C I N T R A F O R

**Working Paper**

**108**

# Material Substitution Trends in Residential Construction

# 1995, 1998, 2001 and 2004

**Indroneil Ganguly**

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**November 2007**

CINTRAFOR
Center for International Trade in Forest Products

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## Executive Summary

The United States residential construction industry, traditionally the largest end-use market for softwood lumber, has been undergoing a period of change for more than a decade. Builders' acceptance of substitute materials and new innovations has increased, providing a unique challenge to softwood lumber producers. In such a situation, understanding the ways in which residential builders specify and use softwood lumber and lumber substitutes is essential to the success of any softwood lumber manufacturer. The Center for International Trade in Forest Products (CINTRAFOR) completed its first study on material substitution in 1995 (CINTRAFOR Working Paper No. 57), providing a benchmark for softwood lumber use in structural applications in residential construction. This was followed by surveys looking at material use in 1998 (CINTRAFOR Working Paper No. 73) and 2001 (CINTRAFOR Working Paper No. 93). The current study, undertaken in 2005, represents the fourth in this series and is intended to describe the trends in material use and substitution in the residential construction industry in 2004. The 2005 survey also explores builders' awareness, usage and perceptions of certified softwood lumber and sets a baseline for tracking certified lumber usage in residential construction.

In 2004, single family construction accounted for over three-quarters of construction firms' revenue. The larger firms reported a high proportion of new single family housing than their smaller counterparts. Additionally, there appears to be a negative relationship between firm size and the amount of revenue generated from repair and remodel activities. These findings are consistent with previous survey findings. The 2005 survey also reveals that the larger firms are more involved in non-residential construction. Builders in the southwest region of the US reported significantly less involvement in the repair and remodeling sector and significantly more involvement in the non-residential sector. The share of single family construction reported by builders was found to be consistent across all regions.

A longitudinal analysis (from 1998 to 2004) of substitute material usage revealed that the largest changes occurred in the usage of glulam beams, LVL, steel framing, wood I-joists, open-web trusses, and structural insulated panels, with wood I-joists, LVL, steel framing and glulam beams recording significant decreases between 2001 and 2004. In contrast, structural insulated panels, panelized wall systems and open-web trusses have experienced an increase in use since 2001. Survey respondents in the southeast and southwest regions of the country reported a steady increase in their usage of finger jointed lumber between 1998-2004. However, the usage of finger jointed lumber nationally was found to be constant over this period. The usage of glulam beams decreased substantially in the eastern US while remaining fairly constant in the western US. Nationally, glulam beams recorded the largest drop in reported use (12.6%). Use of wood I-joists declined across all regions, with the exception of the northwest, as solid wood joist prices moderated. In addition, use of Parallam ™ remained relatively constant between 1998 and 2004, whereas the use of TimberStrand™ lumber increased in the western US while declining in the eastern US. The use of non-wood material substitutes (steel framing and reinforced concrete) generally declined in the southern regions and increased in the northeast.

An analysis of material usage within specific end-use applications revealed that softwood lumber use has either increased or remained relatively constant in all applications with the singular exception of load bearing walls. For headers, wall framing and roof framing applications, softwood lumber remained the dominant material with a market share of more than 70% in each application. For floor framing, the market is split between softwood lumber, wood I-joists and open-web trusses. However, it should be noted that for all structural applications, softwood lumber recorded the largest market share. The market share for softwood lumber increased in floor and roof framing applications, remained constant in header and non-load bearing wall applications and declined in load bearing wall applications. In wall framing applications, none of the substitute materials had a market share of more than 6% whereas softwood lumber (both solid sawn and finger-jointed studs) enjoyed a market share of approximately 88.3% and 80.9% in non-load bearing and load bearing wall applications, respectively. The usage of softwood lumber in floor framing increased from 39% in 2001 to 43% in 2004, making softwood lumber the primary material for floor joists. Significantly, the market share for wood I-joists in flooring applications (its major market) declined by almost 12%. The use of wood trusses for roof framing has experienced a steady increase since 1995, rising from a market share of 46% in 1995 to 53% in 2004.

Builders rated strength, straightness, lack of defects and the availability of softwood lumber as the most important attributes of softwood lumber; a result that has been consistent over the course of the four surveys. The importance ratings for two attributes, price and price stability, have begun to decline in importance. On a positive note, home builders consistently expressed higher satisfaction levels with all of the softwood lumber attributes in the 2005 survey. A review of the data shows that the respondents consistently recorded higher satisfaction levels for all the softwood lumber material attributes between 2001 and 2004. The 2005 survey also marks the first time that builders indicated satisfaction with two important softwood lumber quality attributes: lumber straightness and lack of defects. In all of the previous surveys, builders had consistently indicated dissatisfaction with both of these attributes. The fact that straightness and lack of defects are ranked as two of the most important lumber attributes, combined with the large increase in the satisfaction ratings for both of these attributes, suggests that builders have begun to view softwood lumber as a much better value over the past several years.

It appears that builders are becoming more conscious of the environment and that this is beginning to influence the types of materials specified by some builders. Unfortunately, builders are receiving mixed messages about the environmental performance of non-wood materials. The results of this survey suggest that builders perceptions of the environmental performance of non-wood materials improved slightly between 2001 and 2004 whereas it decreased substantially for wood-based structural materials. With the exception of SIP's, all of the substitute materials are considered to be more enviromentally friendly than softwood lumber. This result sugggests that it is important that the forest products industry in general, and softwood lumber manufacturers in particular, continue to educate builders about the environmental benefits of using wood relative to non-wood materials.

A new section of the 2005 survey considered home builders awareness and use of certified lumber. The results of the survey showed that only 40% of homebuilders indicated that they were aware of certified wood. On average, only about 14% of homebuilders indicated that they have used certified wood. Among the users of certified lumber, the average percentage of homes framed with certified lumber was approximately 50%. Almost 15% of the builders who have used certified wood reported that they framed all of their houses with certified lumber. Further, in considering builders' awareness and use of certified wood within individual states, the survey data suggest that awareness of certified wood was higher among builders located in the eastern US (42.7%) and along the west coast (45.2%) than in the central US (32.2%). However, among those builders who were aware of certified wood, the percentage of builders who reported using it was much higher on the west coast (50%) than in either the eastern US (29.2%) or the central US (38.1%). Previous research has shown that the willingness of customers to pay higher prices for certified wood plays a major role in the usage of certified lumber. This research shows that only 17% of the respondents in the eastern states and 29% of the respondents in the central states believe that their customers would be willing to pay higher prices for homes built using certified wood products. The percentage for respondents in the west coast states was higher at 50%. These survey results suggest that the awareness and usage of environmentally certified wood among builders is much higher on the west coast relative to the rest of the country.

The survey results suggest that in the future large home builders may well lead the effort to increase the use of certified wood in building homes. This observation is based on the fact that 67% of large builders have heard of certified wood (this represents the largest segment for this question), 43% have used certified wood to build homes (this is the second largest segment for this question), 50% think that their customers would be willing to pay a premium for a home built from certified wood (this represents the largest segment for this question) and 75% expect that their use of certified wood will increase in the future (this represents the largest segment for this question). Further research is needed to understand home builders' motivation for using certified wood and to explore the relationship between the use of certified wood and regulatory factors (such as green building codes and efforts to improve the energy efficiency of residential homes).

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## 1.0 Introduction

Standard macroeconomic analysis often treats housing as either one of many consumer goods, or neglects it all together. Mainstream macroeconomics frequently underestimates the economic impact of the housing market (Leung 2003). However, residential housing has historically been the single largest market for softwood lumber in the United States. The revenue generated by the residential construction industry account for more than 50% of total construction revenue in the US (Plunkett 2003). Currently 42.9% of lumber consumption can be attributed to residential construction (WWPA 2006), while the repair and remodeling sector accounts for another 31.9% of lumber consumption. Residential builders are important players in these two markets, and are the subjects interviewed for this study.

The United States residential construction industry, traditionally the largest end-use market for softwood lumber, has been undergoing a period of change for more than a decade. The acceptance of substitute materials and new innovations has increased, providing a unique challenge to softwood lumber producers. In such a situation, understanding the ways in which residential builders specify and use softwood lumber and lumber substitutes is essential to the success of any softwood lumber manufacturer. The Center for International Trade in Forest Products (CINTRAFOR) completed its first study on material substitution in 1995 (CINTRAFOR Working Paper No. 57), providing a benchmark for softwood lumber use in structural applications in residential construction (Eastin, Simon & Shook 1996). In 1998, a second study by CINTRAFOR (CINTRAFOR Working Paper No. 73) found that softwood lumber was slowly losing market share to engineered wood products and non-wood substitutes (Fleishman, Eastin, & Shook 2000). The 1998 CINTRAFOR study also provided a benchmark for wood and non-wood material usage in residential decking applications (CINTRAFOR Working Paper No. 78). A third study conducted in 2001 by CINTRAFOR (CINTRAFOR Working Paper No. 93), found that the use of non-wood substitute materials had declined since the previous survey and in some areas softwood lumber seemed to be regaining favor with builders. The 2001 report also found that builder satisfaction with several attributes of softwood lumber had increased, particularly price and price volatility. The study undertaken in 2005 represents the fourth in this series and is intended to describe the trends in material substitution in the residential construction industry in 2004 to continue the trend analysis of material substitution in structural end-use applications in new homes. The 2005 survey also explores builders' awareness, usage and perceptions of certified softwood lumber and sets a baseline for tracking certified lumber usage in residential construction.

Following this introduction is a review of the literature on the residential construction industry and current substitution trends. Next the survey methodology and research objectives are defined and explained. The results section follows the format of the 1998 and 2001 study closely with the exception of the certified wood usage component of the study which has been added as a separate section in this report. While individual results are interpreted as they are introduced in the results section, the conclusion section will provide a summary of industry trends.

## 2.0 Literature Review

### 2.1 Residential Construction Industry: State of the US housing market

In the economics literature the impact of housing on the overall macro economy is seriously understated or ignored. Residential housing is treated as one of many consumer goods and the interaction between the housing market and the macro-economy is often ignored (Leung 2004). In the past, research on the housing industry has focused on the demand and financial aspects of the housing market (Blackley and Shepard 1996). While the demand, price, investment and neighborhood aspects of housing are important, it is equally important to understand the material supply aspect of the housing industry (Blackley and Shepard 1996). In 2003, the residential construction industry's revenue exceeded $440 billion which was over half of the total construction revenue for the year (Plunkett 2003). In spite of being the largest construction sector in the country, the residential homebuilding industry is often accused of being slow to adopt new innovative products relative to other project-based industries (Taylor 2004). In part, this is because the residential homebuilding industry is highly decentralized.

Various economic factors strongly influence housing starts in the US. One of the major drivers of the housing market is mortgage interest rates. In Figure 2.1, monthly mortgage rates and housing starts are graphed from April 1971 to June 2006. From the figure it can be observed that there is a strong inverse correlation between mortgage rates and housing starts.

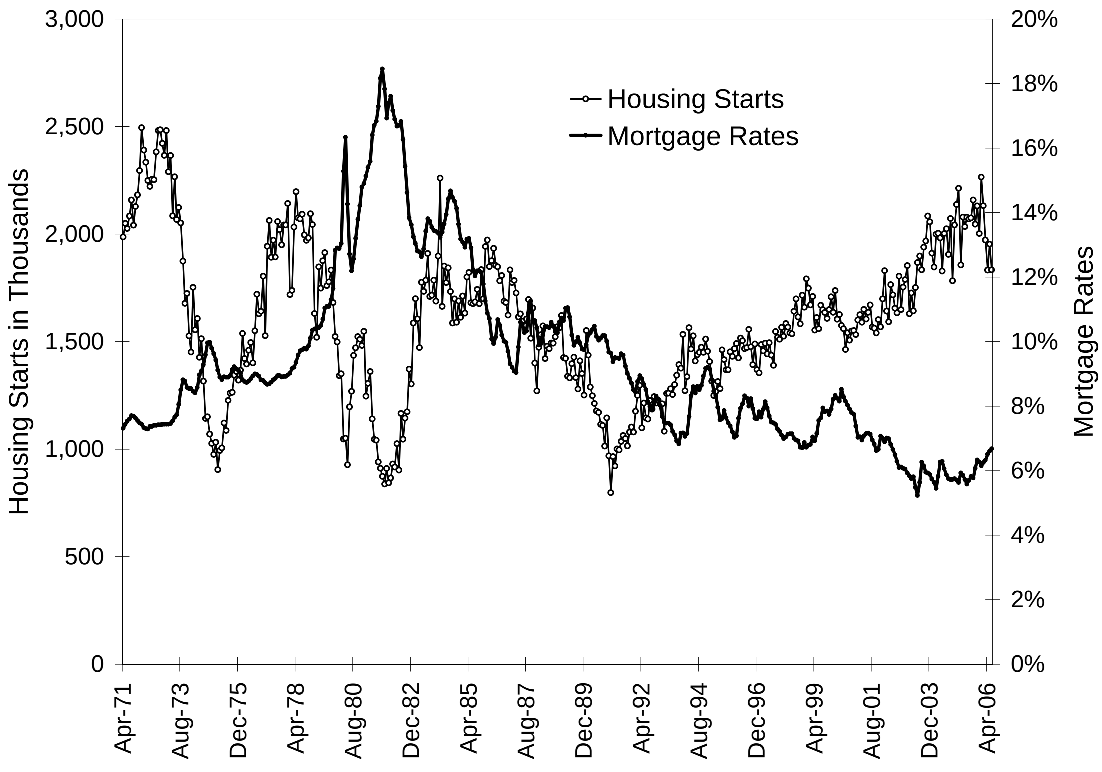


**Figure 2.1. Monthly Mortgage Rates and Housing Starts, 1971-2006**

Source: Financial Forecast Center, LLC

### 2.2 Repair and Remodeling

Large volumes of lumber and wood panel products are used annually in the repair and remodeling of residential structures and properties in the United States (McKeever et. al. 1993). From 1982 to 1987, the repair and remodeling market increased its share of lumber consumption from 20 to almost 30 percent, which corresponds to an increase from roughly 8 billion to 15 billion board feet of lumber consumed (Figure 2.2). Between 1987 and 2000, softwood lumber consumption in the repair and remodeling sector stabilized as new housing starts took off during a period of low mortgage rates and strong economic growth. Median housing prices increased quickly between 2000 and 2006, providing impetus to the repair and the remodeling sector as more homebuyers began purchasing older homes in need of renovation.

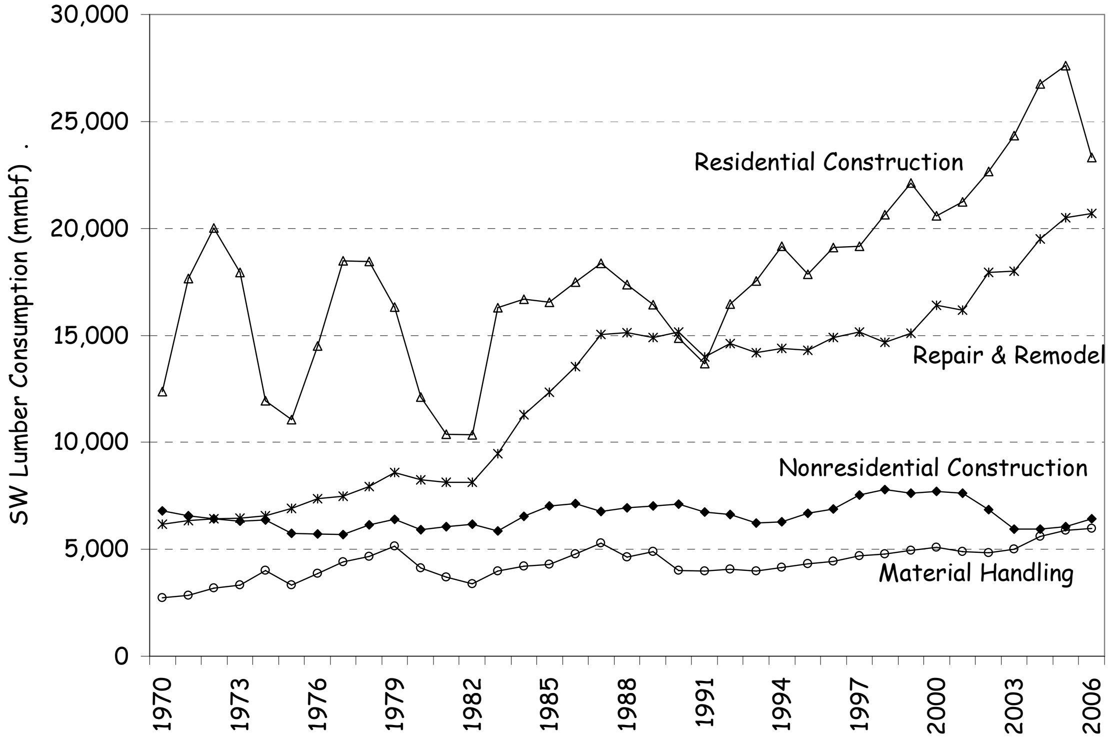


**Figure 2.2. Softwood Lumber Consumption by End-use, 1970 - 2006**

Source: WWPA, 2007

## 2.3 Price And Price Stability

Material substitution studies conducted by CINTRAFOR over the past decade have strongly suggested builder dissatisfaction regarding the price and price volatility of softwood lumber. Figure 2.3 shows that between 1985 and 2000 not only did the mean price of softwood lumber double, but the price volatility of softwood lumber also increased substantially. In Figure 2.3 a sharp increase in the average price can be observed in 1993, approximately three years after the implementation of spotted owl harvest restrictions in public and private forests in Washington and Oregon. The mean price of Douglas-fir and southern pine lumber recorded between 1985 and 1993 was $243 per MBF with a standard deviation of $30 per MBF. Between 1993 and 2006, the mean price of softwood lumber increased by 1.4 times to $333 per MBF, however the price volatility (as measured by the standard deviation) of softwood lumber increased by more than 2.8 times to $85 per MBF. This indicates that the price volatility of softwood lumber has increased at double the rate of lumber prices. In 2006 alone, the price of Douglas-fir lumber ranged between $245 and $425 per MBF and the price of southern pine ranged between $274 and $460 per MBF. A lower overall price and higher price stability would favor the use of softwood lumber because substitute products tend to be more expensive and more price stable than softwood lumber.

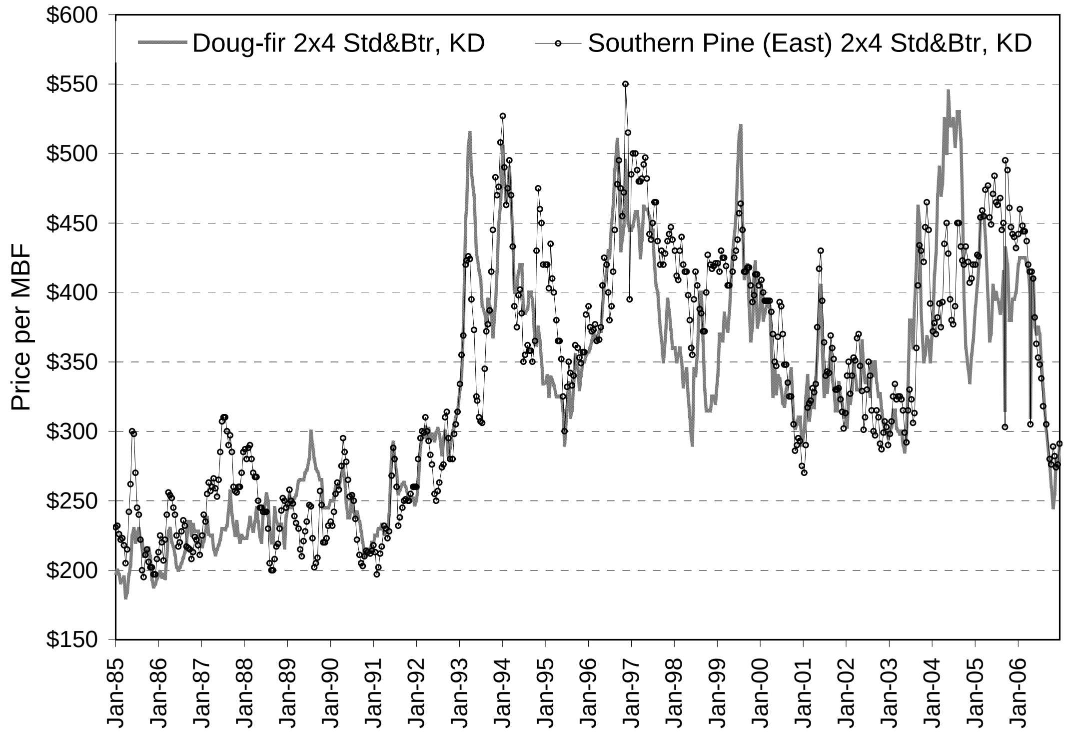


**Figure 2.3. Nominal Prices of Douglas-fir and Southern Pine 2X4 Std & Btr KD**
Source: Random Lengths, Various

## 2.4 Timber Quality

Many sources mention that timber products are coming from smaller diameter trees. Within the current regulatory environment, less timber is being harvested from mature natural forests. What is being harvested is younger, faster growing timber from second and third growth plantations. Youngquist (1999) predicted that "plantations will clearly play a role, and perhaps a dominant role, in providing future wood supplies" in the US. Martin et. al. (1997) pointed out that increasing pressures on the supply of timber have prompted timber companies to invest in more efficient recovery technologies while striving to achieve similar outputs using smaller sized timber inputs. Eastin et. al. (2000) provided an illustration of the timber industry's attempt to address its supply problem by adopting more efficient processing technologies.

