Formwork Design Tables

Based on the principles outlined so far, safe spans for many timber and plywood formwork components have been calculated and arranged in tables for use by formwork designer.

- The tables cover single span beams, two-span beams, and beams continuous over three or more spans carrying a uniform distributed load.
- The tables can be used to develop a preliminary design for cases where rigorous structural analysis is required for formwork design.
Formwork Design Tables

- Four sets of allowable (adjusted) stresses are included in the tables.
  - Adjusted stresses for long term and short term loading stresses for formwork made of No. 2 grade Southern Pine and Douglas Fir-Larch.
  - Adjusted stresses for both short term and long term loading of No. 2 Spruce-Pine-Fir and No. 2 Hem-Fir.
- Table 7-1 shows the expressions which are used to calculate the safe support spacings (spans).

### Table 7-1: Expressions Used in Calculating the Safe Support Spacings of Chapter 7 Design Tables

<table>
<thead>
<tr>
<th>CRITERION</th>
<th>SINGLE SPAN BEAM</th>
<th>TWO SPAN BEAM</th>
<th>THREE OR MORE SPANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_{\text{min}} = \frac{1}{400}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
</tr>
<tr>
<td>$\lambda_{\text{min}} = \frac{1}{500}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
<td>$\frac{4}{3} \frac{EI}{w}$</td>
</tr>
<tr>
<td>$\lambda_{\text{max}} = 1/16$ in.</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
</tr>
<tr>
<td>$\lambda_{\text{max}} = 1/8$ in.</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
</tr>
<tr>
<td>$\lambda_{\text{max}} = 1/4$ in.</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
<td>$\frac{3}{4} \frac{EI}{w}$</td>
</tr>
<tr>
<td>BENDING</td>
<td>$\frac{8}{3} \frac{FS}{w}$</td>
<td>$\frac{8}{3} \frac{FS}{w}$</td>
<td>$\frac{8}{3} \frac{FS}{w}$</td>
</tr>
<tr>
<td>HORIZONTAL SHEAR</td>
<td>$16F_g \frac{h}{w} + 5d$</td>
<td>$19.2F_g \frac{h}{w} + 5d$</td>
<td>$19.8F_g \frac{h}{w} + 5d$</td>
</tr>
<tr>
<td>ROLLING SHEAR, PLYWOOD</td>
<td>$24F_s \frac{h}{w}$</td>
<td>$24F_s \frac{h}{w}$</td>
<td>$24F_s \frac{h}{w}$</td>
</tr>
</tbody>
</table>

- $l = \text{spacing of supports, in.}$
- $w = \text{load, lb per linear ft.}$
- $S = \text{section modulus, in.}^3$
- $F = \text{module of elasticity, psi}$
- $F_s = \text{allowable horizontal shear, psi}$
- $F_g = \text{allowable bending stress, psi}$
- $I = \text{moment of inertia, in.}^4$
- $b = \text{width of section, in.}$
- $h = \text{rolling shear constant, in.}^3$
- $F_s' = \text{allowable rolling shear stress, psi}$
- $Q = \text{need to be determined}$
- $\lambda = \text{drift factor}$
Formwork Design Tables

- The tables are in four groups:
  - Table 7-2 through 7-4 for plywood sheathing
  - Tables 7-5 through 7-7 for joists, studs, stringers or any other beam components of the formwork where framing members are used singly
  - Tables 7-8 through 7-10 for wales or other formwork components where the members are used double
  - Table 7-11 and 7-12 for shore loading and bearing checks

- Nominal lumber sizes are shown in the tables.
- All calculations are based on lumber finished on all four surfaces (S4S).
- Actual thicknesses are shown for plywood.
- In each table, it is shown whether the safe span is controlled by bending, deflection of shear.
Formwork Design Tables

Sheathing Design: Tables 7-2—7-4

- Tables 7-2, 7-3, and 7-4 were calculated for both long term and short term loading using the information from Table 4-2, for face grain parallel and perpendicular to direction of the span.
- Tables 7-2 through 7-4 are applicable to plywood sheathing for columns, slabs, and walls.
- They cover plywood supports as a single span beam, two span beam, or a beam continuous over three or more spans.
- Theoretical deflection of spans in these tables do not exceed $1/16$ in.

Joists, Studs, Beams: Tables 7-5—7-7

- Tables 7-5, 7-6, and 7-7 are applicable to joists, studs, or any other form members loaded uniformly as a beam.
- Tables 7-5.1 through 7-5.4 are beams continuous over three or more spans with the following adjusted (allowable) stresses:

