

Energy Efficient House Construction

What makes a house energy efficient?

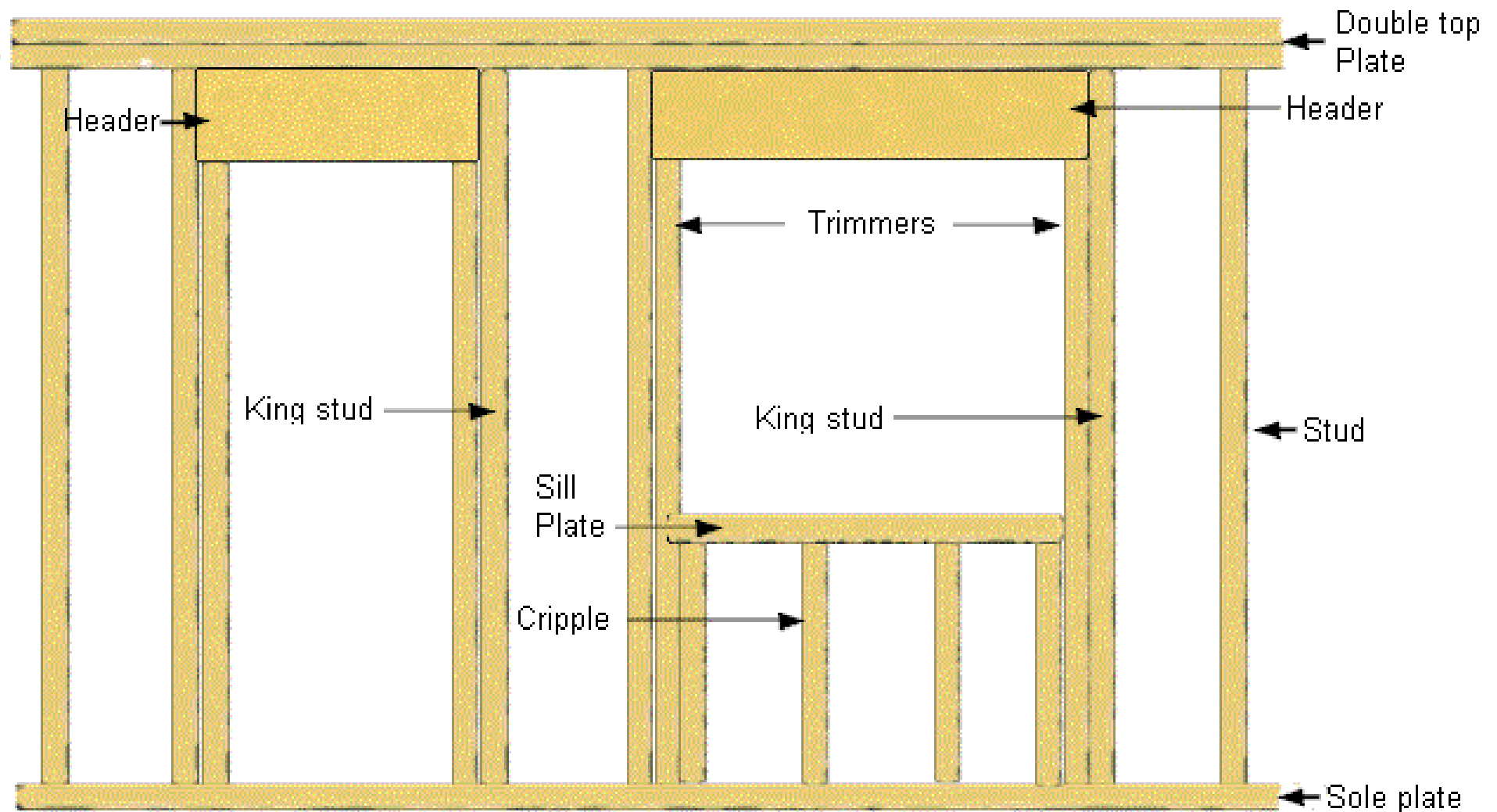
- Good insulation
 - Walls, windows, and doors
- Minimize air infiltration
- Energy efficient heating and cooling
- Energy saving appliances, lighting, etc.

