Design of Steel Deck for Concentrated and Non-Uniform Loading

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Polling Question

- New requirement to earn PDH credits
- Two questions will be asked during the duration of today’s presentation
- The question will appear within the polling section of your GoToWebinar Control Panel to respond
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Learning Objectives

- Recognize load cases that require additional analysis beyond distribution as a uniform load.
- Understand the limit states for design under concentrated loads.
- Examine different load paths for varying concentrated load conditions.
- Review current and NEW SDI design methodology for concentrated and cluster loads.
- Demonstrate potential shortcuts to concentrated load design.
- Present example problems for design with concentrated loads.
Presentation Outline

- Identify Typical Deck Types
- Introduction to Concentrated Load Types
- Roof Deck Limit States and Design Example
- Floor Deck Limit States and Current Design Methodology
- Composite Deck Design Examples – Shortcuts for Multiple Loads
- Form Deck and Steel Fibers
Deck Types

Roof Deck
- Permanent Structural Member
- No Concrete Topping

Composite Deck
- Deck and Concrete Work Together
- Embossments – Composite Action

Form Deck
- Deck is Permanent Form
- Deck Often Carries Slab Weight
Concentrated Loads on Roof Deck

Safety Anchors

Roof Drains

Suspended Loads

Solar Panels
Concentrated Loads on Roof Deck

- People
- Dollies
- Pallets
- Tool Chests
- Roofing Machinery
Concentrated Loads on Floor Deck

*Storage Racks*
Concentrated Loads on Floor Deck

Wall Loads

Parallel

Transverse
Concentrated Loads on Floor Deck

*Equipment Loads*
Available at www.sdi.org
Roof Deck Design Limit States

- Shear
- Bending
- Bending/Shear Interaction
- Web Crippling
- Deflection
Roof Deck – Transverse Distribution

Based on 1 ½” Deck...

\[ L = \text{Span} \quad X = \% \text{ of Span} \]

For \( X \leq 0.25 \)
\[ b_e = B + 6 \geq 12 \]

For \( 0.25 < X \leq 0.50 \)
\[ b_e = B + 18 - \frac{3}{X} \geq 24 - \frac{3}{X} \]

Where:

\( B = \) load footprint width transverse to the deck span. When the load centroid is not at the center of the footprint, let \( B \) equal twice the least dimension from the centroid to the baseplate edge; inches.

\( b_e = \) effective distribution width; inches

\( X = \) percentage of span, measured from the nearest support to the center of the concentrated load, \( \leq 0.50 \)
Roof Deck Design Example

Example 7 From RDDM...

**Given:** Select a WR deck to support the roof load condition below. Use an ASD solution. Combine loads using ASCE 7-10.

1. Uniform Dead Load = 10 psf
2. Uniform Live Load = 20 psf
3. Concentrated Dead Load = 700 lbs on baseplate
   - Baseplate size is 24 inches parallel to deck span and 30 inches perpendicular to deck span
   - Deck End Bearing Length = 1.5 inch
   - Deck Interior Bearing Length = 3 inch
Roof Deck Design Example

\[ L = \text{Span} \]
\[ X = \% \text{ of Span} \]

For \( X \leq 0.25 \)
\[ b_e = B + 6 \geq 12 \]

For \( 0.25 < X \leq 0.50 \)
\[ b_e = B + 18 - \frac{3}{X} \geq 24 - \frac{3}{X} \]

Calculate the transverse distribution of the concentrated load using the procedure found in Section 2.5.

\[ L = 8 \text{ ft} \quad XL = 3 \text{ ft} \quad X = 0.375 \]

\[ b_e = B + 18 - \frac{3}{X} \geq 24 - \frac{3}{X} \]

\[ = 30 + 18 - \frac{3}{0.375} \geq 24 - \frac{3}{0.375} \]
\[ = 40 \text{ inch} \geq 16 \text{ inch} \]

Therefore the 40 inch dimension controls the transverse distribution.
Roof Deck Design Example

P = 210 lb

W = 30 lb/ft

8'-0"

Concentrated Load is converted to a line load as 700 lbs × 12 / 40 = 210 plf.

