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Bill Chaleff, A.I.A., LEED A.P.

SIPs as the Backbone of an Integrated Systems Approach to Building

16 March 2016 course W01

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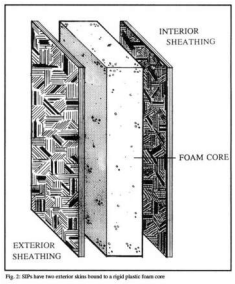

Fig. 2: SIPs have two exterior skins bound to a rigid plastic foam core

1. **SKINS ARE 7/16" OSB.**
2. **CORE IS EXPANDED POLYSTYRENE – USUAL THICKNESSES ARE:**

   1 5/8" 3 5/8" 5 5/8" 7 3/8" 9 3/8" 11 3/8"
3. **ADHESIVE IS PERFORMANCE-BASED AND MAY BE ONE OF SEVERAL TYPES. ASTM-2559 MANY ARE PHENOL-RESORCINOL**

2. What are SIPs ?

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SIPA

CODE LISTINGS ARE BY EITHER **NTA** OR **ICC-ES**.
SEE LIST OF MANUFACTURER'S CODE REPORTS ON THE SIPA WEBSITE. SIPS.ORG

ICC INTERNATIONAL CODE COUNCIL

Two ways to demonstrate Code Compliance

- Prescriptive Method
- Engineering the specific proposal

3. Introduction and Current Industry Practices

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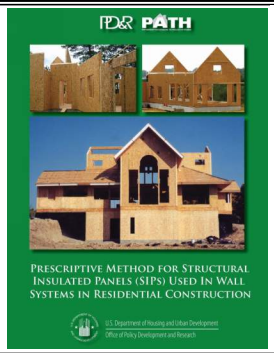
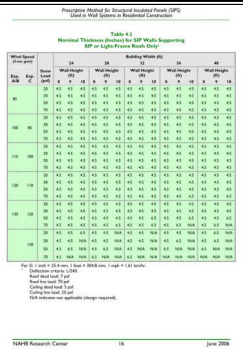




Prescriptive Method for Structural Insulated Panels (SIPs) Used in Wall Systems in Residential Construction

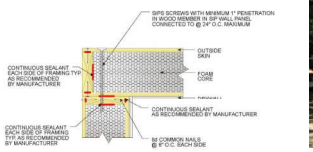
Table 4.2
Nominal Thickness (inches) for SIP Walls Supporting SIP or Light-Frame Roofs Only

Wind Speed (3-sec gust)	Exp. A/B	Exp. C	Snow Load (psf)	Building Width (ft) 24 Wall Height (ft) 8	9	10	28 Wall Height (ft) 8	9	10	32 Wall Height (ft) 8	9	10	36 Wall Height (ft) 8	9	10	40 Wall Height (ft) 8	9	10
85			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
100	85		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
110	100		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
120	110		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
130	120		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
140	130		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
150	140		20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
			70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mph = 1.61 km/hr.
Deflection criteria: L/240
Roof dead load: 7 psf
Roof live load: 20 psf
Ceiling dead load: 5 psf
Ceiling live load: 10 psf
N/A indicates not applicable (design required).

4. Prescriptive Method www.ChaleffAndRogers.com

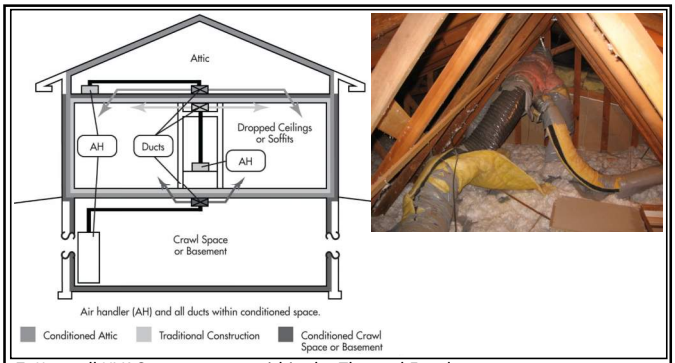
5. SIP Assembly www.ChaleffAndRogers.com



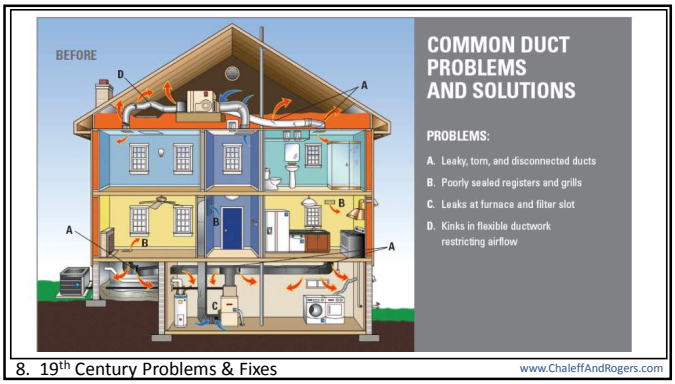
WALL-TO-WALL PANEL CONNECTIONS

CORNER WALL CONNECTION

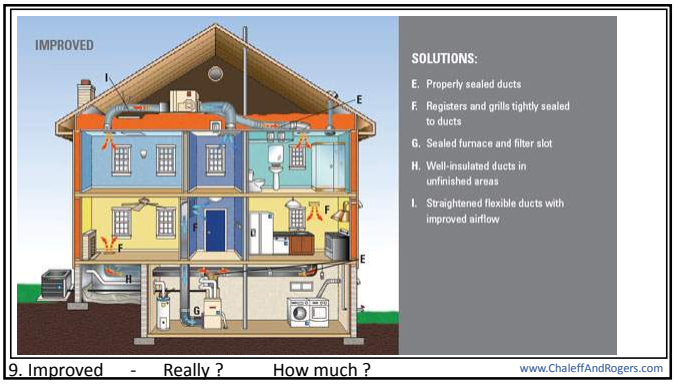
6. Classic SIP Assembly – Classic Connection Detail www.ChaleffAndRogers.com



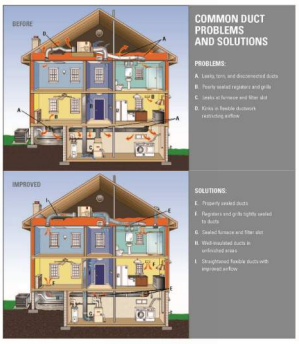
7. Keep all HVAC components within the Thermal Envelope www.ChaleffAndRogers.com



8. 19th Century Problems & Fixes www.ChaleffAndRogers.com



9. Improved - Really ? How much ? www.ChaleffAndRogers.com



The Thermal Envelope Totally Unconsidered.

It's not even a complete Envelope !

