What is a Precast Concrete Sandwich Wall Panel?
Typical Precast Concrete Sandwich Wall Panel
Trucked & Erected (Non-loadbearing)
Load-Bearing Panels
Non-Composite

Composite
How are Sandwich Wall Panels Manufactured?
Wet-Cast:

Fig. 4.3.1.a. First step — Place first layer of strand and concrete.

Fig. 4.3.1.b. Second step — Place insulation and wythe ties.

Fig. 4.3.1.c. Third step — Place second layer of strand and concrete.
Shear Trusses

Solid Zones

Wet-Cast Composite Design
Non-Composite Wythe Connectors

Metallic Pin Connectors

Transverse Welded Wire Ladder Connector

Polypropylene Pin Connector

Glass-Fiber Reinforced Vinyl-Ester Connector
Pin Connectors Inserted in Pre-Drilled Holes
Reveal Strips Glued to Steel Form
Panel with Form Liner Impression and Reveals
Cornice Cast Separately, Attached at Site
Sandblasting Panel - Side Lifters Required
Corewall Panel with Random Rib Finish
Dry-Cast:

Spancrete Non-composite Wall Panel Section
8 ft. Wide Spancrete Panels
Spancrete 8 ft.
Spandrel Panels:
Double-Tee Wall Panel Section
PEC Soundwall form used for Scattered-Site housing in Chicago
Scattered-Site Housing
Scattered-Site Housing
Insulation Types:

- Expanded Polystyrene, R = 4 per inch
- Extruded Polystyrene, R = 5
- Polyisocyanurate, R = 7 to 10
- Phenolic foam: can cause corrosion when wet!
Thermal Lag from Concrete Panel Mass
Thermal Lag from Mass of Concrete Panel

a) Outside Temperature Cycle

b) Heat Flow for Massive Wall
Manufacturing Tolerances

Use PCI Mnl 116 (not 117):

“Manual for Quality Control for Plants and Production of Structural Precast Concrete Products”
How are Sandwich Wall Panels Handled & Erected?
Lifter Locations for Stripping & Handling
Yard Storage
Trucking Extra-Wide Panel on Slant Frame:
Panels arriving at the Job Site
Single-Line Lift
Face Lifters in Form
Top Edge Lifters in Form
Bracing Guidelines:
- Use ASCE 7-95 Design Loads
- Reduce from 50 yr to 5 yr Re-occurrence
- Use 1.5 Factor of Safety for Pipe Braces
Brace to "Deadmen":
How are Sandwich Wall Panels Designed?
Sandwich Wall Panel with Dock Door Opening - Plan View

Warning: Overlapping openings through the same wythe can cause inaccurate results.
Sandwich Wall Panel with Dock Door Opening - Section
Stripping Forces, Shear and Moment Diagrams
Stripping Stresses with 1.4 Handling Factor

- **Top Wythe Stress:**
  - 226.72 psi at 362.52 in.
  - -1011.87 psi at 303.24 in.

- **Allow. Tension** = 295.80 psi
- **Allow. Compr.** = -2100.00 psi

- **Bottom Wythe Stress:**
  - -1930.99 psi at 362.52 in.
  - -177.93 psi at 230.28 in.

- **Allow. Tension** = 295.80 psi
- **Allow. Compr.** = -2100.00 psi

- **% Composite**:
  - 100
- **Handling Factor**:
  - 1.4
- **Left Pick Point, in.**:
  - 94
- **Left Gap, in.**:
  - 0
- **Rt Pick Point, in.**:
  - 94
- **Right Gap, in.**:
  - 0

**Tilt potential is 75.44 deg counter-clockwise**
Erection Forces, Shear and Moment Diagrams - 2 Line Lift
Erection Stresses with 1.2 Handling Factor

Top Wythe Stress:
- 168.71 psi at 362.52 in.
- -682.31 psi at 98.04 in.
Allow. Tension = 424.26 psi
Allow. Compr. = -3000.00 psi

Bottom Wythe Stress:
- 115.30 psi at 98.04 in.
- -1680.75 psi at 362.52 in.
Allow. Tension = 424.26 psi
Allow. Compr. = -3000.00 psi

% Composite: 80
Handling Factor: 1.2
Left Pick Point, in.: 0
Left Gap, in.: 0
Rt Pick Point, in.: 94
Right Gap, in.: 156

Member tilt potential is 86.25 deg clockwise
Factored Erection Moments - Ultimate Capacity Check

Handling Analysis - Ultimate Capacity

- Stripping
- Trucking
- Erection

Ultimate Load Factor = 1.40

Positive Bending at 225.72 in:
- Factored M = 6.04 K-in
- Capacity = 1175.43 K-in
- 1.2MCr = 1502.05 K-in

Negative Bending at 225.72 in:
- Capacity = -1206.37 K-in
- 1.2MCr = -1591.83 K-in

Factored Moment in Red
Ultimate Cap. in Blue
1.2 * Cracking M. in Green

80 % Composite
1.2 Handling Factor
0 Left Pick Point, in.
0 Left Gap, in.
94 Rt Pick Point, in.
156 Right Gap, in.