From a structural analysis using w = 30 plf and P = 210 lbs, the maximum moments and shears are found in the middle span:

- \( M_n = 3918 \text{ inch-lbs at the left support} \)
- \( M_p = 3632 \text{ inch-lbs under the concentrated load} \)
- \( V = 255 \text{ lbs at the left support} \)
- \( R_{\text{INTERIOR}} = 416 \text{ lbs at the left support (OFI)} \)
- \( R_{\text{EXTERIOR}} = 83 \text{ lbs at the right support of the 3rd span (OFE)} \)
Roof Deck Design Example

Table 1 – Section Properties and Flexural Resistance

<table>
<thead>
<tr>
<th>Profile</th>
<th>Gage Number</th>
<th>Design Thickness (inches)</th>
<th>$I_p$ (inch$^4$)</th>
<th>$I_n$ (inch$^4$)</th>
<th>$S_p$ (inch$^3$)</th>
<th>$S_n$ (inch$^3$)</th>
<th>$M_p/\Omega$ inch-lbs</th>
<th>$M_n/\Omega$ inch-lbs</th>
<th>$\Phi M_p$ inch-lbs</th>
<th>$\Phi M_n$ inch-lbs</th>
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</thead>
<tbody>
<tr>
<td>WR</td>
<td>22</td>
<td>0.0295</td>
<td>0.1473</td>
<td>0.1732</td>
<td>0.1713</td>
<td>0.1804</td>
<td>3385</td>
<td>3565</td>
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<td>0.2741</td>
<td>0.2791</td>
<td>0.2883</td>
<td>0.2963</td>
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<td>5855</td>
<td>8563</td>
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<td>WR</td>
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<td>0.0598</td>
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<td>0.3695</td>
<td>0.3722</td>
<td>7301</td>
<td>7355</td>
<td>10974</td>
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Table 6 – Shear and Web Crippling Strength

<table>
<thead>
<tr>
<th>Profile</th>
<th>Gage Number</th>
<th>Shear (lbs)</th>
<th>ASD (lbs)</th>
<th>Web Crippling</th>
<th>LRFD (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ASD $\Omega = 1.60$</td>
<td>LRFD $\Phi=0.95$</td>
<td>$\Omega = 1.70$</td>
<td>$\Omega = 1.75$</td>
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<tr>
<td>NR. IR, WR</td>
<td>22</td>
<td>1325</td>
<td>2014</td>
<td>541</td>
<td>857</td>
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<td>NR. IR, WR</td>
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<td>1588</td>
<td>2413</td>
<td>773</td>
<td>1248</td>
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<td>2809</td>
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</tbody>
</table>
Roof Deck Design Example

Try WR20

For this condition,

\[
\frac{M_n}{\Omega} = 4440 \text{ inch-lbs (Table 1)} \quad > \quad 3918 \text{ inch-lbs} \quad \text{OK}
\]

\[
\frac{M_p}{\Omega} = 4193 \text{ inch-lbs (Table 1)} \quad > \quad 3632 \text{ inch-lbs} \quad \text{OK}
\]

\[
V_{ALLOW} = 1588 \text{ lbs (Table 6)} \quad > \quad 255 \text{ lbs} \quad \text{OK}
\]

Allowable Web Crippling, (Table 6)

\[
\text{OFE} = 773 \text{ lbs (1.5 inch min.)} \quad > \quad 83 \text{ lbs} \quad \text{OK}
\]

\[
\text{OFl} = 1248 \text{ lbs (2.5 inch min.)} \quad > \quad 416 \text{ lbs} \quad \text{OK}
\]

Therefore,

\[
\sqrt{\left( \frac{V}{V_a} \right)^2 + \left( \frac{M}{M_a} \right)^2} = \sqrt{\left( \frac{255}{1588} \right)^2 + \left( \frac{3918}{4440} \right)^2} = 0.897 \leq 1.0 \quad \text{OK}
\]