10. Still 19th Century

The Backbone of an Integrated Building is all about the Thermal Envelope

11. Thermal Envelope

12. Underground home


R- value of earth is between .25 & 1.0 depending upon moisture content percentage.
For HVAC design purposes it is usually taken as .25.
Thermal Capacitance is the real contribution together with
Infiltration resistance.

13. Earth Sheltered……Green Roof www.ChaleffAndRogers.com

14. Building above ground – the Market Preference. www.ChaleffAndRogers.com

Sooooo…..

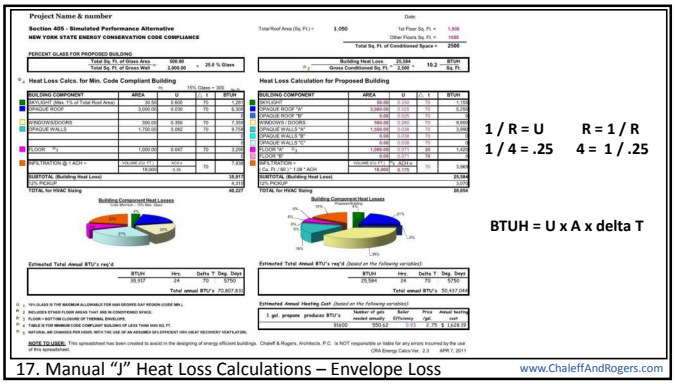
Let's build it with SIPs.

15. SIP School www.ChaleffAndRogers.com

All Ye Need To Know On Earth

1. Heat Energy is the motion of molecules.
2. Heat only flows from high temperature to low temperature.
3. Materials are rated for Resistance or Conductance of heat flow. This is what we know as “R” and “U.”
4. The rate of flow is proportional to the difference in temperature. delta T

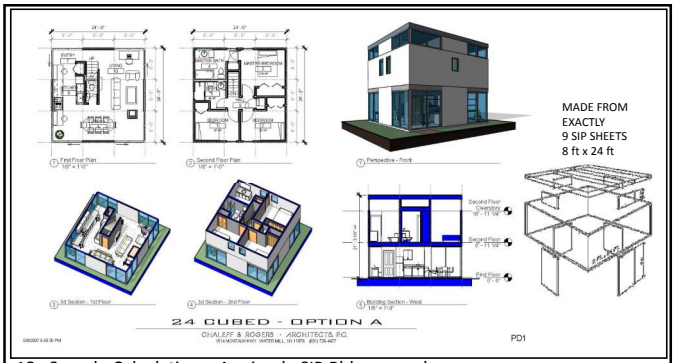
16. Hyper – Advanced Molecular Thermodynamics www.ChaleffAndRogers.com



1 / R = U R = 1 / R
1 / 4 = .25 4 = 1 / .25

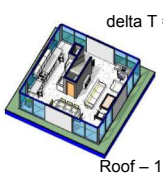
BTUH = U x A x delta T

17. Manual “J” Heat Loss Calculations – Envelope Loss www.ChaleffAndRogers.com

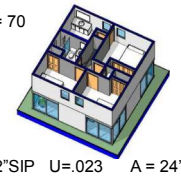


MADE FROM
EXACTLY
9 SIP SHEETS
8 ft x 24 ft

18. Sample Calculation – A simple SIP Bldg on grade www.ChaleffAndRogers.com



delta T = 70



Floor is radiant slab
A = 594 sq. ft.
R = 4" XPS = 5.4 x 4 = 21.6
plus R2 for earth
Total R = 23.6
U = 1 / 23.6 = .042
delta T = 25

Roof – 12"SIP U=.023 A = 24'-4 ½"sq. = 594 sq. ft.

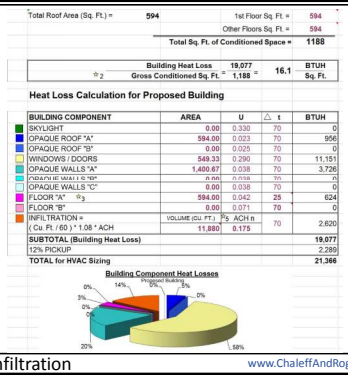
Walls (gross) A = 24'-4 ½" x 20 x 4 = 1,950 sq. ft. U = .063

Glass 8 dr units @ 8' x 8' = 64 x 8 = 512 sq. ft.
4 casements @ 2'-4" x 4'-0" = 37.33 sq. ft.
Total……549.33 sq. ft.
U = .29

Walls (net) 1,950 – 549.33 = 1,400.67 sq. ft.

19. Sample Calculation – B Area Calculations www.ChaleffAndRogers.com

Volume = Area x Height =
594 x 20 = 11,880 cubic feet.



Total Roof Area (Sq. Ft.) = 594 1st Floor Sq. Ft. = 594
Other Floors Sq. Ft. = 594
Total Sq. Ft. of Conditioned Space = 1188

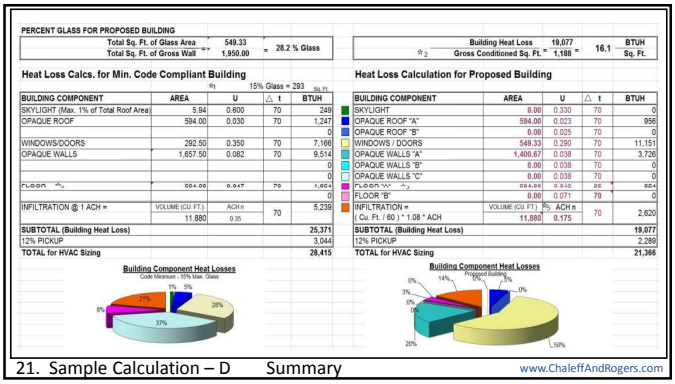
Building Heat Loss 19,077 = 16.1 BTUH
Gross Conditioned Sq. Ft. = 1,188 Sq. Ft.

Heat Loss Calculation for Proposed Building

BUILDING COMPONENT	AREA	U	△ t	BTUH
SKYLIGHT	0.00	0.330	70	0
OPAQUE ROOF "A"	594.00	0.023	70	956
OPAQUE ROOF "B"	0.00	0.025	70	0
WINDOWS / DOORS	549.33	0.290	70	11,151
OPAQUE WALLS "A"	1,400.67	0.038	70	3,726
OPAQUE WALLS "B"	0.00	0.038	70	0
OPAQUE WALLS "C"	0.00	0.038	70	0
FLOOR "A"	594.00	0.042	25	624
FLOOR "B"	0.00	0.071	70	0
INFILTRATION = (Cu. Ft. / 60) * 1.08 * ACH	VOLUME (CU. FT.) 11,880	ACH n 0.175	70	2,620
SUBTOTAL (Building Heat Loss)				19,077
12% PICKUP				2,289
TOTAL for HVAC Sizing				21,366

Building Component Heat Losses
Proposed Building

20. Sample Calculation – C Infiltration www.ChaleffAndRogers.com



PERCENT GLASS FOR PROPOSED BUILDING

Total Sq. Ft. of Glass Area 549.33
Total Sq. Ft. of Gross Wall 1,950.00 = 28.2 % Glass

Heat Loss Calcs. for Min. Code Compliant Building

15% Glass = 293 Sq. Ft.

