---------- U S E S ---------

By this rule the transverse strength of any beam, whether of steel or wood, (I-beam, channels, angles, etc.) can be computed instantly and correctly.

It answers every question having to do with the transverse strength of beams and takes into account the following factors:-

(1). Kind of Material,- (any fiber stress or factor of safety).

(2). Size of Beam,- (in wood from 2" x 2" up to 24" x 30" beams, and in steel from 1 1/2" angles up to a 30" - 200 lb. I-beam).

(3). Length of Span,- (up to 40'0").

(4). Spacing Apart,- (where capacity per square foot of floor area is desired).

(5). Character of Loading and Amount of Load,- (whether uniformly distributed, concentrated, cantilever, fixed beam, etc.).

(6). Number of beams,- (from 1 up to 20).

----- GENERAL DESCRIPTION. -----

Both sides of this slide rule are to all intents and purposes alike, except that one side is used to calculate the strength of wooden beams, while the other side is used for steel. The manner of operation is the same for both and is extremely simple.

On each side of the slide rule four entirely different sets of calculations may be performed (so that it is in reality a combination of eight distinctly different sets of slide-rules). The scales of these slide rules are indicated for convenience in reference by the letters A, B, C, and D, and the four purposes for which each of the scales may be used are as follows:-

1st. When the <u>total load</u> enters into the calculations, use scales A, (for wood) or C, (for steel). In this case the figures in columns A5 and C5 represent total load in pounds.

2nd. When the bending moment enters into the calculations, use scales A or C. In this case the figures in columns A5 and C5 represent the bending moment, in foot pounds.

3rd. When the load in pounds per square foot enters into calculations, use scales B, (for wood) or D, (for steel). In this case the figures in columns B5 and D5 represent load in pounds per square foot of floor area.

4th. When the load per lineal foot of span enters into the calculations, use also scales B and D. In this case the figures in columns B5 and D5 represent load in pounds per lineal foot. In this case a spacing of 1'0" on scales B6 and D6 is always assumed.

Each one of these eight sets of scales is a complete slide rule itself, and each one must therefore be used alone, independent of the other scales. The necessity for this will appear when it is observed that certain figures may stand for different terms dependent upon the set of scales with which these figures are used, as just mentioned above.

The basis for the calculations of strength that may be performed on this slide rule is the generally accepted common theory of flexure, and the slide rule is therefore subject to all the limitations imposed by this theory. The results therefore will not be valid under the following conditions, viz:

1st. When the beams are relatively short.

2nd. When the beams are stressed beyond the elastic limit.

3rd. When the deflections of the beams are relatively large.

It is understood that all beams are braced sideways, so as not to yield by lateral flexure, otherwise special allowance must be made by means of reduced fiber stresses.

-- DIRECTIONS for the USE of SCALES -- A and B for WOODEN BEAMS.

The safe extreme fiber stresses for various kinds of wood are shown on Scales A1, A2, B1, and B2, and are shown for good grade merchantable lumber of good average quality. (See note 2, Appendix, allowable fiber stresses in various cities.)

For second grade lumber or for green lumber these values should be decreased 20 percent.

The safe longitudinal shearing unit stresses should be 1-10th of the extreme fiber stress; (See note 3, Appendix) the modulus of elasticity 1200 times the extreme fiber stress; and the maximum allowable deflection 1-360th of the span, for plastered ceilings, (See Note 4, Appendix) Under these conditions the following three important rules may be laid down as governing all calculations of strength of uniformly loaded wooden beams, supported at both ends, and of any kind of wood:-

Rule 1st. Calculate for horizontal shear when the span is less than 10 times the depth of the beam. (See Note 3, Appendix).

Rule 2nd. Calculate for transverse strength (by means of the WINSLOW strength computing SLIDE-RULE) when span varies from 10 to 20 times the depth of the beam. (See table below).

