

FAS



Practically Constructed – Constructability of SIPs for the Practical Engineer

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Goal of FAS's Pankow Grant

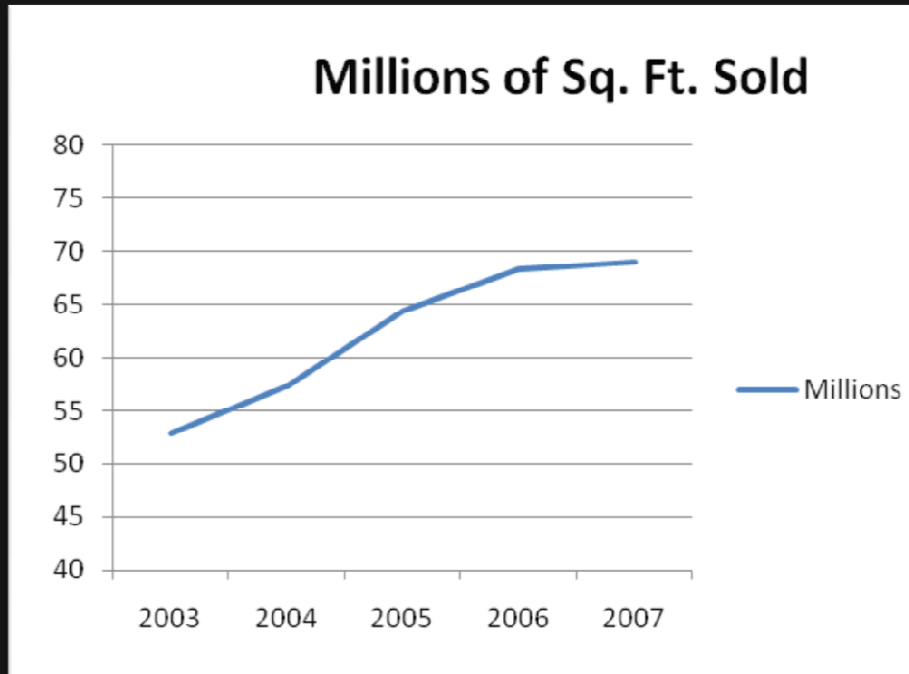
- Answer the key research question:
“How can the unique structural strength, thermal performance, and other features of CSIPs be applied to **multi-story construction** either as **load-bearing elements**, **in-fill panels**, or a combination of the two?”
- Goal to produce a **Design Procedure Document** to guide engineers, architects, and builders for how to apply CSIPs.

General Notes

- Scope of research limited by performance and design of existing panels,
- Limited by current restrictions in relevant building codes, and
- Research will focus on future research and work that will expand the CSIP market
- Limited to the existing collection of CSIP manufacturers
- Primarily EPS based (+90% of market)

Significant Market

The market for easily constructed, energy efficient multi-story buildings is large. The current SIP market has grown rapidly since 2003:



Market Segments (Priority Order)

1. Hotels
2. Health
3. Education
4. Offices
5. Retail
6. Multi-family
7. Religious
8. Recreation
9. Agriculture
10. Industrial

Presentation Overview

- What are the candidate systems for CSIPs? What limits this determination?
- What are the design considerations?
- What is the future research needed, and where is this going?

Wall Functions

- Walls perform basic functions:
 - Providing structural supports if bearing wall
 - Providing structural support for lateral loading
 - Providing structural support for wind loading
 - Protective enclosure for the elements
 - Openings for vision and vent
 - Serves as a filter between indoor and outside for flow of...
 - Heat, Light, Air, Moisture, Dirt, Sound, People

Wall Panels

Curtain
Wall Panels

Slide 6

b1

find diagram from pankow ppt
bdoherty, 9/24/2008



Limiting Factors of Panels

- Combustability
- Fire Rating
- Construction Type
- Weather Barrier
- Performance of CSIPs