BUILDING COMPONENT	AREA	U	△ t	BTUH
SKYLIGHT (Max. 1% of Total Roof Area)	5.94	0.600	70	249
OPAQUE ROOF	594.00	0.030	70	1,247
				0
WINDOWS/DOORS	292.50	0.350	70	7,166
OPAQUE WALLS	1,657.50	0.082	70	9,514
				0
				0
FLOOR "A"	594.00	0.042	70	1,664
				0
INFILTRATION @ 1 ACH =	VOLUME (CU. FT.) 11,880	ACH n 0.35	70	5,239
SUBTOTAL (Building Heat Loss)				25,371
12% PICKUP				3,044
TOTAL for HVAC Sizing				28,415

Building Component Heat Losses
Code Minimum - 15% Max. Glass

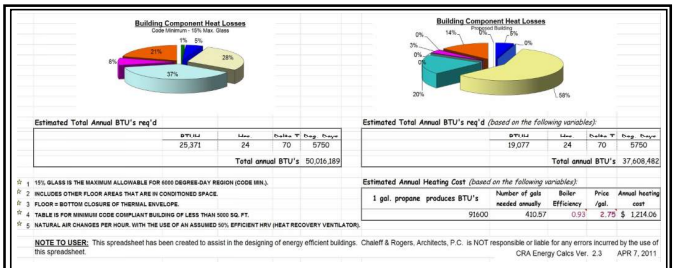
Building Heat Loss 19,077 = 16.1 BTUH
Gross Conditioned Sq. Ft. = 1,188 Sq. Ft.

Heat Loss Calculation for Proposed Building

BUILDING COMPONENT	AREA	U	△ t	BTUH
SKYLIGHT	0.00	0.330	70	0
OPAQUE ROOF "A"	594.00	0.023	70	956
OPAQUE ROOF "B"	0.00	0.025	70	0
WINDOWS / DOORS	549.33	0.290	70	11,151
OPAQUE WALLS "A"	1,400.67	0.038	70	3,726
OPAQUE WALLS "B"	0.00	0.038	70	0
OPAQUE WALLS "C"	0.00	0.038	70	0
FLOOR "A"	594.00	0.042	25	624
FLOOR "B"	0.00	0.071	70	0
INFILTRATION = (Cu. Ft. / 60) * 1.08 * ACH	VOLUME (CU. FT.) 11,880	ACH n 0.175	70	2,620
SUBTOTAL (Building Heat Loss)				19,077
12% PICKUP				2,289
TOTAL for HVAC Sizing				21,366

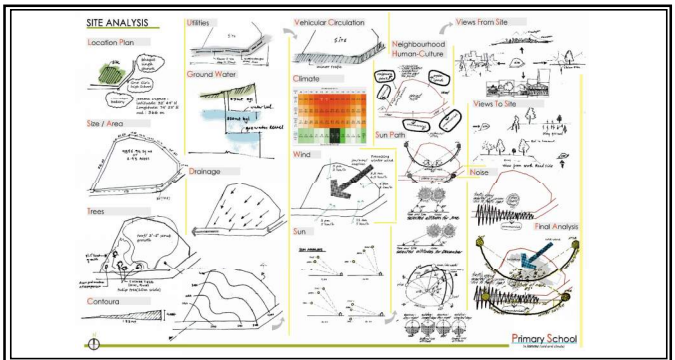
Building Component Heat Losses
Proposed Building

21. Sample Calculation – D Summary www.ChaleffAndRogers.com

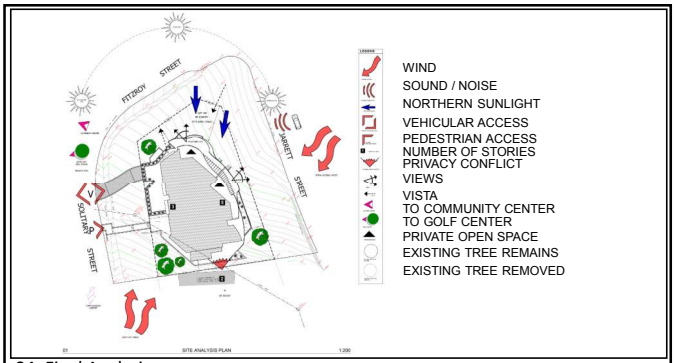


This calculated building performance does not take into consideration Solar Gains or Internal Gains. See DOE III or Edward Mazria's The Passive Solar Energy Book.

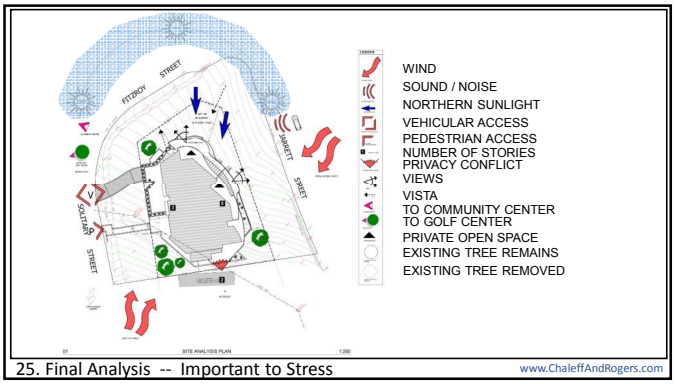
22. Sample Calculation – E Final notes www.ChaleffAndRogers.com



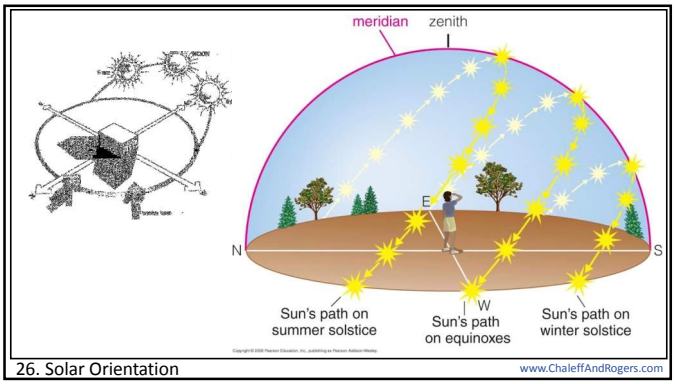
23. Site Analysis: Issues & Concerns / Problems & Opportunities www.ChaleffAndRogers.com