**Result:**

WR20 deck is acceptable for this condition.
Floor Deck Design Standards/Manual

Available at www.sdi.org
Floor Deck Design Limit States

- $V_n$: One Way Beam Shear
- $M_y$: Bending ( + if simple span, +/- if multiple span)
- $V_{pr}$: Punching Shear - unlikely to govern
- $\Delta$: Deflection - unlikely to govern
- $M_w$: Transverse (Weak axis) Bending
- $M_n, M_r$: Proprietary Deck-Slab Bending (no studs)
Floor Deck Load Distribution

(weak) $W$ $b_e$
Current SDI Load Distribution

SDI FDDM/C-2017

\[ b_m = b_2 + 2t_c + 2t_t \]
\[ b_e = b_m + 2 \left( 1 - \frac{x}{L} \right) x \] Wheel/Baseplate Distribution 2.4.10
\[ b_e = b_m + \frac{4}{3} \left( 1 - \frac{x}{L} \right) x \] Single Span Positive Bending 2.4.11
\[ b_{ve} = b_m + \left( 1 - \frac{h}{L} \right) x \] Continuous Span Positive Bending 2.4.12
\[ w = \frac{L}{2} + b_3 < L \] Beam Shear 2.4.13
\[ w = \frac{L}{2} + b_3 < L \] Transverse Bending 2.4.14
Polling Question #1

Which Limit State is NOT Applicable for Designing Concentrated Loads on Concrete Slabs on FLOOR Deck?

a) Weak Axis Bending
b) Web Crippling
c) Punching Shear
d) Positive Bending
e) Negative Bending
Can We Solve This Load Diagram?

Cluster (multiple) loads.
Simple beam loading diagram.
Known engineering mechanics.
  • Shear
  • Bending
  • Deflection

Use traditional engineering mechanics to solve complex cluster analysis.
Cluster Loads

Adjacent Loads, $M_y, V_n, \Delta$

$$b_e' = \frac{b_e + \text{Adjacent load spacing}}{2} \leq b_e$$

In–Line Loads, $M_w$

$$M_w = \left( \frac{P}{w} + \frac{P(\text{Lap})}{w^2} \right) \frac{12 b_e}{15}$$

Adjacent Loads, $M_w$

$$M_x = 5.5 M_1 \left[ \frac{x}{b_e} - \frac{1}{\pi} \sin \left( \frac{\pi x}{b_e} \right) \right] \text{rad}$$
In-line loads act simultaneously on a 1’ effective width.

Use $P/b_e$ model and simple span beam for $M_y$, $V_n$, $\Delta$.

Use New “Lap” equation for $M_w$. 

2 Loads “In-Line”
Distribute loads using associated effective widths, $b_{e1}$ and $b_{e2}$.

$P_1$ and $P_2$ are typically equal, but $P/b_e$ ratios differ.

Simple beam analysis for $M_y$, $V_n$, $\Delta$.

Solve for desired variable; $a$, $b$, $L$, $P$. 

2 Loads “In-Line”, $M_y$, $V_n$, $\Delta$
2 Loads “In-Line”, $M_y$
2 Loads “In-Line”, $V_n$
Do influence zones overlap?

- If no, use existing SDI procedures for a single concentrated load.
- If yes, use new “Lap” equation to correct for “w” overlap.
The great advantage to this equation is “IT WORKS EVERYWHERE” regardless of the overlap. \( \phi_w = 0.75, \Omega_w = 2.0 \)
2 Loads “In-Line”, Scaffold

LAP = 2.33’ (use 2.0’)

- 2 x 12 x 20
- 8-0 span
- 5” NW slab (t = 3”)
- W6xW6-W2.1xW2.1
- d = 1.5”
- Scaffold post, b = 4”

- \( W_L = 0 \)
- \( W_d = (1.2) 52 \text{ psf} \)
- \( \phi M_y = 4140 \text{ ft-lbs/ft} \)
- \( \phi V_n = 5116 \text{ lb/ft} \)
- \( \phi w M_w = 2757 \text{ in-lb/ft} \)

Typical slab capacities for bending and shear from SDI FDDM.