Determining Candidate Applications for CSIPs

- Walls perform basic functions:
 - Providing structural supports if bearing wall
 - CODE LIMITS USE OF SIPs
 - Providing structural support for lateral loading
 - CODE LIMITS USE OF SIPs
 - Providing structural support for wind loading
 - EFFECTIVE
 - Protective enclosure for the elements
 - EFFECTIVE
 - Openings for vision and vent
 - EFFECTIVE
 - Serves as a filter between indoor and outside for flow of Heat, Light, Air, Moisture, Dirt, Sound, People
 - EFFECTIVE

Curtain
Wall Panels

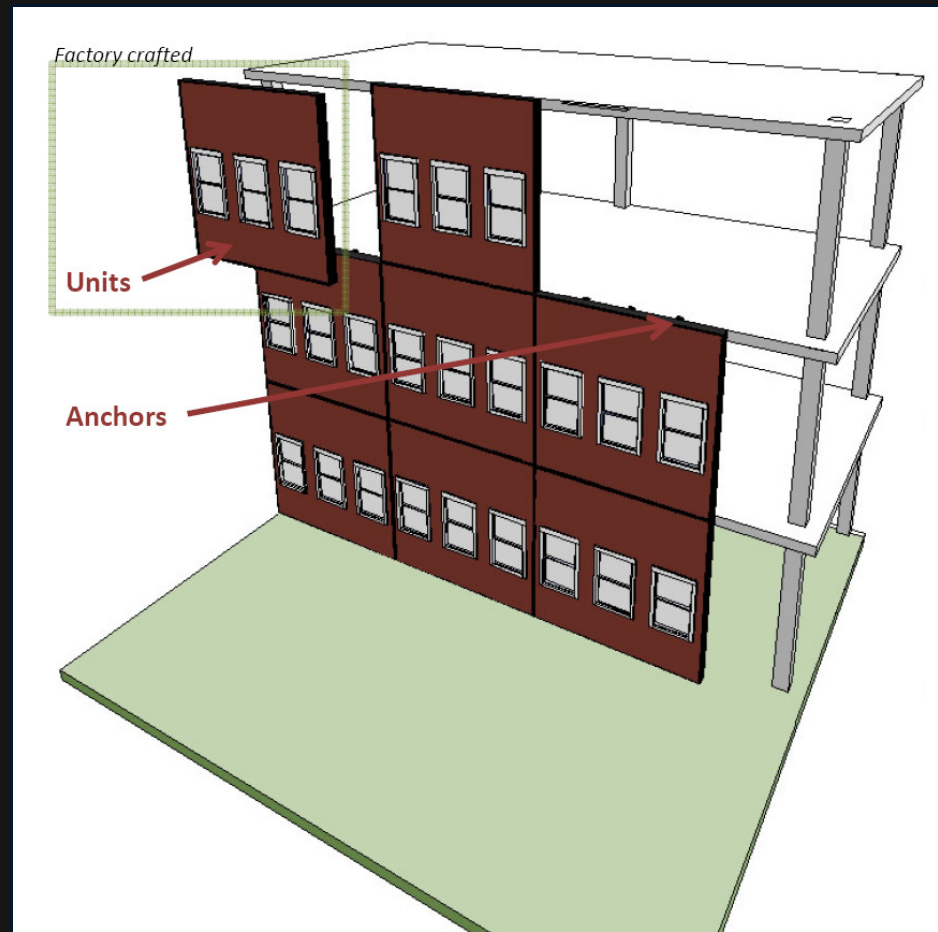
Curtain Wall Systems

- **Sticks System** –infill panel areas are small and all the panel advantages are not fully leveraged. **Not Effective.**
- **Units System** – applicable to CSIPs as the larger system is installed as sections. The system is a candidate based on constructability, cost, and performance of the CSIPs being leveraged. **Effective Application of CSIPs**
- **Unit-mullions System** – similar to the Unit System, its hybrid nature between sticks and units make the system a candidate based on constructability, cost, and performance of the CSIPs being leveraged. **Effective Application of CSIPs**
- **Panel System**, aforementioned limitations and the requirement that the CSIPs have a substructure or panel frame to tie the 4x8 to 4x12 panels together. **Not Effective.**
- **Column-cover-spandrel System**, **Not Effective.**

There are two candidate systems...

