Wood Products Council

WOOD PRODUCTS USED IN THE CONSTRUCTION OF LOW-RISE NONRESIDENTIAL BUILDINGS IN THE UNITED STATES

–2003–

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About the cover:

Columbia Junior High (8-9 grades)
2901-54th Avenue East
Fife, Washington

The school for 8th and 9th graders opened in the fall of 2003.

Architect: Erickson McGovern

Wood Products Used in the Construction of Low-Rise Nonresidential Buildings in the United States, 2003

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Prepared for the
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Abstract

Low-rise nonresidential building construction is an important market for lumber, structural wood panels, nonstructural wood panels, and engineered wood products in the United States. This report examines low-rise nonresidential buildings of four or fewer stories only, because buildings with five or more stories are normally severely restricted by building code from being wood framed. In 2003, 1,324 million board feet of lumber, 56 million bf of glulam timber, 2,293 million square feet, 3/8-in. basis, of structural panels, 76 million square feet, 3/8-in. basis of nonstructural panels, 49 million linear feet of wood I-joists, and nearly 3 million cubic feet of structural composite lumber were used to construct 82,000 new buildings or additions, and in the alterations and renovations of numerous existing buildings. Included are the construction of entirely new buildings, major additions to, or in conjunction with, existing buildings, and alterations and renovations to existing buildings. Volumes include allowances for onsite waste and loss. Not included are the amounts of wood used for facilitation (concrete forms, shoring, etc.) and millwork. Farm construction and nonbuilding construction, such as bridges, dams, and highways, were not included in this study.

Keywords: Nonresidential construction, wood products consumption, value of new construction, lumber, structural panels, engineered wood products.

Acknowledgements

The efforts of many were needed to conduct this study. Included are summer interns Ryan Dutli, Benjamin Enfield, Christopher Hartman, and Michael Maranan who conducted the primary data collection, and performed the approximately 1,000 blue print take-offs which formed the basis for this report. Their support is gratefully acknowledged.

Executive Summary

The construction of low-rise nonresidential buildings (buildings with 4 or fewer stories above ground) is an important market for lumber, structural and nonstructural wood panels, and engineered wood products. This analysis is limited to low-rise nonresidential buildings because buildings with five or more stories are normally restricted by building code from wood framed construction. In 2003, an estimated 1,324 million board feet (bf) of lumber, 56 million bf of glulam timber, 2,293 million square feet (ft^2), 3/8-in. basis, of structural panels, 76 million ft^2, 3/8-in. basis of nonstructural panels, 49 million linear feet (lf) of wood I-joists, and nearly 3 million cubic feet (ft^3) of structural composite lumber (SCL) were used (Table ES-1). These volumes represent about 2 percent of total U.S. lumber consumption, and 6 percent each of total structural panel and engineered wood products consumption in 2003. Included are the construction of entirely new buildings, major additions to or in conjunction with existing buildings, and alterations and renovations to existing buildings. Volumes include allowances for onsite waste and loss. Not included are the amounts of wood used for facilitation and millwork, for nonbuilding construction, and for farm structures.

Wood product consumption estimates for nonresidential building construction in 2003 and prior years are not strictly comparable due to differences in study design, building type classifications, and identified construction types, but can be useful in identifying overall consumption trends. Comparisons indicate that wood products consumption in 2003 tended to be nearly as good or better than it had been in 1995, but

generally poorer than in 1985. Between 1995 and 2003, total lumber (including the board foot equivalent of engineered wood) consumption declined by slightly less than 8 percent (about 130 million bf), while structural panel consumption increased by nearly 100 percent (1,130 million ft^2, 3/8-inch basis) (Table ES-1). Declines in lumber use, particularly framing lumber, are a result of many factors, of which substitution is perhaps the single largest. Both engineered wood products, such as wood I-joists, and nonwood products, such as steel studs, can directly substitute for framing lumber. Overall lumber consumption is directly dependent on the extent of substitution. Hybrid building systems, which combine wood and nonwood materials, also impact lumber consumption much more than structural panel consumption because many hybrid systems replace wood framing components more so than wood sheathing components. Total consumption of all wood products for low-rise nonresidential building construction, measured in board foot equivalents, increased by 465 million bf between 1995 and 2003, about a 20 percent increase. Conversely, between 1985 and 2003 lumber consumption declined more than 45 percent (about 1,260 million bf), and structural panel consumption increased by less than 10 percent (199 million ft^2, 3/8-in. basis). Total wood products consumption fell by more than 1 billion bf between 1985 and 2003. Overall, lumber consumption fell steadily between 1985, 1995 and 2003. Structural panel consumption also declined between 1985 and 1995, but increased dramatically to levels in excess of 1985 consumption by 2003.

The use of wood per square foot of floor area can be used to gauge the extent, or intensity, of wood use in nonresidential buildings. Between 1985 and 1995, total floor area built increased from nearly 2.4 billion to more than 2.8 billion ft^2, but combined use of wood per square foot of floor area fell by more than 50 percent to about 0.8 bf per ft^2 of floor area. Then, between 1995 and 2003, floor area fell to about 2.5 billion ft^2, but still about 6 percent greater than in 1985. The combined use of wood products per square foot of floor area rebounded from 1995 levels to about 1.1 bf per ft^2 of floor area in 2003, well below the 1.6 bf in 1985. These trends indicate a dramatic drop in wood use intensity between 1985 and 1995, and then a gradual increase in intensity since then, but not to levels achieved in 1985.

Changing wood products consumption between 1985, 1995, and 2003 was due, in part, to:

- A 46 percent overall increase in the proportion of the value of construction of large to small buildings. Large buildings tend to use less wood per square foot of floor area than small buildings;
- An overall increase in total floor area built, but a decrease in overall wood use per square foot of floor area;
- Changes in the mix of building types favoring those which tend to use less wood per square foot of floor area;
- Increased use of hybrid framing systems which combine wood and nonwood building materials. Hybrid framing tends to reduce the amount of wood, particularly lumber, used compared to conventional wood framed systems;
- Use of engineered wood products which tends to reduce the amount of traditional wood products required to achieve the same level of performance; and
- Changing consumer and architectural preferences.

These and other non-quantifiable factors make it difficult to accurately measure changes in market shares for wood products. However, the magnitude of change in wood products consumption suggests that lumber has continued to lose

share to competing products, structural panels have gained share relative to competing products, and engineered wood products have maintained a fairly small, specialized market share.

Overall, stores and office buildings used more wood products than other building types in 2003, and accounted for just over 41 percent of all wood products consumption in nonresidential buildings (Table ES-1). Lumber (including engineered wood), and structural panels consumption accounted for 42 and 41 percent respectively; nonstructural panel consumption just 12 percent. Total engineered wood products consumption in 2003 for all building types remained at about 1995 levels, with large shifts between building types being evident.

An additional 5,737 million bf of lumber, 846 million bf of engineered wood, 5,769 million ft^2 of structural panels, and 45 million ft^2 of nonstructural panels could have been used in nonresidential buildings in 2003 if all low-rise concrete and metal framed buildings had been built using the same construction methods as wood framed buildings (Table ES-1). When combined, these additional volumes represent more than a 4-fold increase in wood use. Potential gain is reduced to 3,216 million bf of lumber, and 3,282 million ft^2 of structural panels if estimates exclude buildings that exceed the building code size limits for wood framing. Roofs and exterior walls represent the two greatest applications for incremental volume potential for all wood products.

Nonresidential building construction is an important market for wood products, but one that should not be taken for granted. Nonwood building products are continually challenging wood, particularly solid sawn lumber, in many nonresidential building applications. A large unfulfilled potential exists to greatly increase wood products consumption in nonresidential construction. Wood must remain and become even more competitive in order to maintain and increase its share of the nonresidential building market.

Table ES–1. Wood used in nonresidential building construction, by building type, 1985, 1995 and 2003.

Building type and year	Value of new construction[1] (Bil. $)	Floor area (Mil. ft^2)	Lumber: Dimenison[2] (Mil. bf)	Lumber: Dimension & engineered[3] wood (Mil. bf)	Structural panels[4] (Mil. ft^2, 3/8-inch)	Non-structural panels[5] (Mil. ft^2, 3/8-inch)	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[6] (Mil. ft^3)	Total wood used (Mil. bf)[7]
Stores										
1985	56.1	920.0	–	985.0	731.0	11.0	–	–	–	1,356.0
1995	50.9	876.0	394.2	453.0	354.4	5.7	12.8	26.0	0.5	633.1
2003	52.9	929.4	231.0	272.7	471.1	4.3	13.9	10.6	0.2	510.4
Industrial										
1985	41.0	303.0	–	125.0	80.0	2.9	–	–	–	166.4
1995	44.1	766.4	53.0	113.4	158.2	1.1	20.0	19.8	0	193.0
2003	18.7	371.9	46.9	58.7	47.0	0.0	0.5	3.4	0.5	82.2
Offices										
1985	68.4	480.0	–	596.0	494.0	10.9	–	–	–	848.5
1995	30.5	333.7	278.4	303.9	225.6	2.5	10.8	1.2	0.2	417.9
2003	34.4	305.8	325.0	363.6	469.6	4.5	9.9	15.7	0.2	600.6
Hotels										
1985	13.7	140.0	–	181.0	144.0	18.0	–	–	–	262.0
1995	8.5	103.4	129.3	132.7	48.6	0.5	1.6	0.2	0	157.3
2003	7.3	72.5	143.9	167.5	200.3	0.6	7.6	1.0	0.5	267.9
Education										
1985	17.8	192.0	–	260.0	208.0	4.1	–	–	–	366.0
1995	37.3	276.5	189.5	199.5	148.2	1.8	3.0	2.1	0.1	274.5
2003	60.4	396.7	262.5	300.1	423.5	57.6	9.4	11.4	0.5	540.6
Religious										
1985	4.3	41.0	–	110.0	83.0	1.1	–	–	–	152.0
1995	5.2	57.5	118.1	128.5	78.8	0.3	2.8	3.2	0.1	168.0
2003	7.5	85.5	100.9	120.5	122.6	0.6	2.4	7.0	0.5	182.1
Health										
1985	14.8	148.0	–	335.0	241.0	6.1	–	–	–	458.6
1995	18.5	133.4	141.0	153.0	65.2	0.4	5.2	1.0	0	185.8
2003	23.0	148.9	103.6	108.5	307.8	2.3	0.9	1.4	0.1	263.6
All other										
1985	22.5	166.0	–	188.0	113.0	6.0	–	–	–	247.5
1995	32.9	273.2	160.8	168.4	86.5	0.6	2.3	1.8	0.1	212.0
2003	32.1	212.7	110.3	130.6	250.8	6.2	3.9	5.6	0.4	259.1
All buildings										
1985	238.7	2,390.0	–	2,780.0	2,094.0	60.1	–	–	–	3,857.0
1995	227.8	2,820.2	1,464.4	1,652.4	1,165.4	12.9	58.5	55.3	1.0	2,241.5
2003	236.2	2,523.3	1,324.1	1,522.2	2,292.5	76.0	48.6	56.0	2.8	2,706.5
Potential incremental volumes										
1995	–	–	6,002.9	–	5,969.7	–	–	–	–	–
2003	–	–	5,737.0	6,583.3	5,768.7	45.3	244.7	222.9	8.4	8,763.5

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Constant 2000 dollars.

[2]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[3]Includes glulam and the board foot equivalent of I-joists, and structural composite lumber: 1 lf I-joist = 2 bf; 1 ft^3 SCL = 16 bf.

[4]Includes softwood plywood and oriented strandboard.

[5]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood

[6]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

[7]Includes dimension and engineered wood, and the board foot equivalent of panel products: 1 ft^2 = 0.5 bf.

Sources: Wood Products Promotion Council 1987; McKeever and Adair 1998.

Contents

Wood Products Used in the Construction of Low-Rise Nonresidential Buildings in the United States, 2003

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Introduction

Nonresidential construction is an important component of the United States' construction market, and a major market for wood products. In 2003 the value of all nonresidential construction was $443 billion, 48 percent of all construction (Table 1). The buildings component of nonresidential construction was valued at $283 billion, 64 percent of all nonresidential construction, and nearly one-third of all new construction. Low-rise buildings of four or fewer stories had construction valued at $269 billion in 2003.

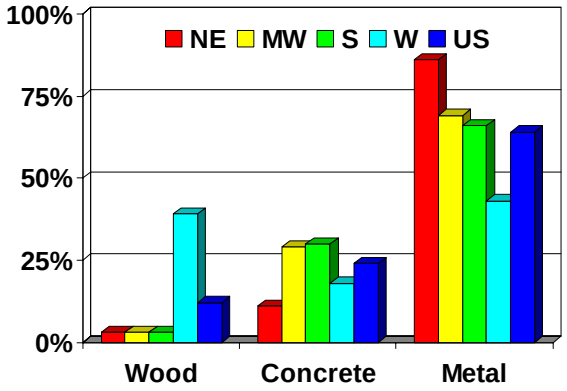
Nonresidential buildings are a diverse mixture of structures with uses ranging from small churches and shops, to large shopping malls and high-rise office buildings. In this study, 11 building types were identified which correspond to those used by the U.S. Bureau of the Census (2006). Building types identified here are: Stores, Industrial, Offices, Hotels, Schools, Colleges, Religious, Health, Public, Recreation, and Miscellaneous. A complete description of each building type, and definitions of other terms used in this report are in Appendix A. This analysis is limited to low-rise nonresidential buildings because high-rise buildings with five or more stories are severely restricted from wood framed construction by building codes. All high-rise buildings were excluded because little if any wood is used for structural purposes in their construction, and because their inclusion would tend to bias results of the analysis. All results cited throughout this report are for low-rise buildings of four or fewer stories.

Three types of construction activity were identified for each building type: 1) new construction, 2) additions to existing buildings which may be either free standing or attached, and 3) alterations and renovations to existing structures. Alterations and renovations typically do not add floor area to the building, and may or may not include the use of structural building materials. There is no framing type or floor area associated with alterations and renovations. Past studies did not make this distinction. For this study new construction and additions are treated as a single construction type.

The construction of an estimated 82,000 new nonresidential buildings in 2003 translated into an estimated 2.5 billion square feet (ft^2) of floor area, 1.2 billion ft^2 of exterior wall area, and 2.2 billion ft^2 of roof area built (Table 1). Wood products were an important part of the mix of building products used in nonresidential buildings in 2003. An estimated 1,324 million board feet (bf) of lumber, 2,293 million ft^2, 3/8-in. basis, of structural panels (1,863 million ft^2 of softwood plywood and 430 million ft^2 of oriented strand board [OSB]), 76 million ft^2, 3/8-in. basis of nonstructural panels, 49 million linear feet (lf) of wood I-joists, 56 million bf of glulam timber, and 3 million cubic feet (ft^3) of structural composite lumber (SCL) were used. All reported volumes in this report include allowances for onsite waste and loss: lumber, and shakes and shingles – 10 percent, wood trusses and engineered wood products (I-joist, glulam, SCL) – 5 percent, and structural and nonstructural panels – 10 percent. Not included are the amounts of wood used for facilitation (formwork, scaffolding, etc.), millwork, and other non-construction uses. All wood-based panel volumes are on a 3/8-in. basis unless otherwise noted.

Nonresidential buildings use a diverse mixture of wood and nonwood building materials and building methods. The choice of materials and methods used are dependent on many factors including building type, location, and size, cost differentials between competing building materials, state and local building codes, architectural styles, and others. Also, wood may be used in specific applications even though the buildings may not be primarily built with wood, or specific applications may use wood more frequently than other applications. For example, on average about 12 percent of the schools in the United States are wood framed. A building's framing type (wood, concrete, or metal) is defined by the predominant building material in the exterior wall (Fig. 1). However, schools in the West region are much more likely to be wood framed than schools located elsewhere. Also, small concrete and metal-framed schools in all regions are more likely to have wood framed roof systems than large concrete and metal framed schools. In order to capture these differences, data for this study were stratified and evaluated by building type, region, size class, construction type, framing type, building application, and wood product.

Figure 1. Incidence of school framing type, by region, 2003.



This study was undertaken cooperatively by the USDA Forest Service, Forest Products Laboratory, Forintek Canada Corporation, and the Wood Products Council (WPC), and provides information on the amounts and types of wood products used in the construction of nonresidential buildings in 2003. This study does not include wood products used for nonbuilding construction (streets and highways, water and sewer systems, conservation and development, utilities, and other nonbuilding construction), nor does it include information on farm structures. Nonresidential construction studies were conducted by the WPC (then called the Wood Products Promotion Council) in 1995 (McKeever and Adair 1998) and in 1985 (WPPC 1987). Prior to 1985, studies on wood products consumption for new nonresidential building

construction were made in 1969 (Wright and Reid 1974, Reid and Wright 1974), 1973 (Reid 1977), and 1982 (Spelter and Anderson 1985).

Wood use estimates in this report are based on information on the frequency (incidence) of construction type, framing type, and wood product use (incidence of use), the amount of wood used per $1,000 of construction value (wood use factors), and the total value of nonresidential buildings put in place. Data to estimate incidence of use, and wood use factors were obtained from a sample of blueprints from the McGraw Hill Construction[1] online database of nonresidential building projects currently out for bid during the 3 month period June 1, 2003 through August 31, 2003. Total value of nonresidential construction and total floor area built data stratified by region and building type were purchased separately from McGraw Hill Construction, and were used to regionalize the value of construction put in place from the U.S. Department of Commerce, Bureau of the Census, and to estimate regional floor area. Descriptions of the analysis procedures used are in Appendix B.

Measures of Construction Activity

Construction activity for new nonresidential buildings is measured in both the value of the new construction and the total floor area built. Value of new construction, by building type, is available for the nation as a whole from the U.S. Department of Commerce (USDC 2006). Floor area built was estimated using floor area per $1,000 of expenditure for buildings in the incidence of use sample. Since building size and location affect wood products use, construction value and floor area were estimated by building size class and region.

[1]See http://www.construction.com/ for more information.

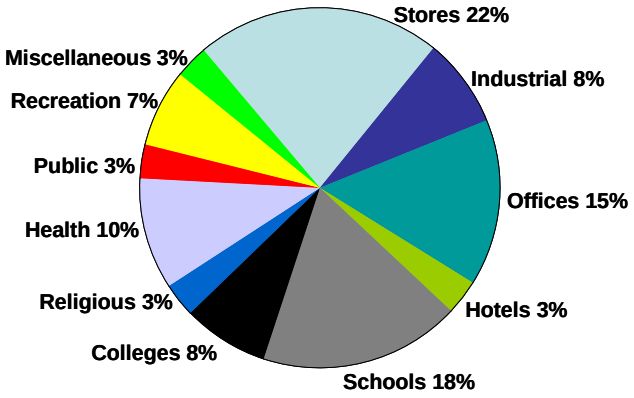
In order to make meaningful comparisons of construction value over time, actual (current) dollars spent were converted to constant 2000 dollars. Constant dollar value measures the level of construction activity with inflationary effects removed. Closely related to floor area is exterior wall area and roof area. Each affects the consumption of wood products, and areas built were estimated here by building size class.

Value of Construction

In 2003 the construction of low-rise nonresidential buildings in the United States was valued at $236 billion (2000 dollars) (Table 2). Nearly half (49 percent) of all construction value was for large buildings (of more than 50,000 ft^2 of floor area); one third (33 percent) for small buildings (50,000 ft^2 of floor area or less), and the remaining 18 percent for alterations and renovations (which have no associated floor area size). The South region had the largest construction value at $91 billion (38 percent), and the Northeast had the smallest at $39 billion (17 percent). Large buildings in each region accounted for about half of total construction value.

Stores were the highest valued building type in 2003 at $53 billion, 22 percent of all nonresidential building construction (Table 2, Fig. 2). Schools and office buildings ranked second and third in total construction value respectively. Combined, these three building types accounted for more than half (55 percent) of all construction value.

Figure 2. Nonresidential construction value, by building type, 2003.



Total construction value: $269,054 million.

