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Product Information Bulletin

DuroFoam® Insulation for Interior Basement Applications

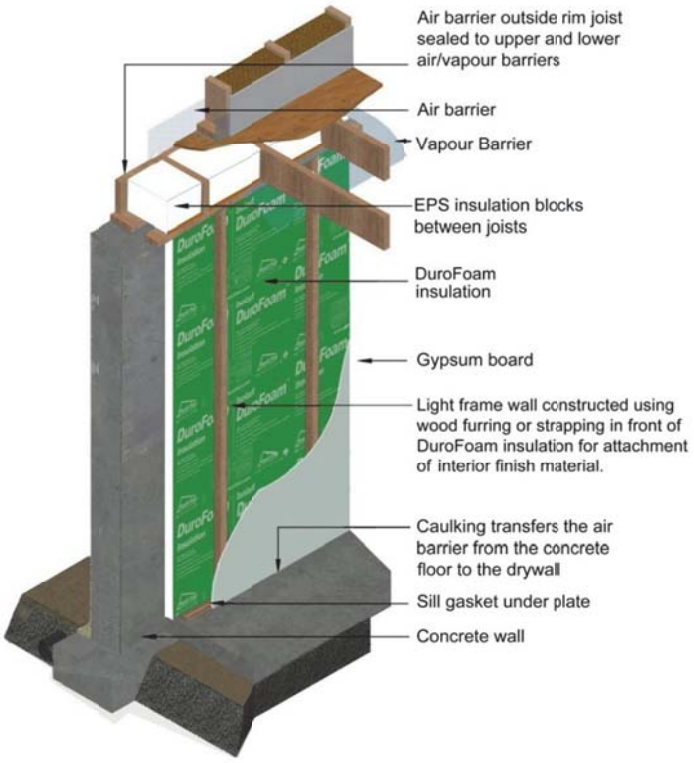
A Canada Mortgage and Housing Corporation (CMHC)/Canadian Home Builders Association (CHBA) report concluded that use of insulation partway down the interior of a basement wall, as is typical for many residential applications, actually increases heat loss to the adjacent soil because the upper zone insulation is appreciably short-circuited by the heat loss from below. ***DuroFoam***® insulation is a moulded expanded polystyrene (EPS) insulation with a laminated film applied to both faces and is an ideal solution to provide continuous full-height interior basement wall insulation.

The reflective facer on ***DuroFoam*** insulation contains a thin layer of foil embedded within the film. The reflective facer does not increase the thermal resistance of ***DuroFoam*** insulation (for additional information see Plasti-Fab PIB 253 - ***Facts About Thermal Resistance of Reflective Insulation***). The green face of ***DuroFoam*** insulation should be left exposed to make use of the markings on this face provided for easy cutting of insulation and spacing of interior framing as required.

Table 1 – *DuroFoam* Insulation Material Properties

Material Property[1]	Test Method	Units	Type 1
Thermal Resistance *Minimum RSI per 25 mm (R per inch)*	ASTM C518	m^2•°C/W (Ft^2•hr•°F/BTU)	0.65 (3.75)
Compressive Resistance *Minimum @ 10% Deformation*	ASTM D1621	kPa (psi)	70 (10)
Flexural Strength *Minimum*	ASTM C203	kPa (psi)	170 (25)
Water Vapour Permeance[2] *Maximum*	ASTM E96	ng/Pa•s•m^2 (perm)	30 (0.5)
Water Absorption[3] *Maximum*	ASTM D2842	% By volume	6.0
Dimensional Stability *Maximum, 7 Days @ 70 ± 2°C (158 ± 4°F)*	ASTM D2126	% Linear Change	1.5
Limiting Oxygen Index *Minimum*	ASTM D2863	%	24

1. ***DuroFoam*** insulation properties are third party certified to CAN/ULC-S701 under a quality listing program administered by Intertek and listed by the Canadian Construction Materials Centre (CCMC) under evaluation listing number 12424-L.
2. ***Maximum*** vapour permeance value for EPS insulation is 300 ng/Pa•s•m^2 for 25-mm (5.2 perms for 1-inch) thickness. The vapour permeance value provided above for DuroFoam insulation is significantly lower as a result of laminated films. Where water vapour permeance is a design issue, contact Plasti-Fab technical services for additional information.
3. Water absorption % by volume is determined using ASTM D2842 which involves complete submersion under a head of water for 96 hours. The value provided in the table above is the ***maximum*** for CAN/ULC-S701, type 1 EPS insulation without facers.



