

Steel

Given: Fitch beam, 2x12 w/ 11" x 1/4" steel plate
Fitch beam = 19'4" with distributed load.

Required: Determine available distributed load

Assumptions: 2x12 wood is #2 Southern Pine $E = 1,400,000$ psi
11" x 1/4" steel plate ASTM-A36 $E = 29,000,000$ psi

Calculation for 19'-4" = 232" steel plate
Maximum allowable deflection = $232 \div 240 = 0.96$ (max 0.75 = 9)

$$y_{\max} = \frac{5wL^4}{384EI} \quad \left(@ \quad \gamma = \frac{L}{2} \right)$$

$$\gamma = \frac{232}{2} = 116"$$

$$L = 232"$$

$$E = 29,000,000 \text{ psi}$$

$$I = \frac{1}{12}bh^3 = \frac{1}{12}(0.25)(11)^3 = 27.73 \text{ in}^4$$

$$w = \frac{y_{\max}(384EI)}{5L^4}$$

$$w = \frac{(0.75)(384)(29,000,000)(27.73)}{(5)(232)^4}$$

$$w = 15.99 \text{ \#/in} = 191.87 \text{ \#/ft}$$

Calculation for 19'-4" = 232" 2x12 #2 Southern Pine
Max deflection = 1.28" $E = 1,400,000$ psi

$$I = \frac{1}{12}bh^3$$

$$w = \frac{(0.75)(384)(1,400,000)(177.97)}{(5)(232)^4}$$

$$= \frac{1}{12}(1.5)(11.25)^3 = 177.97$$

$$w = 4.95 \text{ \#/in} = 59.44 \text{ \#/ft}$$

Total capacity 2x12 Fitch beam with steel plate 19'-4"

$$15.99 \text{ \#/in} + 2(4.95 \text{ \#/in}) = 25.89 \text{ \#/in}$$

$$191.87 \text{ \#/ft} + 2(59.44 \text{ \#/ft}) = 310.75 \text{ \#/ft}$$

Structural Glue laminated beam From American Institute of Timber

$$3\frac{1}{8}'' \times 12\frac{3}{8}'' \text{ capacity} = 361.7 \text{ \#/LF}$$

$$\boxed{\text{Total Capacity both Fitch \& Lamin.} = 672.45 \text{ \#/LF}}$$

Plywood

Given: Fitch beam, 2ea 2x12 w/1/4" Plywood Plate

Required: Determine available distributed load.

Assumptions: 2x12 wood is #2 Southern Pine $E = 1,400,000 \text{ psi}$
1/4" Plywood with S-2 Grade Stress Level & wood species
#2, $E = 1,500,000 \text{ psi}$
Also Assume the plywood is continuous length

Calculation for 19'-4" = 232" Plywood
Maximum allowable deflection = $232" \div 240 = 0.96$ (max 0.75" = y)

$$y_{\max} = \frac{5wL^4}{384EI} \left(@ x = \frac{L}{2} \right)$$

$$L = 232"$$

$$E = 1,500,000 \text{ psi}$$

$$I = \frac{1}{12} bh^3$$

$$= \left(\frac{1}{12} \right) (0.25) (11)^3$$

$$= 27.73 \text{ in}^4$$

$$w = \frac{y_{\max} 384EI}{5L^4}$$

$$w = \frac{(0.75)(384)(1,500,000)(27.73)}{(5)(232)^4}$$

$$w = 0.83 \text{ \#/in} = 9.96 \text{ \#/ft}$$

Calculation for 19'-4" = 232" #2 Southern Pine

$$E = 1,400,000 \text{ psi}$$

$$I = \left(\frac{1}{12} \right) bh^3$$

$$= \left(\frac{1}{12} \right) (1.5) (11.25)^3$$

$$= 177.97 \text{ in}^4$$

$$w = \frac{(0.75)(384)(1,400,000)(177.97)}{(5)(232)^4}$$

$$w = 4.95 \text{ \#/in} = 59.44 \text{ \#/ft}$$

Total Capacity of Fitch beam with Plywood 19'-4"