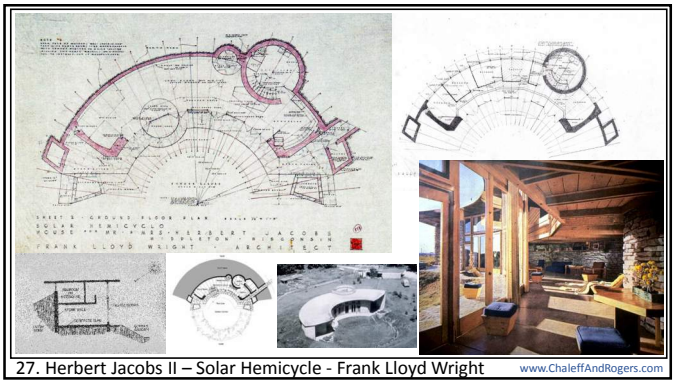
24. Final Analysis www.ChaleffAndRogers.com



25. Final Analysis -- Important to Stress www.ChaleffAndRogers.com

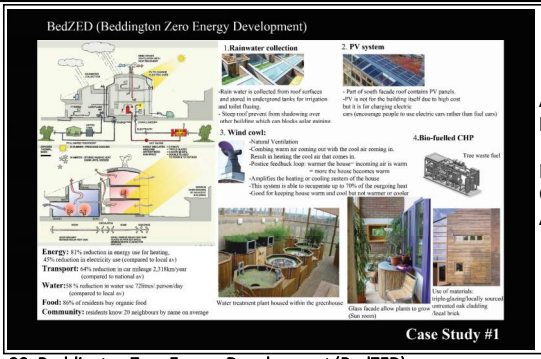


26. Solar Orientation www.ChaleffAndRogers.com



27. Herbert Jacobs II – Solar Hemicycle - Frank Lloyd Wright www.ChaleffAndRogers.com

28. Frank Lloyd Wright – Herbert Jacobs II – solar hemicycle www.ChaleffAndRogers.com

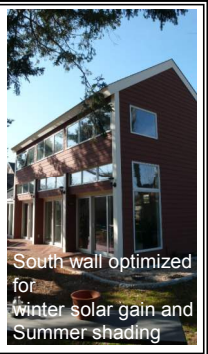


Architect: Bill Dunster

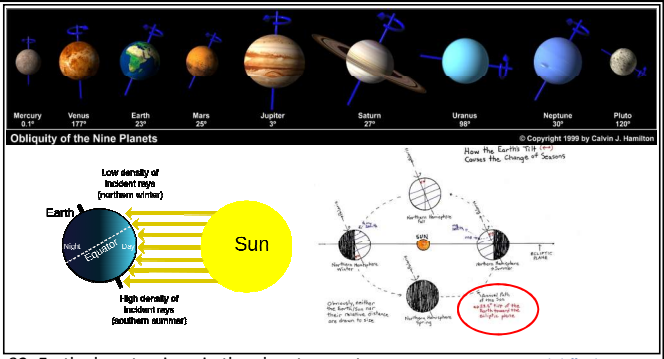
HVAC/green Consultant: Arup Assoc.

29. Beddington Zero Energy Development (BedZED) www.ChaleffAndRogers.com

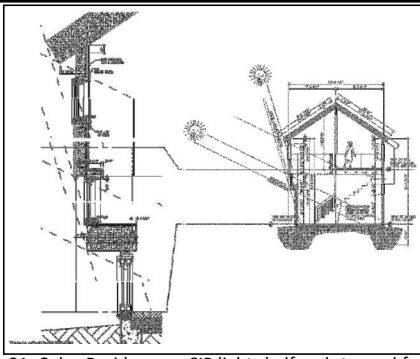
30. Beddington Zero Energy Development (BedZED) www.ChaleffAndRogers.com



31. Coley Residence – SIP light shelf and stepped façade www.ChaleffAndRogers.com



32. Earth almost unique in the planetary system www.ChaleffAndRogers.com



For 41 degrees N. Latitude

Summer Solstice
Altitude @ noon = 73 degrees

Winter Solstice
Altitude @ noon = 26 degrees

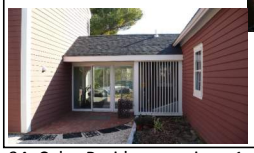
Difference is Constant =
47 degrees

Extra credit question:
Where does the 47 degrees Come from ?

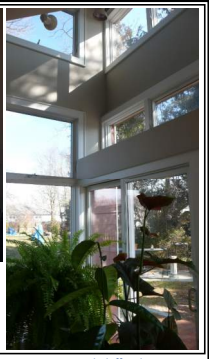
31. Coley Residence – SIP light shelf and stepped façade design www.ChaleffAndRogers.com

Early 18th century street view

View from private back yard

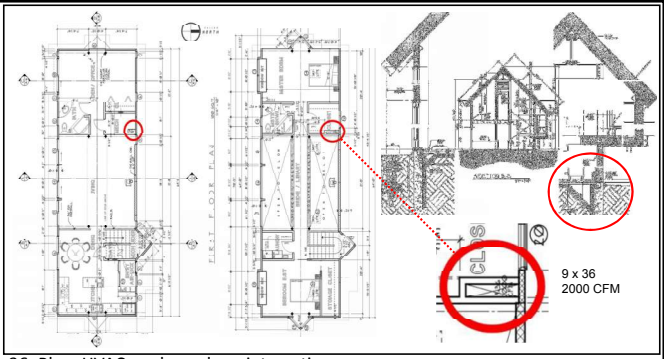


34. Coley Residence – views 1 www.ChaleffAndRogers.com

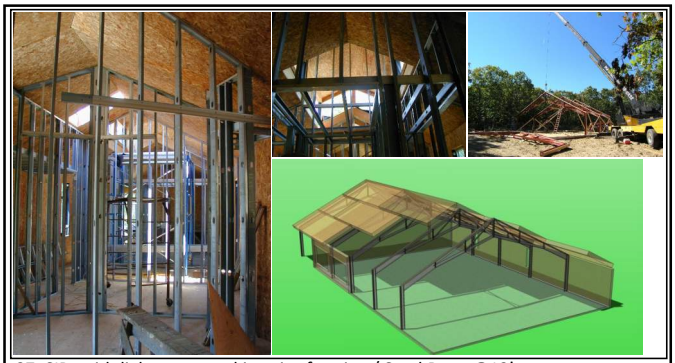


Interior views showing light shelf / stepped façade

34. Coley Residence – views 2 www.ChaleffAndRogers.com



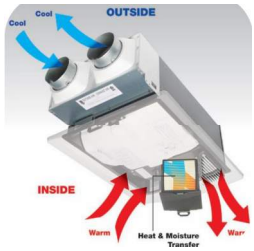
36. Plan, HVAC, and envelope integration www.ChaleffAndRogers.com



37. SIPs with light gage steel interior framing / Steel Bents@12’ www.ChaleffAndRogers.com

Ventilation options –Humidity Control

- Exhaust-only
  - Multiple spot ventilation fans
  - Balanced multiple intake
  - single fan, single exhaust system
- Supply-only
  - Into return side of HVAC system
  - Direct through-the-wall fan
- Balanced
  - Fan-driven air in/air out
  - Heat Recovery (HRV)



38. Humidity Control / IAQ options www.ChaleffAndRogers.com

Questions ?

