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*Institute for
Research in
Construction*

NRC Consultation- PERD 079 Project

Review of Promising Wall Assemblies

Prepared by

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Feb. 2007



National Research
Council Canada

Conseil national
de recherches Canada

Canada

Task 2 Objective

Identify current practices, technologies, issues for buildings subjected to extreme environmental conditions

– **Extreme cold outdoors & high indoor moisture**



To provide knowledge base for selecting building envelope assemblies for the analysis tasks

- ✓ **Global literature review**
- **Consult with communities**

Literature Review Results

- **Significant information on**
 - Building construction practices & issues
 - Heating, ventilating, IAQ, and energy
 - Socio-housing issues
- **Example buildings construction**
Arctic, Antarctica, Scandinavian, Himalaya, Japan
Indigenous architectures' climate adaptation

High Performance of Exterior Walls

Control of heat and moisture flow

- Thermal insulation value
 - fiberglass and mineral fiber batt & blown in
 - Blown-in cellulose fiber
 - Polystyrene boards (EPS , XPS and polyurethane)
 - Sprayed polyurethane foam
- Airtightness (through flow)
 - Material with low air permeance (membrane & board type)
 - Detailing and quality of execution for continuity
- Air circulation (lateral flow)
 - Wind barrier or air infiltration barrier
- Thermal bridges effect
 - Detailing, design of assembly
- Vapour diffusion
 - Material with low vapour permeance

Types of Wall Assemblies

- Single stud wall with
 - insulation in the stud cavity
 - exterior insulating sheathing
 - interior insulating sheathing
 - all insulation & air barrier on exterior of a stud space
- Double stud wall with
 - load-bearing interior stud wall
 - load-bearing exterior stud wall
 - exterior standoff wall
- Rigid insulating core panel walls
- Stress-skin panels (SIPs)
- Insulating concrete forms

Single Stud Walls

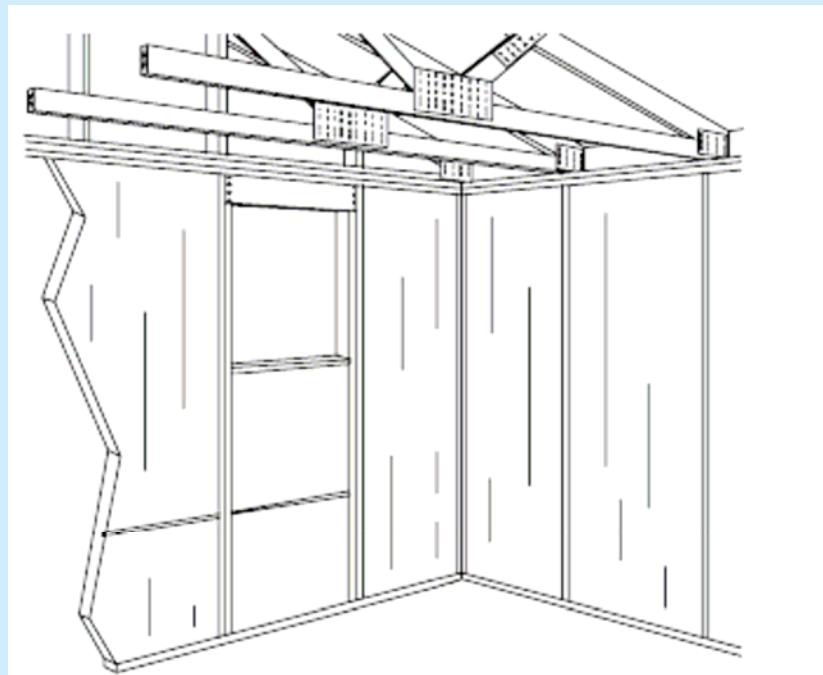
Single stud wall with insulation in the stud cavity

- Traditional construction in 2X4 or 2X6 lumber
- Different insulation materials in stud cavity
- Different airtightness strategies (interior membrane or board, exterior membrane or board)
- Studs constitute thermal bridges
- Limit on R value in the stud cavity

Single Stud Walls

Panelized panels of stud wall filled with insulation

Conventional 2X4 stud wall with polyurethane core

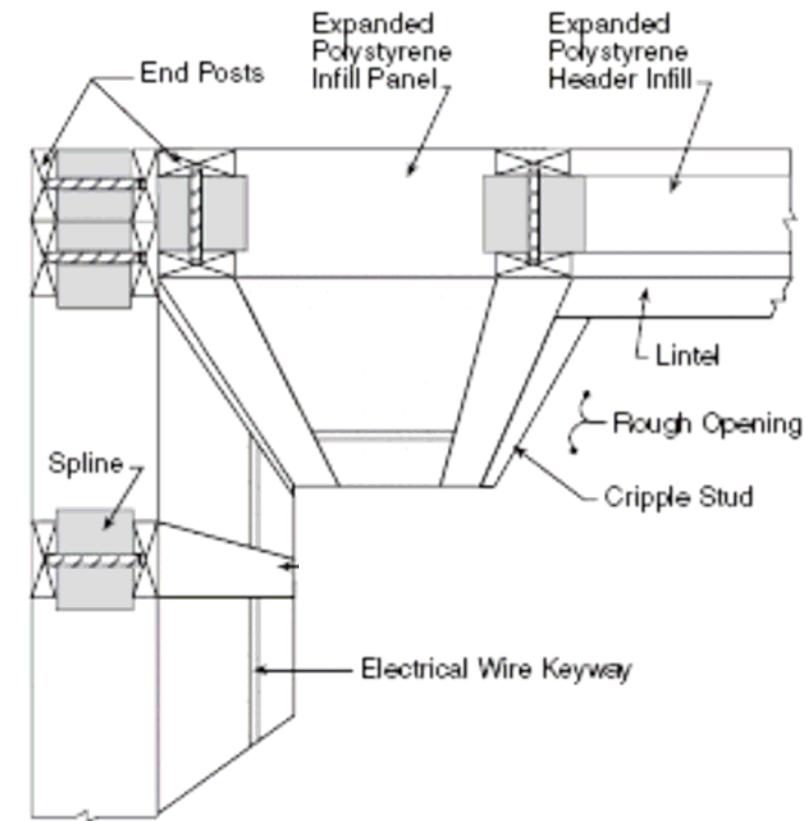


Source: NRC Canadian Construction Materials Centre,
2006 evaluation report CCMC 12145-R