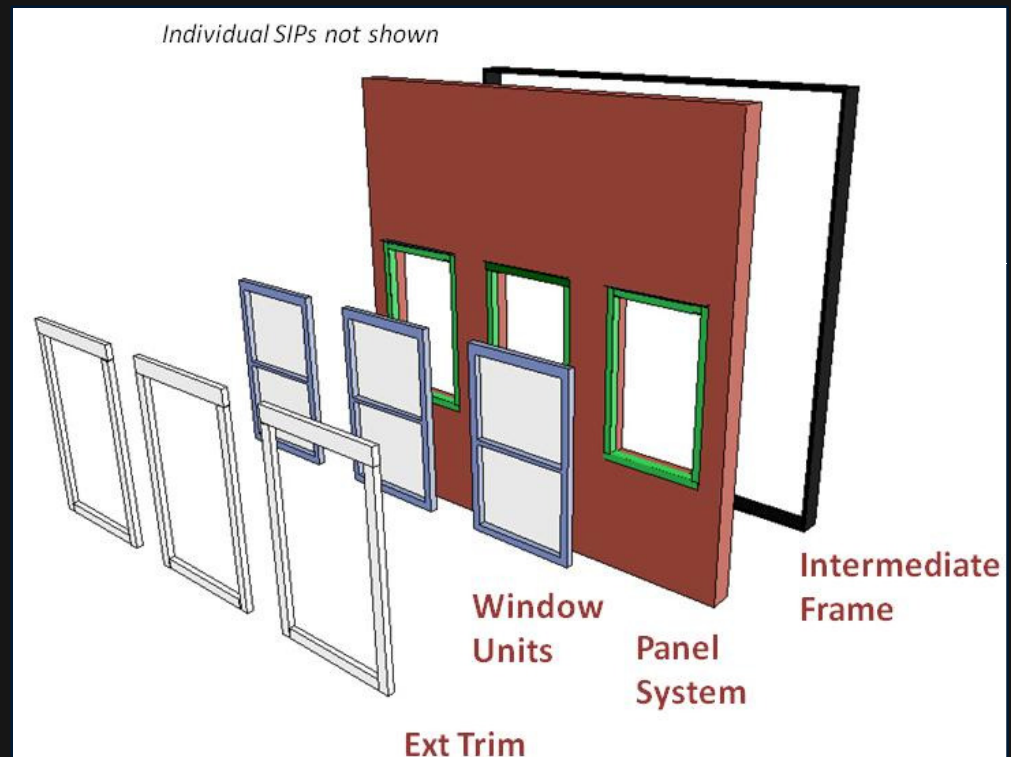
Unit System

- Parts:
 - Anchors
 - Assembled sections as Unit
- Advantages:
 - Factory crafted
 - Less Field Work
 - Factory Tested
 - Joints need to be independent
- Disadvantages:
 - Increase shipping (due to size)
 - Limited Adjustment on site
 - Joints are independent