Types of construction

- Stick frame
- Less practical
 - Dome home
 - Rammed Earth
 - Straw bale
- Insulated Concrete Forms (ICFs)
- Structural Insulated Panels (SIPs)

Stick frame

- Fiberglass insulation (most common)
 - Least energy efficient
 - R13 insulation in a 2x4 wall that leaks like a colander
 - Use a properly installed vapor barrier
 - Tape the seams and caulk cracks
- Spray polyurethane foam
 - Seals cracks
 - Needs no vapor barrier
 - R23 maximum if the cavity is filled
- 2x4s have an R5 rating and take up 15% or more of the wall
- Stick frame construction is actually the weakest and least energy efficient method of construction allowed by law (Building code)



Components of a framed wall
Showing rough door and
window openings

Dome Home in New Hope, AL



Dome Pros And Cons

- Pros
 - Continuous pour concrete provides low air infiltration
 - Nearly a full house storm shelter
 - Organic looking house
- Cons
 - Unusual architecture; does not fit in with other houses
 - External wall builtins need to be custom
 - Takes up more land per square foot
 - Rarely two levels
 - Not many builders

Rammed Earth Tire Home



Structurally Insulated Rammed Earth Home



Rammed Earth Pros And Cons

- Pros
 - Mostly cheap or onsite building materials
 - Good sound barrier
- Cons
 - Labor intensive
 - High cost
 - Totally custom
 - Very thick walls

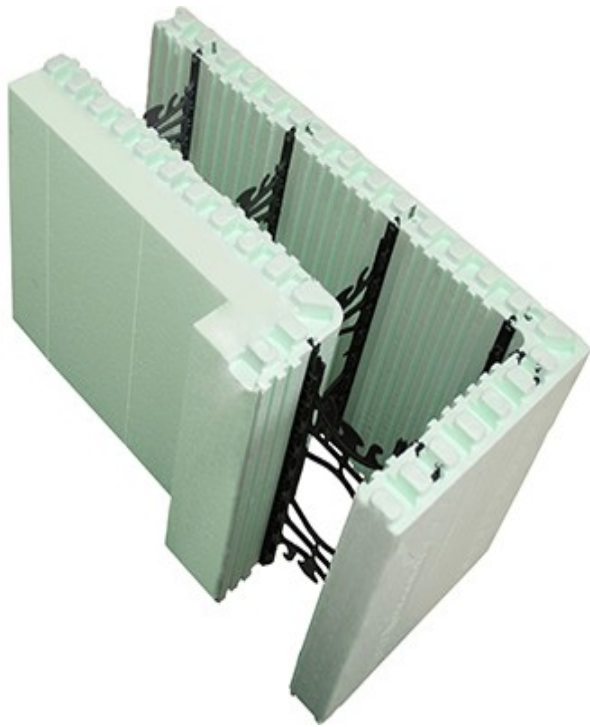
Straw Bale House



Straw Bale Pros And Cons

- Pros
 - Straw is cheap
 - Good sound barrier
- Cons
 - No national building code
 - Must keep the straw dry; not appropriate for high humidity regions
 - Very thick walls
 - Beware of big bad wolves

Insulated Concrete Forms (ICFs)



Green Building Made Easy

With Quad-Lock & Quad-Deck Insulated Concrete Forms

Lower Appetite for Energy - high R-values / low air infiltration

Thermal Comfort

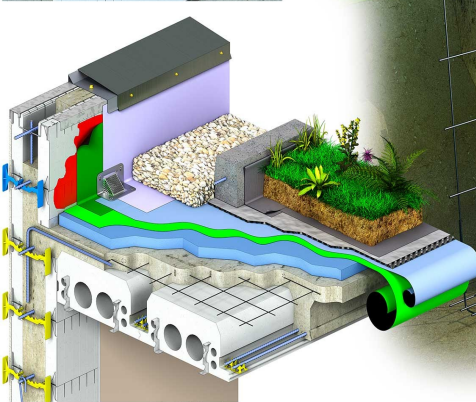
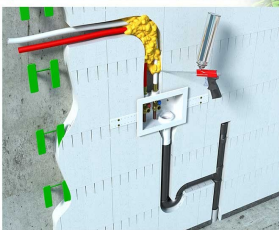
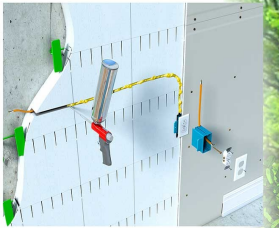
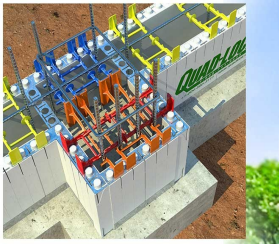
Faster Construction Time; forming and insulating in one step