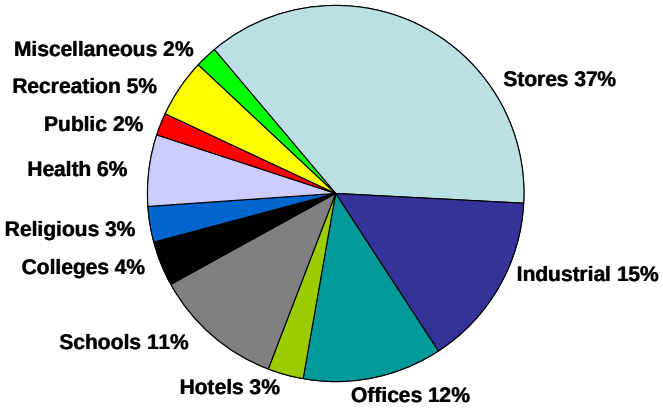
The value of nonresidential building construction rose steadily from 1995 through 2000 at an average rate of over 6 percent per year. Construction then began to fall through 2003 by nearly 6 percent per year. Construction value then rose slightly in 2004, only to fall again in 2005. Construction value in 2003 was about 9 percent higher than in 1995, but just over 5 percent higher in 2005 than 1995.

Floor Area

An estimated 2,523 million ft^2 of floor area were built in 2003 in nonresidential buildings (Table 2). Of this area, 59 percent was in large buildings, 41 percent in small buildings. Regional floor area trends closely follow regional construction value trends. More floor area was built in the South region than any other region, nearly two times as much as in the Northeast, the region with the least amount of floor area built. The remaining floor area was nearly equally divided between the Midwest and West regions. In all regions, large buildings accounted for about 60 percent of total floor area. Overall, about 3 percent of all floor area was below grade, 71 percent on grade, and 26 percent in upper stories.

Stores were the building type with most floor area built in 2003 – 929 million ft^2, 7 percent of all new nonresidential floor area (Table 2, Fig. 3). Industrial buildings ranked a distant second at 372 million ft^2, 15 percent of all new floor area built. Office buildings and schools accounted for 12 and 11 percent of the floor area respectively. Each of the remaining building types accounted for no more than 6 percent of all new floor area.

Figure 3. Nonresidential floor area built, by building type, 2003.



Total floor area built: 2,523 million ft^2.

The value of new construction per square foot of floor area averaged nearly $77 in 2003 (Table 2). Values in the Northeast were the highest at $93 per square foot, and lowest in the South at $69. Average value by building type and region ranged from a high of $164 per square foot for schools in the Northeast to just $45 for industrial buildings in the South. Overall, college buildings were the highest valued building type at $131 per square foot, industrial buildings the lowest at $48 per square foot.

Between 1995 and 2003, total nonresidential floor area built fell by nearly 300 million ft^2, from 2,820 to 2,523 million ft^2, but increased over 1985 when 2,390 million ft^2 were built (Table 3). There were many

differences evident in floor area built in 2003 compared to 1995. The largest floor area gain occurred in the combined schools and colleges building type with floor area increasing by 120 million ft^2 over 1995 levels, while religious buildings had the highest percentage increase at nearly 50 percent. New floor area in industrial buildings fell by 395 million ft^2 from 1995, more than for any other building type. Public buildings declined by more than 75 percent over 1995 levels. Despite the large decline in industrial floor area built, the combined floor area for stores and industrial buildings still accounted for more than half of all floor area built in 2003.
The average construction value per square foot of floor area for all building types combined remained surprisingly constant between 1985, 1995 and 2003, ranging from a high of $77.9 in 1995 to a low of $76.6 in 2003 (Table 3).

Exterior Wall and Roof Area

More than 1,300 million ft^2 of exterior wall area was built in 2003 (Table 4). Fifty-five percent, 714 million ft^2, of all exterior wall area was in small buildings. Total floor area is a good indicator of total exterior wall area by building type. Stores, the building type with the most floor area built in 2003, were also the building type with the largest exterior wall area. In fact, each building type ranked the same in relative amounts of both floor area and exterior wall area built. Factors which affect exterior wall area include size of building (smaller buildings require proportionally more wall area to enclose the floor area), floor to ceiling height, number of stories (multistory buildings require proportionally more wall area to enclose a given floor area), shape of the building, and other architectural characteristics. The average ratio of exterior wall area to floor area for all building types was 0.52, which means that for each square foot of floor area built, about half a square foot of exterior wall area was built. Miscellaneous buildings had the highest ratio at 0.64, while the health building type had the lowest at 0.34.

Total roof area built in 2003 was estimated to be in excess of 2,200 million ft^2 (Table 4). In contrast to exterior wall area, more than half (53 percent) was in large buildings. The correspondence between floor area and roof area is not so clear as in exterior walls. Stores and industrial buildings, the two largest building types for floor area were also the two largest types for roof area. Roof area for the remaining building types did not correspond to their relative floor area size. Factors which affect roof area are number of stories, roof style (flat, pitched, mansard, etc.), extent of overhang, and other architectural characteristics. Overall, 0.88 ft^2 of roof area were required per ft^2 of floor area built in 1995. Stores and industrial buildings had the highest ratio at 1.12, hotels the lowest at 0.39.

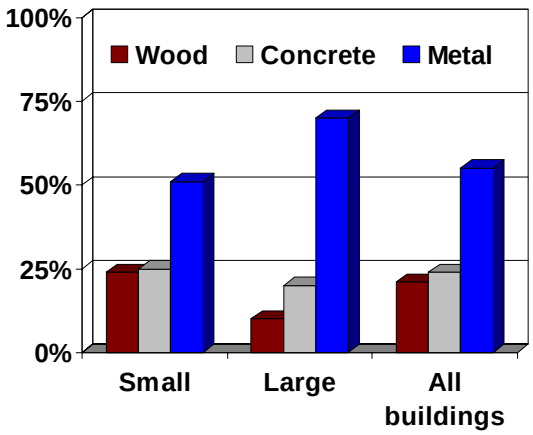
Principal Framing Type

Four principal framing types were identified in this study, and accounted for all nonresidential building construction: 1) wood, 2) concrete, 3) metal, and 4) other/none. Framing type was determined for each individual project by F.W. Dodge, and is defined to be the predominant type of structural material in the exterior wall. Wood construction includes lumber or other wood product framing, regardless of sheathing type; concrete construction includes concrete, masonry, stone, brick and block; metal construction includes primarily steel framing or support members; and other/none refers primarily to alterations and renovations which do not add floor space and thus do not have a framing type. Although some buildings are built entirely from the same structural material as the exterior walls, many combine two or more types of structural materials within or among specific applications in the building. For example, many concrete framed schools have wood framed roofs, or roofs with both

wood and steel framing members. This is why structural wood products are present in many buildings regardless of framing type.

In 2003 wood framed construction accounted for 21 percent of all buildings, concrete framing 24 percent, and metal framing 55 percent (Table 5, Fig. 4). Building size was a good indicator of both wood and concrete construction share in 2003. Small buildings were more likely to be wood or concrete framed than large buildings, while large buildings tended to be more often metal framed than small buildings.

Figure 4. Incidence of principal framing type, by size class, 2003.



Regardless of size class, metal was by far the dominant framing type in 2003.

Metal framing was the dominant framing type in all building types except for hotels in 2003 (Table 5). More than two-thirds of all industrial and college buildings were metal framed, while just 21 percent of all hotels were metal framed. Six of the 11 buildings types had more than 50 percent metal framed buildings. Large buildings were even more intensively metal framed than small buildings. Wood framing had the lowest overall incidence, but was the predominant framing type for hotels where more than one-half (52 percent) were wood framed in 2003. No other building types had wood framing incidence in excess of 50 percent. Health care and religious buildings were next highest wood framed with more than one-third of each being wood. With the exception of small health care buildings, all small buildings of up to 50,000 ft^2 had a greater share of wood framing than large buildings. Concrete framing was intermediate in intensity.

Framing type incidence in 2003 and in prior years may not be strictly comparable, particularly for large buildings, because the 2003 study excluded high-rise buildings of 5 or more stories, and because alterations and renovation projects were not assigned a framing type. Overall, wood and metal framing doubled between 1995 and 2003 at the expense of concrete (Table 5). The greatest changes were in large buildings where metal framing increased from 25 to 71 percent, and concrete framing fell from 70 to 20 percent. Some of this change may be directly attributable to the exclusion of high-rise buildings in 2003.

Wood Products Use, 2003

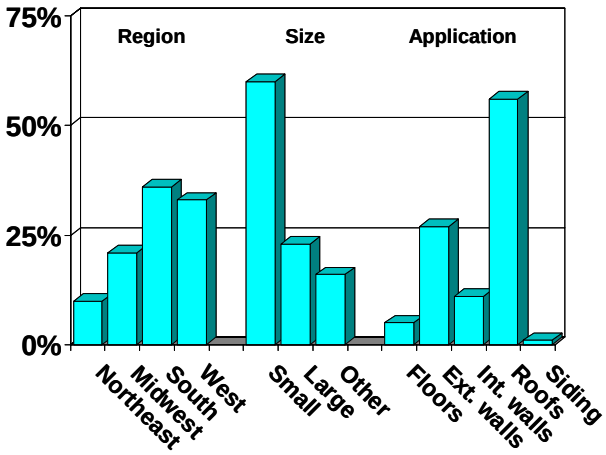
Wood products are important building materials in the construction of nonresidential buildings of all types and sizes. Specific products identified and reported here include lumber (framing and board lumber, shakes, shingles and siding, and wood trusses), structural panels (softwood plywood and oriented strand board [OSB]), nonstructural panels, and engineered wood products (wood I-joists, glulam timber, and structural composite lumber [SCL]). Amounts of each used were estimated by type of nonresidential building, region, size, class, and building application. Nonstructural panels, consisting of particleboard, medium density fiberboard, hardboard, insulation board and hardwood plywood, were reported as a single product type because of their relatively low level of overall use, and declining importance in the new nonresidential building market. All reported volumes in this report include allowances for onsite waste and loss: 10 percent for lumber (excluding trusses), 10 percent for structural and nonstructural panels, and 5 percent for engineered wood products. Not included in the reported amounts is wood used for facilitation (form work, scaffolding, etc.), millwork, and other nonbuilding-related uses. All wood-based panel volumes are on a 3/8-in. basis unless otherwise noted

Lumber

Lumber used for all nonresidential construction in 2003 was estimated to be 1,324 million bf (Table 6). The South was the region with the greatest use of lumber, followed closely by the West. Use for these two regions was 480 and 433 million bf respectively. The Northeast used the least amount of lumber in 2003.

Building size greatly affected lumber use in 2003. Small buildings accounted for 60 percent of all lumber used, and large buildings about 23 percent (Fig. 5). Other buildings (those where only alterations or renovations were made) used the remaining 17 percent. Size class differences are due largely to much higher incidence of wood as the principal framing type for small, as opposed to large, buildings (Table 5).

Figure 5. Percentage of lumber use, by characteristic, 2003.



Roofs were by far the building application with the greatest share of lumber use in 2003 at 747 million bf or about 56 percent of all lumber used (Table 6, Fig. 5). Included is dimension lumber for joist and rafter framing, roof trusses, timber beams and small amounts of deck boards. Dimension lumber, timber beams, and deck boards accounted for about one-third of the lumber used for roofs, and lumber trusses about two-thirds. Nearly one-fourth of all roofs use lumber trusses.

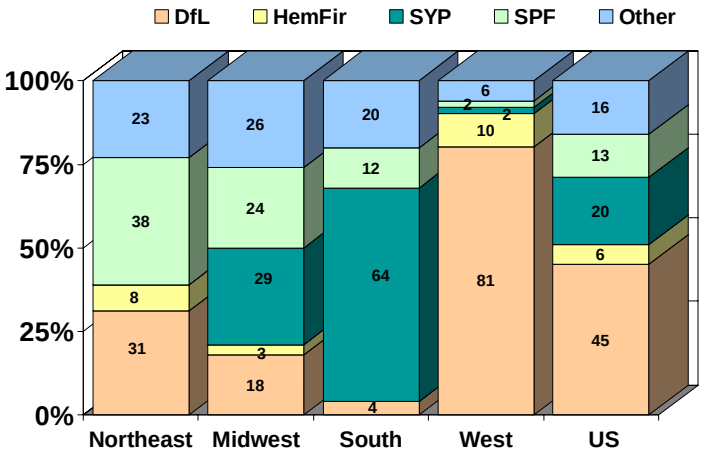
Exterior walls were the second highest lumber using application, and accounted for 27 percent of all lumber used, less than half as much as roofs. Interior walls, floors, and siding followed in decreasing order, and accounted for the remaining 17 percent of total lumber used. Floors accounted for just 5 percent of total lumber use. The relatively small amount of lumber in floors is due, in part, to the very large number of one-story buildings that have concrete slab on grade floor systems. Very little lumber siding was

used, less than 1 percent of total lumber consumption.

Species Composition and Treatment

Five species groups of framing and board lumber were used for the construction of nonresidential buildings in 2003. These were –Douglas fir-larch (DfL), Hemlock-fir (HemFir), Southern yellow pine (SYP), Spruce-pine-fir (SPF) and Other (See Appendix A for definitions). Although actual amounts of lumber used by species group were not measured, their frequency of use when specified in blueprints was measured. Overall, lumber was specified by species just over one-fourth of the time. When species were specified, DfL was specified 45 percent of the time, more than any other species group (Fig. 6). SYP was specified 20 percent, SPF 13 percent, HemFir 6 percent, and other species 16 percent of the time. Construction in the South and West tended to use species indigenous to the region. Sixty four percent of the lumber specified in the South was SYP, and 81 percent specified in the West was DfL. Species composition in the Northeast and Midwest tended to be more evenly distributed over all species groups.

Figure 6. Percentage lumber use, by region and species, 2003.



The frequency of truss lumber specification within three species groups (DfL, SYP and SPF) was also measured. Overall, about 45 percent of specified truss lumber was DfL, 40 percent SYP, and the remaining 15 percent SPF. As with framing lumber and boards, regional preferences were evident for truss lumber. About 70 percent of the truss lumber specified in the South was SYP, and nearly all the truss lumber specified in the West was DfL. Other regions used a mixture of all three species groups.

Preservative treated and fire retardant treated wood (lumber and softwood plywood) were both used in nonresidential buildings in 2003. Being highly specialized products, it was difficult to ascertain the extent of use based on blueprint specification. In general, preservative treated wood was specified about 15 percent of the time, and fire retardant wood about 5 percent. Little regional variation in treated wood specification was apparent.

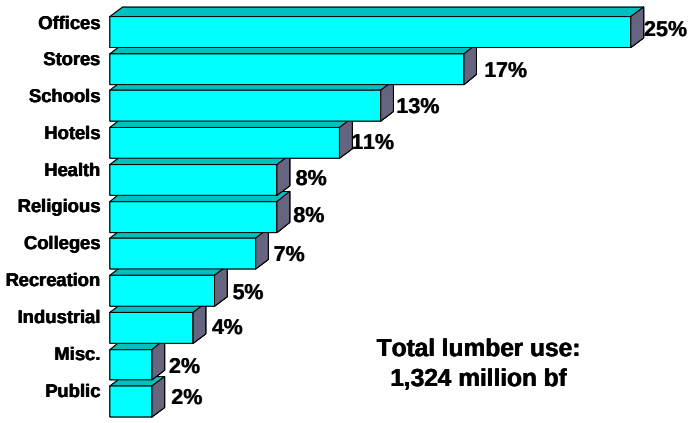
Use by Building Type

Many factors affect the use of wood products in the construction of nonresidential buildings, with building type perhaps being the single largest determining factor. Within each building type, variations in wood use are affected by geographical location of buildings, size of buildings, and by specific applications within the buildings. Tables 7, 8 and 9 report lumber, structural panel, nonstructural panel and engineered wood use by building type and region, building type and size class, and building type and application.

The construction of new office buildings and additions, and for their alterations and renovations used 325 of the 1,324 million bf of lumber used in 2003 for nonresidential building construction, which accounted for one-fourth of all lumber used (Table 7, Fig. 7). Stores and schools were next highest at 231 and 166 million bf respectively. These three building types combined used more than 722 million bf of lumber and accounted for well over half of all lumber used.

Industrial, miscellaneous, and public buildings were the least lumber intensive building types, combining for just 90 million bf of lumber, and accounted for only 7 percent of all lumber use.

Figure 7. Percentage lumber use, by building type, 2003.



Regional lumber use for all building types combined was greatest in the South at 480 million bf, closely followed by the West at 433 million bf. These two regions combined accounted for two-thirds of all lumber used. About one-third of the remaining lumber was used in the Northeast region (133 million bf), and two-thirds in the Midwest (278 million bf) (Table 7). Different regional patterns of use and greater regional variations were evident within specific building types. Schools, colleges, recreation, stores, health, and public buildings in the West used more lumber than was used in other regions within these building types. Hotels, offices, and religious buildings in the South, and miscellaneous, and industrial buildings in the Midwest used more lumber than was used in other regions within these building types. The Northeast region never used more lumber than any other single region in any building type. More lumber was used for office buildings in the South than for any other building type or region, and public buildings in the Midwest used less lumber than any other building type or region. Regional variation in lumber use by individual building types between the lowest and highest lumber using region ranged from a low of less than twice as much for public and miscellaneous buildings, to a high of more than 15 times as much for hotels. Regional variations in lumber use are attributable in part to size differences between regions, differences in traditionally accepted architectural styles and building practices, differences in environmental factors such as snow load requirements, earthquake resistance and insect resistance between regions, and differing levels of success of ongoing wood products promotion activities.

Building size class was a very good indicator of lumber use in 2003. Small buildings with 50,000 ft^2 or less of floor area used 800 million of the 1,324 million bf of lumber used, 60 percent of all lumber used (Table 8). Large buildings (50,000 ft^2 or more of floor area) used just over 300 million bf, or about one-fourth of all lumber used. The remaining 217 million bf was used for alterations and renovations to existing buildings. Alteration and renovation projects do not add floor area to the building; so do not have a floor area or size class associated with them. Size class variations in lumber use by building type range from small hotels using less than 2 times as much lumber as large hotels, to small religious buildings using 37 times as much lumber as large ones. Size class variations in lumber use are due largely to much higher incidence of wood as the principal framing type in nearly all small buildings with the exception of health care, compared to large (Table 5).

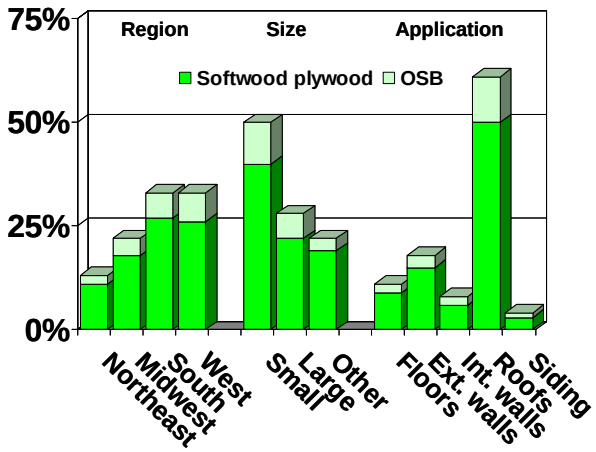
More lumber was used in roof systems than in any other building application in 2003, accounting for nearly 750 million of the 1,324 million bf of lumber used for nonresidential construction (Table 9). This level of consumption is more than half (56 percent) of all lumber used. Exterior walls were a distant second at 27 percent, less than half that of roofs (Fig. 5). Interior

walls (11 percent) and floors (5 percent) were third and fourth in lumber use intensity. Very little lumber siding was used. One reason for the high percentage of lumber in roofs is that not only do wood framed buildings typically have wood roof systems, but many concrete framed buildings also use either all wood framed roofs, or hybrid wood-metal roof systems. Roofs in office buildings accounted for the largest percentage of lumber used in an individual building type at 79 percent of all lumber used. Lumber use by application varied somewhat among building types. Roofs were the largest lumber using application in all building types except for schools where exterior walls were the major lumber application. In nine of the 11 building types, exterior walls were the second largest lumber using application. Interior walls were the second highest lumber using application in hotels at 31 percent of all lumber used, slightly below roofs by 1 percentage point. Variations in relative lumber use by application among building types is directly attributable to characteristics specific to the building type. Many hotels for example tend to be wood framed structures with 2 stories and numerous interior walls and partitions. The first (ground) floor is typically poured concrete, and upper floors wood framed. For these reasons hotels have the greatest percentage of lumber in interior walls and floors than any other building type.