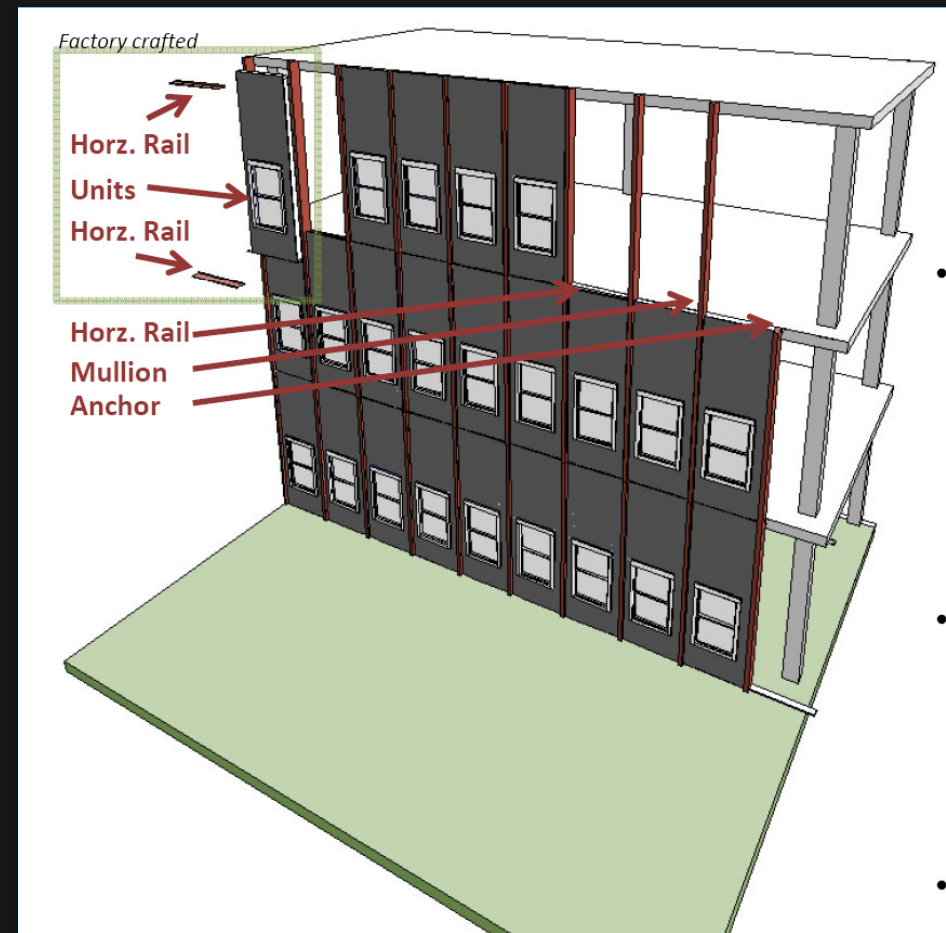
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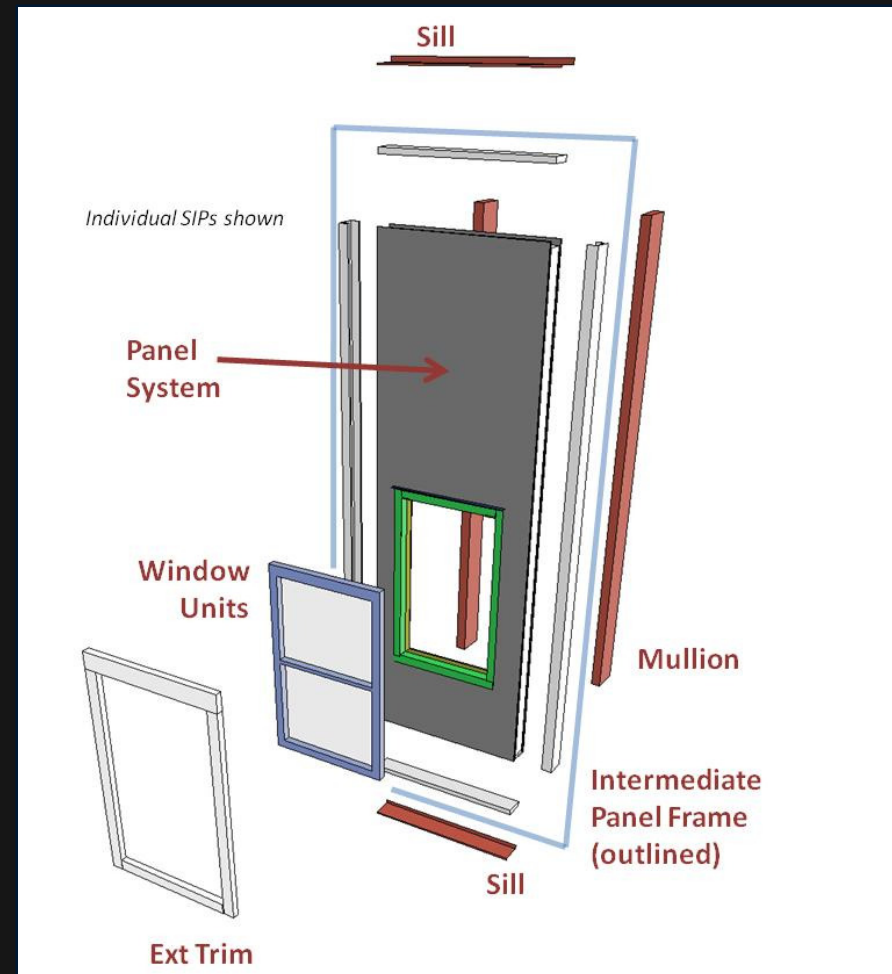
Unit Mullion System