Younger and faster growing trees generally produce lower quality lumber than that produced from old growth timber and builders have reported that they perceived a decrease in lumber quality in previous CINTRAFOR material use surveys (Eastin 2000), and with an increasing volume of softwood lumber coming from second-growth forests, this trend is likely to continue.

## 2.5 Green Building Programs

Respondents in both the 1995 and 1998 CINTRAFOR surveys reported that softwood lumber was less environmentally friendly than many non-wood substitute materials, including steel and concrete (Eastin et. al. 1996; Fleishman et. al. 1998). This perception is also held by many environmental non-governmental organizations (ENGO) and government programs created to promote environmentally friendly building technologies. These green building programs influence the perceptions of builders and should be carefully studied in order to better understand the reasons wood is not seen as an environmentally friendly building material.

Green or Sustainable Buildings incorporate the environment, the economy, and human aspects into the design and construction of a building. Green buildings are created from an integrated process where the site, the design, the construction, the materials, the operation, the maintenance, and the deconstruction of a building are all seen as having an effect on one another. As a result of this integrated process, it is thought that buildings can be made more environmentally friendly, more cost-effective, more resource efficient, while providing a healthier work and living environment. Green Building Programs are slowly but surely emerging across the US. These programs have been adopted to varying degrees across all levels of government, from the local level up through the federal level. Industry, trade and environmental organizations are also beginning to promote green building initiatives at a variety of levels. Most green building programs are designed or organized by guidelines, usually accompanied by a checklist or a point system. Typically, the guidelines are divided into sections such as energy use, water efficiency, materials, indoor air quality, construction waste and demolition.

### *2.5.1 Summary Observations on Green Building Programs*

Green building programs are becoming more common, a trend that is likely to continue. Several factors have been important in supporting the growth of green building programs. First, non-profit organizations and national non-governmental organizations have been actively working to create green building programs. Second, there are enough positive selling points, especially with the use of incentives, to successfully promote this type of building program to residential builders.

Another push for the growth of these programs is coming from government agencies at the city, county, state and federal levels. The public programs, particularly at the city level, differ from the private programs in the sense that they are increasingly becoming mandatory. At present, most mandatory programs are only applicable to publicly funded buildings and construction projects (i.e., parks and walkways). However, green building programs are relatively new and in many cases they are still in the trial period. If these trial programs are successful in the public sector, the program managers interviewed believe they will then be applied more widely to private commercial and residential buildings, most likely on a voluntary basis at first and becoming mandatory later, assuming the continued success of the programs.

Challenges and Opportunities for the Forest Products Industry

Perhaps the most important challenge confronting the wood products industry is the perception of wood, both by builders and program managers, related to how it is presented within the green building programs. There is still much confusion and hesitation towards promoting wood as a green building material on the part of many green building program managers. In order to promote wood as an environmentally friendly building material within these programs, the forest products industry must develop and implement a proactive strategy emphasizing that wood is renewable, recyclable and has low embodied energy. This message must be targeted to program managers responsible for developing and implementing green building programs.

The results of life-cycle analyses (e.g., the CORRIM and ATHENA projects) have firmly established wood as an environmentally sound construction material. However, many green building program managers were unfamiliar with these life-cycle projects or their results. In fact, several green building program managers interviewed suggested that they thought they would have to conduct their own analyses on building materials before they could include life cycle analysis (LCA) or life cycle inventory (LCI) in their green building programs. These results suggest that the forest products industry should proactively provide managers of green building programs with the results of LCA/LCI studies and analyses that have been completed.

Many green building programs consider the energy efficiency of building materials to a large extent. This emphasis is either because the green building program started as an energy conservation program or because the benefits of a green building program can be more readily measured and demonstrated through the energy savings derived from using specific materials or technologies. Given this emphasis on energy efficiency by many green building programs, the forest products industry should work to communicate the superior thermal characteristics of wood relative to alternative building materials (e.g., steel and concrete) to green building program managers.

### 2.6 Solid Lumber Environmental Performance

The Consortium for Research on Renewable Industrial materials (CORRIM) is a research group comprised of 15 research institutions that was assembled with the express objective of measuring the environmental performance of wood and non-wood building materials (Lippke et. al. 2004). The primary objective of the CORRIM study has been to perform a life cycle inventory and subsequent analysis of wood and non-wood light frame construction materials. The inventory covers all aspects of the production and use (from cradle to grave) of each product included in the study. The analysis included an assessment of the resource management, harvesting/extraction, processing, construction, use, maintenance, and disposal of each construction material.

The resulting database was used to compare houses built using wood framing with houses built using both steel and concrete construction systems. For the steel versus wood comparison, two identical houses were built in Minneapolis, MN and the results were analyzed. One house was built using wood framing while the other house used steel framing. For the concrete versus wood house comparison, two identical houses were built in Atlanta, GA and the results were analyzed. One house was built using wood framing while the other house was built using concrete. The results of both comparisons conclusively demonstrated that wood was the more environmentally friendly building material. Table 2.1 summarizes the results of these tests.

**Table 2.1. Environmental Performance Indices for Wood and Steel Buildings**

| **Minneapolis House** | **Wood frame** | **Steel frame** | **Steel vs. wood (% change)** |
|---|---|---|---|
| Embodied Energy (GJ) | 651 | 764 | 17% |
| Global Warming Potential ($CO_2$ | 37,047 | 46,826 | 26% |
| Air Emission Index (index scale) | 8,566 | 9,729 | 14% |
| Water Emission Index (index | 17 | 70 | 312% |
| Solid Waste (total kg) | 13,766 | 13,641 | -0.9% |
| **Atlanta House** | **Wood frame** | **Concrete** | **Concrete vs. wood (% change)** |
| Embodied Energy (GJ) | 398 | 461 | 16% |
| Global Warming Potential ($CO_2$ | 21,367 | 28,004 | 31% |
| Air Emission Index (index scale) | 4,893 | 6,007 | 23% |
| Water Emission Index (index | 7 | 7 | 0% |
| Solid Waste (total kg) | 7,442 | 11,269 | 51% |

Source: Lippke et. al. 2004

In order to simplify the comparison of the data, a variety of environmental outputs associated with each building material were aggregated into five environmental indices. These indices, derived by the ATHENA Institute, were used to compare the relative environmental impact of each type of building material. As an example, embodied energy represents the total amount of energy required to produce a particular product. In a life cycle inventory this value would represent all of the energy used in the extraction, manufacture, use and subsequent disposal of the building material.

To create a comparable index of greenhouse gasses emitted during processing or extraction of each material, a global warming potential was calculated. This index takes all gas emissions and calculated their respective carbon dioxide ($CO_2$) equivalent global warming potential.

The air and water pollution indices were created by estimating the actual amount of air and water pollution emissions and the subsequent volume of air or water that would be required to dilute these contaminants to acceptable levels.

Relative to steel, wood was shown to be superior in its environmental performance in every category except solid waste (Table 2.1). The comparison with concrete favored wood in every category (Table 2.2). It is important to note that all of the house structures analyzed use a substantial amount of common materials. For example, both homes built in Atlanta utilized a concrete foundation. Both houses in Minneapolis employed plywood sheathing. Because of these inherent similarities, the total differences between the houses were reduced somewhat. If the non-wood substitutes were directly compared to their wooden counterparts, the results would weigh more heavily in favor of wood.

The take away message from the CORRIM research is that wood outperforms both concrete and steel as an environmentally friendly construction material. However, many consumers and builders perceive the opposite to be true. This trend was first seen in the 1995 and 1998 CINTRAFOR surveys and was more pronounced in the 2001 survey.

## 2.7 Material Substitution

During a conference in 2000, the National Association of Home Builders noted that softwood lumber was twice as expensive as it was only 10 years prviously (Sichelman 2000). Though recent price data (Figure 2.3) shows that the price of softwood lumber has decreased recently, the price of softwood lumber is subject to a high degree of volatility. It is not surprising then, that many builders have been more open to the idea of substitution. Substitutes are truly gaining acceptance and market share in the residential building industry and that includes steel, concrete, and wood-plastic composites (Eastin et. al. 2000). The APA tracks the number of houses built using one of eight different construction systems, Table 2.2. Though stick built wood is the dominant building method, the 72% figure is a decline from the estimated 80% used in housing construction in 1997.

**Table 2.2 Estimated US Housing Starts by Building Method – 2001 in thousands**

| | Single Family | Multi-Family | Total | Percent |
|---|---|---|---|---|
| Stick-Built Wood | 912 | 245 | 1157 | 72% |
| Panelized Wood | 190 | 33 | 223 | 14% |
| Concrete | 110 | 40 | 150 | 9% |
| Steel Frame | 22 | 8 | 30 | 2% |
| Modular | 20 | 2 | 22 | 1% |
| SIP | 10 | 1 | 11 | 1% |
| Logs | 5 | | 5 | <1% |
| Post & Beam | 3 | | 3 | <1% |
| Other | 1 | 0 | 1 | <1% |
| **Total** | **1,273** | **329** | **1,602** | **100%** |

Source: APA, The Engineered Wood Assn., 2002

When considering the process of material substitution, the idea of new product adoption must be introduced. Innovations can be systemic[1] in nature, requiring simultaneous adoption by multiple firms or they can be incremental in nature where minor changes in the product are made. Researchers have indicated that the successful introduction of innovations depends on the systemic or incremental nature of the new product. The level of new product adoption and usage also depends on the nature of construction and company size. It is the small builders who are increasingly reliant on the repair/remodeling market rather than new construction and are more likely to rely on traditional building materials (softwood lumber). Before a customer will use a new innovative product there is a process that is followed to minimize risk and maximize the benefit of a given product. The products or innovations that are the most expensive or risky tend to take longer to adopt (Baker 1975). Also, there is a demographic profile of the companies or individuals most likely to adopt. The early adopters in the construction industry tend to be the largest companies and those with the most resources (Eastin et al 2000; Fell 1999). To understand why a given company or individual has chosen to adopt a substitute, it helps to look at some of the many models of adoption behavior. Eastin et al (1996) comment that, "the key to achieving a positive outcome during the adoption process is the effective design and implementation of a marketing strategy that makes potential customers aware of the new product and its benefits and persuades them to try the product." Understanding the attitudes of builders in the residential construction industry is key to achieving success in new product adoption. The successful products are those that have correctly identified a need gap and filled it without compromising performance.

### *2.7.1 Steel*

For almost as long as steel has been around it has competed with wood on some level. As early as 1890, it was viewed as an alternative to wood in railroad ties (Tratman 1890). In the early 1990's, the American Iron and Steel Institute projected that steel would claim 25 percent of the residential framing market by 1998 (Price-Robinson 2001). While that ambitious goal is unlikely to be achieved, steel framing saw some gains in the late 1990's. From the NAHB Research Center website, the number of houses using steel framing increased by 10% for single family homes and around 50% for multi family buildings to 38 and 21 thousand homes respectively. These are substantial gains with most of the gains coming in steel floor I-joist (~100% increase from last year). One of the selling points of the North American Steel Framing Alliance is that steel is better for the environment than wood. This claim is disingenuous at best and has been rebutted by several respected organizations, but it appears to have gained some credence with consumers (Price-Robinson 2001).

### *2.7.2 Other non-wood substitutes*

In 1999, over 120,000 houses were built using concrete (most often for basement walls), with about 20,000 using the insulated concrete form system (Sichelman 2000). This system combines concrete and insulation by stacking polystyrene forms in the desired shape and then filling them with concrete. While 20,000 homes represent just over 1 percent of total housing starts, compared to 0 just five years ago, there has been definite growth in this technology.

### *2.7.3 Engineered Wood Products*

Virtually all of the engineered wood products on the market experienced a rise in production and sales over the past 3 years with the exception of laminated veneer lumber (LVL). Acceptance and use of engineered wood products is on the rise due to the strong marketing efforts of APA-The Engineered Wood Association. The Composite Panel Association (CPA) and Composite Wood Council (CWC) have

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[1] "Systemic innovations requiring multiple companies to change in a coordinated fashion include recent advances in supply chain management, increasing use of enterprise resource planning, and the prefabrication of component systems". (Taylor 2004)

also played a role in increasing engineered wood products acceptance with a joint marketing effort (Anonymous 2001). With appearances on television shows and magazines, the CPA & CWC are promoting the environmentally friendly aspects of engineered wood products (Anonymous 2001).

#### *2.7.4 Structural Insulated Panels*

Structural insulated panels are a type of building system that replaces the traditional on-site 2x4 construction practice and requires substantially fewer studs. Simply put, SIPs are comprised of foam core sandwiched between two structural panels. The panels are usually OSB but can be plywood or gypsum board (Cathcart 1998). The foam core is normally made of expanded polystyrene (EPS) but can be one of several other foam composites (Cathcart 1998). The finished panels are installed as the wall of the house and replace many of the studs that would otherwise be used.

Structural insulated panel (SIP) usage in housing construction has been traced back to the 1950's when a student of Frank Lloyd Wright's built a house using structural insulated panels in Midland, Michigan (Cathcart 1998). As early as 1940, SIPs were used for limited applications such as curtain walls and short span roofs over timber frame construction (Tracy 2000).

Over the last decade, producers have reported steady growth and predict that growth will continue in the years to come (Tracy 2000). The main driver for the increased acceptance of SIPs is the reduced labor cost in construction. Labor is cited by many sources as the major cost associated with building a home. SIPs allow much of the labor to occur at the production facility and results in a shortened installation time for wall, floor or roof systems on the building site. As an example, a SIP wall system would only require workers to raise each section of the pre-manufactured wall, anchor it and move to the next piece. Another advantage of SIPs are lower energy costs for the homeowner. Although strict R-value tests have not shown a dramatic improvement over stick framing, the overall building envelope is generally conceded to be more energy efficient than an equivalent wood frame house (Tracy 2000).

The main disadvantage of SIPs is the higher cost. Recent research suggests that SIPs cost more than traditional framing. This high cost can be more than compensated for through labor cost savings and time savings. For example, the McDonalds restaurant chain decided that the use of SIPs in their new store construction program would shorten construction time by more than enough to offset any material cost premiums (Tracy 2000).

The Structural Insulated Panel Association (SIPA) conducted a survey of 61 companies in 2002 to estimate the production and usage of SIPs. They estimate that approximately 70 percent of SIPs produced were used in residential construction and the remainder was used in non-residential construction. In addition, the current estimate is that some 12,000 homes were built using SIPs in 2002. This compares with about 8,000 built in 1997 or a 50 percent increase over 5 years.

### 2.8 Environmentally Certified Wood

Environmentally certified wood indicates that the wood has been sourced from a sustainably managed forest. Environmental certification of wood is usually associated with eco-labeling and chain of custody, which are schemes used to promote and track wood procured from sustainably managed forests. The primary objective of environmental certification of wood is to encourage sustainable management of forests through a market based tool. The process of certification is based on specific tools used to authenticate the credence of the wood procurement process and its environmental aspects. Forest product certification is implemented through chain of custody and product markings. These are ways to communicate to customers and stakeholders that the wood is procured from forests which are managed according to the principles of sustainable forest management. Forest products certification is a market oriented voluntary program based on the belief that consumers are likely to prefer products offered by organizations committed to protecting the natural environment (Upton and Bass 1996). Forest certification is one of the results of a series of events dating back to the 1960s that aimed to address the degradation of natural resources. It was developed as an alternative to other actions from governmental and non-governmental institutions that did not have the expected results of reducing the depletion of forests (Natalia et al. 2003).

### *2.8.1 Market response towards environmentally certified wood*

Since the inception of forest products certification, the awareness regarding certified wood has increased among consumers (Ozanne 2003). However, this increased customer awareness has not translated into increased demand for certified wood products, as was initially expected by its proponents. Moreover, customers, scholars and environmental agencies continue to be skeptical regarding the effectiveness of certification programs in halting deforestation (Ozanne 2003; Gronroos 1999; Rametsteiner 2002). The trustworthiness of the various certifying agencies also varies among customers. Research reveals that the wood products industry is the least trusted entity while non-governmental environmental organizations are most trusted followed by independent third-party certifiers and the federal government (Ozanne 2003). Customers' willingness to pay a premium for certified wood is the key to these programs success. Studies reveal that when purchasing new homes or other wood products, customers prioritize price and other tangible aspects over the environmental aspects (Gronroos 1999; Rametsteiner 2002; Anderson et. al. 2002). At present there is not enough evidence to show a broad based demand for environmentally certified wood products among customers. However, researchers suggest that proper information dissemination regarding the certification programs will not only increase the demand for certified wood products, but convince customers to pay a price premium as well (Kozak et.al. 2004).

A study conducted in 2002 reveals that approximately 39% of the primary wood products companies in Canada and United States are chain of custody certified and an additional 12% plan to implement chain of custody programs over the next 5 years (Natalia et al. 2003). As customers are currently not willing to pay a premium for certified wood, many forest products companies demand non-market based incentives to offset the additional costs associated with certified products (Vlosky 1998). Moreover, only larger companies with backward integration are likely to successfully sustain demand for certified wood (Natalia et al. 2003). Finally, the general feeling among the wood products industry in the US is that certification is more critical for tropical forests than temperate forests (Vlosky 1998).

# 3.0 Methodology

## 3.1 Survey Design

A survey was used to collect primary data on structural lumber use and substitution in the homebuilding industry. The population surveyed for the project was US homebuilders. Based on the time constraints for the project and ensuring the adherence to developing a proper sampling frame, the sample size for the target population was established at 200 residential home builders. The geographic focus of the survey was the US, and measures were taken to ensure proportionate representation of homebuilders for all regions. In order to ensure that the sample was representative of the industry, a systematic random sampling was undertaken.

A telephone survey was selected as the most efficient way to collect data from homebuilders. A local market research company was chosen to conduct the telephone survey because of its experience in conducting telephone surveys for a wide variety of forest products companies and because its interviewers were familiar with the range of wood products included in the survey. The telephone survey was developed in line with previous CINTRAFOR surveys conducted in 1995, 1998 and 2001 in order to ensure compatibility of the data collected for proper longitudinal analysis. Some additions were made to the questionnaire to address contemporary issues. For example, awareness and usage of certified wood was included in the current study.

The sample frame for the target population was obtained from INFOUSA through a systematic random sampling based on the homebuilder SIC code. The sampling frame was designed in such a way that the number of surveys obtained from homebuilders in each state was proportional to the number of housing starts in that state in 2004, Table 3.1. The final sample size was 204 respondents.

Telephone surveys were conducted during the summer of 2005. Survey responses were marked on the survey by the interviewer along with any comments made by the respondents. A total of 244 eligible homebuilders were successfully interviewed. In order to ensure adherence to proper regional representation of the sample, 210 surveys were used for data analysis. The survey responses were then entered into a statistical database (SPSS version 13) for analysis.