<table>
<thead>
<tr>
<th>Bending, $F'_{b}$</th>
<th>Horizontal shear, $F'_{s}$</th>
<th>Modulus of elasticity, $E'$</th>
<th>Use for No. 2 lumber of indicated species</th>
</tr>
</thead>
<tbody>
<tr>
<td>960 to 1440 psi</td>
<td>180 psi</td>
<td>1,600,000 psi</td>
<td>Southern Pine and Douglas Fir-Larch</td>
</tr>
<tr>
<td>1200 to 1610 psi</td>
<td>225 psi</td>
<td>1,600,000 psi</td>
<td></td>
</tr>
<tr>
<td>940 to 1400 psi</td>
<td>140 psi</td>
<td>1,300,000 psi</td>
<td>Spruce-Pine-Fir and Hem-Fir</td>
</tr>
<tr>
<td>1170 to 1750 psi</td>
<td>175 psi</td>
<td>1,300,000 psi</td>
<td></td>
</tr>
</tbody>
</table>
Formwork Design Tables

- Joists, Studs, Beams: Tables 7-5—7-7
  - Tables 7-6 and 7-7 are like Table 7-5, except that span length are calculated for simply supported and two-span rather than continuous beams.
  - Note: Beam sizes are given in conventional fashion with $b$ or the width of beam face to which load is applied given first and the second number indicating depth of beam or $d$.
  - 2x4 (nominal size)
  - 4x2 (nominal)

- Double Members: Tables 7-8—7-10
  - Tables 7-8, 7-9 and 7-10 are similar to Tables 7-5, 7-6, and 7-7 in terms of allowable (adjusted) stresses and general layout, but they cover double members which are commonly used for wales and frequently for stringers.
  - Spans are calculated on the basis of these members side by side with their longer dimension as the depth of the beam.
Formwork Design Tables

- **Wood Shores**: Tables 7-11—7-12
  - Table 7-11 shows allowable loads on wood shores for some of the more commonly used timber sizes, with base value of compression parallel to the grain $F_c$ ranging from 1100 to 1600 psi, with modulus of elasticity values from 1,200,000 psi to 1,600,000 psi.
  - Table 7-11 shows no load when $l/d$ exceeds the recommended limit of 50.

**EXAMPLE**

Flat Slab

- Use the design table to make a preliminary selection of a stringer, joist, and sheathing combination suitable for forming a flat slab with dead plus live load of 200 psf supported on shores spaced 4 ft on centers in both directions. Assume that No. 2 Douglas-Fir Larch is selected for multiple-use forms.
Formwork Design Table - EXAMPLE
Flat Slab

- From Table 4-2, the base stress values are:
  - \( F_b = 900 \text{ psi} \)
  - \( F_v = 180 \text{ psi} \)
  - \( E = 1,600,000 \text{ psi} \)

- As explained above, Tables 7-5.1, 7-6.1, and 7-7.1 are developed with adjusted stresses that can be applied for No. 2 Douglas Fir-Larch or Southern Pine, under long term loads, with conditions as stated.

Formwork Design Tables - EXAMPLE
Flat Slab

- **STRINGERS**
  - With shores placed 4 ft on centers both ways, the stringers will be 4 ft apart and have a span of 4 ft between supports.
  - They will be designed as continuous beams with an equivalent uniform load equal to the distance between stringers times the uniform load on the formwork (psf):
    \[
    4 \text{ ft} \times 200 \text{ psf} = 800 \text{ lb/lf}
    \]
  - Use Table 7-5.1, since the stringers will be continuous over three or more spans. Enter the table at the left on the 800 lb/lf load line.
### Formwork Design Table 7-5.1

**TABLE 7-5.1: SAFE SPACING, IN., OF SUPPORTS FOR JOISTS, STUDS OR OTHER BEAM COMPONENTS OF FORMWORK, CONTINUOUS OVER THREE OR MORE SPANS**

<table>
<thead>
<tr>
<th>Uniform load, ( f_{u} ), ( \text{psf} )</th>
<th>( f ) by ( E = 1,800,000 \text{ psi} )</th>
<th>( f ) by ( E = 160 \text{ psi} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 10 )</td>
<td>( 13 )</td>
<td>( 13 )</td>
</tr>
<tr>
<td>( 15 )</td>
<td>( 15 )</td>
<td>( 15 )</td>
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<tr>
<td>( 20 )</td>
<td>( 20 )</td>
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<td>( 55 )</td>
<td>( 55 )</td>
<td>( 55 )</td>
</tr>
<tr>
<td>( 60 )</td>
<td>( 60 )</td>
<td>( 60 )</td>
</tr>
</tbody>
</table>

### Formwork Design Tables - EXAMPLE

**Flat Slab**

- **STRINGERS (Cont'd)**

  - Note which members can be used for stringers having a 48-in. span. Among the smaller members that are suitable are:
    - 2x10 ⇒ Allowable span 56”
    - 3x8 ⇒ Allowable span 60”
    - 4x6 ⇒ Allowable span 56”

  - The 2x10 provides the necessary span with the least lumber.

  *(But check with local suppliers for availability)*
Formwork Design Tables - EXAMPLE

**Flat Slab**

- **SHEATHING**
  - Shore spacing places the stringers 4 feet apart, and this 4 feet then is the *span* of the joists. How joists are spaced depends on requirements of the sheathing.
  - Assume 3/4-in. Plywood Class I or equal quality plywood is used with its face running in the direction of the span.
  - Since sheathing is continuous over several spans, refer to Table 7-2.
  - The right side of the table, with $F''_V = 1545$ psi, applies since this is a multiple-use form.