$$0.83 \text{ \#/in} + (2 \times 4.95 \text{ \#/in}) = 10.73 \text{ \#/in}$$

$$9.96 \text{ \#/ft} + (2 \times 59.44 \text{ \#/ft}) = 128.84 \text{ \#/ft}$$

Structural Glue Laminated beam from American Institute of Timber

$$3 \frac{3}{8}" \times 12 \frac{3}{8}" \text{ Capacity} = 361.7 \text{ \#/ft}$$

Total Capacity Fitch beam & Laminated beam = 490.5 \#/ft

ALLOWABLE STRESSES FOR PLYWOOD

TABLE 3

ALLOWABLE STRESSES FOR PLYWOOD (psi) conforming to Voluntary Product Standard PS 1-95 for Construction and Industrial Plywood. Stresses are based on normal duration of load, and on common structural applications where panels are 24" or greater in width. For other use conditions, see Section 3.3 for modifications.

Type of Stress		Species Group of Face Ply	Grade Stress Level ⁽¹⁾				
			S-1		S-2		S-3
			Wet	Dry	Wet	Dry	Dry Only
EXTREME FIBER STRESS IN BENDING (F_b)		1	1430	2000	1190	1650	1650
TENSION IN PLANE OF PLYS (F_t)	F_b &	2, 3	980	1400	820	1200	1200
Face Grain Parallel or Perpendicular to Span (At 45° to Face Grain Use 1/6 F_t)	F_t	4	940	1330	780	1110	1110
COMPRESSION IN PLANE OF PLYS		1	970	1640	900	1540	1540
Parallel or Perpendicular to Face Grain (At 45° to Face Grain Use 1/3 F_c)	F_c	2	730	1200	680	1100	1100
		3	610	1060	580	990	990
		4	610	1000	580	950	950
SHEAR THROUGH THE THICKNESS ⁽³⁾		1	155	190	155	190	160
Parallel or Perpendicular to Face Grain (At 45° to Face Grain Use 2 F_v)	F_v	2, 3	120	140	120	140	120
		4	110	130	110	130	115
ROLLING SHEAR (IN THE PLANE OF PLYS)							
Parallel or Perpendicular to Face Grain (At 45° to Face Grain Use 1-1/3 F_s)	F_s	Marine & Structural I	63	75	63	75	—
		All Other ⁽²⁾	44	53	44	53	48
MODULUS OF RIGIDITY (OR SHEAR MODULUS)		1	70,000	90,000	70,000	90,000	82,000
Shear in Plane Perpendicular to Plys (through the thickness) (At 45° to Face Grain Use 4G)	G	2	60,000	75,000	60,000	75,000	68,000
		3	50,000	60,000	50,000	60,000	55,000
		4	45,000	50,000	45,000	50,000	45,000
BEARING (ON FACE)		1	210	340	210	340	340
Perpendicular to Plane of Plys	$F_{c\perp}$	2, 3	135	210	135	210	210
		4	105	160	105	160	160
MODULUS OF ELASTICITY IN BENDING IN PLANE OF PLYS		1	1,500,000	1,800,000	1,500,000	1,800,000	1,800,000
Face Grain Parallel or Perpendicular to Span	E	2	1,300,000	1,500,000	1,300,000	1,500,000	1,500,000
		3	1,100,000	1,200,000	1,100,000	1,200,000	1,200,000
		4	900,000	1,000,000	900,000	1,000,000	1,000,000

(1) See pages 12 and 13 for Guide.

To qualify for stress level S-1, gluelines must be exterior and only veneer grades N, A, and C (natural, not repaired) are allowed in either face or back. For stress level S-2, gluelines must be exterior and veneer grade B, C-Plugged and D are allowed on the face or back.