**Table 3.1. Regional Sample Frame Summary**

| Western US | Housing Starts | % of US Starts | # of Respondents |
|---|---|---|---|
| **Northwest** | | | |
| Alaska | 3,003 | 0.17 | 1 |
| Iowa | 14,789 | 0.85 | 2 |
| Idaho | 13,488 | 0.77 | 2 |
| Minnesota | 38,977 | 2.23 | 4 |
| Montana | 3,574 | 0.20 | 1 |
| North Dakota | 3,265 | 0.19 | 1 |
| Nebraska | 9,278 | 0.53 | 1 |
| Oregon | 22,186 | 1.27 | 3 |
| South Dakota | 4,816 | 0.28 | 1 |
| Washington | 40,200 | 2.30 | 5 |
| Wyoming | 2,045 | 0.12 | 1 |
| California (North) | 95,744* | 5.48 | 11 |
| **Total Northwest** | **251,365** | **14** | **31** |
| **Southwest** | | | |
| Arkansas | 12,436 | 0.71 | 1 |
| Arizona | 66,031 | 3.78 | 8 |
| Colorado | 47,871 | 2.74 | 5 |
| Hawaii | 5,902 | 0.34 | 1 |
| Kansas | 12,983 | 0.74 | 1 |
| Missouri | 28,255 | 1.62 | 3 |
| New Mexico | 12,066 | 0.69 | 1 |
| Nevada | 35,615 | 2.04 | 4 |
| Oklahoma | 12,979 | 0.74 | 1 |
| Texas | 165,027 | 9.44 | 19 |
| Utah | 19327 | 1.11 | 2 |
| California (South) | 63829* | 3.65 | 8 |
| **Total Southwest** | **482,321** | **28** | **56** |
| *Total Western US* | *733,686* | *42* | *87* |

| Eastern US | Housing Starts | % of US Starts | # of Respondents |
|---|---|---|---|
| **Northeast** | | | |
| Connecticut | 9,731 | 0.56 | 1 |
| Washington DC | 1,591 | 0.09 | 1 |
| Delaware | 6,331 | 0.36 | 1 |
| Illinois | 60,971 | 3.49 | 7 |
| Indiana | 39,596 | 2.27 | 5 |
| Massachussets | 17,465 | 1.00 | 2 |
| Maryland | 29,293 | 1.68 | 3 |
| Maine | 7,201 | 0.41 | 1 |
| Michigan | 49,968 | 2.86 | 6 |
| New Hampshire | 8,708 | 0.50 | 1 |
| New Jersey | 30,441 | 1.74 | 3 |
| New York | 49,149 | 2.81 | 6 |
| Ohio | 51,246 | 2.93 | 6 |
| Pennsylvania | 45,114 | 2.58 | 5 |
| Rhode Island | 2,848 | 0.16 | 1 |
| Vermont | 3,072 | 0.18 | 1 |
| Wisconsin | 38,208 | 2.19 | 4 |
| West Virginia | 4,890 | 0.28 | 1 |
| **Total Northeast** | **455,823** | **26** | **54** |
| **Southeast** | | | |
| Alabama | 18,403 | 1.05 | 2 |
| Florida | 185,431 | 10.61 | 20 |
| Georgia | 97,523 | 5.58 | 11 |
| Kentucky | 19,459 | 1.11 | 2 |
| Louisiana | 18,425 | 1.05 | 2 |
| Mississippi | 11,276 | 0.65 | 1 |
| North Carolina | 79,824 | 4.57 | 9 |
| South Carolina | 34,104 | 1.95 | 4 |
| Tennessee | 34,273 | 1.96 | 4 |
| Virginia | 59,445 | 3.40 | 7 |
| **Total Southeast** | **558,163** | **32** | **63** |
| *Total Eastern US* | *1,013,986* | *58* | *117* |

* rough estimate for northern and southern California obtained using California housing starts data
*(Based on 2004 housing starts)*

### 3.2 Regional Breakdown

The regions of the US are defined differently depending on the source of information. The US Census bureau segments the United States into four regions: northeast, midwest, south and west (Figure 3.1). A summary of the ratio of housing starts in each of these regions for each of the material substitution surveys is provided in Figure 3.3. According to the Census Bureau, the south is the leader in housing starts while the northeast represents the smallest segment of the market. In contrast, the CINTRAFOR material substitution surveys (2004, 2001, 1998 and 1995) segment the US into four slightly different regions: northeast, southeast, northwest, and southwest. The housing start ratios for each of these regions are substantially different from those in the US Census (Figure 3.3 and Figure 3.4). The major differences between the two methodologies are that Texas (the second largest state in terms of housing starts) was included in the southwest region in the CINTRAFOR report but is included in the southern region by the US Census. Also, the CINTRAFOR research did not have a Midwest region, instead splitting the states in this region between the northwest and northeast regions (Figure 3.2). The net effect was to equalize the southwest, southeast and northeastern region while leaving the northwest as the smallest region in terms of housing starts.

According to Figure 3.4, the northwest is substantially smaller in terms of housing starts while the rest of the regions are relatively similar. As observed in the census regions, the percentages represented by each region have remained fairly stable. Thus it is important to note the definitional differences between studies because virtually every market research institution uses slightly different regional definitions. These different methodologies cause some variation between the reports which makes direct comparisons difficult.

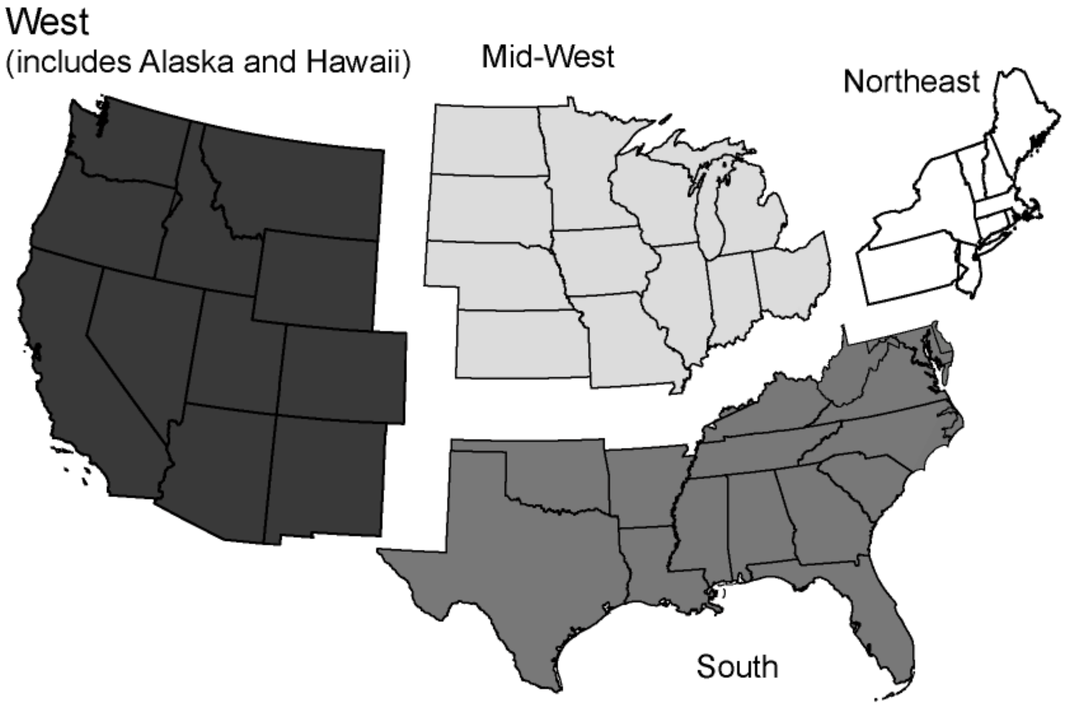


**Figure 3.1. Census Bureau Regional Breakdown of the US**

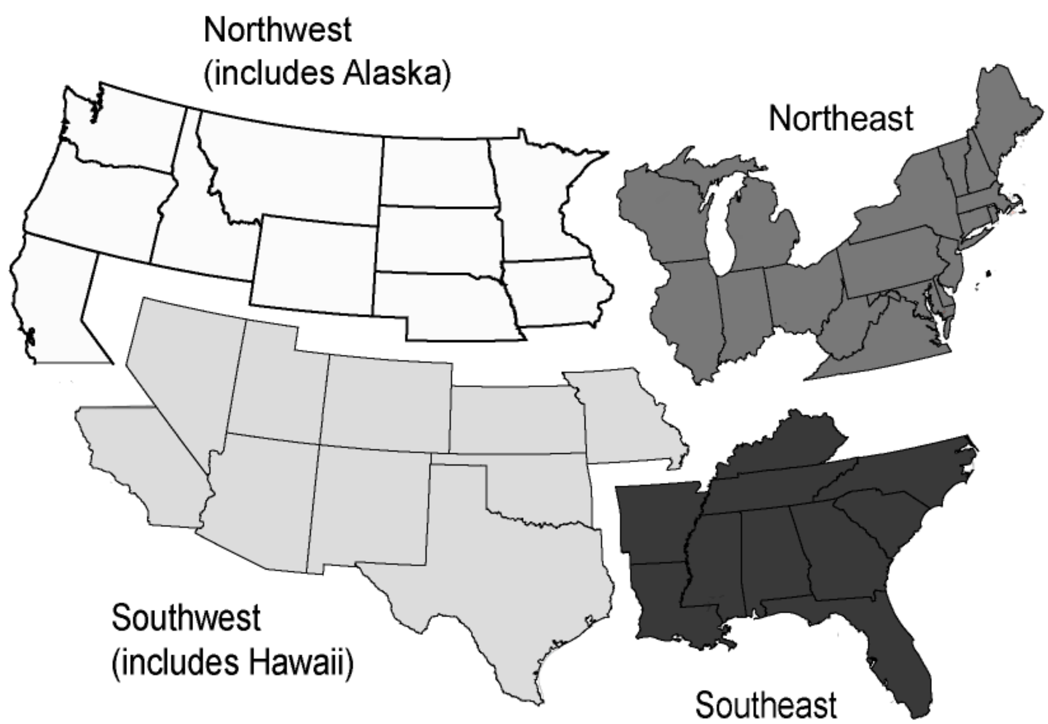


**Figure 3.2. CINTRAFOR Regional Breakdown of the US**

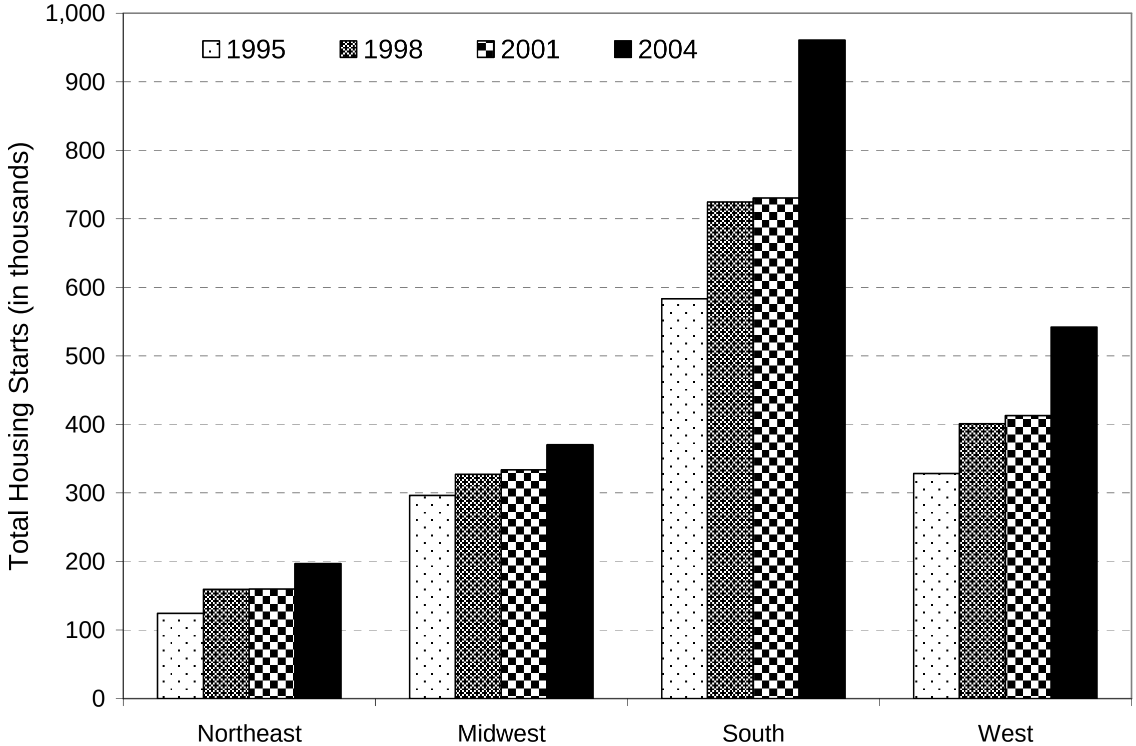


**Figure 3.3. Housing Market Share, by Region, using US Census Bureau Regional Definitions**

Source: US Census Bureau, 2006

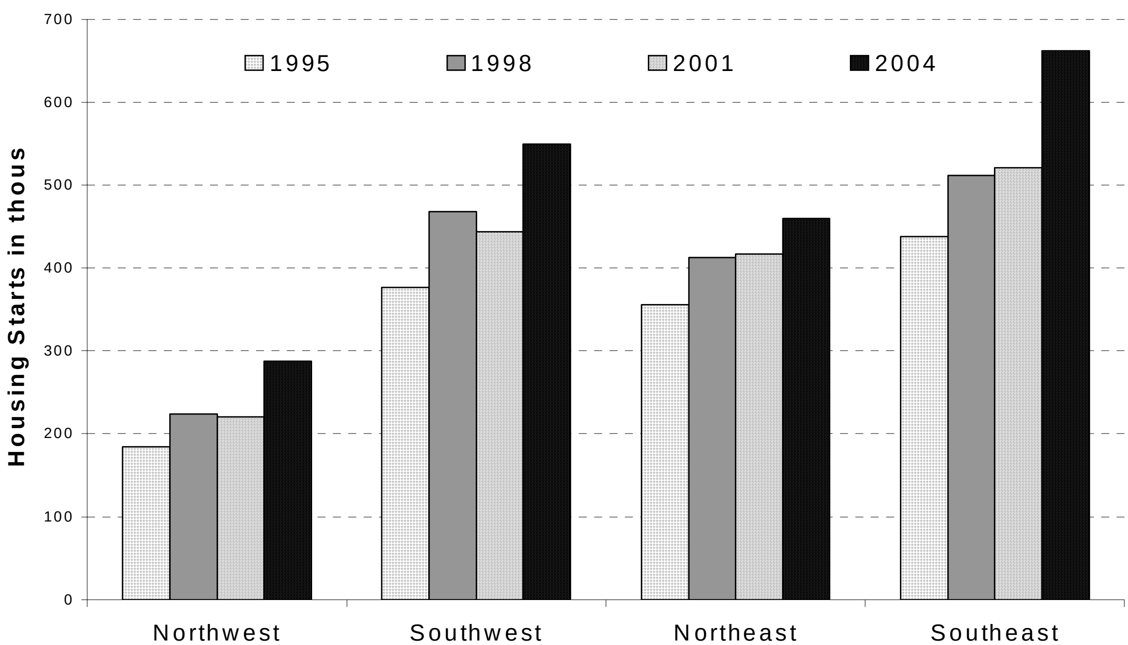


**Figure 3.4. Housing Market Share by Region using CINTRAFOR Regional Definitions**

## 4.0 Material Substitution Results

The 2005 survey was based on previous surveys so as to facilitate the comparison of the surveys. The reporting format of this paper is the same as that used for the 1998 and 2001 CINTRAFOR working papers (wherever possible) to facilitate comparisons between the three surveys. Some sections have been added incrementally to each of these surveys in order to address the dynamic nature of the market. Comparisons between the surveys has been limited to common sections. This report covers all the research questions addressed in the previous surveys while adding a new section regarding home builders awareness and usage of certified wood.

In this section of the report we will discuss the demographic profile of the respondents and compare this with previous surveys. The latter half of this section compares structural lumber and substitute material usage by builders in specific end-use applications. Finally we will analyze the attributes of the softwood lumber substitute materials. We evaluate the importance ratings for different material attributes, as well as builder satisfaction with the material attributes, to determine how the attribute ratings have changed over time.

### 4.1 Sample size

Unlike previous surveys, the data for the 2005 survey was collected using a telephone survey. Following is a table which compares the sample size for each of the material substitution surveys. The table also shows the percentage of builders who reported using at least one substitute product at the time of survey. A steady increase in the use of substitute materials can be observed between 1995 and 2004, with all of the respondents in 2005 indicating that they have used at least one softwood lumber substitute.

### 4.2 Regional Distribution

Each state was categorized into one of four geographic regions: northeast, northwest, southeast, and southwest. The percentage of respondents represented in each of these regions is summarized in Figure 4.1. Since previous surveys were administered via the mail, close adherence to housing start ratios was not possible. This explains some of the difference in the percentage of respondents located in each region in 2004 as compared to 1998 and 2001.

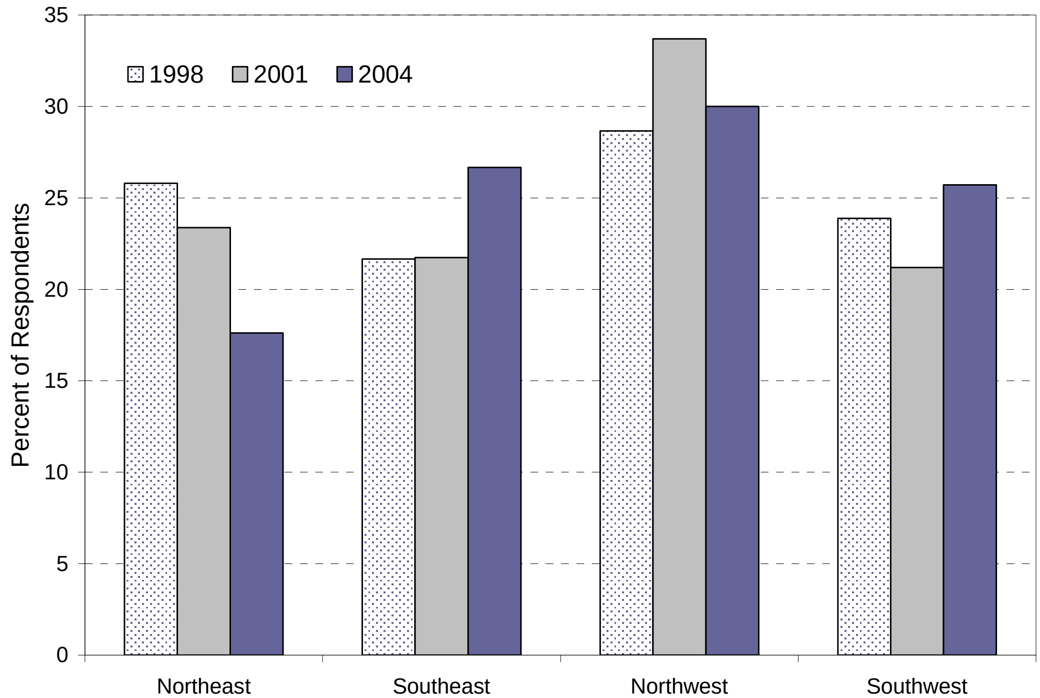


**Figure 4.1. Distribution of Respondents by Region**

### 4.3 Firm Size

In order to facilitate the longitudinal analysis, we have defined firm size exactly as in previous surveys. Firms were asked to indicate their total 2004 sales revenue. Respondents were then assigned to one of seven income categories. The difference in the respondent profile between surveys can be observed in figure 4.2. In 2004 a higher percentage of small firms (revenue less than $1 million) were interviewed.

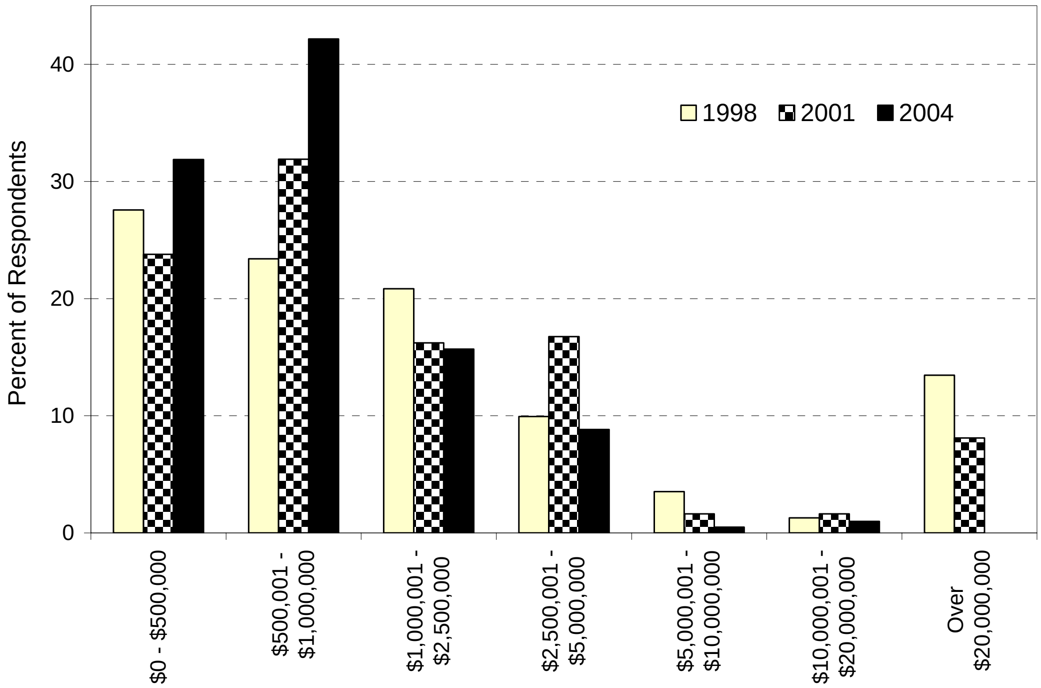


**Figure 4.2. Distribution of respondents by firm size**

To facilitate the analysis of the survey data, respondent firms were re-classified into three categories based on their reported sales revenue. Firms reporting sales revenue of less than $1 million were categorized as 'small firms', firms reporting yearly revenues between $1 million and $2.5 million were categorized as 'medium-size firms', and 'large firms' were defined as those that reported earning more than $2.5 million in annual sales revenue (Table 4.1). In the table we can observe that in 2004, 74% of the firms were categorized as small firms, whereas only 10.3% of the firms were categorized as large firms.