Structural Panels

Total structural panel use in all nonresidential building construction was estimated to be 2,293 million ft^2 in 2003 (Table 6). The South and West regions were the two regions with the highest structural panel use with each using about one-third of the total (Fig. 8). The remaining one-third was divided between the Northeast and Midwest regions at about one-third and two-thirds respectively. When structural panels were specified by type in blueprints, about 20 percent was OSB and 80 percent softwood plywood. This ratio was fairly consistent across all regions with the exception of the Northeast where OSB was about 15 percent of structural panel use. Actual percentage of OSB use may be higher than indicated because it is not uncommon for contractors to substitute between softwood plywood and OSB structural panels.

Figure 8. Percentage of structural panel use, by building characteristic, 2003.



Building size greatly affected structural panel use in 2003. Small buildings accounted for one-half of all panel use, large buildings 28 percent, and the other size class, specifically alteration and renovation projects, the remaining 22 percent (Fig. 8). If the other size class were removed, small buildings would account for nearly two-thirds of consumption, large buildings one-third. Differences by size class were similar to that for lumber, but not so pronounced, and were due primarily to much higher incidence of wood as the principal framing type in small buildings compared to large buildings (Table 5). Not surprisingly, roofs were the building application with the greatest share of structural panel use in 2003 at 1,390 million ft^2, 61 percent of total structural panel use (Table 6, Fig. 8). Exterior wall sheathing was a distant second at 18 percent, followed by floors, interior walls and siding. The high share of structural panel use in roofs compared to other applications is due

in part to the use of wood roof systems on predominately nonwood buildings, and the use of nonwood sheathing panels on wood framed exterior walls. Only minor variations existed in the mix of softwood plywood and OSB used in specific building applications.

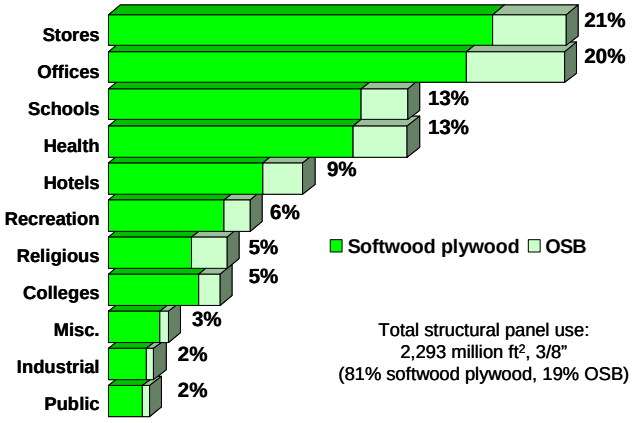
Species Composition and Treatment

Structural panel species, specifically softwood plywood panel species, are virtually never specified. Instances where specific species were specified were too few from which to draw any logical conclusions. Preservative treated and fire retardant treated wood (lumber and softwood plywood) were both used in new nonresidential buildings in 2003. See **Species Composition and Treatment** for **Lumber** above for a discussion of treated wood use in new nonresidential buildings.

Use by Building Type

Over 40 percent of all structural panels in nonresidential building construction in 2003 were used by two building types-stores and offices (Fig. 9). Each used about 470 million ft^2 of the 2,292 million ft^2 of structural panels used in 2003 (Table 7). Schools and hotels each used 13 percent of all structural panels. Health care buildings used 9 percent, and the remaining six building types each used 6 percent or less of all structural panels, and accounted for about one-fourth of total structural panel use. The share of softwood plywood vs. OSB varied somewhat by building type. Overall about 81 percent of all structural panels were specified as softwood plywood, 19 percent OSB. Religious buildings used the lowest share of softwood plywood at about 70 percent, miscellaneous buildings the highest at 86 percent.

Figure 9. Percentage of structural panel use, by building type, 2003.



Structural panel use by region for all building types combined varied considerably, from a low of 282 million ft^2 in the Northeast to a high of 763 million ft^2 in the South, nearly three times that of the Northeast (Table 7). Different regional patterns of use and greater regional variations were evident within specific building types. The South and West regions each had the highest structural panel use in four of the 11 building types, the Midwest in two building types, and the Northeast in one. Regional variation in structural panel use by individual building type was greatest for hotels. Hotels built in the South used 74 percent of all structural panels used for hotels in 2003, compared to just four and 5 percent respectively for hotels built in the Midwest and Northeast.

Structural panel use by building size class was heavily weighted toward small buildings of 50,000 ft^2 or less. Small buildings used one half, or 1,145 million ft^2 of all structural panels used in 2003. Large buildings used 636 million ft^2, and existing buildings used the remaining 511 million ft^2 for alterations and renovations (Table 8). Small buildings in all building types except for two used more structural panels than large buildings. Size class variations by building type ranged from small schools and small health care buildings which used 80 percent of the structural panels that large ones did, to

small miscellaneous buildings using 48 times more structural panels than large ones. Overall, small buildings used about 1.8 times more structural panels than large buildings. Size class variations in structural panel use are due largely to much higher incidence of wood as the principal framing type in nearly all small buildings, with the exception of health care, compared to large (Table 5).

Structural panel use by building application in 2003 was predominately for roofs, accounting for 61 percent of all structural panels used (Fig. 8). Exterior walls and floors were a distant second and third at 18 and 11 percent of all structural panels respectively. Just 7 percent of all structural panels were used for interior walls and 3 percent for siding.

Office building roofs were the single largest use for structural panels in 2003 at nearly 378 million ft^2, followed by store roofs at 275 million ft^2 (Table 9). Although roofs consistently ranked as the top structural panel using application in every building type, the percentage of use within a building type varied. Hotel roofs used the least amount of all structural panels in hotels (33 percent), while office and miscellaneous building roofs used the greatest (80 percent). Exterior walls were the second highest structural panel application in seven building types, floors in four building types.

Softwood plywood as a percent of all structural panels averaged about 80 percent for all building types combined. This percentage varied from about 66 percent softwood plywood for interior walls in religious buildings to about 90 percent softwood plywood for interior walls in industrial buildings. About 80 percent of structural panel siding was softwood plywood. The percentage of softwood plywood to OSB varied by building type from a high of 86 percent in schools and miscellaneous to a low of 76 percent in religious buildings.

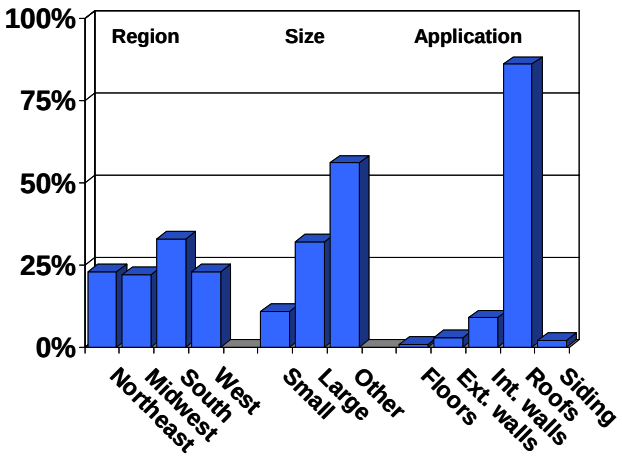
Nonstructural Panels

The use of nonstructural wood panels in nonresidential building construction was small in 2003, totaling just 76 million ft^2 (Table 6). Regional use was fairly evenly distributed across all regions, with the South using slightly more than other regions (Fig. 10).

Nonstructural panel use by building size class was largely for the other (alterations and renovations) size class. These buildings used more than half (53 percent) of all the nonstructural panels, and were the only wood product where use exceeded that for large and small buildings combined (Figure 10). Large buildings used about one-half the volume of nonstructural panels as other buildings, and small buildings about one-third of that used by large buildings.

Nonstructural panels are typically not used in applications requiring a structural building component, which tends to greatly restrict their use. In 2003, 86 percent of all nonstructural panels were used in roofs, primarily as underlayment and insulation for flat, nonwood roofs. Small amounts were also used for floor decking, wall sheathing, and siding (Fig. 10).

Figure 10. Percentage of nonstructural panel use, by building characteristic, 2003.



Use by Building Type

Nearly three-fourths (72 percent) of all nonstructural panels were used in schools in 2003. Each of the remaining building types accounted for 6 percent or less of total nonstructural panel use.

Regional nonstructural panel use was fairly well distributed across all regions, with the South using slightly more than other regions (Table 7). Individually, the other building size class used more nonstructural panels than large and small buildings combined (Table 8). Since nonstructural panels were predominately used for schools, characteristics for schools largely determine use characteristics for all building types. In addition to schools, four other building types used nonstructural panels more in the other size class, than in large and small sizes combined. Three building types (stores, office buildings, and hotels) used more nonstructural panels in small buildings than large or other, and 2 building types (industrial and miscellaneous) used virtually no nonstructural panels.

Overall, roof applications accounted for the largest share of nonstructural panel use in 2003 (Table 9). More than 65 million of the 76 million ft^2 of nonstructural panels used were used for roofs. Minor variations in the distribution of use within individual building types was evident.

Engineered Wood

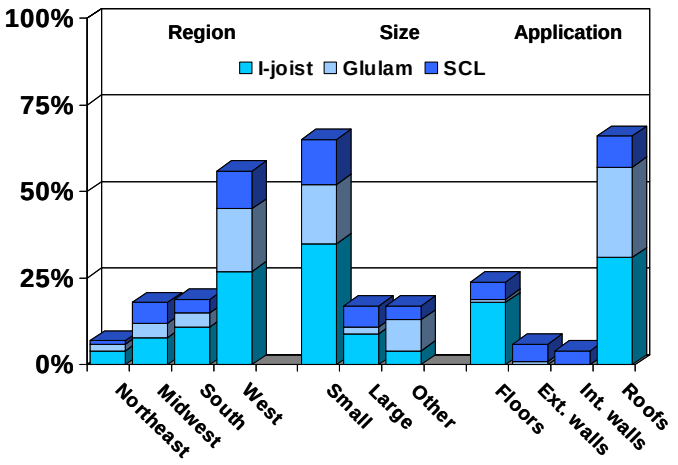
Engineered wood includes a growing family of wood-based building products made from adhesively bonded wood veneers, strands, or flakes. Included here are prefabricated wood I-joists (I-joists), glued laminated timbers (glulam), and structural composite lumber (SCL). SCL includes laminated veneer lumber, parallel strand lumber and oriented strand lumber. (See Appendix A for specific product definitions.) These structural products substitute for lumber and nonwood building products in a variety of floor, wall and roof framing applications. Softwood plywood and OSB are also considered by many to be engineered wood products, but because their primary use is sheathing and decking rather than framing, they were reported separately above.

In 2003 an estimated 48.6 million linear feet (lf) of I-joists, 56 million bf of glulam, and nearly 3 million cubic feet (ft^3) of SCL were used in nonresidential building construction (Table 6). These volumes are equivalent to about a volume of 198 million bf. As such, I-joists accounted for about 49 percent of all engineered wood use, glulam 28 percent, and SCL 23 percent. About 70 percent of the SCL was LVL. Engineered wood use in the West exceeded use in all other regions, with 55 percent of all I-joists, 65 percent of all glulam and 48 percent of all SCL being used. This represents about 56 percent of all engineered wood use (Fig. 11).

Overall, more engineered wood was used in small buildings than buildings in the other two size classes in 2003 (Fig. 11). Percentage use for individual engineered wood products varied from a high of 72 percent of all I-joists to 59 and 58 percent of all glulams and SCL respectively being used in small buildings.

Overall, small buildings used about 65 percent of all engineered wood.

Figure 11. Percentage of engineered wood use, by building characteristic, 2003.



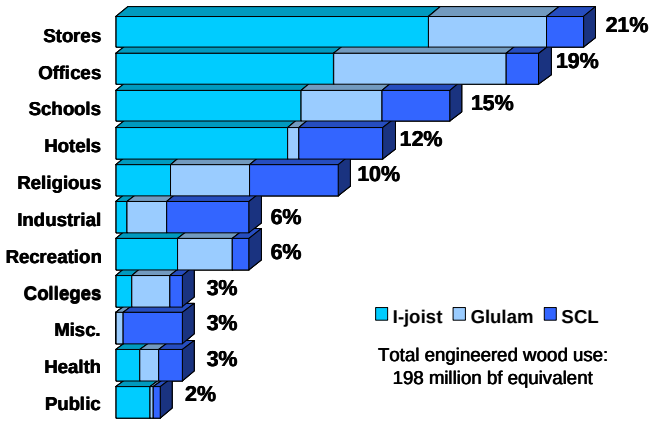
Roofs were by far the dominant use for each engineered wood product. The use of glulam timbers in roofs accounted for more than 90 percent of total glulam use in 2003. Wood I-joist use was second at about 60, and SCL lowest at 40 percent. Overall, roofs accounted for 66 percent of all engineered wood use in 2003 (Fig. 11). Much of the variation by application for individual engineered wood products is due to the uses for which they are designed, and for which they can substitute for framing lumber. I-joists are used primarily for floor and roof framing, and occasionally for door and window headers in walls. Since floors have a much lower incidence of wood as the principal construction type than roofs, and since wood roofs are more common on otherwise nonwood buildings, I-joist use in roofs was greater than that for floors. Also, door and window headers are a small component of wall framing, causing I-joist use in walls to be quite small. The principal use for glulam timbers is as large, often decorative, roof beams and girders where large, clear spans are required. Glulam use in 2003 was principally in roofs, accounting for 92 percent of all use.

Principal uses for SCL include support beams and girders, primarily in roofs, rim joists in wood framed floor systems, door and window headers, and as chord material in I-joists. SCL estimates here do not include use as I-joist chords. In 2003, about 40 percent of all SCL was used in roofs. Floors, exterior walls, and interior walls each used about 20 percent of total use.

Use by Building Type

Engineered wood use varied considerably by building type and product. However, some overall trends were evident. Stores and office buildings used more engineered wood in 2003 than other building types, and accounted for about 40 percent of total use (Fig. 12).

Figure 12. Percentage of engineered wood use, by building type, 2003.



This was equivalent to 49 percent of all I-joists, 47 percent of all glulam, but just 14 percent of all SCL. Schools, hotels and religious buildings were also important markets, and were intermediate in their use of engineered wood. Combined they accounted for 37 percent of total use. The remaining 6 building types used small amounts of engineered wood, 6 percent of total use or less. Much of the variation in use by building type was due to the ability of a specific engineered wood product to satisfy framing needs of the particular building type.

Nonresidential buildings in the West used, on average, more engineered wood than any other region in 2003. I-joist and glulam use was highest in the West in 8 of the 11 building types (Table 7), which accounted for 46 and 60 percent of total use respectively. SCL use was also high in the West in six building types which captured 40 percent of the SCL market.

Small buildings of 50,000 ft^2 or less were the leading market for engineered wood. In 2003 I-joist use was greater in small buildings of every type except for large schools, and accounted for 35 million of the 49 million lf of I-joist used (72 percent) (Table 8). With the exception of two building types, both glulam and SCL use was also greater in small buildings, at 59 percent and 58 percent of total use respectively. It is interesting to note that large schools used more of each engineered wood product than other size classes.

Overall, roofs were the building application using more engineered wood than other applications. I-joist, glulam, and SCL use in roofs accounted for about 60, 90 and 40 percent of total use, respectively. However, minor variations were evident by building type. Hotels tended to use more I-joists and SCL in floors than in other applications (Table 9). Floors in offices, health care, and miscellaneous buildings used more I-joists than did other applications, and walls in religious buildings used more SCL than did other applications.

Wood-Use Factors, 2003

Wood-use factors measure the amount of a specific wood product used per unit of construction activity, i.e., the rate of wood use. Two sets of wood-use factors were estimated for new nonresidential building construction in 2003: wood use per $1,000 of constant (2000) dollar construction value, and wood use per square foot of finished floor area built. Each was stratified by building type, region, building size class, and application, and provide a means of comparing the relative extent of wood use within each stratum. For example, industrial buildings used the least amount of structural panels per $1,000 of construction value of all building types in 2003 at 2.52 ft^2 (Table 10). In comparison, hotels used the greatest amount of structural panels at 27.43 ft^2 per $1,000. Average structural panel use for all buildings combined was 9.70 ft^2 per $1,000 of construction value.

Wood-use factors also provide a means for estimating future levels of wood use for a given level of construction activity. For example, if the total constant 2000 dollar value of all nonresidential building construction in 2006 were known, then total structural panel use for all building types combined could be estimated as:

$$\text{Structural panel use}_{2006} = \text{Value}_{2006}/1{,}000 \times \text{structural panel use factor}_{2003}$$

Several assumptions are implicit in the resulting structural panel use estimate. Since specific building types use structural panels at different rates, estimated use for all building types implies that the relative mix of building types did not change. That is, the construction value for each building type in 2006 accounted for about the same proportion of total construction value as in 2003. Also, the use of structural panels

within a specific building type changes over time as structural panels substitute for, or are replaced, by other wood or nonwood building products. The above estimation procedure assumes that no change in the relative amounts of structural panels used occurred between the base year (2003) and the estimation year (2006). Over a short period of time these assumptions may be valid, but undoubtedly will change over longer time periods.

Wood use factors also provide a means of gauging changes in overall wood products use from activities that tend to change use factors. If promotion efforts to increase the amount of structural panels used in roof systems is expected to increase use by 20 percent in 2006, then total structural panel use in roofs can be estimated as:

$$\text{Structural panel use}_{2006} = \text{Value}_{2003}/1{,}000 \times (\text{Structural panel use factor}_{2003} \times 1.2)$$

Wood use factors can also be used to identify those building types or regions which use wood at rates below all building averages, or below desired minimum levels of use. These building types or regions can then be targeted for additional promotional activity.

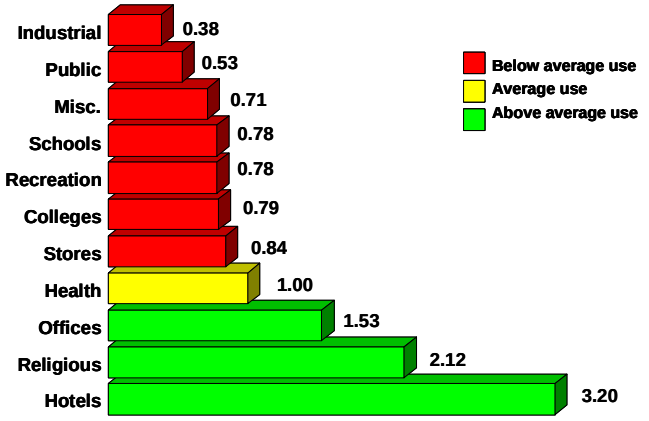
Use per $1,000 of Construction Value

On average, more structural panels were used per $1,000 of constant (2000) construction value than any other wood product at 9.70 ft^2 (7.88 ft^2 of softwood plywood, and 1.82 ft^2 of OSB) (Table 10). Lumber was second highest at 5.60 bf. Use of nonstructural panels and engineered wood products were all less than 1.00.

Hotels were the most wood intensive building type in 2003. With the exception of nonstructural panels and some engineered wood products, more wood of each product type was used per $1,000 of construction value than for any other building type (Table 10). In order to compare total wood use (all wood products combined) per $1,000 of construction value by building types, an index of wood use was constructed. For each building type, use per $1,000 of each wood product was first converted to board foot equivalents[2], and then summed over all wood products. This total use per $1,000 for each building type was then divided by the total use per $1,000 for all buildings combined. The resulting index measures the relative magnitude of wood use per $1,000 compared to the all-building average. The index values for hotels and religious buildings were 3.20 and 2.12 respectively. This means that hotels used more than three times more wood per $1,000 of construction value than the average building, and religious buildings used more than twice as much wood than average (Table 10, Fig. 13). Industrial buildings were the least intensive wood using building type, with an index value of 0.38. Health care buildings, with a wood use index value of 1.00, used wood at the same rate as the average nonresidential building in 2003. Similar indexes were constructed for use per $1,000 by region, by size class, and by application.

[2] Factors used to convert panels and engineered wood products to board foot equivalents. Note, panel conversion based on actual, not nominal dimensions:
Structural and nonstructural panels:
1 ft^2 (3/8-inch basis) = 0.5 bf
Wood I-joists
1 lf = 2 bf:
Structural composite lumber:
1 ft^3 = 16 bf

Figure 13. Index of wood use per $1,000 of construction value, by building type, 2003.



Wood use was considerably and consistently higher in the West than in other regions. About 40 percent more wood products were used per $1,000 of construction value in the West than in all regions combined. Nonstructural panels were the only wood product which was not used in greater amounts in the West than other regions.