End of Course W 01

Bill Chaleff, A.I.A., LEED AP Bill@ChaleffAndRogers.com

39. End of Part ONE www.ChaleffAndRogers.com

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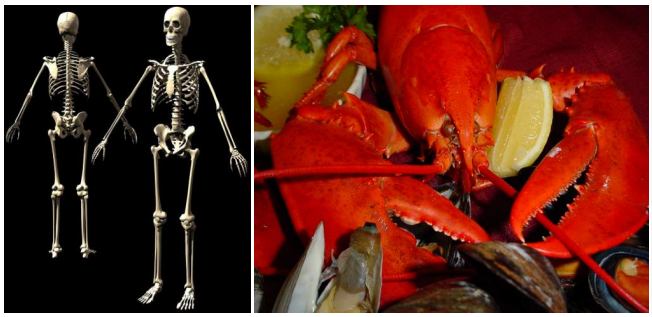
Bill Chaleff, A.I.A., LEED A.P.

SIPs as the Backbone of an Integrated Systems Approach to Building

16 March 2016 course W02

www.ChaleffAndRogers.com



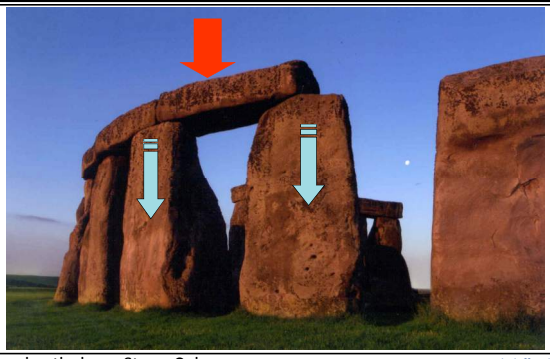
41. Post & Beam vs Thin Shell Construction

www.ChaleffAndRogers.com

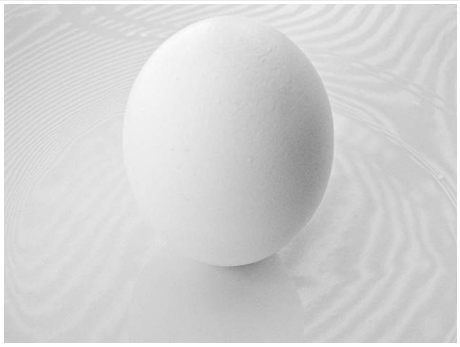
42. Early Post and Beam Construction

www.ChaleffAndRogers.com

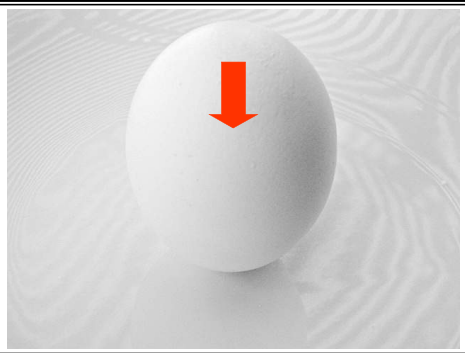
43. Load of Stone Lintel www.ChaleffAndRogers.com



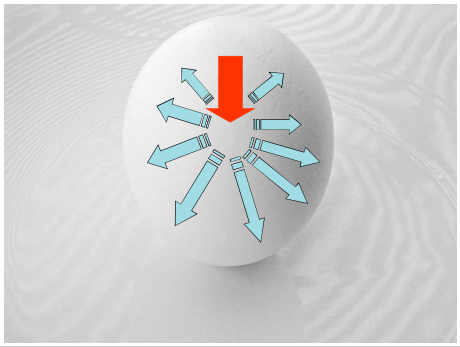
44. Load path down Stone Columns www.ChaleffAndRogers.com



45. Nature's best example of Monocoque Construction www.ChaleffAndRogers.com

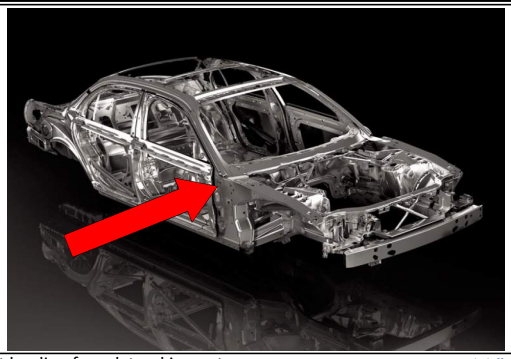


46. Point Load www.ChaleffAndRogers.com

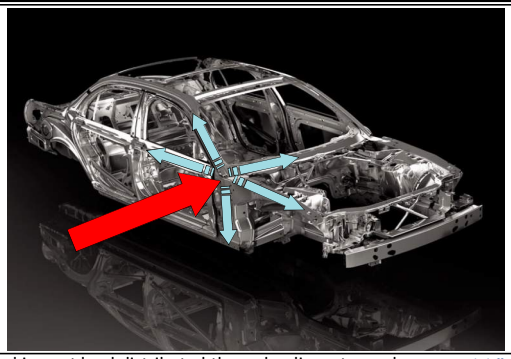


47. Point distributed over large area of shell www.ChaleffAndRogers.com

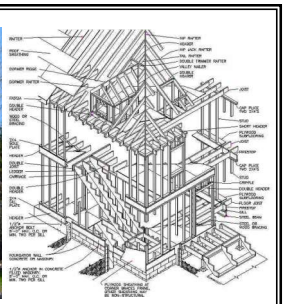
48. Modern Automobile Construction - Monocoque www.ChaleffAndRogers.com



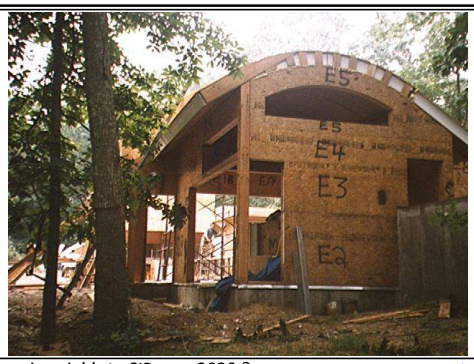
49. Point loading from lateral impact www.ChaleffAndRogers.com