Single Stud Walls

Panelized single “I stud” wall with insulation in cavity

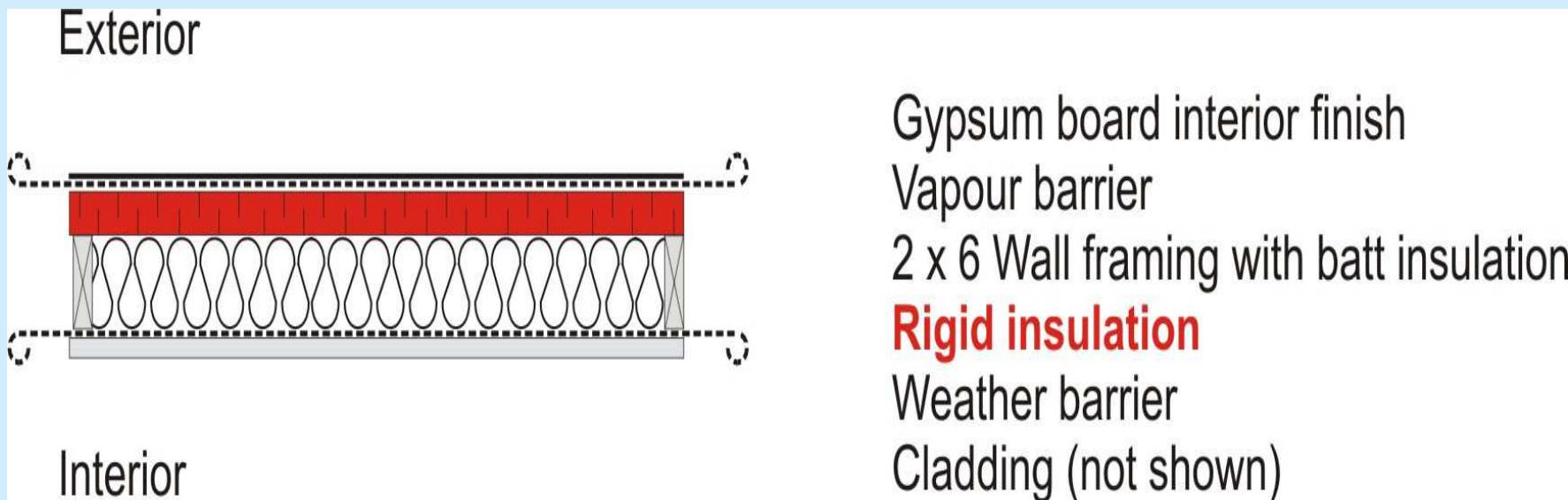
Prefabricated panel system with “I” studs and EPS Type 1 core



Source: NRC Canadian Construction Materials Centre,
2006 evaluation report CCMC 12717-R

Single Stud Walls

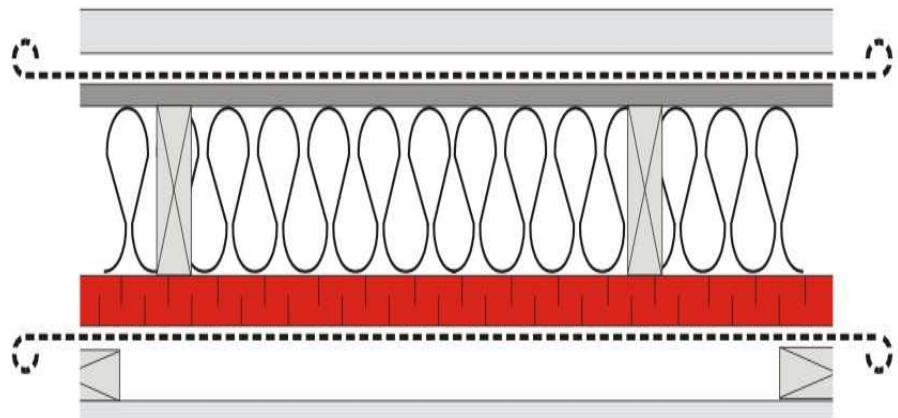
Single stud wall with exterior insulating sheathing



Single Stud Walls

Single stud wall with interior insulating sheathing

Exterior



Interior

Practice in Nunavik:

Galvanized steel siding

1 x 3 strapping

Air barrier membrane

Plywood 9 mm

2 x 6 studs+ batt insul. R 20

Polystyrene board 38 mm, R 8

Vapour barrier

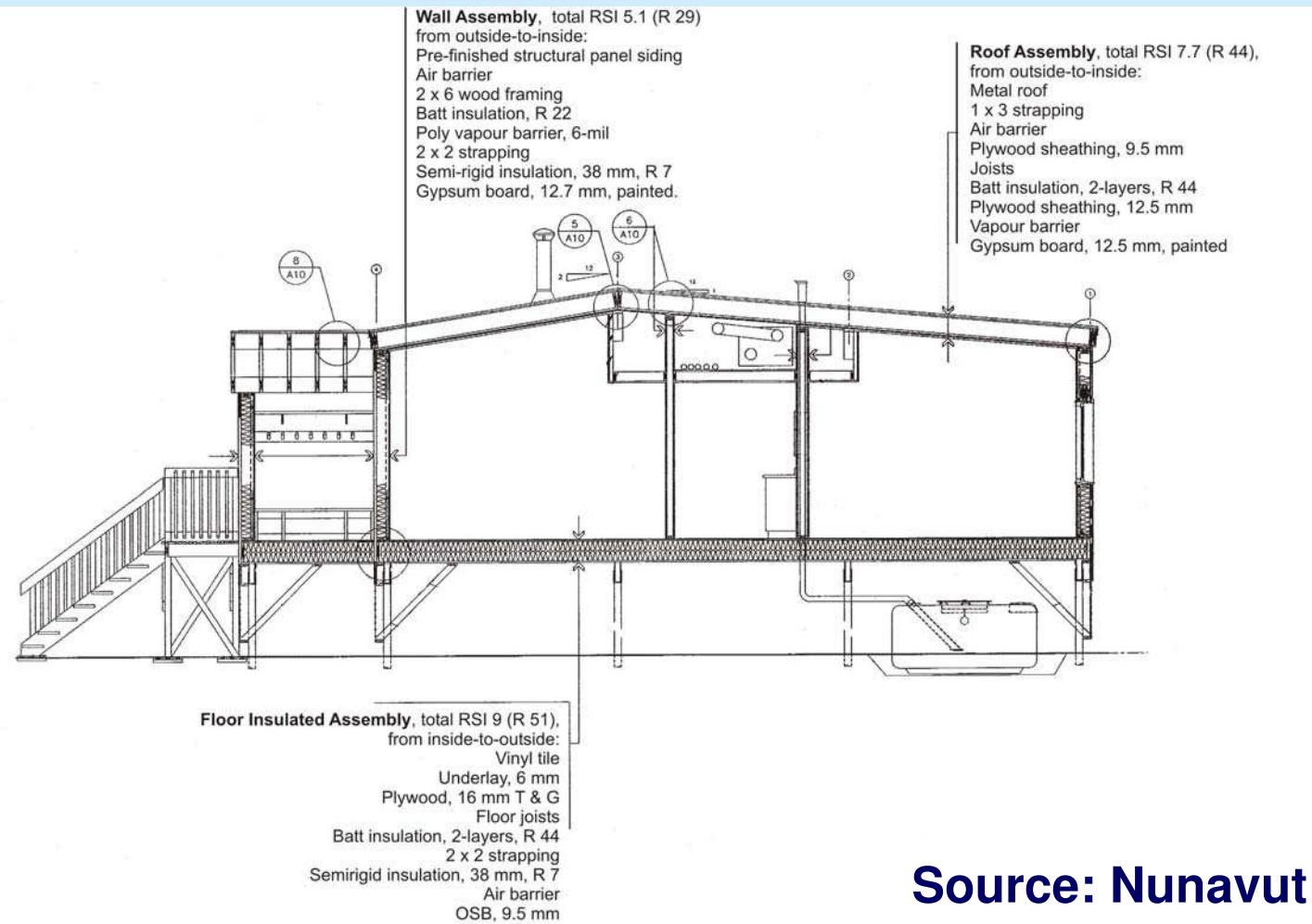
2 x 3 strapping

Gypsum 16 mm

Source: Quebec Housing Corp. 1999

Practice in Nunavut

Single stud wall with interior insulating sheathing



Source: Nunavut Housing Corp.

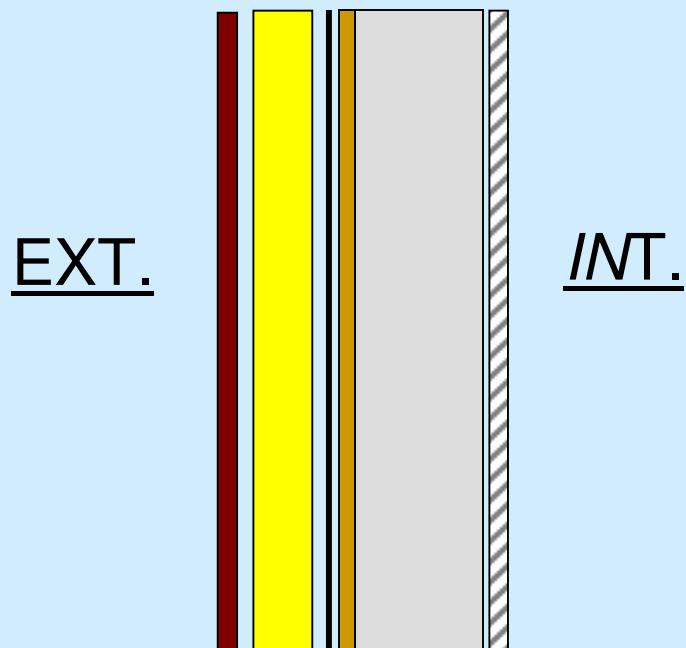
- Insulation in walls, ceiling, and exposed floors**

Example RSI (R) values

	Nunavik, Québec (Quebec Housing Corp. 1999)	Nunavut (Nunavut Housing Corp.)
Walls	5.0 (28)	5.1 (29)
Roof	7.7 (44)	7.7 (44)
Floor	5.4 (31)	9.0 (51)

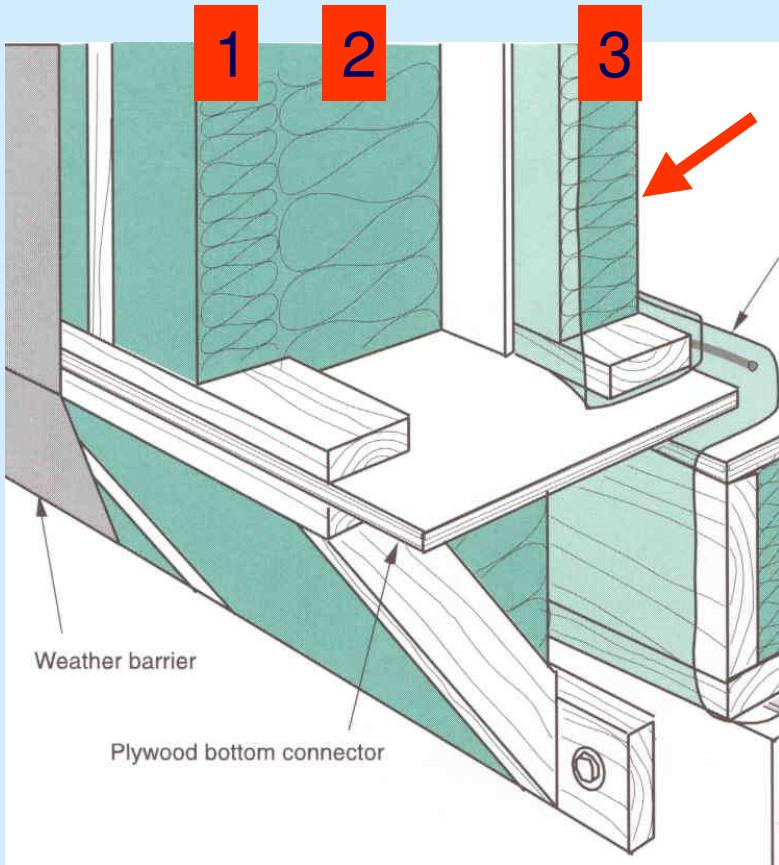
Single Stud Walls

- Single stud wall with all insulation & air barrier on exterior of a stud space “The PERSIST” Approach