DuroFoam insulation can be attached using an adhesive compatible with EPS insulation directly to the interior face of the basement wall to provide a continuous layer of insulation. Special attention is required to ensure the area between the top of the basement wall and the upper building envelope is sealed to reduce air leakage. ***PlastiSpan*** insulation blocks can be used to insulate the rim joist and seal the space between the floor joists.

When applied as the sole insulation on the interior of the basement wall ***DuroFoam*** insulation addresses the following requirements in the National Building Code (NBC) 2005 and 2010:

1. Provides moisture protection for interior finishes as per Sentence 9.13.2.6.(1) of NBC 2005 & 2010.
2. Eliminates the need for a separate vapour barrier as per Sentence 9.13.2.6.(3) of NBC 2010.
3. ***Effective thermal resistance (RSI_{eff}/R_{eff})*** required as per NBC 2010 Article 9.36.2.8.

NBC 2005 and 2010 – Moisture Protection

Using a continuous layer of ***DuroFoam*** insulation attached directly to the basement wall allows construction of a light frame wall using wood furring or strapping built in front of rigid insulation for attachment of the interior finish material.

NBC 2005 and 2010, Sentence 9.13.2.6.(1) requires that the interior surface of basement walls below ground level be protected by a material that minimizes the ingress of moisture from the basement wall into interior spaces, where

a) a separate interior finish is applied to a concrete or unit masonry wall that is in contact with the soil, or
b) wood members are placed in contact with such walls for the installation of finish materials.

DuroFoam insulation applied as a continuous layer on the interior of a basement wall with joints taped provides protection for interior finish materials and wood framing members.

NBC 2005 and 2010 – Vapour Barrier Requirements

The NBC 2005 and 2010 indicates that where low-permeance insulation such as ***DuroFoam*** insulation is the sole thermal insulation in a building assembly, the temperature of the inner surface of the insulation will be close to the interior room temperature. NBC 2010 states that if the foamed plastic insulation has a vapour permeance below 60 ng/Pa•s•m^2, it can fulfill the function of a vapour barrier to control condensation within the assembly due to vapour diffusion.

NBC 2010, Sentence 9.13.2.6.(3) provides additional clarification that where the insulation functions as both moisture protection for interior finishes and as a vapour barrier in accordance with Subsection 9.25.4., it shall be applied over the entire interior surface of the basement wall.

DuroFoam insulation has a vapour permeance value less than 60 ng/Pa•s•m^2 as per Table 1 of this bulletin. Therefore, when ***DuroFoam*** insulation is installed as the sole insulation over the entire surface of the basement wall and joints are taped or sealed, a separate vapour barrier would not need to be installed.

NBC 2010 – Energy Efficiency Requirements

NBC 2010, Section 9.36 provides energy efficiency requirements for buildings 3 storeys or less in building height, having a building area not exceeding 600 m^2 and used for major occupancies classified as residential occupancies. Energy efficiency requirements in NBC 2010, Subsection 9.36.2. are based upon minimum ***effective thermal resistance (RSI$_{eff}$/R$_{eff}$)*** of building assemblies which includes the effect of thermal bridging due to repetitive structural members such as wood framing members in wall or roof assemblies calculated using the formula below.

$$\mathbf{RSI_{eff}\ (R_{eff})} = \frac{100\%}{\frac{\%\ \text{with Framing}}{RSI_F\ (R_F)} + \frac{\%\ \text{Area Cavity}}{RSI_C\ (R_C)}} + \text{RSI(R) Continuous Material Layers}$$

Table 2 provides minimum ***effective thermal resistance*** – ***RSI$_{eff}$ (R$_{eff}$)*** – for basement walls per NBC 2010, Tables 9.36.2.8.A. (Buildings without a Heat-Recovery Ventilator) and 9.36.2.8.B. (Buildings with a Heat-Recovery Ventilator).

Table 2 - Minimum RSI$_{eff}$ (R$_{eff}$) – Basement Walls Below or In Contact with Ground

NBC 2010 Climate Zones	Zone 4	Zone 5	Zone 6	Zone 7a	Zone 7b	Zone 8
Heating Degree-Days (HDD) Celsius Degree-Days	**< 3,000**	**3,000 to 3,999**	**4,000 to 4,999**	**5,000 to 5,999**	**6,000 to 6,999**	**≥ 7,000**
Table 9.36.2.8.A. Effective Thermal Resistance						
RSI$_{eff}$ - m^2•°C/W	1.99	2.98	2.98	3.46	3.46	3.97
R$_{eff}$ - ft^2•hr•°F/BTU	11.3	16.9	16.9	19.6	19.6	22.5
Table 9.36.2.8.B. Effective Thermal Resistance						
RSI$_{eff}$ - m^2•°C/W	1.99	2.98	2.98	2.98	2.98	2.98
R$_{eff}$ - ft^2•hr•°F/BTU	11.3	16.9	16.9	16.9	16.9	16.9

Table 3 provides annual Heating Degree Days (HDD) for some locations across Canada per NBC 2010, Division B, Appendix C.