Stress level S-3 includes all panels with interior or intermediate (IMG) gluelines.

(2) Reduce stresses 25% for 3-layer (4- or 5-ply) panels over 5/8" thick. Such layups are possible under PS 1-95 for APA RATED SHEATHING, APA RATED STURD-I-FLOOR, UNDERLAYMENT, C-C Plugged and C-D Plugged grades over 5/8" through 3/4" thick.

(3) Shear-through-the-thickness stresses for MARINE and SPECIAL EXTERIOR grades may be increased 33%. See Section 3.8.1 for conditions under which stresses for other grades may be increased.

Structural Glued Laminated Timber

ROOF BEAMS

CONSTRUCTION LOAD

F_b	F_v	E	C_D	Deflection limit
2400	270	1.8	1.25	Span / 180
psi	psi	million		for TOTAL LOAD
		psi		

Simple Span Beams
For Preliminary Design Purposes
Lamination thickness: 1.375 in.

BEAM SIZE		BEAM WEIGHT plf	BEAM CAPACITY, UNIFORM LOAD w, plf																							
Width b, in.	Depth d, in.		SPAN, ft																							
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24							
12.5	13.75	4.3	451 D	317 D	231 D	174 D	134 D	105 D	--	--	--	--	--	--	--	--	--	--	--							
3 1/8	5 1/2	5.4	769 B	608 B	451 D	339 D	261 D	205 D	164 D	134 D	110 D	92 D	--	--	--	--	--	--	--							
3 1/8	6 7/8	6.4	1108 B	875 B	709 B	586 D	451 D	355 D	284 D	231 D	190 D	159 D	134 D	114 D	97 D	--	--	--	--							
3 1/8	8 1/4	7.5	1508 B	1191 B	965 B	798 B	670 B	564 D	451 D	367 D	302 D	252 D	212 D	181 D	155 D	134 D	116 D	102 D	90 D							
3 1/8	9 5/8	8.6	1969 B	1556 B	1260 B	1042 B	875 B	746 B	643 B	548 D	451 D	376 D	317 D	270 D	231 D	200 D	174 D	152 D	134 D							
3 1/8	11	9.7	2493 B	1969 B	1595 B	1318 B	1108 B	944 B	814 B	709 B	623 B	536 D	451 D	384 D	329 D	284 D	247 D	216 D	190 D							
3 1/8	12 3/8	10.7	3000 *	2431 B	1969 B	1628 B	1368 B	1165 B	1005 B	875 B	769 B	681 B	608 B	526 D	451 D	390 D	339 D	297 D	261 D							
3 1/8	13 3/4	11.8	3000 *	2942 B	2383 B	1969 B	1655 B	1410 B	1216 B	1059 B	931 B	825 B	735 B	660 B	596 B	519 D	451 D	395 D	348 D							
3 1/8	15 1/8	12.9	3000 *	3000 *	2836 B	2344 B	1969 B	1678 B	1447 B	1260 B	1108 B	981 B	875 B	786 B	709 B	643 B	586 D	513 D	451 D							
3 1/8	16 1/2	14.0	3000 *	3000 *	3000 *	2751 B	2311 B	1969 B	1698 B	1479 B	1300 B	1152 B	1027 B	922 B	832 B	755 B	688 B	629 B	574 D							
5 1/8	5 1/2	7.0	740 D	520 D	379 D	285 D	219 D	172 D	--	--	--	--	--	--	--	--	--	--	--							
5 1/8	6 7/8	8.8	1262 B	997 B	740 D	556 D	428 D	337 D	270 D	219 D	181 D	151 D	--	--	--	--	--	--	--							
5 1/8	8 1/4	10.6	1817 B	1435 B	1163 B	961 D	740 D	582 D	466 D	379 D	312 D	260 D	219 D	186 D	160 D	--	--	--	--							
5 1/8	9 5/8	12.3	2473 B	1954 B	1583 B	1308 B	1099 B	924 D	740 D	602 D	496 D	413 D	348 D	296 D	254 D	219 D	191 D	167 D	147 D							
5 1/8	11	14.1	3230 B	2552 B	2067 B	1708 B	1435 B	1223 B	1055 B	898 D	740 D	617 D	520 D	442 D	379 D	327 D	285 D	249 D	219 D							
5 1/8	12 3/8	15.9	4088 B	3230 B	2616 B	2162 B	1817 B	1548 B	1335 B	1163 B	1022 B	879 D	740 D	629 D	540 D	466 D	405 D	355 D	312 D							
5 1/8	13 3/4	17.6	5047 B	3987 B	3230 B	2669 B	2243 B	1911 B	1648 B	1435 B	1262 B	1118 B	997 B	863 D	740 D	639 D	556 D	487 D	428 D							