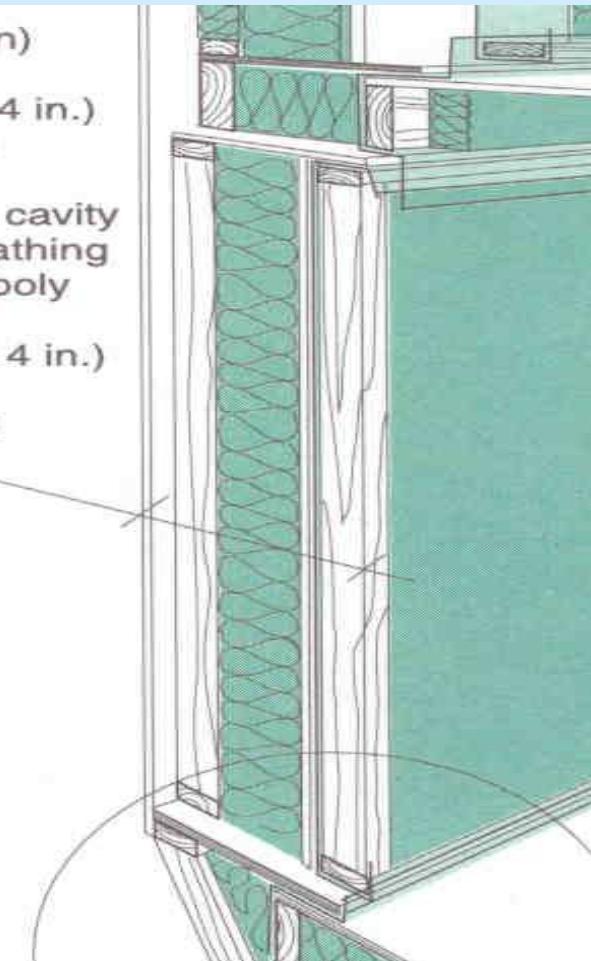


Double Stud Walls

Double stud wall with load-bearing interior stud wall



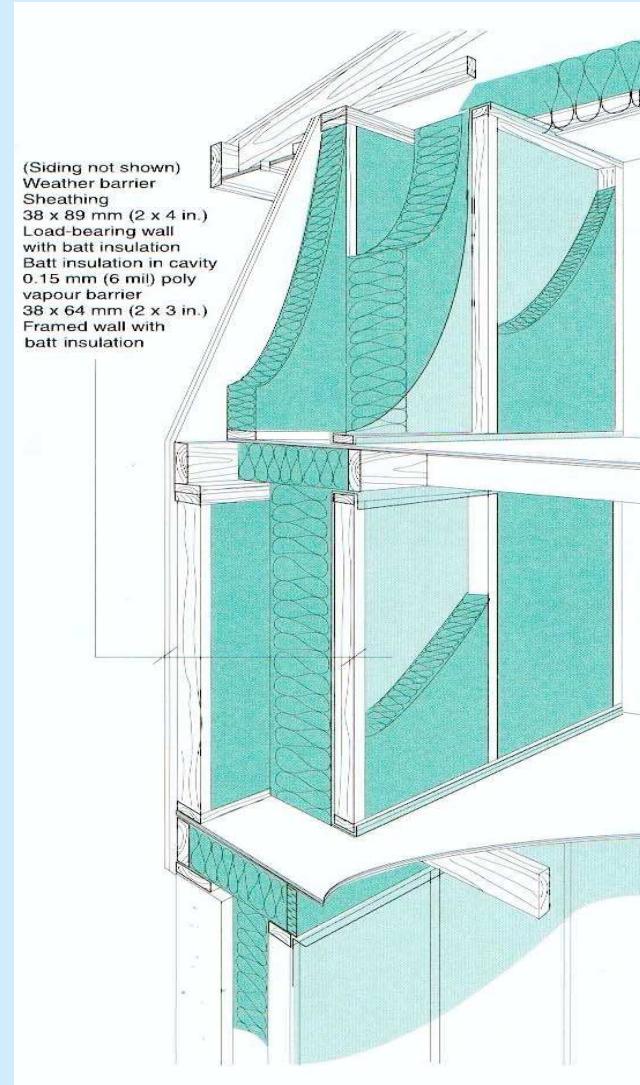
(Siding not shown)
Weather barrier
38 x 89 mm (2 x 4 in.) framing with batt insulation
Batt insulation in cavity
Wood panel sheathing
0.15 mm (6 mil) poly air barrier
38 x 89 mm (2 x 4 in.) load-bearing framing with batt insulation



Source: CHBA Builder's Manual, 2001

Double stud wall with load-bearing exterior stud wall

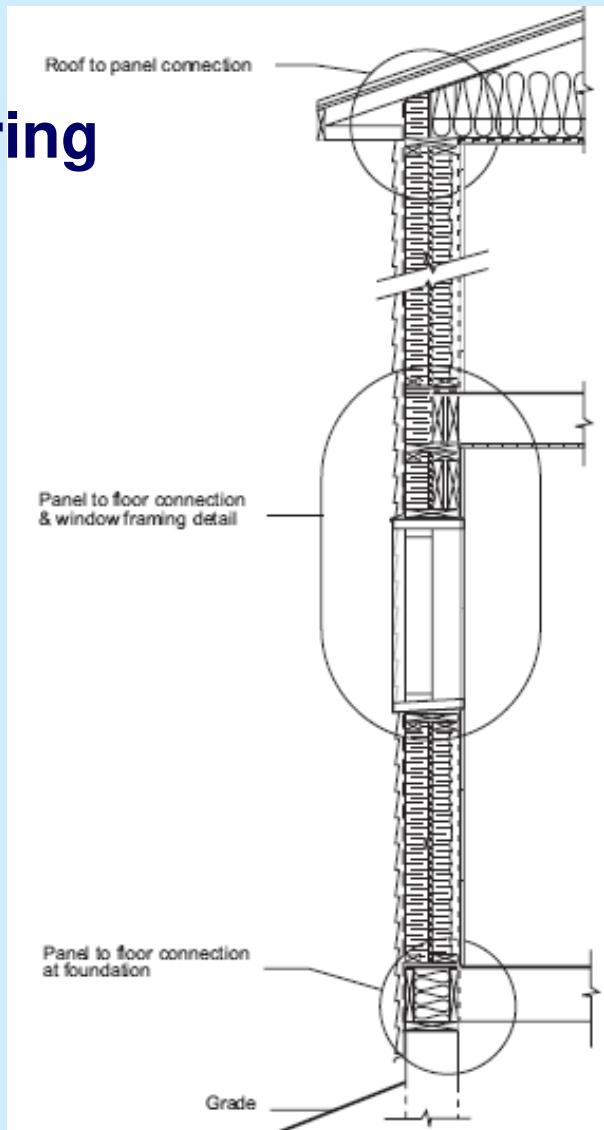
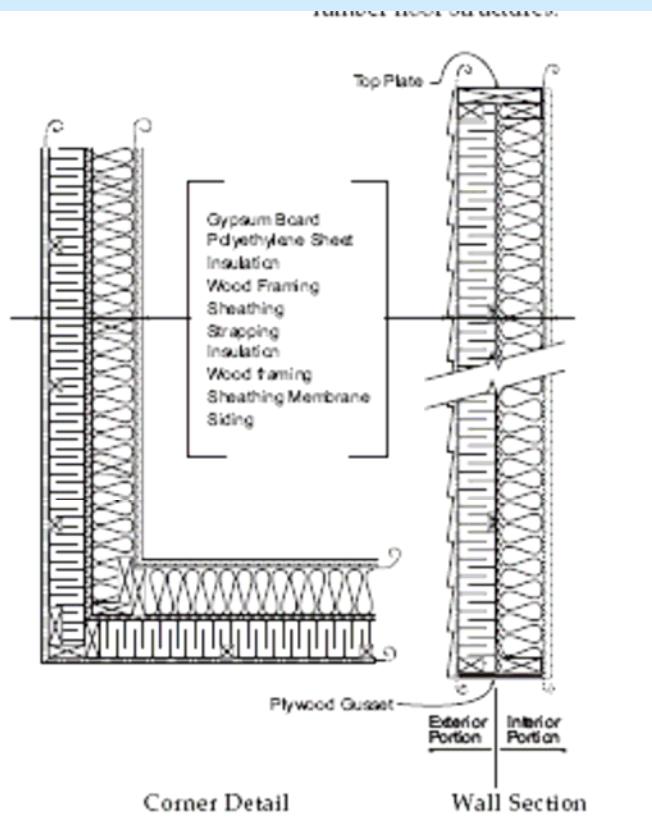
Double Stud Walls