Table 3 – Annual HDD (Celsius Degree Days

Province	Building Location	HDD	Province	Building Location	HDD (Celsius Degree Days)
British Columbia	Victoria	2,650	**Ontario**	Hamilton	3,460
	Vancouver	2,950		Toronto	3,520
	Kelowna	3,400		Mississauga	3,880
	Whistler	4,180		Kitchener	4,200
	Dawson Creek	5,900		Guelph	4,270
Alberta	Lethbridge	4,650		Thunder Bay	5,650
	Calgary	5,000		Kirkland Lake	6,000
	Edmonton	5,400	**Quebec**	Montréal	4,200
	Fort McMurray	6,550		Trois-Rivières	4,900
Saskatchewan	Moose Jaw	5,270		Québec	5,080
	Regina	5,600		Gaspé	5,500
	Saskatoon	5,700		Baie-Comeau	6,020
	Prince Albert	6,100	**New Brunswick**	Schefferville	8,550
	Uranium City	7,500		Edmunston	5,400
Manitoba	Winnipeg	5,670		Fredericton	4,650
	Flin Flon	6,440	**Nova Scotia**	Digby	4,020
	Thompson	7,600		Truro	4,650
	Churchill	8,950		Halifax	4,200
NWT	Inuvik	10,050	**PEI**	Charlottetown	4,600
Nunavut	Alert	13,200	**Newfoundland**	St. John's	4,800
Yukon	Dawson	8,400		Labrador City	7,900

Table 4 provides an example of a basement wall assembly using ***DuroFoam*** insulation to provide a continuous insulation layer over the interior of the basement wall to meet minimum ***RSI_{eff} (R_{eff})*** per NBC 2010, Tables 9.36.2.8.A. and 9.36.2.8.B for Climate Zone 4.

Table 4 – *DuroFoam* Insulation Interior Basement Example

Typical Detail	System Description and Components			
	***DuroFoam* Insulation over interior of basement wall with 2 x interior framed wall**	**RSI_F**	**RSI_C**	**Continuous Materials**
	203 mm (8") Basement wall	----	----	0.08
	102 mm (2.5") ***DuroFoam*** Insulation	----	----	1.65
	Wood Strapping @ 600 mm (24")	0.54	----	----
	13 mm (1/2") Gypsum wall board	----	----	0.08
	Inside Air Film	----	----	0.12
	Total	**0.54**	**NA**	**1.93**
	% Area of Each Component	**13%**	**NA**	**100%**
	Total RSI_{eff} (R_{eff})	**RSI-2.00 (R11.4)**		

Figure 1 - Interior Basement Wall

Table 5 provides an example of a basement wall assembly using ***DuroFoam*** insulation to provide a continuous insulation layer over the interior of the basement wall to meet minimum ***RSI$_{eff}$ (R$_{eff}$)*** NBC 2010, Tables 9.36.2.8.A. for Climate Zones 4 to 6 and Table 9.36.2.8.B for Climate Zones 5 to 8.

Table 5 – *DuroFoam* Insulation Interior Basement Example

Typical Detail	System Description and Components			
 **Figure 2 - Interior Basement Wall**	***DuroFoam* Insulation over interior of basement wall with 2 x interior framed wall**	**RSI$_F$**	**RSI$_C$**	**Continuous Materials**
	203 mm (8") Basement wall	----	----	0.08
	102 mm (4") ***DuroFoam*** Insulation	----	----	2.64
	Wood Strapping @ 600 mm (24")	0.54	----	----
	13 mm (1/2") Gypsum wall board	----	----	0.08
	Inside Air Film	----	----	0.12
	Total	**0.54**	**NA**	**2.92**
	% Area of Each Component	**13%**	**NA**	**100%**
	Total RSI$_{eff}$ (R$_{eff}$)	**RSI-2.99 (R17.0)**		

As indicated previously, where ***DuroFoam*** insulation is applied as the sole insulation it provides the required moisture protection for interior finishes and a separate vapour barrier in accordance with NBC 2010, Subsection 9.25.4. is not required.