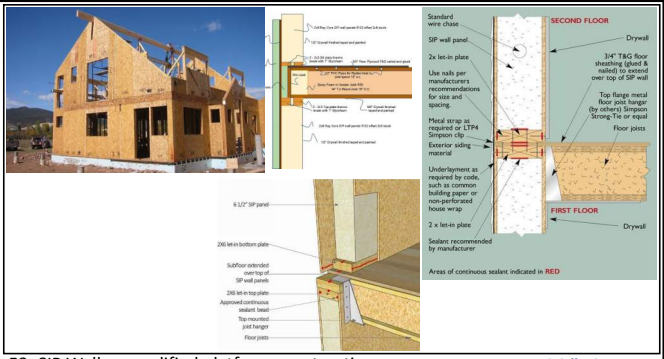
50. Lateral impact load distributed through adjacent members www.ChaleffAndRogers.com



51. Timber frame yields to Stick faming right after 1840 www.ChaleffAndRogers.com

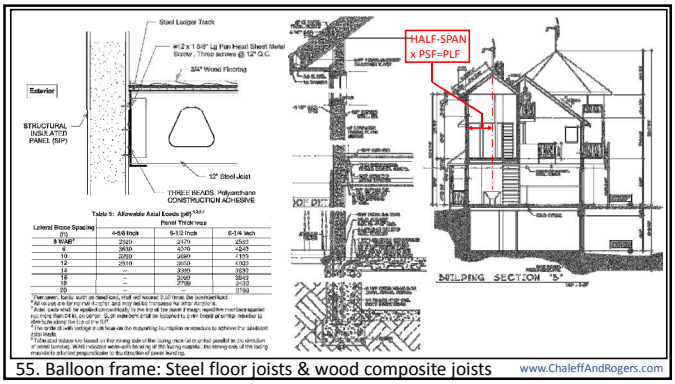


52. Stick framing yields to SIPs……..2020 ?

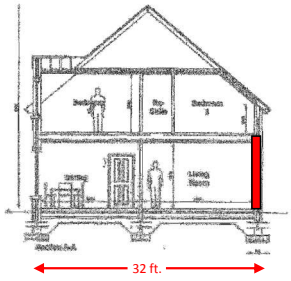


53. SIP Walls – modified platform construction

Slide Text and caption



55. Balloon frame: Steel floor joists & wood composite joists



ROOF LOAD = 16ft x 62.5lbs = 1,000 plf

2nd FLOOR = 8ft x 62.5lbs = 500 plf

TOTAL LOAD @ Top 1st flr = 1,500 plf

56. Load verification

Table 5: Allowable Axial Loads (plf)[1,2,3,4]

Lateral Brace Spacing (ft)	Panel Thickness		
	4-5/8-inches	6-1/2-inches	8-1/4-inches
8 WAB[5]	2420	2580	2650
8	3700	4080	4230
10	3370	3930	4140
12	2990	3730	4020
14	--	3500	3890
16	--	3240	3720
18	--	2960	3540
20	--	--	3340

1. Permanent loads, such as dead load, shall not exceed 0.50 times the tabulated load.
2. All values are for normal duration and may not be increased for other durations.
3. Axial loads shall be applied concentrically to the top of the panel through repetitive members spaced not more than 24-inches on center. Such members shall be fastened to a rim board or similar member to distribute along the top of the SIP panel.
4. The ends of both facings must bear on the supporting foundation or structure to achieve the tabulated axial loads.
5. Tabulated values are based on the strong-axis of the facing material oriented parallel to the span direction. WAB indicates weak-axis bending of the facing material (i.e. the facing material weak-axis is parallel to the span direction).

57. NTA Listing "Axial" Loading table

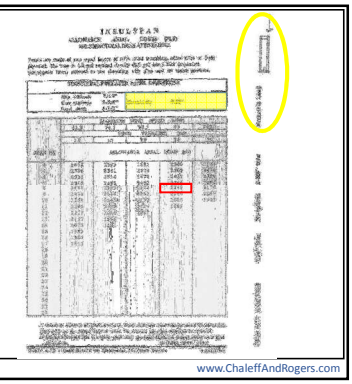
Table 6: Allowable In-Plane Shear Strength (Pounds per Foot) for SIP Shear Walls (Wind and Seismic Loads in Seismic Design Categories A, B and C)[1,2]

Spline Type[3]	Nominal SIP Thickness (in.)	Minimum Facing Connections[2,4]			Shear Strength (plf)
		Chord[2]	Plate[2]	Spline[3]	
Block or Surface Spline	4.625	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	380
	6.625	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	380
	8.375	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	400

[1] Maximum shear wall dimension ratio shall not exceed 2:1 (height : width) for resisting wind or seismic loads.
[2] Chords, holdowns, and connection to other structural elements must be designed by a registered design professional in accordance with accepted engineering practice.
[3] Spline type at interior panel-to-panel joints only, solid chord members are required at each end of each shearwall segment.
[4] Required connections must be made on each side of the panel. Dimensional or engineered lumber shall have an equivalent specific gravity of 0.42 or greater.

APA Report T2007P-05

58. Shear Values – important for diaphragm calculations



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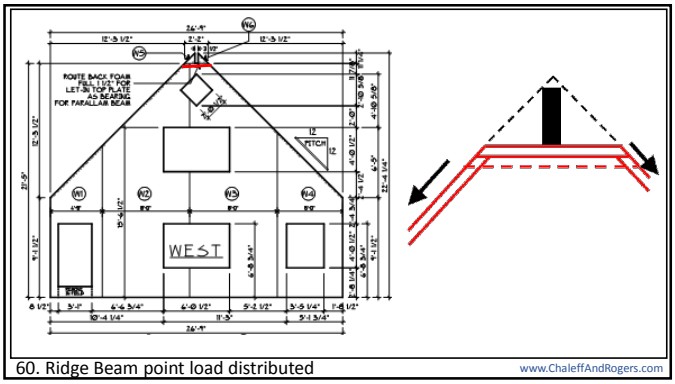
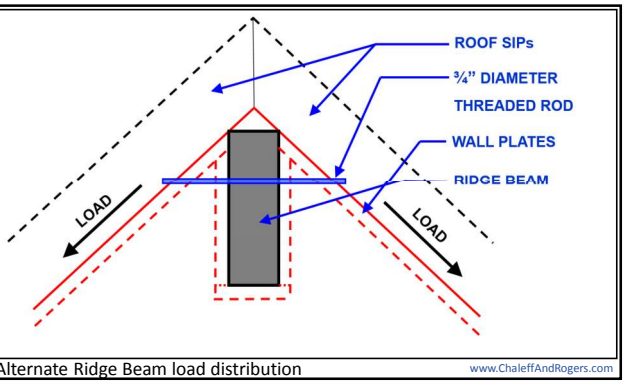
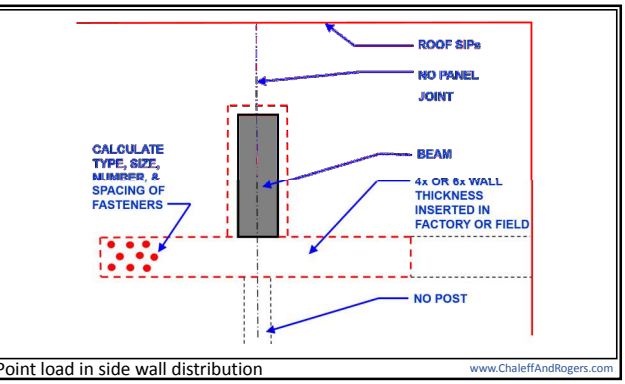