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**Formwork Design Table 7-2**

**TABLE 7-2: SAFE SPACING IN INCHES OF SUPPORTS FOR PLYWOOD SHEATHING, CONTINUOUS OVER FOUR OR MORE SUPPORTS**

**NOTES:** Allow 1½ in. deflection control span. Select clear span, not deflection control span. Not suitable for columns, piers, or walls. Use 3/4-in. minimum grade 2A plywood for columns. 7/8-in. minimum grade 1A plywood for walls. Sheathing to be continuous over supports, spaced not more than 10 ft apart. Joist spacing determined by span and deflection requirements of sheathing. Sheathing to be continuous over supports, spaced not more than 10 ft apart. Joist spacing determined by span and deflection requirements of sheathing.
Temporary Structures

Formwork Design Table

Formwork Design Tables - EXAMPLE
Flat Slab

- SHEATHING (Cont’d)
  - From the column for 3/4-in. thickness with face grain parallel to the span, for load of 200 psf, read the allowable span of 19 in.
  - In order to use 4x8 sheets of plywood efficiently, a span of 96 ÷ 5 or 19.2 in. probably will be used, dividing each 8-ft. piece of plywood into five equal spans, while permitting edge support for the plywood panels.

- JOISTS
  - This 19.2 in. becomes the required joist spacing, and joist span has already been fixed at 4-feet.
  - What is the required joist size?
    - Joist loading = Joist spacing (feet) x Load on forms
      \[ (19.2 \div 12) \times 200 = 320 \text{ lb/lf} \]
  - Again using Table 7-5.1 since joists are continuous over several spans, note that a 2x6 loaded at 300 lb/lf has an allowable span of 59 inches and at 400 lb/lf has an allowable span of 51 inches.
Formwork Design Tables – EXAMPLE: Flat Slab

- **JOISTS (Cont'd)**
  - By inspection, the 2x6 appears to be the lightest joist that would be satisfactory on a 48-in. span.
  - But also consider the 4x4 which has an allowable span of 54 in. at 400 lb/lf. The 4x4 is often selected for this type of form, because its shape provides inherent lateral stability.

- **Bearing**
  - A check of bearing stresses where joists rest on stringers and where stringers rest on shores would be advisable.
Formwork Design Tables - EXAMPLE Wall Forms

- Use the tables to determine spacing of wall form members, assuming continuous reuse of the forms and No. 2 grade Douglas Fir-Larch or equal lumber, with sheathing of plywood. Design a 10-feet high wall form for a maximum lateral pressure of 600 psf, assuming no reduction of pressure near the top of the form.

Formwork Design Tables - EXAMPLE Wall Forms

- SHEATHING
  - Assuming that 1-inch plywood is used with face grain vertical, the grain will be perpendicular to the span between the studs, and plywood will be continuous across several spans.
  - The right side of Table 7-2 applies because the lower stress levels are recommended when forms are designed for continuing reuse, and the far right column applies because the face grain is perpendicular to the span.
  - Entering the table at 600 psf level, we find span of 13 in.
  - It is decided to set the studs 12 inches O.C. so that they can be uniformly spaced and also support plywood at the panel edges.
Formwork Design Tables - EXAMPLE Wall Forms

**STUDS**
- With the studs 12 in. apart, the load per lineal foot is 
  \[ \frac{12}{12} \times (600) \text{ or } 600 \text{ lb per ft} \]
- Assuming that the studs are continuous over three or more spans, refer to Table 7-5.1 for choice of span and member.
- Entering table at left on the 600 lb/lf load line, the 3x4 stud has an allowable span of 37 inches.
- Support for studs (wale or ties) would be needed at about 3-feet intervals.
- Placing top and bottom wales 6 inches above bottom of form and 6 inches below top of form would permit use of four wales spaced 3 feet apart.

**WALES**
- If double wales are spaced feet apart, the equivalent uniform load per lineal foot is 
  \[ \frac{36}{12} \times (600) = 1800 \text{ lb per ft} \]
- Assuming continuity of wales, the left side of Table 7-8.1 would be used to determine spacing of wale supports.
- Entering the table from left on the 1800 lb/lf load line, a convenient span and double member combination may be chosen from the left side of the table where adjusted bending stresses are applicable for long term loading of Douglas fir-Larch of Southern Pine.
Wall Forms

- **WALES (Cont’d)**
  - For example, if double 2x6 wales are used the spacing between ties that support the wales can be a maximum of 33 inches.
  - A check of the load capacity of available ties might help in confirming the wale selection.
  - If the double 2x6 were used with supporting ties spaced at 33 inches, the average tie load would be $33/12 \times 36/12 \times 600 = 4950$ lb
  - A tie with a safe working load of 5000 lb should be selected.
  - With a tie spacing of 24 inches, the necessary tie capacity will be 3600 lb. [24/12 x 36/12 x 600 = 3600 lb]

Questions?

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