Small buildings (50,000 ft^2 of floor area or less) used wood at much higher rates than buildings of other size classes. About 60 percent more wood was used per $1,000 of construction value in small buildings than the average building.

Roofs were consistently the most intensive wood using building application in 2003. All wood products were used at higher rates in roofs than other applications without exception. Exterior walls were second highest with overall wood use per $1,000 of construction value at about one-third that of roofs. Floors and interior walls were third and fourth in wood use per $1,000 of construction value, followed by siding.

Use per Square Foot of Floor Area

Wood products use per square foot of finished floor area is another measure of the intensity of wood products use in new nonresidential buildings. Since total construction value and area of finished floor area built are closely related, it is not surprising that relative intensity of wood products use per ft^2 of floor area by building type, region, size class and application are very similar to use per $1,000 of construction value. Overall, hotels and religious buildings remained the two most intensive wood-using building types in 2003 as measured by the wood use per ft^2 of floor area index value (Table 11). Industrial buildings were the least intensive. Buildings of intermediate use shifted slightly in order of importance when compared to use per $1,000.

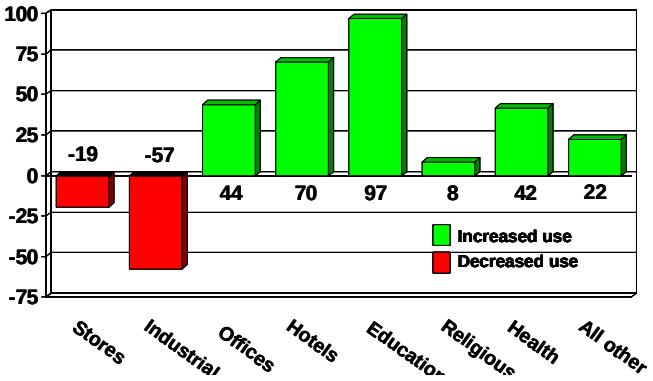
Buildings in the West and small buildings used more wood per ft^2 of floor area than buildings in other regions or size classes. Roofs were the most intensive wood-using building application, siding the least.

Wood-Use Comparisons, 1995 and 2003

Nonresidential construction is a very dynamic, changing market for both wood and nonwood building products. Some of the trends in wood products consumption which occurred between 1985 and 1995 continue, others do not. Between 1985 and 1995, the use of nearly every wood product, with few exceptions, decreased in nearly every building type. Total lumber use (including the board foot equivalent of engineered wood) fell 41 percent, structural panel use 44 percent, and nonstructural panel use 79 percent. This all occurred as the value of nonresidential construction increased by 16 percent. For a complete discussion of changes between 1985 and

1995, see McKeever and Adair 1998. Results from this study indicate that important changes in the downward trend in the use of wood in nonresidential buildings have occurred. The use of all wood products, in terms of their board foot equivalent, increased between 1995 and 2003 from 2.2 billion to 2.7 billion board feet, about a 21 percent increase (Table 12). Although well below the 3.8 billion bf of wood used in 1985, it is still a substantial increase from 1995, and a step in the right direction. This is not to say that all wood products increased in use between 1995 and 2003. Lumber use continued its decline, falling by 11 percent from 1995 levels to 1,324 million bf. Substitution is perhaps the single largest reason for the steady decline in lumber use in the past 20 years. Both engineered wood products, such as wood I-joists, and nonwood products, such as steel studs, can directly substitute for framing lumber. Also, engineered wood products can replace large dimension solid sawn lumber which has become scarcer, and more expensive over the years. Lumber consumption is directly dependent on the extent of this substitution. Hybrid building systems, which combine wood and nonwood materials, also impact lumber consumption much more than structural panel consumption because many hybrid systems replace framing components rather than sheathing components. Structural panels posted the largest absolute volume gain, increasing by more than 1,127 million ft^2 to 2,293 million, nearly a twofold increase. Nonstructural panels posted the greatest percentage gain, due largely to its large decline between 1985 and 1995. Although use increased by nearly 6-fold, actual use increased just 63 million ft^2 to 76 million. Engineered wood increased modestly from 188 to 198 million bf equivalent.

Figure 14. Percentage of change in wood use, by building type, 1995 and 2003.



Changes in wood use between 1995 and 2003 varied considerably by building type. In order to facilitate comparisons between 1995 and 2003 several building types had to be combined. Schools and colleges were combined to form the “Education” building type, and public, recreation and miscellaneous were combined to form the “All other” building type. Education had the largest increase in combined wood use between 1995 and 2003 in terms of both amount (266 million bf), and percentage (97%). Conversely, industrial building had the greatest overall decrease in both amount (-111 million bf), and percentage (-57%) (Table 12). Of the eight building types, two had declining, and six increasing combined wood use (Fig. 14). Lumber was the only wood product which declined in total use between 1995 and 2003. Five of eight building types fell, three increased. Stores had the greatest reduction at 41 percent, education the greatest increase at 39 percent. Structural panel use increased in all building types except for industrial. Industrial use fell by about 70 percent. Health care buildings increased structural panel use by more than fourfold. Nonstructural panel use increased overall due solely to huge gains in education buildings. Changes in all of the other building types were modest. Overall, engineered wood use increased about 5 percent between 1995 and 2003. However, large changes were seen in several building types. Industrial buildings

used 80 percent less engineered wood in 2003 than in 1995, while hotels had a six-fold increase in use. Three of eight building types used less engineered wood in 2003 than 1995.

Many factors contributed to the ongoing changing use of wood in new nonresidential building construction. Some are anecdotal, others more quantifiable. Some of these are:

- An increase in total value of nonresidential construction measured in constant (2000) dollars between 1995 and 2003 would tend to increase overall wood use.

- A decrease in total floor area between 1995 and 2003 would tend to decrease overall wood use. But the effect of removing alteration and renovation projects from floor area in 2003 may offset any actual declines in wood use.

- A fairly constant share of small vs. large buildings which tend to maintain levels of wood use because small buildings typically use more wood per square foot of floor area than large buildings.

- A slightly lower constant dollar construction value per square foot of floor area in 2003 may, or may not, affect overall wood use depending on the relative costs of wood vs. nonwood building materials.

- An increase in the mix of building types constructed which are more wood intensive would tend to increase overall wood use.

- An overall increase in the proportions of wood framed buildings to other framing types in 2003 would tend to increase wood use.

- The increased use of metal framing largely at the expense of concrete framing in 2003 may have mixed effects on overall wood use depending on the extent of wood use for uses other than exterior wall framing in each framing type.

- Rapid adoption of the International Building Code for nonresidential construction would tend to favor increased overall wood use because it creates more opportunities for wood use. (See the Potential Wood Products Market Growth section of this report for a more complete discussion.)

- The rate of adoption of new wood building products and systems, new nonwood building products and systems, and hybrid wood/nonwood building products and systems which affect overall wood use.

The changing use of wood in nonresidential building construction between 1995 and 2003 affected average wood use per $1,000 of constant (2000) construction value, and average wood use per square foot of finished floor area. Overall, combined wood products use increased from 10.2 to 11.5 bf per $1,000 of construction value in 2003 (Table 13). This was about a 12 percent increase. Lumber use fell by about 1 bf per $1,000 to 5.6 bf. Both structural and nonstructural panel use per $1,000 of construction value increased. Structural panel use increased from 5.3 to 9.7 ft^2 per $1,000 of construction value, more than an 80 percent increase. Nonstructural panel use increased by about 450 percent, but in terms of actual amounts used per $1,000 of construction, it increased from less than 0.1 to 0.3 ft^2. Engineered wood use per $1,000 remained essentially unchanged. Much variation in the change combined wood use per $1,000 between 1995 and 2003 among building types was evident. Hotels nearly doubled its use while use for stores and religious buildings fell by 25 percent.

The use of all wood products combined per square foot of floor area also increased between 1995 and 2003 by about 9 percent (Table 13). It should be noted that use per square foot of floor area estimates for 1995 and 2003 are not strictly because of the change in study design between the two years. In 2003 alteration and renovation projects were not included in floor area estimates because technically they have no floor area associated with them. They use building products, but do not add new floor area. Including alteration and renovation projects in 2003 would increase wood use while not increasing floor area, causing use per ft^2 of floor area to be artificially high. Excluding these projects makes comparison between the two years more meaningful. Also, since floor area is so closely correlated to construction value, trends in use per $1,000 of construction value closely reflect trends in use per ft^2 of floor area.

U.S. Wood Products Consumption

Overall, the construction of nonresidential buildings in 2003 accounted for just over 3 percent of total U.S. consumption of lumber, structural and nonstructural panels, and engineered wood products (Table 14). Structural panels and engineered wood products consumption each accounted for 6 percent of U.S. consumption. Glulam captured the largest share of the U.S. market at nearly 18 percent of consumption, and softwood plywood second at 12 percent. The market share for SCL was greater than indicated because large amounts are used for I-joist flanges. Differences in the percentage of total consumption between the various wood products were not unexpected. Products with a more diverse market base such as lumber and nonstructural panels tend to have lower percentage use in nonresidential construction than those with a more limited base.

Potential Wood Products Market Growth

The construction of new nonresidential buildings holds great potential for expanding the use of wood building products. In 2003 concrete and metal construction continued to dominate the nonresidential building construction market, accounting for nearly 80 percent of total construction (Table 5). Since 1995 wood framed construction made modest gains against concrete and steel, but additional gains are possible. Currently, only about 20 percent of all new buildings are wood framed. Numerous approaches to examine the potential amounts of wood which could be used in nonresidential building construction exist. The two most plausible approaches are the maximum potential wood use method, and the International Building Code method. Each are described below. It should be noted that alteration and renovation projects are not included in this discussion because they typically do not add new floor area, and because if building materials are used, they typically are determined by the existing building structure.

Maximum Potential Wood Use

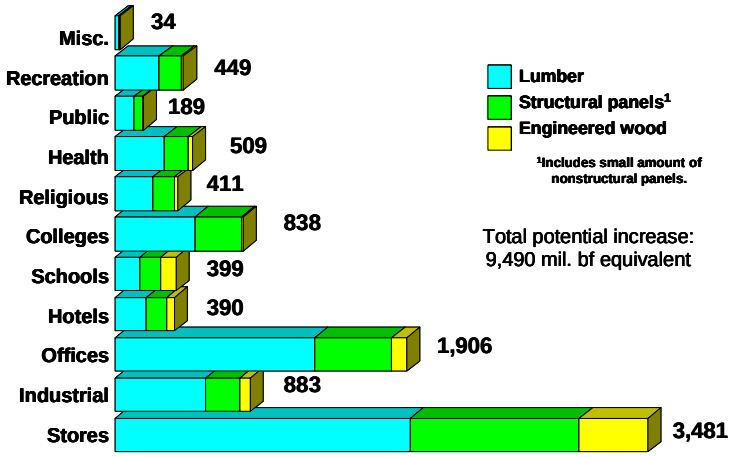
Substantial additional amounts of lumber and structural panels, and lesser amounts of engineered wood and nonstructural panels could be used if concrete and metal applications were built with wood. Realistically, very little, if any, wood will ever penetrate the foundation and ground level floor market. Also, if wood were to replace concrete and metal in other applications, the usage rate (volume of wood used per ft^2 of floor area) would not be expected to exceed current wood usage rates for applications which are principally built from wood.

In 2003, roof systems in small, wood framed office buildings in the Midwest

region averaged 2.6 ft^2 of structural panels per square foot of finished floor area. Roof systems in small, concrete framed office buildings averaged 0.8 ft^2 of structural panels per square foot of finished floor area. Thus, wood framed office buildings used 1.6 ft^2 more of structural panels than concrete framed buildings. The structural panel potential for roofs in small concrete framed office buildings would then be the total finished floor area in concrete buildings multiplied by 1.6 ft^2. A realistic limit to the maximum potential for wood products in new nonresidential buildings would be the amounts of these products which would be used if concrete and metal upper story floors, exterior and interior walls, roofs, and siding were built principally with wood at current wood usage rates.

In 2003 an additional 5,737 million bf of lumber and 5,769 million ft^2 of structural panels, 45 million ft^2 of nonstructural panels, and 846 million bf of engineered wood could have been used in new nonresidential buildings if all concrete and metal building applications, except foundations and ground level floors, were built with wood at usage rates similar to those for wood-based building applications (Table 15). This was equivalent to nearly 9,500 million bf of wood products (Fig. 15). Roofs had the greatest incremental potential for all wood products, accounting for just under one-half of the lumber, and structural and nonstructural panels potential (Table 16). Roofs accounted for three-fourths of total engineered wood potential. The West region had the highest share of engineered wood potential, while the South had the greatest share for all other wood products. Since large buildings typically use much less wood than small, the share of potential by size class strongly favored large buildings. Potential varied considerably by wood product and building type. In general, stores, office buildings, and colleges had the highest potential for nearly all wood products.

Figure 15. Potential increase in wood product use (new construction), by building type, 2003.



International Building Code

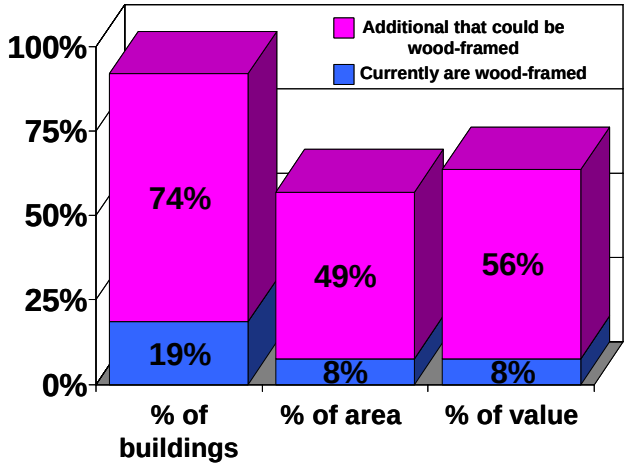
The previous section describes the theoretical maximum increase in wood usage, that is, the amount of additional wood consumed if every low-rise building were built almost entirely of wood. However, building codes in the United States place limits on the use of wood framing according to area, height and intended usage ("occupancy") of a building. Therefore, another way to estimate growth potential for wood in nonresidential construction is by using a code-limits approach. This method calculates the maximum increase in wood usage if only those buildings allowed by code to be wood framed were built with wood. For this analysis, the International Building Code (IBC) was used as it is the dominant model code currently in place in the U.S.

The IBC provides a table that defines area and height limits for each building code occupancy (school, mercantile, business, etc.) and for various types of structural assemblies that are defined by the code in terms of fire protection. For example, a school built with non-combustible exterior walls such as concrete block masonry and

heavy timber elements everywhere else would be defined as construction type IV, and would be limited to 25,500 square feet per floor and three stories (IBC 2003). If the intended school is to be larger than that, the designers would have to choose entirely non-combustible materials. Alternatively, the tabular area and height limits can be substantially increased through the addition of automatic fire protection sprinklers, and through the provision of substantial frontage to the building to enable easy firefighting access. In this analysis, the most aggressive assumptions were taken regarding sprinklers, use of fire-rated assemblies, and building frontages in order to capture the maximum code-allowable gain for wood. The estimate includes buildings that would be permitted to use wood in all assemblies, as well as buildings that could only use wood in some assemblies, such as roofs.

Buildings typically hit the code limit for wood due to building area rather than height, which means that the largest buildings are not available to wood. Although nearly all buildings (92%) do fall within code limits for wood, losing the largest buildings causes a proportionally larger loss of total constructed area available to wood (60%) (Figure 16). Area limits in the IBC can be overcome through the use of fire walls, highly fire-resistant wall assemblies that are used to subdivide a large building into smaller spaces, each of which is considered a separate building for code compliance. The maximum wood increase described in the previous section is essentially a calculation of wood potential usage if the area limits of the IBC were overcome due to the widespread use of fire walls in the largest buildings. Similarly, the future adoption of performance-based codes in the U.S. would likely remove most area and height limits for wood in the IBC, thus the previously described maximum wood increase could also be considered an estimate of market potential for wood under a revised code scenario. A few other countries have already implemented performance-based building codes, and this trend is expected to eventually affect North American codes.

Figure 16. Percentage of current and potential wood framing (new construction) based on the IBC, 2003.

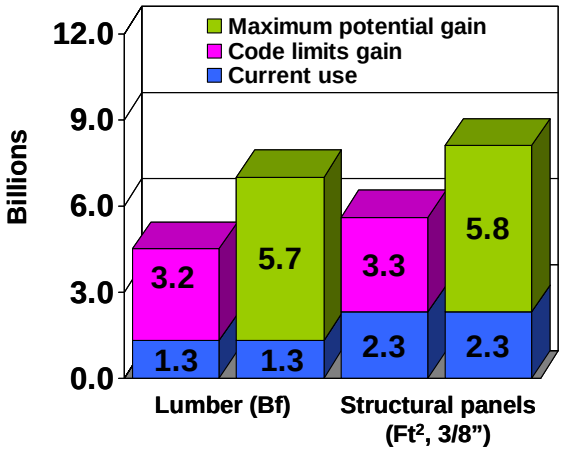


Recent widespread adoption of the IBC allows more buildings to be framed in wood as the area and height allowances are typically higher than in the previous three U.S. mode- building codes. Almost 64% of total constructed nonresidential value could be framed in wood in 2003, versus the 50% of value previously estimated using a similar method but under the previous U.S. codes (Goetzl and McKeever 1999).
Using a similar approach as described in the previous section, wood usage rates were applied to all concrete and steel buildings that were small enough to fall within the size limits in the IBC for wood – either all-wood or partially wood (IBC construction types III, IV and V). In 2003 an additional 3,216 million bf of lumber and 3,282 million ft^2 of structural panels could have been used in new nonresidential construction if every building allowed to have wood elements did (Figure 17).

Summary and Conclusions

The construction of nonresidential buildings in the United States is an important, but changing, market for lumber, wood-based panels, and engineered wood products. Unlike residential construction where wood is the dominate building material and limited variability in construction techniques exist, nonresidential building construction uses a diverse mixture of new and changing building products and construction techniques. The mix of building types also affects the amounts and types of wood used. When construction of buildings which tend to use more wood per unit of construction activity, such as hotels and religious buildings, is high, overall wood use tends to increase. When construction of buildings which tend to use less wood per unit of construction, such as public and industrial buildings, is high, lesser amounts of wood are used. Average building size also affects overall wood use. Smaller buildings tend to use wood more intensively than larger buildings, and both tend to use more wood than alterations and renovations. Variability best describes the overall nonresidential building market, and the types and amounts of building products used.

Figure 17. Current (all construction) and potential lumber and structural panel use (new construction), 2003.



The construction of nonresidential buildings in 2003 was valued at $236 billion, or about $193 billion in constant 2000 dollars. This level of construction translated into an estimated 82,000 new nonresidential buildings, plus large numbers of alterations and renovations to existing buildings. A total of 2.5 billion ft^2 of new floor area, 1.3 billion ft^2 of exterior wall area, and 22 billion ft^2 of roof area were constructed. In total, an estimated 1,324 million bf of lumber, 2,293 million ft^2, 3/8-in. basis, of structural panels, 76 million ft^2, 3/8-in. basis, of nonstructural panels, 49 million lf of wood I-joists, 56 million bf of glulam timber, and 3 million ft^3 of structural composite lumber were used.

If all wood products are converted to their equivalent board foot volumes and combined, then office buildings used more wood than any other building type in 2003. Public and miscellaneous buildings used the least. More wood was used in the West than other regions, and small buildings used more wood than large buildings.

In terms of overall combined amounts of wood used per unit of construction activity, hotels far exceeded all other building types. In 2003, hotels used more than 3 times the amount of wood per $1,000 of construction value than average. Religious buildings used about two times as much. Conversely, public and industrial buildings used one-half the amount of wood or less than average. Buildings in the West and small buildings both used about 1.4 and 1.7 times the average amount of wood per $1,000 of construction value respectively.

The value of nonresidential buildings in 2003 was about $9 billion (4 percent) greater than in 1995, measured in constant 2000 dollars. Combined wood products consumption was also greater in 2003 by about 20 percent, or 500 million bf. Much of this difference was due to a large increase in structural panel use and a small decrease in lumber use between the two years. Changes in nonstructural panel and

engineered wood use were small compared to lumber and structural panels. Combined use per constant 2000 dollar of construction value was about 16 percent higher in 2003 than in 1995.