- Parts:
 - Anchors
 - Vertical Mullion running across floors
 - Horizontal Rail as sill
 - Assembled Sections as Units
 - Interior Rails
- Advantages:
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Benefits of using CSIPs as a curtain wall

- Offer tight building envelope
- High insulation value
- Ease of Construction
- Simple weatherization details



Design Procedure Highlights

- Codes
- Testing
- Structural
- Energy
- Weatherization
- Fire Safety
- Constructability

Codes and Testing

- Verify product certification per relevant building code
- Follow diagram of design responsibility (as outlined in FAS Design Procedure Document)



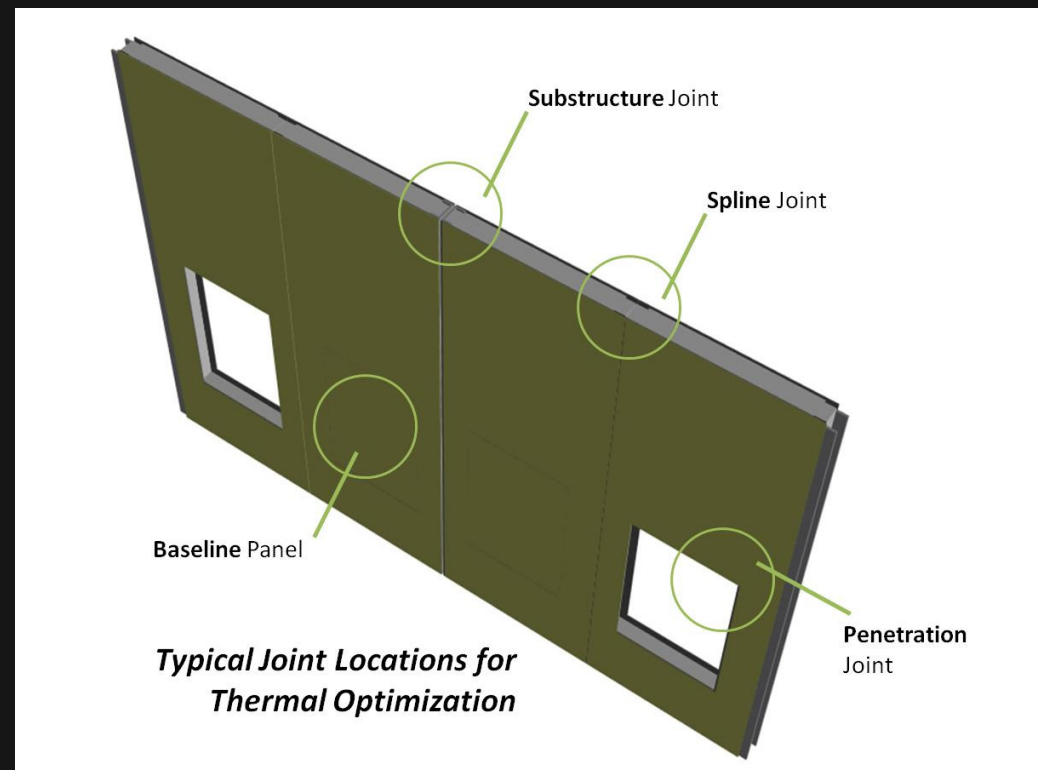
Design Procedure: Structural

- Analysis of panel properties, of panels as a system assembly, and analysis of substructure to the larger building frame.
- Ductility of connections (seismic response)
- Anchoring units to building frame










*Panels cannot be relied upon as primary structural members per code

Design Procedure: Energy

- Identify proper baseline panel thickness.
- Engineer structural components then model joints and connections for both structure and heat flow
- Optimize Splines, Connections, and Boundary Conditions
- Building Tightness through proper detailing



Typological Connection Type & Relative Performance

	U-factor	R-factor	Error
 <p>Blank panel (baseline) <i>Assumed baseline panel</i></p>	0.0400	25.00	0.00%
 <p>Wood Surface Spline</p>	0.0416	24.04	1.70%
 <p>Metal Surface Spline <i>Preferred panel to panel connection.</i></p>	0.0430	23.26	4.50%
 <p>Full Wood Spline</p>	0.0580	17.24	1.20%
 <p>Full Metal Spline</p>	0.1752	5.71	7.95%
 <p>Guarded Metal Tube</p>	0.0862	11.60	6.53%
 <p>Guarded Metal Solid <i>Preferred substructure panel connection.</i></p>	0.0870	11.49	6.56%
 <p>Metal Offset Spline</p>	0.1154	8.67	7.61%
