ARCH 324 STRUCTURE II

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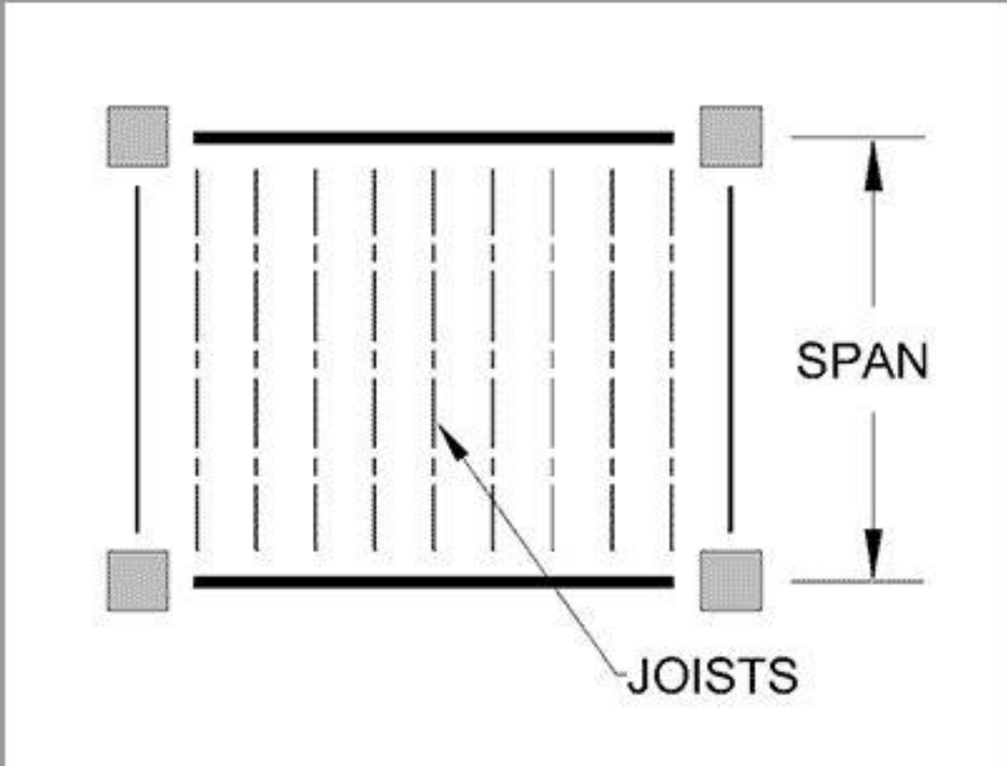
Recitation

2. Wood Beam Design

Design a 2x dimensioned lumber floor joist to carry the given dead + live floor load (neglect joist selfweight). Assume the floor meets conditions of 4.4.1 so CL=1.0. Also Ct, Cfu, and Ci = 1.0. Find the short term deflection of your chosen beam under live load only (100% LL is short term). Compare your LL deflection with the code limit of L/360.

DATASET: 1 -2- -3-

Wood Species	WESTERN CEDARS
Wood Grade	No.1
Span	16 FT
Joist Spacing, o.c.	16 IN
Moisture Content, m.c.	12 %
Floor DL	7 PSF
Floor LL	40 PSF



Design a 2*X dimensional lumber

- **neglect joist self weight**
- Cl=1.00
- Ct=1.00
- Cfu=1.00
- Ci=1.00
- **Wood species: western cedars**
- **Wood grade: NO.1**
- Joist spacing: 16 IN
- Span=16 FT
- MOISTURE CONTENT: M.C.= 12%
- FLOOR LL= 40 PSF
- FLOOR DL= 7 PSF

