

2 Sizer: Beam Mode Tutorial 2 – Determine Capacity of a pre-determined Beam Size (US)

2.1 Software Version and Standard

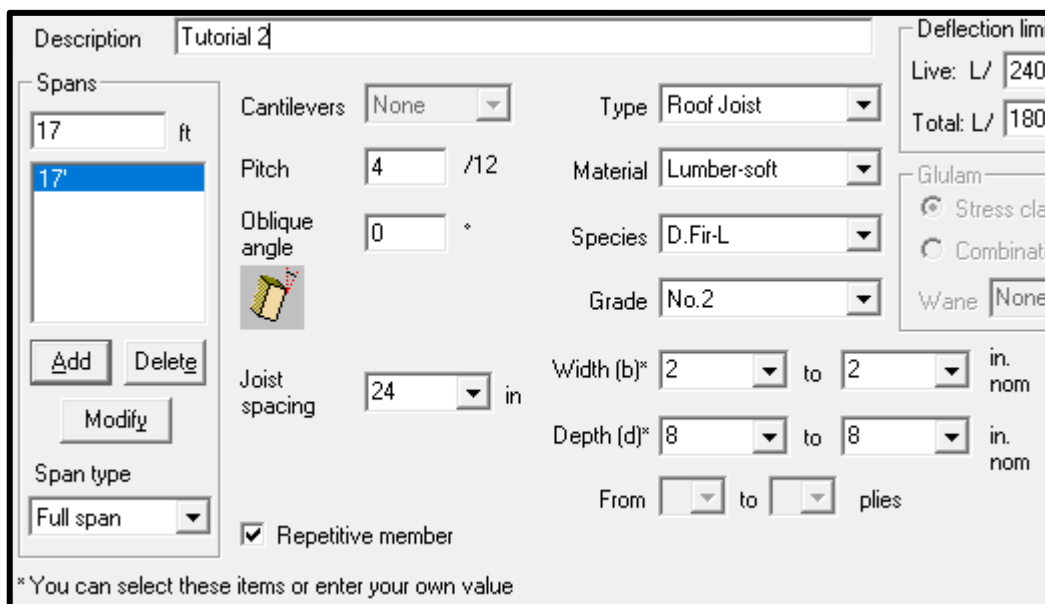
This tutorial was completed using WoodWorks® US 2019, and NDS 2018.

2.2 Introduction

Click [here](#) to download the Sizer file (.wwb) created from going through this tutorial.

2.3 Defining Beam Parameters

1. Click on the **New Beam Mode File** button on the toolbar.
2. Specify **Span** as **17 (ft)**.
3. Click on **Add**.
4. Specify **Full span** from the **Span type** drop-down list.
5. In the **Pitch** field enter a value of **4**.
6. Specify **24 (in.)** from the **Joist spacing** drop-down list.
7. Specify **Roof Joist** from the **Type** drop-down list.
8. Specify **Lumber-soft** from the **Material** drop-down list.
9. Specify **D.Fir-L** from the **Species** drop-down list.
10. Specify **No.2** from the **Grade** drop-down list.
11. Specify **2 (in)** from the **Width (b)** drop-down list.
12. Specify **8 (in)** from the **Depth (d)** drop-down list.



The screenshot displays the 'Sizer' software interface for 'Tutorial 2'. The 'Spans' list on the left contains '17' ft and '17'' (selected). The 'Span type' is set to 'Full span'. The 'Cantilevers' are set to 'None'. The 'Pitch' is '4 /12'. The 'Oblique angle' is '0 °'. The 'Joist spacing' is '24' in. The 'Type' is 'Roof Joist'. The 'Material' is 'Lumber-soft'. The 'Species' is 'D.Fir-L'. The 'Grade' is 'No.2'. The 'Width (b)*' is '2' in. The 'Depth (d)*' is '8' in. The 'From' and 'to' fields for width and depth are both set to '2'. The 'Repetitive member' checkbox is checked. The 'Deflection limit' section shows 'Live: L/ 240' and 'Total: L/ 180'. The 'Glulam' section has 'Stress cla' selected. The 'Wane' is set to 'None'. A note at the bottom states: '* You can select these items or enter your own value'.