Source: CHBA Builder's Manual, 2001

Double Stud Walls

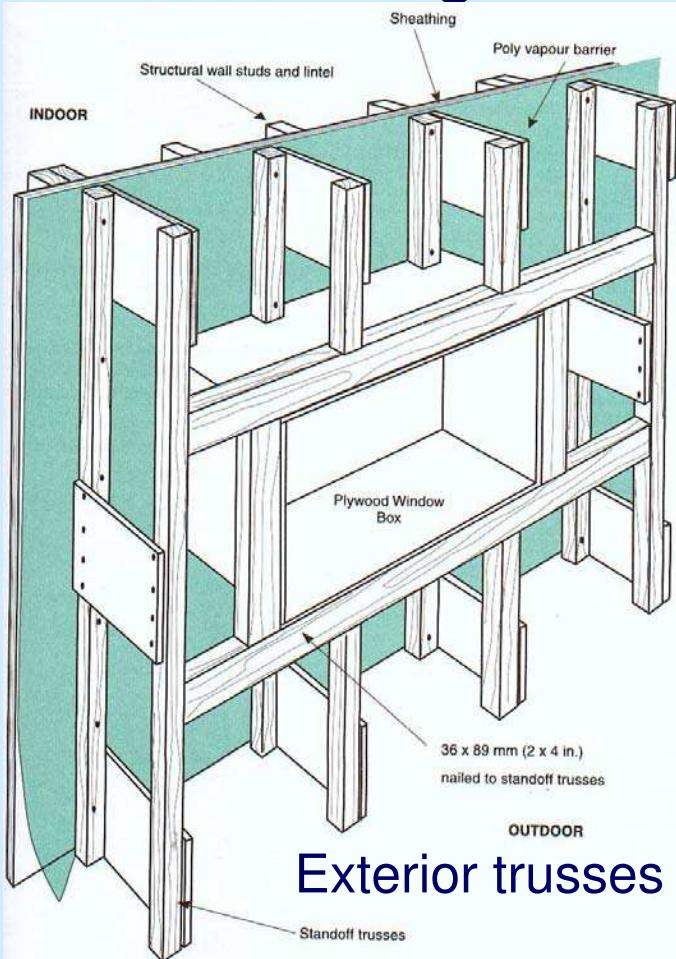
**Panelized double stud wall with load-bearing
interior stud wall (no insulated space
between the stud walls)**



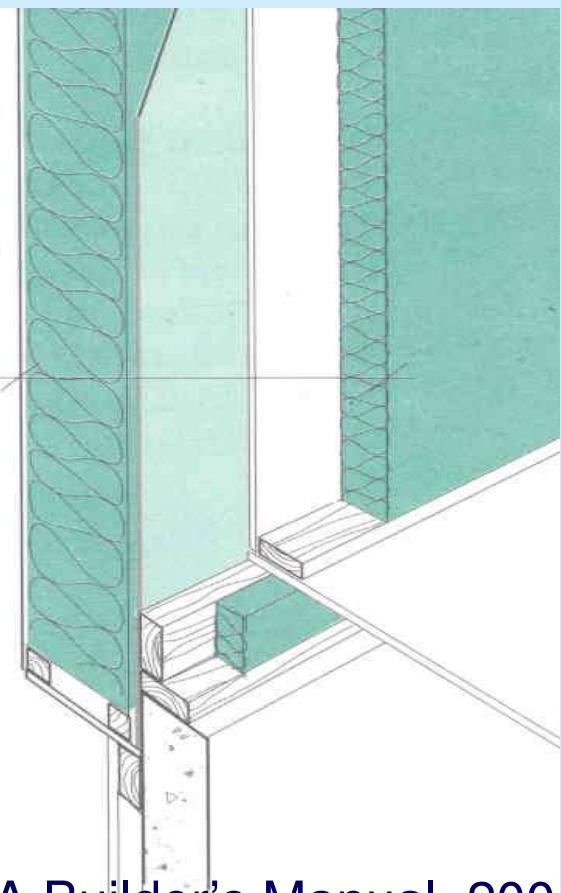
Source: NRC Canadian Construction Materials Centre, 2006 evaluation report CCMC 12889-R

Standoff Walls

Variation on the double stud wall: Load-bearing interior stud wall with an exterior truss wall



(Siding not shown)
Weather barrier
Standoff truss with
batt insulation
0.15 mm (6 mil)
Polyethelene air barrier
Sheathing
Frame wall with
batt insulation



