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Steel - the Clear Cut Alternative

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STEEL - THE CLEAR CUT ALTERNATIVE

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The current use of cold-formed steel owes its success to efforts which started 50 years ago. In 1946 AISI published the first specification for the design of cold-formed (then known as light gage) steel structural members. The specification was the end product of a doctoral thesis by Dr. George Winter which was initiated in 1939. Since 1946 AISI has continually updated and modernized the AISI Specification for the Design of Cold-Formed Steel Structural Members. The 1956 manual was the first design specification to have a companion commentary. In 1991 AISI published the LRFD version of the Design of Cold-Formed Steel Structural Members. Today AISI is currently developing a single specification which combines the ASD and LRFD design methodologies.

The creation of the first design specification for cold-formed steel members and its subsequent improvements have been critical to the growth in the use of cold-formed steel in construction. In 1995 the US construction market used an estimated 8.5 million tons of cold-formed steel products in construction, that is more steel than was used in hot rolled structural shapes in the same time period. Cold-Formed steel is used in a variety of construction applications such as steel roofing and siding, purlins and girts, floor and roof deck, storage racks and steel framing to name a few. The presence of a uniformly accepted design specification encourages product development and eases the acceptance by building officials. Those principals are as true today as they were 50 years ago. The use of cold-formed steel continues to grow and expand into new markets using the AISI Specification for the Design of Cold-Formed Steel Structural Members. The focus of this paper is on the use of steel in residential construction which is the largest potential growth market for steel. AISI estimates that if steel captures 25% of the residential market, it will consume 2 million tons.

Builders across the country are increasingly using steel as a replacement for wood. According to an NAHB survey 6%, or 78,000 homes, built in 1993 used steel framing for the interior non load bearing walls and 1%, or 13,000 homes, used steel framing for the walls, joists and trusses. This represented a significant growth over 1992 which we estimated to be only 1/4% of the market. Our expectation is that in 1996 these numbers will grow equally dramatically, with possibly as many as 75,000 homes will be built with steel as the load bearing framing material.

The product which is increasingly being used to build homes was developed in the 1960's and it is a lightweight steel "cee" section. It is called a "cee" section because its end profile looks like a squared version of the letter "C". The steel "cee" stud and accessory members were designed to be used in a manner similar to wood studs and were intended to replace wood as the framing material for home construction. While the steel stud did not catch on for use in home construction, it was widely accepted in commercial construction throughout the 1970's and 1980's.

Interest in steel has grown recently due to concern about the availability of dimensional lumber. No other event in recent history has caused so much concern for the home building industry as the decision in 1991 by the National Fish and Wildlife Services to set aside 6.4 million acres to protect the habitat of the spotted owl. In 1990 logging practices were found to be in violation of the Endangered Species Act, the National Environmental Policy Act, and the National Forest Management Act. Court injunctions were filed and gridlock resulted. The Pacific Northwest produced 4 billion board feet of lumber in 1990. This represented about 30% of US production of lumber. In 1993 production was reduced to 250 million board feet. The result was dramatically rising lumber prices and a decreasing supply of quality lumber. This combination of factors sent the nations home builders searching for alternatives to traditional dimensional lumber.

There are a several reasons why steel has been able to capitalize on the opportunities created by fluctuating lumber prices. The existence of a universally accepted design specification and acceptance of the cee stud in commercial construction set the stage for steel framing to be used in residential construction. Also, since steel is being used in commercial construction, many of the tools have been developed and there is some skilled labor available.

The most critical feature of steel framing has been price stability. Steel prices have remained stable since the early 1980's. This is important to the home building industry because a builder typically sets the price of the home with the buyer three months prior to ordering the framing. In recent years it is not uncommon for the price of the framing material to increase 40 or 50% in that three month period. This significantly reduced the builders expected profit.

Steel also has environmental advantages because steel has the inherent property that it is infinitely recyclable. This means that it seldom ends up in a land fill. When specifying building materials, end of use properties are very important since one quarter of the volume of material going into our nations land fills are from construction and demolition. The construction of an average suburban home creates 50 cubic yards of landfill material. Because steel is easily and profitably recycled, it seldom usually ends up at a recycling center rather than a landfill.

To satisfy the inquiries from builders and designers AISI has focused on developing educational brochures and videos. A Residential Framing Manual has been distributed. The manual includes an introduction to steel framing; a directory of steel framing and roofing manufacturers, and a listing of steel home builders; fastener guidelines; construction specifications; and, standard framing details. The manual includes 70 three-dimensional details and shows all common applications of steel framing. All details are available on computer disk as well. To respond the increasing number of builder and designer inquiries, AISI has set up a national clearing house at the NAHB Research Center. Questions are answered by an on staff technical expert. The clearing house can be reached by calling 1 800 79 STEEL.

Prescriptive Standards

One of the major barriers to the use of load bearing steel studs and joists is the lack of standard sections and load span tables. Designers have been required to select from a wide variety of different shapes, sizes and thcknesses of steel framing members. To remedy this situation a three year project is being conducted by the National Association of Home Builders Research Center and funded by AISI, the NAHB (National Association of Home Builders) and HUD (Housing and Urban Development). The scope of the project is to develop prescriptive standards which are similar to those which have adopted by the building codes for wood. All of the section properties and load span tables were calculated according to the AISI 1986 Edition of the Specification for the Design of Cold-Formed Steel Structural Members with the 1989 Addendum.

