Wood Products Used in New Nonresidential Building Construction, 1995

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Executive Summary

Wood products are an important component of the mix of building products used in new nonresidential building construction. In 1995 an estimated 1,464.4 million board feet (bf) of dimension lumber, 55.3 million bf of glulam timber, 1,165.4million square feet (ft^2), 3/8-in. basis, of structural panels, 12.9 million ft^2, 3/8-in. basis of nonstructural panels, 58.5 million linear feet (lf) of wood I-joists, and 1.0 million cubic feet (ft^3) of structural composite lumber (SCL) were used. These 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.

Comparisons made with a 1985 study indicate that wood products consumption was greater in 1985 when 2,780 million bf of dimension lumber and engineered wood, 2,094 million ft^2, 3/8-in. basis, of structural panels, and 60 million ft^2, 3/8-in. basis, of nonstructural panels were consumed (Table ES-1). Declining overall wood use between 1985 and 1995 was due, in part, to:

- A 37 percent overall reduction in the share of small buildings which tend to use more wood per square foot of floor area than large buildings in 1995,
- Lower constant dollar construction value per square foot of floor area in 1995 indicating a preference for lower cost buildings and building materials which may not favor wood,
- Changes in the mix of building types constructed favoring those which tend to use less wood per square foot of floor area,
- Increased use of concrete as the principal construction type at the expense of wood, and
- The introduction, and growing acceptance of engineered wood products which tends to reduce the amount of wood required to achieve the same level of performance.

These and other non-quantifiable factors make it difficult to accurately measure changes in market shares for wood products. The magnitude of change in wood products consumption does suggest that wood products have lost share to competing products over the past decade.

Overall, stores and office buildings used more wood products than other building types in 1995 (Table ES-1). Five building types: stores, offices, schools, religious and miscellaneous, reported SCL use in excess of 100,000 ft^3 in 1995. Reported volumes of engineered wood products in 1995 may be under-estimated due to their relative "newness" and low incidence of use.

An additional 6,003 million bf of lumber and 5,970 million ft^2 of structural panels could have been used in nonresidential buildings in 1995 if concrete and metal components in upper floors, walls (including exterior siding) and roofs were built with wood. Roofs

represent the greatest single area for incremental volume potential for both lumber and structural panels.

Overall, new nonresidential building construction is an important market for wood products, but one which cannot be taken for granted. Nonwood building products are continually challenging wood in many nonresidential building applications as evidenced by reduced market shares for wood construction in 1995. Wood products must be competitive in order to maintain and increase their share of the nonresidential building market.

Table ES-1.-Wood use in new nonresidential buildings, by building type, 1985[1] and 1995

Building type/ year	Construc-tion value[2] (Mil. $)	Lumber		Structural panels[4] (Mil. ft²)	Non-structural panels[4,5] (Mil. ft²)	Engineered wood		
		Dimension only (Mil. bf)	Dimension + engineered wood[3] (Mil. bf)			I-joist (Mil. lf)	Glulam (Mil. bf)	SCL (Mil. ft³)
Stores								
1985	41,435	--	985.0	731.0	11.0	--	--	--
1995	38,098	394.2	453.0	354.4	5.7	12.8	26.0	0.5
Industrial								
1985	18,186	--	125.0	80.0	2.9	--	--	--
1995	30,391	53.0	113.4	158.2	1.1	20.0	19.8	([6])
Offices								
1985	35,416	--	596.0	494.0	10.9	--	--	--
1995	22,891	278.4	303.9	225.6	2.5	10.8	1.2	0.2
Hotels								
1985	8,614	--	181.0	144.0	18.0	--	--	--
1995	6,351	129.3	132.7	48.6	0.5	1.6	0.2	([6])
Schools								
1985	13,545	--	260.0	208.0	4.1	--	--	--
1995	24,145	189.5	199.5	148.2	1.8	3.0	2.1	0.1
Religious								
1985	3,147	--	110.0	83.0	1.1	--	--	--
1995	3,864	118.1	128.5	78.8	0.3	2.8	3.2	0.1
Health								
1985	10,801	--	335.0	241.0	6.1	--	--	--
1995	13,905	141.0	153.0	65.2	0.4	5.2	1.0	([6])
Public and miscellaneous								
1985	12,444	--	188.0	113.0	6.0	--	--	--
1995	25,059	160.8	168.4	86.5	0.6	2.3	1.8	0.1
Public	19,638	86.5	91.3	34.6	0.3	1.6	1.1	([6])
Misc.	5,421	74.3	77.1	51.9	0.3	0.7	0.7	0.1
All buildings								
1985	143,588	--	2,780.0	2,094.0	60.1	--	--	--
1995	164,704	1,464.4	1,652.4	1,165.4	12.9	58.5	55.3	1.0

[1]Excludes millwork, concrete forms and scaffolds, and other and not specified use.
[2]Constant 1992 dollars.
[2]Includes glulam and bf equivalent of I-joists and SCL: 1 lf I-joist=2 bf; 1 ft³ SCL =16 bf.
[4]3/8-inch basis.
[5]Excludes 50% of particleboard and 80% of hardboard used in 1985 for millwork.
[6]Less than 0.05 million.
Source: 1985: Wood Products Promotion Council 1987.

Introduction

New nonresidential construction is an important component of the new construction market in the United States, and a major market for wood products. In 1995 the value of all new nonresidential construction was $299 billion, 56 percent of all new construction (Table 1). The construction of new nonresidential buildings was valued at $184 billion, 62 percent of all new nonresidential construction, and nearly 35 percent of all new construction.

Nonresidential buildings are a heterogeneous mix of structures with uses ranging from small one room barber shops and churches to large shopping malls and hospitals. In this study, 9 building types were identified which correspond to those used by the U.S. Bureau of the Census (1997). Building types identified here are: stores, industrial, offices, hotels, schools, religious, health, public, and miscellaneous. Complete descriptions of each building type, and definitions of other terms used in this report are in Appendix A. This level of new nonresidential building construction translated into an estimated 2.8 billion square feet (ft^2) of floor area, 1.5 billion ft^2 of exterior wall area, and 2.6 billion ft^2 of roof area built in 1995. Wood products are an important part of the mix of building products used in new nonresidential buildings. In 1995 an estimated 1,464.4 million (million) board feet (bf) of lumber, 1,165.4 million ft^2, 3/8-in. basis, of structural panels (718.8 million ft^2 of softwood plywood and 446.6 million ft^2 of oriented strand board OSB)), 12.9 million ft^2, 3/8-in. basis of nonstructural panels, 58.5 million linear feet (lf) of wood I-joists, 55.3 million bf of glulam timber, and 1.0 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: 10 percent for dimension lumber, 5 percent for structural and nonstructural panels, and 2 percent for engineered wood products (I-joists, glulam timber, SCL and composites). 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.

New nonresidential buildings use a diverse mixture of wood and nonwood building materials and building techniques. The choice of materials and techniques 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, industrial buildings are predominately built with concrete and steel (Fig.1). However, those in the West region are more likely to have wood floor, wall, and especially roof systems than industrial buildings located elsewhere. In order to capture these differences, data for this study were stratified and evaluated by building type, region, size class, building application, and wood product.

This study was undertaken cooperatively by the USDA Forest Service, Forest Products Laboratory and the Wood Products Promotion Council (WPPC)[1], and provides information on the amounts and types of wood products used in the construction of new nonresidential buildings in 1995. 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. Prior to the 1985 WPPC report, 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 of wood use (incidence of use), the amount of wood used per square foot of finished floor area when wood is used (wood use factors), estimated finished floor area built, and the total value of new nonresidential buildings put in place. Incidence of use, wood use factors and estimated finished floor area built were supplied by F.W. Dodge[2] and were based on a sample of blueprints for buildings completed, started or planned for the three year period 1993-1995. Total value of new construction put in place was obtained from the U.S. Department of Commerce, Bureau of the Census. Supplementary information was collected by field representatives of APA-The Engineered Wood Association to augment data provided by F.W. Dodge. A description of the analysis procedures used are in Appendix B.

[1]Member associations of the Wood Products Promotion Council include the American Forest and Paper Association, American Wood Council, APA-The Engineered Wood Association, Southern Forest Products Association, and Western Wood Products Association.

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

Measures of Construction Activity

Construction activity for new nonresidential buildings is measured in both the value of the new construction and total floor area built. Value of new construction, by building type, is available for the Nation as a whole from the Bureau of the Census (1997). 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. In order to make meaningful comparisons of construction value over time, actual (current) dollars spent were converted to constant 1992 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 New Construction

In 1995 the construction of new nonresidential buildings in the United States was valued at $164.7 billion constant (1992) dollars (Table 2). Nearly 58 percent of the total value was for large buildings (more than 50,000 ft^2 of floor area), 42 percent for small buildings (50,000 ft^2 of floor area or less). Construction value in the North and South regions were nearly equal at $65.4 and $63.4 billion respectively. Construction value in the West was $35.9 billion. Large buildings in each region, and in the U.S. overall, accounted for about 58 percent of total construction value.

Stores were the highest valued building type in 1995 at $42.7 billion, 23 percent of all new nonresidential building construction (Table 2, Fig. 2). Industrial buildings and schools ranked second and third in total construction value respectively. Combined, these three building types accounted for more than half, 56 percent, of all new construction.

Between 1985 and 1995, the value of new nonresidential buildings increased by $21.1 billion, from $143.6 to 164.7 billion (Table 3). Stores were the highest valued building type in 1985 at $41.4 billion constant (1992) dollars, 29 percent of all construction value. Offices and industrial buildings were second and third highest, respectively. These three building types accounted for about two-thirds of all new construction in 1985.

Floor Area

An estimated 2,820 million ft^2 of floor area were built in 1995 in all nonresidential buildings (Tables 2 and 3). Sixty percent of this area was in large buildings, 40 percent in small buildings. Like the value of new construction, floor area built in the North and South regions were nearly equal, 1,062 and 1,178 million ft^2 respectively, and considerably more than in the West. Floor area built in the West was about half that of

the North and the South. In all regions, large buildings accounted for about 60 percent of total floor area. Overall, about 2 percent of all floor area was below grade, 78 percent on ground level, and 20 percent in upper stories.

Stores were the building type with most floor area built in 1995 at 876 million ft^2, 31 percent of all new nonresidential floor area (Table 2, Fig. 3). Industrial buildings ranked second at 766 million ft^2, and office buildings a distant third at 334 million ft^2. Stores and industrial buildings combined accounted for 58 percent of all floor area built in 1995.

The value of new construction per square foot of floor area averaged $58.4 in 1995 (Table 2). Small buildings averaged $61.6 per square foot, large buildings $56.3. Values in the North and West regions were nearly equal at $61.6 and $61.8 respectively. Values in the South were about $8 per square foot less than other regions. Average value by building type and region ranged from a high of $118.6 per square foot for public buildings in the West to just $37.1 for industrial buildings in the South.

Between 1985 and 1995, total floor area in new nonresidential buildings increased by 430 million ft^2, from 2,390 to 2,820 million ft^2 (Table 3). Stores were the building type with the most floor area built in 1985 at 920 million ft^2, 38 percent of all floor area built. Offices were second highest at 480 million ft^2, only about half that of stores. These two building types accounted for 59 percent of all floor area built in 1985. This is nearly the same percentage in 1995 when stores and industrial buildings, the two building types with the most floor area, accounted for 58 percent of all floor area built.

Construction value per square foot of floor area averaged $60.1 in 1985, $1.7 greater than in 1995 (Table 3). Values in 1985 ranged from a high of $76.7 for religious buildings to a low of $45.0 for stores.

Exterior Wall and Roof Area

Nearly 1,500 million ft^2 of exterior wall area were built in 1995 (Table 4). More than half, 826 million ft^2 or 55 percent of all exterior wall area, was in small buildings. Total floor area by building type was a good indicator of total exterior wall area by building type. Stores, the building type with the most floor area built in 1995, was 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 (multiple story 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 in 1995 was 0.53. That is, for each square foot of floor area built, about half a square foot of exterior wall area was built. Religious buildings had the highest ratio at 0.68, public buildings the lowest at

0.40. Religious buildings tend to be small (under 50,000 ft^2 of floor area) and tend to have large floor to ceiling heights, resulting in a relatively large exterior wall to floor area.

Total roof area built in 1995 was estimated to be nearly 2,600 million ft^2 (Table 4). In contrast to exterior wall area, more than half (58 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, 0.92 ft^2 of roof were required per ft^2 of floor area built in 1995. Stores had the highest ratio at 1.12, hotels the lowest at 0.35.

Principal Construction Type

Three principal construction types account for nearly 100 percent of all new nonresidential construction: 1) wood, 2) concrete, and 3) metal. Wood construction includes lumber or other wood product framing, regardless of sheathing type, concrete construction includes concrete, masonry, stone, brick and block, and metal construction includes primarily steel framing or support members. Although some buildings are built entirely using a single construction type, most combine two or more types. It is therefore difficult, and not very useful, to classify entire buildings by construction type. However, specific applications within a building usually rely on a single construction type, for example, concrete foundation or wood framed roof, Shifts to, or from, wood directly affect overall wood products consumption.

In 1995 wood framed construction accounted for less than 20 percent of all construction in every application for all buildings and sizes combined (Table 5). Shares ranged from about 1 percent of all ground floor area to 19 percent of all roof area. Concrete construction dominated ground floors (99 percent) and exterior walls (62 percent), and metal construction dominated upper floors (51 percent), interior walls (64 percent) and roofs (71 percent). Building size was a good indicator of both wood and concrete construction share in 1995. As building size increased, the average share of wood framed construction decreased dramatically, while average concrete construction shares increased in all applications. In general, metal construction also increased with the exception of exterior walls.

Between 1982[3] and 1995 the share of wood framed construction for all building sizes combined fell in all applications, concrete construction share increased, and metal construction increased in some applications (interior walls and roofs) and decreased in others (floors and exterior walls) (Table 5). The greatest loss for wood was in interior

[3] Principal construction types reported in the 1985 Wood Products Promotion Council report are for 1982.

walls where its share fell by 22 percentage points between 1982 and 1995. Similar trends were evident for both small and large buildings with few minor exceptions. The shifts away from wood to concrete and metal construction directly impact wood products consumption, and may be the single, most important factor in explaining changing wood use.

Exterior siding is another important building application which can be categorized by principal construction type. Unlike floors, walls, and roofs, exterior siding may more often contain two or more siding types. Reported 1995 principal siding types are based on the siding type most often used regardless of other, lesser associated types. This information reflects the relative frequency of use for each principal siding type, not absolute amounts used.

Concrete, including masonry, stone and stucco, was the principal siding type of choice in 1995 (Fig. 4). Concrete accounted for more than half of all siding types. Other siding types, including vinyl, fiberglass, and no added siding, was second at about one third. Metal accounted for 10 percent, and wood just 2 percent of siding types in 1995. Concrete, metal and wood siding all experienced large declines from 1985. The concrete siding category fell 15 percent, metal 47 percent, and wood 66 percent. Vinyl siding is most likely responsible for much of the decrease.

Wood Products Use, 1995

A wide variety of wood products were used in the construction of new nonresidential buildings in 1995. Specific products identified and reported here include lumber, structural panels (softwood plywood and oriented strand board (OSB)), nonstructural panels, and engineered wood products (wood I-joists, glulam timber, and structural composite (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 dimension lumber, 5 percent for structural and nonstructural panels, and 2 percent for engineered wood products. Not included in the reported amounts are wood used for facilitation (form work, scaffolding, etc.) and millwork. All wood-based panel volumes are on a 3/8-in. basis unless otherwise noted

Lumber

Total lumber use in all new nonresidential buildings was estimated to be 1,464 million bf in 1995 (Table 6). Regionally, few differences in overall lumber use were evident. The North used slightly more lumber than other regions at 36 percent of the total (Fig. 5). The South and West regions each used about 32 percent of all lumber.

Building size greatly affected lumber use in 1995. Small buildings accounted for 73 percent of all lumber use, large buildings 27 percent (Fig. 5). This difference by size class is primarily due to much higher incidence of wood as the principal construction type in most building applications in small buildings compared to large buildings (Table 5).

Roofs were the building application with the greatest share of lumber use in 1995 at 593 million bf or 41 percent of all lumber use (Fig. 5). Included are dimension lumber for joists and rafters, roof trusses, timber beams and a small amount of decking boards. Dimension lumber and boards were used most often, and accounted for 56 percent of all lumber used in roofs (Fig. 6). Lumber roof trusses were also an important component of roof systems. About 16 percent of all roofs used lumber trusses, and these trusses accounted for 42 percent of all lumber in roofs. The remaining 2 percent of lumber was in timber beams.

Exterior and interior walls were the second and third highest lumber using applications at 32 and 16 percent respectively. The larger volume of lumber used in exterior walls compared to interior walls is largely due to the greater surface area of exterior walls on average. Floors accounted for 10 percent of total lumber use. Very little lumber siding was used, less than 1 percent of total consumption.

Species Composition and Treatment

Five species groups of dimension and board lumber were used in new nonresidential buildings in 1995--Douglas Fir-Larch (DfL), Hemlock-Fir (HemFir), Southern Yellow Pine (SYP), Spruce-Pine-Fir (SPF) and Other (See Appendix A for definitions). Actual amounts of lumber used in each species group were not measured, but the frequency of blueprint specification of each was. Overall, when lumber species were specified, DfL was specified 40 percent of the time, more than any other species group (Fig. 6). SYP was specified 25 percent, HemFir 15 percent, SPF 12 percent, and other species 8 percent of the time. Construction in the South and West tended to use species indigenous to the region. Forty two percent of the lumber specified in the South was SYP, and 63 percent specified in the West was DfL. Species composition in the North was more evenly distributed over all species groups.