**Table 4.1: Classification of Respondent by Firm Size**

| | **1995** | | **1998** | | **2001** | | **2004** | |
|---|---|---|---|---|---|---|---|---|
| | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** | **Freq.** | **%** |
| Small | 58 | 33.5% | 159 | 56.4% | 103 | 60.6% | 151 | 74.0% |
| Medium | 69 | 39.9% | 107 | 37.9% | 30 | 17.6% | 32 | 15.7% |
| Large | 46 | 26.6% | 16 | 5.7% | 37 | 21.8% | 21 | 10.3% |
| **Total** | **173** | **100.0%** | **282** | **100.0%** | **170** | **100.0%** | **204** | **100%** |

Figure 4.3 shows the regional distribution of firms by firm size. It should be noted that 90% of the respondents from the southeast were small homebuilders whereas only 51% of the builders from the northwest were small builders. This is consistent with the results obtained from previous surveys where a higher proportion of builders in the southeast were classified as small builders as compared to other US regions. Of all the regions, the northwest had a significantly higher percentage of medium-size homebuilders. Large builders were also more prevalent in the western part of the country.

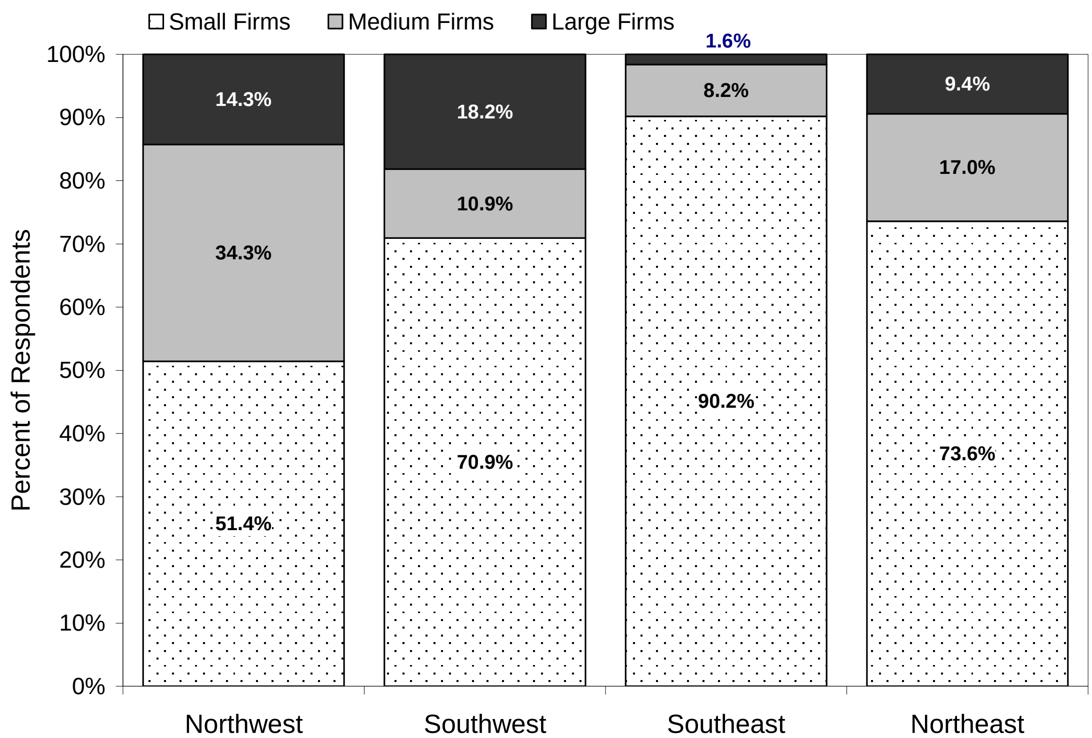


**Figure 4.3. Regional Distributions of Respondents by Firm Size**

**Table 4.2. Average Revenue Generated from Various Construction Activities**

| | 1995 | 1998 | 2001 | 2004 |
|---|---|---|---|---|
| Single family | 72.7% | 52.3% | 53.9% | 76.6% |
| Multi-family | 9.4% | 5.7% | 3.9% | 4.8% |
| Repair/Remodeling | 12.9% | 26.6% | 30.0% | 12.6% |
| Patio/Decks | 1.2% | 2.4% | 2.4% | 0.5% |
| Nonresidential | 3.2% | 11.1% | 8.3% | 4.8% |

## 4.4 Type of Construction Activity

Builders were asked to estimate the percentage of their company's sales revenue that was generated from different construction activities including new single family units, new multi-family units, repair and remodeling, patio and decks, and nonresidential projects (Table 4.2). When looking at the 2004 results, single family construction accounted for over three-quarters of construction firms' revenue. In 1998 and 2001, single family housing starts were reported to be 1.15 and 1.13 million units, respectively. In 2004, single family housing starts were reported to be 1.4 million units, an increase of almost 20% over 2001. This may have resulted in firms deriving a higher percentage of their annual revenues from construction of single family housing relative to 1998 and 2001.

### *Regional distribution*

There are few statistically significant differences in revenue earned from various construction activities between the different regions (Table 4.3). Builders in the southwestern part of United States reported significantly less revenue from repair and remodeling jobs and significantly more revenue derived from non-residential construction activities. Single family construction was found to be consistent across all the regions. Respondents from the southwest reported generating a marginally higher percentage of their income from multifamily housing. It should also be noted that very little patio and deck work is done by the homebuilders, even when housing starts are low.

### *Firm size*

Another important demographic factor of the respondents is firm size. The results indicate that larger firms reported a higher proportion of new single family housing than did their smaller counterparts. Also, there appears to be a negative relationship between firm size and the amount of revenue generated from repair and remodel activities. These findings are consistent with the 2001 survey findings. The 2005 survey also reveals that the larger firms are more involved in nonresidential construction.

**Table 4.3. Type of Construction Activity by Region**

| | Northwest | Southwest | Southeast | Northeast |
|---|---|---|---|---|
| Single family | 77.5% | 76.1% | 79.8% | 72.9% |
| Multi-family | 3.5% | 7.2% | 3.0% | 5.5% |
| Repair/Remodeling | 14.2% | 5.1% | 14.7% | 16.8% |
| Patio/Decks | 1.1% | 0.5% | 0.0% | 0.6% |
| Nonresidential | 3.7% | 10.8% | 1.7% | 3.0% |

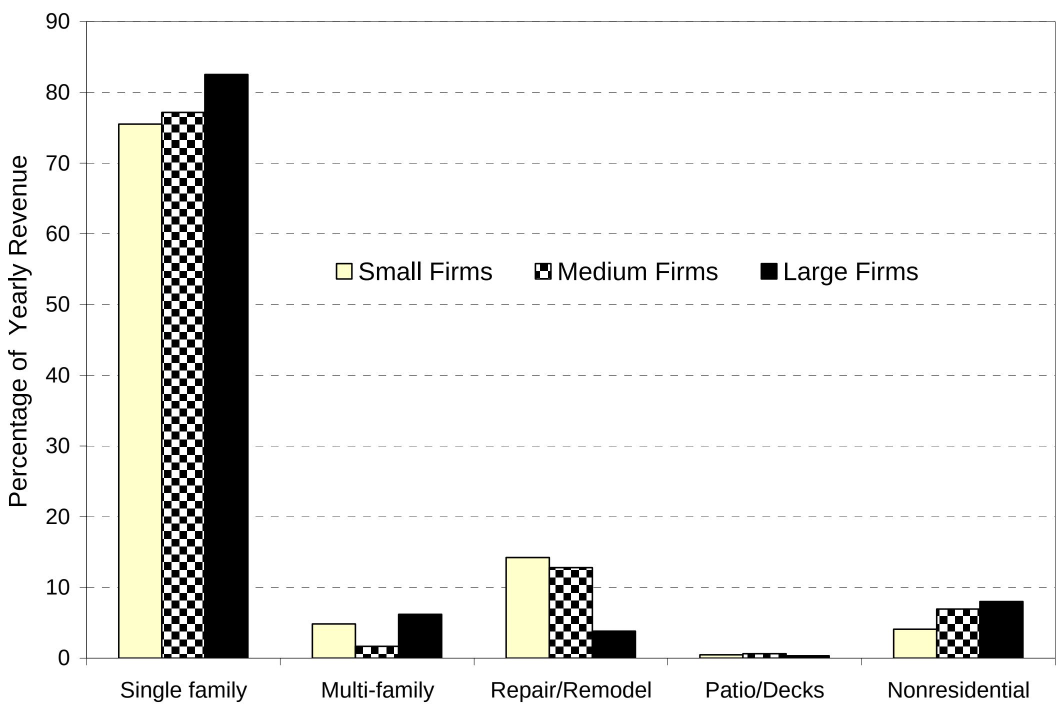


**Figure 4.4. Construction Activity by Firm Size**

**Table 4.4. Number of Respondents Using at Least One Substitute for Softwood Lumber**

| | 1995 | 1998 | 2001 | 2004 |
|---|---|---|---|---|
| Total Respondents | 176 | 284 | 189 | 210 |
| # reporting usage of substitutes | 161 | 281 | 188 | 210 |
| % who have used a substitute | 91.5% | 98.9% | 99.5% | 100.0% |
| % who have not used a substitute | 8.5% | 1.1% | 0.5% | 0.0% |

### 4.5 Use of Structural Materials

One of the primary objectives of this study was to evaluate the ongoing process of substitution between structural softwood lumber and alternative materials. To assess respondents' use of substitute materials, they were asked whether their usage of thirteen substitute materials had increased, decreased or remained the same over the past two years. None of the respondents indicated that they had never used any of the substitute products (Table 4.4). This compares to 0.5% of the 2001 survey respondents, 1.1% of the 1998 survey respondents and 8.5% in 1995.

Table 4.5 summarizes the percentage of respondents who have used each of the structural products included in the survey. TimberStrand lumber was not included in the 1995 survey and structural insulated panels were not included in the 1995 and 1998 surveys. To test the statistical significance of these changes, a t-test was performed to test the difference between the 2001 and 2004 data. The biggest changes were in the usage of glue laminated beams (glulam), steel framing, wood I-joists, open web trusses and structural insulated panels. Of all these substitute materials, wood I-joists, laminated veneer lumber (LVL), steel framing and glue laminated beams (glulam) experienced a significant decrease between 2001 and 2004. In contrast, structural insulated panels, panelized wall systems and open-web trusses experienced a significant increase since the 2001 survey.

**Table 4.5. Percentage of Respondents Reporting Usage of Each Substitute Product, 1995 – 2004**

| | Percent usage | | | | 2001-2004 |
|---|---|---|---|---|---|
| **Structural Product** | **1995** | **1998** | **2001** | **2004** | ***% Change*** |
| Reinforced concrete | 30.7% | 78.3% | 75.0% | 73.3% | -1.7% |
| Finger-jointed (FJ) studs | 19.3% | 28.5% | 36.2% | 35.7% | -0.5% |
| Glued laminated beams (Glulam) | 72.9% | 85.9% | 89.2% | 76.7% | -12.6*% |
| TimberStrand lumber | -- | 63.7% | 60.8% | 59.0% | -1.7% |
| Laminated Veneer Lumber (LVL) | 45.3% | 82.4% | 87.6% | 80.5% | -7.2*% |
| Parallam beams and headers | 41.1% | 70.7% | 70.1% | 70.5% | 0.4% |
| Structural insulated panels | -- | -- | 20.5% | 26.7% | 6.1*% |
| Steel framing | 28.6% | 42.8% | 47.8% | 40.5% | -7.4*% |
| Wood I-joists | 55.2% | 85.1% | 90.4% | 82.4% | -8.0*% |
| Panelized wall systems | 15.1% | 24.7% | 25.0% | 31.0% | 5.9% |
| Open web joists | 37.5% | 62.7% | 45.1% | 55.2% | 10.2*% |

*-- Data not available; * Significant at 0.05 level of significance*

***Regional distribution***

In order to explore the regional differences in the usage of substitute materials, Table 4.6 summarizes the material usage data by region. In the case of finger jointed lumber, the usage has remained more or less the same nationally. At the regional level, the respondents in the southeast and southwestern regions of the country reported a steady increase in their usage between 1998 and 2004. In the southeast, 12% more homebuilders reported using finger jointed lumber than in 2004 than in 2001. In contrast, almost 20% fewer homebuilders in the northwest reported using finger jointed lumber in 2004 from that reported in the 2001 study.

The usage of glulam beams decreased substantially in the eastern US while remaining fairly constant in the western US. Nationally, glulam beams recorded the largest drop in reported use (12.6%) of all the products included in the survey. Use of wood I-joists declined across all regions, with the exception of the northwest as solid wood joist prices moderated. In addition, use of Parallam remained relatively constant across all regions whereas the use of TimberStrand lumber increased substantially in the western US while declining in the eastern US.

The use of non-wood material substitutes (steel framing and reinforced concrete) generally declined in the southern region between 2001 and 2004. Steel framing use in these regions displayed a 10% drop in use. A similar decline for steel framing was reported in the northwest region, although reinforced concrete use increased substantially in this region. However, the use of non-wood substitute increased in the northeast region.

**Table 4.6. Percent of Firms Reporting Usage of Each Substitute Product by Region**

| Structural Product | Northwest | | | Southwest | | | Southeast | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 |
| Finger-jointed Lumber | 13.9% | 27.9% | 8.1% | 17.9% | 40.0% | 48.2% | 29.9% | 32.3% | 44.4% | 35.4% | 43.6% | 31.5% |
| Glue Laminated Beams | 81.4% | 79.1% | 81.1% | 78.6% | 87.5% | 85.7% | 91.7% | 90.3% | 76.2% | 92.4% | 87.2% | 64.8% |
| Laminated Veneer Lumber | 90.1% | 90.7% | 86.5% | 45.4% | 85.0% | 66.1% | 83.5% | 85.5% | 84.1% | 78.1% | 87.2% | 87.0% |
| Panelized Wall Systems | n/a | 23.3% | 29.7% | n/a | 25.0% | 30.4% | n/a | 27.4% | 27.0% | n/a | 20.5% | 37.0% |
| Parallam™ | 69.4% | 69.8% | 75.7% | 54.5% | 65.0% | 67.9% | 73.8% | 66.1% | 68.3% | 78.8% | 74.4% | 72.2% |
| Reinforced Concrete | 71.8% | 55.8% | 70.3% | 80.0% | 82.5% | 80.4% | 77.4% | 82.3% | 69.8% | 85.7% | 64.1% | 72.2% |
| Steel Framing | 45.1% | 41.9% | 29.7% | 38.2% | 52.5% | 42.9% | 35.7% | 50.0% | 38.1% | 58.1% | 41.0% | 48.1% |
| Structural Insulated Panels | 26.5% | 27.9% | 18.9% | 15.8% | 15.0% | 26.8% | 21.7% | 19.4% | 23.8% | 26.6% | 17.9% | 35.2% |
| TimberStrand™ | 53.8% | 53.5% | 81.1% | 47.2% | 45.0% | 55.4% | 74.4% | 64.5% | 49.2% | 67.2% | 71.8% | 59.3% |
| Wood I-Joists | 83.3% | 86.0% | 100.0% | 74.1% | 85.0% | 76.8% | 89.4% | 95.2% | 76.2% | 93.9% | 92.3% | 83.3% |
| Open web truss | 67.6% | 25.6% | 27.0% | 63.0% | 50.0% | 66.1% | 54.2% | 48.4% | 54.0% | 75.0% | 46.2% | 64.8% |

## 4.6 Number of Substitute Products Used

The substitution curves shown in Figure 4.5 indicate the cumulative frequency of the reported usage of substitute products by the survey respondents. It should be noted that the substitute material usage curves measure the range of substitute material diversification by homebuilders rather than the volume of substitute material usage. A rightward shift of the cumulative substitution curve indicates that the respondents have increased the number of substitute materials that they use. Such a rightward shift of the cumulative substitute usage curve can be observed between 1995 and 1998. Significantly, the shift from 1998 to 2001 was less dramatic. Between 2001 and 2004 the substitute material usage curve seems to have straightened, indicating that homebuilders have increased the number of substitute materials that they have used. In 2004, a higher proportion of homebuilders reported using less than 5 substitute products while at the same time a higher proportion of homebuilders also reported using more than 8 substitute products. Correspondingly, a lower proportion of respondents reported using between 6 & 9 substitute products in the 2005 survey. This result has multiple interpretations, one of which may be that some of the homebuilders have reduced their usage of substitute materials and have returned to a higher reliance on softwood lumber. This trend may reflect their increased satisfaction with the price and quality of softwood lumber. In contrast, another segment of homebuilders reported using more substitute materials.

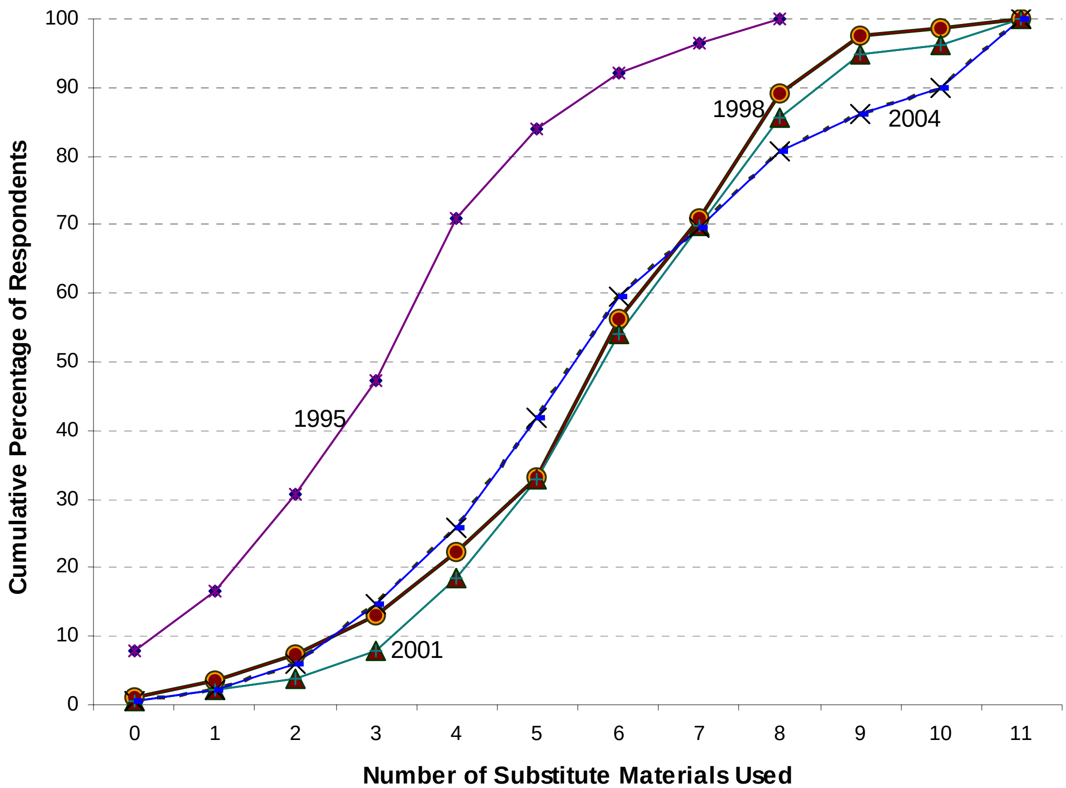


**Figure 4.5. Number of Substitute Products Used**

### 4.7 Change in Softwood Lumber substitute material Usage

Builders were asked to indicate whether their usage of each of the substitute materials had increased, decreased, or remained the same over the past two years. Each respondent also had the option to indicate that they had never used a particular product (Figure 4.6). Table 4.7 indicates the percentage of homebuilders who reported having used each substitute product.

