Machine Graded Lumber

MSR Introduction

Lumber has been graded visually for many decades as a reliable way of assuring consistent quality. A second grading system, using machines to sort the lumber into grades, has been in use for over 30 years. One of these lumber products, machine-stress rated [MSR] lumber, has been used for many years in highly demanding engineered applications. Recently, a similar product called machine evaluated lumber [or MEL] has also become available. Both MSR and MEL are specialty lumber products falling within the size parameters of dimension lumber.

The precision of machine grading results in more efficient use of the forest resource. This translates into a set of cost-competitive products that extend the use of lumber into high strength applications. MSR lumber is favoured particularly by specialized users such as truss manufacturers where higher strength per volume of lumber and reliability resulting from measured design values is required.

Quality Control

Visual and Machine Grading

Lumber which is evaluated mechanically is called machine stress-rated (MSR) lumber. Canadian MSR lumber is manufactured in conformance with the National Lumber Grades Authority (NLGA) Special Product Standard 2 (SPS-2)

Most lumber is visually graded by lumber graders. They examine each piece, applying visual "rules" to establish its grade, which determines the structural design value. Visual grading still works well, however, the increase in demand for high-performance lumber has led to greater demand for enhanced grading techniques. Also, the emergence of managed high yield forests is producing trees whose strength is more difficult to accurately determine by visual grading alone.

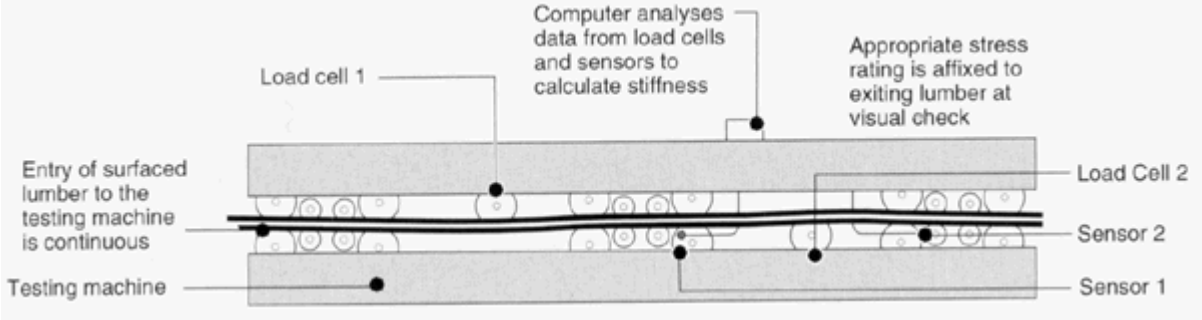
In addition, building techniques have changed. The heavy roof beams and rafters of the 1930s and 1940s have been replaced by the highly engineered truss systems of today. These engineered systems have become so sophisticated that they push structural lumber elements close to the limit of their design capacity.

Machine grading makes this possible. It works by measuring a characteristic, such as stiffness or density that correlates with the structural properties of interest, such as bending strength. The process combines information about the visual characteristics of the grade with measured stiffness or density, sorts by the predicted strength, and labels each piece with a grade stamp.

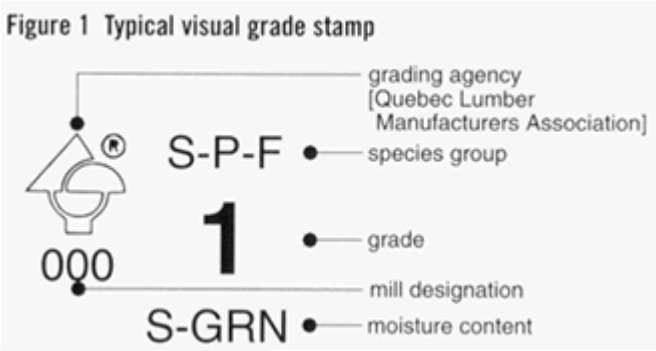
As lumber is fed continuously into the mechanical evaluating equipment, stiffness is measured and recorded by a small computer, and strength is assessed by correlation methods. MSR grading can be accomplished at speeds up to 365m (1000') per minute including the affixing of an MSR grade mark. MSR lumber is also visually checked for properties other than stiffness which might affect the suitability of a given piece.

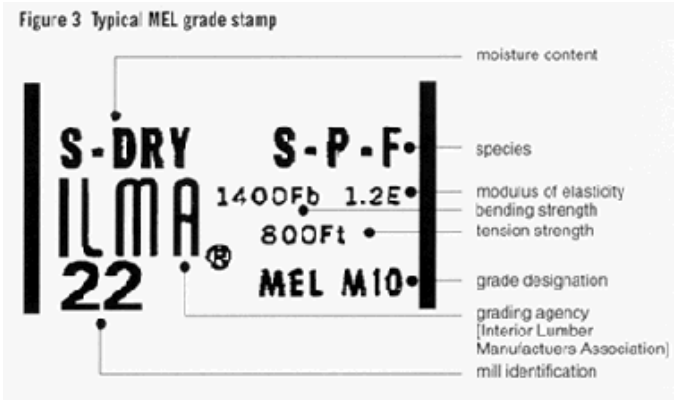
The result is a more precise understanding of the strength of each piece of machine graded lumber than is possible with visually graded lumber.

The image below, shows a schematic representation of the apparatus used to rate MSR lumber. A typical Canadian MSR grade stamp looks similar to that of visually graded lumber, but in addition indicates the grade, by reference to bending strength (F_b), and stiffness (E).