Overall, the construction of new nonresidential buildings and the alteration and renovation to existing buildings was, and still is, an important market for wood products, but one which should not be taken for granted. Nonwood building products are continually challenging wood in many nonresidential building applications, as evidenced by reduced market shares for some wood products, and stagnant growth for others. Product uniformity and consistency, availability, cost advantage, performance, and acceptance all affect the choice of building materials used. Recent changes in building codes that permit wood construction in a wider range of applications should positively affect the use of wood products in the future. Wood products must be competitively priced in order to maintain and increase their share of the nonresidential building market, and remain a viable alternative in this market.

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Tables

Table 1. Value of all construction, and area and wood products consumption for nonresidential building construction in the United States, 2003.

Value of construction[1,2]	Bil. $	%
Residential	482	52
Nonresidential		
Buildings	283	31
Nonbuildings	159	17
Total, nonresidential	443	48
Total, all construction	925	100
Value of construction, low-rise nonresidential buildings[2,3]	269	
Area in new low-rise nonresidential buildings[3,4]	Mil. ft^2	
Floor area	2,523	
Exterior wall area	1,301	
Roof area	2,228	

Wood consumption in low-rise nonresidential buildings[2,3]	Mil.
Lumber (Bf)	1,324
Structural panels (Ft^2, 3/8" basis)	
Softwood plywood	1,863
OSB	430
Total, structural panels	2,293
Nonstructural panels (Ft^2, 3/8" basis)	76
Engineered wood	
I-joist (Lf)	49
Glulam (Bf)	56
Structural composite lumber (Ft^3)	3
Number of new, low-rise nonresidential buildings[3,5]	82,187

[1]Current dollars. Based on U.S.Department of Commerce, Bureau of the Census. 2006, and McGraw-Hill, 2006.

[2]Includes all construction.

[3]Buildings with four or fewer stories.

[4]Includes new construction and additions only. Alterations and renovations have no associated floor area.

[5]Includes new construction and additions only.

Table 2. Value, floor area, and value per square foot of floor area in nonresidential building construction in the United States, by building type, region, and size class, 2003.

Building type and region	Value of new construction[1]				Floor area[2]			Value per ft[2] of floor area, all buildings[4] ($)
	Small buildings[3] (Bil $)	Large buildings[3] (Bil $)	Other[3] (Bil $)	Total (Bil $)	Small buildings[3] (Mil ft[2])	Large buildings[3] (Mil ft[2])	Total (Mil ft[2])	
Stores								
Northeast	1.4	4.8	1.1	7.4	25.3	86.5	111.8	56.0
Midwest	3.3	6.5	1.1	10.8	64.1	125.5	189.6	51.4
South	6.4	12.7	2.5	21.6	136.4	270.7	407.1	47.0
West	4.8	6.5	1.7	13.1	94.2	126.6	220.8	51.3
Total	16.0	30.5	6.4	52.9	320.1	609.3	929.4	50.0
Industrial								
Northeast	1.0	1.3	0.2	2.5	18.7	25.0	43.7	52.2
Midwest	2.3	2.0	0.1	4.4	46.2	41.2	87.4	49.3
South	2.2	4.8	0.3	7.3	49.9	107.6	157.5	44.8
West	2.6	1.5	0.4	4.4	52.4	30.9	83.3	48.9
Total	8.1	9.7	1.0	18.7	167.2	204.7	371.9	47.7
Offices								
Northeast	1.5	1.0	2.1	4.6	17.9	12.8	30.7	82.0
Midwest	3.2	1.8	2.0	7.0	41.4	23.6	65.0	77.4
South	5.2	6.0	3.5	14.8	63.6	73.3	136.9	82.0
West	1.9	3.9	2.2	7.9	23.9	49.3	73.2	78.7
Total	11.8	12.8	9.8	34.4	146.9	158.9	305.8	80.2
Hotels								
Northeast	0.1	0.9	0.0	1.0	1.0	9.1	10.0	103.5
Midwest	0.1	0.8	0.0	0.9	1.1	9.0	10.1	93.3
South	1.4	1.0	0.2	2.6	16.1	11.6	27.7	86.3
West	0.4	2.2	0.1	2.7	4.0	20.6	24.7	106.6
Total	2.0	5.0	0.3	7.3	22.2	50.3	72.5	96.5
Schools								
Northeast	2.6	4.3	2.2	9.2	16.1	26.3	42.4	164.0
Midwest	2.2	5.8	0.6	8.6	16.9	44.6	61.5	129.7
South	3.1	9.2	1.5	13.8	31.8	95.0	126.8	96.8
West	2.2	6.4	2.2	10.8	15.2	44.2	59.4	145.3
Total	10.1	25.7	6.6	42.4	80.0	210.1	290.1	123.5
Colleges								
Northeast	1.1	2.2	0.6	3.9	6.8	13.3	20.1	162.5
Midwest	0.9	1.5	1.4	3.7	7.7	12.5	20.2	116.8
South	2.4	2.9	1.4	6.7	20.7	25.3	46.0	116.3
West	1.2	1.8	0.6	3.6	7.9	12.5	20.4	147.6
Total	5.6	8.4	4.0	18.0	43.1	63.5	106.6	131.1
Religious								
Northeast	0.4	0.2	0.1	0.7	3.7	1.6	5.4	108.6
Midwest	1.4	0.2	0.2	1.8	17.4	2.9	20.3	79.9
South	3.1	0.5	0.3	3.9	41.2	7.2	48.4	75.5
West	0.8	0.2	0.1	1.1	9.0	2.5	11.5	91.9
Total	5.7	1.2	0.6	7.5	71.3	14.3	85.5	80.8

Table 2. Value, floor area, and value per square foot of floor area in nonresidential building construction in the United States, by building type, region, and size class, 2003 -- cont.

Building type and region	Value of new construction[1]				Floor area[2]			Value per ft^2 of floor area, all buildings[4] ($)
	Small buildings[3] (Bil $)	Large buildings[3] (Bil $)	Other[3] (Bil $)	Total (Bil $)	Small buildings[3] (Mil ft^2)	Large buildings[3] (Mil ft^2)	Total (Mil ft^2)	
Health								
Northeast	1.1	1.8	1.3	4.2	8.3	14.4	22.7	127.0
Midwest	1.6	3.2	0.7	5.6	12.6	25.5	38.1	126.8
South	2.6	3.7	1.5	7.8	22.8	32.1	54.9	114.6
West	1.7	3.0	0.7	5.4	12.0	21.2	33.2	141.7
Total	7.0	11.7	4.2	23.0	55.7	93.2	148.9	125.7
Public								
Northeast	0.5	0.2	0.5	1.2	3.4	1.5	5.0	154.4
Midwest	0.7	0.2	0.7	1.5	6.3	1.9	8.2	103.9
South	1.0	1.1	1.1	3.2	9.9	10.6	20.5	101.5
West	0.6	0.8	0.3	1.8	3.9	5.5	9.4	155.3
Total	2.8	2.4	2.6	7.7	23.5	19.5	43.1	119.8
Recreation								
Northeast	0.6	1.6	0.3	2.5	4.1	11.7	15.9	140.0
Midwest	1.2	1.6	0.9	3.6	10.9	14.7	25.6	108.1
South	2.2	3.0	1.0	6.2	22.0	29.7	51.7	100.6
West	2.5	1.2	1.1	4.8	18.9	9.3	28.3	130.7
Total	6.4	7.4	3.3	17.2	56.0	65.5	121.5	114.3
Miscellaneous								
Northeast	0.4	0.0	1.6	2.0	7.3	0.5	7.8	59.4
Midwest	0.3	0.1	0.7	1.2	7.5	2.4	9.9	46.8
South	0.9	0.1	1.7	2.7	19.4	1.5	20.9	48.3
West	0.9	0.2	0.1	1.3	7.6	2.0	9.6	124.4
Total	2.7	0.5	4.0	7.2	41.7	6.4	48.1	64.9
All buildings								
Northeast	10.7	18.5	10.1	39.3	112.7	202.7	315.4	92.7
Midwest	17.1	23.8	8.4	49.3	232.1	303.8	535.9	76.3
South	30.6	45.1	15.0	90.7	433.7	664.6	1,098.3	68.9
West	19.7	27.9	9.4	57.0	249.2	324.5	573.7	82.9
Total	78.1	115.2	42.9	236.2	1,027.7	1,495.7	2,523.3	76.6

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Constant 2000 dollars.

[2]New construction and additions only. Alterations and renovations have no reported floor area.

[3]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2. Other: Alterations and renovations with no associated floor area.

[4]Data limitations necessitated combining size classes for regional floor area estimation.

Table 3. Estimated value of nonresidential building construction, floor area built, and value per square foot of floor area, by building type, 1985, 1995 and 2003.

	Value of new construction[1]				Floor area			Value per ft^2 of floor area		
			2003				2003			2003
	All construction[2]		All construc-	New & additions	All construction		New & additions	All construction		New & additions
Building type	1985 (Bil. $)	1995 (Bil. $)	tion (Bil. $)	only[3] (Bil. $)	1985 (Mil. ft^2)	1995 (Mil. ft^2)	only[3] (Mil. ft^2)	1985 ($/ft^2)	1995 ($/ft^2)	only[3] ($/ft^2)
Stores	56.1	50.9	52.9	46.5	920	876	929	60.9	58.0	50.0
Industrial	41.0	44.1	18.7	17.7	303	766	372	135.3	57.6	47.7
Offices	68.4	30.5	34.4	24.5	480	334	306	142.6	91.5	80.2
Hotels	13.7	8.5	7.3	7.0	140	103	72	98.1	82.0	96.5
Education	17.8	37.3	60.4	49.8	192	277	397	92.7	134.9	125.6
Schools	--	--	42.4	35.8	--	--	290	--	--	123.5
Colleges	--	--	18.0	14.0	--	--	107	--	--	131.1
Religious	4.3	5.2	7.5	6.9	41	57	86	105.3	89.7	80.8
Health	14.8	18.5	23.0	18.7	148	133	149	100.1	138.4	125.7
All other	22.5	32.9	32.1	22.2	166	273	213	135.7	120.4	104.2
Public	17.3	25.7	7.7	5.2	--	179	43	--	143.4	119.8
Recreation	--	--	17.2	13.9	--	--	121	--	--	114.3
Misc.	5.2	7.2	7.2	3.1	--	94	48	--	77.0	64.9
Total	238.7	227.8	236.2	193.4	2,390	2,820	2,523	99.9	80.8	76.6

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Constant 2000 $.

[2]Revised.

[3]Alterations and renovations have no associated floor area.

Sources: Wood Products Promotion Council 1987; McKeever and Adair 1998, U.S Dept. of Commerce 2006.

Table 4. Floor, exterior wall and roof area in nonresidential building construction, by building type and size class, 1995 and 2003.

Building type	Floor area			Exterior wall area				Roof area			
						Total				Total	
	Small buildings[1] (Mil. ft^2)	Large buildings[1] (Mil. ft^2)	Total (Mil. ft^2)	Small buildings[1] (Mil. ft^2)	Large buildings[1] (Mil. ft^2)	(Mil. ft^2)	Per ft^2 of floor area (Ft^2)	Small buildings[1] (Mil. ft^2)	Large buildings[1] (Mil. ft^2)	(Mil. ft^2)	Per ft^2 of floor area (Ft^2)
1995[2]											
Stores	297	579	876	224	260	484	0.55	328	653	981	1.12
Industrial	288	479	766	250	174	424	0.55	298	483	780	1.02
Offices	175	159	334	111	71	181	0.54	153	67	220	0.66
Hotels	49	55	104	38	20	58	0.56	21	16	37	0.35
Schools & colleges	94	182	277	61	68	129	0.46	87	143	229	0.83
Religious	51	6	57	35	5	39	0.69	48	5	53	0.93
Health	68	65	133	39	30	70	0.52	59	26	86	0.64
Public	68	111	179	39	32	71	0.40	62	75	137	0.76
Recreation & misc.	40	54	94	30	13	43	0.45	40	30	70	0.75
Total	1,130	1,690	2,820	826	672	1,498	0.53	1,096	1,497	2,593	0.92
2003[3]											
Stores	320	609	929	248	285	533	0.57	350	596	946	1.02
Industrial	167	205	372	137	37	174	0.47	188	190	379	1.02
Offices	147	159	306	89	80	169	0.55	138	80	218	0.71
Hotels	22	50	72	17	23	40	0.55	10	18	28	0.39
Schools	80	210	290	49	87	136	0.47	77	159	237	0.82
Colleges	43	64	107	27	20	47	0.44	35	30	65	0.61
Religious	71	14	86	42	8	51	0.60	66	12	77	0.91
Health	56	93	149	28	23	51	0.34	49	46	95	0.64
Public	24	20	43	13	5	19	0.43	22	14	36	0.84
Recreation	56	65	121	35	16	52	0.42	58	39	97	0.80
Miscellaneous	42	6	48	29	1	31	0.64	44	5	48	1.00
Total	1,028	1,496	2,523	714	587	1,301	0.52	1,038	1,190	2,228	0.88

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2.

[2]Includes all construction.

[3]Includes new construction and additions only. Alterations and renovations have no associated floor area.

Source: McKeever and Adair 1998.

Table 5. Incidence of principal framing type[1] in nonresidential building construction, by building type and size class, 1982, 1995, and 2003.

	Small buildings[2]			Large buildings[2]			Total		
Building type	Wood (%)	Concrete (%)	Metal (%)	Wood (%)	Concrete (%)	Metal (%)	Wood (%)	Concrete (%)	Metal (%)
2003[3]									
Stores	19	26	55	2	17	82	14	24	62
Industrial	14	18	68	0	36	64	12	20	67
Office	43	13	43	7	18	75	41	14	45
Hotels	57	24	20	35	40	25	52	27	21
Schools	15	26	59	8	23	70	12	25	63
Colleges	15	18	66	7	20	72	13	19	68
Religious	40	17	44	6	24	71	38	17	45
Health	36	16	48	50	12	38	39	15	46
Public	18	30	53	4	30	67	16	30	54
Recreation	18	40	42	7	20	72	17	39	44
Misc.	15	24	61	9	9	81	14	22	64
Total									
1982[4]	22	42	38	7	58	34	18	47	35
1995[4]	17	49	33	5	70	25	10	62	28
2003[3]	24	25	51	10	20	70	21	24	55

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Principal framing type is determined by predominant exterior wall framing material.

[2]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2.

[3]New construction and additions only. Alterations and renovations have no associated floor area.

[4]Principal framing type was referred to as principal construction type in 1982 and 1995.

Sources: Wood Products Promotion Council 1987; McKeever and Adair 1998.

Table 6. Wood used in nonresidential building construction, all building types, by characteristic, 2003.

Building type, and characteristic	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)	Engineered wood: Total (Mil. bf equivalent)[4]
Region									
Northeast	132.6	243.2	38.7	281.9	17.2	3.5	3.9	0.2	13.8
Midwest	278.4	408.8	93.6	502.4	16.5	7.5	7.6	0.8	35.2
South	479.9	616.5	146.3	762.8	24.7	10.6	8.2	0.5	37.6
West	433.3	594.3	151.2	745.5	17.6	26.9	36.2	1.3	111.6
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8	198.2
Size class[5]									
Small	800.9	926.0	219.3	1,145.3	8.7	35.1	33.0	1.6	129.2
Large	305.8	500.2	136.0	636.2	24.4	9.2	4.7	0.7	35.1
Other	217.4	436.5	74.6	511.0	42.8	4.2	18.3	0.4	33.8
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8	198.2
Application									
Floors	70.6	198.3	49.7	248.0	1.0	17.7	2.0	0.6	47.1
Exterior walls	357.5	344.2	77.3	421.5	2.1	0.0	2.2	0.6	11.3
Interior walls	142.1	127.3	34.4	161.7	6.5	0.0	0.2	0.5	8.1
Roofs	746.8	1,135.6	253.9	1,389.5	65.2	30.8	51.5	1.2	131.6
Siding	7.0	57.3	14.5	71.8	1.3	0.0	0.0	0.0	0.0
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8	198.2

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[2]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood

[3]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

[4]Based on 2 bf per lf of I-joists and 16 bf per ft^3 of SCL.

[5]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2. Other: Alterations and renovations with no associated floor area.

Table 7. Wood used in nonresidential building construction, by building type and region, 2003.

Building type, and region	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)
Stores								
Northeast	14.6	38.6	7.8	46.4	0.2	0.6	0.1	0.0
Midwest	63.5	132.5	19.6	152.1	0.5	2.1	0.4	0.1
South	58.3	87.3	16.3	103.7	1.3	1.7	0.5	0.0
West	94.6	137.0	31.9	168.9	2.2	9.5	9.6	0.1
Total	231.0	395.4	75.6	471.1	4.3	13.9	10.6	0.2
Industrial								
Northeast	10.3	6.2	0.8	7.0	0.0	0.0	0.9	0.0
Midwest	21.2	17.3	1.2	18.5	0.0	0.1	1.5	0.0
South	6.1	4.9	0.8	5.7	0.0	0.2	0.6	0.0
West	9.3	11.1	4.7	15.8	0.0	0.2	0.5	0.4
Total	46.9	39.5	7.5	47.0	0.0	0.5	3.4	0.5
Offices								
Northeast	32.0	37.5	6.5	44.1	1.1	0.8	0.0	0.0
Midwest	68.2	74.7	21.6	96.4	1.0	4.1	2.8	0.1
South	164.3	121.0	31.0	152.1	2.2	1.6	0.3	0.0
West	60.4	135.2	41.9	177.1	0.2	3.4	12.6	0.1
Total	325.0	368.5	101.1	469.6	4.5	9.9	15.7	0.2
Hotels								
Northeast	6.4	8.8	0.8	9.6	0.0	0.6	0.0	0.0
Midwest	11.4	7.9	0.1	8.0	0.0	0.0	0.1	0.0
South	97.0	109.2	38.8	148.0	0.3	5.6	0.2	0.3
West	29.1	33.0	1.7	34.7	0.3	1.3	0.7	0.1
Total	143.9	158.9	41.4	200.3	0.6	7.6	1.0	0.5
Schools								
Northeast	24.1	48.0	5.5	53.6	13.2	0.1	0.3	0.0
Midwest	17.8	25.7	6.5	32.2	12.0	0.1	0.1	0.0
South	31.7	82.1	9.3	91.4	16.9	0.1	0.2	0.0
West	92.1	104.5	26.3	130.8	12.4	8.2	6.9	0.3
Total	165.8	260.4	47.7	308.0	54.5	8.5	7.4	0.4
Colleges								
Northeast	15.0	14.8	2.0	16.8	0.4	0.6	2.0	0.0
Midwest	16.4	15.9	4.4	20.3	1.1	0.1	0.0	0.0
South	21.9	35.9	7.8	43.7	1.0	0.1	1.9	0.0
West	43.5	26.7	7.9	34.6	0.6	0.0	0.1	0.0
Total	96.7	93.4	22.1	115.4	3.1	0.8	4.0	0.1
Religious								
Northeast	6.7	7.4	1.0	8.4	0.0	0.2	0.2	0.0
Midwest	28.6	23.2	11.2	34.4	0.2	0.7	1.8	0.2
South	34.4	30.2	9.4	39.6	0.1	0.4	3.0	0.1
West	31.2	25.3	14.8	40.1	0.2	1.1	1.9	0.2
Total	100.9	86.1	36.4	122.6	0.6	2.4	7.0	0.5

Table 7. Wood used in nonresidential building construction, by building type and region, 2003 – cont.