The frequency of truss lumber specification was also measured. Three species groups were identified--pine, fir, and other. Overall, about one third of specified truss lumber was pine, nearly two thirds was fir, and a small amount was other species. Regional preferences were evident. About 90 percent of the truss lumber specified in the South was pine, and 90 percent specified in the West was fir. The North used about 33 percent pine, 44 percent fir, and 22 percent other species.

About 60 percent of the exterior lumber siding used was specified as cedar. The remaining 40 percent of exterior lumber siding was not specified by species type.

Preservative treated and fire retardant treated wood (lumber and softwood plywood) were both used in new nonresidential buildings in 1995. As with lumber use by species group, actual amounts of treated wood used in 1995 were not measured. Frequencies of blueprint specification and qualitative extent of use were, and offer insights into the use of these specialized products. The extent of use was classified as either "incidental" or "extensive". Incidental use of preservative treated wood was specified 71 percent of the time, and extensive use 4 percent of the time (Fig. 7). Little regional variation in preservative treated specification was apparent. Fire retardant wood was specified for incidental use 37 percent of the time, and extensive use 6 percent of the time. No fire retardant wood use was specified 57 percent of the time. Only slight regional variation existed.

Use by Building Type

As previously mentioned, many factors affect the use of wood products in the construction of new nonresidential buildings. Building type is perhaps the single largest determining factor. Within each building type, variations in wood use resulted from 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.

Stores used nearly 394 of the 1,464 million bf of lumber used in 1995 in new nonresidential buildings, and accounted for more than one fourth of all lumber used (Table 7, Fig. 8). Offices and schools were next highest at 278 and 190 million bf respectively. These three building types combined used more than 862 million bf of lumber and accounted for 59 percent of all lumber use. Public, miscellaneous and industrial buildings were the least lumber intensive building types. Combined, they used just 214 million bf of lumber, and accounted for 15 percent of all lumber use.

Lumber use by region for all building types combined was fairly evenly distributed, ranging from a low of 451 million bf in the Westto a high of 523 million bf in the North (Table 7). The percentage difference between low and high use was about 13 percent. Thirty six percent of all lumber was used in the North, 33 percent in the South and 31 percent in the West. Different regional patterns of use and greater regional variations were evident within specific building types. Schools, health, public and miscellaneous buildings in the North used more lumber than was used in other regions in these building types. Stores, hotels and religious buildings in the South, and industrial, and office buildings in the West used more lumber than was used in other regions in these building types. Regional variation in lumber use by individual building types between the lowest and highest lumber using region ranged from a low of 29 percent difference for stores, and a high of more than 300 percent difference for religious and health

buildings. Much of the regional variation in lumber use is attributable to different regional building code requirements, environmental factors (snow load requirements, earthquake resistance and insect resistance), and architectural styles.

Lumber use by building size class was heavily weighted towards small buildings of 50,000 ft^2 or less. Small buildings used nearly 1,070 million bf of lumber in 1995 compared to 395 million bf by large buildings (Table 8), more than 2.7 times as much. Size class variations in lumber use by building type range from small stores using 1.8 times as much lumber as large stores, to small religious buildings using 18.4 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 construction type in all building applications in small buildings compared to large (Table 5).

Lumber use by building application in 1995 was predominately in roofs (41 percent of all lumber) and exterior walls (32 percent) for all building types combined (Fig. 5). Interior walls (16 percent) and floors (10 percent) were third and fourth in lumber use intensity, and very little lumber siding was used. Roofs in public buildings accounted for the largest percentage of lumber use in an individual building type at 68 percent of all lumber used. Lumber use by application varied among building types. Roofs were the largest lumber using application in stores, industrial, religious, public and miscellaneous building, ranging from 43 percent of all lumber used in miscellaneous buildings to 68 percent in public buildings. Store roofs were the single largest lumber using application in 1995 at 200 million bf (Table 9). Exterior walls were the highest lumber using application in office buildings and schools at 50 and 44 percent of all lumber used respectively. Interior walls were the highest lumber using application in hotels and health buildings at 42 and 40 percent of all lumber respectively. Much of the variation in relative lumber use by application among building types is directly attributable to characteristics specific to the building type. For example hotels tend to be wood framed, 2 story structures with numerous interior walls and partitions. Thedistribution of lumber by application and relative importance in hotels is interior walls, floors, roofs and exterior walls. Conversely, industrial buildings tend to have concrete exterior walls and ground level floors, and a fairly low incidence of upper story floors and interior walls. Roofs, particularly in the West, have a higher incidence of wood construction than other applications. Lumber use in industrial buildings is largely in roofs, accounting for 64 percent of all lumber used.

Amounts of finished wood flooring used in 1995 were not measured, but frequency of blueprint specification was. Overall, finished wood flooring was specified for use about 8 percent of the time, with maple flooring being specified 63 percent of the time, oak flooring 15 percent, pine flooring 4 percent and other species 19 percent. Much variation by building type was evident with no wood flooring being specified in industrial buildings to 21 percent in religious buildings. Hotels, schools, and miscellaneous buildings all had finished wood flooring specified 10 percent or more of the time.

Structural Panels

Total structural panel use in all new nonresidential buildings was estimated to be 1,165 million ft^2 in 1995 (Table 6). More structural panels were used in the West (41 percent of total use) than any other region (Fig. 9). The South and North were second and third in structural panel consumption at 31 and 28 percent of total use respectively. More than half of all structural panels used in each region was softwood plywood, but the percentage which was softwood plywood varied greatly. OSB consumption in the North was 47 percent of all structural panel consumption, higher than any other region (Fig. 10). Just the opposite was true in the South where OSB accounted for just 27 percent. Consumption in the West was intermediate at 59 percent softwood plywood, 41 percent OSB.

Building size greatly affected structural panel use in 1995. Small buildings accounted for 69 percent of all panel use, large buildings 31 percent (Fig. 9). The difference by size class was similar to that for lumber, and was primarily due to much higher incidence of wood as the principal construction type in most building applications in small buildings compared to large buildings (Table 5). The mix of softwood plywood and OSB showed little size class variation (Fig. 10).

Roofs were the building application with the greatest share of structural panel use in 1995 at 743 million ft^2, or 64 percent of total structural panel use (Table 6, Fig. 9). 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. Minor variations in the mix of softwood plywood and OSB used in all applications except siding were evident in 1995 (Fig. 10). Floors used the lowest percent of OSB (36 percent), exterior walls the highest (42 percent). Structural panel siding was predominately softwood plywood (82 percent).

Treatment

Preservative treated and fire retardant treated wood (lumber and softwood plywood) were both used in new nonresidential buildings in 1995. See **Species Composition and Treatment** for **Lumber** above for a discussion of treated wood use in new nonresidential buildings.

Use by Building Type

Half of all structural panels used in new nonresidential buildings in 1995 were used by two building types-stores and offices (Fig. 11). Stores used 354 million ft^2 of the 1,165 million ft^2 of structural panels used in 1995, and accounted for 30 percent of all structural panels used. Offices were next highest at 226 million ft^2 or nearly 20 percent (Table 7). Industrial buildings and schools were nearly equal at 14 and 13 percent of

all structural panels used respectively. The remaining five building types (religious, health, miscellaneous, hotels and public buildings) each used 6 percent or less of all structural panels, and accounted for about one-fourth of total structural panels use.

The share of softwood plywood vs. OSB varied considerably by building type. Overall 62 percent of all structural panels were softwood plywood (Fig. 11). Stores and hotels used the lowest share of softwood plywood at about 58 percent, health and public buildings the highest at 71 percent.

Structural panel use by region for all building types combined varied considerably, from a low of 323 million ft^2 in the North to a high of 482 million ft^2 in the West. (Table 7). The percentage difference between low and high use was about 50 percent. Twenty-eight percent of all structural panels were used in the North, 31 percent in the South and 41 percent in the West. Different regional patterns of use and greater regional variations were evident within specific building types. The West was the region with highest structural panel use in 6 of the 9 building types, and the South in the remaining 3 building types. Regional variation in structural panel use by individual building types between the lowest and highest structural panels using region ranged from a low of 13 percent for hotels to a high of nearly 80 percent for public buildings.

Structural panel use by building size class was heavily weighted towards small buildings of 50,000 ft^2 or less. Small buildings used nearly 804 million ft^2 of structural panels in 1995 compared to 362 million ft^2 by large buildings (Table 8). Size class variations in structural panels use by building type range from small industrial buildings using 1.2 times more structural panels than large industrial buildings, to small religious buildings using 31.8 times more structural panels than large ones. Overall, small buildings used about 2.2 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 construction type in all building applications in small buildings compared to large (Table 5).

Structural panel use by building application in 1995 was predominately for roofs, accounting for 64 percent of all structural panels used (Fig. 9). Exterior walls and floors were a distant second and third at 18 and 12 percent of all structural panels respectively. Just 5 percent of all structural panels were used for interior walls and 1 percent for siding.

Store roofs were the single highest use for structural panels in 1995 at nearly 213 million ft^2, followed by industrial roofs at 150 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 (44 percent), while industrial building roofs used the greatest (95 percent). Exterior walls were consistently the second highest structural panel application with the exception of floors in industrial and health buildings.

Softwood plywood as a percent of all structural panels averaged about 62 percent for all building types combined. Excluding siding, this percentage varied from about 55 percent softwood plywood for exterior walls in stores to about 80 percent softwood plywood for interior walls in miscellaneous buildings. The percentage of siding that was softwood plywood was much higher than other applications, averaging 82 percent over all building types. Percentages of structural panel siding that were softwood plywood by building type ranged from 73 percent for schools to 95 percent for stores.

Nonstructural Panels

Use of nonstructural panels in new nonresidential buildings was small in 1995, just under 13 million ft^2 (Table 6). Regional use was concentrated in the South and West. These two regions used 47 and 34 percent of all nonstructural panels respectively (Fig. 12). Just 19 percent of all nonstructural panels were used in the North.

Nonstructural panel use by building size class favored small buildings of 50,000 ft^2 or less. Small buildings used 57 percent of all nonstructural panels in 1995, large buildings 43 percent (Fig. 12). The difference in use between the two size classes (14 percent) was much less than that for lumber (46 percent) or structural panels (38 percent). Nonstructural panels are typically not used in applications requiring structural building components. This tends to restrict use to more limited, specialized uses such as siding, floor underlayment, and nonstructural sheathing applications, and limits the impact of higher wood construction in small buildings compared to large.

In 1995 47 percent of all nonstructural panels, nearly 6 million ft^2, were siding (Table 6, Fig. 12). Exterior wall and roof sheathing use were nearly equal at 26 and 22 percent of all nonstructural panels respectively, Small amounts were used for interior wall sheathing and floors. Nearly all nonstructural panel siding is hardboard. Composition of the remaining 7 million ft^2 was about 52 percent particleboard, 42 percent fiberboard (insulation board) and 6 percent hardboard panels,

Use by Building Type

Nearly half (44 percent) of all nonstructural panels were used in stores in 1995 (Fig. 12). Offices and schools were the next highest nonstructural panel using building types at 19 and 14 percent respectively. These three building types combined used 10 of the 13 million ft^2 of nonstructural panels (Table 7), or about 77 percent. Industrial buildings used about 8 percent of all nonstructural panels, and the remaining 5 building types each used 4 percent or less. Regionally, stores in the South used more nonstructural panels than any other single building type or region.

Overall, small buildings used more nonstructural panels than large buildings, averaging about 35 percent more. Stores and schools (two of the top 3 nonstructural panel using building types) are the exception. Large stores used 3.4 million ft^2 of nonstructural

panels in 1995 (Table 8), nearly 50 percent more than small stores, while large schools used nearly 60 percent more nonstructural panels than small schools.

Siding was the principal nonstructural panel application in 1995 for all building types combined. This was due to relatively high levels of use of nonstructural panel siding in stores. An estimated 3.2 of the 5.9 million ft^2 of nonstructural panel siding used in 1995 was for stores (Table 9).

Nonstructural panel use for interior wall siding was not measured, but frequency of blueprint specification indicated that interior wall paneling was specified for use about 5 percent of the time. When specified, hardwood plywood was specified 62 percent of the time, softwood plywood 28 percent and hardboard 10 percent of the time. Variation by building type ranged from no specification in schools and public buildings to 10 percent in religious buildings and 13 percent in hotels.

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 engineered wood products but because their primary use as sheathing and decking rather than framing applications, they were reported separately above.

In 1995 58.5 million linear feet (lf) of I-joists, 55.3 million bf of glulams, and 1.0 million cubic feet (ft^3) of SCL were used in new nonresidential buildings (Table 6). About 90 percent of the SCL was LVL. Engineered wood use in the West far exceeded use in all other regions, with 59 percent of all I-joists, 88 percent of all glulam and 80 percent of all SCL being used (Figs. 14-16).

Overall, more engineered wood was used in small buildings than large buildings in 1995. However, percentage use varied from a high of 79 percent of all I-joists to a low of 52 percent of all glulams being used in small buildings (Figs. 14-16). SCL use was intermediate at 60 percent.

Roofs were by far the dominate use for engineered wood accounting for 85 percent or more of each engineered wood product use (Figs. 14-16). Much of the variation by application for individual engineered wood products is due to the uses for which they substitute for framing lumber. I-joist are used for floor and roof framing, and for door and window headers in walls. Since floors have a 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 small compared to roofs and floors. The principal use for glulam timbers is as large, often decorative, roof beams and girders where large, clear spans are required. Glulam use in 1995 was principally in roofs, accounting for 96 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 1995 90 percent of all SCL was used in roofs, 10 percent in exterior walls, and small amounts in floors and interior walls.

Use by Building Type

Engineered wood use varied considerably by building type and specific engineered wood product. However, some overall trends were evident. Stores were consistently in the top 3 engineered wood using building types in 1995, and used more glulam and SCL than any other building type (Figs. 17-19). Industrial and office buildings were also important markets for engineered wood, placing in the top 3 engineered wood using building types for 2 of the 3 engineered wood products. Schools and religious buildings tended to be intermediate in use, and hotels, health, public and miscellaneous buildings tended to use small amounts of engineered wood. 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 1995. I-joist and glulam use was highest in the West in 8 of the 9 building types (Table 7), and accounted for 59 and 87 percent of total use respectively. SCL use was also highest in the West, capturing 80 percent of the SCL market

Small buildings of 50,000 ft^2 or less are the major market for engineered wood. In 1995 I-joist use was greater in small buildings of every type than large buildings, and accounted for 46.4 million of the 58.5 million lf of I-joist used (Table 8). With the exception of industrial buildings, glulam use was also greater in small buildings of all building types. SCL use was less specific to small buildings than other engineered wood products. Overall 60 percent of all SCL was used in small buildings.

Overall, roofs were the building application using more engineered wood than other applications. Eighty-five percent or more of each engineered wood product was used for roofs in 1995, but minor variations were evident by building type. Hotels tended to use more of each engineered wood product in floors than in other applications (Table 9). Floors in health building used more I-joists than did other applications, and exterior walls in religious buildings used more SCL than did other applications.

Wood Use Factors, 1995

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 1995: wood use per $1,000 of constant (1992) dollar construction value, and wood use per square foot of finished floor area built. Each was stratified by building type, by region, by building size class, and by application, and provide a means of comparing the relative extent of wood use within each stratum. For example, public buildings used the least amount of I-joists per $1,000 of construction value of all building types in 1995 at 0.08 lf (Table 10). In comparison, religious buildings used the greatest amount of I-joists at 0.72 lf per $1,000. Average I-joist use for all buildings combined was 0.38 lf 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 1992 dollar value of all new nonresidential building construction in 1996 were known, then total I-joist use for all building types combined could be estimated as:

$$\text{I-joist use}_{1996} = \text{Value}_{1996}/1{,}000 \times \text{I-joist use factor}_{1995}$$

Several assumptions are implicit in the resulting I-joist use estimate. Since specific building types use I-joists at different rates, estimated I-joist 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 1996 accounted for the same proportion of total construction value as in 1995. Also, the use of I-joists within a specific building type changes over time as I-joists 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 I-joists used occurred between the base year (1995) and the estimation year (1996). Over a short period of time these assumptions may be valid, but undoubtedly will change over longer periods of time.

Wood use factors also provide a means of gauging changes in overall wood products use from activities which tend to change the use factors. If promotion efforts to increase the amount of I-joists used in roof systems is expected to increase their use by 20 percent in 1996, then total I-joist use in roofs can be estimated as:

$$\text{I-joist use}_{1996} = \text{Value}_{1996}/1{,}000 \times (\text{I-joist use factor}_{1995} \times 1.2)$$

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 lumber was used per $1,000 of constant (1992) construction value than any other wood product (8.89 bf) (Table 10). Structural panels were second highest at 7.08 ft^2 (4.36 ft^2 of softwood plywood and 2.71 ft^2 of OSB). Use of nonstructural panels and engineered wood products were all less than 1.00

Religious buildings were the most wood intensive building type in 1995. With the exception of nonstructural panels, more wood products 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 cubic meters[4], 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 value for religious buildings was 3.2 which means that religious buildings used 3.2 times more wood per $1,000 of construction value than average (Table 10, Fig. 20). Industrial and public buildings were the least intensive wood-using building types, with an index value of 0.4. Wood use per $1,000 of construction for these two building types was just 0.4 times that of the all buildings average. Similar indexes were constructed for use per $1,000 by region, by size class, and by application.

Wood use was considerably and consistently higher in the West than in other regions. About 40 percent more lumber and 90 percent more structural panels were used per $1,000 of construction value in the West than in all regions combined. Engineered wood products use was 2-3 times higher in the West.

Small buildings (up to 50,000 ft^2 of floor area) used wood at much higher rates than large buildings. About 2.5 times more wood was used per $1,000 of construction value in small buildings than large.

