board.”* Homeowners would also have doubts or misconceptions, thinking *“someone could just take a saw and hey jump into my house.”* Basically, homeowners were seeing this as an inferior product. Another builder stated that you would see more foam in the 1980s, but *“recently, less of it, at least we switched over to OSB probably 15 years ago. And we’ve had no problems with it. I mean you still see some builders that will use it.”*

A very small proportion of the homes built by participants are delivered with a deck. Most respondents indicated that a deck increases the cost of the house, and that most buyers wait to build one, if any. Other builders were trying to sell patios, as they want to avoid deck building, especially with treated wood. Builders were very much likely to specify composite decking, and some would not even build a deck if it was not composite. A builder who was familiar with all types of decking surfaces suggested that: *“it’s a price driven product. If you have the means to choose composite you’ll go composite, typically.”* For participants, the preference for composite decking was best summarized through comments such as: *“Most customers know how bad treated lumber is,”* *“Every customer that already had a deck with treated lumber doesn’t really like to maintain it,”* or *“Everyone wants maintenance-free siding, maintenance-free soffit fascia, they want the whole house to be maintenance free.”* However, users of composite decking noted that this product still requires maintenance, none the least because of stains and mold on deck surfaces. Some participants noted that PVC may well be used more in decking applications in the future. A builder who was building 90% spec homes was indeed specifying conventional lumber for decking. On this point, a builder went as far as saying that he gets his customers to sign a disclaimer when they want conventional, treated lumber, because he does not want any callbacks.

Participants in Chicago were asked: *“With the current trend towards more energy-efficient and greener buildings, do you feel your practices – using OSB - are still adapted to the demands of energy performance? Have you seen more demand for energy performance? If so, is it more code driven, or customer driven?”* To this question, participants rapidly pointed out that construction costs were the biggest issue despite the interest for green and energy-efficient homes. In the words of a participant: *“Yes, they’re asking for energy performance, but energy performance usually means more money and when that subject comes up you go back to a normal*

²The difference between Gary and Chicago is based on the comments received from Tom Kositzky, Director of Field services at the APA –The Engineered Wood Products Association.

way.” This comment was shared by the others who have all addressed energy performance or green building to some degree, but always face the challenge of profitably selling green homes. A participant nevertheless noted: *“These last couple of years we built half our houses green and I don’t think they pay more. If anything it will encourage them to buy ours instead of someone else’s (...) for the same price.”*

On green matters, participants felt that there was much confusion in the market and that people do not know what green exactly is. The same would hold true for builders: *“There is no standard, everybody could say they’re green.”* Some participants further noted that much of their current practices can be certified anyway to some degree within the NAHB green standard. Going higher in the certification scheme and aiming for the emerald level was seen as inevitably more expensive. However, a participant warned that *“The problem is that customers don’t understand that at that level.”* Indeed, there was a strong consensus on the fact that there is not much awareness of green building standards among homebuyers. Respondents felt that they needed more information from their suppliers when designing green homes. None of them has ever heard of FSC-certified lumber.

The labor market for construction trades in Gary did not appear as a major issue for homebuilders. Builders somewhat expressed that homebuyers are more demanding in these difficult times. As such, products that help reduced maintenance, callbacks, and, of course, costs were demanded. Indeed, price sensitivity has been increased by the downturn.

Denver

The session in Denver took place on January 28, 2010. A local prodealer participated with two of its managers, and four builders attended. These builders covered a broad range of the local housing activity. One came from the homebuilding division of a land developer. This division typically builds single- and multi-family homes, but is getting increasingly into 55+ type of housing. Another came from a national builder (11 divisions nationally, down from 21) whose only product is rental units. This builder has a project where he produced 2,500 units in the past two years, but projects are typically in the range of 350-450 units. The third builder was a high-end custom home builder with products in the 1 to 2 million dollar price point with an average of 24 homes per year. The fourth builder was a national builder (20 divisions nationally) with a focus on first-time and first move-up homebuyers. This company is moving away from multi-family homebuilding primarily for litigation reasons. Over the years, law suits were too frequent and costly for this company in the multi-family segment.