Extensive Lifecycle - concrete buildings can last hundreds of years

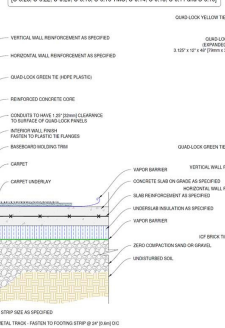
Lower Costs for Operations & Maintenance

Disaster Resistant Designs with Reinforced Concrete

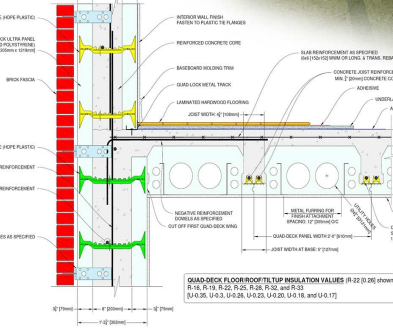
Low Susceptibility to Water Damage



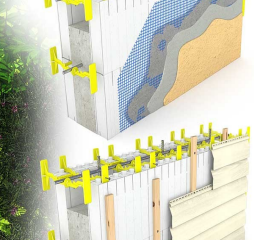
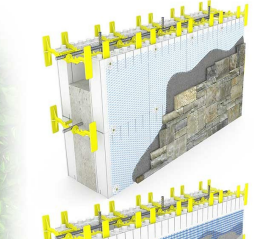
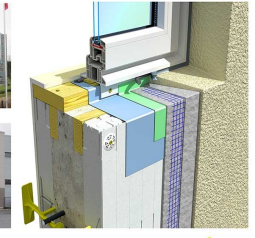
QUAD-LOCK WALL INSULATION VALUES (R-28 wall assembly shown)
R-22, R-20, R-18, R-16, R-14, R-12, R-10, R-8, R-6, R-4, R-2, and R-1 (U-0.04, U-0.05, U-0.06, U-0.07, U-0.08, U-0.09, U-0.10, U-0.11, and U-0.12)