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[4] Factors to convert wood products consumption to m^3

Lumber and glulam timber:
1000 bf, softwood lumber = 1.70 m^3
1000 bf, hardwood lumber = 2.36 m^3
Structural and nonstructural panels, and I-joist web
1000 ft^2 (3/8-inch basis) = 0.885 m3
Structural composite lumber, and I-joist flanges:
1 ft^3 = 0.0283 m3
I-joists:
1 lf = 1 ft2 (3/8" basis) of structural panels:
1 lf = 0.046 ft3 of flange where 79% was LVL, and 21% was lumber.

Roofs were consistently the most intensive wood using building application in 1995. All wood products were used at higher rates in roofs than other applications with the exception of nonstructural panels (Table 10). Exterior walls were second highest with overall wood use per $1,000 of construction value at about half 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. Religious buildings were the most intensive wood-using building type in all wood products except nonstructural panels and SCL in 1995 (Table 11), and had the highest wood use per ft^2 of floor area index value (Fig. 21). Hotels remained the second most intensive, and industrial and public 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, 1985 and 1995

Results from the 1985 (WPPC 1987) and 1995 studies indicate that important changes in the use of wood in new nonresidential buildings have occurred. With few exceptions, the use of nearly every wood product decreased in nearly every building type. In 1985 2,780 million bf of lumber, 2,094 million ft^2, 3/8-in. basis, of structural panels and 60million ft^2, 3/8-in. basis, of nonstructural panels were consumed (Table 12). Wood use in 1985 was adjusted from that reported to remove amounts used for millwork, concrete forms, scaffolding, and other and not specified uses which were not included in the 1995 wood use estimates. Also, glulam timbers and wood I-beams were included with lumber in 1985. In order to better compare lumber use between 1985 and 1995, engineered wood products (I-joists, glulam and SCL) were added to lumber use in 1995. Throughout this discussion of 1985 and 1995 wood use, lumber use in 1995 refers to combined lumber and engineered wood products use. In 1985 public and miscellaneous buildings were combined and recreational buildings were an individual building type. In 1995 public and miscellaneous buildings were individual types. Recreational buildings were included with miscellaneous buildings. For comparison

purposes, public, miscellaneous and recreational buildings were all combined into the public & miscellaneous building type. Finally, differences in survey and analysis procedures between the 1985 and 1995 studies may affect the comparability of wood use estimates between the points in time.

Lumber use in 1995 for all building types combined was 1,652 million bf (a 41percent decrease from 1985), structural panel use was 1,165 million ft^2 (44 percent decrease), and nonstructural panel use was 13 million ft^2 (79 percent decrease). With the exception of lumber in religious buildings, and structural panels in industrial buildings, all wood products used in all building types declined between 1985 and 1995. To compare overall wood products use by building type, amounts of lumber (plus engineered wood products), structural panels, and nonstructural panels used by building type were converted to cubic meters and summed for each year. Percentage differences between 1985 and 1995 were calculated. Industrial and religious buildings both showed increased total wood use by 16 percent and 12 percent respectively (Fig. 22). Use in all other building types fell, by as much as 60 percent for health buildings and over 50 percent for stores and offices. Overall, total wood consumption fell by 42 percent between 1985 and 1995.

Many factors contributed to the declining use of wood in new nonresidential buildings between 1985 and 1995. These include:

1) A 37 percent overall reduction in the share of small buildings which tend to use more wood per square foot of floor area than large buildings in 1995,
2) Lower constant dollar construction value per square foot of floor area in 1995 indicating a preference for lower cost buildings and building materials which may not favor wood,
3) Changes in the mix of building types constructed favoring those which tend to use less wood per square foot of floor area,
4) Increased use of concrete as the principal construction type at the expense of wood, and
5) A growing acceptance of engineered wood products which tends to reduce the amount of wood required to achieve the same level of performance.

A detailed discussion of these factors and their affect on wood use was included in the "Measures of Construction Activity" section of this report.

The declining use of wood in new nonresidential building construction between 1985 and 1995 affected average wood use per $1,000 of constant (1992) construction value, and average wood use per square foot of finished floor area. Lumber use per $1,000 fell from 19.4 bf in 1985 to 10.0 bf in 1995, a 48 percent reduction (Table 12). Structural panel use fell 51 percent to 7.1 ft^2 and nonstructural panel use fell 81 percent to less than 0.1 ft^2 per $1,000 of construction value in 1995. Variations in the magnitude of change were evident by building type, but with the exception of structural panel use in industrial buildings, the use per $1,000 of construction value of all wood products in all building types fell between 1985 and 1995.

The use of all wood products per square foot of floor area also dropped dramatically between 1985 and 1995. In 1995 lumber use was down 50 percent, structural panel use was down 53 percent, and nonstructural panel use was down 82 percent from 1985 levels (Table 12). Use per square foot of floor area of every wood product fell in every building type.

Much of the reduction in wood use experienced between 1985 and 1995 is likely due to increasing building size resulting in lost market share of wood construction to concrete, steel and other building products.

U.S. Wood Products Consumption

The construction of new nonresidential buildings in 1995 accounted for 4 percent or less of total U.S. consumption of lumber, structural panels and nonstructural panels (Table 13). Engineered wood products consumption for new nonresidential buildings was much greater with 16 percent of all I-joists and 24 percent of all glulam timber being used for nonresidential construction. Although SCL use was low, large amounts were used for I-joist flanges making total amounts of SCL present in nonresidential buildings more substantial than indicated by the SCL category alone. The differences in the percentage of total consumption between lumber, structural and nonstructural panels, and engineered wood products are not unexpected. Traditional wood products have a more diverse market than engineered wood products for uses such as dunnage, pallets, containers, furniture, and other industrial applications.

Potential Wood Products Market Growth

The construction of new nonresidential buildings holds great potential for expanding the use of wood building products. In 1995 concrete and metal construction dominated the nonresidential buildings construction market, accounting for more than 80 percent of total construction in each application type. Wood construction was used in just 1 percent of all first story (ground level) floors, 14 percent of upper story floors, 10 percent of exterior walls, 13 percent of interior walls, 19 percent of roofs, and a very small percentage of exterior siding. Substantial additional volumes of lumber and structural panels, and lesser volumes 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. For example, if wood roof systems in stores in the West averaged 1.6 ft^2 of structural panels per ft^2 of finished floor area, then the structural panel potential for concrete and metal roofs would be the total finished floor area in the concrete and metal buildings multiplied by 1.6 ft^2 of structural panels less any wood which had been used in conjunction with the concrete and metal construction. Realistic limits to potential incremental lumber and

structural panel use in new nonresidential buildings are 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 1995 an additional 6,003 million bf of lumber and 5,970 million ft^2 of structural panels could have been used in new nonresidential buildings if all concrete and metal building applications, except foundations and ground level floors, had been built with wood at usage rates similar to those for wood-based building applications (Table 14). Roofs had both the greatest lumber and structural panel incremental potential accounting for nearly 45 percent of the lumber and 65 percent of the structural panel potential (Table 15). Potential in the North and South regions was nearly equal at 42 percent each for lumber and 40 and 44 percent respectively for structural panels. Overall lumber potential was greatest for store roofs, and structural panel potential was greatest for industrial roofs. Regionally, stores in the North had the greatest potential for lumber and structural panels. Figure 23 shows potential increases by building type.

Summary and Conclusions

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

In 1995 new nonresidential buildings were valued at $185 billion, or nearly $165 billion constant 1992 dollars. This level of construction translated into an estimated 2.8 billion square feet of floor area, 1.5 billion ft^2 of exterior wall area, and 2.6 billion ft^2 of roof area, and use of an estimated 1,464 million bf of lumber, 1,165 million ft^2, 3/8-in. basis, of structural panels, 13 million ft^2, 3/8-in. basis of nonstructural panels, 59 million lf of wood I-joists, 54 million bf of glulam timber, and 1 million ft^3 of structural composite lumber.

Stores used more of each wood product except I-joists than any other building type in 1995. Industrial and public buildings used the least amount of wood overall. More

wood was used in the West than other regions, and small buildings used more wood than large buildings.

In terms of overall amounts of wood used per unit of construction activity, religious buildings far exceeded all other building types. In 1995 religious buildings used more than 3 times the amount of wood per $1,000 of construction value than average. Public and industrial buildings used half the amount of wood or less than average. Buildings in the West and small buildings both used about 1.7 times the average amount of wood per $1,000 of construction value.

The value of new nonresidential buildings in 1985 was about $2 billion greater than in 1995, measured in constant 1992 dollars, but wood products consumption was much greater in 1985 when 2,780 million bf of dimension lumber and engineered wood, 2,094 million ft^2, 3/8-in. basis, of structural panels, and 60 million ft^2, 3/8-in. basis, of nonstructural panels were consumed. Use per constant 1992 dollar of new construction value was also higher in 1985 than 1995, by about 50 percent.

Overall, the construction of new nonresidential buildings 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 wood construction in 1995. Product uniformity and consistency, availability, cost advantage, and performance all affect the choice of building materials used. Wood products must be competitive 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 new construction, and area and wood products consumption in new nonresidential buildings in the United States, 1995

Value of new construction[1]	(Bil. $)	(%)
Residential	235.0	44.0
Nonresidential	299.1	56.0
Buildings	184.4	34.5
Nonbuildings	111.7	20.9
Farms	3.0	0.6
Total	534.1	100.0
Area in nonresidential buildings	(Mil. ft^2)	
Floor area	2,820.0	
Exterior wall area	1,497.8	
Roof area	2,593.3	

Wood consumption[2] for nonresidential buildings	(Mil.)
Lumber (bf)	1,464.4
Structural panels[3] (ft^2)	1,165.4
Softwood plywood[3] (ft^2)	718.8
OSB[3] (ft^2)	446.6
Nonstructural panels[3] (ft^2)	12.9
Engineered wood	
I-joist (lf)	58.5
Glulam (bf)	55.3
SCL (ft^3)	1.0

[1]Current dollars. Source: U.S. Bureau of the Census 1997.
[2]Excludes millwork, concrete forms and scaffolds, and other and not specified
[3]3/8-inch basis.

Table 2.-Value of new nonresidential building construction, floor area built, and value per square foot of floor area in the United States, by building type, region, and size class, 1995

Building type/ region	Value of new construction[1]			Floor area			Value per ft^2 of floor area		
	Small building (Bil. $)	Large building (Bil. $)	All building (Bil. $)	Small building (Mil. ft^2)	Large building (Mil. ft^2)	All building (Mil. ft^2)	Small building ($)	Large building ($)	All building ($)
Stores									
North	5.6	9.4	15.0	106.7	220.1	326.8	52.8	42.6	45.9
South	6.2	8.4	14.5	123.8	236.5	360.3	49.8	35.4	40.4
West	3.6	4.9	8.5	66.9	122.0	188.9	53.7	40.6	45.2
U.S.	15.4	22.7	38.1	297.4	578.6	876.0	51.7	39.3	43.5
Industrial									
North	4.8	7.9	12.7	120.4	191.4	311.9	40.1	41.1	40.7
South	5.0	6.7	11.7	120.4	194.1	314.5	41.3	34.4	37.1
West	1.9	4.1	6.0	46.6	93.4	140.0	40.8	44.3	43.2
U.S.	11.7	18.7	30.4	287.5	478.9	766.4	40.7	39.0	39.7
Offices									
North	4.3	4.0	8.3	61.4	52.2	113.6	70.0	76.1	72.8
South	4.4	4.6	9.1	67.1	67.9	135.0	65.9	68.3	67.1
West	3.1	2.5	5.6	46.6	38.6	85.1	66.0	64.5	65.3
U.S.	11.8	11.1	22.9	175.0	158.7	333.7	67.4	69.9	68.6
Hotels									
North	0.8	1.1	1.9	15.6	14.9	30.5	52.9	72.4	62.5
South	1.2	1.4	2.6	23.9	21.3	45.1	50.5	64.7	57.2
West	0.5	1.3	1.9	9.0	18.8	27.8	58.3	71.2	67.0
U.S.	2.6	3.8	6.4	48.5	55.0	103.4	52.7	69.0	61.4
Schools									
North	4.0	5.9	9.9	37.2	65.6	102.8	107.2	89.6	95.9
South	3.1	6.5	9.6	38.4	88.5	127.0	80.6	73.8	75.8
West	2.0	2.7	4.7	18.8	28.0	46.8	106.3	95.0	99.6
U.S.	9.1	15.1	24.1	94.3	182.2	276.5	96.2	82.7	87.3
Religious									
North	1.2	0.1	1.3	17.5	1.2	18.7	70.2	88.9	71.5
South	1.5	0.3	1.9	25.4	4.7	30.0	61.1	64.5	61.6
West	0.6	0.0	0.7	8.2	0.6	8.7	79.5	49.0	77.6
U.S.	3.4	0.4	3.9	51.0	6.4	57.5	67.2	67.8	67.2
Health									
North	2.6	4.0	6.6	28.1	29.4	57.5	91.8	136.7	114.8
South	2.5	2.2	4.8	29.9	23.6	53.5	84.2	95.1	89.0
West	1.0	1.5	2.6	10.4	12.0	22.4	100.1	125.4	113.7
U.S.	6.1	7.8	13.9	68.4	65.0	133.4	89.7	119.5	104.2
Public									
North	2.7	5.2	7.9	25.9	43.4	69.3	103.7	120.7	114.3
South	2.8	4.3	7.1	30.0	40.6	70.6	94.1	104.8	100.3
West	1.3	3.4	4.6	12.2	26.9	39.1	103.2	125.7	118.6
U.S.	6.8	12.9	19.6	68.1	110.8	179.0	99.4	116.1	109.7
Miscellaneous									
North	1.0	0.9	1.8	14.1	17.1	31.2	68.8	50.8	58.9
South	1.1	1.2	2.2	16.0	25.4	41.4	66.4	46.0	53.9
West	0.8	0.6	1.4	9.8	11.8	21.6	77.0	50.4	62.5
U.S.	2.8	2.6	5.4	39.9	54.3	94.2	69.9	48.5	57.5
All buildings									
North	27.0	38.4	65.4	426.8	635.4	1,062.2	63.3	60.4	61.6
South	27.8	35.6	63.4	474.9	702.6	1,177.5	58.6	50.6	53.8
West	14.8	21.1	35.9	228.5	352.0	580.5	64.8	59.9	61.8
U.S.	69.6	95.1	164.7	1,130.2	1,690.0	2,820.2	61.6	56.3	58.4

[1]Constant 1992 dollars.

Table 3. - Estimated value of new nonresidential buildings, floor area built, and value per square foot of floor area, by building type, 1985 and 1996

Building type	Value of new construction (1992 $)		Floor area		Value per ft^2 of floor area	
	1985 (Bil. $)	1995 (Bil. $)	1985 (Mil. ft^2)	1995 (Mil. ft^2)	1985 ($/ft^2)	1995 ($/ft^2)
Stores	41.4	38.1	920	876	45.0	43.5
Industrial	18.2	30.4	303	766	60.0	39.7
Offices	35.4	22.9	480	334	73.8	68.5
Hotels	8.6	6.4	140	103	61.5	61.7
Schools	13.5	24.1	192	277	70.5	87.2
Religious	3.1	3.9	41	57	76.7	67.8
Health	10.8	13.9	148	133	73.0	104.5
Public & misc.[1]	12.4	25.1	166	273	75.0	91.8
All buildings	143.6	164.7	2,390	2,820	60.1	58.4

[1]Includes recreational buildings.
Source: 1985: Wood Products Promotion Council 1987.

Table 4. - Exterior wall and roof area in new nonresidential buildings, by building type and size class[1], 1995

Building type	Exterior wall area				Roof area			
			All sizes				All sizes	
	Small buildings (Mil. ft^2)	Large buildings (Mil. ft^2)	Total (Mil. ft^2)	Per ft^2 of floor area (Ft^2)	Small buildings (Mil. ft^2)	Large buildings (Mil. ft^2)	Total (Mil. ft^2)	Per ft^2 of floor area (Ft^2)
Stores	224.0	259.6	483.6	0.55	328.0	652.9	981.0	1.12
Industrial	249.5	174.2	423.7	0.55	297.6	482.5	780.2	1.02
Offices	110.7	70.7	181.5	0.54	153.4	66.5	219.9	0.66
Hotels	38.0	20.3	58.3	0.56	20.8	15.8	36.6	0.35
Schools	60.7	67.8	128.5	0.46	86.6	142.8	229.4	0.83
Religious	34.7	4.7	39.4	0.68	48.0	5.4	53.4	0.93
Health	39.4	30.4	69.8	0.52	59.2	26.4	85.6	0.64
Public	39.0	31.7	70.7	0.40	61.8	75.0	136.8	0.76
Miscellaneous	29.8	12.7	42.4	0.45	40.3	30.1	70.5	0.75
All buildings	825.9	671.9	1,497.8	0.53	1,095.8	1,497.6	2,593.3	0.92

[1]Small buildings: ≤50, 000ft^2; Large buildings: >50,000 ft^2.