Weak axis bending capacity, 2757 in-lb/ft, calculated.

Why is LRFD desirable?
2 Loads “In-Line”, Scaffold, $M_y, V_n, \Delta$

FP$_1$
\[
\frac{3.30}{FP_1}
\]

FP$_2$
\[
\frac{4.78}{FP_2}
\]

FP = 33822 lbs
FP = 13377 lbs
FP = 7029 lbs
FP = 5470 lbs
2 Loads “In-Line”, Scaffold, $M_w$

\[
\frac{FP}{W} = \frac{FP}{4.33}
\]

\[
b_{e\text{ max}} = 4.78'
\]

1. Distribute $P$ over an effective width “$w$”, not “$b_e$”.
2. The weak axis beam length = $b_e$ and will differ for $P_1$ and $P_2$. Use $b_{e\text{ max}}$
3. Use the new $\phi M_w$ to correct for influence zone overlap.
4. Use $\phi_w = 0.75$ and $\Omega_w = 2.0$ (not ACI factors)

\[
\Phi M_w = \left(\frac{FP}{w} + \frac{FP(\text{Lap})}{w^2}\right) b_e \frac{12}{15}
\]

\[
M_{w@P2} = 2757 = \left(\frac{12FP}{4.33} + \frac{12FP(2.0)}{4.33^2}\right) \left(\frac{4.78}{15}\right)
\]

• $FP = 2135$ lbs
2 Loads “Adjacent”

Do influence zones overlap?

• If no, use existing SDI procedures for a single concentrated load.
• If yes, use **New** $P/b_e$ model for $M_y$, $V_n$, $\Delta$ . . . . “don’t use concrete twice”.
• If yes, use **New** $M_x\sin$ equation with $M_w$. 
2 Loads “Adjacent”, $M_y$, $V_n$, $\Delta$

\[ \frac{P}{b_e'} \]

\[ a \quad \quad b \]

\[ b'_e = \frac{b_e + \text{Adjacent load spacing}}{2} \leq b_e \]

NEW
Overlapping adjacent influence zones may result in cumulative weak axis bending moments, and traditional SDI mechanics may not be appropriate for a two-way slab problem with sinusoidal stress distribution.

To demonstrate, the next 3 slides show the effects of load spacing and superposition.
2 Loads “Adjacent”, $M_w$

$b_e$ overlap < load spacing

Load Locations Along $b_e$, ft

$M_w$, ft-lbs

$M_{WP_2}$, $M_{WP_1}$, $\Sigma M$

$P/w$
2 Loads “Adjacent”, $M_w$

Load Locations Along $b_e$, ft

- $M_{wn}$
- $M_{wp1}$
- $M_{wp2}$
- $\Sigma M$

$b_e$ overlap > load spacing

$p/w$
2 Loads “Adjacent”, $M_w$

$$b_e \text{ overlap } \gg \text{load spacing}$$

$$M_w = 5.5 M_1 \left[ \frac{x}{b_e} - \frac{1}{\pi} \sin \left( \frac{\pi x}{b_e} \right) \right] \text{ rad}$$
2 Loads “Adjacent”, Scaffold

- 2 x 12 x 20
- 8-0 span
- 5” NW slab (t = 3”)
- W6xW6-W2.1xW2.1
- d = 1.5”
- Scaffold post, b = 4”

\[ W_L = 0 \]
\[ W_d = (1.2) 52 \text{ psf} \]
\[ \phi M_y = 4140 \text{ ft-lbs/ft} \]
\[ \phi V_n = 5116 \text{ lb/ft} \]
\[ \phi M_w = 2757 \text{ in-lb/ft} \]

\[ b_e' = \left( \frac{b_e + \text{load spacing}}{2} \right) = \left( \frac{4.78 + 1.5}{2} \right) = 3.14 \text{ ft} \]
2 Loads “Adjacent”, Scaffold $M_y, V_n, \Delta$