According to participants, most of the Denver market is a slab-on-grade market. In basement applications, there are reportedly some steel joists being used. In smaller homes, the national builder has returned to dimensional lumber and wood-based crawl space because of shorter spans and costs. When asked: What do steel joists do better than I-Joists? Respondents summed up that mold and rot were a very important concern in the area. Especially, the soil in the area

poses construction challenges. Mold seems to be very acute in basements. In some instances, wood is sprayed with an antimicrobial. Questioned whether the use of slabs contributes to a decrease in sales of structural floor systems, the prodealer stated that still, full basements with a slab are widespread. Indeed, the main substitution in floors systems is the adoption of engineered-wood joists in place of dimensional lumber. There are quite a lot of open web floor trusses in the area, too. For multi-family construction, slab-on-grade dominates, however.

Participants either stick frame or panelize their wall structures. Especially, the larger builder solely relies on prefab panels. There is an interest for more engineered solutions in wall framing as expressed by the high-end custom home builder: *“We started a shift towards engineered lumber, like, anything right now, anything over 20 feet in height, we’re going with timberstrand, which is kind of a recent change. If timberstrand was cheaper than dimensional lumber, we would use as much engineered lumber as we could, even for framing. There is less work, and less callbacks. In floors, dimensional lumber just twists.”* Generally, steel studs were not seen as a performing substitute for lumber, except in larger, multi-family buildings, where they have an important market share.

For sheathing, participants were all using OSB. Most were prone to try alternative products, but have faced supplier issues with these. As a result: *“The OSB is just a consistent product.”* Participants discussed a new OSB system, which was seen as an interesting product, having a vapour-barrier, seal finish on one side. However, they were concerned about the possible cost. Plywood was not used mostly because of costs. On sheathing issues, all respondents offered a resounding yes when asked: *“So you are open to new products like an OSB offered with either a barrier or even at some point with insulation?”* Products like SIPs, but single sided, are also gaining awareness and interest. None of the participants has ever heard of wood-based insulation, but all were definitely interested in knowing more about such products. Builders are concerned about energy performance, but not as much as they are about leakage. To sum up: *“The biggest thing we find in Colorado is the water proof integrity of the insulation and the shell.”*

Builders at the session are mostly using composite decking products and, to a lesser extent, redwood. Redwood was not seen as very expensive, because it competes with composite decking. However, builders agreed that: *“(Redwood) is getting really harder around here to find.”* All builders noted that they, much more so than the homebuyers, are responsible for specifying the decking material. Not surprisingly, low maintenance is paramount for builders and homebuyers alike. In general, builders also see composite decking as a source of much fewer callbacks than other products. The prodealer added that the Denver market is a very high UV area. The dealer then carries various composite products because its customers have different national programs with certain manufacturers. Redwood (*sequoia sempervirens*) is bought from another lumber distribution yard.

Most of the stud market in Denver is hem-fir or Douglas fir, KD. While coastal studs were seen as more problematic, FJ lumber has been used and much appreciated by build-

ers in the region, according to the prodealer. The current issues with FJ lumber appear to be price and availability. However, FJ lumber was thought to prevent recalls much better than solid-sawn lumber.

Builders felt that homebuyers were interested in green building but would not be even close to paying for it. A willingness to pay for energy efficiency was more likely, at least for a small proportion of homebuyers. Nevertheless, most energy-efficiency extra features do not sell to more than a couple of percent of homebuyers. Green certification schemes such as LEED and NAHB were seen as complicated to implement and manage: "...but their program just drove me crazy, and I know a bunch of other builders think so too." On energy performance, certification was seen as easier: "It's kind of a standard right now, which is fine with me. You know LEED; I've done some studies, and it's complicated, but we like to use Energy Star appliances, efficient water heaters, heat pump combos, you know we try to take the things that we're already doing and do them as well as we can." This was reinforced by the national builder: "We're close to offering energy performance guaranties. A hundred percent of our homes nationally are Energy Star. It's a big deal." The prodealer interestingly stated that, when selling materials to a commercial LEED project, the cost of FSC wood is prohibitive. In the end, he reckoned that customers "find a different way to get their LEED points rather than buying FSC wood, which costs as much as 30% more." According to a participant: "When the housing market returns, we'll have a large problem with the labor." Especially, there is a sense that the demand for prefab panels and floor decks will increase when the new housing starts increase.