Building type, and region	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft², 3/8")	Structural panels: OSB (Mil. ft², 3/8")	Structural panels: Total (Mil. ft², 3/8")	Non-structural panels[2] (Mil. ft², 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft³)
Health								
Northeast	8.8	40.7	6.3	47.0	0.8	0.1	0.1	0.0
Midwest	31.7	68.1	18.8	86.9	0.4	0.1	0.2	0.1
South	29.5	80.3	17.4	97.7	0.8	0.3	0.4	0.0
West	33.6	63.1	13.0	76.2	0.3	0.4	0.6	0.0
Total	103.6	252.2	55.6	307.8	2.3	0.9	1.4	0.1
Public								
Northeast	4.7	8.2	0.9	9.1	1.2	0.2	0.0	0.0
Midwest	3.5	10.9	2.4	13.3	0.9	0.1	0.0	0.0
South	5.9	8.2	1.4	9.6	1.8	0.2	0.0	0.0
West	6.5	8.2	2.1	10.3	0.8	0.7	0.2	0.0
Total	20.6	35.5	6.8	42.3	4.8	1.2	0.2	0.0
Recreation								
Northeast	6.1	11.1	4.2	15.3	0.1	0.3	0.4	0.0
Midwest	9.5	20.1	4.4	24.5	0.3	0.2	0.4	0.0
South	24.3	45.5	12.0	57.5	0.2	0.4	1.1	0.0
West	28.4	42.7	6.0	48.7	0.7	1.9	2.8	0.1
Total	68.3	119.4	26.6	146.0	1.3	2.7	4.7	0.1
Miscellaneous								
Northeast	4.0	21.7	3.0	24.7	0.0	0.0	0.0	0.0
Midwest	6.7	12.5	3.2	15.7	0.0	0.0	0.1	0.3
South	6.3	11.8	2.0	13.8	0.0	0.0	0.1	0.0
West	4.5	7.4	0.8	8.2	0.0	0.0	0.4	0.0
Total	21.4	53.4	9.1	62.5	0.0	0.0	0.6	0.3
All buildings								
Northeast	132.6	243.2	38.7	281.9	17.2	3.5	3.9	0.2
Midwest	278.4	408.8	93.6	502.4	16.5	7.5	7.6	0.8
South	479.9	616.5	146.3	762.8	24.7	10.6	8.2	0.5
West	433.3	594.3	151.2	745.5	17.6	26.9	36.2	1.3
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8

NOTE. Includes only low-rise buildings with four or fewer stories.

[1]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[2]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[3]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

Table 8.-Wood used in nonresidential building construction, by building type and size class, 2003.

Building type and size class[4]	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)
Stores								
Small	155.1	226.4	35.6	262.0	2.3	13.4	10.0	0.2
Large	58.6	125.5	29.3	154.8	1.3	0.3	0.5	0.0
Other	17.3	43.6	10.7	54.3	0.7	0.2	0.1	0.0
Total	231.0	395.4	75.6	471.1	4.3	13.9	10.6	0.2
Industrial								
Small	39.3	37.3	7.1	44.4	0.0	0.5	3.4	0.5
Large	4.7	1.1	0.3	1.4	0.0	0.0	0.1	0.0
Other	2.9	1.1	0.1	1.2	0.0	0.0	0.0	0.0
Total	46.9	39.5	7.5	47.0	0.0	0.5	3.4	0.5
Offices								
Small	208.9	198.6	59.5	258.1	4.3	7.9	2.6	0.2
Large	11.1	15.9	5.3	21.2	0.0	0.0	0.0	0.0
Other	105.0	153.9	36.3	190.3	0.1	2.0	13.1	0.0
Total	325.0	368.5	101.1	469.6	4.5	9.9	15.7	0.2
Hotels								
Small	63.8	84.7	17.1	101.7	0.6	4.0	0.9	0.0
Large	77.6	71.0	24.3	95.3	0.0	3.5	0.0	0.4
Other	2.5	3.2	0.0	3.2	0.0	0.1	0.0	0.0
Total	143.9	158.9	41.4	200.3	0.6	7.6	1.0	0.5
Schools								
Small	78.9	83.7	15.8	99.4	0.5	2.3	2.4	0.1
Large	68.7	106.5	22.9	129.4	22.7	5.2	3.8	0.3
Other	18.2	70.2	9.0	79.2	31.3	0.9	1.2	0.0
Total	165.8	260.4	47.7	308.0	54.5	8.5	7.4	0.4
Colleges								
Small	45.6	47.8	12.7	60.4	0.1	0.6	3.8	0.1
Large	36.4	26.5	7.8	34.3	0.3	0.0	0.1	0.0
Other	14.8	19.0	1.6	20.7	2.7	0.2	0.0	0.0
Total	96.7	93.4	22.1	115.4	3.1	0.8	4.0	0.1
Religious								
Small	85.7	69.2	31.8	100.9	0.5	2.0	3.9	0.5
Large	2.3	5.0	0.0	5.0	0.0	0.1	0.0	0.0
Other	12.9	11.9	4.6	16.6	0.1	0.4	3.1	0.0
Total	100.9	86.1	36.4	122.6	0.6	2.4	7.0	0.5

Table 8. Wood used in nonresidential building construction, by building type and size class, 2003 – cont.

Building type and size class[4]	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)
Health								
Small	57.2	84.3	20.0	104.3	0.2	0.9	0.8	0.1
Large	30.3	104.1	32.4	136.5	0.1	0.0	0.1	0.0
Other	16.0	63.8	3.2	67.0	2.1	0.0	0.5	0.0
Total	103.6	252.2	55.6	307.8	2.3	0.9	1.4	0.1
Public								
Small	10.7	16.9	3.8	20.7	0.0	1.0	0.1	0.0
Large	4.2	4.3	1.4	5.7	0.0	0.0	0.1	0.0
Other	5.7	14.4	1.6	16.0	4.7	0.2	0.0	0.0
Total	20.6	35.5	6.8	42.3	4.8	1.2	0.2	0.0
Recreation								
Small	41.9	58.5	11.7	70.2	0.3	2.4	4.4	0.1
Large	10.4	39.8	12.3	52.1	0.0	0.1	0.0	0.0
Other	15.9	21.1	2.6	23.7	1.1	0.2	0.3	0.0
Total	68.3	119.4	26.6	146.0	1.3	2.7	4.7	0.1
Miscellaneous								
Small	13.8	18.8	4.2	23.1	0.0	0.0	0.6	0.0
Large	1.4	0.5	0.0	0.5	0.0	0.0	0.0	0.0
Other	6.2	34.1	4.8	38.9	0.0	0.0	0.0	0.3
Total	21.4	53.4	9.1	62.5	0.0	0.0	0.6	0.3
All buildings								
Small	800.9	926.0	219.3	1,145.3	8.7	35.1	33.0	1.6
Large	305.8	500.2	136.0	636.2	24.4	9.2	4.7	0.7
Other	217.4	436.5	74.6	511.0	42.8	4.2	18.3	0.4
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8

NOTE.Includes only low-rise buildings with four or fewer stories.

[1]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[2]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[3]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

[4]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2. Other: Alterations and renovations with no associated floor area.

Table 9. Wood used in nonresidential building construction, by building type and application, 2003.

Building type and application	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)
Stores								
Floors	11.1	19.3	4.2	23.5	0.2	1.0	0.0	0.0
Exterior wall	81.0	102.6	16.1	118.7	1.0	0.0	0.4	0.1
Interior wall	28.9	33.0	6.6	39.6	1.8	0.0	0.0	0.0
Roof	109.9	228.0	46.6	274.6	1.0	13.0	10.1	0.1
Siding	0.1	12.5	2.2	14.6	0.2	0.0	0.0	0.0
Total	231.0	395.4	75.6	471.1	4.3	13.9	10.6	0.2
Industrial								
Floors	1.8	0.8	0.1	0.9	0.0	0.1	0.5	0.0
Exterior wall	10.8	8.6	1.8	10.4	0.0	0.0	0.3	0.0
Interior wall	0.8	7.8	0.9	8.7	0.0	0.0	0.0	0.0
Roof	33.1	19.7	4.0	23.7	0.0	0.5	2.7	0.5
Siding	0.3	2.6	0.7	3.3	0.0	0.0	0.0	0.0
Total	46.9	39.5	7.5	47.0	0.0	0.5	3.4	0.5
Offices								
Floors	3.4	15.6	5.6	21.2	0.5	5.6	0.1	0.0
Exterior wall	51.2	27.1	9.9	37.0	0.0	0.0	0.1	0.0
Interior wall	14.0	6.0	1.8	7.8	1.3	0.0	0.1	0.0
Roof	256.1	300.0	77.9	377.8	2.2	4.3	15.4	0.1
Siding	0.2	19.8	6.0	25.8	0.5	0.0	0.0	0.0
Total	325.0	368.5	101.1	469.6	4.5	9.9	15.7	0.2
Hotels								
Floors	17.9	48.4	14.3	62.6	0.0	6.9	0.1	0.2
Exterior wall	35.2	24.2	7.3	31.5	0.2	0.0	0.2	0.1
Interior wall	44.4	27.5	11.2	38.7	0.2	0.0	0.0	0.1
Roof	46.3	57.1	8.2	65.3	0.1	0.7	0.7	0.1
Siding	0.2	1.7	0.4	2.1	0.0	0.0	0.0	0.0
Total	143.9	158.9	41.4	200.3	0.6	7.6	1.0	0.5
Schools								
Floors	9.3	16.7	3.2	19.9	0.2	2.2	1.2	0.0
Exterior wall	79.2	89.0	17.8	106.8	0.2	0.0	0.4	0.0
Interior wall	14.0	22.6	5.3	27.9	0.8	0.0	0.1	0.1
Roof	62.9	129.8	21.0	150.8	53.0	6.3	5.7	0.2
Siding	0.3	2.3	0.4	2.7	0.3	0.0	0.0	0.0
Total	165.8	260.4	47.7	308.0	54.5	8.5	7.4	0.4

Table 9. Wood used in nonresidential building construction, by building type and application, 2003 – cont.

Building type and application	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft², 3/8")	Structural panels: OSB (Mil. ft², 3/8")	Structural panels: Total (Mil. ft², 3/8")	Non-structural panels[2] (Mil. ft², 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft³)
Colleges								
Floors	10.9	15.1	3.3	18.4	0.0	0.2	0.0	0.0
Exterior wall	19.8	10.6	2.6	13.2	0.1	0.0	0.0	0.0
Interior wall	17.8	5.3	1.5	6.8	0.2	0.0	0.0	0.0
Roof	42.8	62.1	14.6	76.7	2.7	0.7	3.9	0.0
Siding	5.5	0.3	0.1	0.3	0.1	0.0	0.0	0.0
Total	96.7	93.4	22.1	115.4	3.1	0.8	4.0	0.1
Religious								
Floors	2.5	13.1	5.9	19.0	0.0	0.1	0.0	0.0
Exterior wall	14.3	13.9	6.4	20.2	0.4	0.0	0.0	0.2
Interior wall	6.0	2.9	1.5	4.4	0.0	0.0	0.0	0.2
Roof	77.9	55.6	22.4	78.0	0.1	2.3	7.0	0.0
Siding	0.2	0.7	0.2	0.9	0.0	0.0	0.0	0.0
Total	100.9	86.1	36.4	122.6	0.6	2.4	7.0	0.5
Health								
Floors	7.7	44.0	7.9	51.9	0.0	0.8	0.1	0.0
Exterior wall	30.0	40.3	8.8	49.1	0.0	0.0	0.2	0.0
Interior wall	10.9	16.0	4.3	20.3	2.1	0.0	0.0	0.0
Roof	54.6	141.5	31.5	173.0	0.1	0.1	1.1	0.1
Siding	0.3	10.4	3.0	13.4	0.1	0.0	0.0	0.0
Total	103.6	252.2	55.6	307.8	2.3	0.9	1.4	0.1
Public								
Floors	1.2	6.7	1.4	8.1	0.0	0.2	0.0	0.0
Exterior wall	3.4	2.6	0.6	3.2	0.0	0.0	0.0	0.0
Interior wall	0.2	2.0	0.4	2.4	0.0	0.0	0.0	0.0
Roof	15.8	23.3	4.2	27.6	4.7	1.0	0.2	0.0
Siding	0.0	0.8	0.2	1.1	0.0	0.0	0.0	0.0
Total	20.6	35.5	6.8	42.3	4.8	1.2	0.2	0.0
Recreation								
Floors	3.8	15.1	3.3	18.4	0.0	0.7	0.0	0.0
Exterior wall	26.7	19.9	4.8	24.7	0.0	0.0	0.6	0.0
Interior wall	3.2	3.7	1.0	4.6	0.0	0.0	0.0	0.0
Roof	34.6	75.5	16.4	91.9	1.2	2.0	4.1	0.1
Siding	0.0	5.3	1.1	6.4	0.0	0.0	0.0	0.0
Total	68.3	119.4	26.6	146.0	1.3	2.7	4.7	0.1

Table 9. Wood used in nonresidential building construction, by building type and application, 2003 – cont.

Building type and application	Lumber[1] (Mil. bf)	Structural panels: Softwood plywood (Mil. ft^2, 3/8")	Structural panels: OSB (Mil. ft^2, 3/8")	Structural panels: Total (Mil. ft^2, 3/8")	Non-structural panels[2] (Mil. ft^2, 3/8")	Engineered wood: I-joist (Mil. lf)	Engineered wood: Glulam (Mil. bf)	Engineered wood: SCL[3] (Mil. ft^3)
Miscellaneous								
Floors	0.8	3.6	0.6	4.2	0.0	0.0	0.0	0.3
Exterior wall	5.9	5.5	1.1	6.6	0.0	0.0	0.0	0.0
Interior wall	1.8	0.3	0.1	0.4	0.0	0.0	0.0	0.0
Roof	13.0	43.0	7.1	50.1	0.0	0.0	0.6	0.0
Siding	0.0	1.0	0.2	1.2	0.0	0.0	0.0	0.0
Total	21.4	53.4	9.1	62.5	0.0	0.0	0.6	0.3
All buildings								
Floors	70.6	198.3	49.7	248.0	1.0	17.7	2.0	0.6
Exterior wall	357.5	344.2	77.3	421.5	2.1	0.0	2.2	0.6
Interior wall	142.1	127.3	34.4	161.7	6.5	0.0	0.2	0.5
Roof	746.8	1,135.6	253.9	1,389.5	65.2	30.8	51.5	1.2
Siding	7.0	57.3	14.5	71.8	1.3	0.0	0.0	0.0
Total	1,324.1	1,862.7	429.8	2,292.5	76.0	48.6	56.0	2.8

NOTE. Includes only low-rise buildings with four or fewer stories.

[1]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[2]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[3]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

Table 10. Wood used per $1,000 of construction value in nonresidential building construction, 2003.

	Construction value			Structural panels			Non-structural	Engineered wood			Wood use
Characteristic	Current $ (Mil.)	2000 $ (Mil.)	Lumber[1] (Bf)	Softwood plywood (Ft^2, 3/8")	OSB (Ft^2, 3/8")	Total (Ft^2, 3/8")	panels[2] (Ft^2, 3/8")	I-joist (Lf)	Glulam (Bf)	SCL[3] (Ft^3)	index[4]
Building type											
Stores	60,246	52,899	4.37	7.48	1.43	8.91	0.08	0.26	0.20	0.00	0.84
Industrial	21,285	18,689	2.51	2.11	0.40	2.52	0.00	0.03	0.18	0.02	0.38
Offices	39,133	34,361	9.46	10.72	2.94	13.67	0.13	0.29	0.46	0.01	1.53
Hotels	8,317	7,303	19.70	21.76	5.67	27.43	0.08	1.04	0.13	0.06	3.20
Schools	48,339	42,444	3.91	6.13	1.12	7.26	1.28	0.20	0.17	0.01	0.78
Colleges	20,498	17,999	5.38	5.19	1.23	6.41	0.17	0.05	0.22	0.00	0.79
Religious	8,543	7,501	13.45	11.48	4.86	16.34	0.07	0.32	0.93	0.07	2.12
Health	26,150	22,961	4.51	10.98	2.42	13.40	0.10	0.04	0.06	0.00	1.00
Public	8,803	7,729	2.67	4.60	0.88	5.47	0.62	0.15	0.03	0.00	0.53
Recreation	19,576	17,188	3.97	6.95	1.55	8.50	0.08	0.16	0.27	0.01	0.78
Misc.	8,164	7,168	2.99	7.45	1.26	8.71	0.00	0.00	0.09	0.04	0.71
Total	269,054	236,243	5.60	7.88	1.82	9.70	0.32	0.21	0.24	0.01	1.00
Region											
Northeast	44,778	39,317	3.37	6.18	0.99	7.17	0.44	0.09	0.10	0.00	0.63
Midwest	56,094	49,253	5.65	8.30	1.90	10.20	0.33	0.15	0.15	0.02	1.01
South	103,291	90,694	5.29	6.80	1.61	8.41	0.27	0.12	0.09	0.01	0.88
West	64,892	56,978	7.60	10.43	2.65	13.08	0.31	0.47	0.64	0.02	1.44
Total	269,054	236,243	5.60	7.88	1.82	9.70	0.32	0.21	0.24	0.01	1.00
Size class[5]											
Small	88,965	78,115	10.25	11.85	2.81	14.66	0.11	0.45	0.42	0.02	1.61
Large	131,243	115,238	2.65	4.34	1.18	5.52	0.21	0.08	0.04	0.01	0.53
Other	48,847	42,890	5.07	10.18	1.74	11.92	1.00	0.10	0.43	0.01	1.15
Total	269,054	236,243	5.60	7.88	1.82	9.70	0.32	0.21	0.24	0.01	1.00
Application											
Floors	–	–	0.30	0.84	0.21	1.05	0.00	0.08	0.01	0.00	0.09
Exterior wall	–	–	1.51	1.46	0.33	1.78	0.01	0.00	0.01	0.00	0.21
Interior wall	–	–	0.60	0.54	0.15	0.68	0.03	0.00	0.00	0.00	0.08
Roof	–	–	3.16	4.81	1.07	5.88	0.28	0.13	0.22	0.00	0.60
Siding	–	–	0.03	0.24	0.06	0.30	0.01	0.00	0.00	0.00	0.02
Total	269,054	236,243	5.60	7.88	1.82	9.70	0.32	0.21	0.24	0.01	1.00

NOTE. Includes only low-rise buildings with four or fewer stories.

[1]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[2]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[3]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

[4]Relative magnitude of wood products use compared to the total use average, based on board foot equivalent.

[5]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2. Other: Alterations and renovations with no associated floor area.

Table 11. Wood used per 1,000 square feet of floor area in nonresidential building construction, 2003.

Characteristic	Floor area[1] (Mil. ft^2)	Lumber[2] (Bf)	Structural panels: Softwood plywood (Ft^2, 3/8")	Structural panels: OSB (Ft^2, 3/8")	Structural panels: Total (Ft^2, 3/8")	Non-structural panels[3] (Ft^2, 3/8")	Engineered wood: I-joist (Lf)	Engineered wood: Glulam (Bf)	Engineered wood: SCL[4] (Ft^3)	Wood use index[5]
Building type										
Stores	929	230.0	378.6	69.9	448.5	3.8	14.8	11.3	0.2	0.47
Industrial	372	118.3	103.2	19.9	123.1	0.0	1.3	9.3	1.2	0.20
Offices	306	719.5	701.7	211.9	913.6	14.2	26.0	8.7	0.5	1.17
Hotels	72	1,951.1	2,147.9	571.3	2,719.1	8.3	104.0	13.2	6.3	3.39
Schools	290	508.9	655.3	133.4	788.8	79.8	26.1	21.3	1.2	0.97
Colleges	107	768.8	696.8	191.7	888.5	4.0	6.0	36.8	0.6	1.19
Religious	86	1,028.4	867.4	371.6	1,239.0	5.6	24.1	45.5	5.6	1.71
Health	149	587.9	1,265.4	351.6	1,617.0	1.5	5.9	5.9	0.7	1.33
Public	43	346.0	490.9	121.2	612.1	1.2	23.0	5.1	0.3	0.66
Recreation	121	431.0	809.4	197.5	1,007.0	2.2	20.5	36.6	0.7	0.96
Misc.	48	315.6	401.1	88.0	489.1	0.4	0.1	11.8	0.2	0.54
Total	2,523	438.6	565.2	140.8	706.0	13.1	17.6	14.9	0.9	1.00
Region										
Northeast	315	306.0	446.4	95.4	541.8	4.4	10.5	12.2	0.5	0.85
Midwest	536	442.5	627.9	152.4	780.3	20.2	12.4	8.6	0.9	0.99
South	1,098	352.8	459.7	120.4	580.2	12.3	8.7	6.1	0.4	0.78
West	574	672.1	774.0	193.8	967.8	12.9	43.3	39.2	2.2	1.53
Total	2,523	438.6	565.2	140.8	706.0	13.1	17.6	14.9	0.9	1.00
Size class[6]										
Small	1,028	779.3	901.1	213.4	1,114.5	8.5	34.1	32.1	1.6	1.41
Large	1,496	204.5	334.5	90.9	425.4	16.3	6.2	3.1	0.5	0.41
Other	–	–	–	–	–	–	–	–	–	–
Total	2,523	438.6	565.2	140.8	706.0	13.1	17.6	14.9	0.9	1.00
Application										
Floors	–	22.7	57.3	17.2	74.5	0.4	6.6	0.5	0.1	0.08
Exterior wall	–	125.7	115.8	27.9	143.8	0.8	0.0	0.9	0.2	0.22
Interior wall	–	51.4	46.4	13.0	59.4	1.2	0.0	0.1	0.2	0.09
Roof	–	237.8	329.4	78.4	407.8	10.3	11.0	13.4	0.4	0.59
Siding	–	0.9	16.2	4.3	20.6	0.4	0.0	0.0	0.0	0.01
Total	2,523	438.6	565.2	140.8	706.0	13.1	17.6	14.9	0.9	1.00

NOTE. Includes only low-rise buildings with four or fewer stories.