- $b_e = 4.78$ ft
- $b_e' = 3.14$ ft
- $W = 4.33$ ft
- $W_d = 62$ psf

$FP_1 = \frac{3.14}{3.14}$

$R_R = 5116$ lbs = $\frac{62 \text{ plf} \times (8 \text{ ft})}{2} + \frac{FP \times (3.5 \text{ ft})}{3.14 \text{ ft} \times 8 \text{ ft}}$

$R_L = 5116$ lbs = $\frac{62 \text{ plf} \times (8 \text{ ft})}{2} + \frac{FP \times (4.5 \text{ ft})}{3.14 \text{ ft} \times 8 \text{ ft}}$

$M_{@P} = 4140 \frac{\text{ ft } - \text{ lbs}}{\text{ ft}} = \frac{62 \text{ plf} \times (3.5 \text{ ft}) \times (4.5 \text{ ft})}{2} + \frac{FP \times (4.5 \text{ ft}) \times (3.5 \text{ ft})}{(3.14 \text{ ft}) \times 8 \text{ ft}}$

- $FP = 34938$ lbs
- $FP = 27174$ lbs
- $FP = 5824$ lbs
2 Loads “Adjacent”, Scaffold $M_w$

$$\phi M_1 = \frac{12FP}{w} \left( \frac{b_e}{15} \right)$$

Load P develops a sinusoidal moment envelope over a beam length = $b_e$ resisted by the available weak axis bending moment = $\phi M_w$ and $\phi M_w < \phi M_n$
2 Loads “Adjacent”, Scaffold \( M_w \)

\[
\Phi M_1 = \frac{12FP}{w} \left( \frac{b_e}{15} \right)
\]

\[
M_x = 5.5 \Phi M_1 \left[ \frac{x}{b_e} - \frac{1}{\pi} \sin \left( \frac{\pi x}{b_e} \right) \right] \text{ rad}
\]

The adjacent load \( P \) develops a similar moment curve. In this example, we are interested in the weak axis moment at \( x = 0.65' \).
2 Loads “Adjacent”, Scaffold $M_w$

\[ \Phi M_1 = \frac{12FP}{w} \left( \frac{b_e}{15} \right) \]

\[ M_{x=0.65} \]

\[ \Sigma M_n < 2757 \]

\[ 2757 \frac{\text{in}-\text{lbs}}{\text{ft}} = \frac{12FP}{4.33 \frac{\text{ft}}{15}} \left( \frac{4.78 \text{ ft}}{15} \right) + 5.5 \left[ \frac{12FP}{4.33 \frac{\text{ft}}{15}} \left( \frac{4.78 \text{ ft}}{15} \right) \right] \left[ \frac{0.65 \text{ ft}}{4.78 \text{ ft}} - \frac{1}{\pi} \sin \left( \frac{\pi (0.65 \text{ ft})}{4.78 \text{ ft}} \right) \right] \text{ rad} \]

FP = 2977 lbs

Focus on the picture, not the equation.
4 Loads “In-Line” and “Adjacent”

You guessed it . . . 4 loads . . . “In-line” and “adjacent”.
“What size lift can this floor support?”

Slab (FDDM Example 4)
- 2 x 12 composite deck
- 20 gage
- 4 ½” total depth
- 3 ksi NW concrete
- 9-0 clear span
- 25 psf concurrent LL
- 6x6 – W2.1xW2.1 WWR
- d = 1.25"

Assumed Lift
- 52“ length
- 30“ width
- 12” x 4.5“ tires
- 2.5 mph
As a general rule for scissor lift shear, one tire near the support and smaller lift dimension “adjacent”.