Source: CHBA Builder's Manual, 2001

Examples of Applications

RSI (R) Values

	Eagle Lake house North Ontario	Factor 9 house Regina Sask	Hanover house New Hampshire	Illinois house
Wall framing	Standoff truss	SIP with polyurethane core	double 2x4 stud 11½ in.	Standoff 12 in. truss
Walls RSI (R)	8.8 (50) Glass fiber	6.1 (34.5)	7 (40) cellulose	10.6 (60) glass fiber + 4 in. EPS board
Roof RSI (R)	10.6 (60)	14 (80)	10.6 (60)	10.6 (60)
Floor RSI (R)	5.3 (30)	2 (11.4)		10 (56)
Basement walls		8.8 (50)	1.9 (11) from inside	4.2 (24) from outside
Windows RSI (R)		triple glazed	1.2 to 1.6 (6.7 to 9)	1.26 (7.14) triple glazed
Air tightness (ach at 50 Pa)	not available	Target 0,5ACH @50Pa	0.37	Not measured

Rigid Insulation Core Panels Walls

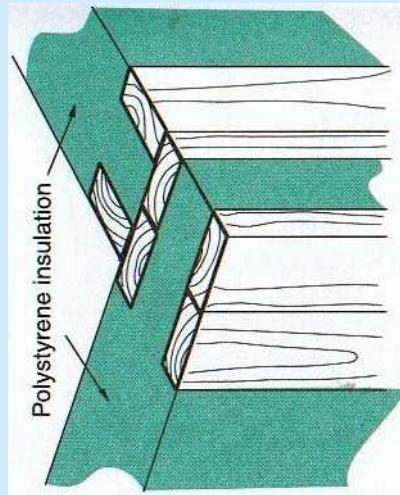


Figure 11.24 Sample Pre-formed Panel Wall System, Corner Detail

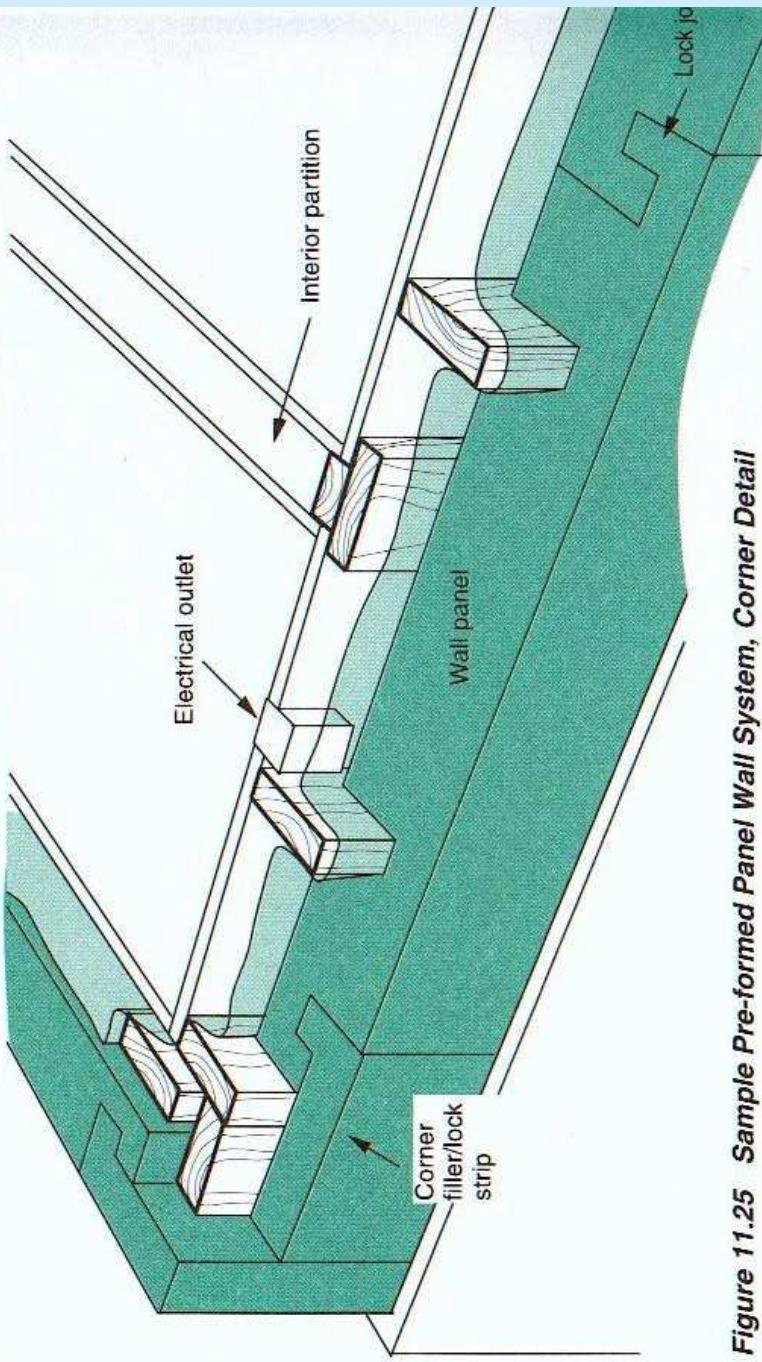
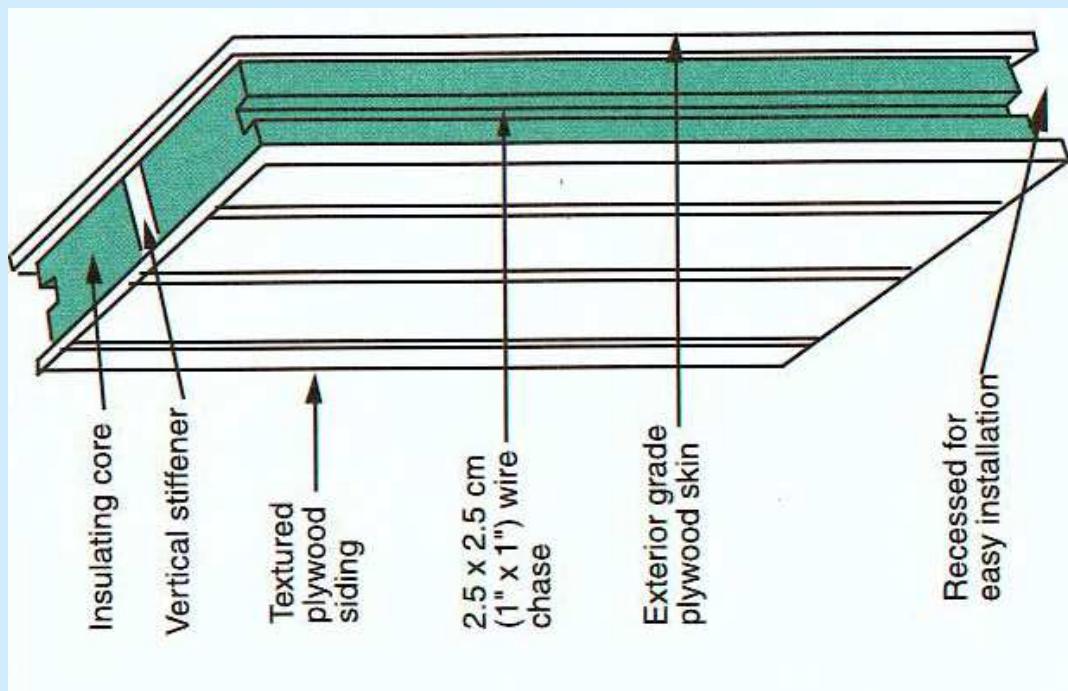