Table 5.-Incidence of principal construction type in new nonresidential buildings, by application and size class, all building types combined, 1982 and 1996

Application year	Small <10,000 ft² Wood (%)	Small <10,000 ft² Concrete[1] (%)	Small <10,000 ft² Metal (%)	Small 10,000-50,000 ft² Wood (%)	Small 10,000-50,000 ft² Concrete (%)	Small 10,000-50,000 ft² Metal (%)	Large >50,000 ft² Wood (%)	Large >50,000 ft² Concrete[1] (%)	Large >50,000 ft² Metal (%)	All sizes Wood (%)	All sizes Concrete[1] (%)	All sizes Metal (%)
Ground floors												
1982	7	92	1	3	95	2	1	93	7	4	93	3
1995[2]	-	-	-	1	98	1	0	99	1	1	99	1
Upper floors												
1982	80	10	10	35	13	52	4	16	79	18	15	67
1995[2]	-	-	-	27	24	49	7	40	52	14	35	51
Exterior walls												
1982	27	45	29	16	38	46	7	58	34	18	47	35
1995[2]	-	-	-	17	49	33	5	70	25	10	62	28
Interior walls												
1982	60	14	26	34	14	51	12	11	77	35	13	52
1995[2]	-	-	-	23	22	53	6	24	70	13	24	64
Roofs												
1982	46	3	50	36	2	62	23	5	72	36	3	60
1995[2]	-	-	-	33	5	63	10	13	77	19	10	71

[1]Includes concrete, masonry, stucco, and stone.
[2]<10,000 ft² included with 10,000-50,000 ft².
Source: 1982: Wood Products Promotion Council 1987.

Table 6.-Wood use in new nonresidential buildings, all building types, by characteristic, 1995

Building type/ characteristic	Lumber (Mil. bf)	Structural panels[1] Softwood plywood (Mil. ft²)	Structural panels[1] OSB (Mil. ft²)	Structural panels[1] Total (Mil. ft²)	Non structural panels[1] (Mil. ft²)	Engineered wood I-joist (Mil. lf)	Engineered wood Glulam (Mil. bf)	Engineered wood SCL (Mil. ft³)
Region								
North	523.2	169.3	153.2	322.6	2.4	3.6	2.0	0.1
South	490.4	263.1	97.7	360.8	6.1	20.6	5.2	0.1
West	450.8	286.4	195.6	482.0	4.4	34.3	48.0	0.8
All regions	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0
Size class								
Small	1,069.5	499.5	304.1	803.7	7.4	46.4	29.0	0.6
Large	394.9	219.2	142.5	361.7	5.5	12.1	26.3	0.4
All size classes	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0
Application								
Floors	150.6	89.7	50.5	140.2	0.1	8.7	1.0	([2])
Exterior walls	475.5	120.2	88.7	208.9	3.3	0.2	1.1	0.1
Interior walls	240.7	37.6	23.8	61.4	0.8	0.1	0.3	([2])
Roofs	593.4	461.5	281.4	742.9	2.8	49.5	52.9	0.9
Siding	4.2	9.9	2.2	12.1	5.9	0.0	0.0	0.0
All applications	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0

[1]3/8-inch basis.
[2]Less than 0.05 million.

Table 7.-Wood use in new nonresidential buildings, by building type and region, 1995

Building type/ region	Lumber (Mil. bf)	Structural panels[1] Softwood plywood (Mil. ft²)	OSB (Mil. ft²)	Total (Mil. ft²)	Non structural panels[1] (Mil. ft²)	Engineered wood I-joist (Mil. lf)	Glulam (Mil. bf)	SCL (Mil. ft³)
Stores								
North	122.1	40.1	43.4	83.5	0.5	0.4	0.5	([2])
South	137.3	76.6	35.2	111.8	3.3	2.1	2.5	0.1
West	134.8	88.3	70.7	159.1	1.9	10.3	23.0	0.4
U.S.	394.2	205.1	149.3	354.4	5.7	12.8	26.0	0.5
Industrial								
North	13.5	19.5	15.0	34.5	0.1	0.2	0.2	([2])
South	16.3	19.2	7.3	26.5	0.8	13.9	0.3	([2])
West	23.2	55.5	41.7	97.2	0.1	5.9	19.4	([2])
U.S.	53.0	94.2	64.0	158.2	1.1	20.0	19.8	([2])
Offices								
North	79.7	39.4	33.7	73.0	0.9	0.4	0.1	([2])
South	90.4	48.5	18.0	66.5	0.8	1.9	0.1	([2])
West	108.2	48.7	37.4	86.0	0.8	8.5	1.0	0.2
U.S.	278.4	136.5	89.1	225.6	2.5	10.8	1.2	0.2
Hotels								
North	32.9	7.4	9.0	16.4	0.2	0.3	0.1	([2])
South	59.9	10.3	4.7	15.0	0.2	0.5	0.1	([2])
West	36.5	9.9	7.4	17.3	0.2	0.7	0.1	([2])
U.S.	129.3	27.5	21.1	48.6	0.5	1.6	0.2	([2])
Schools								
North	88.1	26.1	22.4	48.5	0.1	0.5	0.2	0.1
South	34.8	32.0	10.1	42.1	0.5	0.4	0.1	([2])
West	66.7	42.3	15.4	57.7	1.1	2.1	1.8	([2])
U.S.	189.5	100.3	47.8	148.2	1.8	3.0	2.1	0.1
Religious								
North	44.6	17.9	12.7	30.6	0.1	0.6	0.6	([2])
South	59.4	25.2	8.2	33.4	0.1	0.9	1.8	([2])
West	14.1	7.9	6.8	14.8	0.1	1.3	0.7	([2])
U.S.	118.1	51.0	27.7	78.8	0.3	2.8	3.2	0.1
Health								
North	74.8	9.1	7.7	16.8	0.3	0.7	0.2	([2])
South	48.0	22.3	5.9	28.3	([2])	0.7	0.2	([2])
West	18.3	14.6	5.6	20.2	0.1	3.9	0.7	([2])
U.S.	141.0	46.0	19.2	65.2	0.4	5.2	1.0	([2])
Public								
North	37.8	1.8	1.7	3.5	0.1	0.3	0.1	([2])
South	22.3	11.1	2.7	13.7	0.1	0.3	0.1	([2])
West	26.4	11.5	5.8	17.3	0.1	1.1	0.9	([2])
U.S.	86.5	24.4	10.1	34.6	0.3	1.6	1.1	([2])
Miscellaneous								
North	29.6	8.1	7.7	15.8	0.1	0.1	0.1	([2])
South	22.1	17.9	5.7	23.5	0.2	([2])	0.1	([2])
West	22.6	7.7	4.9	12.6	([2])	0.5	0.5	([2])
U.S.	74.3	33.7	18.3	51.9	0.3	0.7	0.7	0.1
All buildings								
North	523.2	169.3	153.2	322.6	2.4	3.6	2.0	0.1
South	490.4	263.1	97.7	360.8	6.1	20.6	5.2	0.1
West	450.8	286.4	195.6	482.0	4.4	34.3	48.0	0.8
U.S.	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0

[1]3/8-inch basis.
[2]Less than 0.05 million.

Table 8.-Wood use in new nonresidential buildings, by building type and size class, 1995

Building type/ size class	Lumber (Mil. bf)	Structural panels[1] Softwood plywood (Mil. ft²)	Structural panels[1] OSB (Mil. ft²)	Structural panels[1] Total (Mil. ft²)	Non structural panels[1] (Mil. ft²)	Engineered wood I-joist (Mil. lf)	Engineered wood Glulam (Mil. bf)	Engineered wood SCL (Mil. ft³)
Stores								
Small	251.6	121.9	85.1	207.0	2.3	7.3	13.8	0.2
Large	142.7	83.2	64.2	147.4	3.4	5.5	12.2	0.2
All sizes	394.2	205.1	149.3	354.4	5.7	12.8	26.0	0.5
Industrial								
Small	33.9	51.1	33.8	84.9	0.9	16.0	7.2	([2])
Large	19.1	43.1	30.2	73.2	0.1	4.0	12.6	([2])
All sizes	53.0	94.2	64.0	158.2	1.1	20.0	19.8	([2])
Offices								
Small	243.7	117.0	77.1	194.1	2.0	9.5	1.0	0.1
Large	34.7	19.5	12.0	31.5	0.5	1.3	0.2	([2])
All sizes	278.4	136.5	89.1	225.6	2.5	10.8	1.2	0.2
Hotels								
Small	100.7	22.0	16.4	38.3	0.4	1.3	0.2	([2])
Large	28.6	5.6	4.7	10.3	0.1	0.2	([2])	([2])
All sizes	129.3	27.5	21.1	48.6	0.5	1.6	0.2	([2])
Schools								
Small	112.7	57.5	28.6	86.1	0.7	2.5	1.6	([2])
Large	76.8	42.9	19.2	62.1	1.1	0.4	0.5	0.1
All sizes	189.5	100.3	47.8	148.2	1.8	3.0	2.1	0.1
Religious								
Small	112.1	49.4	26.9	76.3	0.3	2.7	3.1	0.1
Large	6.1	1.7	0.8	2.4	([2])	([2])	([2])	([2])
All sizes	118.1	51.0	27.7	78.8	0.3	2.8	3.2	0.1
Health								
Small	104.1	39.3	16.0	55.3	0.3	5.1	0.9	([2])
Large	36.9	6.7	3.3	10.0	0.1	0.2	0.1	([2])
All sizes	141.0	46.0	19.2	65.2	0.4	5.2	1.0	([2])
Public								
Small	59.8	16.6	6.6	23.2	0.2	1.3	0.7	([2])
Large	26.7	7.9	3.5	11.4	0.1	0.4	0.3	([2])
All sizes	86.5	24.4	10.1	34.6	0.3	1.6	1.1	([2])
Miscellaneous								
Small	50.9	24.9	13.6	38.5	0.3	0.6	0.5	([2])
Large	23.3	8.8	4.6	13.4	([2])	0.1	0.2	([2])
All sizes	74.3	33.7	18.3	51.9	0.3	0.7	0.7	0.1
All buildings								
Small	1,069.5	499.5	304.1	803.7	7.4	46.4	29.0	0.6
Large	394.9	219.2	142.5	361.7	5.5	12.1	26.3	0.4
All sizes	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0

[1]3/8-inch basis.
[2]Less than 0.05 million.

Table 9.- Wood use in new nonresidential buildings, by building type and application, 1995

Building type/ application	Lumber (Mil. bf)	Structural panels[1] Softwood plywood (Mil. ft²)	OSB (Mil. ft²)	Total (Mil. ft²)	Non structural panels[1] (Mil. ft²)	Engineered wood I-joist (Mil. lf)	Glulam (Mil. bf)	SCL (Mil. ft³)
Stores								
Floors	36.9	12.0	7.9	19.9	([2])	0.7	0.1	([2])
Exterior walls	130.0	38.7	32.2	70.9	0.7	([2])	0.2	([2])
Interior walls	25.6	27.8	19.1	46.9	([2])	([2])	([2])	([2])
Roofs	200.3	123.0	90.0	213.0	1.8	12.0	25.7	0.5
Siding	1.4	3.5	0.2	3.7	3.2	0.0	0.0	0.0
All applications	394.2	205.1	149.3	354.4	5.7	12.8	26.0	0.5
Industrial								
Floors	10.2	4.0	1.9	5.9	([2])	0.6	0.1	([2])
Exterior walls	5.1	0.5	0.4	0.9	0.2	([2])	([2])	([2])
Interior walls	3.8	0.3	0.2	0.5	([2])	([2])	([2])	([2])
Roofs	33.8	88.9	61.4	150.3	0.6	19.5	19.7	([2])
Siding	0.1	0.4	0.1	0.5	0.3	0.0	0.0	0.0
All applications	53.0	94.2	64.0	158.2	1.1	20.0	19.8	([2])
Offices								
Floors	28.1	20.5	13.6	34.1	([2])	2.1	0.4	([2])
Exterior walls	139.1	32.5	22.7	55.2	1.2	([2])	([2])	([2])
Interior walls	31.0	3.5	1.5	5.1	([2])	([2])	([2])	([2])
Roofs	78.2	78.2	50.7	128.8	0.4	8.7	0.7	0.2
Siding	1.9	1.9	0.5	2.4	0.9	0.0	0.0	0.0
All applications	278.4	136.5	89.1	225.6	2.5	10.8	1.2	0.2
Hotels								
Floors	32.0	11.4	8.8	20.2	([2])	1.5	0.1	([2])
Exterior walls	18.5	3.3	2.8	6.1	0.3	([2])	([2])	([2])
Interior walls	54.9	0.3	0.2	0.5	([2])	([2])	([2])	([2])
Roofs	24.0	12.3	9.3	21.6	([2])	0.1	0.1	([2])
Siding	([2])	0.2	0.1	0.3	0.2	0.0	0.0	0.0
All applications	129.3	27.5	21.1	48.6	0.5	1.6	0.2	([2])
Schools								
Floors	18.1	19.0	7.0	26.1	([2])	0.4	0.1	([2])
Exterior walls	83.4	16.7	13.2	29.9	0.2	0.1	0.6	([2])
Interior walls	26.3	3.7	1.8	5.5	0.6	([2])	0.2	([2])
Roofs	61.6	58.7	24.9	83.6	([2])	2.5	1.3	0.1
Siding	0.1	2.3	0.8	3.1	1.0	0.0	0.0	0.0
All applications	189.5	100.3	47.8	148.2	1.8	3.0	2.1	0.1
Religious								
Floors	5.6	3.6	1.8	5.4	([2])	0.2	0.1	([2])
Exterior walls	35.9	15.5	9.2	24.7	0.2	([2])	([2])	0.1
Interior walls	22.4	([2])	([2])	0.1	([2])	([2])	([2])	([2])
Roofs	53.7	30.8	16.4	47.3	([2])	2.6	3.1	([2])
Siding	0.5	1.1	0.3	1.4	0.1	0.0	0.0	0.0
All applications	118.1	51.0	27.7	78.8	0.3	2.8	3.2	0.1
Health								
Floors	10.6	10.0	5.5	15.5	([2])	3.1	([2])	([2])
Exterior walls	22.5	3.7	2.5	6.2	0.3	([2])	0.2	([2])
Interior walls	56.7	0.3	0.2	0.4	([2])	([2])	0.1	([2])
Roofs	51.2	31.9	11.0	42.9	([2])	2.1	0.8	([2])
Siding	0.1	0.1	([2])	0.1	0.0	0.0	0.0	0.0
All applications	141.0	46.0	19.2	65.2	0.4	5.2	1.0	([2])

Table -9. Wood use in new nonresidential buildings, by building type and application, 1995–cont.

Building type/ application	Lumber (Mil. bf)	Structural panels[1] Softwood plywood (Mil. ft²)	OSB (Mil. ft²)	Total (Mil. ft²)	Non structural panels[1] (Mil. ft²)	Engineered wood I-joist (Mil. lf)	Glulam (Mil. bf)	SCL (Mil. ft³)
Public								
Floors	3.2	2.7	1.4	4.0	([2])	0.1	0.1	([2])
Exterior walls	15.6	3.1	1.7	4.8	0.1	([2])	0.1	([2])
Interior walls	9.0	0.9	0.5	1.4	([2])	([2])	([2])	([2])
Roofs	58.7	17.4	6.4	23.9	([2])	1.5	0.9	([2])
Siding	0.1	0.3	0.1	0.4	0.1	0.0	0.0	0.0
All applications	86.5	24.4	10.1	34.6	0.3	1.6	1.1	([2])
Miscellaneous								
Floors	5.9	6.4	2.7	9.1	([2])	0.1	0.1	([2])
Exterior walls	25.5	6.1	4.1	10.2	0.1	([2])	([2])	([2])
Interior walls	10.9	0.8	0.3	1.0	0.2	([2])	([2])	([2])
Roofs	32.0	20.2	11.3	31.5	([2])	0.6	0.6	([2])
Siding	0.1	0.1	([2])	0.2	0.0	0.0	0.0	0.0
All applications	74.3	33.7	18.3	51.9	0.3	0.7	0.7	0.1
All buildings								
Floors	150.6	89.7	50.5	140.2	0.1	8.7	1.0	([2])
Exterior walls	475.5	120.2	88.7	208.9	3.3	0.2	1.1	0.1
Interior walls	240.7	37.6	23.8	61.4	0.8	0.1	0.3	([2])
Roofs	593.4	461.5	281.4	742.9	2.8	49.5	52.9	0.9
Siding	4.2	9.9	2.2	12.1	5.9	0.0	0.0	0.0
All applications	1,464.4	718.8	446.6	1,165.4	12.9	58.5	55.3	1.0

[1]3/8-inch basis.
[2]Less than 0.05 million.

Table 10.-Wood used per $1,000 of constant construction value in new nonresidential buildings, 1995

Characteristic	Construction value[2] (Mil. $)	Lumber (Bf)	Structural panels[1] Softwood plywood (Ft²)	Structural panels[1] OSB (Ft²)	Structural panels[1] Total (Ft²)	Non structural panels[1] (Ft²)	Engineered wood I-joist (Lf)	Engineered wood Glulam (Bf)	Engineered wood SCL (Ft³)	Wood use index[3]
Building type										
Stores	38,098	10.35	5.38	3.92	9.30	0.15	0.33	0.68	0.01	1.23
Industrial	30,391	1.74	3.10	2.11	5.20	0.04	0.66	0.65	([4])	0.44
Offices	22,891	12.16	5.96	3.89	9.86	0.11	0.47	0.05	0.01	1.34
Hotels	6,351	20.36	4.34	3.32	7.66	0.09	0.25	0.03	([4])	1.84
Schools	24,145	7.85	4.16	1.98	6.14	0.07	0.12	0.09	([4])	0.85
Religious	3,864	30.58	13.21	7.18	20.38	0.07	0.72	0.82	0.03	3.22
Health	13,905	10.14	3.31	1.38	4.69	0.03	0.38	0.08	([4])	0.98
Public	19,638	4.41	1.24	0.52	1.76	0.02	0.08	0.06	([4])	0.41
Misc.	5,421	13.70	6.21	3.37	9.58	0.05	0.12	0.12	0.01	1.42
All buildings	164,704	8.89	4.36	2.71	7.08	0.08	0.36	0.34	0.01	1.00
Region										
North	65,429	8.00	2.59	2.34	4.93	0.04	0.05	0.03	([4])	0.79
South	63,396	7.74	4.15	1.54	5.69	0.10	0.32	0.08	([4])	0.84
West	35,879	12.56	7.98	5.45	13.43	0.12	0.96	1.34	0.02	1.67
All regions	164,704	8.89	4.36	2.71	7.08	0.08	0.36	0.34	0.01	1.00
Size class										
Small	69,638	15.36	7.17	4.37	11.54	0.11	0.67	0.42	0.01	1.69
Large	95,066	4.15	2.31	1.50	3.81	0.06	0.13	0.28	([4])	0.49
All size classes	164,704	8.89	4.36	2.71	7.08	0.08	0.36	0.34	0.01	1.00
Application										
Floors	--	0.91	0.54	0.31	0.85	([4])	0.05	0.01	([4])	0.11
Exterior walls	--	2.89	0.73	0.54	1.27	0.02	([4])	0.01	([4])	0.27
Interior walls	--	1.46	0.23	0.14	0.37	0.01	([4])	([4])	([4])	0.12
Roof	--	3.60	2.80	1.71	4.51	0.02	0.30	0.32	0.01	0.50
Siding	--	0.03	0.06	0.01	0.07	0.04	0.00	0.00	0.00	0.01
All applications	164,704	8.89	4.36	2.71	7.08	0.08	0.36	0.34	0.01	1.00

[1]3/8-inch basis.
[2]Constant 1992 dollars.
[3]Relative magnitude of wood products use compared to the “All buildings” average.
[4]Less than 0.005.