GIVEN INFORMATION OF THE PROBLEM

STEP 1: FIND MAX SHEAR AND MOMENT

W=DL+LL=7+40=47 PSF

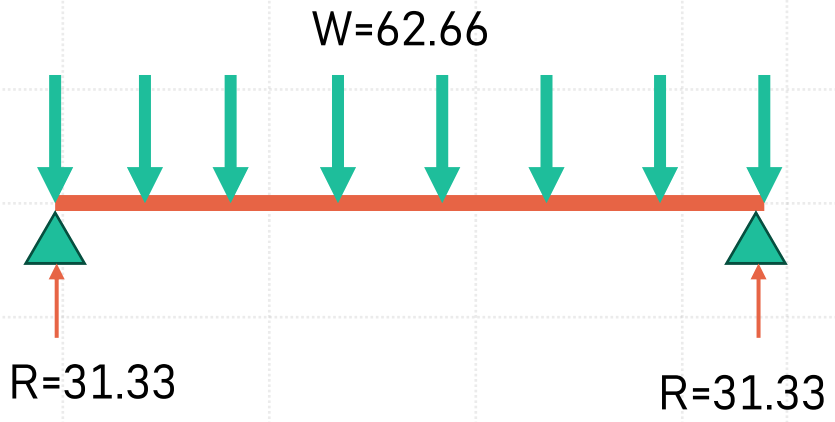
Joist spacing = 16 IN

Span=16 FT

W= 47*16/12= **62.66** PLF

Vmax= 62.66*16/2 =**501.28**

$Mmax = \frac{62.66*16^2}{8}$=**2005.12**



STEP 2: FIND Fv,Fb,G AND E FROM NDS SUPPLEMENT

Table 4A (Cont.) **Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]**

(All species except Southern Pine—see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
WESTERN CEDARS										
Select Structural	2" & wider	1,000	600	155	425	1,000	1,100,000	400,000	0.36	WCLIB WWPA
No. 1	2" & wider	725	425	155	425	825	1,000,000	370,000		
No. 2	2" & wider	700	425	155	425	650	1,000,000	370,000		
No. 3	2" & wider	400	250	155	425	375	900,000	330,000		
Stud	2" & wider	550	325	155	425	400	900,000	330,000		
Construction	2" - 4" wide	800	475	155	425	850	900,000	330,000		
Standard	2" - 4" wide	450	275	155	425	650	800,000	290,000		
Utility	2" - 4" wide	225	125	155	425	425	800,000	290,000		

STEP 3: DETERMINE REQUIRED SECTION MODULUS

TRY1

Assume F'b=Fb=725 psi

$$Sx = \frac{M}{F'b} = \frac{2005.12*12}{725} = 33.18$$ Required

Table 1B Section Properties of Standard Dressed (S4S) Sawn Lumber

Nominal Size b x d	Standard Dressed Size (S4S) b x d in. x in.	Area of Section A in.²	X-X AXIS Section Modulus S_{xx} in.³	X-X AXIS Moment of Inertia I_{xx} in.⁴	Y-Y AXIS Section Modulus S_{yy} in.³	Y-Y AXIS Moment of Inertia I_{yy} in.⁴	Approximate weight in pounds per linear foot (lbs/ft) of piece when density of wood equals: 25 lbs/ft³	30 lbs/ft³	35 lbs/ft³	40 lbs/ft³	45 lbs/ft³	50 lbs/ft³
Dimension Lumber (see NDS 4.1.3.2) and Decking (see NDS 4.1.3.5)												
2 x 3	1-1/2 x 2-1/2	3.750	1.56	1.953	0.938	0.703	0.651	0.781	0.911	1.042	1.172	1.302
2 x 4	1-1/2 x 3-1/2	5.250	3.06	5.359	1.313	0.984	0.911	1.094	1.276	1.458	1.641	1.823
2 x 5	1-1/2 x 4-1/2	6.750	5.06	11.39	1.688	1.266	1.172	1.406	1.641	1.875	2.109	2.344
2 x 6	1-1/2 x 5-1/2	8.250	7.56	20.80	2.063	1.547	1.432	1.719	2.005	2.292	2.578	2.865
2 x 8	1-1/2 x 7-1/4	10.88	13.14	47.63	2.719	2.039	1.888	2.266	2.643	3.021	3.398	3.776
2 x 10	1-1/2 x 9-1/4	13.88	21.39	98.93	3.469	2.602	2.409	2.891	3.372	3.854	4.336	4.818
2 x 12	1-1/2 x 11-1/4	16.88	31.64	178.0	4.219	3.164	2.930	3.516	4.102	4.688	5.273	5.859
2 x 14	1-1/2 x 13-1/4	19.88	43.89	290.8	4.969	3.727	3.451	4.141	4.831	5.521	6.211	6.901

STEP 4: FIND C_D,C_F,C_M FROM NDS SUPPLEMENT

Table 2.3.2 Frequently Used Load Duration Factors, C_D[1]

Load Duration	C_D	Typical Design Loads
Permanent	0.9	Dead Load
Ten years	1.0	Occupancy Live Load
Two months	1.15	Snow Load
Seven days	1.25	Construction Load
Ten minutes	1.6	Wind/Earthquake Load
Impact[2]	2.0	Impact Load