Left Pick Pt. → Left Gap
Right Gap → Right Pick Pt.

Change Allowable Stress
Member tilt potential is 86.25 deg clockwise

Shear/Mom
Stresses
Ultimate Check
Print
Done

Factored Erection Moments - Ultimate Capacity Check
In-Place Loads for Load-Bearing Panel:
Applied Loads:

- Wind
- Gravity (Roof)
- Earth Pressure
Account for Differential Temperature Strains
Service Wind Load Moment Diagram

Input:

- Applied Loads
- Supports
- Bow & Temperature
- % composite at ultimate: 80
- Cracking stress coefficient: 7.5
- Include slenderness effects? Yes

Output:

Load Case 4:

1 2 3 4 5 6
7 8 9 10 11 12

Service Dead + Wind

- Show Moment Diagrams
- Show Stresses
- Crack Str
- Connection Forces
- Interaction Curves
- Edit Default Load Cases
- Print Input
- Sections
- Print Diagrams
- Done

Click on graph for values at any pt.
ACI 318 Section 14.8.4:

The maximum deflection due to service loads, including P-Delta effects, shall not exceed L/150.
Differential Temperature Strain Moment Diagram

Input:
- Applied Loads
- Supports
- Bow & Temperature
  - % composite at ultimate: 80
  - Cracking stress coefficient: 7.5
- Include slenderness effects? Yes

Load Case 7:

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<th>3</th>
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<th>5</th>
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<td>8</td>
<td>9</td>
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</table>

ACI 1.4 (Dead + Temp)

Output:

Suction at 412.68 in:
- Pu (kips) = 70.77
- Mu (kip-in) = -732.81
- Outer Stress (psi) = -2649.48
- Inner Stress (psi) = 482.20
- Section is Uncracked
- Midpoint Bow (in) = 1.29
  (Outward Bow is Positive)
- Force in Floor Ties in Kips = 19.42
  (Compression is Negative)

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Click on graph for values at any pt.
### Differential Temperature Stresses - Note Panel Bow

**Input:**
- **Applied Loads**
- **Supports**
- **Bow & Temperature**
  - % composite at ultimate: 80%
  - Cracking stress coefficient: 7.5
- **Include slenderness effects?**
  - Yes
  - No

**Load Case 7:**
- 1 2 3 4 5 6
- 7 8 9 10 11 12

**ACI 1.4 (Dead + Temp)**
- Show Moment Diagrams
- Show Stresses
- Crack Str
- Connection Forces
- Interaction Curves
- Edit Default Load Cases
- Print Input
- Print Sections
- Print Diagrams
- Print Readout

**Output:**

#### Suction at 412.68 in:
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**Stresses**

Click on graph for values at any point.
Relevant ACI 318 Code Sections:

- **14.3.6, 18.11.2.2:** Column ties not required when flexural tension controls

- **14.2.7:** Maximum height/thickness ratio of 25:1 can be waived when structural analysis is done (P-Delta)

- **14.2.7, 16.4.2, 18.11.2.3:** Minimum transverse reinforcement ratio of 0.001 can be used (instead of 0.002)

- **11.10.8:** Shear walls do not usually need any shear reinforcement

- **10.11.5:** Must use a 2nd order non-linear analysis including cracking when kl/r > 100
Individual

Shear Wall Design Examples

Linked
Design Tips to Save $$:

- Use repetition to reduce form changes
- Use Precaster’s library of standard connection details
- Anticipate erection sequence to minimize move-ins
- Use modules for bay spacing:
  - 42’ or 48’ for 12’ wide panels
  - 40’ or 50’ for 10’ wide panels
Design Tips (continued):

- Punched openings preferred over “pork-chops” and C-shapes:
Hung Panels over Dock
Rabbet at Top of Panel for Bearing Steel Bar-Joist
Continuous Joist Bearing Angle
Cast-in Deck Bearing Ledge
Nut-Type Slotted Tie-back Connection with Threaded Rod
Slotted Tie-back Connection with Strap
Knife-Edge Embedded Plates Bearing on Column Haunches
Steel Bearing Tube Haunch in Form
Hung Panel Rotation
Preferred Base Detail to Prevent Potential Water Infiltration at Floor Level
PCI COMMITTEE REPORT

STATE-OF-THE-ART OF PRECAST/PRESTRESSED SANDWICH WALL PANELS
First Invitation

Washington, D.C.
May 29 – June 2, 2010
Gaylord National Resort
www.fib2010washington.com

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- Over 700 papers presented
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