Figure 11.25 Sample Pre-formed Panel Wall System, Corner Detail

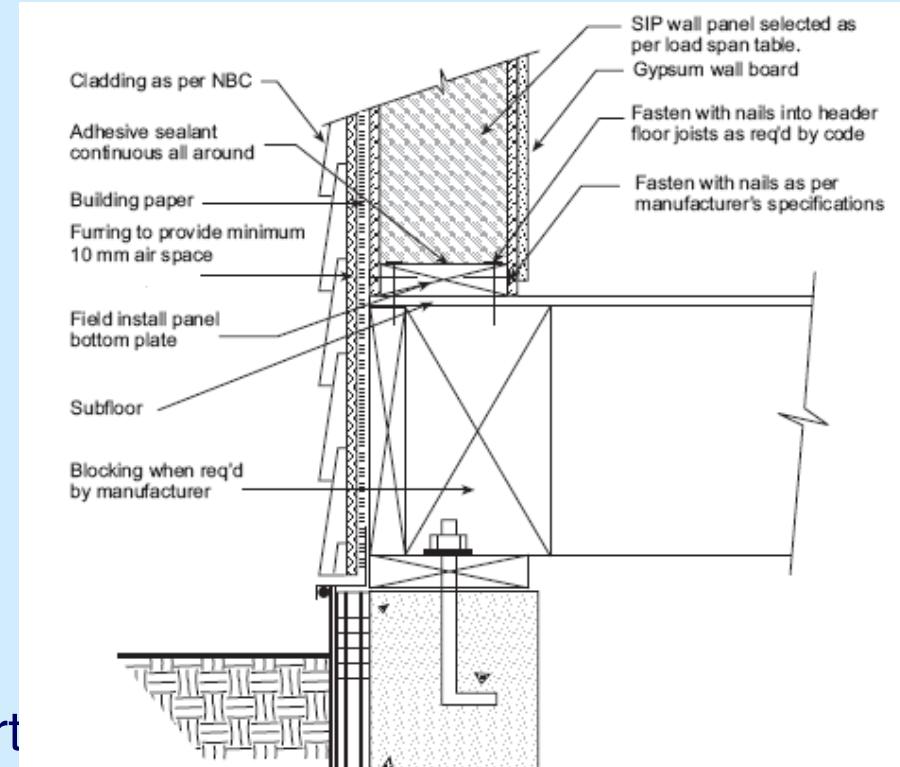
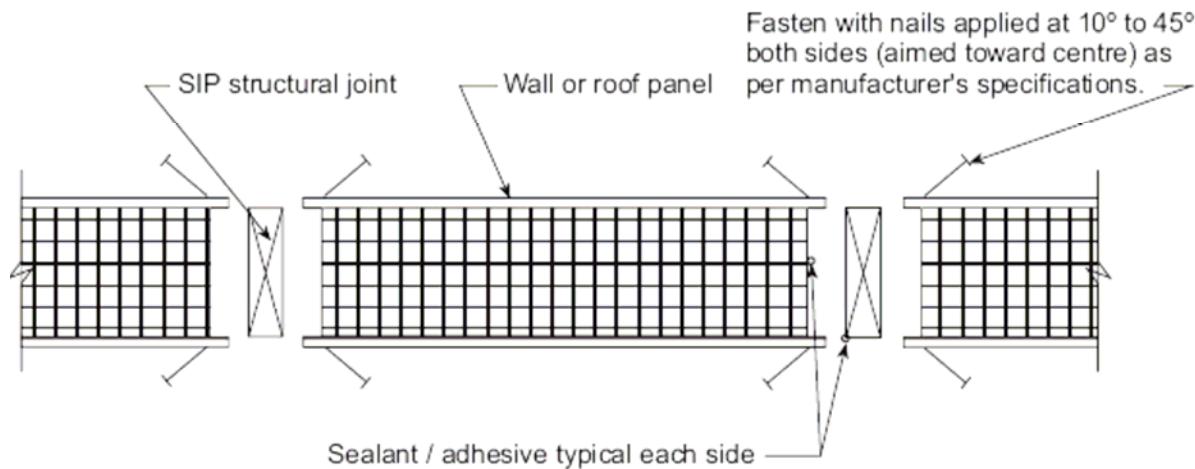
Source: CHBA Builder's Manual, 2001