Wet Service Factors, C_M

F_b	F_t	F_v	$F_{c\perp}$	F_c	E and E_{min}
0.85*	1.0	0.97	0.67	0.8**	0.9

* when $F_b \leq 1{,}150$ psi, $C_M = 1.0$

** when $F_c \leq 750$ psi, $C_M = 1.0$

Size Factors, C_F

Grades	Width (depth)	F_b Thickness (breadth) 2" & 3"	F_b Thickness (breadth) 4"	F_t	F_c
Select Structural, No.1 & Btr, No.1, No.2, No.3	2", 3", & 4"	1.5	1.5	1.5	1.15
	5"	1.4	1.4	1.4	1.1
	6"	1.3	1.3	1.3	1.1
	8"	1.2	1.3	1.2	1.05
	10"	1.1	1.2	1.1	1.0
	12"	1.0	1.1	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9
Stud	2", 3", & 4"	1.1	1.1	1.1	1.05
	5" & 6"	1.0	1.0	1.0	1.0
	8" & wider	Use No.3 Grade tabulated design values and size factors			
Construction, Standard	2", 3", & 4"	1.0	1.0	1.0	1.0
Utility	4"	1.0	1.0	1.0	1.0
	2" & 3"	0.4	—	0.4	0.6

STEP 5: RECALCULATE F’b and F’v BASED ON ADJUSTMENT FACTORS

$F'b = Cd \,.\, Cm \,.\, Ct \,.\, Cl \,.\, Cf \,.\, Cfu \,.\, Ci \,.\, Cr \,.\, Fb$

$= 1.15 * 1*1*1* 0.9*1*1*1.15* 725 = 862.93$

$F'v = Cd \,.\, Cm \,.\, Ct \,.\, Ci \,.\, Fv$

$= 1.15 * 0.97*1*1* 155 = 172.9$

Based on provided information:

Cl=1.00
Ct=1.00
Cfu=1.00
Ci=1.00

Repetitive Member Factor, C_r

Bending design values, F_b, for dimension lumber 2" to 4" thick shall be multiplied by the repetitive member factor, $C_r = 1.15$, when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24" on center, are not less than 3 in number and are joined by floor, roof, or other load distributing elements adequate to support the design load.

STEP 6: CALCULATE ACTUAL STRESSES

$$fb = \frac{M}{S} = \frac{2005.12*12}{43.89} = 548.222 \ < 862.93$$

$$fv = \frac{1.5V}{A} = \frac{1.5*501.28}{19.88} = 37.82 \ < 172.9$$

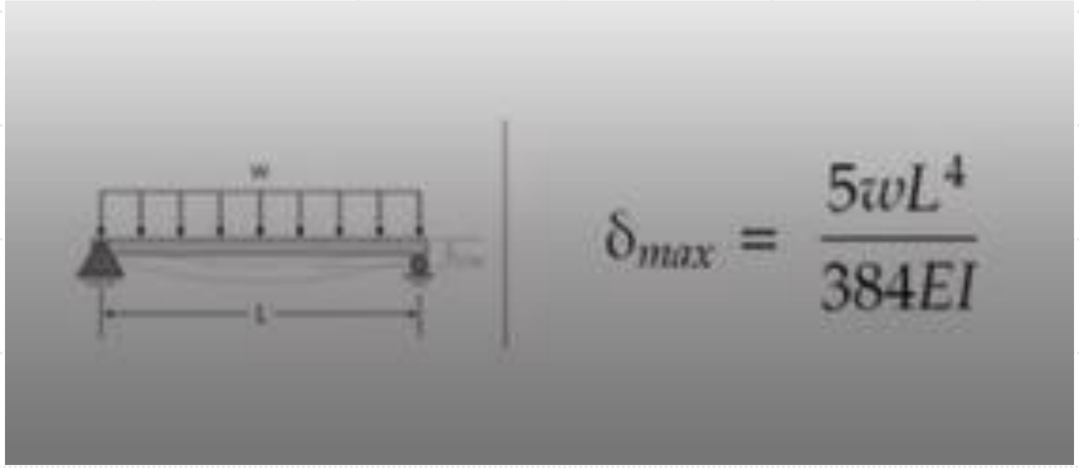
CHECK DEFELECTION

- SHORT TERM DEFELECTION UNDER LIVE LOAD ONLY(100% LL IS SHORT TERM)
- COMPARE LL DEFELECTION WITH CODE LIMIT OF L/360

LIMIT: L/360 = 16*12/360 = 0.533 in

FLOOR LL= 40 PSF
Wl= 40*16/12=53.33*1/12=4.44

$$\Delta pl = \frac{5*4.44*(16*12)^4}{384*1000000*290.8} = 0.027$$



E'= Cm*Ct*Ci*E= 1000000

- Thanks for your attention ☺