Rule 3rd. Calculate the stiffness (deflection) when the span is greater than 20 times the depth of the beam. The upper limit 20 will reduce to 15

for beams deflecting 1-480th
of the span. (See note 4,
Appendix).

Rule 2, above, gives the range of usefulness of the WINSLOW strength computing SLIDE-RULE as calculations for transverse strength only may be performed on this rule, and not calculations for shear or deflection except by means of the equivalent fiber stress as given hereafter. (See Note 4, Appendix).

For ready reference these limits (spans from 10 to 20 times the depth of the beam) have been worked out for various depths in the following table:-

Depth of Beam	Span, (10 x depth)	Span, (20 x depth)
2"	1'8"	3'4"
4"	3'4"	6'8"
6"	5'0"	10'0"
8"	6'8"	13'4"
10"	8'4"	16'8"
12"	10'0"	20'0"
14"	11'8"	23'4"
16"	13'4"	26'8"
18"	15'0"	30'0"
20"	16'8"	33'4"
22"	18'4"	36'8"
24"	20'0"	40'0"
26"	21'8"	43'4"
28"	23'4"	46'8"
30"	25'0"	50'0"

Beams having less span than those given by the lower limits (10 x the depth) of this table should be calculated for horizontal shear, and beams having longer spans than those given by the upper limits (20 x the depth) of this table should be calculated for deflection.

***** E X A M P L E S. *****

WOODEN BEAMS

Total Load given.

Example 1. Scales A1 - A8

Find the beam section required when the following terms are given:-

(1). Extreme Fiber stress - 750 lbs. per sq. inch.

(2). Beam to be supported at both ends and properly secured sideways.

(3). Total live and dead load, 9000 lbs. uniformly distributed.

(4). Span - 16'0".

Solution: Slide value "1" for "one" beam on scale A3 opposite to 750 (lbs. per sq. inch fiber stress) on scale A2. Then tighten the thumb screw and slide 9000 (total load in lbs.) on scale A5, opposite to the uniformly loaded beam (relative moment constant 8) on scale A4. Then opposite 16'0" (the span) on scale A6 will be found the answer, viz 12"x 12" (width x depth). on Scale A7.

(Note on Example 1:- The answer requires a 12"x 12" "full size" timber. By glancing at the column (A'7) of "Commercial sizes", we see that a 10"x 14" beam (actually 9 1/2" x 13 1/2") will also carry this load at a span of 16'0" while an 8"x 16" in the same column (A'7) will carry the load safely at a span of 16'6", therefore it would be better to use an 8" x 16", the more especially as the latter contains less lumber in cross-section than either the 12"x 12" or 10"x 14" and comes within the limit in Rule 2).

(Note 2 on example 1:- If for any reason, it is not desired to use a single beam of large section the size of two or more (up to 20) beams required for the same load may be ascertained by sliding the value on Scale A3 for 2 (or more) beams opposite the given fiber stress. The answer will then be the size of each of the 2 (or more) beams required.

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Scales A1 - A8 may also be used for an additional set of calculations, namely, when it is desired to calculate the size of wooden beams when the Bending Moment enters into the calculations. For such cases it must be remembered that the figures on Scale A5 represent the Bending Moment in foot pounds, and not the total load as shown in column heading.

Bending Moment Given.

Example 2. Scales A1 - A8

Find the size of beams required when the Bending Moment of the beam equals 24,000 foot-pounds, and the extreme fiber stress equals 1,200 lbs. per square inch.

Solution: Slide value "1" for "one" beam on Scale A3 opposite to 1,200 (lbs. per sq. inch extreme fiber stress) on Scale A2, then tighten the thumb screw, and slide 24,000 (foot-pounds) on Scale A5 opposite to "B. M." on Scale A4 and the answer will be found on Scale A7 or A'7 invariably opposite to the mark "B. M." on Scale A6. In this case a 10"x 12" "full size" or 12"x 12" "commercial size" will answer.

Floor Load in Pounds per Square Foot given.

Example 3. Scales A1 - A8.