DuroFoam insulation can also be installed on the interior face of a basement wall with additional insulation installed in a wood frame wall cavity built in front of the ***DuroFoam*** insulation. If ***DuroFoam*** insulation is installed full height on the basement wall in combination with cavity insulation, a separate vapour barrier must be installed on the warm (inside) face of the framed wall and the above grade portion of the wall assembly must meet the requirements of NBC 2010, Section 9.25.5. related to properties and position of insulation materials.

DuroFoam Insulation Used in Combination with Cavity Insulation

DuroFoam insulation has an air leakage characteristic less than 0.1 L/(s•m^2) at 75 Pa and a vapour permeance characteristic less than 60 ng/(Pa•s•m^2). NBC 2010, Subsection 9.25.5.1. addresses implications for potential moisture accumulation in wall assemblies using low air and vapour permeance materials. Article 9.25.5.2. permits the use of continuous low air and vapour permeance insulation – e.g., full height on the interior of a basement wall – based upon the ***ratio of outboard to inboard thermal resistance***.

Table 6 - Minimum Ratio of Outboard to Inboard Thermal Resistance (NBC 2010, Table 9.25.5.2.)

Heating Degree-Days	Ratio	Heating Degree-Days	Ratio
up to 4999	0.20	9000 to 9999	0.55
5000 to 5999	0.30	10000 to 10999	0.60
6000 to 6999	0.35	11000 to 11999	0.65
7000 to 7999	0.40	12000 or higher	0.75
8000 to 8999	0.50		

Wall assemblies with a ratio of outboard to inboard thermal resistance value greater than those given in Table 6 ensure that the inner surface of the ***DuroFoam*** insulation is likely to be warm enough for most of the heating season such that no significant accumulation of moisture will occur. The vapour barrier function must be provided by a separate building element installed on the warm side of the assembly. For additional information on assumptions used in developing Table 9.25.5.2., refer to NBC 2010, Appendix Note A-9.25.5.2.

NBC 2010, Sentence 9.36.2.8.(3) states that where the top of a section of foundation wall is on average less than 600 mm (24") above the adjoining ground level, the above-ground portion of that section of wall shall be insulated to the effective thermal resistance required for the below-grade portion of the wall.

Table 7 provides an example of a basement wall assembly using ***DuroFoam*** insulation to provide a continuous insulation layer over the interior of the basement wall in combination with cavity insulation to meet minimum ***RSI_{eff} (R_{eff})*** NBC 2010, Table 9.36.2.8.A. for Climate Zones 4 to 6 and Table 9.36.2.8.B for Climate Zones 5 to 8.

Table 7 – *DuroFoam* Insulation Interior Basement Example

Typical Detail	System Description and Components			
	***DuroFoam* Insulation over interior of basement wall with 2 x interior framed wall and cavity insulation**	**Framed Portion**		**Continuous Materials**
		RSI_F	**RSI_C**	
	200 mm (8") Concrete Wall	----	----	0.08
	1-1/2" (41 mm) DuroFoam Insulation	----	----	0.99
	Stud Cavity Insulation	----	2.29	----
	2 x 4 Wood Stud @ 16" (406 mm) o.c.	0.76	----	----
	6 mil polyethylene vapour barrier	----	----	----
	1/2" (12.7 mm) Gypsum Wall Board	----	----	0.08
	Inside Air Film	----	----	0.12
	RSI Sub-Totals	**0.76**	**2.29**	**1.27**
	% Area of Each Component	**16%**	**84%**	**100%**
	Total RSI_{eff} (R_{eff})	**RSI-3.00 (R-17.0)**		

Ratio of Outboard to Inboard Thermal Resistance Calculation

Outboard Insulation Components	RSI	Inboard Insulation Components	RSI
Outside air film (above grade)	0.08	Stud cavity insulation	2.29
200 mm (8") Concrete Wall	0.08	Gypsum board	0.08
1 1/2" (41 mm) ***DuroFoam*** Insulation	0.99	Inside air film	0.12
Total Outboard RSI	**1.15**	**Total Inboard RSI**	**2.49**
Ratio of Outboard to Inboard RSI		**1.15/2.49**	**0.46**

NOTE: As can be seen, the ***Ratio of Outboard to Inboard Thermal Resistance*** can be increased by increasing the thermal resistance of ***DuroFoam*** insulation or by decreasing the thermal resistance of cavity insulation. If the wall assembly design selected does not provide a ratio value greater than the minimum in Table 6, ***DuroFoam*** insulation should be installed extending from the underside of the interior finish up the face of the basement wall to a point just above the level of the ground outside and a separate vapour barrier should be installed on the warm side of the wall assembly.