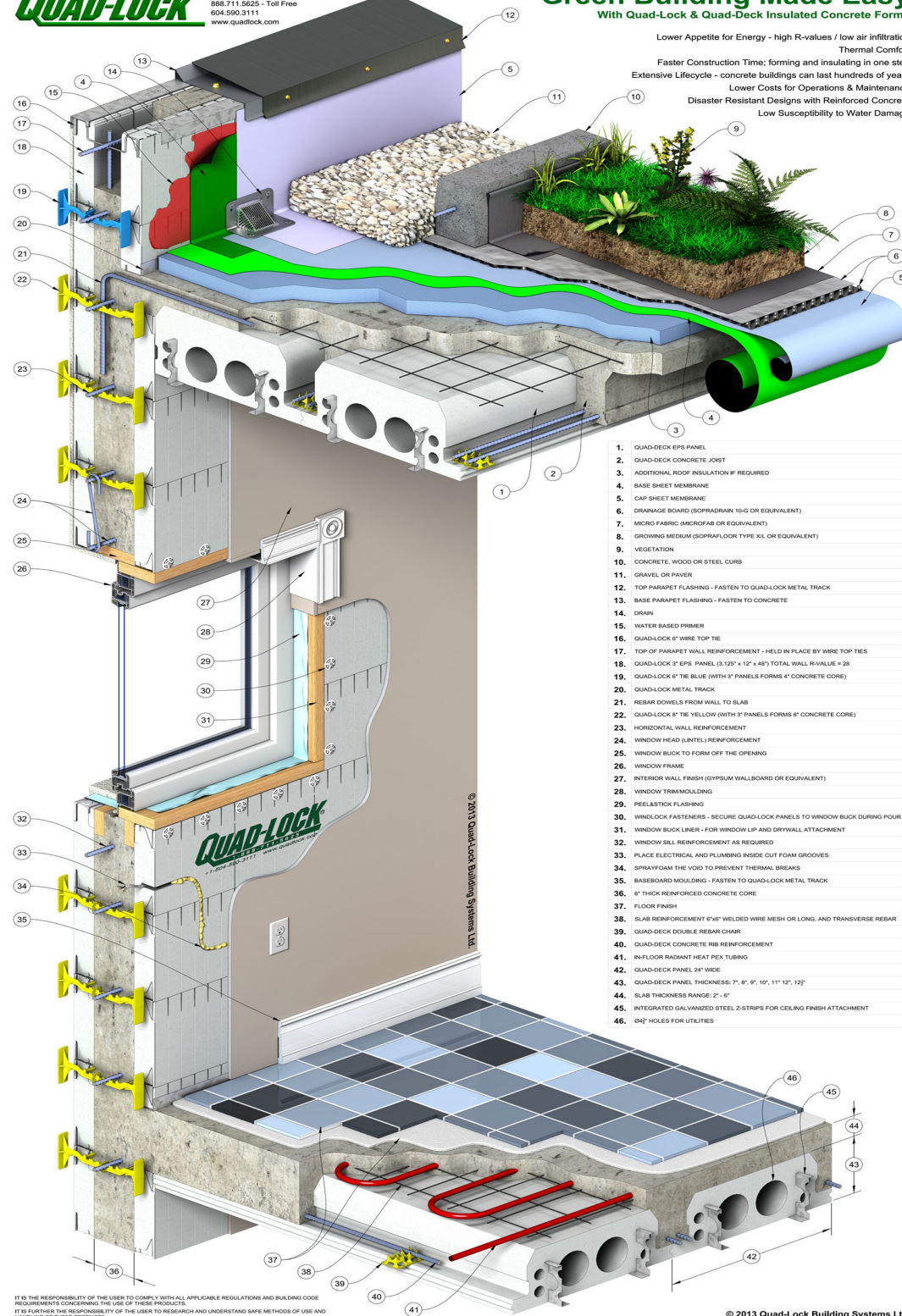
QUAD-LOCK FLOOR/ROOF/CEILING INSULATION VALUES (R-22 (0.28) shown)
R-16, R-14, R-12, R-10, R-8, R-6, R-4, R-2, and R-1 (U-0.06, U-0.07, U-0.08, U-0.09, U-0.10, U-0.11, and U-0.12)



IT IS THE RESPONSIBILITY OF THE USER TO COMPLY WITH ALL APPLICABLE REGULATIONS AND BUILDING CODE REQUIREMENTS CONCERNING THE USE OF THESE PRODUCTS. IT IS FURTHER THE RESPONSIBILITY OF THE USER TO RESEARCH AND UNDERSTAND SAFE METHODS OF USE AND HANDLING OF THESE PRODUCTS.



Lower Appetite for Energy - high R-values / low air infiltration
Thermal Comfort
Faster Construction Time; forming and insulating in one step
Extensive Lifecycle - concrete buildings can last hundreds of years
Lower Costs for Operations & Maintenance
Disaster Resistant Designs with Reinforced Concrete
Low Susceptibility to Water Damage