In the 2001 survey, over 40% of the survey respondents reported that their use of LVL, wood I-joists, Parallam and Timberstrand lumber had increased while the percentage of respondents who reported that they had decreased their usage of these products was generally less than 5%. This result suggests a relatively high level of builder satisfaction with these products. However, in 2004 this type of increased usage was only observed for LVL and wood I-joists. From Figure 4.6 it appears that all the substitute products, with the exception of panelized wall systems, have experienced increased usage. The 2005 survey found that SIPS have the lowest level of market penetration followed by panelized wall systems, finger-jointed studs and steel framing, in that order. More than 75% of the respondents indicated some experience using wood I-joists, LVL and glulam beams.

Similar to 2001, the 2005 survey found that the highest proportion of homebuilders reported having used wood I-joists. However, the survey also found that the proportion of homebuilders reporting usage of wood I-joists, LVL, glulam beams and steel framing had decreased between 2001 and 2005. The proportion of homebuilders who reported using open web trusses, panelized wall systems and structural insulated panels increased substantially in the 2005 survey. Relative to the 2001 survey, 6% more homebuilders reported using panelized wall systems and structural insulated panels while 10% more homebuilders reported using open web joists in 2005.

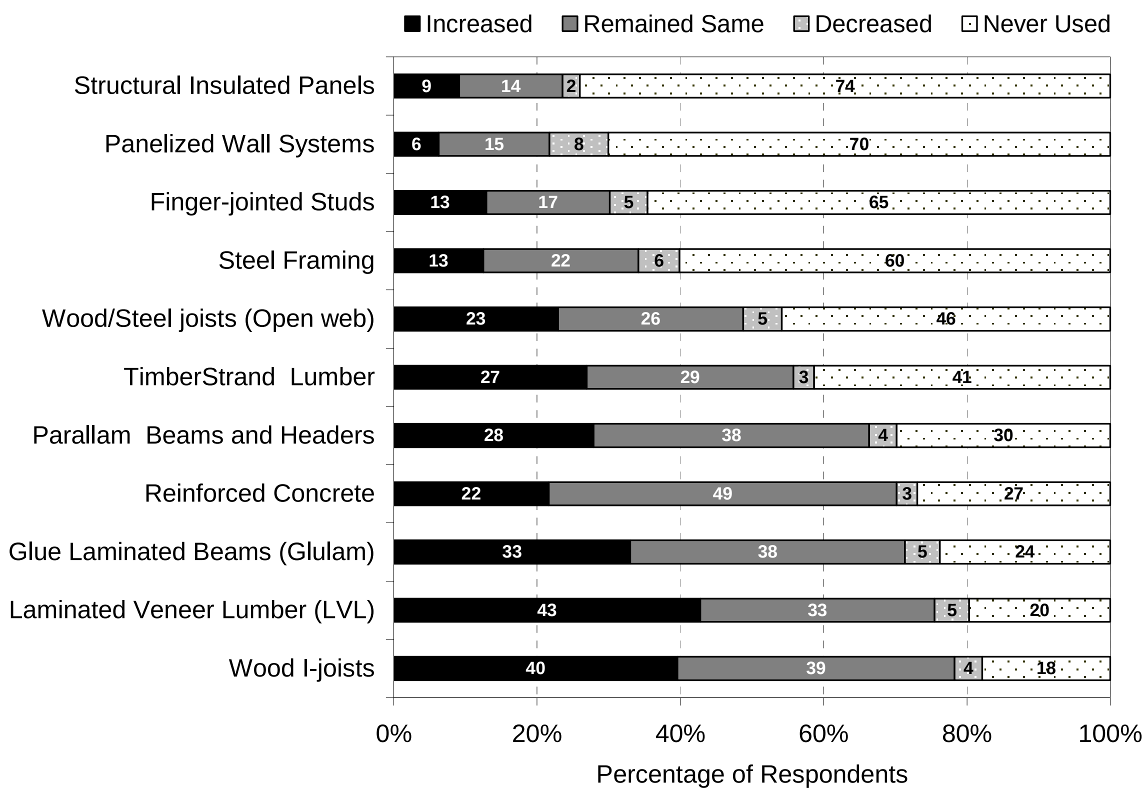


**Figure 4.6. Substitute Product Usage Change**

**Table 4.7. Percent of Builders Reporting Usage of Substitute Products**

| | Percent Usage | |
|---|---|---|
| | **2001** | **2004** |
| Wood I-Joists | 90.4% | 82.4% |
| LVL | 87.6% | 80.5% |
| Glulam | 88.7% | 76.7% |
| Concrete | 75.0% | 73.3% |
| Parallam™ | 70.1% | 70.5% |
| TimberStrand™ | 60.8% | 59.0% |
| Open web Truss | 45.1% | 55.2% |
| Steel Framing | 47.8% | 40.5% |
| Finger-jointed Lumber | 36.2% | 35.7% |
| Panelized Wall Systems | 25.0% | 31.0% |
| Structural Insulated Panels | 20.5% | 26.7% |

## 4.8 Material Use in Specific End-use Applications

Survey participants were asked to estimate the percentage of their material usage for specific end-use applications in 2004 (Table 4.8). The end-use applications included in the 2005 survey were sub-floors, roof framing, headers and wall framing (both load bearing and non-load bearing walls). In the 1998 survey wall framing was included as a single category and the non-load bearing and load bearing wall categories were broken out in the 2001 survey. Information on headers application was also introduced in the 2001 survey.

For all end-use applications, softwood lumber use either increased or remained more or less same with the exception of load bearing walls (Table 4.8). For headers, wall framing and roof truss applications, softwood lumber was the dominant material with a market share of more than 70% in each case. For floor joists, the market was split between softwood lumber, wood I-joists and wood floor trusses. However, it should be noted that for all end-use applications, softwood lumber had the largest market share.

The market share for softwood lumber increased in floor and roof framing applications, remained constant in header and non-load bearing wall end-uses and declined in load bearing walls. In contrast the market share for wood I-joists in flooring applications (its major market) declined by almost 12%. Similarly, steel framing saw its market share decline in every end-use application. LVL's market share declined by 7% in header applications (its major end-use) but doubled in load bearing wall applications.

**Table 4.8. Product Usage in Specific Framing Applications, 1995, 1998, 2001 and 2004.**

| End-Use Application | | | | | |
|---|---|---|---|---|---|
| **Floor Framing** | **1995** | **1998** | **2001** | **2004** | |
| Softwood lumber | 59.0% | 41.8% | 38.6% | 42.5% | ↑ |
| Wood I-joist | 23.0% | 38.8% | 43.2% | 31.5% | ↓ |
| Open web truss | 16.0% | 10.4% | 12.7% | 14.4% | ↑ |
| LVL | 0.0% | 3.0% | 2.3% | 2.1% | ↔ |
| Steel framing | 2.0% | 2.2% | 1.7% | 1.3% | ↓ |
| Finger-jointed stud | 0.0% | 0.3% | 0.3% | 0.7% | ↑ |
| **Roof Framing** | **1995** | **1998** | **2001** | **2004** | |
| Roof truss | 46.0% | 47.7% | 49.7% | 53.3% | ↑ |
| Softwood lumber | 51.0% | 40.0% | 40.9% | 43.9% | ↑ |
| Steel framing | 1.0% | 2.9% | 1.7% | 1.4% | ↓ |
| LVL | 0.0% | 2.7% | 2.7% | 1.1% | ↓ |
| Wood I-joist | 2.0% | 3.4% | 3.0% | 1.0% | ↓ |
| Finger-jointed stud | 0.0% | 1.3% | 0.1% | 0.1% | ↔ |
| **Headers** | | | **2001** | **2004** | |
| Softwood lumber | | | 71.9% | 72.0% | ↔ |
| LVL | | | 20.4% | 14.7% | ↓ |
| Open web truss | | | 1.6% | 2.8% | ↑ |
| Steel framing | | | 3.8% | 1.8% | ↓ |
| Wood I-joist | | | 1.2% | 1.5% | ↔ |
| Finger-jointed stud | | | 0.2% | 1.1% | ↑ |
| **Non-Load Bearing Wall Framing** | | | **2001** | **2004** | |
| Softwood lumber | | | 83.9% | 83.5% | ↔ |
| Finger-jointed stud | | | 5.5% | 4.8% | ↓ |
| Steel framing | | | 8.5% | 3.9% | ↓ |
| Open web truss | | | 0.8% | 2.8% | ↑ |
| LVL | | | 0.4% | 1.7% | ↑ |
| Wood I-joist | | | 0.4% | 1.1% | ↑ |
| **Load Bearing Wall Framing** | | | **2001** | **2004** | |
| Softwood lumber | | | 83.4% | 77.2% | ↓ |
| LVL | | | 2.7% | 5.5% | ↑ |
| Open web truss | | | 1.1% | 4.8% | ↑ |
| Steel framing | | | 6.6% | 3.9% | ↓ |
| Finger-jointed stud | | | 5.5% | 3.7% | ↓ |
| Wood I-joist | | | 0.4% | 1.2% | ↑ |

### *4.8.1 Wall Framing*

In wall framing applications, both load bearing and non-load bearing, none of the substitute products had a market share of more than 6% whereas softwood lumber (both solid sawn and finger-jointed studs) enjoyed a market share of approximately 88.3% and 80.9% in non-load bearing and load bearing applications, respectively. The usage of softwood lumber for non-load bearing walls remained constant between 2001 and 2004 whereas it declined by 8% in load bearing walls. Steel framing suffered substantial declines in both non-load bearing and load bearing wall applications.

**Table 4.9. Product usage in non-load bearing walls, by region.**

| Average | Northwest | Southwest | Southeast | Northeast |
|---|---|---|---|---|

| Non-load bearing walls | 2001 | 2004 | 2001 | 2004 | 2001 | 2004 | 2001 | 2004 |
|---|---|---|---|---|---|---|---|---|
| Softwood lumber | 81.2% | 93.8% | 81.0% | 80.1% | 89.3% | 77.7% | 82.3% | 86.1% |
| Open web truss | 2.8% | 0.0% | 0.0% | 3.3% | 0.2% | 3.5% | 0.8% | 3.7% |
| Finger-jointed stud | 7.6% | 0.0% | 2.5% | 11.1% | 4.2% | 5.2% | 8.5% | 1.1% |
| Wood I-joist | 0.2% | 1.4% | 0.5% | 0.5% | 0.2% | 1.7% | 0.8% | 0.9% |
| Laminated Veneer Lumber | 0.4% | 0.0% | 1.2% | 0.7% | 0.2% | 3.9% | 0.0% | 1.5% |
| Steel Framing | 6.5% | 0.0% | 14.8% | 2.1% | 5.2% | 7.7% | 7.7% | 4.5% |

### *Non-Load Bearing Walls*

In non-load bearing wall applications, softwood lumber maintained its market share at approximately 83%. Finger jointed studs more or less maintained their market share at around 5% in 2004. The market share of steel framing experienced a steep decline from 8.5% in 2001 to 3.9% in 2004. This is a continuation of the decline in market share that began in 1998. The use of wood trusses increased from 0.8% in 2001 to 2.8% in 2004.

Regarding the usage of specific structural materials in non-load bearing walls on a regional basis, the use of softwood lumber increased significantly in the northwest, jumping from 81.2% in 2001 to 93.8% in 2004, Table 4.9. In the other regions, the usage of softwood lumber decreased substantially in the southeast (dropping from 89% in 2001 to 78% in 2004) and increased modestly in the northeast. While the usage of steel framing experienced a decline in almost all of the regions of the country between 2001 and 2004 (with the exception of the southeast), the decline was greatest in the southwest with an almost 13% decline followed by the northwest, where none of the respondents reported using steel in non-load bearing walls. LVL use increased substantially in the southeast while the use of wood trusses increased to approximately 3.5% in all regions with the exception of the northwest. Whereas the overall market share for finger-jointed lumber declined only slightly in 2004, the use of finger-jointed lumber increased in the south (particularly the southwest) while its use was virtually discontinued in the northern US.

**Table 4.10. Product usage in load bearing walls, by region**

| | Northwest | | Southwest | | Southeast | | Northeast | |
|---|---|---|---|---|---|---|---|---|
| **Load bearing walls** | **2001** | **2004** | **2001** | **2004** | **2001** | **2004** | **2001** | **2004** |
| Softwood lumber | 77.3% | 93.8% | 73.8% | 69.4% | 90.2% | 71.4% | 85.9% | 79.8% |
| Open web truss | 5.2% | 0.0% | 0.3% | 7.0% | 0.2% | 7.4% | 0.8% | 3.4% |
| Finger-jointed stud | 6.1% | 0.0% | 4.0% | 7.2% | 4.0% | 4.6% | 8.5% | 1.8% |
| Wood I-joist | 0.2% | 1.4% | 0.5% | 0.3% | 0.2% | 1.8% | 0.8% | 1.5% |
| Laminated Veneer Lumber | 3.4% | 2.4% | 6.4% | 3.2% | 2.0% | 6.1% | 0.0% | 9.4% |
| Steel Framing | 4.5% | 2.3% | 8.5% | 5.3% | 2.6% | 3.4% | 4.1% | 4.1% |

Load Bearing Walls

In load bearing wall applications, the overall market share for softwood lumber decreased from 83% in 2001 to 77% in 2004, Table 4.8. A large increase in market share in the northwestern US was offset by substantial declines in market share in the other three regions, Table 4.10. Similar to the pattern observed in non-structural walls, the use of finger-jointed lumber declined in the northern regions and increased in the southern regions. The market share for laminated veneer lumber doubled between 2001 and 2004, largely due to strong gains in the eastern markets which more than offset market declines in the western regions. The usage of open-web trusses increased four-fold to reach a market share of 4.8% in 2004, with strong gains in all regions except for the northwest. The market share for steel framing dropped substantially in the western US and increased only slightly in the eastern US between 2001 and 2004.

### *4.8.2 Floor Framing*

The usage of softwood lumber in floor framing increased from 39% in 2001 to 43% in 2004, making softwood lumber the primary material for floor joists, Table 4.8. The market share for wood I-joists dropped from 43% in 2001 to 32% in 2004. Wood I-joist's usage in floor framing application had steadily increased between 1995 and 2001 before registering its decline in 2004. The market shares for the other substitute materials remained more or less constant between 2001 and 2004.

Despite strong gains in market share for softwood joists in the northeast and southwest, its market share declined in both the southeast and northwest, Table 4.11. The use of solid sawn joists is strongly regional with almost half of the market in the northeast and southwest, whereas its market share in the other regions is only about 30%. The use of wood I-joists declined significantly in both the northeast and southwest regions although they showed a strong gain in the southeast. Open web wood trusses have increased their share of the market, reaching 14.4% in 2004. The market share for open web trusses almost doubled in the western regions, and while open web truss use declined in the southeast is still totaled 21.6% of the market. The market share for steel joists declined in all regions except the northeast and its market share in all regions was below 2.5%.

**Table 4.11. Product usage in floor framing, by region.**

| Floor framing | Northwest | | | Southwest | | | Southeast | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 | 1998 | 2001 | 2004 |
| Softwood lumber | 29.4% | 35.9% | 29.2% | 35.5% | 30.8% | 45.3% | 45.9% | 44.2% | 32.1% | 58.7% | 39.6% | 59.7% |
| Wood I-joist | 55.9% | 51.0% | 47.4% | 44.7% | 56.7% | 21.1% | 22.2% | 20.9% | 33.3% | 26.1% | 43.3% | 29.4% |
| Open web truss | 8.3% | 7.9% | 14.0% | 10.5% | 8.4% | 15.5% | 14.0% | 28.7% | 21.6% | 10.1% | 10.0% | 5.8% |
| Finger-jointed stud | 0.6% | 0.2% | 0.0% | 0.0% | 0.5% | 0.6% | 0.0% | 0.0% | 2.0% | 0.5% | 0.8% | 0.1% |
| LVL | 3.1% | 2.4% | 2.8% | 5.7% | 0.5% | 1.2% | 1.1% | 2.2% | 2.5% | 1.9% | 4.0% | 2.3% |
| Steel framing | 1.3% | 1.0% | 0.1% | 0.5% | 3.0% | 2.3% | 7.1% | 1.9% | 0.3% | 0.8% | 1.6% | 2.3% |

### *4.8.3 Roof framing*

The use of wood trusses for roof framing has experienced a steady increase since 1995, rising from a market share of 46% in 1995 to 53% in 2004, Table 4.8. It is followed closely by softwood lumber with a market share of 43.9% in 2004. The roof framing market is basically split between these two products with insignificant (and declining) market shares for all other materials.

**Table 4.12. Product usage in roof framing, by region.**

| | Northwest | | | Southwest | | | Southeast | | | Northeast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Roof framing** | **1998** | **2001** | **2004** | **1998** | **2001** | **2004** | **1998** | **2001** | **2004** | **1998** | **2001** | **2004** |
| Softwood lumber | 29.1% | 39.2% | 24.2% | 40.4% | 47.9% | 48.5% | 46.0% | 38.4% | 40.7% | 48.0% | 38.2% | 56.3% |
| Wood truss | 57.4% | 54.1% | 69.0% | 43.1% | 44.5% | 42.2% | 42.0% | 54.3% | 53.1% | 44.4% | 48.3% | 36.4% |
| Finger-jointed stud | 1.3% | 0.2% | 0.0% | 2.5% | 0.1% | 0.2% | 1.7% | 0.0% | 0.0% | 0.0% | 0.2% | 0.2% |
| Wood I-joist | 5.1% | 3.5% | 1.4% | 4.7% | 3.7% | 0.2% | 2.4% | 1.4% | 1.5% | 1.1% | 3.3% | 1.2% |
| LVL | 2.7% | 1.8% | 0.9% | 5.6% | 0.6% | 0.1% | 0.9% | 0.7% | 2.1% | 1.6% | 3.1% | 1.1% |
| Steel framing | 2.8% | 0.5% | 0.0% | 3.3% | 3.1% | 3.4% | 5.4% | 2.2% | 0.0% | 0.7% | 1.7% | 1.9% |

Table 4.12 summarizes material usage in roof framing across the different regions. The northwest region displayed the highest level of truss usage with over two-thirds of all roofs being framed with wood trusses. Wood trusses were the dominant roofing system used in the northwest and southeast regions while rafters were the primary roofing technique used in the northeast and southwest. Steel usage has decreased steadily in the southeast and northwest since 1998 while remaining relatively constant in the other regions. However, the market share for steel in roof framing applications remained low, dropping from 2.9% in 1998 to 1.4% in 2004.

### *4.8.4 Headers*

The share of softwood lumber used in header applications exceeded 70% in 2004, remaining relatively stable since 2001, Table 4.8. The market share for LVL in header applications declined from 20% in 2001 to 15% in 2004. Though some LVL is used in wall, floor and roof framing, its largest end-use application is in header applications which often require the higher stiffness of LVL to bridge wide window, door and garage door openings.

**Table 4.13. Product usage for headers, by region.**

| | Northwest | | Southwest | | Southeast | | Northeast | |
|---|---|---|---|---|---|---|---|---|
| **Headers** | **2001** | **2004** | **2001** | **2004** | **2001** | **2004** | **2001** | **2004** |
| Softwood lumber | 72.8% | 73.9% | 74.7% | 65.9% | 70.9% | 77.1% | 68.1% | 71.5% |
| Wood truss | 1.0% | 3.5% | 1.8% | 3.9% | 0.0% | 1.8% | 3.2% | 2.4% |
| Finger-jointed stud | 0.1% | 0.0% | 0.0% | 4.2% | 0.5% | 0.0% | 0.2% | 0.0% |
| Wood I-joist | 1.2% | 0.0% | 0.9% | 2.0% | 0.0% | 1.8% | 2.0% | 1.9% |
| LVL | 22.5% | 13.8% | 17.2% | 10.7% | 19.6% | 15.7% | 22.7% | 18.2% |
| Steel framing | 1.5% | 0.0% | 3.8% | 3.5% | 9.0% | 0.0% | 2.6% | 3.0% |

Table 4.13 summarizes the regional market share for the different materials used for headers in the US. The data suggests that the use of softwood lumber has increased in the eastern regions while declining in the southwestern US. Usage of LVL for header applications declined substantially in all the regions between 2001 and 2004. The use of steel for headers remained low and declined substantially in the southeastern US where its market share dropped from 9% to 0% between 2001 and 2004.

## 4.9 Perceived Environmental Performance

Builders and home buyers perceptions of the environmental impacts of building materials can affect their use of different building materials. This study addressed the issue of the environment from two distinctly different perspectives. First, and similar to previous CINTRAFOR material substitution surveys, this survey assessed builders perceptions of the environmental impacts associated with the use of each substitute material relative to softwood lumber. The 2005 survey also explored builders' awareness and use of certified softwood lumber. This new component of the survey is discussed in chapter 5 of this report.