Discussion

In floors systems, it is important to note that two of the three most important attributes (namely *durability* and *strength/structural integrity*) were said to be best achieved by concrete than wood overall. It is worth observing that northern areas such as Chicago, Philadelphia, New York, and Minneapolis favored concrete over wood for these two attributes. Potentially, these areas may be more prone to favor concrete over wood in floor systems. These results are supported by the intended increase in concrete use foreseen by respondents. While these results come at no surprise for the U.S. South, the areas of San Francisco, Los Angeles, Minneapolis, Philadelphia, and Washington all show future use of concrete in floors as being important. Results from the discussion sessions in Philadelphia and Chicago temper this conclusion, because concrete was not seen as an imminent substitute for wood framing by builders who attended the sessions.

If gains are to be made by wood (versus concrete) in the U.S. South, then the perception that wood does not comply well with building codes is a hurdle that must be overcome. This is especially acute in the areas of Austin, Dallas, Miami, Tampa, and Orlando. Product development and communication activities for wood products in floor systems may highlight *durability*, *strength/structural integrity*, and *acoustic performance* as the most important attributes to develop

and promote.

As noted in the methods section, the division between small and large builders was set at a volume of 40 homes per year. Generally, above this number, the volume of homes built by individual firms quickly escalates (Fell and Robichaud 2002). In the dataset, there were 148 homebuilders who completed 40 units or more. Interestingly, this segmentation is confirmed by the types of markets served by homebuilders. In the dataset, 144 homebuilders declared to serve either multiple markets in a region or multiple markets across the nation, thus being larger builders. In floors systems, large builders were found to be much more likely to use monolithic concrete slabs than were smaller builders. Large builders have used monolithic slabs for 52% of their units, and small builders, 30% ($\alpha = 0.05$). Full basements with wood floors accounted for 35% of units built by small builders, and 26% for large builders. In terms of structural products in floor systems, untreated lumber, wood I-joists, or wood floor trusses reached a market share of 62% among small builders, and 55% among large ones ($\alpha = 0.10$). In other words, larger builders are more likely to substitute concrete for wood. A conclusion that can be drawn is that the most important competitive substitute for wood currently is concrete. This means that strategies for developing wood use must focus on those attributes for which concrete performs the best. And when comparing wood with concrete in wall systems, concrete significantly outperforms wood on *durability*, *strength/structural integrity*, and *acoustic performance*. Two of these attributes (*durability* and *strength/structural integrity*) are among the top three most important attributes for homebuilders in walls.

In wall systems, no differences in the use of structural materials were found between large and small builders. The matter is very different for wall sheathing materials. All wood-based sheathings combined (untreated OSB, preservative- or mold-treated OSB, radiant barrier OSB, untreated plywood, treated plywood, and fiberboard) have a market share of 80% among large builders, and 91% among smaller ones ($\alpha = 0.05$). Foam and kraftboard, alone or in combination, have a market share of 5% among small builders, and 17% among large ones ($\alpha = 0.05$). In line with previous studies (e.g., Eastin et al. 2001, Fell and Robichaud 2002, Robichaud 2003), substitution for non-wood products is more likely to happen as builder size increases. These results provide an impetus for wood suppliers to monitor consolidation trends in the homebuilding industry.

Regionally, wood-based sheathing (OSB, plywood, and fiberboard) detain over 85% of the market in 17 of the 20 metro areas. However, foam and kraftboard sheathing (alone or in combination) have a market share of 10% or more in six areas: Detroit, Houston, Austin, Dallas, Phoenix, and Chicago. In Chicago, the market share of foam and kraftboard together even reaches 24%. With respect to sheathing, the performance of wood-based panels is significantly seen to be higher than that of competing materials. However, acoustics and energy performance in sheathing applications prove to be valuable paths for future product development.

Composite decking has captured at least 20% market share in 12 of 20 of the metro areas. Clearly, composite deck-

ing now offers the greatest competition to wood materials in decking applications. This is shown by the satisfaction measures of decking materials, which are significantly greater with tropical hardwood and composite/plastic lumber than with wood, treated or not. In the Denver area, there seems to be a paradox: while this area shows one of the greatest favorabilities to wood against steel and concrete in structural applications, it is also where the market share for composite decking is the greatest. The session in Denver confirmed that composite decking is much appreciated and specified by builders themselves. Elsewhere, the market share for composite decking is not as high, but maintenance and warranty issues were crucial for builders in all focus groups.