The first draft of the prescriptive standards was submitted to CABO in January of 1996. The industry agreed to five web depths and one standard flange width of 1.625 inches. Other flanges widths up to 2 inches (51 mm) are acceptable but there is no increase in load carrying capacity. Also the minimum length of the edge stiffener is 0.5 inches. The maximum length should be limited to that permitted by the AISI Specifications for the Design of Cold-Formed Structural Steel Members. The standard profile dimensions are listed in Table 1. Other profiles are permitted, but they must be designed in accordance with the AISI Specification for the Design of Cold-Formed Structural Steel Members.

Material

The material requirements are limited to three common ASTM standards which are listed below.

ASTM A653 Grades 33, 37, 40, 50 (Class 1 and 3)
ASTM A875 Grades 33, 37, 40, 50 Class 1 and 3)
ASTM A792 Grades 33, 37, 40, 50A

Profiles

Standard profiles have been agreed to as well. For wall studs the dimension of the web was set to that of a common wood stud which is either 3.5 inches and 5.5 inches. For floor joists the dimension of the web was set to integer values.

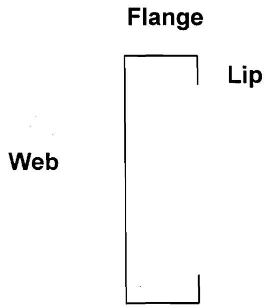

Figure 1

Table 1 - C-Shape Sizes

MEMBER SIZE	WEB DEPTH (inches)	MINIMUM FLANGE WIDTH (inches) (1)	MINIMUM LIP SIZE (inches)
2 x 4	3.5	1.625	0.5
2 x 6	5.5	1.625	0.5
2 x 8	8	1.625	0.5
2 x 10	10	1.625	0.5
2 x 12	12	1.625	0.5

Notes: Tracks shall have a minimum flange size of 1-1/4" (32 mm)
Maximum flange size permitted is 2 inches (51 mm)

The industry also agreed to standard material thicknesses. The out dated system of referring to steel thickness by gauge number is strongly discouraged. Instead users are encouraged to use mils, which is the actual thickness multiplied by 1,000. The thicknesses listed in Table 2 are bare metal thicknesses, exclusive of any coatings.

Table 2 - Material Thickness

Designation (mils)	Minimum Delivered Thickness inches (mm)	Reference Gauge Number
33	0.0329 (0.836)	20
43	0.0428 (1.087)	18
54	0.0538 (1.367)	16
68	0.0677 (1.720)	14

Floor Joists

Standard profiles, material and thickness has permitted the creation of standard load span tables. A sample load span table is listed below.

Table 3

Nominal Joist Sizes[3]	**39 psf Live Load**[3,4] **Spacing Inches**		**40 psf Live Load**[3,4] **Spacing (Inches)**	
	16	24	16	24
2x6x33	10'-7"	9'-1"	9'-7"	8'1"
2x6x43	11'-6"	10'-0"	10'-5"	9'-1"
2x6x54	12'-4"	10'-9"	11'-2"	9'-9"
2x6x68	13'-2"	11'-6"	12'-0"	10'-6"
2x8x33	13'-3"	8'-10"	10'-7"	7'-1"
2x8x43	15'-6"	13'-7"	14'-1"	12'-3"
2x8x54	16'-8"	14'-7"	15'-2"	13'-3"
2x8x68	17'-11"	15'-7"	16'-3"	14'-2"
2x10x43	18'-8"	15'-3"	16'-8"	13'-1"
2x10x54	20'-1"	17'-6"	18'-3"	15'-11"
2x10x68	21'-6"	18'-10"	19'-7"	17'-1"
2x12x43	20'-3"	14'-1"	16'-10"	11'-3"
2x12x54	23'-4"	19'-7"	21'-3"	17'-6"
2x12x68	25'-1"	21'-11"	22'10"	19'-11"

Notes:

1. Table provides the maximum joist span in feet and inches.
2. Bearing stiffeners shall be installed at all support points and concentrated loads. End bearing stiffeners are not required for floor joists 54 mils or thicker, spanning 14 feet or less, for one story homes (walls and roof only) in areas with maximum ground snow load of 30 psf or less.
3. Joists supporting roof and single wall only may cantilever up to a maximum of 24" measured from the centerline of the bearing point, provided that bearing stiffeners are installed at the end of cantilever and the bearing point, and no punchouts are allowed in cantilevered section. Hole reinforcements may be used to cover up holes.
4. Deflection criteria: L/480 for live loads; L/240 for totals loads.

Table 4

Load Bearing Wall Studs
Exposure B at 100 mph
Exposure C at 90 mph
1 Story or 2nd Story of 2 Story

Wall Ht.	Nominal Member	Spacing o.c.	Building Width (feet) 24	28	32	36
8	2 x 4	16	33	33	33	33
8	2 x 4	24	43	43	43	43
8	2 x 6	16	33	33	33	33
8	2 x 6	24	33	33	33	43
10	2 x 4	16	43	43	43	43
10	2 x 4	24	68	68	68	68
10	2 x 6	16	33	33	33	33
10	2 x 6	24	33	33	43	43

The standardization of cold-formed steel framing members will greatly enhance the acceptance in the residential market by permitting the creation of prescriptive standards. This will eliminate the need for engineers to design size homes thus reducing the cost to builders. Larger custom homes will still require a structural engineer, but the design process will be made easier due the existence of standard profiles. There will also be a significant benefit to commercial framing as well. Designers will be able to specify profiles which are universally available. The prescriptive standards will be available through AISI later this summer.