Building America Research Program Update Building Science Consortium

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Goal

50 percent reduction in total energy consumption for no more than a 5 percent increase in construction cost

Can get there with the following approach: Insulating sheathing Advanced framing Blown in cavity insulation Air tight enclosure High performance glazing Insulated foundation (slab, crawl, basement) Equipment, lighting, appliances























Relative Humidity (RH) %

* For 80% or more of the occupants in a space





 μ_D = Dry cup permeability



Permeability vs. Relative Humidity

- Typical relationship between dry- and wet-cup methods and spot permeability for many hygroscopic building materials such as asphalt impregnated felt building papers, plywood, OSB and kraft facings on insulation batts
- $\mu_W = 2$ to 3 times greater than μ_D
- Wet cup testing occurs with 50% RH on one side of test specimen and 100% RH on other side
- Dry cup testing occurs with 0% RH on one side of test specimen and 50% RH on other side






































































































































































































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DELIVERY or DISPOSAL





WHERE 4 IS GOOD





WHERE 5 IS BETTER





9 HAS GOT TO BE JUST GREAT!





23 MAKES IT BULLET PROOF





Design Issues

 Design buildings that coordinate advanced framing practices with material availability and integrate with building envelope design and mechanical system layout





Advanced Framing System

•Stack Framing Concept





Design Issues

 Provide drawings that integrate advanced framing into complete building envelope design and mechanical system layout







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- Insulated headers
- No header necessary at non-bearing walls









- Insulated headers
- No header necessary at non-bearing walls





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 Drywall clips allow for better installation with less drywall cracking





















- HOUSE SPECIFICATIONS
 - Conditioned Floor Area
 - Total Floor Area
 - Typical Wall Height
 - Total Conditioned Volume
 - Length of Exterior Wall
 - Length of Interior Wall

2,495 sq ft 2,910 sq ft 9'-11 1⁄2" 24,850cu ft 252 ln ft 340 ln ft



• 2x4 16" oc WALL

	8'Studs	Bd Ft	Cost	
 Ext Wall 	467	1634 bd ft		\$866
– Ext Plate	95	331 bd ft		\$175
 Int Wall 	715	2502 bd ft		\$1326
– Int Plate	126	446 bd ft		\$237
– Header		273 bd ft		\$145
– TOTAL WALL FR		\$2749		



• 2x6 24" oc ADVANCED FRAME WALL

		8'Studs	Bd Ft	Cost
_	Ext Wall	238	1312 bdft	\$695
_	Ext Plate	63	347 bd ft	\$183
_	Int Wall	279	977 bd ft	\$518
_	Int Plate	85	298 bd ft	\$158
_	Header		148 bd ft	\$78
_	TOTAL WALL FR	AME COST		\$1632



• WOOD FRAME WALL SUMMARY

	2x4	2x6	REDUCED BY
– 8' Studs	1403	665	(-738 / -52%)
– Bd Ft	5186	3082	(-2104 / -40%)
– COST	\$2749	\$1632	(-\$1117 / -40%)



Building America Research

Affordable Inset Shear Panels for Seismic and Wind Load to permit use of advanced framing and insulating sheathing



Test Configuration and Procedures



- Three Specimens of Each PanelVertical Actuators:
 - - Apply Vertical Load
 - Hold Top Beam Horizontal
- Out-of-Plane Motion
- RestrainedMonotonic Test of each Panel



Evolution of Approaches





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CUREe/Caltech Woodframe Cyclic Load History



Reference Deformation, $\Delta = 2.0$ in., Rates = 10 sec/cycle; 20 sec/cycle



Standard Plywood Panel - 2x4 Frame





Standard Plywood Panel Performance







Standard OSB Panel (P3-6)





Standard OSB Panel Performance (P3-6)







Diagonal Strap Shear Panel (P3-1) CUREe1





Diagonal Strap Panel Performance (P3-1) CUREe1





















Advanced Shear Panel





Recommended Inset Panel – Threaded Rod





Recommended Inset Panel (P3-3M) CUREe1









- Interior Rods
- Rod/Couplin g
- ⊥ Inset Frame
- 3-1/2" Cavity



•CERL (the US Army research laboratory), and BSC are facilitating code approval of advanced framing techniques by the Division of the State Architect in California, and other earthquake and high wind loading locations.

•Full scale assemblies have been tested under the new dynamic seismic loading protocols developed after the Northridge earthquake. New non-proprietary shear panels are now available for use that allow for advanced envelope design





Narrow Inset Panel – No Threaded Rod (P3-7)





Narrow Inset Panel Performance (P3-7) CUREe2











2 Story Aligned





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Summary

We are close with all of these - but we are not quite ready for prime time. We should be ready to push all of these within a year.

Insulating sheathing Advanced framing Blown in cavity insulation Air tight enclosure High performance glazing Insulated foundation (slab, crawl, basement) Equipment, lighting appliances