Example Problem, $V_n$

\[ b_{e1} = 1.12 \text{ ft} \]
\[ b_{e2} = 4.94 \text{ ft} \]
\[ b_{e2}' = 3.8 \text{ ft} \]
Example Problem, $V_n$

$$R_R = 4715 \text{ lbs} = \frac{53 \text{ plf (9 ft)}}{2} + \frac{25 \text{ plf(1.6)(9 ft)}}{2} + \frac{\text{FP}}{1.12 \text{ ft}} \left( \frac{0.17 \text{ ft}}{9 \text{ ft}} \right) + \frac{\text{FP}}{3.8 \text{ ft}} \left( \frac{4.5 \text{ ft}}{9 \text{ ft}} \right)$$

FP = 28943 lbs

$$R_L = 4715 \text{ lbs} = \frac{53 \text{ plf (9 ft)}}{2} + \frac{25 \text{ plf(1.6)(9 ft)}}{2} + \frac{\text{FP}}{1.12 \text{ ft}} \left( \frac{8.83 \text{ ft}}{9 \text{ ft}} \right) + \frac{\text{FP}}{3.8 \text{ ft}} \left( \frac{4.5 \text{ ft}}{9 \text{ ft}} \right)$$

FP = 4264 lbs
AISC 15th 3-223 – Maximum bending occurs when \( x = b \) or when the larger load is over the center of gravity of all loads. So, where is C.G.? 

We know \( M_{\text{max}} \) should be near midspan. Is this close enough?
As a general rule for scissor lift bending, one tire at midspan is reasonable, but $a = 0.45L$ is more accurate. Smaller lift dimension “in-line”, but check rotated 90°.
Example Problem, \( M_y \)

\[
\begin{align*}
FP_1 &= 3.90 \\
FP_2 &= 4.64 \\
2.0' &\quad 2.5' &\quad 4.5'
\end{align*}
\]

\[
M_{@P1} = 3511 \frac{\text{ft} - \text{lbs}}{\text{ft}} = \left( \frac{53 \text{ plf} + 25 \text{ plf}(1.6)}{2} \right) (2.0 \text{ ft})(7.0 \text{ ft}) + \frac{FP(2.0 \text{ ft})(7.0 \text{ ft})}{(3.9 \text{ ft})9 \text{ ft}} + \frac{FP(4.5 \text{ ft})(2.0 \text{ ft})}{(4.64 \text{ ft})9 \text{ ft}}
\]

\[FP = 4655 \text{ lbs}\]

\[
M_{@P2} = 3511 \frac{\text{ft} - \text{lbs}}{\text{ft}} = \left( \frac{53 \text{ plf} + 25 \text{ plf}(1.6)}{2} \right) (4.5 \text{ ft})(4.5 \text{ ft}) + \frac{FP(2.0 \text{ ft})(4.5 \text{ ft})}{(3.9 \text{ ft})9 \text{ ft}} + \frac{FP(4.5 \text{ ft})(4.5 \text{ ft})}{(4.64 \text{ ft})9 \text{ ft}}
\]

\[FP = 3465 \text{ lbs}\]

Computer model, FP = 3410 lbs
Example Problem, $M_w$

As a general rule for scissor lift weak axis, same lift location and orientation as $M_y$.

$b_{\text{emax}} = 4.94$ ft
$w = 4.88$ ft
$Lap = 2.38$ ft
Example Problem, $M_w$

\[ \Phi_w M_1 = \left( \frac{FP}{w} + \frac{FP(Lap)}{w^2} \right) \frac{12b_{emax}}{15} \]

Correction for "in – line" overlap

\[ \Phi_w M_x = 5.5[\Phi_w M_1]\left[ \frac{x}{b_{emax}} - \frac{1}{\pi} \sin \left( \frac{\pi x}{b_{emax}} \right) \right] \]

Correction for "adjacent" overlap

\[ x = \frac{b_{emax}}{2} - \text{Adjacent Load spacing} > 0 \]

\[ \Phi_w M_w = \Phi_w M_1 + \Phi_w M_x \]