In order to evaluate the perceived environmental impacts of each substitute material, survey respondents were asked to compare the environmental impact of each substitute material relative to softwood lumber using a 7-point Likert-like scale (where a rating of 1 meant that the substitute material is less environmentally friendly than softwood lumber, a rating of 4 means that the substitute material and softwood lumber have similar environmental impacts and a rating of 7 means that the substitute material is more environmentally friendly than softwood lumber). Table 4.14 summarizes the average environmental ratings for all of the surveys in order to display the longitudinal trends in builders perceptions. In comparing the results from the various surveys, it is clear that the environmental ratings for all of the wood based substitute materials decreased substantially in 2004. In the case of the non-wood substitute materials (concrete blocks, reinforced concrete and steel framing), the environmental ratings improved slightly between 2001 and 2004.

An average environmental rating above 4 indicates that builders perceive that the substitute material has less of an environmental impact than softwood lumber. The survey results clearly suggest that builders perceive that all of the building materials are environmentally superior to softwood lumber. That said, the changes in environmental ratings between 2001 and 2004 suggest that there is less of a gap in the perceived environmental performance of the substitute materials relative to softwood lumber (Figure 4.7). Clearly builders still perceive softwood lumber as having a poor environmental image. However, the downward shift of the 2004 curve from that of 2001 indicates that the efforts to improve the environmental image of wood have been successful to some extent.

**Table 4.14. Perception of the Environmental Impact of Substitute Materials Relative to Softwood Lumber**

| Product | 1995 | 1998 | 2001 | 2004 |
|---|---|---|---|---|
| Concrete Blocks | 4.1 | 4.2 | 4.6 | 4.7 |
| Reinforced Concrete | 4.5 | 4.6 | 4.7 | 4.6 |
| Steel Framing | 3.8 | 3.8 | 4.4 | 4.5 |
| Finger-jointed Studs | 4.6 | 4.8 | 4.9 | 4.4 |
| Glulam | 4.9 | 5.1 | 5.3 | 4.9 |
| LVL | 5.0 | 5.4 | 5.6 | 4.8 |
| Parallam™ | 4.9 | 5.2 | 5.4 | 5.0 |
| SIP | 4.3 | 4.4 | 4.7 | 4.1 |
| TimberStrand™ | 4.9 | 5.3 | 5.4 | 4.8 |
| Wood I-Joists | 4.9 | 5.4 | 5.4 | 4.9 |
| Open web Trusses | 4.8 | 4.9 | 5.2 | 4.6 |
| WPC Lumber | 4.5 | 4.7 | 4.9 | 4.4 |

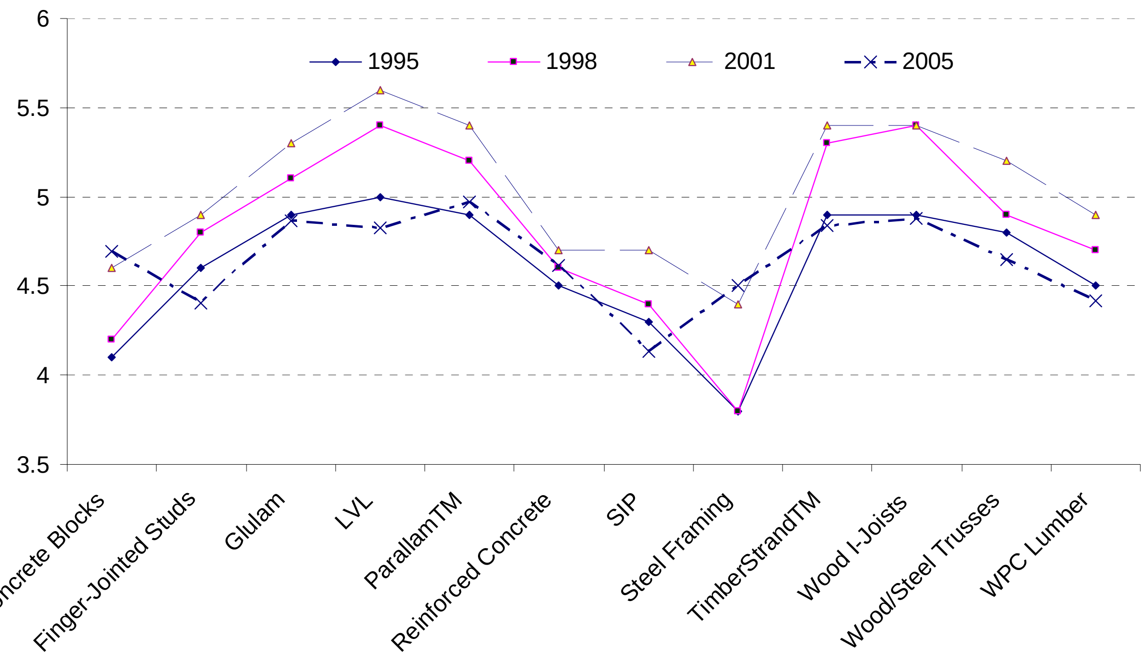


**Figure 4.7. Perceptions of Environmental Performance of Substitute Products Relative to Softwood Lumber**

## 4.10 Importance/Satisfaction Ratings for Softwood Lumber Attributes

In order to understand the factors that influence builders use and perceptions of softwood lumber, it is important to understand the relative importance that builders attach to the various material attributes. Moreover, it is equally important to understand homebuilders satisfaction (or dissatisfaction) with each attribute. A comparison of the importance and satisfaction ratings can provide useful insights into the factors that influence material substitution trends within the residential construction industry.

As in previous surveys, builders were asked to rate the importance of a broad range of structural softwood lumber attributes in influencing their material specification decision using a Likert-like scale (where a rating of 1 = not important at all, a rating of 4 = somewhat important and a rating of 7 = very important). The importance ratings indicate that over the past decade, strength, straightness, lack of defects and availability of softwood lumber have consistently been ranked as the most important material attributes, Table 4.15. Comparing the importance ratings over the four surveys suggests that the relative ranking of the attributes has remained consistent over time with only a few exceptions. The importance ratings for the price attributes (price and price stability), while still perceived to be highly important, have steadily declined over the four surveys. This may be due to the fact that builders have become less concerned about softwood lumber prices as prices have declined and become more stable since the late 1990's (Figure 2.3.). The importance rating for energy efficiency has steadily increased since the first survey. This increase may be a reflection of high energy costs in recent years and increasing awareness of green building codes. The fact that the importance ratings for most of the softwood lumber attributes have remained relatively consistent over the past 4 surveys suggests that builders continue to value the same mix of product attributes for structural lumber.

**Table 4.15. Average Softwood Lumber Importance Ratings**

| | 1995 | 1998 | 2001 | 2004 |
|---|---|---|---|---|
| Strength | 6.4 | 6.5 | 6.5 | 6.7 |
| Straightness | 6.4 | 6.6 | 6.5 | 6.5 |
| Lack of defects | 6.1 | 6.1 | 6.1 | 6.2 |
| Availability | 6.2 | 6.2 | 6.2 | 6.2 |
| Ease of use | 5.7 | 5.9 | 5.9 | 5.8 |
| Overall Price | 6.2 | 6.0 | 6.0 | 5.8 |
| Price Stability | 6.1 | 6.0 | 5.9 | 5.8 |
| Little product waste | n/a | 5.8 | 5.8 | 5.7 |
| Availability of Tech./Eng. support | 5.6 | 5.6 | 5.6 | 5.5 |
| Availability of Longer length | 5.7 | 5.8 | 5.9 | 5.5 |
| Energy Efficiency | 4.9 | 5.1 | 5.2 | 5.5 |
| Appearance | 5.0 | 5.3 | 5.3 | 5.1 |
| Red. Environmental Impact | 4.5 | 4.5 | 4.7 | 4.7 |

*n/a - Data not available*

**Table 4.16. Average Softwood Lumber Satisfaction Ratings**

| | 1995 | 1998 | 2001 | 2004 |
|---|---|---|---|---|
| Ease of use | n/a | 5.4 | 5.5 | 5.8 |
| Availability | 5 | 5.5 | 5.5 | 5.8 |
| Strength | 5 | 5.1 | 5 | 5.7 |
| Availability of Longer length | 4.1 | 4.5 | 4.7 | 5.1 |
| Availability of Tech./Eng. support | n/a | 4.5 | 4.7 | 5.1 |
| Appearance | n/a | 4.2 | 4.2 | 5.1 |
| Little product waste | n/a | 4.2 | 4.6 | 5.0 |
| Energy Efficiency | 4.1 | 4.5 | 4.7 | 5.0 |
| Overall Price | 3.3 | 4.5 | 4.8 | 4.9 |
| Straightness | 3.7 | 3.6 | 3.8 | 4.8 |
| Lack of defects | 3.5 | 3.5 | 3.7 | 4.7 |
| Price Stability | 2.7 | 4.2 | 4.5 | 4.7 |
| Reduced Environmental Impact | 4.1 | 4.1 | 4.4 | 4.6 |

*n/a - Data not available*

Similar to the importance ratings, survey respondents were asked to rate their level of satisfaction with each softwood lumber attribute using a 7 point Likert-like scale where a rating of 1 = not satisfied, a rating of 4 = somewhat satisfied and a rating of 7 = very satisfied). The satisfaction ratings for the softwood lumber attributes are summarized in Table 4.16. A review of the data shows that respondents consistently reported substantially higher satisfaction levels for all the attributes between 2001 and 2004, with the exception of the price attributes where the satisfaction ratings were only slightly higher. The 2005 survey also marks the first time that builders indicated satisfaction with two softwood lumber quality attributes: lumber straightness and lack of defects. In all of the previous surveys, builders had consistently indicated that they were dissatisfied with each of these attributes. The increases in builder satisfaction with softwood lumber may well be attributable to the fact that builders have adjusted to, and are more familiar with, softwood lumber quality in the post-spotted owl environment. The fact that straightness and lack of defects are ranked as two of the most important lumber attributes, combined with the large increase in the satisfaction ratings for both of these attributes, suggests that builders have begun to view softwood lumber as a much better value over the past several years. This increase in builder satisfaction could also be a reflection of the fact that they have had more experience using substitute materials over the past 10 years and that their experiences with these substitute materials have not always been positive. For example, some builders interviewed at trade shows have indicated that structural materials like steel framing require additional training for their carpenter crews, require a different set of tools and the sharp edges can easily cut workers. At the end of the day, productivity gains were not often achieved and did not offset potential savings in material costs.

A gap analysis that looks at the difference between the importance and the satisfaction ratings for each softwood lumber attribute can be used to identify large differences between the importance that builders accord to specific lumber attributes and their satisfaction with those same attributes. Large differences between the two ratings would indicate attributes of concern that could adversely influence builders' use of softwood lumber. The gap scores can be interpreted on an absolute basis simply by comparing the gap score derived from the most recent survey. Changes in the gap scores can also be observed over time by comparing the gap scores across the different surveys, Table 4.17. The gap scores were calculated by subtracting the satisfaction rating from the importance rating for each product attribute. While all of the gap scores for 2004 declined relative to 2001, large gaps were still recorded for several material attributes, including lumber straightness and lack of defects. Since these two attributes were the second and third highest rated in terms of their importance ratings, a large gap score suggests that builders remain less satisfied with these lumber attributes and that these should be areas of concern for softwood lumber manufacturers.

Evaluating the longitudinal trend in the gap scores is also useful in assessing builder satisfaction with softwood lumber attributes over time. The final column in Table 4.17 summarizes the trend in the gap scores between 2001 and 2004. For all of the lumber attributes, the 2004 importance-satisfaction gaps have decreased from those recorded in 2001. This trend further supports the observation that builders are becoming more familiar (and satisfied) with lumber quality and pricing in the post spotted owl era.

**Table 4.17. Average Gap between Satisfaction and Importance**

| | 1995 | 1998 | 2001 | 2004 | Change from 2001 - 2004 |
|---|---|---|---|---|---|
| Appearance | n/a | 1.1 | 1.1 | 0 | ↓ |
| Ease of use | n/a | 0.5 | 0.4 | 0 | ↓ |
| Reduced Environmental Impact | 0.4 | 0.4 | 0.3 | 0.1 | ↓ |
| Availability | 1.2 | 0.7 | 0.7 | 0.4 | ↓ |
| Availability of Longer length | 1.6 | 1.3 | 1.2 | 0.4 | ↓ |
| Availability of Tech./Eng. support | n/a | 1.1 | 0.9 | 0.4 | ↓ |
| Energy Efficiency | 0.8 | 0.6 | 0.5 | 0.5 | ↔ |
| Little product waste | n/a | 1.6 | 1.2 | 0.7 | ↓ |
| Overall Price | 2.9 | 1.5 | 1.2 | 0.9 | ↓ |
| Strength | 1.4 | 1.4 | 1.5 | 1 | ↓ |
| Price Stability | 3.4 | 1.8 | 1.4 | 1.1 | ↓ |
| Lack of defects | 2.6 | 2.6 | 2.4 | 1.5 | ↓ |
| Straightness | 2.7 | 3 | 2.7 | 1.7 | ↓ |

*n/a- Data not available*

### 4.11 Factor Analysis of Softwood Lumber Attributes

A factor analysis can be used to reduce the number of variables (material attributes) to facilitate the analysis of the survey data and to identify the latent (underlying and unobserved) relationships between variables and classify a large number of similar attributes into a smaller group of factors to help simplify the analysis of the data. In this section we use a factor analysis of the softwood lumber attributes and their importance ratings. Factor analysis evaluates the correlation among the softwood lumber importance ratings for the thirteen attributes used in the study and helps group similar attributes into factors to help identify shared traits among the homebuilders. For example, one group of homebuilders might be economy-oriented, in which case they will tend to rate the economics related attributes higher than other groups of home builders. On the other hand, the homebuilders who are quality oriented might rate the quality attributes higher than the economic attributes. As a result, the attributes grouped within each factor tend to be highly correlated while there is much less correlation between attributes grouped into other factors. Once the attributes have been classified into factors, it then becomes the job of the researcher to consider the combination of material attributes grouped into each factor and assign a name to each factor that reflects the underlying dimensions of the grouped attributes.

The factor analysis of the attribute importance data revealed three distinct factors, Table 4.18. A review of the attributes grouped together in each factor led to the naming of the factor groups: Factor 1 was labeled "Technical Characteristics", Factor 2 was labeled "Economics" and Factor 3 was named "Product Quality" (Table 4.18). The factor names reflect the latent values which underlay the group of attributes included in each factor. The factors obtained from the 2004 analysis are similar to those obtained from the 2001 and 1998 studies. This indicates that when purchasing softwood lumber, builders consistently evaluate these three aspects of the product, the technical characteristics of softwood lumber, the economics of softwood lumber and the overall product quality of softwood lumber.

The statistical validity and characteristics of these factors can be estimated using a number of measures. Some of the significant measures that reflect the statistical characteristics of the factors are presented in Table 4.19. Cronbach's alpha is a reliability test of the factors and typically ranges between 0 and 1, where a value close to 1 indicates high reliability of the factors. There are a number of 'rules of thumb' that can be used to indicate how good a value of Cronbach's alpha is required for reliability. As was used in the 2001 study, a value over 0.7 will be considered to be acceptable since it is considered to be high enough to be interpreted as a reliable factor (Lattin et. al. 2003; p.184). A high loading for this statistic validates the scale used in a particular factor. In addition, only those factors with an eigenvalue of more than 1 were selected for the analysis. An eigenvalue is a measure of the amount of the variance in the raw data that can be explained by a specific factor considering the total number of attributes in the model. Hence a higher eigenvalue indicates that the corresponding factor is able to account for a larger amount of the variance in the data. The absolute amount of variance in the data explained by the final factor solution is estimated by summing up the variance explained by each individual factor, Table 4.19. The three factors resulting from the factor analysis together explained 59% of the total variance among the attributes included in the analysis.

Similar to the 1998 and 2001 studies, the importance attributes were aggregated into their respective factors and the average importance rating for each factor was calculated, Table 4.20. The results are similar to those obtained in the 2001 study where the quality of the product was found to be most important to builders, followed by the economic attributes and the technical attributes. The results of the factor analysis suggests that there are three fundamental factors that influence a builders purchase decision for structural building materials: the overall product quality, the economic value of the product and the technical characteristics of the product. In addition, combining the importance rating data with the results of the factor analysis suggests that product quality is by far the most important consideration used by builders when specifying structural building materials followed by the economic value of the product. The third factor, technical performance, is of much lower importance.

**Table 4.18. Rotated component matrix for factor analysis of importance ratings.**

| Attributes | Factor 1 | Factor 2 | Factor 3 | Factor Name |
|---|---|---|---|---|
| **Energy Efficiency** | **0.755564** | 0.028113 | 0.158247 | **Technical Characteristics** |
| **Reduced Environmental Impact** | **0.674575** | 0.102484 | -0.031770 | |
| **Appearance** | **0.543728** | 0.035974 | 0.322815 | |
| **Technical/Engineering Support** | **0.541924** | 0.207789 | 0.368400 | |
| **Availability of Longer Lengths** | **0.514513** | 0.392175 | 0.065625 | |
| **Ease of Use** | **0.431462** | 0.386596 | 0.321054 | |
| **Price Stability** | 0.096417 | **0.900989** | 0.084299 | **Economics** |
| **Overall Price** | 0.073079 | **0.897050** | 0.100052 | |
| **Availability** | 0.212112 | **0.618986** | 0.329873 | |
| **Strength** | -0.103370 | 0.120372 | **0.844234** | **Product Quality** |
| **Straightness** | 0.321257 | 0.104540 | **0.774886** | |
| **Lack of Defects** | 0.395320 | 0.209701 | **0.653115** | |
| **Little Product Waste** | 0.469392 | 0.321568 | **0.505377** | |

**Table 4.19. Total variance explained by the factors.**

| | Eigenvalue | % Variation Explained | Cumulative Percent | Cronbach's Alpha |
|---|---|---|---|---|
| **Factor 1** | 4.96 | 38.16 | 38.16 | 0.721 |
| **Factor 2** | 1.52 | 11.66 | 49.82 | 0.799 |
| **Factor 3** | 1.17 | 8.97 | 58.79 | 0.770 |

**Table 4.20. Importance factor score summary.**

| Attributes | 2004 Importance Rating | Avg. Factor Imp. Rating | Factor Name |
|---|---|---|---|
| **Energy Efficiency** | 5.5 | **5.35** | **Technical Characteristics** |
| **Reduced Environmental Impact** | 4.7 | | |
| **Appearance** | 5.1 | | |
| **Technical/Engineering Support** | 5.5 | | |
| **Availability of Longer Lengths** | 5.5 | | |
| **Ease of Use** | 5.8 | | |
| **Price Stability** | 5.8 | **5.93** | **Economics** |
| **Overall Price** | 5.8 | | |
| **Availability** | 6.2 | | |
| **Strength** | 6.7 | **6.28** | **Product Quality** |
| **Straightness** | 6.5 | | |
| **Lack of Defects** | 6.2 | | |
| **Little Product Waste** | 5.7 | | |

## 5.0 Certification: Awareness and Acceptance

In the 2005 survey, builders were asked a series of questions regarding their awareness and use of environmentally certified wood products. The survey results show that overall approximately 40% of the respondents said that they were aware of certified wood products. The results also show interesting differences in builders' awareness of certified wood products based on their geographic location, Figure 5.1. Over 43% of the respondents from the southeastern and northeastern regions indicated that they were aware of certified lumber, whereas, 36% of respondents from the southwest and 38% of respondents from the northwest reported being aware of certified wood. This result suggests the builders in the eastern US were more likely to be aware of certified wood than were builders located in the western US. In contrast, builders in the west were more likely to have used certified wood.