5 1/8	15 1/8	19.4	6000 *	4825 B	3908 B	3230 B	2714 B	2312 B	1994 B	1737 B	1527 B	1351 B	1202 B	1075 B	968 B	851 D	740 D	648 D	570 D							
5 1/8	16 1/2	21.1	6000 *	5742 B	4651 B	3844 B	3230 B	2752 B	2373 B	2067 B	1813 B	1601 B	1424 B	1274 B	1147 B	1038 B	944 B	841 D	740 D							
5 1/8	17 7/8	22.9	6000 *	6000 *	5458 B	4511 B	3791 B	3230 B	2785 B	2418 B	2119 B	1871 B	1664 B	1490 B	1341 B	1213 B	1103 B	1007 B	923 B							
5 1/8	19 1/4	24.7	6000 *	6000 *	6000 *	5232 B	4396 B	3746 B	3219 B	2794 B	2448 B	2162 B	1923 B	1721 B	1549 B	1402 B	1274 B	1163 B	1066 B							
5 1/8	20 5/8	26.4	6000 *	6000 *	6000 *	6000 *	5047 B	4287 B	3683 B	3197 B	2801 B	2473 B	2200 B	1969 B	1773 B	1604 B	1458 B	1331 B	1220 B							
5 1/8	22	28.2	6000 *	6000 *	6000 *	6000 *	5729 B	4862 B	4176 B	3626 B	3176 B	2805 B	2495 B	2233 B	2010 B	1819 B	1653 B	1509 B	1383 B							
5 1/8	23 3/8	29.9	6000 *	6000 *	6000 *	6000 *	6000 *	5472 B	4701 B	4081 B	3575 B	3157 B	2808 B	2513 B	2263 B	2047 B	1861 B	1699 B	1557 B							
6 3/4	5 1/2	9.3	975 D	685 D	499 D	375 D	289 D	227 D	--	--	--	--	--	--	--	--	--	--	--							
6 3/4	6 7/8	11.6	1662 B	1313 B	975 D	732 D	564 D	444 D	355 D	289 D	238 D	198 D	--	--	--	--	--	--	--							
6 3/4	8 1/4	13.9	2393 B	1891 B	1531 B	1266 D	975 D	767 D	614 D	499 D	411 D	343 D	289 D	246 D	211 D	--	--	--	--							
6 3/4	9 5/8	16.2	3257 B	2573 B	2084 B	1723 B	1448 B	1218 D	975 D	793 D	653 D	544 D	459 D	390 D	334 D	289 D	251 D	220 D	194 D							
6 3/4	11	18.6	4254 B	3361 B	2723 B	2250 B	1891 B	1611 B	1389 B	1183 D	975 D	813 D	685 D	582 D	499 D	431 D	375 D	328 D	289 D							
6 3/4	12 3/8	20.9	5384 B	4254 B	3446 B	2848 B	2393 B	2039 B	1758 B	1531 B	1344 B	1157 D	975 D	829 D	711 D	614 D	534 D	467 D	411 D							
6 3/4	13 3/4	23.2	6647 B	5252 B	4254 B	3516 B	2954 B	2517 B	2170 B	1884 B	1650 B	1457 B	1296 B	1137 D	975 D	842 D	732 D	641 D	564 D							
6 3/4	15 1/8	25.5	8000 *	6355 B	5147 B	4254 B	3574 B	3042 B	2613 B	2268 B	1987 B	1755 B	1561 B	1397 B	1258 B	1121 D	975 D	853 D	751 D							
6 3/4	16 1/2	27.8	8000 *	7563 B	6126 B	5063 B	4247 B	3604 B	3096 B	2688 B	2355 B	2079 B	1850 B	1655 B	1490 B	1348 B	1226 B	1108 D	975 D							
6 3/4	17 7/8	30.2	8000 *	8000 *	7189 B	5933 B	4964 B	4213 B	3619 B	3142 B	2752 B	2431 B	2162 B	1935 B	1742 B	1576 B	1433 B	1308 B	1199 B							
6 3/4	19 1/4	32.5	8000 *	8000 *	8000 *	6856 B	5736 B	4868 B	4182 B	3630 B	3180 B	2809 B	2498 B	2236 B	2013 B	1821 B	1656 B	1511 B	1385 B							
6 3/4	20 5/8	34.8	8000 *	8000 *	8000 *	7843 B	6562 B	5569 B	4784 B	4153 B	3638 B	3213 B	2858 B	2558 B	2303 B	2083 B	1894 B	1729 B	1585 B							
6 3/4	22	37.1	8000 *	8000 *	8000 *	8000 *	7442 B	6316 B	5425 B	4710 B	4126 B	3644 B	3241 B	2901 B	2611 B	2363 B	2148 B	1961 B	1797 B							
6 3/4	23 3/8	39.4	8000 *	8000 *	8000 *	8000 *	8000 *	7108 B	6106 B	5301 B	4644 B	4101 B	3648 B	3265 B	2939 B	2659 B	2418 B	2207 B	2023 B							
6 3/4	24 3/4	41.8	8000 *	8000 *	8000 *	8000 *	8000 *	7946 B	6826 B	5926 B	5192 B	4585 B	4078 B	3650 B	3286 B	2973 B	2703 B	2467 B	2261 B							
6 3/4	26 1/8	44.1	8000 *	8000 *	8000 *	8000 *	8000 *	8000 *	7585 B	6585 B	5769 B	5095 B	4531 B	4056 B	3651 B	3304 B	3003 B	2742 B	2512 B							