Moments are cumulative at $x$

\[ \Phi_w M_w = \left( \frac{FP}{w} + \frac{FP(Lap)}{w^2} \right) \frac{12b_{emax}}{15} + 5.5 \left[ \left( \frac{FP}{w} + \frac{FP(Lap)}{w^2} \right) \frac{12b_{emax}}{15} \right] \left[ \frac{x}{b_{emax}} - \frac{1}{\pi} \sin \left( \frac{\pi x}{b_{emax}} \right) \right] \]
Example Problem, $M_W$

\[
x = \frac{b_{\text{emax}}}{2} - \text{Adjacent Load spacing} > 0 = \frac{4.94'}{2} - \frac{52''}{12} = -1.86'
\]

Use $x = 0$
Example Problem, $M_w$

\[
\Phi_wM_w = \left(\frac{FP}{w} + \frac{FP(Lap)}{w^2}\right) \frac{12b_{e_{\text{max}}}}{15} + 5.5 \left[\left(\frac{FP}{w} + \frac{FP(Lap)}{w^2}\right) \frac{12b_{e_{\text{max}}}}{15}\right] \frac{x}{b_{e_{\text{max}}}} - \frac{1}{\pi} \sin \left(\frac{\pi x}{b_{e_{\text{max}}}}\right)
\]

Typical for scissor lifts

\[
2285 \text{ in} - \frac{\text{lbs}}{\text{ft}} = \left(\frac{FP}{4.88'} + \frac{FP(2.38')}{4.88'^2}\right) \frac{12(4.94')}{15}
\]

Solve for $FP = 1896$ lbs

Computer model = 1893 lbs

Checks for deflection and punching are not shown, and did not control. Maximum scissor lift wheel load is limited by weak axis bending = 1896 lbs.

What limits do we give the contractor?
Example Answer

FP = 1896 lbs from $M_w$
If loads are balanced:

Lift = 4FP = 7584 lbs

Impact is unlikely, but possible if platform falls quickly. Try 25% impact.

Lift = 7584/(1.25) = 6067 lbs

In most cases, lift weight far exceeds platform capacity and travels at 2.5 mph. For construction, F = 1.4 is reasonable.

Lift = 6067/(1.4) = 4334 lbs

Product specs from on-line literature,
Weight = 2702 lbs
Capacity = 500 lbs
Total = 3202 lbs < 4334 lbs OK
## FDDM Scissor Lift Tables?

### 1.5 x 6 Composite + 25 psf construction load

<table>
<thead>
<tr>
<th>Slab Gage</th>
<th>WWR</th>
<th>WWR</th>
<th>( \phi_b M_y )</th>
<th>( \phi_w M_w )</th>
<th>( \phi_v V_n )</th>
<th>( \phi_v V_c )</th>
<th>( \phi_P_u ) / Simple Span, lbs</th>
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### Capacities above are Ultimate wheel loads. Apply appropriate load, impact or unbalanced factors as applicable.

- WWR located at slab centerline (\( d = t/2 \))
- Positive Bending (\( \phi_b M_y \)), Weak Axis Bending (\( \phi_w M_w \)), Beam Shear (\( \phi_v V_n \) + \( \phi_v V_c \)), Punching Shear (\( \phi_P u \)) and L/360 Deflection (\( \Delta L/360 \))

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Capacities above are Ultimate wheel loads. Apply appropriate load, impact or unbalanced factors as applicable.

WWR located at slab centerline \( d = t/2 \)

Positive Bending \( \phi_b M_y \), Weak Axis Bending \( \phi_w M_w \), Beam Shear \( \phi_d V_d + \phi_c V_c \), Punching Shear \( \phi V_p \) and \( L/360 \) Deflection \( \Delta \)
### FDDM Scissor Lift Tables?

**3.0 x 12 Composite + 25 psf construction load**

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<tr>
<th>Slab</th>
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<th>WWR</th>
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Capacities above are **Ultimate** wheel loads. Apply appropriate load, impact or unbalanced factors as applicable.