Figure 1: Sizer: Beam Mode – Tutorial 2 – Defining Length and Materials of Beam

13. Under the **Supports for bearing and notch design** section, select **All supports** from the **Applies to** drop-down list.
14. Specify **Wall** from the **Type** drop-down list.
15. Specify **Lumber stud** from the **Material** drop-down list.
16. Specify **D.Fir-L** from the **Species** drop-down list.
17. Specify **No.2** from the **Grade** drop-down list.
18. Specify **3-1/2 (in)** from the **Bearing length*** drop-down list.
19. Specify **Same as joist** from the **Bearing width*** drop-down list.

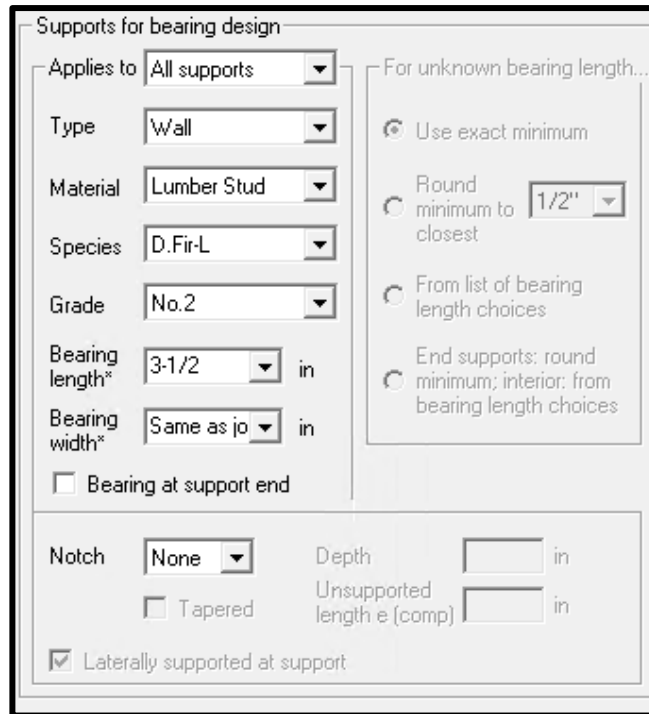


Figure 2: Sizer: Beam Mode – Tutorial 2 – Specifying Bearing Length Details

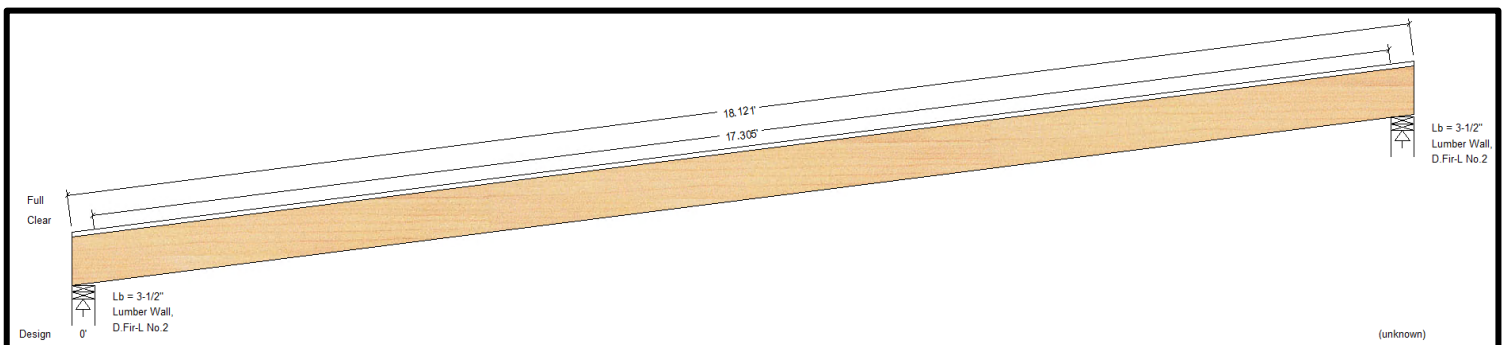