1. QUAD-DECK EPS PANEL
2. QUAD-DECK CONCRETE JOIST
3. ADDITIONAL ROOF INSULATION IF REQUIRED
4. BASE SHEET MEMBRANE
5. CAP SHEET MEMBRANE
6. DRAINAGE BOARD (SOPRADRAIN 10-G OR EQUIVALENT)
7. MICRO FABRIC (MICROFAB OR EQUIVALENT)
8. GROWING MEDIUM (SOPRAFLOR TYPE XL OR EQUIVALENT)
9. VEGETATION
10. CONCRETE, WOOD OR STEEL CURB
11. GRAVEL OR PAVEMENT
12. TOP PARAPET FLASHING - FASTEN TO QUAD-LOCK METAL TRACK
13. BASE PARAPET FLASHING - FASTEN TO CONCRETE
14. DRAIN
15. WATER BASED PRIMER
16. QUAD-LOCK 6" WIRE TOP TIE
17. TOP OF PARAPET WALL REINFORCEMENT - HELD IN PLACE BY WIRE TOP TIES
18. QUAD-LOCK 3" EPS PANEL (3,125" x 12" x 48") TOTAL WALL R-VALUE = 28
19. QUAD-LOCK 6" TIE BLUE (WITH 3" PANELS FORMS 4" CONCRETE CORE)
20. QUAD-LOCK METAL TRACK
21. REBAR DOWELS FROM WALL TO SLAB
22. QUAD-LOCK 8" TIE YELLOW (WITH 3" PANELS FORMS 6" CONCRETE CORE)
23. HORIZONTAL WALL REINFORCEMENT
24. WINDOW HEAD (INTEL) REINFORCEMENT
25. WINDOW BUCK TO FORM OFF THE OPENING
26. WINDOW FRAME
27. INTERIOR WALL FINISH (GYPSUM WALLBOARD OR EQUIVALENT)
28. WINDOW TRIMMOULDING
29. PEEL&STICK FLASHING
30. WINDOW LOCK FASTENERS - SECURE QUAD-LOCK PANELS TO WINDOW BUCK DURING POUR
31. WINDOW BUCK LINER - FOR WINDOW LIP AND DRYWALL ATTACHMENT
32. WINDOW SILL REINFORCEMENT AS REQUIRED
33. PLACE ELECTRICAL AND PLUMBING INSIDE CUT FOAM GROOVES
34. SPRAYFOAM THE VOID TO PREVENT THERMAL BREAKS
35. BASEBOARD MOULDING - FASTEN TO QUAD-LOCK METAL TRACK
36. 6" THICK REINFORCED CONCRETE CORE
37. FLOOR FINISH
38. SLAB REINFORCEMENT 6"x6" WELDED WIRE MESH OR LONG AND TRANSVERSE REBAR
39. QUAD-DECK DOUBLE REBAR CHAIR
40. QUAD-DECK CONCRETE RIB REINFORCEMENT
41. IN-FLOOR RADIANT HEAT PEX TUBING
42. QUAD-DECK PANEL 24" WIDE
43. QUAD-DECK PANEL THICKNESS: 7", 8", 9", 10", 11" 12", 12 1/2"
44. SLAB THICKNESS RANGE: 2" - 6"
45. INTEGRATED GALVANIZED STEEL Z-STRIPS FOR CEILING FINISH ATTACHMENT
46. 6"x6" HOLES FOR UTILITIES

ICF Roof Ready for Concrete



ICF Pros

- Continuous concrete pour reduces air infiltration
- Will not promote rot, mold, or mildew
- Very strong especially with ICF roof
 - Nearly a full house storm shelter
- Fire resistant but form will melt
- Not a food source for insects or small animals
- Recyclable construction materials
- Good sound barrier

ICF Cons

- Thick walls require custom window and door trim
- Not as good R value as polyurethane insulation
- Difficult to alter post construction
- Only flat or shallow slope roof
 - Steeper roofs require different roof system
- Possible problems with below grade use
 - Insects may tunnel through forms and go undetected