WWR located at slab centerline ($d = t/2$)

Positive Bending ($\phi_b M_y$), Weak Axis Bending ($\phi_w M_w$), Beam Shear ($\phi_d V_d + \phi_c V_c$), Punching Shear ($\phi_{V_p}$), and L/360 Deflection ($\Delta$)
Data Rack

**Slab**
- 1.5 x 6 x 18 ga composite deck
- 5.0” Total Depth
- 3 ksi NW Concrete
- 7-0 Clear Span
- 40 psf Concurrent LL
- 6x6 – W2.9xW2.9 WWR
- d = 1.0”

**Data Rack**
- 42” deep
- 28” overall width
- 21” caster spacing
- 3” casters
- 3000# static capacity
Data Rack
Line load analysis with $b_e$ at L/4

Use $b'_e$ for overlap of adjacent loads and calculation of $V_n$, $M_y$, $\Delta$

$M_w$ is a bit more complicated.
Data Rack

26” 14” 21” 14” 26”

14” 12” 14” 12”

$2364 \text{ in} - \text{ lbs} / \text{ ft}$

$290 \text{ in} - \text{ lbs} / \text{ ft}$

$20 \text{ in} - \text{ lbs} / \text{ ft}$

$2674 \text{ in} - \text{ lbs} / \text{ ft}$

$b_e = 4.33’$
Form Deck

+V₁, FP₁/₁₇₁, +V₂, FP₂/₂₇₂, +V₃, -V₂, -V₃, -V₄, +M₁₂, +M₂₃, +M₃₄, -M₂, -M₃
Steel Fibers

In theory, fibers are not a replacement for WWR as a tensile component, so \( A_s = 0 \).

If so, \( M_w = 0 \), which suggests \( P = 0 \).  

*This simply cannot be true.*
Steel Fibers, Draft Proposals

Performance-Based Requirements for Fiber Dosage for Concentrated Loads on Composite Steel Deck Floor-Slabs

Section 2.4.B.11, Concentrated Loads, of the ANSI/SDI C-2017 Standard for Composite Steel Deck Floor-Slab permits a concentrated load to be laterally distributed perpendicular to the deck ribs (see Fig. 1). Accordingly, the concrete above the top of a steel deck is required to be designed as a one-way concrete slab, transverse to the deck ribs, in accordance with Chapter 7 of ACI 318 to resist the weak axis moment, \( M_{wa} \), due to the concentrated load.

A procedure for calculating \( M_{wa} \) is provided in Section 2.4.B.11.b of the standard using the following equations (Eq. 2.4.15a and Eq. 2.4.15b in ANSI/SDI C-2017):

\[
M_{wa} = 12P \cdot b_e / (15W) \quad \text{in.-lb/ft} \\
= P \cdot b_e / (15W) \quad \text{N-mm/mm}
\]

Single load analysis. Use new for cluster loads.

where,
- \( P \) = magnitude of concentrated load; lb (N)
- \( b_e \) = effective width of concentrated load, perpendicular to the deck ribs; in. (mm)
- \( W \) = effective length of concentrated load, parallel to the deck ribs; in. (mm)

This technical bulletin provides a methodology to calculate the required fiber dosage for a given application to permit the use of fibers in lieu of welded-wire reinforcement (WWR).
• Use $P/b_e$ and simple beam mechanics
• $M_w$ often limits capacity; increase $d$ or $A_s$
• Cluster Loads – for $M_y V_n \Delta$, use $b_e'$
• Grouping loads is overly conservative
• Replace SDI $M_w$ equation with new
• Check with supplier for $M_n < M_y$
Polling Question #2

What loads are included in Transverse (weak axis) bending analysis?

a) Dead + Concentrated

b) Live + Concentrated

c) Concentrated only

d) Dead + Live + Concentrated
Polling Question Answers

Which Limit State is NOT Applicable for Designing Concentrated Loads on Concrete Slabs on FLOOR Deck?

B) Web Crippling

What loads are included in Transverse (weak axis) bending analysis?

C) Concentrated only
Questions?

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