Find the size of joists required when the following terms are given:-

(1). Extreme fiber stress = 750 lbs. per square inch.

(2). Span = 20'0"

(3). Total live and dead load = 75 lbs. per sq. foot of floor.

(4). Spacing of joists = 16 inches, from center to center.

Solution: Slide value "1" for "one" beam on Scale B3 opposite to 750 on Scale B2. Tighten the thumb screw and slide 75 (lbs. per sq. foot.) on Scale B5 opposite to 20'0" (span) on Scale B4. The answer: 3"x 14" ("Commercial Size") joist will be found on Scale B7 nearly opposite the given spacing of 1'4" (16" on Scale B6) and will be the most suitable size for this load and span. Other sizes and spacing of joists may be picked out (either from the "full size" column, B7, or from the "Commercial size" column B'7) as desired without resetting any of the slides, thus 3"x 12" - 12"ct,- 2"x 16" - 14"ct, commercial sizes will also answer the purpose.

Load in Pounds per Lineal Foot of Span given.

Example 4. Scales B1 - B8.

Find the size of timber required to carry 1000 lbs. per lineal foot, when the span is 20'0" and the extreme fiber stress not more than 1600 pounds per square inch.

Solution:

Slide value "1" for "one" beam on Scale B3 opposite to 1600 on Scale B2. Tighten the thumb screw and slide 1000 on Scale B5 opposite to 20'0" on Scale B4. The answer, 12"x 14" "full size" or 10"x 16" "commercial size" will be found on Scales B7 and B'7 respectively nearest opposite to the spacing of 1'0" on Scale B6. When the slide-rule is used for this kind of calculations the figures on Scale B5 represent load per lineal foot of span, provided a 1'0" spacing is assumed on Scale B6.

STEEL BEAMS.

The three corresponding rules for uniformly loaded steel beams, supported at both ends will be as follows:-

Rule 1. Calculate for horizontal shear when the span is less than 6 times the depth of the beam.

Rule 2. Calculate for transverse strength (by means of the WINSLOW strength computing SLIDE-RULE) when the span varies from 6 to 24 times the depth of the beam. (See table below).

Rule 3. Calculate for stiffness (deflection) when the span is greater than 24 times the depth of the beam. See Appendix for rule about reducing fiber stress for longer spans and lighter loads.

The upper limit, 24, will reduce to 18 for beams deflecting 1-480th of the span.

As a general rule all the limits given above will be reduced when the load on the beam is not uniformly distributed.

There will also be a reduction in values of allowable fiber stress and safe loads, for shapes used as beams, due to lateral flexure in beams without lateral support. (See table Appendix Note 5).

Table. (Spans from 6 to 24 times the depth of the beam).

Depth of Beam.	Span = 6 x depth.	Span = 24 x depth.
1"	0'6"	2'0"
1 1/2"	0'9"	3'0"
2"	1'0"	4'0"
2 1/2"	1'3"	5'0"
3"	1'6"	6'0"
3 1/2"	1'9"	7'0"
4"	2'0"	8'0"

Depth of Beam.	Span = 6 x depth.	Span = 24 x depth.
5"	2'6"	10'0"
6"	3'0"	12'0"
7"	3'6"	14'0"
8"	4'0"	16'0"
9"	4'6"	18'0"
10"	5'0"	20'0"
12"	6'0"	24'0"
15"	7'6"	30'0"
18"	9'0"	36'0"
20"	10'0"	40'0"
21"	10'6"	42'0"
24"	12'0"	48'0"
26"	13'0"	52'0"
27"	13'6"	54'0"
28"	14'0"	56'0"
30"	15'0"	60'0"

Total Load given.

Example 5. Scales C1 - C8.

Find the steel beam required when the following terms are given:

(1). Extreme fiber stress = 16,000 lbs. per square inch.

(2). Beam to be supported at both ends and loaded at the center.

(3). Total Load = 12,000 lbs.