Table 11.-Wood used per 1,000 square feet of floor area in new nonresidential buildings, 1995

Characteristic	Floor area (Mil. ft²)	Lumber (Bf)	Structural panels[1] Softwood plywood (Ft²)	Structural panels[1] OSB (Ft²)	Structural panels[1] Total (Ft²)	Non structural panels[1] (Ft²)	Engineered wood I-joist (Lf)	Engineered wood Glulam (Bf)	Engineered wood SCL (Ft³)	Wood use index[2]
Building type										
Stores	876	0.450	0.234	0.170	0.405	0.007	0.015	0.030	0.001	0.91
Industrial	766	0.069	0.123	0.083	0.206	0.001	0.026	0.026	([3])	0.30
Offices	334	0.834	0.409	0.267	0.676	0.007	0.032	0.004	0.001	1.58
Hotels	103	1.250	0.266	0.204	0.470	0.005	0.015	0.002	([3])	1.93
Schools	277	0.685	0.363	0.173	0.536	0.006	0.011	0.008	([3])	1.26
Religious	57	2.056	0.888	0.483	1.371	0.005	0.048	0.055	0.002	3.70
Health	133	1.057	0.345	0.144	0.489	0.003	0.039	0.008	([3])	1.75
Public	179	0.483	0.137	0.057	0.193	0.002	0.009	0.006	([3])	0.77
Misc.	94	0.788	0.357	0.194	0.551	0.003	0.007	0.007	0.001	1.40
All buildings	2,820	0.519	0.255	0.158	0.413	0.005	0.021	0.020	([3])	1.00
Region										
North	1,062	0.493	0.159	0.144	0.304	0.002	0.003	0.002	([3])	0.84
South	1,177	0.416	0.223	0.083	0.306	0.005	0.017	0.004	([3])	0.77
West	581	0.777	0.493	0.337	0.830	0.008	0.059	0.083	0.001	1.76
All regions	2,820	0.519	0.255	0.158	0.413	0.005	0.021	0.020	([3])	1.00
Size class										
Small	1,130	0.946	0.442	0.269	0.711	0.007	0.041	0.026	0.001	1.78
Large	1,690	0.234	0.130	0.084	0.214	0.003	0.007	0.016	([3])	0.48
All size classes	2,820	0.519	0.255	0.158	0.413	0.005	0.021	0.020	([3])	1.00
Application										
Floors	--	0.053	0.032	0.018	0.050	([3])	0.003	([3])	([3])	0.11
Exterior wall	--	0.169	0.043	0.031	0.074	0.001	([3])	([3])	([3])	0.27
Interior Wall	--	0.085	0.013	0.008	0.022	([3])	([3])	([3])	([3])	0.12
Roof	--	0.210	0.164	0.100	0.263	0.001	0.018	0.019	([3])	0.50
Siding	--	0.001	0.004	0.001	0.004	0.002	0.000	0.000	0.000	0.01
All applications	2,820	0.519	0.255	0.158	0.413	0.005	0.021	0.020	([3])	1.00

[1]3/8-inch basis.
[2]Relative magnitude of wood products use compared to the “All buildings” average.
[3]Less than .0005.

Table 12.-Total wood used, wood used per $1,000 of constant (1992) construction value, and wood used per square foot of finished floor area in new nonresidential buildings, by building type, 1985[1] and 1995

	Total wood used			Per $1,000 of construction			Per square foot of floor area		
Building type/ year	Lumber (Mil. bf)	Structural panels[4] (Mil. ft²)	Non-structural panels[4,5] (Mil. ft²)	Lumber (Bf)	Structural panels[4] (Ft²)	Non-structural panels[4,5] (Ft²)	Lumber (Bf)	Structural panels[4] (Ft²)	Non-structural panels[4,5] (Ft²)
Stores									
1985	985.0	731.0	11.0	23.77	17.64	0.27	1.07	0.79	0.01
1995	453.0	354.4	5.7	11.89	9.30	0.15	0.52	0.40	0.01
Industrial									
1985	125.0	80.0	2.9	6.87	4.40	0.16	0.41	0.26	0.01
1995	113.4	158.2	1.1	3.73	5.20	0.04	0.15	0.21	([6])
Offices									
1985	596.0	494.0	10.9	16.83	13.95	0.31	1.24	1.03	0.02
1995	303.9	225.6	2.5	13.27	9.86	0.11	0.91	0.68	0.01
Hotels									
1985	181.0	144.0	18.0	21.01	16.72	2.09	1.29	1.03	0.13
1995	132.7	48.6	0.5	20.89	7.66	0.09	1.29	0.47	0.01
Schools									
1985	260.0	208.0	4.1	19.20	15.36	0.30	1.35	1.08	0.02
1995	199.5	148.2	1.8	8.26	6.14	0.07	0.72	0.53	0.01
Religious									
1985	110.0	83.0	1.1	34.96	26.38	0.34	2.68	2.02	0.03
1995	128.5	78.8	0.3	33.26	20.38	0.07	2.25	1.38	([6])
Health									
1985	335.0	241.0	6.1	31.01	22.31	0.57	2.26	1.63	0.04
1995	153.0	65.2	0.4	11.01	4.69	0.03	1.15	0.49	([6])
Public & miscellaneous									
1985	188.0	113.0	6.0	15.11	9.08	0.48	1.13	0.68	0.04
1995	168.4	86.5	0.6	6.72	3.45	0.02	0.62	0.32	([6])
All buildings									
1985	2,780.0	2,094.0	60.1	19.36	14.58	0.42	1.16	0.88	0.03
1995	1,652.4	1,165.4	12.9	10.03	7.08	0.08	0.59	0.41	([6])
% diff	-41%	-44%	-79%	-48%	-51%	-81%	-50%	-53%	-82%

[1]Excludes millwork, concrete forms and scaffolds, and other and not specified use.
[2]Constant 1992 dollars.
[3]Includes glulam and bf equivalent of I-joists, and SCL: 1 lf I-joist =2 bf; 1 ft³ SCL=16 bf.
[4]3/8-inch basis.
[5]Excludes 50% of particleboard and 80% of hardboard used in 1985 for millwork.
[6]Less than .005.
Source: 1985: Wood Products Promotion Council 1987.

Table 13.-Total wood products consumption in the United States, and consumption for new nonresidential buildings, 1995

Wood product		Consumption: Total U.S.	Consumption: New non-residential buildings	New non-residential buildings as a % of total U.S.
Lumber	(Mil. bf)	59,100	1,464	2.5
Structural panels[1]	(Mil. ft²)	28,969	1,165	4.0
Softwood plywood	(Mil. ft²)	17,940	719	4.0
OSB	(Mil. ft²)	11,029	447	4.0
Nonstructural panels[1]	(Mil. ft²)	20,000	13	0.1
Engineered wood				
I-joists[2]	(Mil. lf)	358	58	16.3
Glulam	(Mil. bf)	232	55	23.8
SCL[2,3]	(Mil. ft³)	35	1	2.9

[1]3/8-inch basis.
[2]U.S. production due to minimal net foreign trade.
[3]About one half of all U.S. consumption used for I-joist flanges.
Sources:
U.S. lumber and nonstructural panel consumption:
Howard, James L. 1998. Personal communication. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI.
U.S. structural panel and engineered wood consumption:
Adair, Craig. 1997. Regional production and market outlook for structural panels and engineered wood products, 1997-2001. APA Economics Report E62. Tacoma, WA: APA-The Engineered Wood Association. Tacoma, WA. 63 p.

Table14.-Potential incremental lumber and structural panel volumes[1] in new nonresidential buildings, 1995.

	Application						Region			
Application	Upper floors	Exterior walls	Interior walls	Roofs	Siding	Total	North	South	West	Total
					Lumber (Mil. bf)					
Stores	143.0	373.6	350.6	580.0	0.6	1,447.8	643.6	575.0	229.1	1,447.8
Industrial	63.3	39.4	44.4	108.3	0.1	255.4	57.4	155.4	42.6	255.4
Offices	122.4	350.2	96.5	465.1	0.9	1,035.1	439.1	393.6	202.5	1,035.1
Hotels	108.6	44.5	83.4	58.1	(2)	294.7	74.4	134.2	86.1	294.7
Schools	64.5	425.7	272.5	527.3	(2)	1,290.1	566.4	533.8	189.9	1,290.1
Religious	6.6	54.8	31.0	73.8	0.2	166.3	59.4	98.1	8.8	166.3
Health	40.0	90.1	116.6	242.3	(2)	489.1	275.3	178.6	35.3	489.1
Public	8.9	97.9	62.7	417.3	(2)	586.7	247.3	234.9	104.5	586.7
Misc.	14.9	149.6	66.0	207.2	(2)	437.7	143.0	226.9	67.8	437.7
Total	572.2	1,625.8	1,123.7	2,679.4	1.8	6,002.8	2,505.8	2,530.4	966.7	6,002.9
					Structural panels (Mil. ft^2, 3/8" basis)					
Stores	109.0	380.3	353.4	643.9	5.9	1,492.5	800.2	480.5	211.8	1,492.5
Industrial	36.1	6.5	83.1	1,327.6	0.6	1,453.8	579.7	692.7	181.5	1,453.8
Offices	133.6	117.9	87.6	677.5	4.2	1,020.8	526.3	357.9	136.6	1,020.8
Hotels	60.7	42.1	35.3	52.1	0.6	190.8	77.4	43.0	70.5	190.8
Schools	94.7	142.0	109.0	560.2	0.5	906.4	418.9	301.2	186.3	906.4
Religious	6.8	22.4	0.5	53.4	0.4	83.6	31.5	41.5	10.6	83.6
Health	55.3	52.9	36.5	141.6	0.1	286.3	114.0	107.7	64.6	286.3
Public	13.8	25.9	14.3	202.4	0.2	256.5	20.1	169.9	66.6	256.5
Misc.	16.5	30.1	10.5	221.7	0.1	278.9	71.1	176.5	31.4	278.9
Total	526.2	820.1	730.3	3,880.5	12.6	5,969.7	2,639.1	2,370.8	959.8	5,969.7

[1]Volumes of lumber and structural panels likely to be used if concrete and metal framed applications with wood at the same usage rate as wood framed applications.
[2]Less than 0.05 million bf.

Table 15.-Percentage potential incremental lumber and structural panel use in new nonresidential buildings, 1995

	Application						Region			
Applicatio	Upper floors	Exterior walls	Interior walls	Roofs	Siding	Total	North	South	West	Total
					Lumber (Percent)					
Stores	2.4	6.2	5.8	9.7	(1)	24.1	10.7	9.6	3.8	24.1
Industrial	1.1	0.7	0.7	1.8	(1)	4.3	1.0	2.6	0.7	4.3
Offices	2.0	5.8	1.6	7.7	(1)	17.2	7.3	6.6	3.4	17.2
Hotels	1.8	0.7	1.4	1.0	(1)	4.9	1.2	2.2	1.4	4.9
Schools	1.1	7.1	4.5	8.8	(1)	21.5	9.4	8.9	3.2	21.5
Religious	0.1	0.9	0.5	1.2	(1)	2.8	1.0	1.6	0.1	2.8
Health	0.7	1.5	1.9	4.0	(1)	8.1	4.6	3.0	0.6	8.1
Public	0.1	1.6	1.0	7.0	(1)	9.8	4.1	3.9	1.7	9.8
Misc.	0.2	2.5	1.1	3.5	(1)	7.3	2.4	3.8	1.1	7.3
Total	9.5	27.1	18.7	44.6	(1)	100.0	41.7	42.2	16.1	100.0
					Structural panels (Percent)					
Stores	1.8	6.4	5.9	10.8	0.1	25.0	13.4	8.0	3.5	25.0
Industrial	0.6	0.1	1.4	22.2	(1)	24.4	9.7	11.6	3.0	24.4
Offices	2.2	2.0	1.5	11.3	0.1	17.1	8.8	6.0	2.3	17.1
Hotels	1.0	0.7	0.6	0.9	(1)	3.2	1.3	0.7	1.2	3.2
Schools	1.6	2.4	1.8	9.4	(1)	15.2	7.0	5.0	3.1	15.2
Religious	0.1	0.4	0.0	0.9	(1)	1.4	0.5	0.7	0.2	1.4
Health	0.9	0.9	0.6	2.4	(1)	4.8	1.9	1.8	1.1	4.8
Public	0.2	0.4	0.2	3.4	(1)	4.3	0.3	2.8	1.1	4.3
Misc.	0.3	0.5	0.2	3.7	(1)	4.7	1.2	3.0	0.5	4.7
Total	8.8	13.7	12.2	65.0	0.2	100.0	44.2	39.7	16.1	100.0

[1]Less than 0.05 percent.

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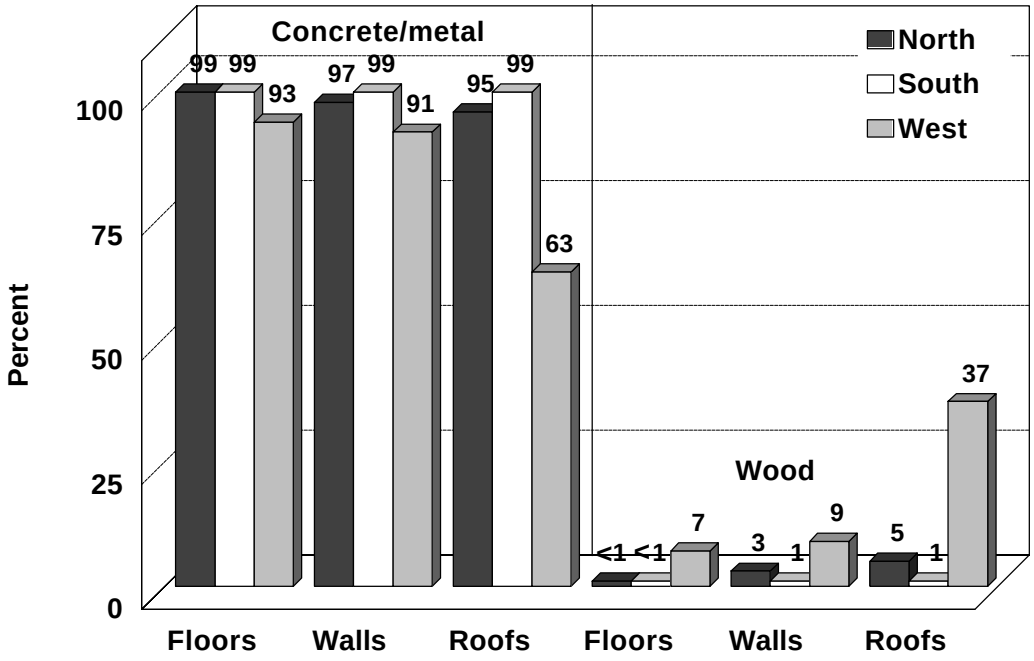


Figure 1.-Incidence of principal construction type for industrial buildings, by application and region, 1995

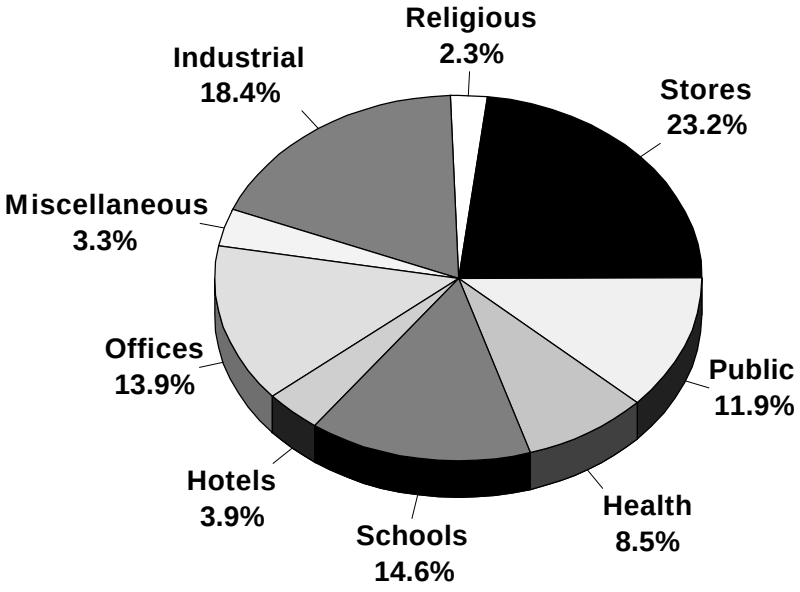


Figure 2.- Distribution of new nonresidential construction value, by building type, 1995