60. Ridge Beam point load distributed



61. Alternate Ridge Beam load distribution www.ChaleffAndRogers.com



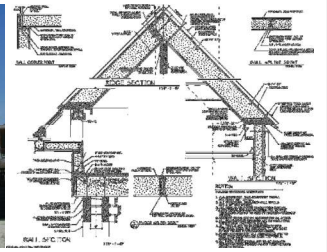
62. Point load in side wall distribution www.ChaleffAndRogers.com

Creep (deformation) the tendency of a solid material to slowly move or deform permanently under the influence of stresses

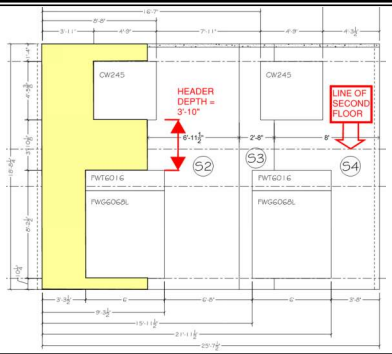
Achilles' Heel of SIPs

63. Creep www.ChaleffAndRogers.com


64. Folded Plate – Diaphragm Construction www.ChaleffAndRogers.com

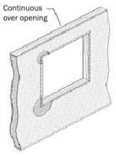
65. SIP Floor Construction www.ChaleffAndRogers.com



66. SIP Header depth increased with balloon framing www.ChaleffAndRogers.com

Load Chart 7: Allowable Header Loads (plf)
Condition 1–Panel is Continuous Over Opening (No Splines)

Header Depth	Deflection	Header Span (ft.)			
		4'	6'	8'	10'
12"	L/480	740*	385*	229*	142*
	L/360	740*	385*	229*	142*
	L/240	740*	385*	229*	142*
18"	L/480	798*	574*	385*	311*
	L/360	798*	574*	385*	311*
	L/240	798*	574*	385*	311*
24"	L/480	886*	629*	429*	361*
	L/360	886*	629*	429*	361*
	L/240	886*	629*	429*	361*

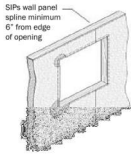


* indicates ultimate load divided by 3 for the design capacity.
In all cases where a concentrated load is placed over on opening or the design loads exceed the capacity of a panel header, Premier Insul-Beam II should be used if possible or an engineered header assembly is required.
More information on this chart can be found in Technical Bulletin #10 (www.pbssips.com).

67. SIP Headers – no joint over opening

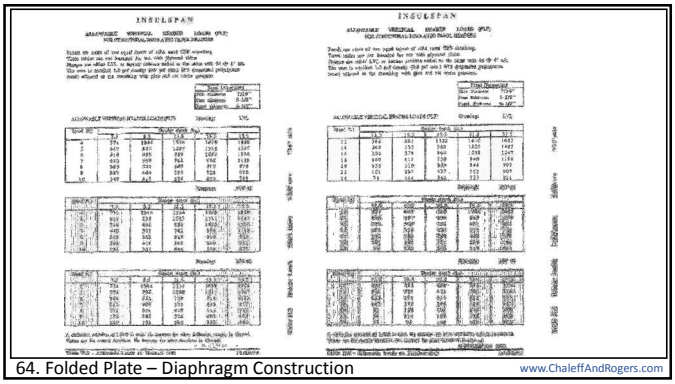
Load Chart 8: Allowable Header Loads (plf)
Condition 2–Panel is Not Continuous Over Opening (Splines)

Header Depth	Deflection	Header Span (ft.)			
		4'	6'	8'	10'
12"	L/480	345	243	156	99
	L/360	450	295	190	125
	L/240	630	382	236*	153*
18"	L/480	705	388	254	235
	L/360	750*	482	302*	281*
	L/240	750*	482	302*	281*
24"	L/480	886	582*	363*	350*
	L/360	886*	582*	363*	350*
	L/240	886*	582*	363*	350*

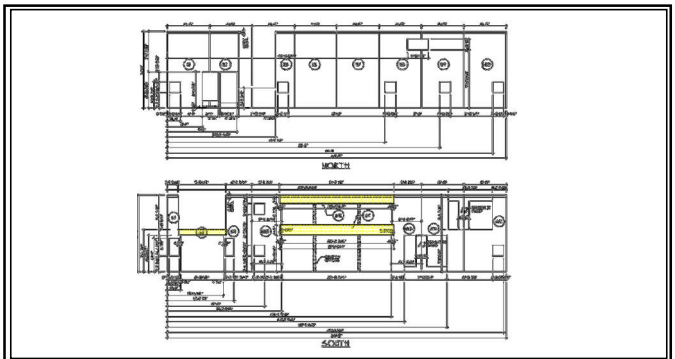


* indicates ultimate load divided by 3 for the design capacity.
In all cases where a concentrated load is placed over on opening or the design loads exceed the capacity of a panel header, Premier Insul-Beam II should be used if possible or an engineered header assembly is required.
More information on this chart can be found in Technical Bulletin #10 (www.pbssips.com).