MSR and MEL lumber bears a grade stamp just like visually graded lumber [see Figure 1 below]. The MSR grade stamp indicates the F_b [design bending stress] and E [modulus of elasticity or stiffness] values. Thus, the MSR grade 1650f-1.5E designates the bending stress of 1650 psi and the stiffness of 1.5 million psi in its grade name. Other design properties are as listed in the National Design Specification [NDS].





The MEL grades are designated by the letter "M" followed by a number [i.e. M-10, M-19, etc.] which is not correlated to any strength property. As with MSR, the design properties for the MEL grades are indicated on the grade stamp and are listed in the NDS.

Checks and Balances

MSR and MEL machine grading systems also include an off-line testing process for verifying the stress ratings on a daily basis. Lumber is loaded on its edge to 2.1 times its assigned design bending stress. MEL processes also require the lumber to be loaded in tension to 2.1 times its assigned tensile stress. Both MSR and MEL testing include daily monitoring of stiffness which verifies the accuracy of the machine grading process. For architects, engineers, and building designers, this testing assures a product with highly predictable strength properties. Truss designers, particularly, have taken advantage of the efficiency of MSR and MEL to design and build trusses that closely match the size and strength of lumber components to the desired span.

Design Values

While there are 46 total grades of MSR and MEL, only a handful of these grades are currently produced by sawmills. The MSR Lumber Producers Council compiles a handy survey each year which identifies volumes produced by species, size, and grade. The most common MSR grades are 1650f-1.5E, 2100f-1.8E and 2400f-2.0E. Calling local lumber suppliers will identify the grades available in local markets. Below are U.S. and Canadian design values for popular grades of MSR and MEL.

US Design Values for Mechanically Graded Dimension Lumber				
Species and commercial grade	Design values in pounds per square inch (psi)			
	Bending F_b	Tension parallel to grain F_t	Compression parallel to grain F_c	Modulus of elasticity E
Machine Stress Rated (MSR) Lumber				
1650f-1.5E	1650	1020	1700	1,500,000
1800f-1.5E	1800	1300	1750	1,500,000
1800f-1.6E	1800	1175	1750	1,600,000
1950f-1.7E	1950	1375	1800	1,700,000
2000f-1.6E	2000	1300	1825	1,600,000
2100f-1.8E	2100	1575	1875	1,800,000
Machine Evaluated Lumber				
M-10	1400	800	1600	1,200,000
M-19	2000	1300	1825	1,600,000
M-23	2400	1900	1975	1,800,000

Canadian Specified Strengths and MOE for Machine Stress-Rated Grades 38 mm Thick by All Widths (MPa)				
Grade	Bending at extreme fibre f_b	Compression parallel to grain f_c	Tension parallel to grain f_t	Modulus of elasticity E
Machine Stress Rated (MSR) Lumber				
1200F_b-1.2E	17.4	15.1	6.7	8,300
1350F_b-1.3E	19.5	16.9	8.4	9,000
1450F_b-1.3E	21.0	17.3	9.0	9,000
1500F_b-1.4E	21.7	17.5	10.1	9,700
1650F_b-1.5E	23.9	18.1	11.4	10,300
1800F_b-1.6E	26.1	18.7	13.2	11,000
1950F_b-1.7E	28.2	19.3	15.4	11,700
2100F_b-1.8E	30.4	19.9	17.7	12,400
2250F_b-1.9E	32.6	20.5	19.6	13,100
2400F_b-2.0E	34.7	21.1	21.6	13,800
2550F_b-2.1E	36.9	21.7	23.0	14,500
2700F_b-2.2E	39.1	22.3	24.1	15,200
2850F_b-2.3E	41.3	22.9	25.8	15,900
3000F_b-2.4E	43.4	23.5	26.9	16,500
Machine Evaluated Lumber				
M-10	20.3	17.1	9.0	8300
M-11	22.4	17.7	9.5	10,300
M-12	23.2	17.9	9.5	11,000
M-13	23.2	17.9	10.7	9,700
M-14	26.1	18.7	11.2	11,700
M-15	26.1	18.7	12.3	10,300
M-18	29.0	19.5	13.5	12,400
M-19	29.0	19.5	14.6	11,000
M-21	33.3	20.7	15.7	13,100
M-22	34.0	20.9	16.8	11,700
M-23	34.7	21.1	21.3	12,400
M-24	39.1	22.3	20.2	13,100
M-25	39.8	22.5	22.4	15,200
M-26	40.6	22.7	20.2	13,800

Notes:

- Tabulated values are based on standard term duration of load and dry service conditions.

Applications

Since initial development in the 1960s, machine graded lumber has been used primarily in engineered wood products. Metal plate-connected wood trusses, wood I-beams, and glued-laminated timber are three examples. Some engineers and architects use machine graded lumber directly in framing applications to take advantage of its higher stiffness and strength properties.

The Cost-Savings Niche

With its more precise grading and daily quality control testing, machine-graded lumber allows the designer to comfortably utilize full design strength to minimize expensive overbuilding. Thus cost savings result by specifying the optimum lumber grades and sizes in a truss for a given span, or in some cases by substituting smaller sizes, such as a 2x8 machine grade for a 2x10 visual grade in direct framing applications.

Growth on the Horizon

The production volume of machine graded lumber has grown by over 50% since 1990, to approximately 1.1 billion board feet in 1997, or about 2% of total North American lumber production. As machine-graded lumber becomes more available, engineers and architects will undoubtedly specify it directly as they find new and innovative uses for the product. With their efficient use of the forest resource, MEL and MSR lumber will evolve in the coming years, extending the use of lumber and adapting to changes in timber design.

Information in this section comes from Wood Design & Building #7 by authors: Helen Griffin, Dave Gromala, Tom Rogers and Ross Theilen

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