(4). Span = 16'0"

Solution: Slide the value "1" for "one" beam on Scale C3 opposite to 16,000 (lbs. per sq. inch extreme fiber stress) on Scale C2. Then tighten the thumb screw and slide 12,000 (total load in pounds) on Scale C5 opposite to a beam supported at both ends and loaded at the center (relative moment constant 4) on Scale C4. Then opposite 16'0" (the span) on Scale C6 will be found the answer, viz: 12" I 31.5 lbs. on Scale C7. as the nearest available size and weight of I-beam.

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Scales C1 - C8 may, in like manner as Scales A1 - A8, be used for Bending Moment calculations. When used in this manner the figures on Scale C5 stand for the Bending Moment in foot pounds and not for the total load as shown in the column heading.

Bending Moment given.

Example 6 Scales C1 - C8.

Find the beam section required for an extreme fiber stress of 16,000 lbs. per sq. inch, and a Bending Moment of 156,000 foot-pounds.

Solution: Slide the value "1" for a single beam on Scale C3 opposite to 16,000 (lbs. per sq. inch extreme fiber stress) on Scale C2. Then tighten the thumb screw and slide 156,000 "foot-pounds" on Scale C5 opposite to "B. M." on Scale C4, and the answer will be found on Scale C7 or C'7 invariably opposite the mark "B. M." on Scale C6. In this case a 20" I 65 lbs. or a 21" I 57.5 lbs. beam will answer.

(Note on Example 6: If it is desired for any reason to use 2 (or more) beams in place of a single beam, the size may be obtained by sliding the value, on Scale C3 for 2 (or more) beams, opposite the given fiber stress. The answer given on Scales C7 and C'7 opposite "B. M." on Scale C6 will be the size of each of the 2 (or more) beams required. In the above example two 15" I 42 lbs. could be used instead of one 20" I 65 lbs. or the 21" I 57.5 lbs.

Load in Pounds per Square Foot given.

Example 7. Scales D1 - D8.

Find the size and spacing of steel beams when the following terms are given:-

(1). Extreme fiber stress = 16,000 lbs. per sq. inch.

(2). Span = 24'0"

(3). Total live and dead load = 167 lbs. per sq. foot of floor.

Solution: Slide the value "1" for "one" beam on Scale D3 opposite to 16,000 on Scale D2. Tighten the thumb screw and slide 167 (lbs. per sq. foot) on Scale D5, opposite to 24'0" (span) on Scale D4. The answer; 12" I 31.5 lbs. 4'0" on centers, will be read off on scales D6 and D7, or a 12" I 40 lbs., 5'0" on centers will also be satisfactory; thus the most practical size and spacing for any given case can be easily picked out without resetting the slides. This feature alone of the WINSLOW strength computing SLIDE-RULE, renders it invaluable as a time saver.

Load in Pounds per Lineal Foot of Span given.

Example 8. Scales D1 - D8.

Find the size of beam required to carry 1000 pounds per lineal foot when the span is 20'0" and the extreme fiber stress 16,000 pounds per square inch.

Solution: Slide value "1" for "one" beam on Scale D3 opposite to 16,000 on Scale D2. Tighten the thumb screw and slide 1000 on Scale D5 opposite to 20'0" on Scale D4. The answer 12" I 35 lbs. will be found on Scale D7 opposite to the spacing of 1'0" on Scale D6. When the slide rule is used for this kind of calculation the figures on Scale D5 represent load per lineal foot of span, provided 1'0" spacing is assumed on Scale D6.

Use of the Section Modulus Scales.

Beams of Any Material and of Any Section whatever, whether shown in the lists given on Scales A7, B7, C7, D7, or not, can be calculated by the WINSLOW strength computing SLIDE-RULE.

For this purpose Scales A8, B8, C8, and D8, the "Section Modulus" scales are incorporated. For such cases, find first the section modulus, note its position on the scale and then use the slide-rule in the usual manner, setting the slide at the proper fiber stress for the specific material used.