Figure 3: Sizer: Beam Mode – Tutorial 2 – Beam Diagram

2.4 Loading the Beam

1. Click on the **Loads View** button on the toolbar.
2. Select **Dead** from the **Type** drop-down list.
3. Specify **Full Uniform Area** from the **Distribution** drop-down list.
4. In the **Magnitude** field enter a value of **10 (psf)**.
5. Click **Add**.
6. Select **Snow** from the **Type** drop-down list.
7. Specify **Full Uniform Area** from the **Distribution** drop-down list.
8. In the **Magnitude** field enter a value of **20 (psf)**.
9. Click **Add**.

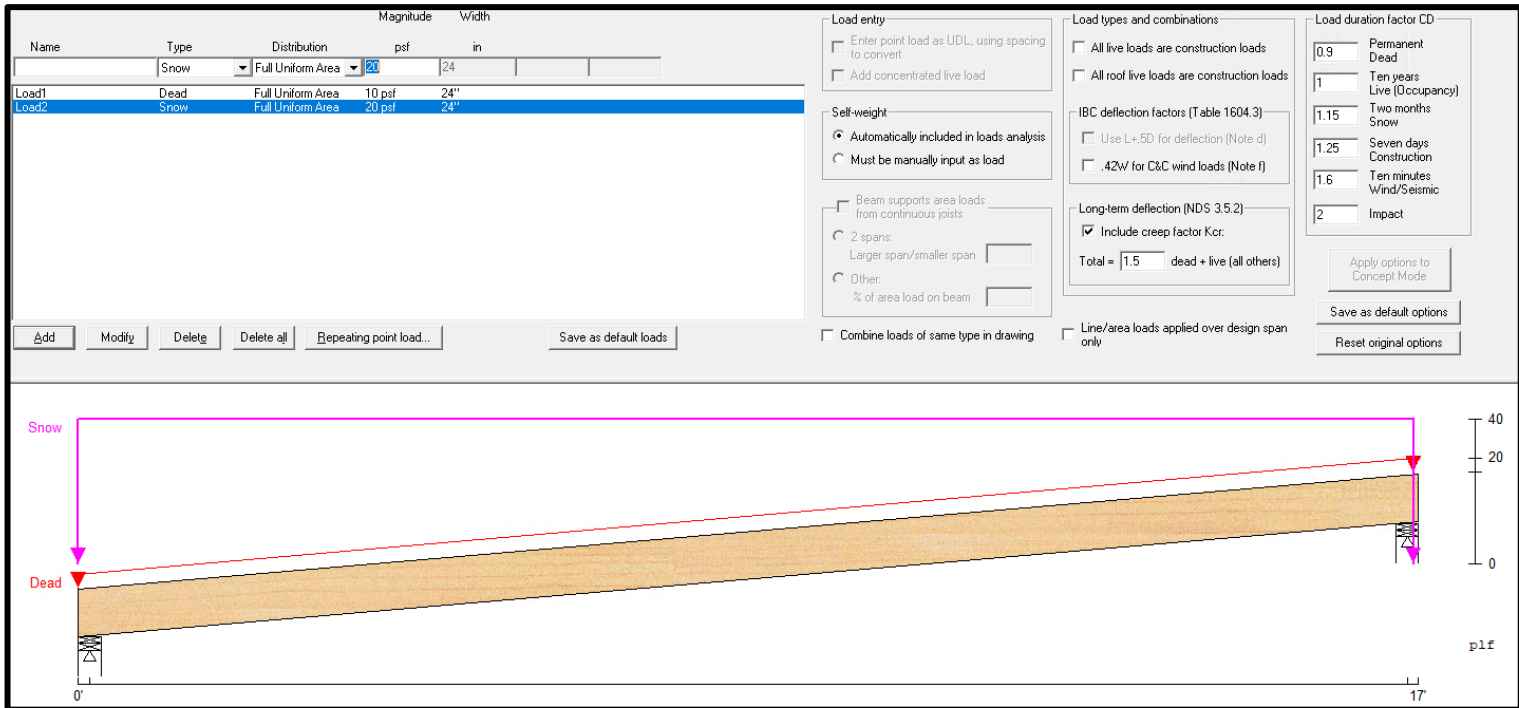


Figure 4: Sizer: Beam Mode – Tutorial 2 – Loaded Beam

2.5 Designing the Beam

1. Click the **Run** button on the toolbar. *Sizer* automatically designs the member.

Note: *Sizer* will prompt you to save the project file.