Decking materials are found both in new residential construction and in repair and remodeling. While this study focused on new residential construction, it is interesting to investigate where the construction of new homes is accompanied by decking materials purchases. Indeed, marketing practices are likely to vary between areas where decking materials are mostly consumed by homebuilders and those where they are mostly consumed by homeowners and remodelers. In this study, the percentage of new homes built with a deck was found (but not reported due to space constraints) above 60% in four areas: Seattle, Denver, New York, and Atlanta. It is important to observe that all these areas are also among the greatest markets for composite decking. Clearly, this indicates that homebuilders are very important specifiers of composite decking materials. While 27% of homes built by large homebuilders include a deck, this figure reaches 44% among small ones. The only significant differences for materials use by builder size are found for composite decking and treated lumber. The market share for treated lumber is 27% among small builders and 42% among large ones. On the opposite, composite decking is much more used by smaller homebuilders, where the market share reaches 29.5%, as opposed to 17% among large builders.

Most generally, builders interviewed for the discussion sessions expressed the need for new products addressing their concerns. In focus group sessions, labor issues came out as one of these concerns (except in Chicago). Especially, the current housing downturn has forced many trades out of the homebuilding sector, and most builders met fear that there will be a severe shortage of qualified labor once the housing market rebounds. Other issues concerning builders include a combination of insulation and structural properties for sheathing (confirmed by the quantitative research), low-maintenance and low-callback products, and ease of installation. From the discussion sessions, there is also room for new insulation products. While builders turn toward green construction at various degrees, energy efficiency appeared more important on their agenda. While much of the observations from the quantitative design were confirmed by the focus groups, some of them were not. For instance, the future use of concrete did not appear as strong in the focus groups as in the survey in Philadelphia. In the Chicago area, the use of non-structural and foam base wall sheathing was also less prevalent in the focus group than in the survey. This should not be surprising because focus groups are not meant to be statistically valid. However, these differences may also point

to possible biases in quantitative results.

Study Limitations

One of the most noticeable observations that could be made from this research is that wood is at threat of losing market share against concrete in floors and walls systems in northern areas of the U.S. such as New York, Minneapolis, Washington, and Philadelphia. However, discussion sessions did not confirm this trend. In the Southern U.S., this substitution would come less as a surprise for it has been highlighted in past research. As multi-family homebuilders typically rely more on concrete than their single-family counterpart, a possible bias might have come from an abnormal amount of multi-family homebuilders taking part in the survey. A comparison of materials use was then performed between homebuilders mostly involved in multi-family construction and those mostly involved in single-family construction. While multi-family homebuilders were found to rely slightly more (but significantly at an alpha level of 0.05) on steel, both types of builders were no different in wood and concrete use. However, the claim that wood is at threat elsewhere than in the U.S. South may be premature before the survey method is replicated within the same areas over time. As pointed out in the introduction to this paper, past studies have shown that the use of steel structurally in homebuilding has increased and then retreated.

Conclusion

The intent of this project was to funnel down the market intelligence on wood products at the level of significant metro areas where housing starts are important. Special attention was given to the substitution of wood by competing materials, such as steel and concrete. To do so, the preferences of homebuilders in their building practices were unveiled in order to better explain why and where substitution may happen. In summary, wood is at threat in decking applications, where composite materials appear to suit better the most demanded attributes, including *durability*, *appearance*, and *longevity*. Substitution of wood by concrete in structural walls and floors is currently confined in the U.S. South, although concrete may well experience further inroads in other markets. Especially, the areas of Chicago, Philadelphia, New York, Washington, and Minneapolis are worth further investigation and follow-up with respect to concrete use in structural walls and floors. The most important attributes sought by concrete adopters in structural applications are *durability*, *strength/structural integrity*, and *acoustic performance*. For wood to remain a competitive alternative, these attributes should be guiding the development of future wood-based products and building systems. With respect to sheathing, the performance of wood-based panels is significantly higher than that of competing materials. However, acoustics and energy performance in sheathing applications prove to be valuable paths for product development. Generally, green labeling was not seen much as an important requirement. The quantitative data set was complemented with focus groups held in Philadelphia, Chicago, Phoenix, and Denver. These sessions helped characterize the specificities of these markets. Future work may further investigate which aspects of green labeling may come as more important to

homebuilders. Overall, the study of the top 20 U.S. markets for housing provided a detailed knowledge of the competitive position of wood against other materials. This work can form a baseline upon which future iterations will build for the monitoring of wood's competitive position.

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