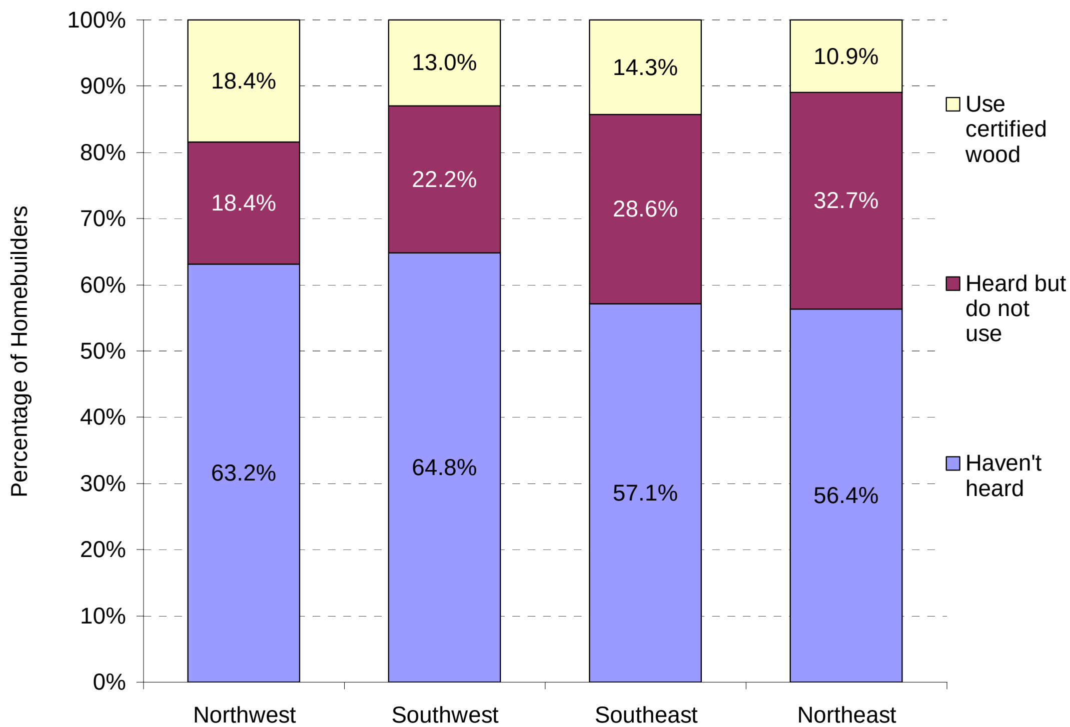


**Figure 5.1: Respondent's awareness and usage of certified wood.**

### 5.1 Usage of Certified Wood

Those builders who were aware of environmentally certified lumber were asked to answer further questions related to their usage of certified wood. Of those respondents who indicated that they were aware of certified wood, approximately a third (34.5%) reported that they had used certified wood. In other words, only 14% of the total respondents have used certified wood. Builder's use of certified wood was found to vary greatly across the different regions of the country. Figure 5.1 shows the percentage of respondents within each geographic region who reported having used certified wood. It appears that though the awareness of certified wood is higher in the eastern regions, awareness does not necessarily translate into usage of certified wood. For example, in the northwestern region, 50% of the respondents who expressed awareness of certified wood reported using certified wood. In contrast, while the northeast had the highest proportion of respondents who had heard of certified wood, it also had the lowest proportion of respondents using certified wood, with just 25% of those aware of certified wood having actually used it.

Further, in considering builders' awareness and use of certified wood within individual states, the survey data suggest that awareness of certified wood was higher among builders located in the eastern US (42.7%) and along the west coast (45.2%) than in the central US (32.2%). However, among those builders who were aware of certified wood, the percentage of builders who reported using it was much higher on the west coast (50%) than in either the eastern US (29.2%) or the central US (38.1%).

***Level of usage of certified wood***

Respondents who indicated that they use or have used certified wood were asked to estimate the percentage of their homes that were framed using certified lumber. The results obtained from this question were interesting and demonstrate that a substantial number of builders have already integrated certified lumber into their building material list, Figure 5.2. Among the users of certified lumber, the average percentage of homes framed with certified lumber was approximately 50%. Almost 15% of the builders who reported using certified wood reported that they framed all of their houses with certified lumber.

Previous research has shown that the willingness of customers to pay higher prices for certified wood products plays a major role in the usage of certified wood. This research found that only 17% of the respondents in the eastern states and 29% of the respondents in the central states believe that their customers would be willing to pay higher prices for homes built using certified wood. The percentage of respondents in the west coast states was higher at 50% relative to the rest of the country. These survey results suggest that the awareness and usage of certified wood among builders is much higher along the west coast relative to the rest of the country. The following discussion will provide further insights into the various market dynamics that contribute to the increased use of certified lumber. The remainder of this section will look at builders use and perceptions of certified wood. However, it is important to note that only those builders who had heard of certified wood were included in the analysis of the questions related to certified wood use. Therefore, it is important that the reader not apply the results for these questions to the entire population of homebuilders.

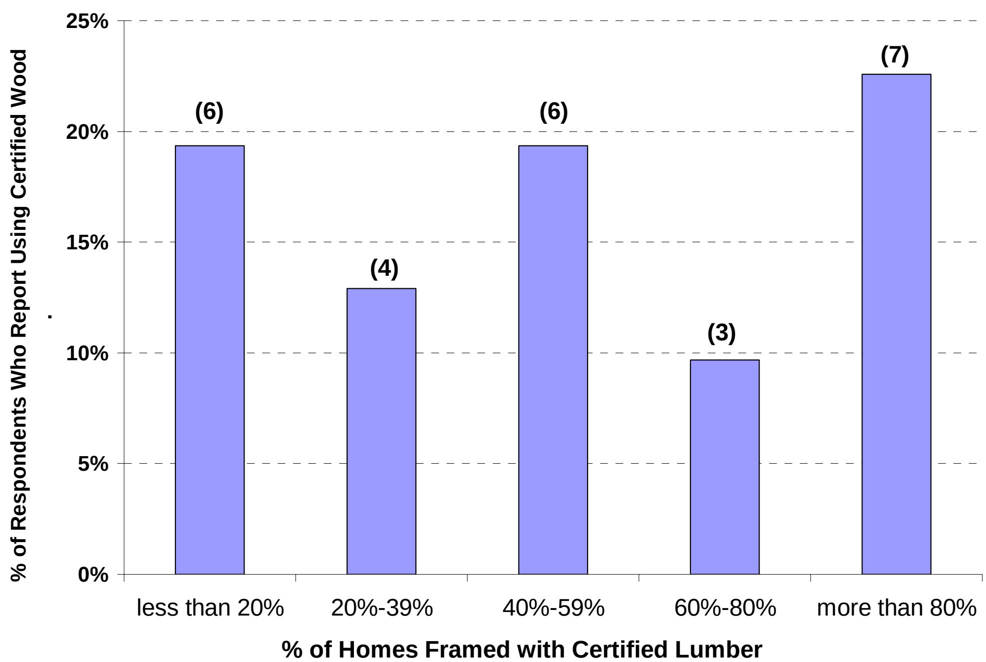


**Figure 5.2. Respondent's Usage of Certified Wood.**

### 5.2 Awareness and Usage of Certified Wood by firm size

The survey data was analyzed to determine the impact of firm size on builder's awareness of certified wood, Figures 5.3-5.6. The results of this analysis suggests that large builders have the lowest level of awareness (33%) whereas almost 40% of small builders and half of the medium-size builders reported that they were aware of certified wood, Figure 5.3. However, this difference, while substantial, was found to be statistically insignificant suggesting that builder's awareness of certified lumber may be independent of firm size.

Further analysis of the data shows that there are significant differences in the use (as opposed to awareness) of certified lumber based on firm size, Figure 5.4. The survey found that 56% of medium-sized firms reported using certified lumber, while only 28% of the small homebuilders and 43% of the large homebuilders reported using certified lumber. While the difference in certified lumber use between the large and medium-size homebuilders was not significant, the data analysis showed that smaller homebuilders are significantly less likely to use certified lumber.

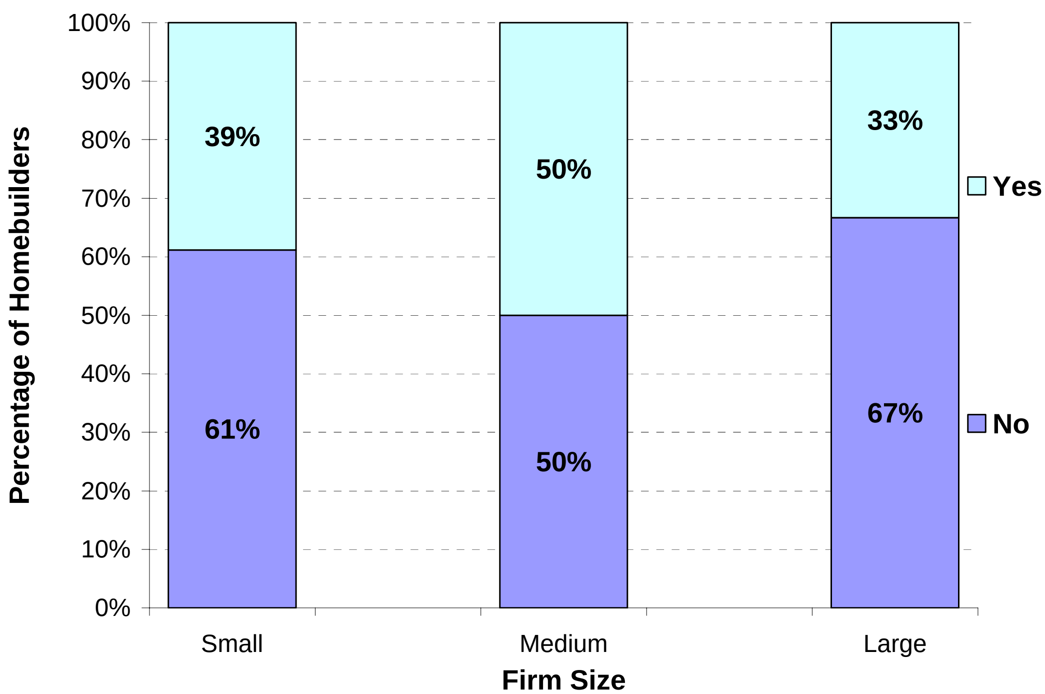


**Figure 5.3. Awareness of Environmentally Certified Wood Products, by Firm Size**

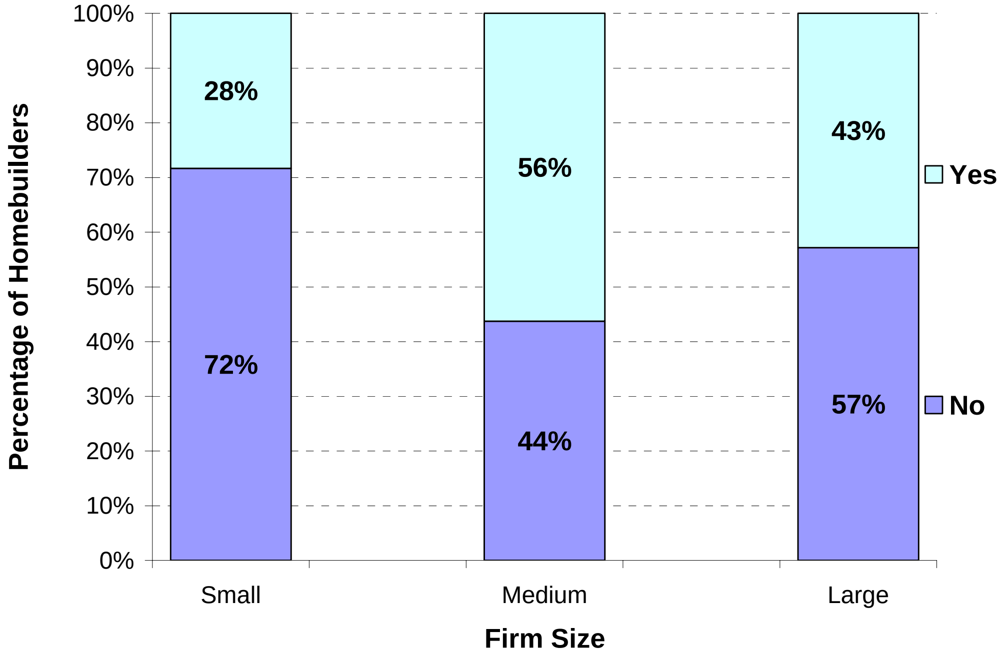


**Figure 5.4. Respondent's Use of Certified Wood, by Firm Size**

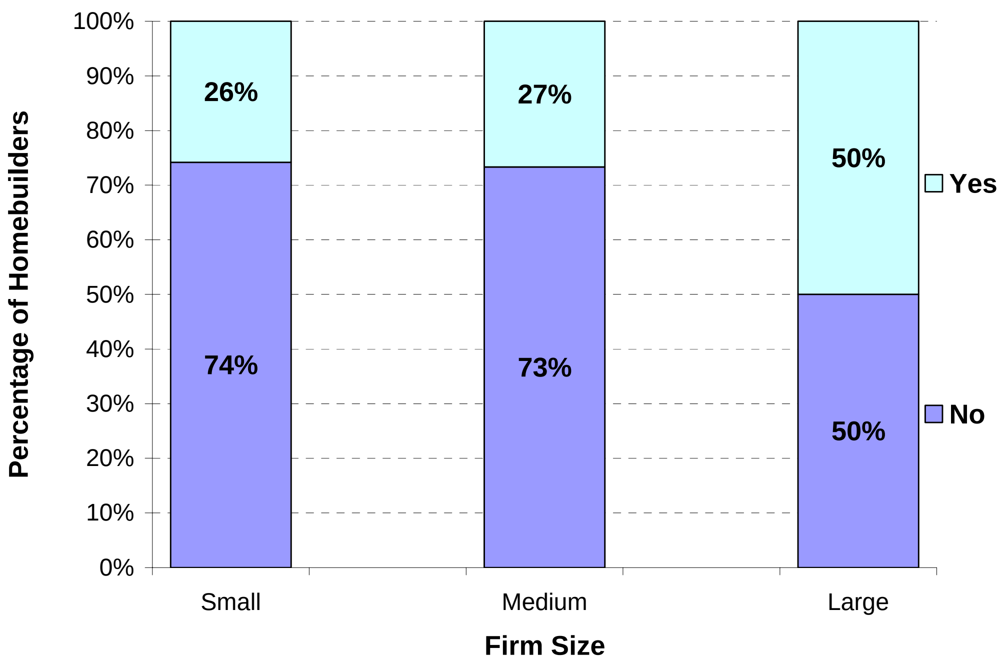


**Figure 5.5. Respondent's Perceptions of Their Customer's Willingness to Pay a Premium for Certified Wood, by Firm Size.**

The price of certified wood is generally higher than uncertified wood, reflecting the price premium associated with the additional costs of forest certification as well as establishing and maintaining a verifiable chain of custody for certified wood. To develop a better understanding of the perceived willingness of homebuyers to pay a premium for a home built using certified wood, homebuilders were asked if they thought that their customers would be willing to pay a higher price for a home built using certified lumber, Figure 5.3. Approximately 75% of the small and medium-sized homebuilders thought that their customers would not be willing to pay any premium for a house built from certified wood. However, 50% of the large homebuilders thought that their customers would be willing to pay a premium for a house built using certified wood. These results show that medium-sized homebuilders report the highest usage of certified wood (56%) despite the fact that they reported that that only 27% of their customers might be willing to pay a premium for a house built using certified wood. This suggests that medium-sized builders appear to be ***currently*** leading the homebuilding industry in adopting certified wood and that their reasons for doing this are not necessarily profit driven. For example, they may be advertising the fact that they use certified wood in their homes as a selling point that provides them with a competitive advantage and an opportunity to differentiate their homes from competitors within specific market segments. It may also suggest that they are competing in markets that are more environmentally aware.

Respondents were also asked if they thought that they would be increasing their use of certified wood over the next three years, Figure 5.6. A majority of the respondents reported that they expected their use of certified wood to increase over the next three years, with three-quarters of large homebuilders indicating that their use will likely increase. Overall, the results of these questions suggest that large builders may be leading the effort to increase the use of certified wood in building homes ***in the future***. This observation is based on the fact that 67% of large builders have heard of certified wood (this represents the largest segment for this question), 43% have used certified wood to build homes, 50% think that their customers would be willing to pay a premium for a home built from certified wood (this represents the largest segment for this question) and 75% expect that their use of certified wood will increase in the future (this represents the largest segment for this question). Again, we caution readers that the small sample sizes for these questions makes it impossible to generalize these findings to the entire population of homebuilders in the US.

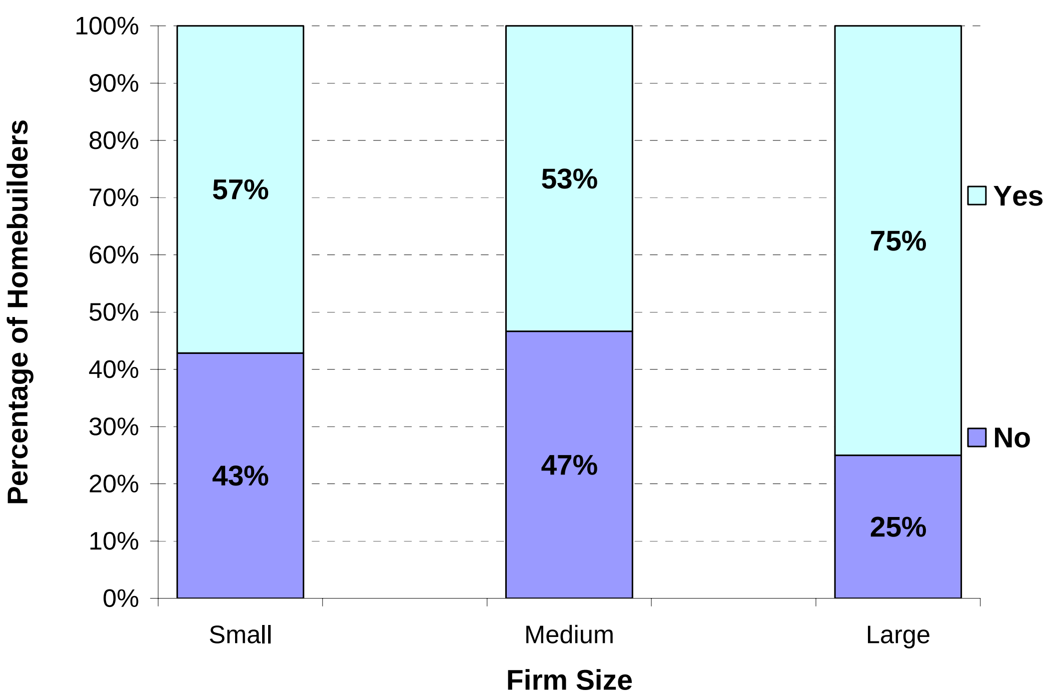


**Figure 5.6. Respondent's Perceptions of Future Use of Certified Wood, by Firm Size.**

### 5.3 Awareness and Usage of Certified Wood by Area of Operation

The survey data was also analyzed to determine if respondents' area of operation influenced their use of certified wood, Figures 5.7-5.10. For this analysis, respondents were categorized into three groups based on their self-reported area of operation (urban/suburban, small town and rural). The results of this analysis suggest that the awareness of certified wood products is highest in the urban/suburban areas followed by small towns and rural areas, although the differences between these areas were not significant, suggesting that builder's awareness of certified wood is likely not influenced by area of operation.

While there were no significant differences in respondent's awareness of certified wood based on their area of operation, the survey results show that a significantly higher proportion of builders in small towns and urban locations have used certified wood to build homes than have builders located in rural areas, Figure 5.8. Interestingly, small town home builders who have used certified wood indicated that 58% of their homes were built using certified wood.