Sizer will complete the design, and will automatically generate the **Design Summary, Analysis Results,** and **Analysis Diagrams.** These buttons are displayed on the toolbar.



Figure 5: *Sizer: Beam Mode – Tutorial 1 – Beam Design*

2.6 Designing the Beam

The **Design Check Calculation Sheet** will appear and summarizes the loads, maximum reactions, bearing resistances, bearing lengths, force vs. resistance and deflection information, additional data and most importantly if the section passes or fails the design.

Note: The selected section **fails in bending and deflection** as it cannot resist the applied load.

Click [here](#) to download a PDF of the design check calculation sheet.

Click [here](#) to download a PDF of the analysis results.

Click [here](#) to download a PDF of the analysis diagrams.

| Tutorial 2 | | | | | | | | | | | | |
|---|----------------|--------------|------|-----------------|-------|-------|-----|------|------|------|------|-----|
| Lumber-soft, D.Fir-L, No.2, 2x8 (1-1/2"x7-1/4") | | | | | | | | | | | | |
| Supports: All - Lumber Stud Wall, D.Fir-L No.2 | | | | | | | | | | | | |
| Roof joist spaced at 24.0" c/c; Total length: 18.12'; Clear span: 17.305'; volume = 1.4 cu.ft.; Pitch: 4/12 | | | | | | | | | | | | |
| Lateral support: top= continuous, bottom= at supports; Repetitive factor: applied where permitted (refer to online help); | | | | | | | | | | | | |
| This section FAILS the design check | | | | | | | | | | | | |
| WARNING: This section violates the following design criteria: Bending and deflection | | | | | | | | | | | | |
| Analysis vs. Allowable Stress and Deflection using NDS 2015 : | | | | | | | | | | | | |
| Criterion | Analysis Value | Design Value | Unit | Analysis/Design | | | | | | | | |
| Shear | fv = 64 | Fv' = 207 | psi | fv/Fv' = 0.31 | | | | | | | | |
| Bending(+) | fb = 1974 | Fb' = 1428 | psi | fb/Fb' = 1.38 | | | | | | | | |
| Live Defl'n | 0.96 = L/216 | 0.87 = L/240 | in | 1.11 | | | | | | | | |
| Total Defl'n | 1.82 = L/114 | 1.16 = L/180 | in | 1.58 | | | | | | | | |
| Additional Data: | | | | | | | | | | | | |
| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 1.000 | 1.200 | - | 1.15 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | 1.00 | - | 2 |
| CRITICAL LOAD COMBINATIONS: | | | | | | | | | | | | |
| Shear : LC #2 = D+S, V max = 498, V design = 462 lbs | | | | | | | | | | | | |
| Bending(+): LC #2 = D+S, M = 2161 lbs-ft | | | | | | | | | | | | |
| Deflection: LC #2 = D+S (live) | | | | | | | | | | | | |
| LC #2 = D+S (total) | | | | | | | | | | | | |
| D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake | | | | | | | | | | | | |
| All LC's are listed in the Analysis output | | | | | | | | | | | | |
| Load combinations: ASCE 7-10 / IBC 2015 | | | | | | | | | | | | |
| CALCULATIONS: | | | | | | | | | | | | |
| Deflection: EI = 76.21 lb-in ² | | | | | | | | | | | | |
| "Live" deflection is due to all non-dead loads (live, wind, snow...) | | | | | | | | | | | | |
| Total deflection = 1.5 dead + "live" | | | | | | | | | | | | |
| Bearing: Allowable bearing at an angle F'theta calculated for each support as per NDS 3.10.3 | | | | | | | | | | | | |