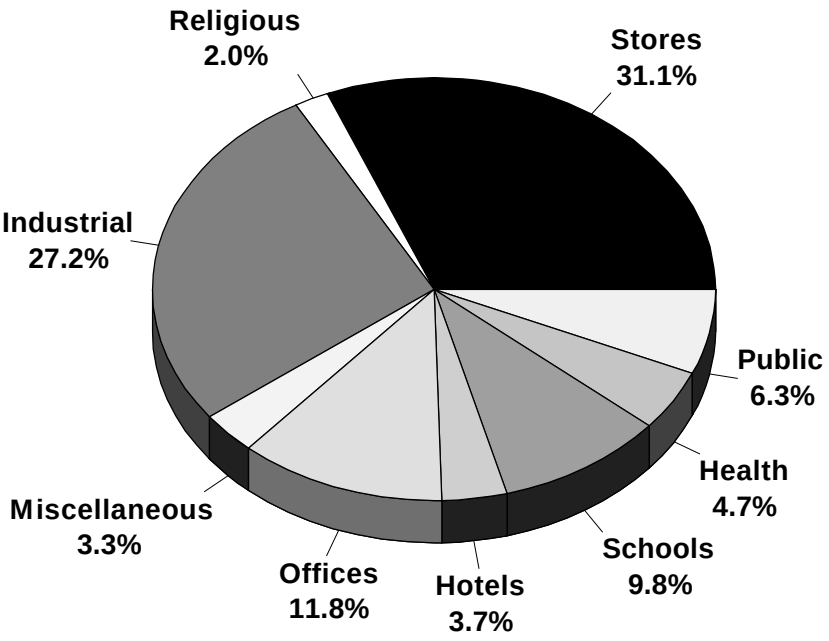


Figure 3.- Distribution of new nonresidential floor area built, by building type, 1995

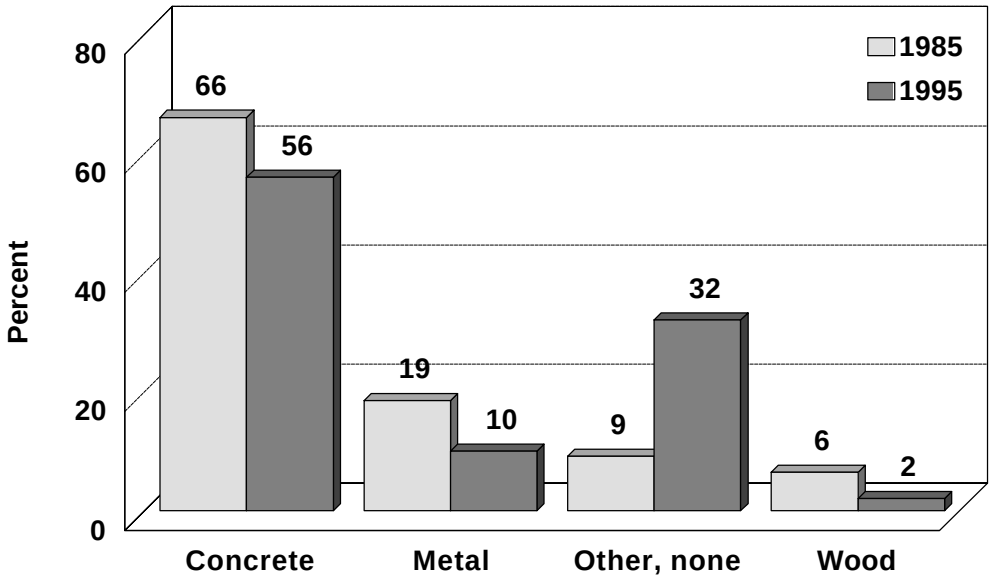


Figure 4.-Incidence of principal siding type, 1985 and 1995

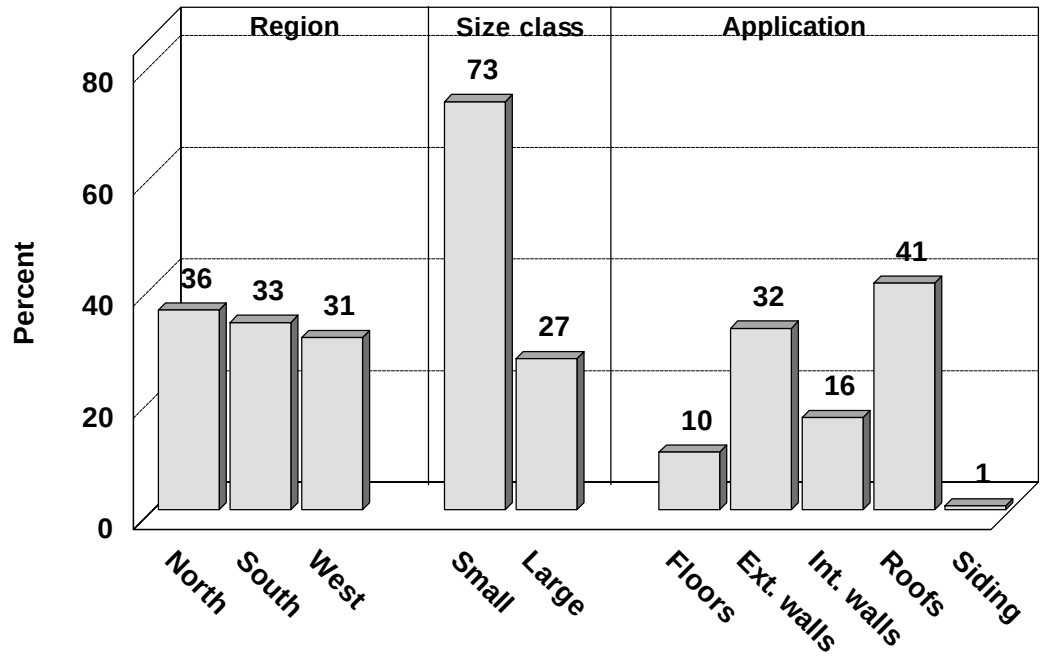


Figure 5.-Percentage lumber use in new nonresidential buildings, by building characteristic, 1995

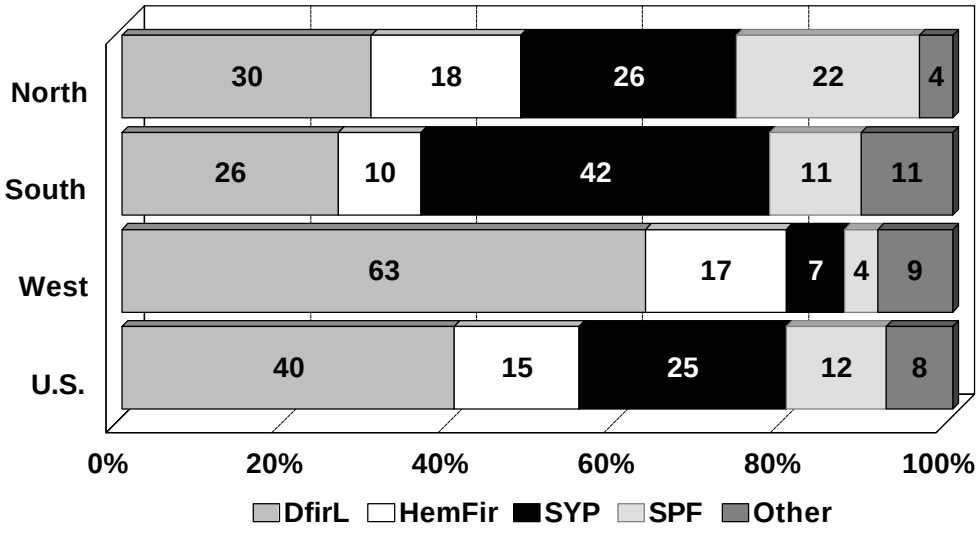


Figure 6.-Percentage lumber use in new nonresidential buildings, by region and species group, 1995

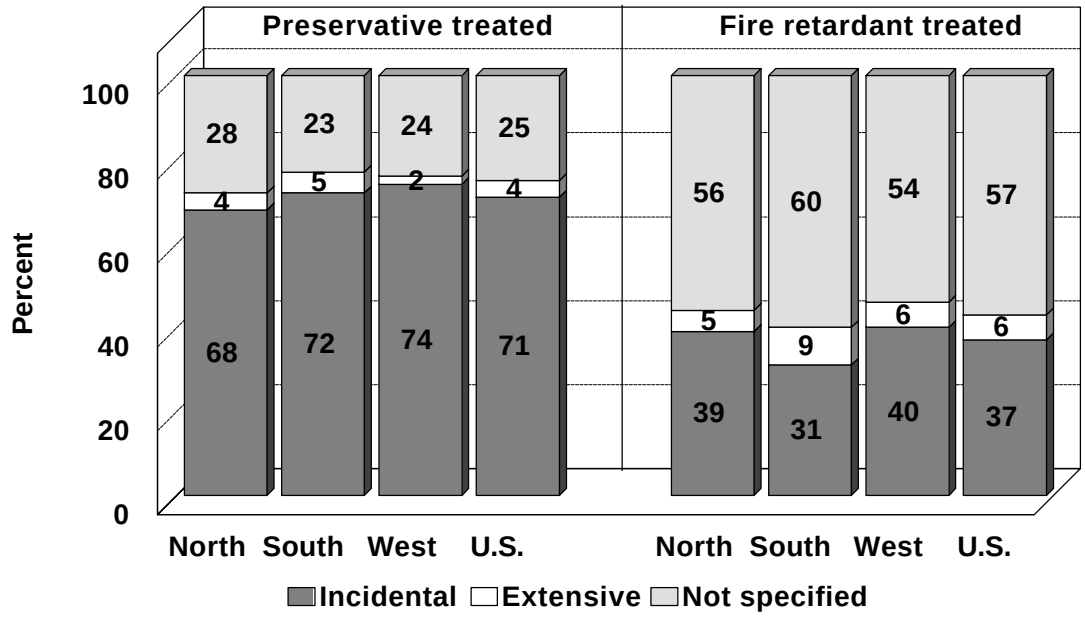


Figure 7.-Percentage use of treated wood in new nonresidential buildings, 1995

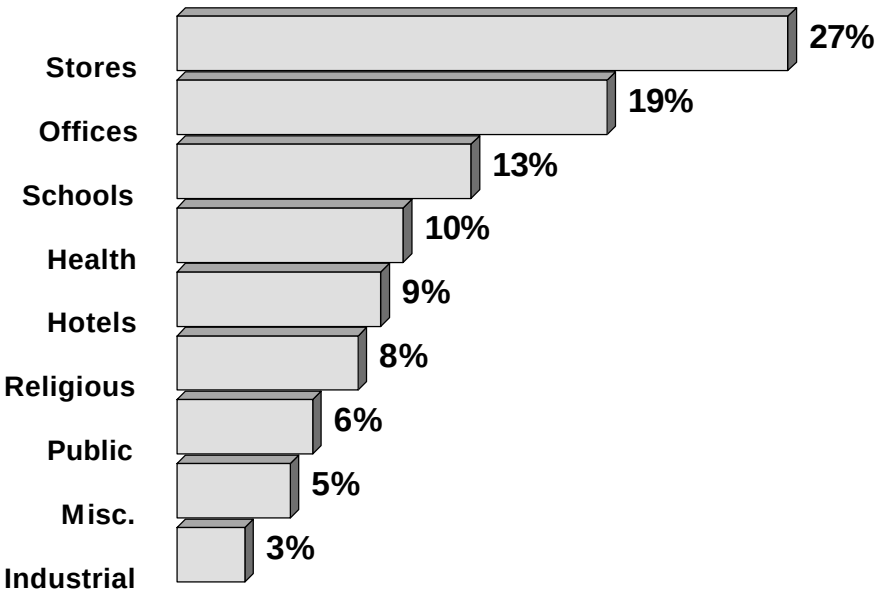


Figure 8.-Percentage lumber use in new nonresidential buildings, by building type, 1995

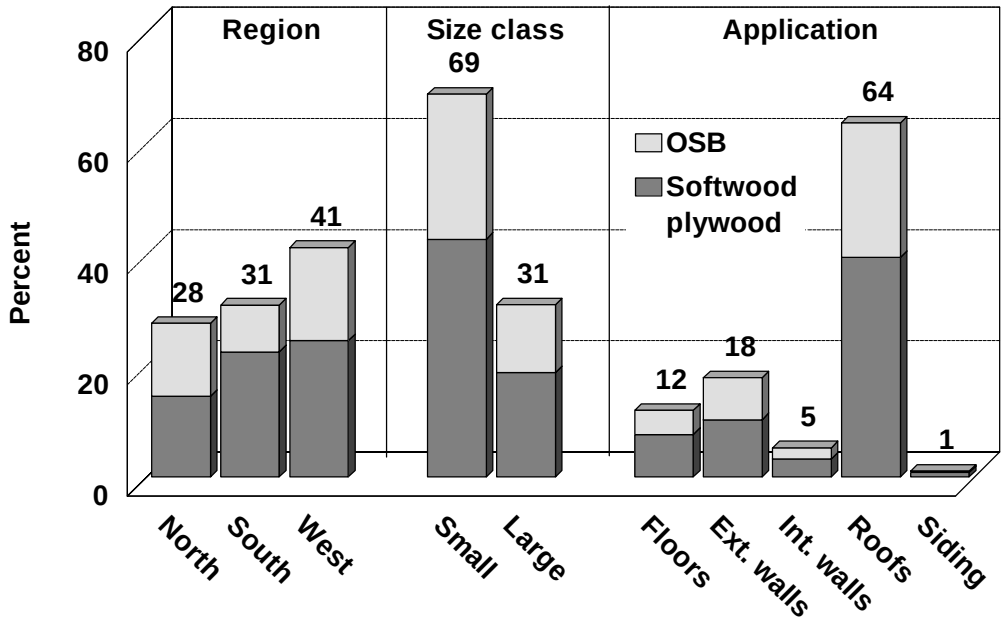


Figure 9.-Percentage structural panels in new nonresidential buildings, by building characteristic, 1995

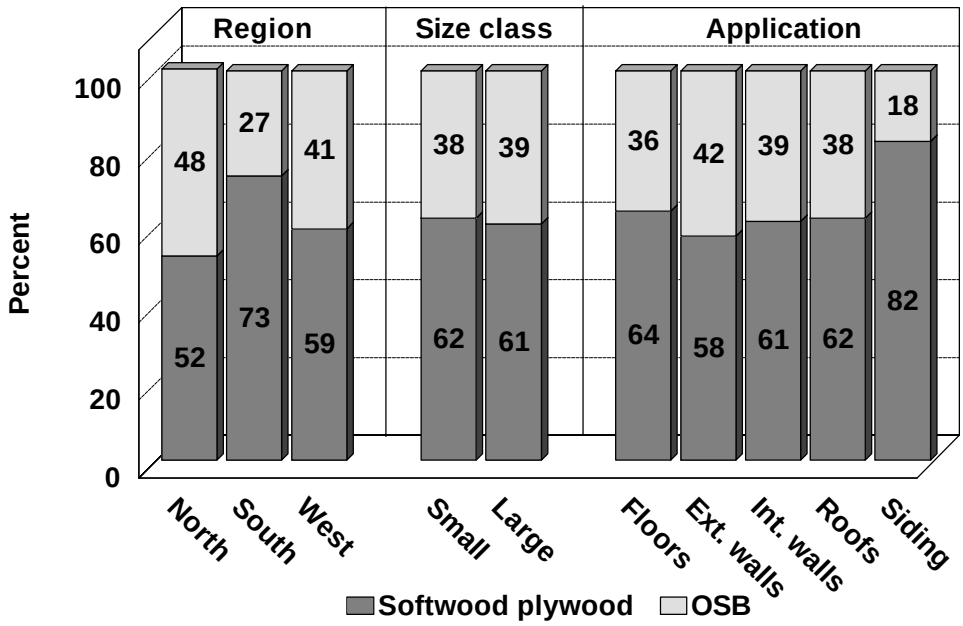
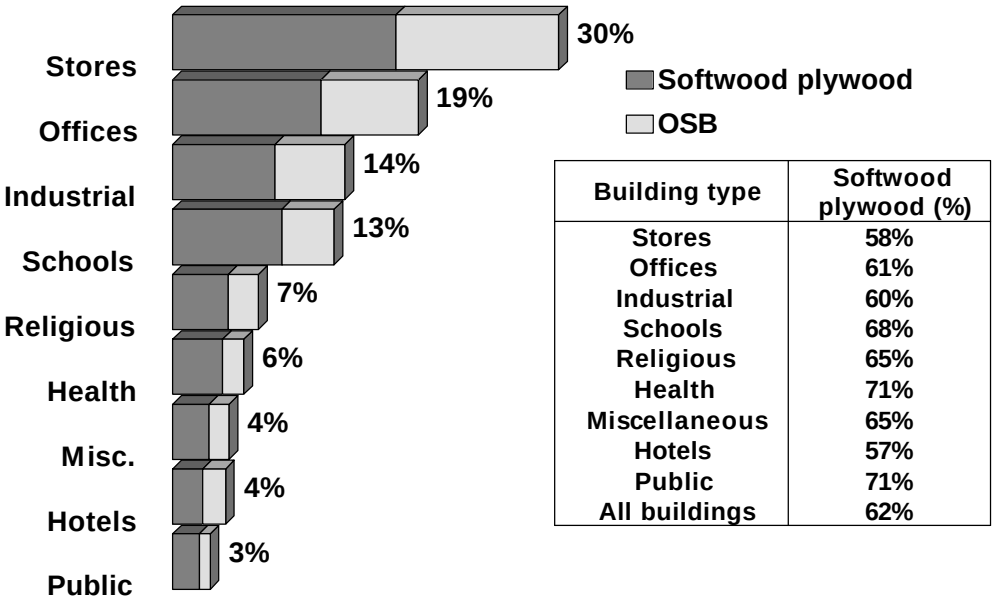