TABLE SPECIFICATIONS: This table applies to straight, simply supported glued laminated timber beams under dry conditions of use. Beams must be laterally supported at the top along the length of the beam and at the top and bottom at the ends. The load carrying capacities tabulated are for total load including the weight of the member.

BEAM WEIGHT: 36.0 pounds per cubic foot was used to determine beam weight per lineal foot shown in the table.

DESIGN VALUE MODIFICATIONS: The allowable stress in bending, F_b , has been adjusted by the AITC volume factor, CV.

For determination of load carrying capacities governed by shear, loads within a distance "d" (the depth of the beam) from the ends have been neglected.

DEFLECTION LIMITS: For roof beams, deflection is limited to span /180 for total load.

CONTROLLING VALUES: Values marked with a D are controlled by deflection, B are bending controlled, and S are shear controlled.

SPAN: Span is defined as the length from centerline to centerline of bearing. This span is the length used in standard engineering equations to calculate deflection, bending and shear.

* The values have been limited to reasonable capacities. Engineering calculations may allow for greater capacities.

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While these capacity tables have been prepared in accordance with recognized engineering principles and are based on the most accurate and reliable technical data available, these tables should not be used or relied upon for any general or specific application without competent professional examination and verification of their accuracy, suitability, and applicability by a licensed professional engineer, designer, or architect.

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