[1]Includes new construction and additions only. Alterations and renovations have no associated floor area.

[2]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[3]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[4]Structural composite lumber (SCL) includes laminated veneer lumber, parallam, and timberstrand.

[5]Relative magnitude of wood products use compared to the total use average, based on board foot equivalent.

Table 12. Total wood used in nonresidential building construction, by building type, 1995 and 2003.

Building t	Lumber[2] (Mil. bf)	Structural panels[3] (Mil. ft^2, 3/8")	Non-structural panels[4] (Mil. ft^2, 3/8")	Engineered wood[5] (Mil. bf)	Combined use[1] (Mil. bf equiv.)	Usage change	% change
Stores							
1995	394.2	354.4	5.7	58.8	633.1	–	–
2003	231.0	471.1	4.3	41.7	510.4	-122.7	-19
Industrial							
1995	53.0	158.2	1.1	60.4	193.0	–	–
2003	46.9	47.0	0.0	11.8	82.2	-110.8	-57
Offices							
1995	278.4	225.6	2.5	25.5	417.9	–	–
2003	325.0	469.6	4.5	38.6	600.6	182.7	44
Hotels							
1995	129.3	48.6	0.5	3.4	157.3	–	–
2003	143.9	200.3	0.6	23.6	267.9	110.6	70
Education[6]							
1995	189.5	148.2	1.8	10.0	274.5	–	–
2003	262.5	423.5	57.6	37.6	540.6	266.1	97
Religious							
1995	118.1	78.8	0.3	10.3	168.0	–	–
2003	100.9	122.6	0.6	19.6	182.1	14.1	8
Health							
1995	141.0	65.2	0.4	12.0	185.8	–	–
2003	103.6	307.8	2.3	5.0	263.6	77.7	42
All other[7]							
1995	160.8	86.5	0.6	7.6	212.0	–	–
2003	110.3	250.8	6.2	20.3	259.1	47.2	22
All buildings							
1995	1,464.4	1,165.4	12.9	188.1	2,241.5	–	–
2003	1,324.1	2,292.5	76.0	198.2	2,706.5	464.9	21

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Includes lumber plus the board foot equivalent of structural and nonstructural panels: 1 ft^2 (3/8-inch basis) = 0.5 bf.

[2]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[3]Includes softwood plywood and oriented strandboard.

[4]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[5]Includes glulam and the board foot equivalent of I-joists, and structural composite lumber: 1 lf I-joist = 2 bf; 1 ft^3 SCL = 16 bf.

[6]Combined schools and colleges building types.

[7]Combined public, recreation, and miscellaneous building types.

Source: McKeever and Adair 1998.

Table 13. Wood used per $1,000 of construction value, and wood used per square foot of floor area in nonresidential building construction, by building type, 1995 and 2003.

		Use per $1,000 of construction value							Use per ft² of floor area (based new and additions only)						
	Construction value[2]	Lumber[3]	Structural panels[4]	Non-structural panels[5]	Engineered wood[6]	Combined use[1]		Floor area[7]	Lumber[3]	Structural panels[4]	Non-structural panels[5]	Engineered wood[6]	Combined use[1]	
Building t	(Bil. $)	(Bf)	(Ft², 3/8")	(Ft², 3/8")	(Bf)	(Bf equiv.)	% change	(Mil ft²)	(Bf)	(Ft², 3/8")	(Ft², 3/8")	(Bf)	(Bf equiv.)	% change
Stores														
1995	50.9	7.75	6.97	0.11	1.16	12.45	–	876	0.450	0.405	0.007	0.067	0.723	–
2003	52.9	4.37	8.91	0.08	0.79	9.65	-23	929	0.230	0.448	0.004	0.044	0.500	-31
Industrial														
1995	44.1	1.20	3.59	0.02	1.37	4.37	–	766	0.069	0.206	0.001	0.079	0.252	–
2003	18.7	2.51	2.52	0.00	0.63	4.40	1	372	0.118	0.123	0.000	0.032	0.212	-16
Offices														
1995	30.5	9.12	7.39	0.08	0.83	13.69	–	334	0.834	0.676	0.007	0.076	1.252	–
2003	34.4	9.46	13.67	0.13	1.12	17.48	28	306	0.719	0.914	0.014	0.069	1.252	0
Hotels														
1995	8.5	15.25	5.74	0.06	0.40	18.55	–	103	1.250	0.470	0.005	0.033	1.520	–
2003	7.3	19.70	27.43	0.08	3.23	36.69	98	72	1.951	2.719	0.008	0.322	3.637	139
Education[8]														
1995	37.3	5.08	3.97	0.05	0.27	7.36	–	277	0.685	0.536	0.006	0.036	0.993	–
2003	60.4	4.34	7.01	0.95	0.62	8.94	22	397	0.579	0.816	0.059	0.083	1.100	11
Religious														
1995	5.2	22.91	15.27	0.05	2.01	32.58	–	57	2.056	1.371	0.005	0.180	2.924	–
2003	7.5	13.45	16.34	0.07	2.62	24.28	-25	86	1.028	1.239	0.006	0.183	1.833	-37
Health														
1995	18.5	7.64	3.53	0.02	0.65	10.07	–	133	1.057	0.489	0.003	0.090	1.393	–
2003	23.0	4.51	13.40	0.10	0.22	11.48	14	149	0.588	1.617	0.001	0.029	1.426	2
All other[9]														
1995	32.9	4.89	2.63	0.02	0.23	6.44	–	273	0.588	0.317	0.002	0.028	0.776	–
2003	32.1	3.44	7.82	0.19	0.63	8.08	25	213	0.388	0.810	0.002	0.066	0.859	11
All buildings														
1995	227.8	6.43	5.12	0.06	0.83	9.84	–	2,820.2	0.519	0.413	0.005	0.067	0.795	–
2003	236.2	5.60	9.70	0.32	0.84	11.46	16	2,523.3	0.439	0.706	0.013	0.065	0.863	9

NOTE. Data for 2003 includes only low-rise buildings with four or fewer stories.

[1]Includes lumber plus the board foot equivalent of structural and nonstructural panels: 1 ft² (3/8-inch basis) = 0.5 bf.

[2]Constant 2000 dollars.

[3]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[4]Includes softwood plywood and oriented strandboard.

[5]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[6]Includes glulam and the board foot equivalent of I-joists, and structural composite lumber: 1 lf I-joist = 2 bf; 1 ft³ SCL = 16 bf.

[7]New and additions floor area only. Alterations and renovations have no associated floor area.

[8]Combined schools and colleges building types.

[9]Combined public, recreation, and miscellaneous building types.

Source: McKeever and Adair 1998.

Table 14. Total wood products consumption in the United States, and consumption for new nonresidential building construction, 2003.

Wood product		Consumption: Total U.S.	Consumption: Nonresidential building construction	Nonresidential as a % of total U.S.
Lumber	(Mil. bf)	56,250	1,324	2%
Structural panels				
Softwood plywood	(Mil. ft^2, 3/8")	15,602	1,863	12%
OSB	(Mil. ft^2, 3/8")	22,538	430	2%
Total	(Mil. ft^2, 3/8")	38,140	2,293	6%
Nonstructural panels	(Mil. ft^2, 3/8")	17,750	76	0%
Engineered wood				
I-joists	(Mil. lf)	945	49	5%
Glulam	(Mil. bf)	319	56	18%
SCL[2,3]	(Mil. ft^3)	68	3	4%
Total	(Mil. bf equivalent)	3,289	198	6%
Total, all wood products	(Mil. bf equivalent)	78,609	2,668	3%

NOTE. Includes only low-rise buildings with four or fewer stories.

Sources:

U.S. lumber and nonstructural panel consumption: Howard 2006.

U.S. structural panel and engineered wood consumption: Adair 2004.

Table 15. Potential incremental wood products volumes[1] in new nonresidential building construction, 2003.

	Application					Region				Size class[2]		
Building type	Floors	Exterior walls	Interior walls	Roofs	Siding	Northeast	Midwest	South	West	Small	Large	Total
						Lumber[3] (Mil. bf)						
Stores	16.2	900.3	207.2	803.4	1.3	328.6	426.1	911.2	262.5	559.2	1,369.3	1,928.5
Industrial	9.7	135.8	4.5	435.9	9.3	122.1	208.6	159.4	105.1	262.1	333.1	595.2
Offices	4.7	371.0	108.0	819.4	2.0	84.3	142.1	857.3	221.4	508.2	796.9	1,305.1
Hotels	21.7	65.0	74.0	46.4	0.4	34.0	76.9	21.1	75.4	32.2	175.1	207.3
Schools	11.0	62.7	33.7	54.9	0.8	17.8	33.4	41.6	70.2	17.9	145.2	163.1
Colleges	84.9	186.5	197.6	44.6	9.4	49.8	79.7	153.5	240.0	196.4	326.6	523.0
Religious	1.1	35.9	24.4	187.9	0.8	14.2	56.4	159.4	20.1	196.0	54.1	250.1
Health	16.1	123.8	58.8	120.6	1.8	31.6	152.3	67.1	70.1	90.1	231.0	321.1
Public	0.5	31.8	4.8	90.9	0.2	17.5	22.7	59.2	28.8	67.6	60.6	128.2
Recreation	10.9	120.4	8.0	150.9	0.5	46.0	32.6	176.2	35.9	110.6	180.2	290.8
Misc	0.2	11.9	2.3	10.1	0.1	4.7	6.0	6.8	7.1	20.3	4.3	24.7
Total	177.0	2,045.1	723.1	2,765.1	26.6	750.6	1,236.7	2,613.0	1,136.7	2,060.6	3,676.4	5,737.0
						Structural panels[4] (Mil. ft^2, 3/8" basis)						
Stores	95.1	1,040.7	140.9	852.0	55.5	165.1	971.5	786.7	260.8	626.9	1,557.2	2,184.1
Industrial	18.5	80.0	1.7	305.5	35.5	86.7	177.4	137.5	39.7	179.0	262.2	441.2
Offices	114.7	196.3	16.8	591.1	87.0	50.3	192.0	550.1	213.4	356.8	649.0	1,005.8
Hotels	101.1	49.2	73.2	30.9	4.1	47.9	43.9	95.9	70.8	67.1	191.5	258.6
Schools	21.2	72.9	82.9	91.4	0.4	42.4	51.9	86.2	88.3	48.2	220.6	268.8
Colleges	246.7	130.9	129.0	102.0	2.7	108.3	83.1	188.1	231.7	220.9	390.4	611.3
Religious	59.5	54.3	21.4	145.1	0.0	9.8	62.7	186.5	21.4	221.9	58.5	280.4
Health	107.8	35.3	72.8	89.7	9.3	18.3	157.7	71.7	67.4	94.9	220.1	315.0
Public	1.4	14.1	0.0	70.7	20.5	9.8	17.4	53.7	25.8	51.4	55.4	106.8
Recreation	16.2	36.5	4.4	195.6	31.9	27.0	29.2	211.8	16.5	110.8	173.7	284.5
Misc	0.5	0.0	1.6	6.7	3.5	0.3	8.0	2.5	1.6	7.6	4.6	12.3
Total	782.8	1,710.4	544.6	2,480.7	250.3	565.9	1,794.7	2,370.7	1,037.4	1,985.6	3,783.1	5,768.7
						Nonstructural panels[5] (Mil. ft^2, 3/8" basis)						
Stores	3.0	7.0	5.2	12.1	0.2	8.1	2.2	12.8	4.4	7.6	19.8	27.4
Industrial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Offices	0.1	0.3	0.0	1.5	0.0	0.0	0.4	1.1	0.4	0.0	1.8	1.9
Hotels	0.2	1.6	1.6	0.7	0.0	0.1	0.1	1.2	2.7	0.8	3.3	4.1
Schools	0.6	1.0	0.3	3.0	0.0	0.1	0.3	3.2	1.2	1.5	3.3	4.8
Colleges	0.3	0.4	0.1	1.2	0.0	0.9	0.5	0.2	0.5	0.7	1.3	2.0

Table 15. Potential incremental wood products volumes[1] in new nonresidential building construction, 2003 – cont.

	Application					Region				Size class[2]		
Building type	Floors	Exterior walls	Interior walls	Roofs	Siding	Northeast	Midwest	South	West	Small	Large	Total
Nonstructural panels[5] (Mil. ft^2, 3/8" basis) – continued												
Religious	0.1	0.1	0.1	0.4	0.0	0.0	0.1	0.4	0.1	0.5	0.2	0.6
Health	0.2	0.2	0.1	0.8	0.0	0.0	0.4	0.5	0.4	0.4	0.9	1.3
Public	0.1	0.1	0.0	0.5	0.0	0.0	0.4	0.1	0.3	0.5	0.3	0.8
Recreation	0.2	0.3	0.1	1.0	0.0	0.0	0.3	0.5	0.9	0.9	0.9	1.8
Misc	0.1	0.1	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.5
Total	4.9	11.2	7.6	21.4	0.2	9.3	4.6	20.5	10.8	13.4	31.9	45.3
Engineered wood[6] (Mil. bf equivalent)												
Stores	0.8	11.6	0.7	434.1	0.0	68.9	54.5	158.3	165.6	134.1	313.1	447.2
Industrial	0.0	0.8	0.0	66.2	0.0	8.6	36.5	7.6	14.2	32.4	34.6	67.0
Offices	65.0	2.1	5.9	24.5	0.0	13.2	28.5	23.1	32.7	37.1	60.4	97.5
Hotels	38.4	5.2	3.4	3.9	0.0	2.3	1.5	17.4	29.7	13.4	37.5	50.9
Schools	16.4	4.0	7.4	71.4	0.0	17.6	34.9	19.0	27.8	25.9	73.4	99.3
Colleges	2.0	1.5	5.3	0.0	0.0	4.3	1.2	1.0	2.3	2.9	5.8	8.7
Religious	1.3	6.9	5.1	6.8	0.0	1.1	8.2	8.1	2.7	14.7	5.4	20.1
Health	15.7	4.7	1.5	7.7	0.0	3.6	4.4	11.6	10.0	9.2	20.4	29.6
Public	0.1	0.2	0.0	6.8	0.0	0.9	1.8	1.2	3.2	3.3	3.8	7.1
Recreation	4.1	1.0	0.6	9.7	0.0	2.2	2.8	3.7	6.7	5.3	10.2	15.5
Misc	0.4	1.8	1.0	0.2	0.0	0.1	0.3	0.6	2.4	2.7	0.7	3.4
Total	144.1	40.0	30.8	631.3	0.0	122.7	174.7	251.6	297.2	281.0	565.3	846.3

NOTE. Includes only low-rise buildings with four or fewer stories. Excludes alterations and renovations.

[1]Volumes of wood products likely to be used if concrete and metal framed applications were built with wood at the same usage rates as wood framed applications.

[2]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2.

[3]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[4]Includes softwood plywood and oriented strandboard.

[5]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[6]Includes glulam and the board foot equivalent of I-joists, and structural composite lumber: 1 lf I-joist = 2 bf; 1 ft^3 SCL = 16 bf.

Table 16. Percentage potential incremental wood products volumes[1] used in new nonresidential building construction, 2003.

	Application					Region				Size class[2]		
Building type	Floors	Exterior walls	Interior walls	Roofs	Siding	Northeast	Midwest	South	West	Small	Large	Total
						Lumber[3] (%)						
Stores	0.3	15.7	3.6	14.0	0.0	5.7	7.4	15.9	4.6	9.7	23.9	33.6
Industrial	0.2	2.4	0.1	7.6	0.2	2.1	3.6	2.8	1.8	4.6	5.8	10.4
Offices	0.1	6.5	1.9	14.3	0.0	1.5	2.5	14.9	3.9	8.9	13.9	22.7
Hotels	0.4	1.1	1.3	0.8	0.0	0.6	1.3	0.4	1.3	0.6	3.1	3.6
Schools	0.2	1.1	0.6	1.0	0.0	0.3	0.6	0.7	1.2	0.3	2.5	2.8
Colleges	1.5	3.3	3.4	0.8	0.2	0.9	1.4	2.7	4.2	3.4	5.7	9.1
Religious	0.0	0.6	0.4	3.3	0.0	0.2	1.0	2.8	0.4	3.4	0.9	4.4
Health	0.3	2.2	1.0	2.1	0.0	0.6	2.7	1.2	1.2	1.6	4.0	5.6
Public	0.0	0.6	0.1	1.6	0.0	0.3	0.4	1.0	0.5	1.2	1.1	2.2
Recreation	0.2	2.1	0.1	2.6	0.0	0.8	0.6	3.1	0.6	1.9	3.1	5.1
Misc	0.0	0.2	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.4	0.1	0.4
Total	3.1	35.6	12.6	48.2	0.5	13.1	21.6	45.5	19.8	35.9	64.1	100.0
						Structural panels[4] (%)						
Stores	1.6	18.0	2.4	14.8	1.0	2.9	16.8	13.6	4.5	10.9	27.0	37.9
Industrial	0.3	1.4	0.0	5.3	0.6	1.5	3.1	2.4	0.7	3.1	4.5	7.6
Offices	2.0	3.4	0.3	10.2	1.5	0.9	3.3	9.5	3.7	6.2	11.2	17.4
Hotels	1.8	0.9	1.3	0.5	0.1	0.8	0.8	1.7	1.2	1.2	3.3	4.5
Schools	0.4	1.3	1.4	1.6	0.0	0.7	0.9	1.5	1.5	0.8	3.8	4.7
Colleges	4.3	2.3	2.2	1.8	0.0	1.9	1.4	3.3	4.0	3.8	6.8	10.6
Religious	1.0	0.9	0.4	2.5	0.0	0.2	1.1	3.2	0.4	3.8	1.0	4.9
Health	1.9	0.6	1.3	1.6	0.2	0.3	2.7	1.2	1.2	1.6	3.8	5.5
Public	0.0	0.2	0.0	1.2	0.4	0.2	0.3	0.9	0.4	0.9	1.0	1.9
Recreation	0.3	0.6	0.1	3.4	0.6	0.5	0.5	3.7	0.3	1.9	3.0	4.9
Misc	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.2
Total	13.6	29.6	9.4	43.0	4.3	9.8	31.1	41.1	18.0	34.4	65.6	100.0
						Nonstructural panels[5] (%)						
Stores	6.6	15.5	11.5	26.7	0.3	17.8	4.8	28.2	9.8	16.7	43.8	60.6
Industrial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Offices	0.2	0.6	0.1	3.2	0.0	0.1	0.8	2.4	0.9	0.1	4.0	4.1
Hotels	0.5	3.6	3.6	1.5	0.0	0.2	0.2	2.8	5.9	1.8	7.3	9.2
Schools	1.4	2.1	0.6	6.6	0.0	0.3	0.6	7.1	2.7	3.3	7.4	10.7
Colleges	0.6	0.9	0.3	2.7	0.0	2.0	1.1	0.4	1.0	1.6	2.8	4.5

Table 16. Percentage potential incremental wood products volumes[1] used in new nonresidential building construction, 2003 – cont.