Stress-Skin Panel Walls



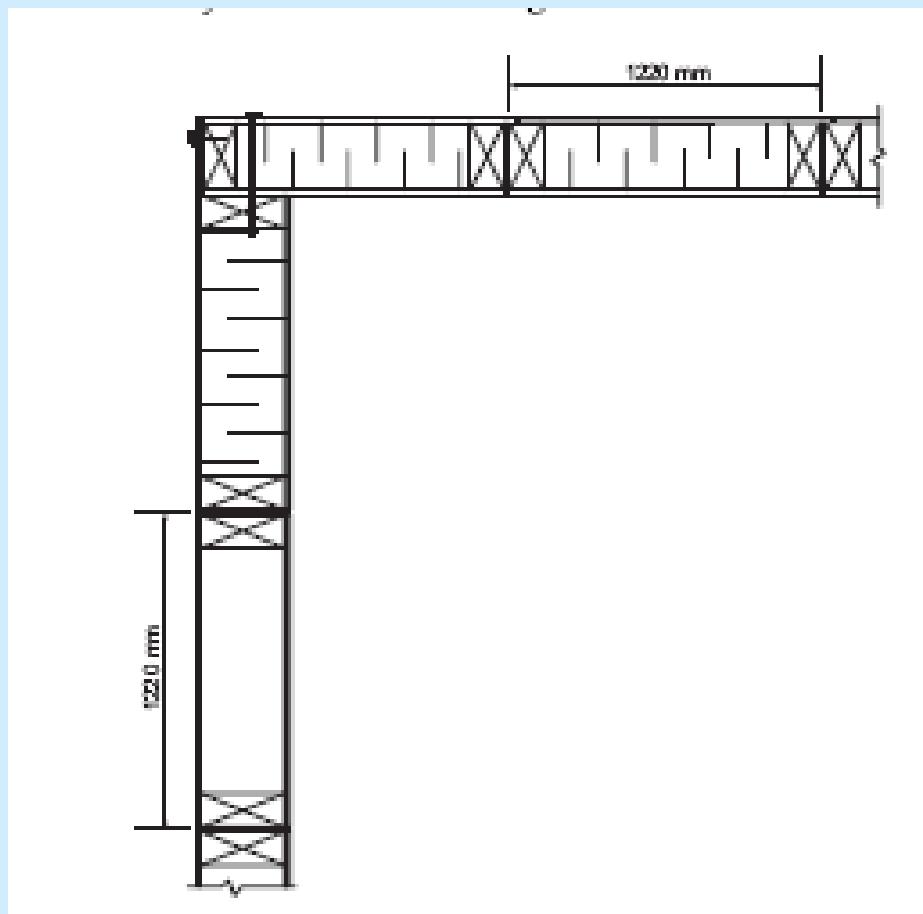
Source: CHBA Builder's Manual, 2001

Stress-Skin Panel Walls



Source: NRC Canadian Construction Materials Centre, 2006 evaluation report
CCMC 13016-R

Stress-Skin Panel Walls



Source: NRC Canadian Construction Materials
Centre, 2006 evaluation report CCMC 10741-R

Insulating Concrete Form (ICF) Systems

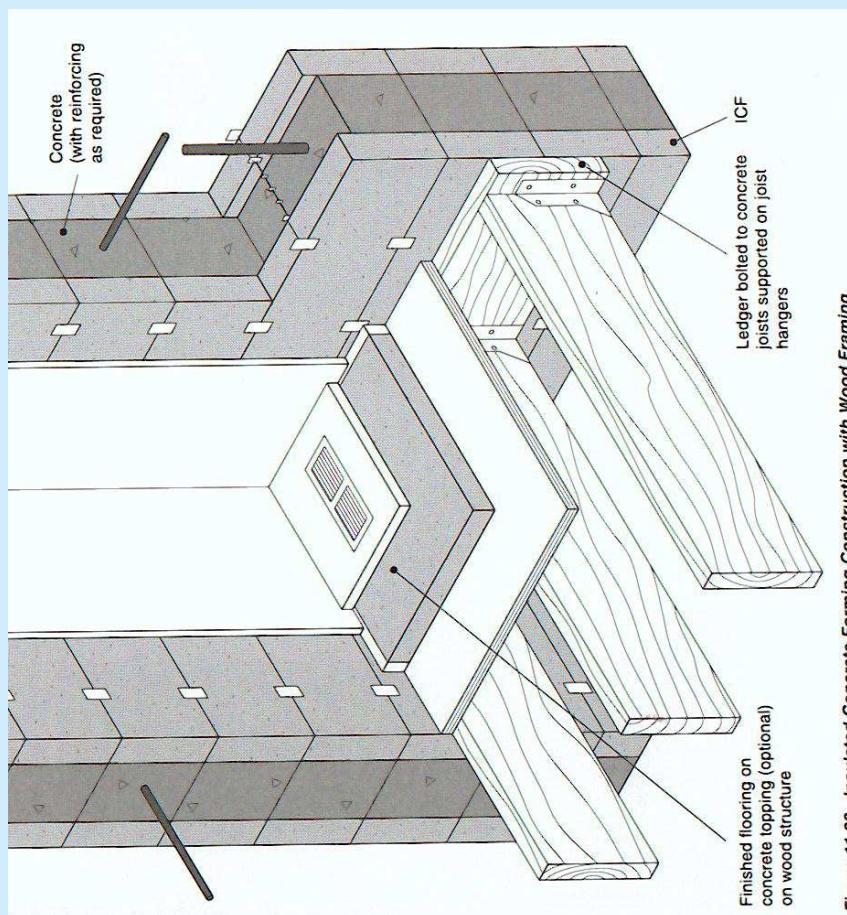


Figure 11.28 Insulated Concrete Forming Construction with Wood Framing

Source: CHBA Builder's Manual, 2001

Construction Challenges in Northern Canada

Criterion	Rating		Rating
1. CONSTRUCTABILITY	<i>1</i>	5. HEALTH & COMFORT	<i>1</i>
a. Local skills	1	a. Emissions	1
b. Details	1	b. Mould	1
c. Appropriateness	1	c. Ventilation	1
d. Construction season	1	d. Thermal comfort	1
e. Logistics	1	e. Anything else?	1
f. Anything else?	1	6. HYGROTHERMAL PERFORMANCEE	<i>1</i>
2. COST	<i>1</i>	a. R-value	1
a. Materials	1	b. Air-leakage	1
b. Labour costs	1	c. Surface temperatures	1
c. Anything else?	1	d. Condensation	1
3. DURABILITY/LCA	<i>1</i>	e. Energy use	1
a. Service life	1	Thermal bridges	1
		Anything else?	
b. Risk	1	7. SOCIO-ECONOMIC	<i>1</i>
c. Maintenance	1	a. Local manufacture	1
d. LCA	1	b. Local skills	1
e. Anything lese?	1	c. Knowledge transfer	1
4. ENVIRONMENT/SUSTAINABILITY	<i>1</i>	d. Culture and customs	1
a. Embodied energy	1	e. Anything else?	1
b. GHC emissions	1	8. ANYTHING ELSE?	<i>1</i>
c. LEED points	1	a. Anything else?	1
d. Local/Renewable	1	Baseline wall: 2X6 single stud wall; assuming all weights are 1.0	
e. Anything else?	1		
Overall rating		8	