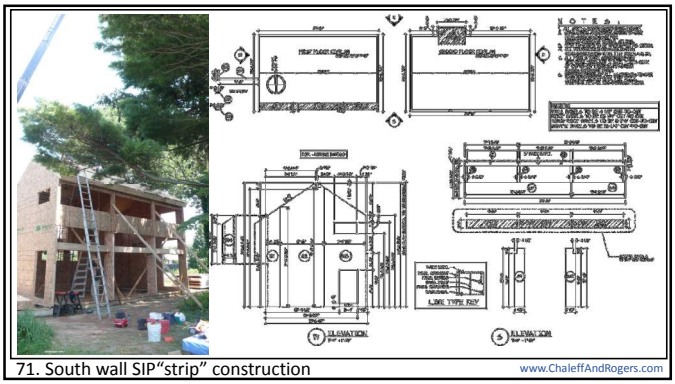
67. SIP Headers – with joint over opening



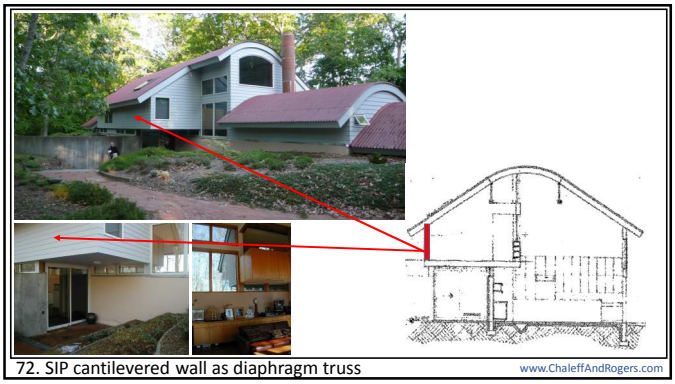
64. Folded Plate – Diaphragm Construction



70. North wall & South wall - punched holes / SIP "strips" www.ChaleffAndRogers.com

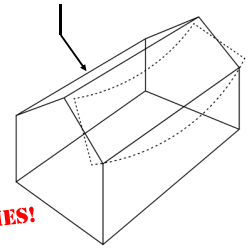


71. South wall SIP"strip" construction www.ChaleffAndRogers.com



72. SIP cantilevered wall as diaphragm truss www.ChaleffAndRogers.com

ROOF PLANE ACTS AS SHEAR DIAPHRAGM;
RIDGE IS IN COMPRESSION,
EAVE IS IN TENSION



ANOTHER WAY TO THINK OF THE ROOF PLANE IS THAT IT IS A BOX BEAM CANTED OVER AT AN ANGLE.

NO RIDGE BEAM OR COLLAR TIES!

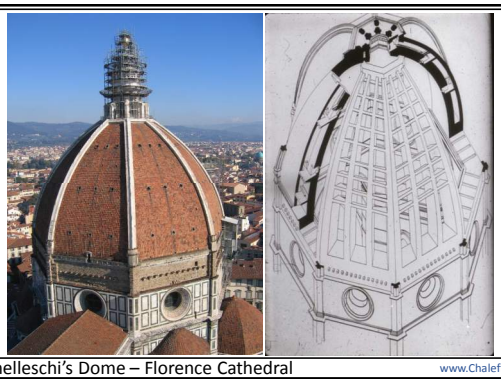
73. SIPs enables the removal of ancillary framing members www.ChaleffAndRogers.com

74. SIP dormer cheeks strengthen openings www.ChaleffAndRogers.com

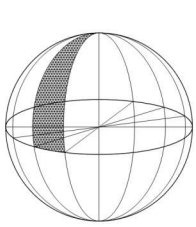
75. Cantilever – Diaphragm Construction www.ChaleffAndRogers.com

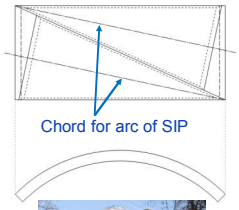
76. Curved SIPs - A www.ChaleffAndRogers.com

77. Curved SIPs - B www.ChaleffAndRogers.com



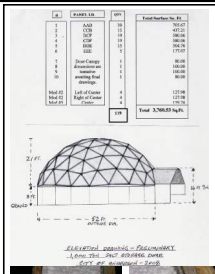
78. Brunelleschi's Dome – Florence Cathedral www.ChaleffAndRogers.com

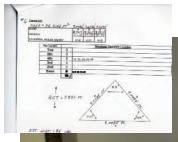




1. Construct SIP to predetermined radius
2. Layout and cut gores
3. Assemble gores to make dome

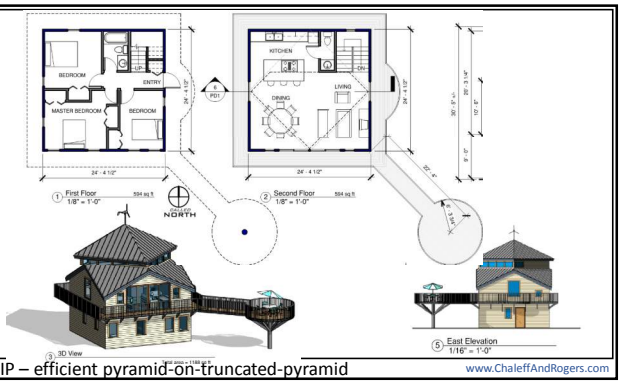
78. SIP Segmented vaulted dome construction



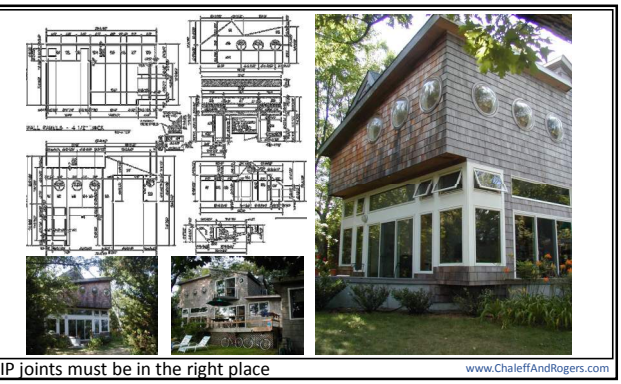


80. SIP Geodesic dome

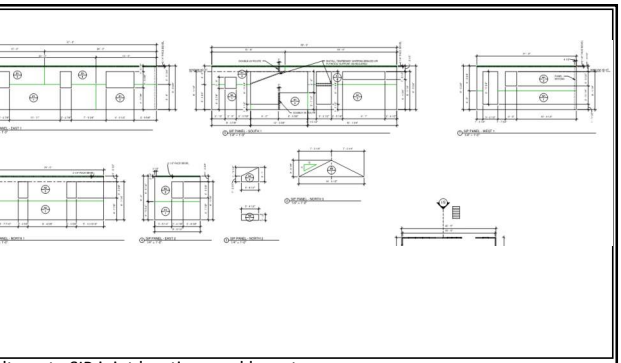
81. SIP free-form “egg”



82. SIP – efficient pyramid-on-truncated-pyramid www.ChaleffAndRogers.com



83. SIP joints must be in the right place www.ChaleffAndRogers.com



84. Alternate SIP joint locations and layouts www.ChaleffAndRogers.com

Questions ?

End of Course W 02

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85. End of Part TWO