The Five Ws of the SIPA Structural Insulated Panel Design Manual

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Who is SIPA?

• Formed in 1990
• Non-Profit Trade Association Representing
  • Manufacturers
  • Suppliers
  • Dealers
  • Design Professionals
  • Builders
• Provides Technical and Educational Information Regarding SIPs
Who is the Design Manual For?

- Not an introduction to SIPs
- Not for builders
- Not a casual read

Intended for Engineers
Who is the Design Manual For?

- Not an introduction to SIPS
- Not for builders
- Not a casual read

Intended for Engineers

WARNING: Non-Engineers will find little more than confusion within its pages
Why do we need a Design Manual?

• Establish best practices and limits of use
• Unified design procedures
• Discretely identify limit states
  • Tables obscure limits states

<table>
<thead>
<tr>
<th>Panel Length (ft)</th>
<th>4-5/8-in. SIP thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deflection Limit²</td>
</tr>
<tr>
<td></td>
<td>L/180</td>
</tr>
<tr>
<td>8 WAB³</td>
<td>50.8</td>
</tr>
<tr>
<td>8</td>
<td>68.8</td>
</tr>
<tr>
<td>10</td>
<td>45.1</td>
</tr>
<tr>
<td>12</td>
<td>30.8</td>
</tr>
<tr>
<td>14</td>
<td>21.7</td>
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<tr>
<td>16</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>--</td>
</tr>
</tbody>
</table>

Deflection?  
Shear?  
End-Conditions?
Why do we need a Design Manual?

• Establish best practices and limits of use
• Unified design procedures
• Discretely identity limit states
  • Tables obscure limits states
• Continuous functions for SIP limit states
  • Interpolate/Extrapolate
Why do we need a *Design Manual*?

• Provide rational means for assessing conditions that cannot be tested
  • Combined Loading Conditions
  • Complex Loading/Support Arrangements
Why do we need a Design Manual?

• Provide roadmap for future research
  • Each provisions is a hypotheses that can be tested
  • Future testing will confirm or modify provisions
    • Increased confidence in the material
  • Consider: AISC Manual for Structural Steel
    • First published in 1923 (13 pages)
    • Nearly 100 years later--provisions still being researched, revised and expanded to include new research and reflect current design practice

Only the beginning of the process...
What does the Design Manual contain?
Three Sections
Three Sections

1. Design Specification—engineering design rules
Three Sections

1. *Design Specification*—engineering design rules

2. *Commentary*—background on engineering rules
Three Sections

1. **Design Specification**—engineering design rules

2. **Commentary**—background on engineering rules

3. **Design Examples**—provisions applied to actual design problems
Specification Scope

• Material Limits
  • OSB Facings
  • EPS or Polyurethane Cores
Use Considerations: Creep

- $P_{\text{Short}}$
- $P_{\text{Normal}}$
- $P_{\text{Permanent}}$

Graph showing:
- $P_{\text{Short}}$
- $P_{\text{Normal}}$
- $P_{\text{Permanent}}$

Time axis
Use Considerations: Creep

- $P_{Short}$
- $P_{Normal}$
- $P_{Permanent}$

Graph showing the creep behavior over time with points indicating short, normal, and permanent creep.
Use Considerations: Creep

• As Duration Increases:
  • Strength decreases
  • Deflection increases

• Three durations
  • Short—Test, wind, earthquake, impact
  • Normal—Snow, occupancy live load
  • Permanent—Dead, lateral earth pressure, storage live loads
Flexural Limit States

\[ F_T < F_c \]
Flexural Deflection

\[ \Delta_{Total} = \Delta_B + \Delta_S \]
Core Shear Strength

Affected by
• Foam Source
• Voids
• Geometry/Depth
Compression Strength: Crushing

1. Concentric
   - Uniform Stress
   - Max Strength
   - $1/2t$

2. Eccentricity @ Kern
   - No Tension
   - $2/3t$
   - $\approx 70\%$ Max Strength

3. Eccentric/Balloon
   - Tension & Compression
   - $t$
   - $\approx 50\%$ Max Strength
Compression Strength: Crushing/Buckling Interaction

$P + P_{cr} = \text{Greater Strength Reduction than Eccentricity Alone}$
Combined Loads

Combined Effect in Sheathing

- Axial Tension, Flexural Tension, Racking
- Axial Compression, Bending Compression, and Racking
Lateral Force-Resisting Systems
Lateral Force-Resisting Systems

Conventional Plates/Chords
Lateral Force-Resisting Systems

Conventional Plates/Chords
Lateral Force-Resisting Systems

Block Spline

Conventional Plates/Chords
Lateral Force-Resisting Systems

- Block Spline
- Boundary
- Conventional Plates/Chords
Lateral Force-Resisting Systems
Lateral Force-Resisting Systems

Nail Bending/Yielding

Boundary
Lateral Force-Resisting Systems

Nail Bending/Yielding
Lateral Force-Resisting Systems

- Nail Bending/Yielding
- Nail Tilting

Weaker Connection = Reduced Capacity
Increased Restraint = Increased Capacity
Connections and Joints

Three support conditions

• Face Bearing
  • Unblocked
Connections and Joints

Three support conditions

• Face Bearing
  • Unblocked
Connections and Joints

Three support conditions

• Face Bearing
  • Unblocked
  • Blocked
Connections and Joints

Three support conditions

• Face Bearing
  • Unblocked
  • Blocked

• End Supported
  • Peeling of Facing
Connections and Joints

Three support conditions

• Face Bearing
  • Unblocked
  • Blocked

• End Supported
  • Peeling of Facing
  • Fasteners Increase Strength
Openings
Reinforced Panels

Direction of Span

Solid Wood, EWP, Wood I-Joist
Reinforced Panels

Solid Wood, EWP, Wood I-Joist

Direction of Span
Reinforced Panels

- Solid Wood, EWP, Wood I-Joist

Load Shared

Direction

Span
Reinforced Panels

Total Load Proportioned to Each Element based on Stiffness

SIP Designed using Specification

+ 

Wood Elements Designed using NDS
When will the Design Manual be completed?

• First complete draft of the Specification and Commentary issued March 2017

• Design Example creation and technical review of the Specification and Commentary document will continue through 2017

• Anticipated completion date of April 2018
Where can I get a copy of the *Design Manual*?

- Draft version of new Design Manual only available to SIPA members
- Forerunner to the design manual, *NTA Design Guide*, is available
- Existing design guide and the final *Design Manual* will be available on the SIPA website:

  [www.SIPs.org](http://www.SIPs.org)