Compound ICF

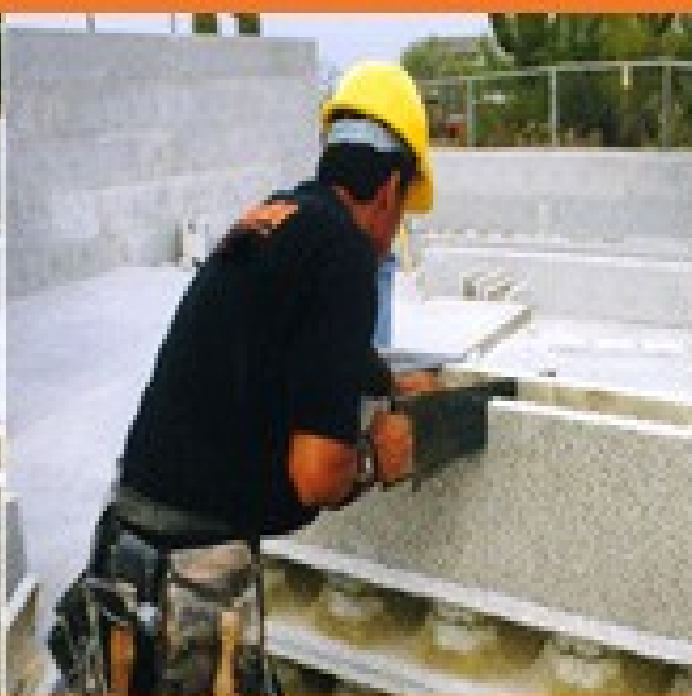


Very form-able

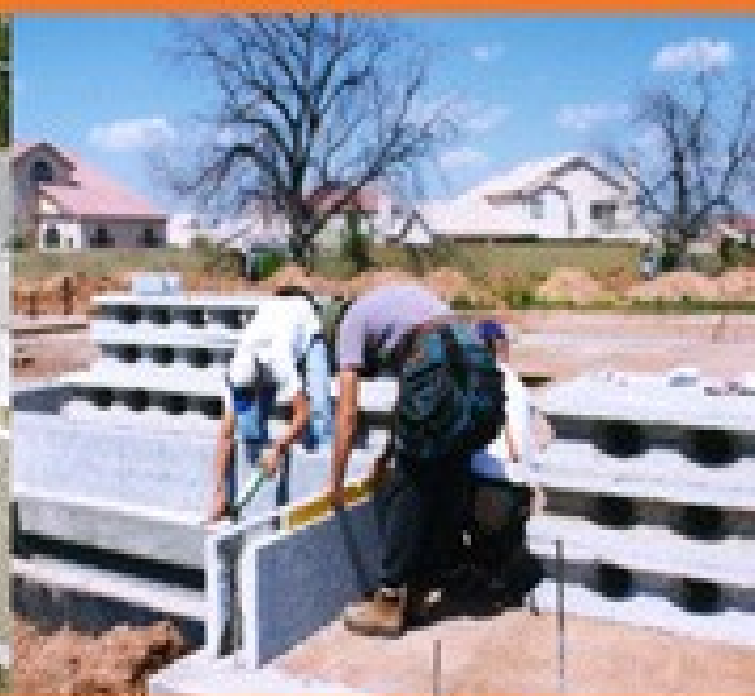




MARK IT



CUT IT



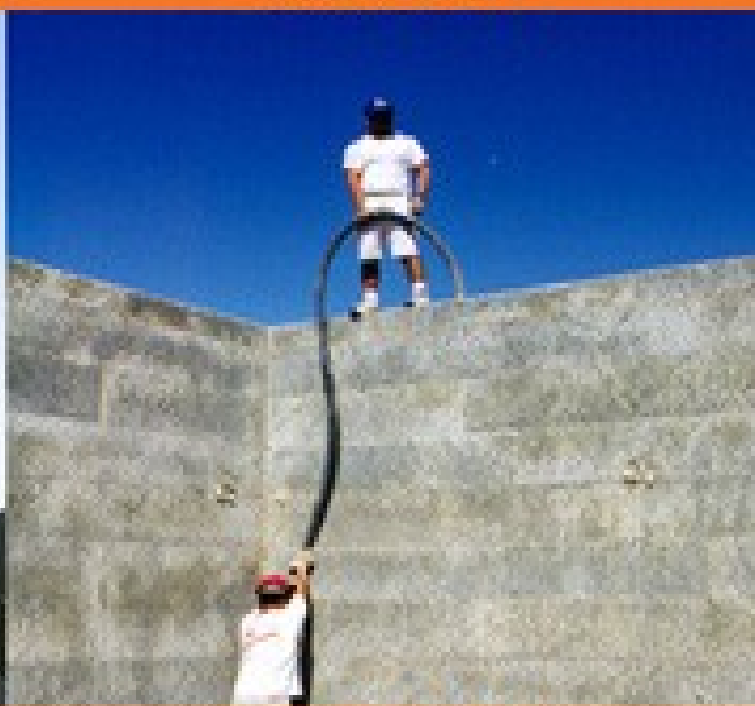
PLACE IT



CHECK IT



TACK IT



GROUT IT

Differences from ICF

- Forms 85% recycled EPS with 15% cement
- Usable below grade
 - Insects cannot burrow through
- Better fire resistance
 - Withstands 4 Hrs at 2000 degree heat
- Concrete fill grid pattern may allow more air infiltration