 <p>Guarded Metal Offset Spline <i>Preferred substructure panel connection.</i></p>	0.0709	14.10	8.99%

Note: assume 5.5" insulation core throughout.

Design Procedure: Weatherization

- Proper water management detailing between units and at unit corners
- Diagram all details to illustrate the unbroken path of water movement and drying back to exterior
- Manage drainage on unit scale
- Create internal drainage where minor leakage is assumed to occur and provide for water management (weep holes, water catchers, pressure equalized cavities).



Fire Safety

- Combustability of EPS/Rigid Foam Core limits use structurally
- Ensure proper fire rating of assemblies



Constructability

- One of the often overlooked, but dramatically important points to working with CSIPs
- Follow Industry established and tested details
- Don't deviate in the field
- Work with a reliable manufacturer

Future Research

- Fire resistance. *ONGOING*
- Diaphragm assemblies. *NEEDED IN INDUSTRY*
- Connections. *UCBERKELEY, PENN ST. RESEARCHING*
- Openings and penetrations. *NEEDED IN INDUSTRY*
- Standards for manufacturing, testing, material handling and industry accepted quality assurance and control. *BEING ADDRESSED BY THE TRADE ASSOCIATION (SIPA)*

Future Potential

- Potential to provide a cost-effective, easily built curtain wall solution to address the dramatic energy problems facing the nation and industry.
- With future research, CSIPs have the long-term potential to provide easily constructed, cheap, pre-finished building system with beneficial energy and seismic properties in multistory buildings.

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Draft Copy of Research Available for Review and Comment

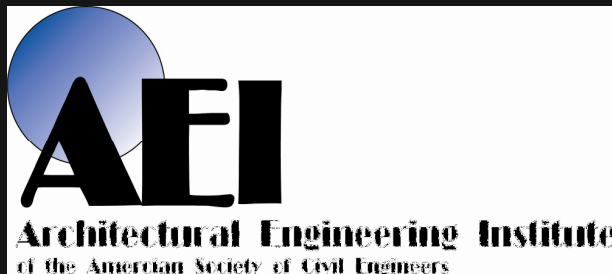
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Thank you for your time!

QUESTIONS??

**This concludes The American Institute of Architects
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