Figure 6: Sizer: Beam Mode – Tutorial 2 – Design Check Calculation Sheet (Fail)

2.7 Modify Beam Parameters to Ensure a Suitable Section

1. Increase *Depth (d)* to 10 (in).

Tutorial 2
Lumber-soft, D.Fir-L, No.2, 2x10 (1-1/2"x9-1/4")
 Supports: All - Lumber Stud Wall, D.Fir-L No.2
 Roof joist spaced at 24.0" c/c; Total length: 18.18'; Clear span: 17.305'; volume = 1.8 cu.ft.; Pitch: 4/12
 Lateral support: top= continuous, bottom= at supports; Repetitive factor: applied where permitted (refer to online help);

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|--------------|----------------|----------------|------|-------------------|
| Shear | $f_v = 49$ | $F_v' = 207$ | psi | $f_v/F_v' = 0.24$ |
| Bending(+) | $f_b = 1227$ | $F_b' = 1309$ | psi | $f_b/F_b' = 0.94$ |
| Live Defl'n | $0.46 = L/448$ | $0.87 = L/240$ | in | 0.53 |
| Total Defl'n | $0.89 = L/233$ | $1.16 = L/180$ | in | 0.77 |

Additional Data:

| FACTORS: | F/E (psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrr | Ci | Cn | LC# |
|----------|--------------|------|------|------|-------|-------|-----|------|------|------|------|-----|
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 1.000 | 1.100 | - | 1.15 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
 Shear : LC #2 = D+S, V max = 504, V design = 458 lbs
 Bending(+): LC #2 = D+S, M = 2187 lbs-ft
 Deflection: LC #2 = D+S (live)
 LC #2 = D+S (total)

D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:
 Deflection: $EI = 158.29 \text{ lb-in}^2$
 "Live" deflection is due to all non-dead loads (live, wind, snow...)
 Total deflection = 1.5 dead + "live"
 Bearing: Allowable bearing at an angle $F'\theta$ calculated for each support
 as per NDS 3.10.3

Figure 7: Sizer: Beam Mode – Tutorial 2 – Design Check Calculation Sheet (Alternative 1)

2. Decrease *Joist spacing* to **12 (in)**.

Tutorial 2
Lumber-soft, D.Fir-L, No.2, 2x8 (1-1/2"x7-1/4")
 Supports: All - Lumber Stud Wall, D.Fir-L No.2
 Roof joist spaced at 12.0" c/c; Total length: 18.12'; Clear span: 17.305'; volume = 1.4 cu.ft.; Pitch: 4/12
 Lateral support: top= continuous bottom= at supports: Repetitive factor: applied where permitted (refer to online help);

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|--------------|----------------|--------------|------|-----------------|
| Shear | fv = 33 | Fv' = 207 | psi | fv/Fv' = 0.16 |
| Bending(+) | fb = 1029 | Fb' = 1428 | psi | fb/Fb' = 0.72 |
| Live Defl'n | 0.48 = L/432 | 0.87 = L/240 | in | 0.55 |
| Total Defl'n | 0.96 = L/216 | 1.16 = L/180 | in | 0.83 |

Additional Data:

| FACTORS: | F/E (psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cf _{rt} | Ci | Cn | LC# |
|--------------------|--------------|------|------|------|-------|-------|-----|------|------------------|------|------|-----|
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 1.000 | 1.200 | - | 1.15 | 1.00 | 1.00 | - | 2 |
| F _{cp} ' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| E _{min} ' | 0.58 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
 Shear : LC #2 = D+S, V max = 260, V design = 241 lbs
 Bending(+): LC #2 = D+S, M = 1126 lbs-ft
 Deflection: LC #2 = D+S (live)
 LC #2 = D+S (total)

D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:
 Deflection: EI = 76.21 lb-in²
 "Live" deflection is due to all non-dead loads (live, wind, snow...)
 Total deflection = 1.5 dead + "live"
 Bearing: Allowable bearing at an angle F'_{theta} calculated for each support
 as per NDS 3.10.3

Figure 8: Sizer: Beam Mode – Tutorial 2 – Design Check Calculation Sheet (Alternative 2)