Structural Insulated Panels (SIPs)

- Two basic types of insulation used
 - Expanded PolyStyrene (EPS) (R3.5 per inch)
 - Polyurethane (R7 per inch)



SIP Pros

- High R values
- Very low air infiltration
- Various panel thicknesses available
- Naturally vaulted ceilings
- Quick shell installation
- Good sound barrier
- No 2x4 studs to miss when hanging drywall, cabinets, and pictures
- 20-30% stronger than stick framing
- No place for mold and mildew to grow
- Window and door jams, electrical outlets, wire chases, and beam pockets can be preinstalled

SIP Cons

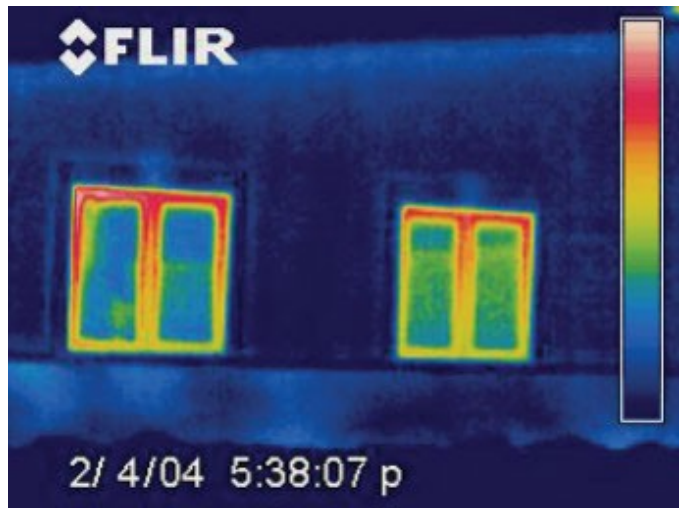
- Higher initial material cost
 - Offset by lower construction labor cost
 - Offset by lower utilities cost
- More difficult to change design during construction

SIP Polyurethane vs EPS

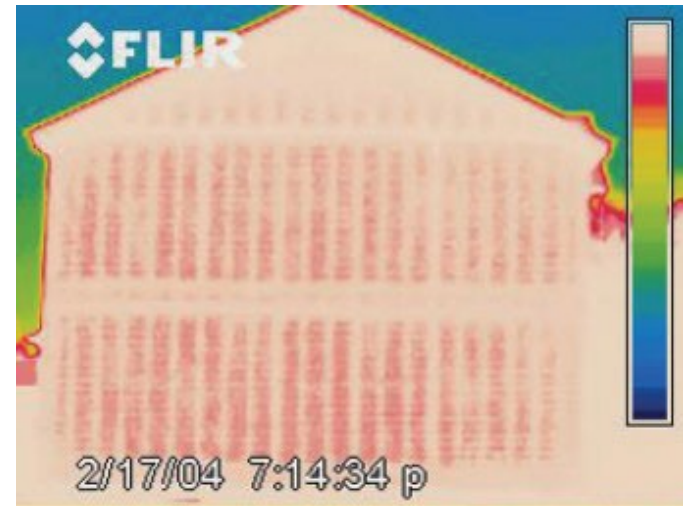
- Most over-the-counter chemicals won't damage polyurethane (adhesives)
 - Field modifications
- Polyurethane has a better fire rating
- Polyurethane has nearly double the R value per inch
- Polyurethane panels can be custom created vs cut from standard EPS panel blanks
- EPS is generally inferior to polyurethane except in price

SIP Infrared Comparison

Thermocore panels



Stick built



The following is our house
construction using a type of tilt-up
ICFs and Thermocore SIPs





















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Our House Energy Summary

- Insulation: R28 exterior walls and R41 roof
- 3800 square feet of living space
- Needs half the normal sized HVAC system (3 ton vs 6 ton compressor)
- Move in construction cost around \$59/sq-foot
 - Sweat equity helped reduce the cost
- Used 16715 kWh in 2015
 - 1393 kWh/month, or 45.8 kWh/day, or \$132/month

Primary References

- <http://www.quadlock.com/>
- <http://www.rastra.com/>
- <http://thermocore.com/>