	Application					Region				Size class[2]		
Building type	Floors	Exterior walls	Interior walls	Roofs	Siding	Northeast	Midwest	South	West	Small	Large	Total
Nonstructural panels[5] (%) – continued												
Religious	0.2	0.2	0.1	0.9	0.0	0.0	0.3	0.9	0.2	1.1	0.4	1.4
Health	0.4	0.5	0.2	1.7	0.0	0.0	0.9	1.2	0.8	0.9	2.0	2.9
Public	0.2	0.3	0.1	1.1	0.0	0.1	0.9	0.1	0.6	1.0	0.7	1.7
Recreation	0.6	0.7	0.3	2.3	0.0	0.1	0.7	1.2	2.0	1.9	2.0	3.9
Misc	0.2	0.2	0.1	0.6	0.0	0.0	0.0	1.0	0.1	1.0	0.1	1.1
Total	9.2	22.7	16.0	40.7	0.4	20.4	7.4	40.9	20.3	23.6	65.4	89.0
Engineered wood[6] (%)												
Stores	0.1	1.4	0.1	51.3	0.0	8.1	6.4	18.7	19.6	15.8	37.0	52.8
Industrial	0.0	0.1	0.0	7.8	0.0	1.0	4.3	0.9	1.7	3.8	4.1	7.9
Offices	7.7	0.3	0.7	2.9	0.0	1.6	3.4	2.7	3.9	4.4	7.1	11.5
Hotels	4.5	0.6	0.4	0.5	0.0	0.3	0.2	2.1	3.5	1.6	4.4	6.0
Schools	1.9	0.5	0.9	8.4	0.0	2.1	4.1	2.2	3.3	3.1	8.7	11.7
Colleges	0.2	0.2	0.6	0.0	0.0	0.5	0.1	0.1	0.3	0.3	0.7	1.0
Religious	0.2	0.8	0.6	0.8	0.0	0.1	1.0	1.0	0.3	1.7	0.6	2.4
Health	1.9	0.6	0.2	0.9	0.0	0.4	0.5	1.4	1.2	1.1	2.4	3.5
Public	0.0	0.0	0.0	0.8	0.0	0.1	0.2	0.1	0.4	0.4	0.4	0.8
Recreation	0.5	0.1	0.1	1.1	0.0	0.3	0.3	0.4	0.8	0.6	1.2	1.8
Misc	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.1	0.4
Total	17.0	4.7	3.6	74.6	0.0	14.5	20.6	29.7	35.1	33.2	66.8	100.0

NOTE. Includes only low-rise buildings with four or fewer stories. Excludes alterations and renovations.

[1]Based on volumes of wood products likely to be used if concrete and metal framed applications were built with wood at the same usage rates as wood framed applications.

[2]Small: Floor area of 50,000 ft^2 or less. Large: Floor area greater than 50,000 ft^2.

[3]Includes framing lumber, boards, wood trusses, and shakes, shingles and siding.

[4]Includes softwood plywood and oriented strandboard.

[5]Includes hardboard, insulation board, particleboard, medium density fiberboard, and hardwood plywood.

[6]Includes glulam and the board foot equivalent of I-joists, and structural composite lumber: 1 lf I-joist = 2 bf; 1 ft^3 SCL = 16 bf.

Appendix A–Definitions

Building Characteristics

Value of new construction put in place– A measure of the value of construction installed or erected at the site during a given period, including:

1. Cost of materials installed or erected.
2. Cost of labor and a proportionate share of construction equipment rental cost.
3. Contractor's profit.
4. Cost of architectural and engineering work.
5. Miscellaneous overhead and office costs chargeable to the project on the owner's books.
6. Interest and taxes paid during construction.

Floor area–Area measured from the outside of the exterior walls, and including all enclosed, usable floor space.

Building application–Major systems in a building including foundation, first and upper floors, exterior and interior walls, roofs, and exterior siding.

Principal construction type–Classification of the principal type of construction activity. Principal construction types are:

New–New construction not associated with any other existing building.

Addition–Attached or free-standing additions to existing buildings or structures.

Alterations and renovations– Changes made to existing buildings and structures for maintenance, upgrades, improvements, change of use, etc. Typically, no new floor area is added, and framing type is not applicable.

Principal framing type–Classification by the principal type of building material used to build the exterior wall of a new building, or a major addition to a building. Principal framing types are:

Wood–Exterior walls are primarily framed with lumber, or other wood products.

Concrete–Concrete, masonry, stone, brick or block exterior walls.

Metal–Steel framed or supported exterior walls.

Nonresidential Building Types

Stores–Wholesale, retail, or service trade buildings. Includes shopping centers and malls, department stores, low-rise banks and financial institutions, drug stores, parking garages, auto service stations and repair garages, beauty schools, grocery stores, restaurants, and dry cleaning stores. Also includes warehouses and storage buildings not located at industrial sites.

Industrial–All buildings and structures at manufacturing sites. Office buildings and warehouses owned by industrial companies but not located at industrial sites are excluded.

Offices–Office and professional buildings used primarily for office space. Excludes office buildings by public utilities for their own use, and office buildings at industrial sites.

Hotels–Hotels, motels, tourist courts and cabins, and similar facilities. Excludes dormitories built on college campuses and military barracks.

Schools–Schools for grades K through 12, either public or private, and associated buildings. Includes libraries, cafeteria, gymnasiums, indoor swimming pools, etc.

Colleges–Colleges, universities, community colleges, technical schools, other academic

buildings, and associated buildings. Includes libraries, cafeteria, dormitories, student unions, etc., and noncommercial museums, art galleries, and similar establishments. Beauty schools and dance schools are classified as ‘‘Stores.’’

Religious–Houses of worship and other religious buildings. Excludes educational or charitable institutions, hospitals, and publishing houses owned by religious organizations.

Health–Health car, institutional and assisted living facilities. Includes assisted living facilities, convalescent and rest homes, nursing homes, orphanages, and similar establishments for prolonged care, and surgical or outpatient clinics affiliated with a hospital.

Public–Publicly owned general administrative buildings, jails and prisons, courthouses, police and fire stations, civic centers, passenger terminals, space facilities, postal facilities, and customs houses. Excludes military owned buildings.

Recreation–Includes motion picture studios, theaters, casinos, health clubs, and buildings which provide amusement and recreational services.

Miscellaneous–Nonresidential buildings not classified in any of the above categories, including radio and television stations, bus and airline terminal buildings, and animal hospitals.

Regions

Northeast–Northeastern U.S. Bureau of the Census region:
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

Midwest–Midwestern U.S. Bureau of the Census region:
Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin

South–Southern U.S. Bureau of the Census region:
Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

West–Western U.S. Bureau of the region:
Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

Wood Products

Lumber–Solid sawn timber, including dimension, boards and squares.

Structural panels–Wood panels suitable for structural building applications such as floor decking, wall and roof sheathing, exterior siding and concrete forming. Includes softwood plywood and oriented strand board.

Softwood plywood–Performance rated wood panels made from softwood veneers arranged in perpendicular layers and adhesively bonded.

Oriented strand board (OSB)–Performance rated wood panels consisting of layered and oriented wood strands adhesively bonded. Both softwood and hardwood species are used. May include small amounts of waferboard (wood panels made from randomly oriented wood wafers adhesively bonded.)

Nonstructural panels–Wood-based panels not specifically designed for structural applications. Includes particleboard, medium density fiberboard, hardboard, insulation board, and hardwood plywood. Uses include siding, floor underlayment, interior wall paneling, and numerous industrial applications.

Engineered wood–Composite wood products designed to substitute directly for dimension lumber in many building and structural applications. Includes prefabricated wood I-joists, glued laminated timber and structural composite lumber (laminated veneer lumber, parallel strand lumber and oriented strand lumber).

Prefabricated wood I-joists (I-joists)–Structural, load-carrying members designed for roof and floor joist applications, offering long lengths with low material weights. The I-joist flange is typically dimension lumber or structural composite lumber; the web material, softwood plywood or oriented strand board.

Glued laminated timber (Glulam)–Engineered, stress-rated product created by adhesively bonding individual pieces of lumber having a thickness of 2 inches or less. It is versatile and can be shaped into forms ranging from straight to complex curved beams. Uses include headers, girders, purlins, beams, and arches.

Structural composite lumber (SCL)–Composite products designed to be dimension lumber substitutes. Includes laminated veneer lumber, parallel strand lumber and oriented strand lumber.

Laminated veneer lumber (LVL)–A structural composite lumber product made by adhesively bonding thin sheets of wood veneer into a large billet. The grain of the veneers are all parallel in the “long” direction. The billet is then sawn to desired dimensions. Uses include headers, beams, rafters, scaffold planking, and flanges for prefabricated wood I-joists.

Parallel strand lumber (PSL)–A structural composite lumber product made by adhesively bonding veneer that has been chopped into strands to take out knots and other imperfections. A billet is formed with the grain of the strands in the long direction and then sawn. Uses include beams and garage door headers.

Oriented strand lumber (OSL)–A structural composite lumber product made from flaked wood strands that have a high length-to-thickness ratio. The strands are oriented with the grain in the long direction into a billet and then sawn to desired dimension. Uses include millwork parts, studs and flanges for prefabricated wood I-joists.

Species Groups

Douglas fir-Larch (DfL)–Includes Douglas fir (Pseudotsuga menziesii) and Western Larch (Larix occidentalis), sometimes called Mountain Larch or Western Tamarack.

Hemlock-Fir (HemFir)–Includes Western Hemlock (Tsuga heterophylla) and five of the true firs: California Red Fir (Abies magnifica), Grand Fir (Abies grandis), Noble Fir (Abies procera), Pacific Silver Fir (Abies amabilis), and White Fir (Abies concolor).

Southern Yellow Pine (SYP)– Includes Longleaf pine (Pinus palustris), shortleaf pine (Pinus echinata), Loblolly pine (Pinus taeda), Slash pine (Pinus elliottii), and other southern yellow pines.

Spruce-Pine-Fir (SPF)–Includes a variety of spruces, Jack pine (Pinus banksiana), Lodgepole pine (Pinus contorta), and Balsam fir (Abies balsamea).

Other–Includes softwood species not included in species groups above and all hardwood species.

Appendix B–Study Procedure

Wood products consumption for nonresidential building construction is largely dependent on (1) the overall size and mix of the nonresidential building market, (2) the incidence of principal types of construction activity, (3) the incidence of principal framing types used for each type of building, (4) the incidence of wood products used in each principal construction, framing and building type, and (5) the amount of each wood product used per unit of construction activity. This study was designed to use information published by the U.S. Department of Commerce, Bureau of the Census on the overall value, and types of nonresidential buildings built in 2003, and information purchased from F.W. Dodge, Inc.[3] to estimate the incidence of principal construction and framing types, the incidence of wood products used, average amounts of wood used per unit of construction activity by building type for the 3-month period from June through August 2003, and estimates of construction value and floor area built regionally in 2003.

A database of nonresidential building construction projects was developed from projects posted on the F.W. Dodge, Inc. online Dodge Plans subscription service during the 3 month period June 1, 2003 though August 31, 2003. Information on a total of 9,702 projects was downloaded to the database. The downloaded information was then used to assign each project to a specific building type, region, construction type, framing type, and size and height classes. Construction type incidence, and framing type incidence were then developed from these 9,702 projects. Next, two sub samples of projects were selected. The first was a sample of blueprints for 3,664 projects to determine the frequency, or incidence, of the use of each wood product in each construction type, framing type, building type and region. The second consisted of a downloaded sample of 1,069 blueprints needed to estimate wood use factors, or specific amounts of each wood product used for each application. In a study of this size, it is not uncommon for some cells in the database to have no observations. When this occurred, neighboring cells were combined to ensure that needed wood-use-factors would be available. Algorithms were written to specifically address this issue during wood-use-factor data analysis. Results of cell combinations were reviewed, and not felt to negatively impact final wood-use factor estimates. The information in the database also provided the basis for estimating total floor area built by building type, size and height classes, and for regionalizing U.S. Department of Commerce, Bureau of the Census construction value.

Information in the database was edited and summarized to identify erroneous and/or questionable data, to ensure consistency within and between records, and to identify areas where additional information was needed to augment missing, questionable, or incomplete data. Once the database was finalized, the following 7-step procedure was used to estimate wood used in the construction of nonresidential buildings in 2003:

1. Estimate average incidence of principal construction type for each building type, region, and size class. Incidence of principal construction type is an estimate of the percentage of each building type which was new construction, major additions, or alterations and renovations. Since alterations and renovations do not add new floor area, size class is not applicable.

2. Estimate average incidence of principal (exterior wall) framing type for each building type, region, and size class within each construction type. Intensity of wood used is

[3] F.W. Dodge, Market Analysis Group, 24 Hartwell Avenue, Lexington, MA 02173.

greatly dependent on the type of framing used in a building. For example, buildings with wood framed exterior walls typically have wood framed roofs, inferior walls, and upper-story floors. Buildings with concrete exterior walls, may or may not contain any wood in roofs, upper story floors or interior walls. Stratifying buildings by principal framing type permits overall wood use estimates to capture differences in the intensity of wood use due to these differences.

3. Estimate average incidence of wood products used in each principal construction and framing type, and building type, by region, size class and building application. Incidence of wood products use is an estimate of the presence of a specific wood product in a specific building application expressed as a percent. An incidence of I-joist use of 36 percent for wood upper-story floors indicates that 36 percent of these floors, on average, had I-joists present to a greater or lesser degree. Just as the intensity of wood uses varies by principal framing type, so does the presence of specific wood products by principal construction type.

4. Estimate wood use factors for each wood product by construction type, framing, building type, region, size class and building application. Wood use factors measure actual amounts of each wood product used per unit of construction activity, and were based on a tally of all wood products included in each blueprint in the database. When adequate detail was not present, typical construction techniques were applied. For example, if roof trusses were used, and a truss design was included in the blueprint, each individual wood truss member was measured. If trusses were used, but no design was available, a standard truss suitable for the application was selected, and measured. Construction activity is measured in both dollars of construction value, and square feet of finished floor area. Wood use factors provide the means to estimate total wood used based on either measure of construction activity. An I-joist use factor of 0.36 for upper-story floors, on a floor area basis, indicates that on average, 0.36 lf of I-joists are used for every square foot of floor area built for the specified building type, region, size class and construction and framing types. An I-joist use factor of 5.60 for upper-story floors, on a per $1,000 of construction value basis, indicates that on average, 5.60 lf of I-joists are used for every $1,000 of construction value for the specified building type, region, size class and construction and framing types. Use factors measure not only amounts of each wood product used, but also the extent of substitution by or for other wood and nonwood building products. For example, as the I-joist share of upper floor framing increases, the use factor increases, but, since I-joists typically substitute for dimension lumber in floor framing, the lumber use factor decreases.

5. Estimate total value of construction, and total floor area of nonresidential buildings built in the United States in 2003 by building type, region and size class. The U.S. Department of Commerce, Bureau of the Census reports annual value of new nonresidential building construction in both current and constant dollars. Ratios of construction value by building type, region and size class to total value from F.W. Dodge were used to estimate national value of construction by building type, region and size class based on reported U.S. Department of Commerce, Bureau of the Census data. Total national floor area constructed was estimated based on ratios of floor area to value from F.W. Dodge data.

6. Calculate wood products used for nonresidential buildings in 2003 by building type, principal construction type, principal framing type, region, size class, building application, and wood product. Information from steps 1–5 was used to estimate total wood use. Estimates of the amounts of each wood product used in each principal construction and framing type were made

for each building type, size class, and building application. Waste factors were applied to the estimated amounts of wood to account for amounts required for construction, not just the amounts in the finished building.

7. Similar calculations were made for each wood product, region, construction type, framing type, building application, size class and building type. Table B-1 shows the estimation procedure for lumber, wood I-joists, and structural panels used for roofs on new and additions to small schools. Table B-2 summarizes total lumber, wood I-joists, and structural panels used, use per square foot of floor area, and use per $1,000 of constant (2000) construction value for roofs in small schools in 2003.

Table B-1. Estimated lumber, I-joists, and structural panels used for roofs in new, and additions to, small schools, 2003.

Framing type and region	Construction value (Mil $)	Incidence of wood products use: Lumber (%)	I-joists (%)	Structural panels[1] (%)	Wood used per $1,000 of construction value: Lumber (Bf)	I-joists (Lf)	Structural panels[1] (Ft^2)	Total use: Lumber (Mil bf)	I-joists (Mil. lf)	Structural panels[1] (Mil. ft^2)
Wood framed										
Northeast	25	100%	11%	100%	0.506	0.028	4.769	13	6	119
Midwest	55	100%	50%	100%	0.506	0.585	4.967	28	64	271
South	100	100%	11%	100%	0.506	0.028	6.503	50	26	649
West	1,347	100%	50%	98%	4.408	0.585	8.878	5,940	1,577	12,270
Concrete framed										
Northeast	325	73%	0%	82%	6.161	0.000	11.556	2,755	0	4,593
Midwest	664	83%	0%	78%	0.679	0.000	10.635	541	0	9,077
South	1,111	92%	0%	87%	0.653	0.000	17.079	787	0	21,845
West	433	84%	16%	84%	8.261	0.007	14.317	4,248	20	7,362
Metal framed										
Northeast	2,661	86%	0%	86%	0.017	0.000	0.834	52	0	2,567
Midwest	1,772	85%	6%	79%	0.017	0.000	0.905	34	8	2,019
South	2,291	88%	0%	83%	0.018	0.000	0.732	46	0	2,020
West	741	80%	8%	72%	0.015	0.002	0.675	13	17	696
Total										
Northeast	3,011	--	--	--	--	--	--	2,820	6	7,279
Midwest	2,490	--	--	--	--	--	--	603	72	11,366
South	3,502	--	--	--	--	--	--	883	26	24,514
West	2,522	--	--	--	--	--	--	10,201	1,615	20,328
United States	11,525	--	--	--	--	--	--	14,507	1,719	63,487

[1]3/8-inch basis.

Table B-2. Estimated lumber, I-joists, and structural panels used, use per square foot of floor area, and use per $1,000 of constant (2000) construction value for roofs in new, and additions to, small schools, by region, 2003.

Region	Floor area (Mil. ft^2)	Construction value[1] (Mil. $)	Wood products consumption: Lumber (Mil. bf)	I-joists (Mil. lf)	Structural panels[2] (Mil ft^2)	Per ft^2 of floor area: Lumber (Bf)	I-joists (Lf)	Structural panels[2] (Ft^2)	Per $1,000 of construction value: Lumber (Bf)	I-joists (Lf)	Structural panels[2] (Ft^2)
Northeast	16.1	2,644	2,820	6	7,279	174.9	0.4	451.4	1.1	0.0	2.8
Midwest	16.9	2,186	603	72	11,366	35.8	4.3	674.4	0.3	0.0	5.2
South	31.8	3,075	883	26	24,514	27.8	0.8	771.8	0.3	0.0	8.0
West	15.2	2,214	10,201	1,615	20,328	669.6	106.0	1,334.2	4.6	0.7	9.2
U.S.	80.0	10,120	14,507	1,719	63,487	181.4	21.5	793.8	1.4	0.2	6.3

[1]Constant 2000 dollars.

[2]3/8-inch basis.

Appendix C–Example of Wood Use in Schools

Carol B. Milgard Lower School

The Carol B. Milgard Lower School on the campus of Charles Wright Academy in University Place, Washington is an inspiring educational structure, which features an extensive use of engineered wood products. Throughout the 46,123-square-foot building, the economies of all-wood construction are evident as the overall costs came in at approximately $117 per square foot. Plywood sheathing was used in the walls, I-joists and exposed glulam beams form the ceiling of the “cafetorium” and the main hall features a series of spectacular glulam beams and columns connected with steel knife plates.

Designed for preschool to fifth-grade students, the new building replaced the old “Lower School” elementary building - an Italian diner before it was renovated to serve the school in 1957.

Treated glulam beams and columns in the breezeway set the visual stage for the soaring glass and glulam front entrance.

“The design goals were to create a place of learning that is warm, welcoming and inspiring. The use of exposed glulam beams and columns plays an important role in helping us achieve these goals,” said Paul Akiyama, AIA, BCRA Principal.

Teacher Carrie Olsen said the building makes students and teachers feel more valued. “The kids feel like doing quality work in a quality building,” she added.

Headmaster Robert Camner said the new building will encourage a variety of teaching styles. Each grade has two adjoining classrooms with large doors between them. That encourages teachers to collaborate and students in the same grade to intermingle.

Carol B. Milgard Lower School
7723 Chambers Creek Road West
University Place, WA 98467

Completed August 2005

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WOOD PRODUCTS USED IN THE CONSTRUCTION OF LOW-RISE NONRESIDENTIAL BUILDINGS IN THE UNITED STATES, 2003 / by David B. McKeever, Craig Adair, and Jennifer O'Connor.

Tacoma, WA : APA, the Engineered Wood Association, 2006. 68 Pages