Figure 10.-Percentage softwood plywood and OSB in new nonresidential buildings, by building characteristic, 1995



Building type	Softwood plywood (%)
Stores	58%
Offices	61%
Industrial	60%
Schools	68%
Religious	65%
Health	71%
Miscellaneous	65%
Hotels	57%
Public	71%
All buildings	62%

Figure 11.-Percentage structural panel use in new nonresidential buildings, by building type, 1995

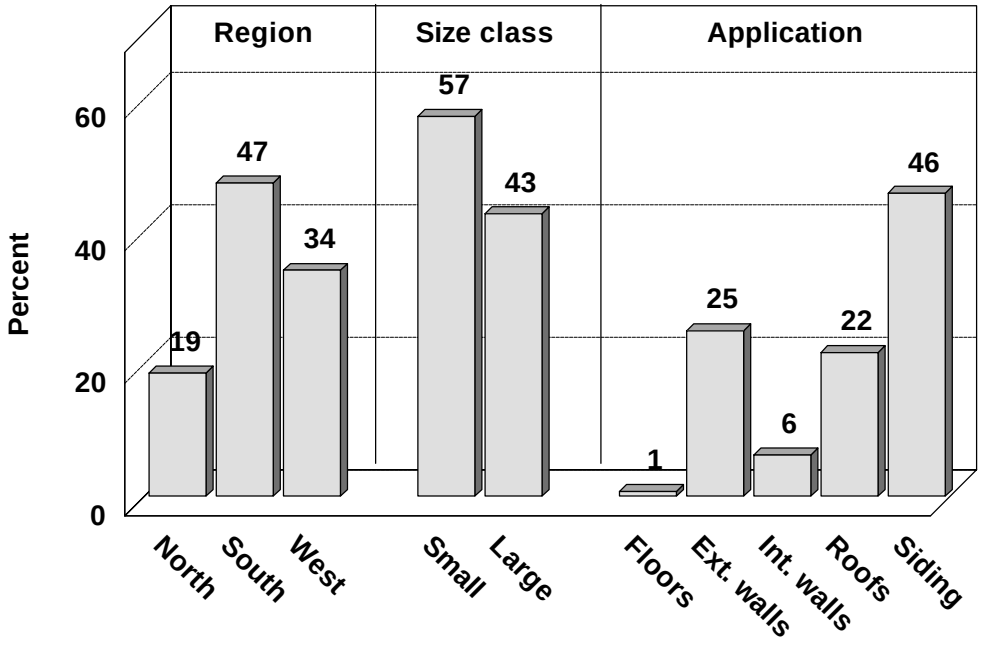


Figure 12.-Percentage nonstructural panels in new nonresidential buildings, by building characteristic, 1995

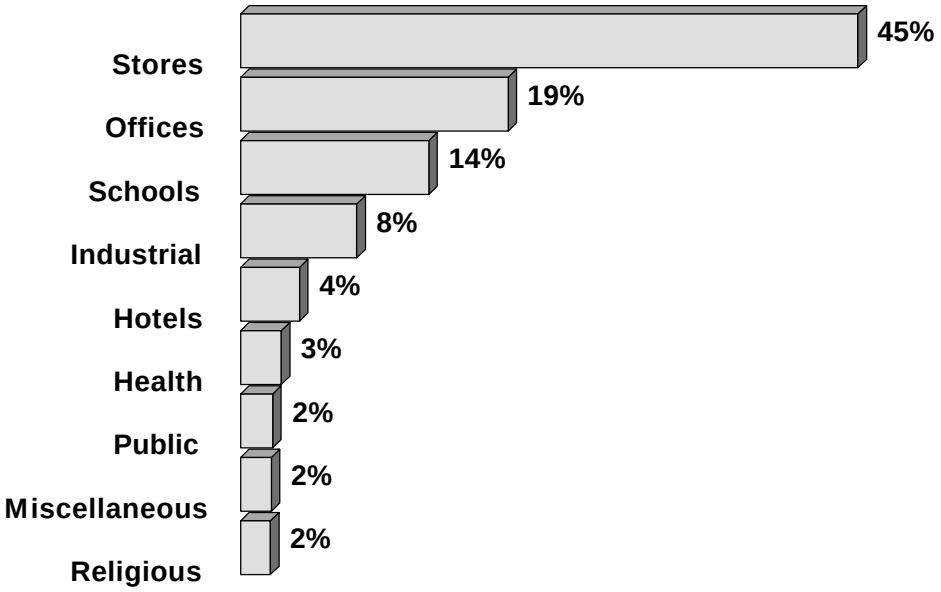


Figure 13.-Percentage nonstructural panel use in new nonresidential buildings, by building type, 1995

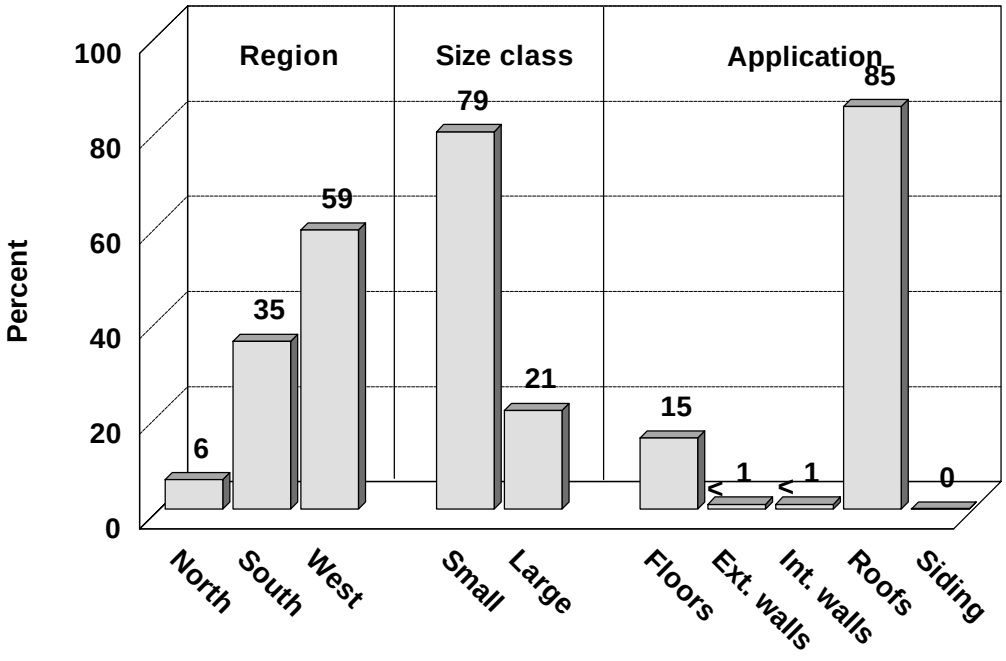


Figure 14.-Percentage I-joists in new nonresidential buildings, by building characteristic, 1995

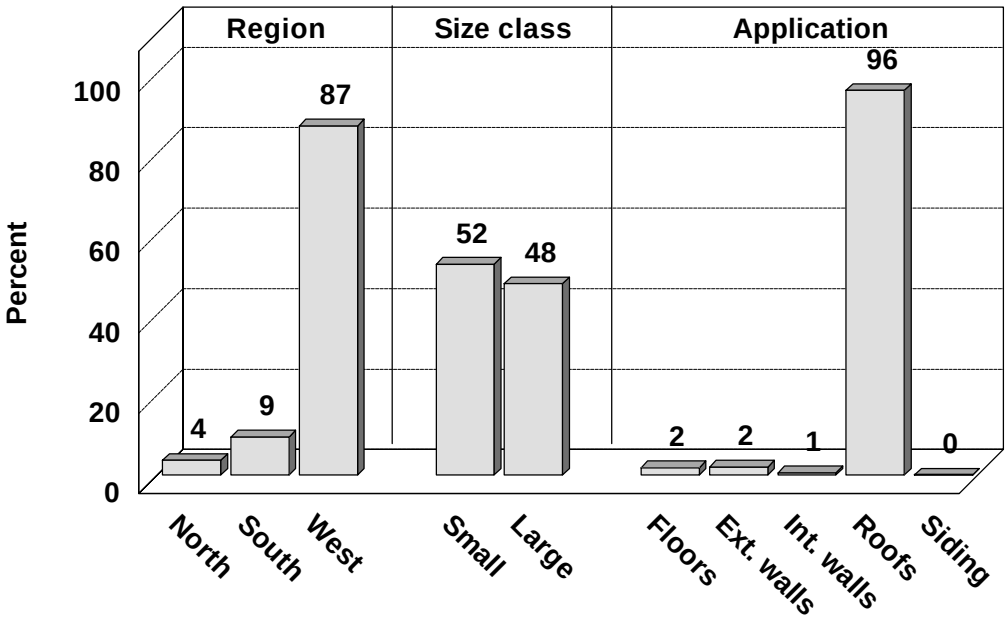


Figure 15.-Percentage glulam in new nonresidential buildings, by building characteristic, 1995

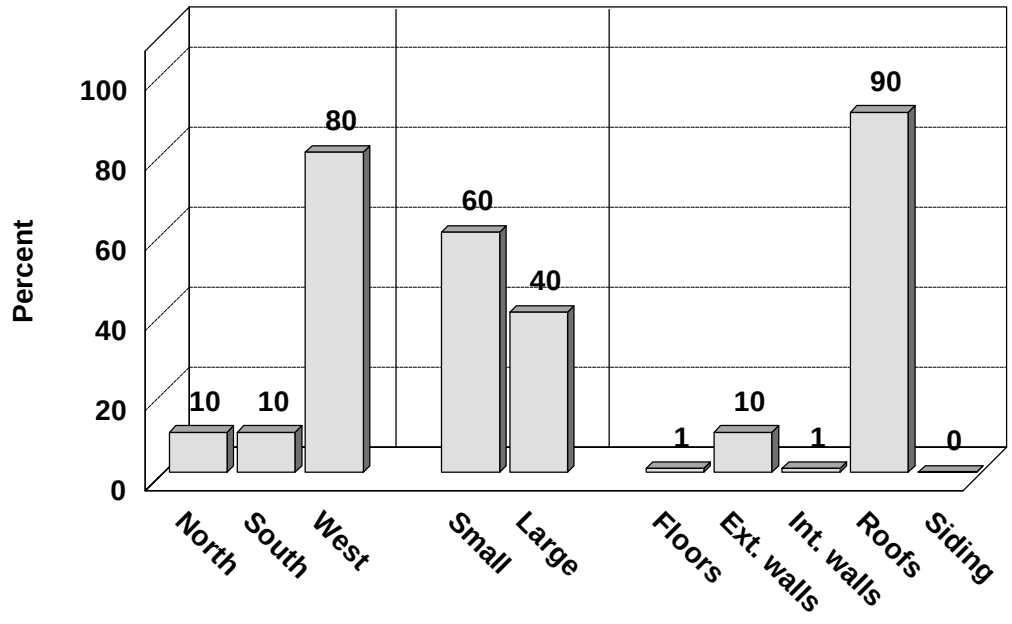


Figure 16.-Percentage SCL in new nonresidential buildings, by building characteristic, 1995

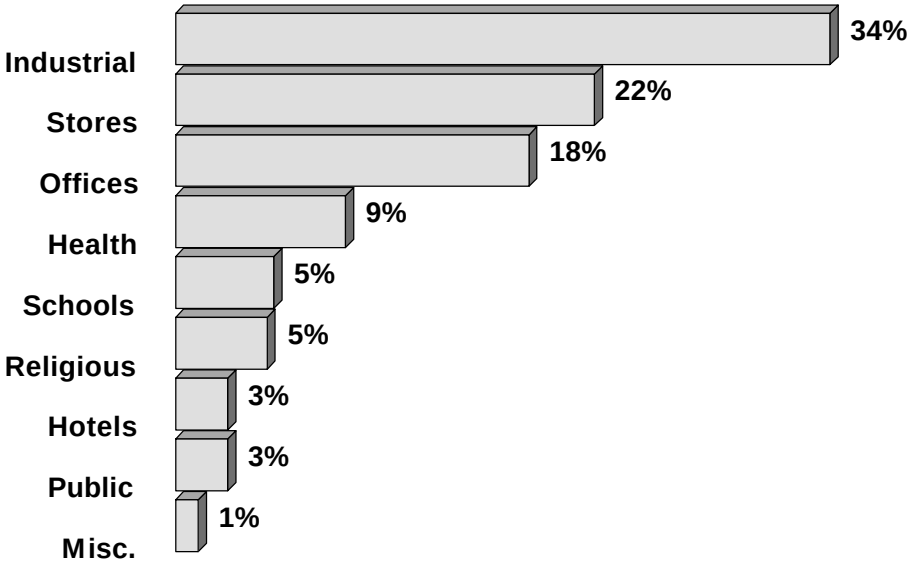


Figure 17.-Percentage I-joist use in new nonresidential buildings, by building type, 1995

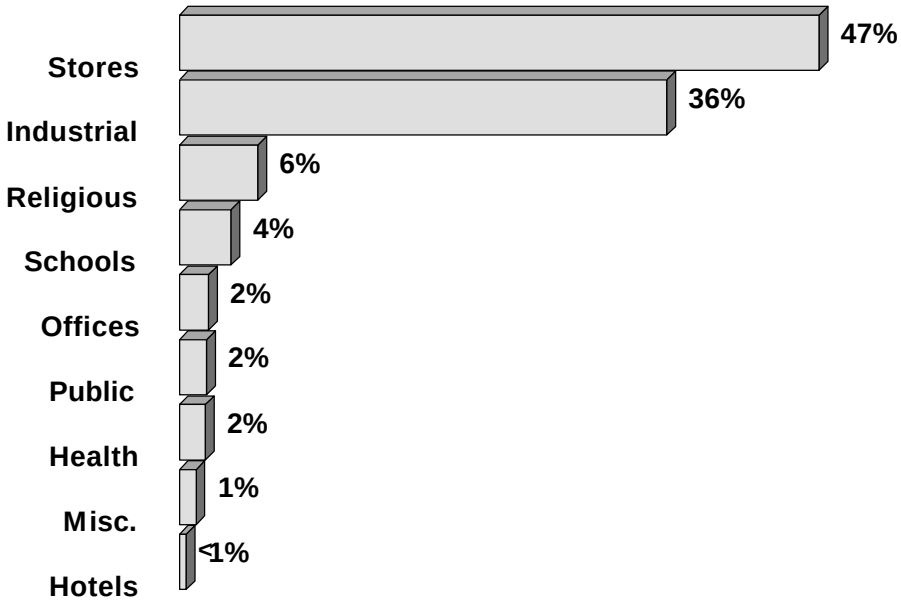


Figure 18.-Percentage glulam use in new nonresidential buildings, by building type, 1995

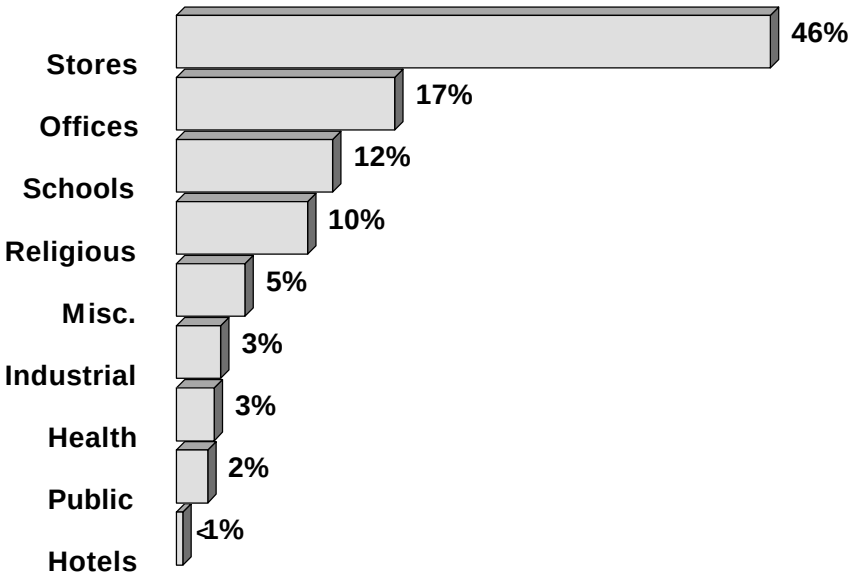


Figure 19.-Percentage SCL use in new nonresidential buildings, by building type, 1995