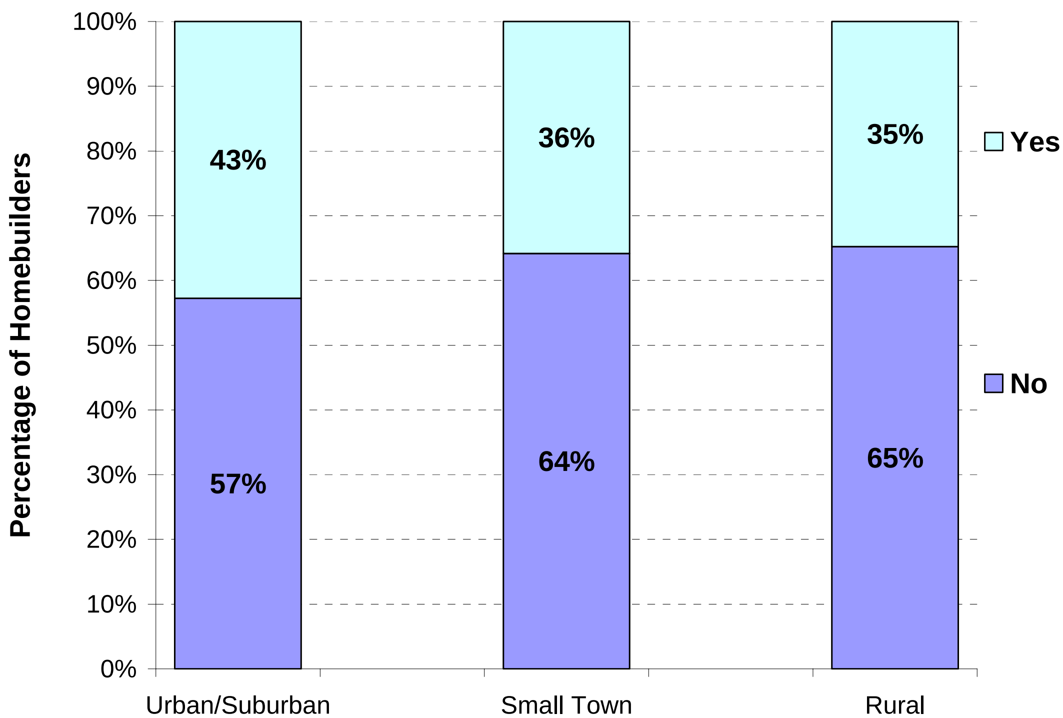


**Figure 5.7. Respondent's Awareness of Certified Wood, by Area of Operation**

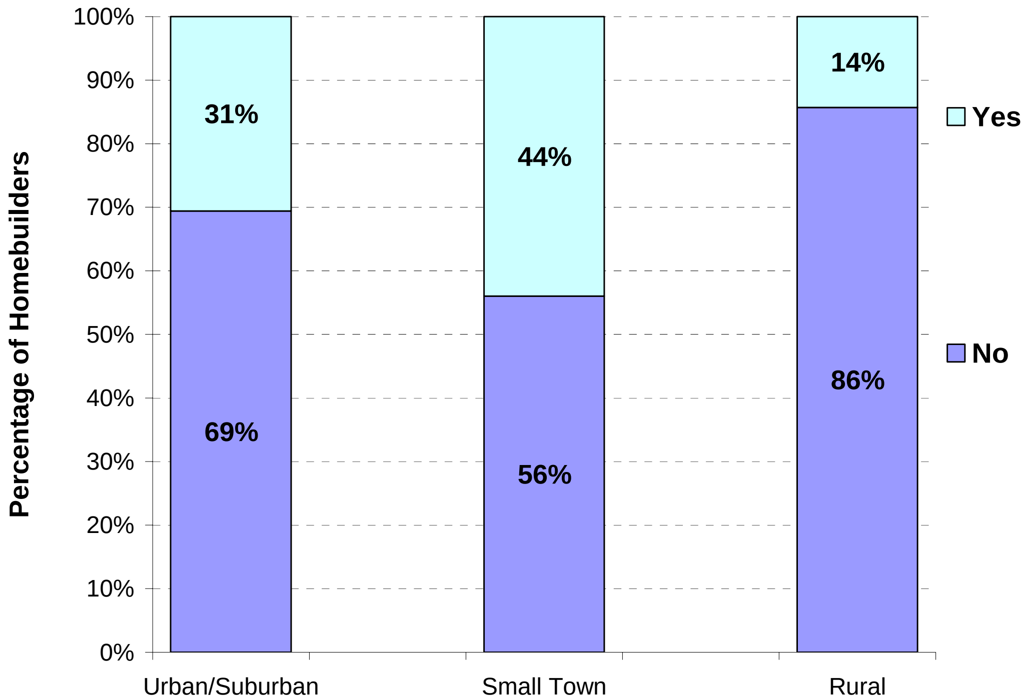


**Figure 5.8. Respondent's Use of Certified Wood, by Area of Operation**

Respondents were also asked if they thought that their customers would be willing to pay a premium for a house built using certified wood, Figure 5.9. Only 13% of the rural homebuilders thought that their customers would be willing to pay a premium for a house built from certified wood while almost 38% of the homebuilders operating in small towns and 27% of homebuilders in urban areas thought that their customers would be willing to pay a premium for a home made with certified wood. Finally, while 38% of homebuilders in rural areas indicated that they thought their use of certified wood would increase over the next three years, 50% of homebuilders in small towns and 64% of homebuilders in urban areas reported that they thought their use would increase, Figure 5.10.

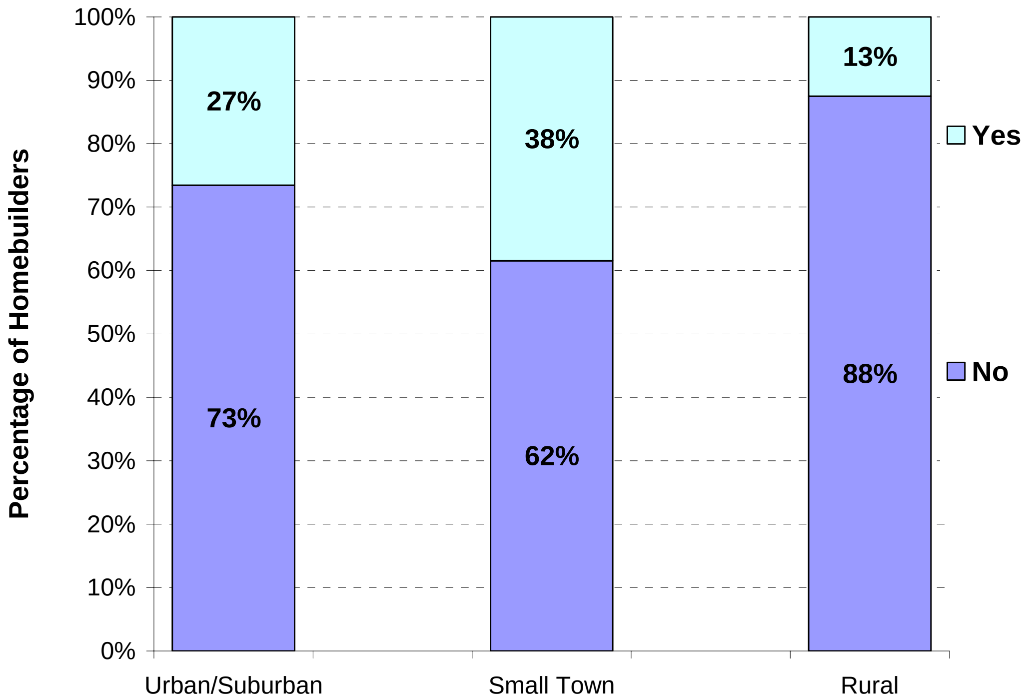


**Figure 5.9. Respondent's Perceptions of Their Customer's Willingness to Pay a Premium for Certified Wood, by Area of Operation.**

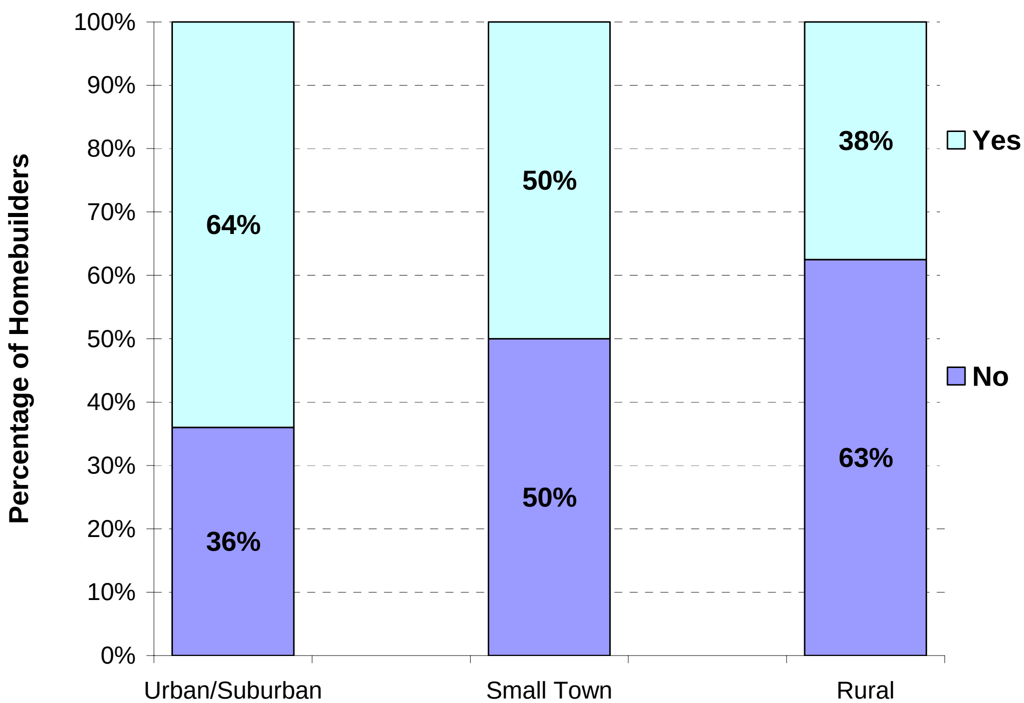


**Figure 5.10. Respondent's Perceptions of Future Use of Certified Wood, by Area of Operation.**

## 6.0 Conclusions

This survey represents the fourth in a longitudinal analysis comparing material use and material substitution trends in structural framing applications within the US residential construction industry in 1995, 1998, 2001 and 2004. In general, the high degree of material substitution observed in 1998 was found to have moderated in 2001 and 2004. In most end-use applications, softwood lumber increased or maintained it market share although it lost market share in load bearing walls. Of all the softwood lumber substitute materials, wood I-joists, LVL, steel framing and glulam beams experienced a significant decrease in usage between 2001 and 2004 while structural insulated panels and open web trusses increased their market share in 2004.

In all of the structural end-use applications, softwood lumber is the dominant material used by residential homebuilders. The market share of softwood lumber for headers, non-load bearing walls, load bearing walls and roof framing (rafters plus roof trusses) exceeded 75% while in floor framing it reached 57% (solid wood joists plus open web trusses). Considering the substitute materials, steel framing lost market share in all end-use applications between 2001 and 2004, suggesting that builders have begun to move away from steel as a structural framing material in the residential housing sector.

Builders have consistently rated strength, straightness, lack of defects and availability as the material attributes that have the most important influence on their specification and use of softwood lumber. This was true across all four of the builder surveys. Two additional material attributes (price and price stability) that were rated as being very important in the early surveys, were found to decline in importance in the two most recent surveys, suggesting that builders are less concerned with these attributes. Builders have also indicated that they are increasingly satisfied with the material attributes of softwood lumber across the series of surveys. This observation is supported by the fact that the difference between the importance ratings and satisfaction ratings for all of the material attributes declined between 2001 and 2004.

It appears that builders are becoming more conscious of the environment and that this is beginning to influence the material specification process of some builders. Unfortunately, builders continue to receive mixed messages about the environmental performance of the different structural framing materials. The results of the 2005 survey show that builders' perceptions of the environmental performance of non-wood structural materials relative to softwood lumber improved slightly between 2001 and 2004 whereas it decreased substantially for all of the wood-based structural materials. With the exception of SIP's, all of the substitute materials are considered to be more enviromentally friendly than softwood lumber. This finding is in stark contrast to the results generated from the CORRIM life cycle research which has clearly demonstrated the environmental superiority of softwood lumber over both steel and reinforced concrete in residential construction. This result indicates that it is important that the forest products industry, and softwood lumber manufacturers in particular, renew their efforts to educate builders regarding the environmental benefits of using wood in place of non-wood materials.

A new component of the 2005 survey looked at home builders awareness and use of environmentally certified lumber. The results of the survey showed that while 40% of the survey respondents indicated that they were aware of certified wood, just 14% reported that they have used certified wood to frame a new house. Among the users of certified lumber, the average percentage of homes framed with certified lumber was approximately 50% and almost 15% of the builders who used certified lumber reported that they framed all of their houses with certified lumber. One factor that will influence the extent to which builders expand their use of certified lumber is the willingness of home buyers to pay a price premium for these houses to offset the higher material costs associated with using certified lumber. This research shows that only 17% of the survey respondents in the eastern states and 29% of the respondents in the central states believe that their customers would be willing to pay a price premium for a house built using certified lumber, while 50% of the survey respondents located on the west coast thought their customers would be willing to pay a price premium.  In fact, the survey results suggest that the awareness and usage of certified wood among home builders was much higher in the west coast states than in the rest of the country.

The results suggest that large home builders may lead the effort to increase the use of certified wood in residential construction in the future.  This observation is based on the fact that 67% of large builders have heard of certified wood (this represents the largest segment for this question), 43% have used certified wood to build homes (this is the second largest segment for this question), 50% think that their customers would be willing to pay a premium for a home built from certified wood (this represents the largest segment for this question) and 75% expect that their use of certified wood will increase in the future (this represents the largest segment for this question).  Further research is needed to understand home builders' motivation for using certified wood and to explore the relationship between the use of certified wood and regulatory factors (such as green building codes and efforts to improve the energy efficiency of residential homes).

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## 8.0 Survey Instrument

**Interviewer, please fill this section in from database spreadsheet prior to the interview!**

Field Company Interviewer ID: ____ ____ ____ ____ City/State of Respondent ________________________

Respondents total sales ______________________ Number of employees _________________________

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**CINTRAFOR's 2005 Survey of U.S. Residential Builders**

**Use of Structural Lumber in Residential Construction**

Hello, I'm ______________of The Field Company, a market research firm in Seattle. We're conducting a survey on behalf of the University of Washington on the different types of structural products used to frame houses. The purpose of this survey is to learn how often and why certain types of structural products are used by homebuilders. All responses will be kept strictly confidential and the results will be used in aggregate form only, and a summary of the final survey results will be available to all participants. Is now a convenient time for you to answer some questions?

*Is residential construction a primary focus of your business?*

*(Note: Discontinue interview if residential construction is not identified as a primary focus of the company.)*

1) Approximately what percentage of your company's 2004 sales revenue was generated from the following activities?

Single Family Construction _______%

Multi-family Construction _______%

Home Improvement /Remodeling _______%

Patio/Deck Construction _______%

Nonresidential Construction _______%

Other (please specify below) _______%

______________________

Total = 100%

2) Which of the following best describes the area that your company conducts most of its business? (*please only check on box*)

❑ URBAN/SUBURBAN: A city or group of contiguous communities with a population greater than 50,000.

❑ SMALL TOWN: A city or town that is generally isolated from a major urban area with a population less than 50,000.

❑ RURAL: Low density population scattered over a wide area

❑ Other (______________________________)

3a) I'll be reading a list of building materials, and I'd like you to indicate whether your company's use of each structural framing material has *Increased*, *Remained the Same*, or *Decreased relative to your use of softwood lumber* over the past two years. Also, what was the year that your company first used each product (*please provide a response for each product listed*).

| | **Over The Past Two Years, My Company's Use of This Product Relative to Softwood Lumber Has…..** | | | **My Company** | |
|---|---|---|---|---|---|
| **Structural Product** | **Increased** | **Remained the Same** | **Decreased** | **Has Never Used This Product** | **Year First Used (if applicable)** |
| Finger-jointed Studs | ❑ | ❑ | ❑ | ❑ | _________ |
| Steel Framing | ❑ | ❑ | ❑ | ❑ | _________ |
| Reinforced Concrete | ❑ | ❑ | ❑ | ❑ | _________ |
| Structural Insulated Panels | ❑ | ❑ | ❑ | ❑ | _________ |
| Panelized Wall Systems | ❑ | ❑ | ❑ | ❑ | _________ |
| Wood I-joists | ❑ | ❑ | ❑ | ❑ | _________ |
| Wood/Steel joists (Open web) | ❑ | ❑ | ❑ | ❑ | _________ |
| Laminated Veneer Lumber (LVL) | ❑ | ❑ | ❑ | ❑ | _________ |
| TimberStrand™ Lumber | ❑ | ❑ | ❑ | ❑ | _________ |
| Parallam™ Beams and Headers | ❑ | ❑ | ❑ | ❑ | _________ |
| Glue Laminated Beams (Glulam) | ❑ | ❑ | ❑ | ❑ | _________ |

3b) Have you ever used a substitute for softwood lumber in a structural framing application?

❑ Yes ❑ No (Skip to Question #4)

3c) (If respondent has used a substitute for softwood lumber in a structural framing application). Why did you switch from softwood lumber?

________________________________________________________

________________________________________________________

4) I'll be reading a list of structural framing applications. For each of the end-use applications listed, please estimate the percentage (on a volume basis) of each material used for that application during the past year by your company. (*Write the approximate PERCENTAGE in the appropriate category for each building application*)

| | **Structural Materials** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **End-Use Application** | **Softwood Lumber** | **Wood Truss** | **Finger-Jointed Stud** | **Wood I-joist** | **Laminated Veneer Lumber** | **Steel Framing** | **Other (specify)** ______ | **Total** |
| Floor Joists | | | | | | | | 100% |
| Load Bearing Walls | | | | | | | | 100% |
| Non-Load Bearing Walls | | | | | | | | 100% |
| Headers | | | | | | | | 100% |
| Roofs | | | | | | | | 100% |

5) I'll be reading a list of building materials. In your opinion, how do each of these materials compare to softwood lumber with respect to their impact on the environment? (*Please rate each product on a scale of 1 = LESS FAVORABLE IMPACT ON THE ENVIRONMENT to 7 = MORE FAVORABLE IMPACT ON THE ENVIRONMENT*).

| **PRODUCTS** | **LESS FAVORABLE** | | | **THE SAME** | | | **MORE FAVORABLE** |
|---|---|---|---|---|---|---|---|
| Steel Framing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Wood-Plastic Composite Lumber (Trex) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Finger-Jointed Studs | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Reinforced Concrete | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Concrete Blocks | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Structural Insulated Panels | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Wood I-joists | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Wood/Steel Open Web Trusses | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Laminated Veneer Lumber (LVL) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Parallam™ Beams and Headers | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TimberStrand™ Lumber | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Glue Laminated Beams (Glulam) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

6) I'll be reading a list of material attributes. How important is each of these attributes when you are considering purchasing a structural framing material (EITHER **WOOD OR NON-WOOD**)? (*Please rate each attribute on a scale of 1 = NOT IMPORTANT to 7 = VERY IMPORTANT*)

| **LUMBER ATTRIBUTES** | **NOT IMPORTANT AT ALL** | | | **NEUTRAL** | | | **EXTREMELY IMPORTANT** |
|---|---|---|---|---|---|---|---|
| Strength | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Straightness | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Reduced Environmental Impact | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Availability | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Price Stability | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Overall Price | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Availability of Longer Lengths | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Energy Efficiency | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Ease of Use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Technical/Engineering Support | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Lack of Defects | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Appearance | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Little Product Waste | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

7a) I'll be reading the same list of material attributes. When purchasing **SOFTWOOD LUMBER**, how satisfied are you with the following attributes. (*Please rate each statement on a scale of 1 = NOT SATISFIED to 7 = VERY SATISFIED*)

| **LUMBER ATTRIBUTES** | **NOT SATISFIED AT ALL** | | | **NEITHER SATISFIED NOR UNSATISFIED** | | | **VERY SATISFIED** |
|---|---|---|---|---|---|---|---|
| Strength | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Straightness | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Reduced Environmental Impact | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Availability | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Price Stability | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Overall Price | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Availability of Longer Lengths | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Energy Efficiency | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Ease of Use | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Technical/Engineering Support | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Lack of Defects | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Appearance | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Little Product Waste | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

7b) Using the same scale, what is your **overall** satisfaction with softwood lumber as a structural building material?

____________________________________________________________

## Contractor Use of Environmentally Certified Lumber

8) Have you heard of environmental certification for wood products? ❑ Yes ❑ No (Skip to Question #12)

9a) Have you ever used environmentally certified softwood lumber for structural framing?

❑ Yes ❑ No

9b) If yes, approximately what percentage of your homes are framed with environmentally certified lumber? _________%

10) In general, do you think that your customers are willing to pay a higher price to offset the higher cost of building with environmentally certified lumber?

❑ Yes ❑ No

11) Do you expect that your use of environmentally certified lumber will increase over the next three years?

❑ Yes ❑ No

## Contractor Built Decks

12) Approximately what percentage of the spec and custom homes that your company built in 2004 had a deck?

Percent of spec homes built with deck: ______ % Percent of custom homes built with deck: ______ %

13) What was the *average size* of the decks that your company built in 2004?

Average deck size for spec homes: ____________ $ft^2$ Average deck size for custom homes: ____________ $ft^2$

14) Please indicate the average construction cost *to your company* of the decks you built in 2004.

Average cost for spec homes: $____________ Average cost for custom homes: $_____________

**15)** Please estimate the approximate cost distribution among the primary deck components?

| | |
|---|---|
| Deck Structure: | __________% |
| Deck Surface: | __________% |
| Deck Accessories: | __________% |
| **Total** | **100** % |

**Finally, we would like some information about you and your company for statistical purposes.**

★ ***ALL SURVEY INFORMATION IS KEPT STRICTLY CONFIDENTIAL*** ★

***All identifying information (personal names, company names, and locations) will be removed from the data***

16) Approximately how many years has your company been building homes? _______ years

17) Approximately how many of the following types of structures did your company complete in 2004?

________ single family homes ________ multi-family homes _______ nonresidential structures

18) How many of the single family homes you built in 2004 were:

________ spec homes ________ custom homes

19) What was the average floor area of the houses you built in 2004

________ floor area of spec homes ________ floor area of custom homes

20) On average, what percentage of your company's framing costs were subcontracted to other companies? ________ %

Thank you for your time and cooperation in completing this survey. Please provide the following information if you would like a summary of the final survey results.

Name: ____________________________________________________

Address: ____________________________________________________

____________________________________________________

____________________________________________________