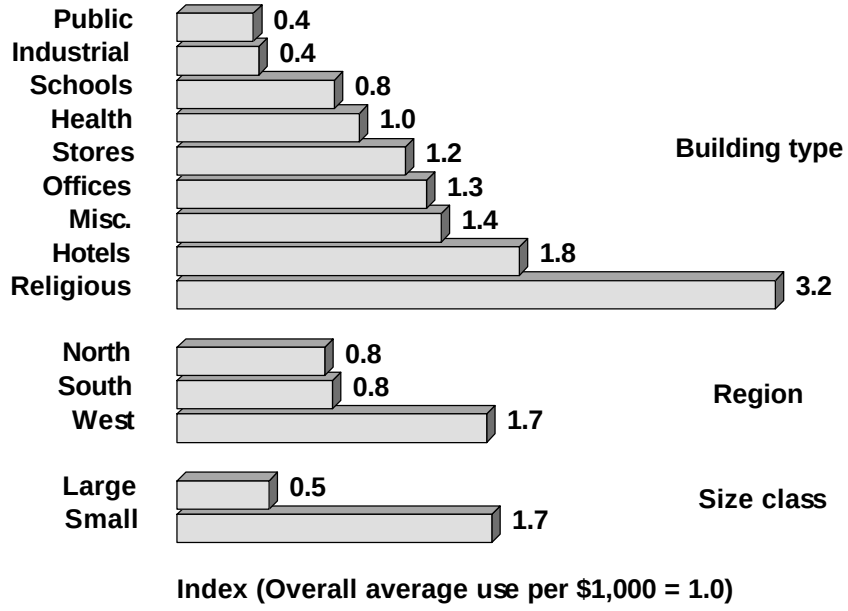


Figure 20.-Index of wood use per $1,000 (constant 1992) of construction value, 1995

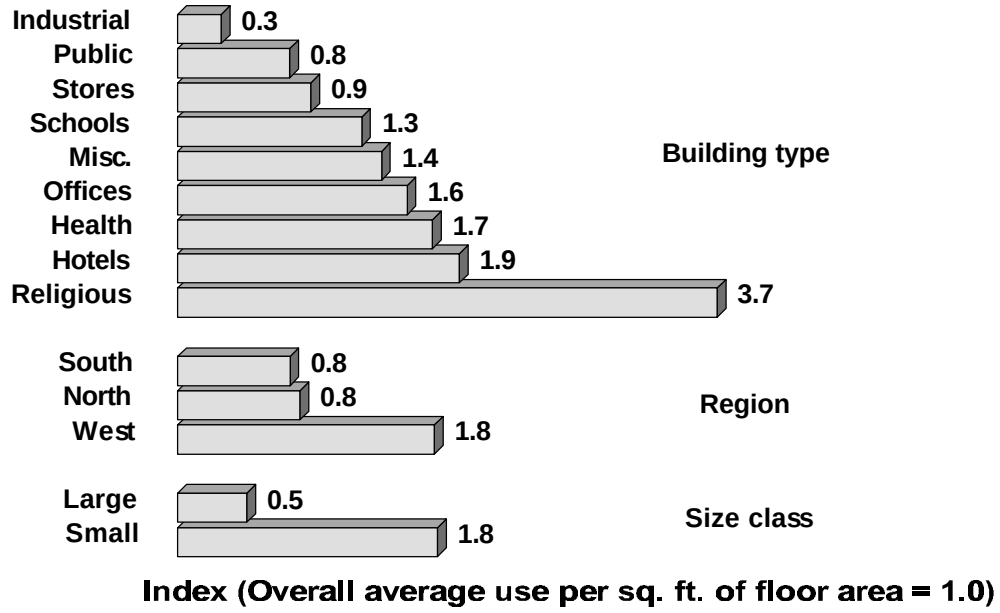


Figure 21.-Index of wood use per square foot of floor area, 1995

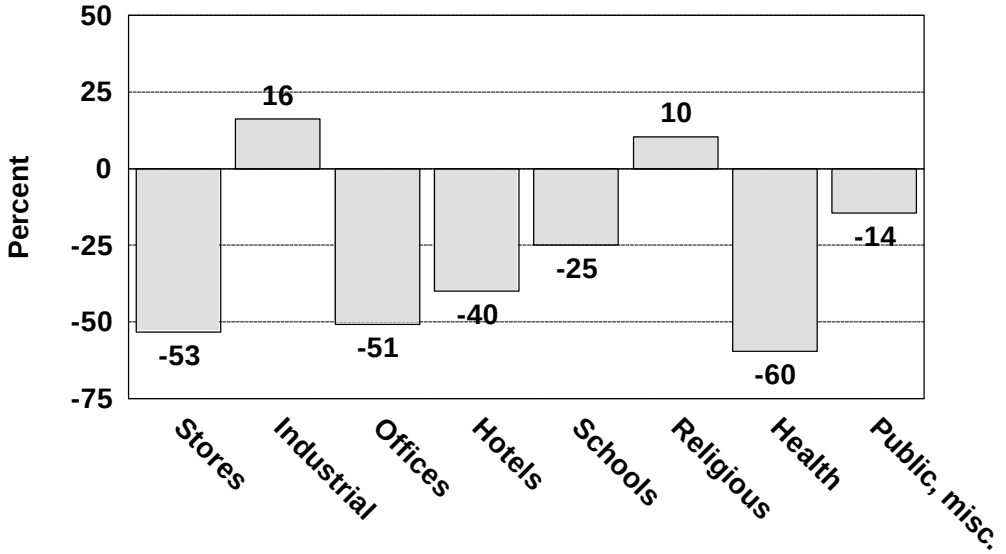


Figure 22.-Percentage change in total wood used in new nonresidential buildings between 1985 and 1995, by building type

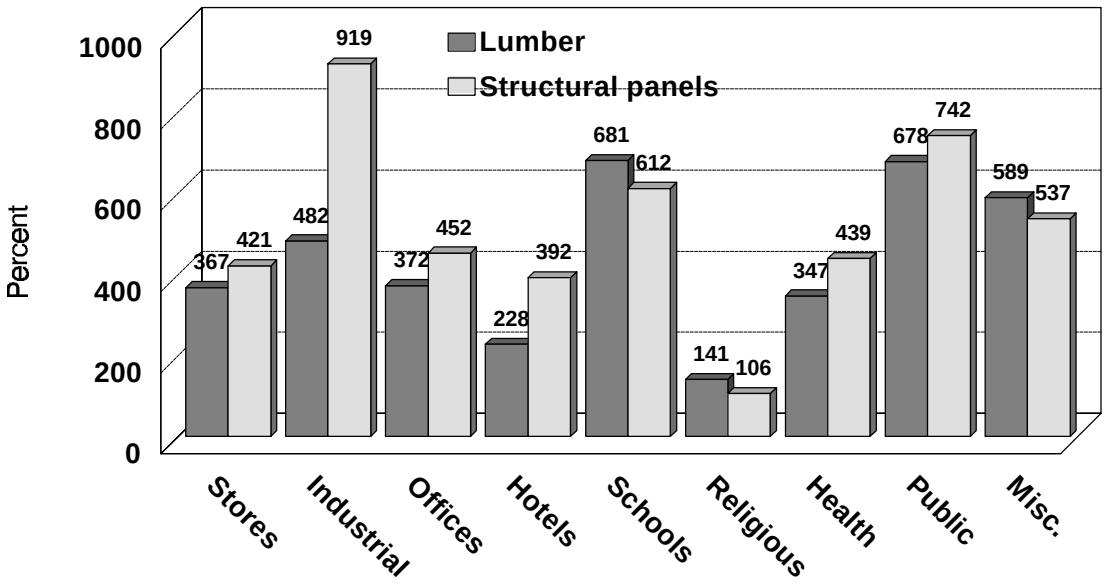


Figure 23.-Potential increase in lumber and structural panel use in new nonresidential buildings, by building type, 1995

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 for each building application by the principal type of building material used. Principal construction types are:

Wood - Lumber framed foundations, floors, walls or roofs; lumber, structural panel or nonstructural panel siding.

Concrete - Concrete, masonry, stone, brick or block foundations, floors, walls or roofs. Includes asbestos or stucco siding.

Metal - Steel framed or supported foundations, floors, walls or roofs. Includes steel and aluminum siding.

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, universities and 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.

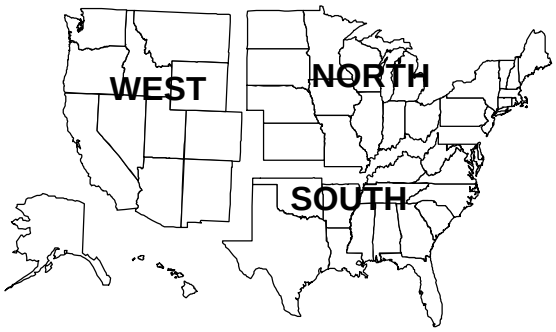
Health - Health care and institutional facilities. Includes sanatoria, convalescent and rest homes, nursing homes, orphanages, and similar establishments for prolonged care, and surgical or outpatient clinics affiliated with a hospital.

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.

Miscellaneous - Nonresidential buildings not classified in any of the above categories. Includes motion picture studios, theaters, casinos, health clubs, and buildings which provide amusement and recreational services, radio and television stations, bus and airline terminal buildings, and animal hospitals.

Regions

North - Northeast and Midwest U.S. Bureau of the Census regions.
South - Southern U.S. Bureau of the Census region.
West - Western U.S. Bureau of the region.



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 new nonresidential building construction is largely dependent on (1) the overall size of the new nonresidential buildings market in the United States and the mix of building types therein, (2) the frequency or incidence of principal construction types used for each type of building, (3) the incidence of wood products used for each principal construction and building type, and (4) the amount of each wood product used per unit of construction activity in each building type (wood use factors). This study was designed to use information published by the U.S. Department of Commerce, Bureau of the Census on the overall size and types of new nonresidential buildings constructed in 1995, information purchased from F.W. Dodge, Inc.[5] to estimate the incidence of principal construction types, the incidence of wood products used, and average amounts of wood used per unit of construction activity by building type for the 3 year period 1993-1995, and information collected specifically for this study by APA-The Engineered Wood Association[6] field representatives to augment missing data, to verify existing information, or to resolve specific questions.

The information purchased from F.W. Dodge provided the basis for estimating incidence of use and wood use factors, and for estimating total floor area built by building type. Four specific sets of information were included. The first was a sample of 2,500 buildings which were recently completed, under construction or planned during the 3 year period 1993-1995. For each building in this data set, information included the type of building, its location, value, floor and roof areas, perimeter, and principal construction type by building application--foundation, ground level floor, upper story floors, exterior walls, interior walls, roof and siding. This information was used to develop estimates of the incidence of principal construction type by building type, region, size class, and building application. The second data set itemized the amounts of wood products used for each of 500 buildings. Information included building type and location, and the amounts of lumber, softwood plywood, OSB, nonstructural panels, I-joists, glulam, and structural composite lumber used by building application. Wood use per square foot of finished floor area by building type, region, size class and building application were developed from these data. The third data set consisted of an approximate 25 percent subset of the first two data sets, and contained information on 630 individual buildings. This data set included all the information included in the first data set plus information of the types of wood products used for each building application. Incidence of wood products use by building type, region, size class and building application were developed from these data. The final data set was a complete listing of the value of construction and floor areas for all buildings in the F.W. Dodge database. This information provided the means to estimate total floor area built in the U.S. from total U.S. value of construction by building type from the U.S. Department of Commerce, Bureau of the Census.

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

[6] APA-The Engineered Wood Association, P.O. Box 11700, 7011 South 19th Street, Tacoma, WA 98411.

Information in each data set was initially edited, reformatted and summarized to identify erroneous and/or questionable data, to insure consistency within and between records, and to identify areas where additional information was needed to augment missing, questionable, or incomplete data. This additional information was collected, as needed, by APA field representatives from buildings currently under construction, or from general construction techniques and building materials typically used for new nonresidential buildings in their areas. After all data sets were finalized, the following six-step procedure was used to estimate wood used in new nonresidential buildings in 1995:

1. Estimate average incidence of principal construction type for each building type, region, size class and building application. Incidence of principal construction type is an estimate of the percentage of each building application type which was primarily built with wood, concrete, or metal. The intensity of wood used is greatly dependent on the type of construction used for a specific application in a building. For example, if upper story floors were primarily concrete, little if any wood would be used. If these same floors were built entirely from wood, large amounts of wood would be used. Stratifying buildings by principal construction type permits overall wood use estimates to capture differences in the intensity of wood use due to different construction types.

2. Estimate average incidence of wood products used in each principal construction 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 construction type, so does the presence of specific wood products by principal construction type.

3. Estimate wood use factors for each wood product by construction type, building type, region, size class and building application. Wood use factors measure actual amounts of each wood product used per square foot of finished floor area, and provide the means to estimate total wood used based on total floor area built. A I-joist use factor of 0.12 for upper story floors indicates that on average, 0.12 lf of I-joists are used for every square foot of floor area built for the specified building type, region, size class and construction type. 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 largely substitute for dimension lumber in floor framing, the lumber use factor decreases.

4. Estimate the total floor area of new nonresidential buildings built in the United States in 1995 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. Current dollar value of construction was used to estimate total floor area built by applying ratios developed from F.W. Dodge data on value of construction and floor area. Total floor area was used to expand from wood use in the F.W. Dodge sample to national levels of use.

5. Calculate wood products used for new nonresidential buildings in 1995 by building type, principal construction type, region, size class, building application, and wood product. Information from steps 1-4 were used to estimate total wood use. Estimates of the amounts of each wood product used in each principal construction 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. A waste factor of 10 percent was used for lumber, 5 percent for structural and nonstructural panels, and 2 percent for engineered wood products. Wood products consumption for small buildings (those less than or equal to 50,000 ft^2 of floor area) was adjusted upward to account for higher levels of consumption in buildings of less than 10,000 ft^2 compared to those of 10,000 to 50,000 ft^2. The data from which wood use factors were estimated were not sufficient enough to support stratification of each building type, region, application and wood product into into <10,000 ft^2 and 10,000-50,000 ft^2 size classes for each principal construction type. The data did however enable the estimation of weighting factors to adjust wood products consumption by building type, region and application upward to account for more intensive wood use in smaller building within the small buildings size class. Application of these weighting factors resulted in better estimates of consumption, and slightly higher levels of wood use for small buildings. The amount of lumber used for wood exterior walls in small stores in the North was calculated as:

Floor area in small stores	x	Incidence of wood construction	x	Wood use per ft^2 of floor area	x	Incidence of lumber framing + incidence of lumber sheathing	x	Waste factor	x	Small building weighting factor

6. Similar calculations were made for each wood product, region, construction type, building application, size class and building type. Table B-1 shows the estimation procedure for lumber and softwood plywood used for exterior walls in small stores in the North. Wood use in each principal construction was summed, resulting in total wood used for exterior wall construction in small stores, by region.Calculate wood use per square foot of floor area and per $1,000 of constant (1992) construction value based on total estimated wood used. These two wood use factors provide a convenient means of comparing relative use of wood between building types, regions, and years. Table B-2 summarizes total lumber and softwood plywood used, use per square foot of floor area, and use per $1,000 of constant (1992) construction value for exterior walls in small stores in 1995.

Table B-1.-Estimated lumber and softwood plywood used for exterior walls in small stores, 1995

Principal construction type/ region	Floor area (Mil ft²)	Incidence of principal construction type (%)	Incidence of wood products use: Framing: Lumber (%)	Framing: Softwood plywood (%)	Sheathing: Lumber (%)	Sheathing: Softwood plywood (%)	Wood used per ft² of floor area: Lumber (Bf}	Wood used per ft² of floor area: Softwood plywood² (Ft²)	Weighting factor¹: Lumber (%)	Weighting factor¹: Structural panels (%)	Final weighted wood use: Lumber (Mil bf)	Final weighted wood use: Softwood plywood² (Mil. ft²)
WOOD												
North	--	37.6	100.0	0.0	0.7	18.8	0.605	0.093	--	--	30.8	0.8
South	--	31.3	100.0	0.0	0.4	44.3	0.694	0.313	--	--	41.4	6.1
West	--	62.9	100.0	0.0	0.1	52.1	0.153	0.380	--	--	7.1	9.5
CONCRETE												
North	--	28.9	54.7	0.0	0.0	13.1	0.118	0.143	--	--	2.5	0.7
South	--	48.1	31.2	0.0	0.0	27.1	0.023	0.064	--	--	0.7	1.1
West	--	25.0	36.4	0.0	0.0	27.2	0.112	0.115	--	--	0.8	0.6
METAL												
North	--	33.5	54.2	0.0	0.0	18.1	0.095	0.180	--	--	2.3	1.3
South	--	20.6	89.8	0.0	63.6	44.4	0.097	0.261	--	--	5.9	3.3
West	--	12.1	0.0	0.0	0.0	0.0	0.097	0.037	--	--	0.0	0.0
TOTAL												
North	106.7	--	--	--	--	--	--	--	1.15	1.08	35.7	2.8
South	123.8	--	--	--	--	--	--	--	1.39	1.08	47.9	10.5
West	66.9	--	--	--	--	--	--	--	1.01	1.08	7.9	10.1
U.S.	297.4	--	--	--	--	--	--	--	--	--	91.5	23.4

[1]Adjustment for greater intensity of wood use in small buildings with less than 10,000 ft² of floor area compared to those with 10,000-50,000 ft².
[2]3/8-inch basis.

Table B-2.-Estimated lumber and softwood plywood used, use per square foot of finished floor area, and use per $1,000 of constant (1992) construction value for exterior walls in small stores, 1995

Region	Floor area (Mil ft²)	Construction value (Mil. 1992 $)	Wood products consumption: Lumber (Mil bf)	Wood products consumption: Softwood plywood¹ (Mil. ft²)	Per ft² of floor area: Lumber (Mil bf)	Per ft² of floor area: Softwood plywood¹ (Mil. ft²)	Per $1,000 of constant (1992) construction value: Lumber (Mil bf)	Per $1,000 of constant (1992) construction value: Softwood plywood¹ (Mil. ft²)
North	106.7	5,631	35.7	2.8	0.334	0.026	6.335	0.491
South	123.8	6,163	47.9	10.5	0.387	0.085	7.770	1.711
West	66.9	3,594	7.9	10.1	0.118	0.150	2.200	2.803
U.S.	297.4	15,388.7	91.5	23.4	0.307	0.079	5.944	1.519

[1]3/8-inch basis.