ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2015 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

14-BA-A7 BUILDING ENVELOPE DESIGN

QUESTION #1 **(4 points)**

Choose two products that can be used as principal components in an **exterior** air barrier system for a wall assembly built in a cold climate zone. The wall assembly is made up of steel studs with mineral wool insulation between the studs with an interior vapor barrier and exterior gypsum sheathing with brick cladding. Circle the two best choices.

a) Tyvek sheathing membrane
b) 6 Mil polyethylene vapor barrier
c) Blueskin VP 160 peel and stick membrane
d) Semi Rigid mineral fiber insulating sheathing

QUESTION #2 **(4 points)**

Name two types of insulations that can be used in a conventional flat roof assembly?

1) _____

2) _____

QUESTION #3 **(4 points)**

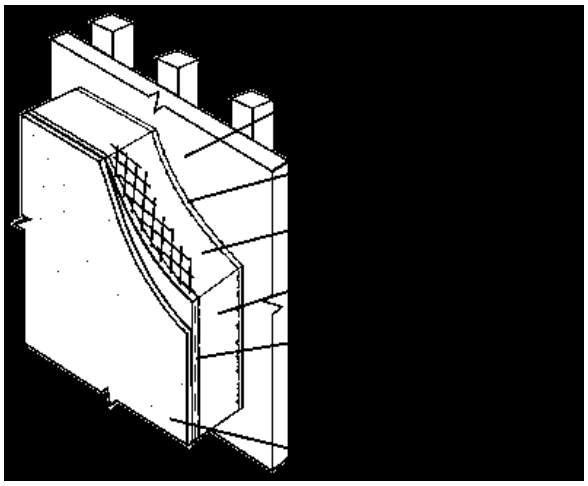

Figure 1

Name two types of insulations that can be used in an Exterior Insulating and Finishing Wall System (Acrylic finish wall systems).

1) _____
2) _____

QUESTION #4 **(12 points)**

Complete the drawing. Illustrate the continuity of the exterior air barrier system, the vapor barrier and exterior rigid foam insulation at the wall / roof junction. An exterior air barrier membrane is used over the gypsum board as the air barrier and moisture barrier for the wall system.
Name all the major components for the conventional roof assembly.

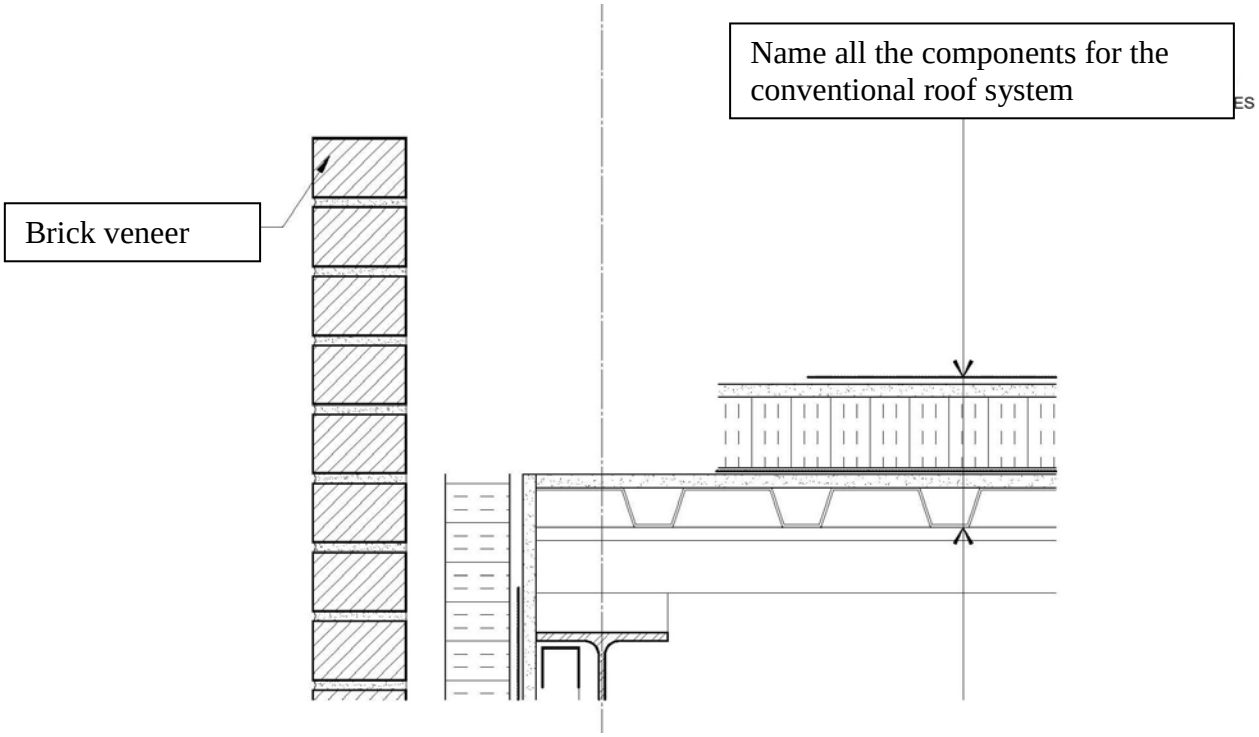

Figure 2

QUESTION #5 **(5 points)**

What is the benefit of performing a hygrothermal analysis for a proposed wall system?

_____

_____

QUESTION #6 **(6 points)**

Name the two principal benefits of adding exterior insulating sheathing to a steel stud wall assembly?

1)_____
_____
_____
_____

2)_____
_____
_____
_____

QUESTION #7 **(12 points)**

Each component in a protected membrane roof system is labeled with a number. Name each of the components and its principal function within the roof system

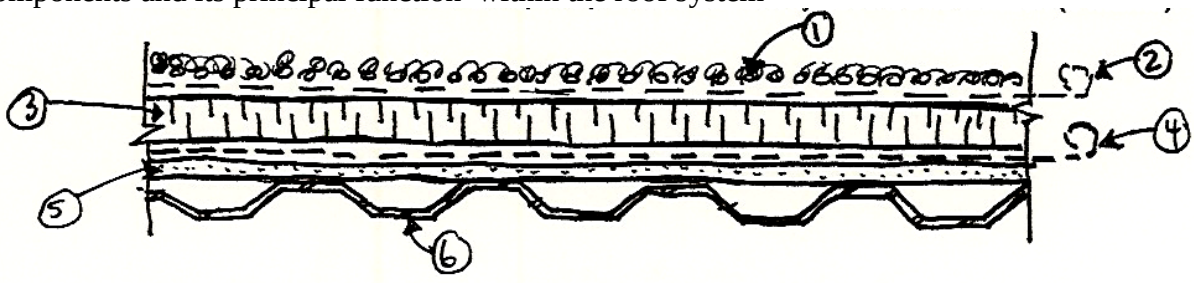

Figure 3

1) Name:_____ Function: _____
2) Name:_____ Function: _____
3) Name:_____ Function: _____
4) Name:_____ Function: _____
5) Name:_____ Function: _____
6) Name:_____ Function: _____

QUESTION #8 **(16 points)**

Exterior wood stud wall assembly made up of 2x6 wood studs spaced 16''c c (38x140 mm @ 400 mm c c).

- Project is in Laval, Québec (4600 Heating Degree Days)
- Required outboard to inboard ratio for use of low permeance insulating sheathings (<60 ng/Pa s m2) per the Quebec Building Code is 0.20 for regions up to 4,999 Heating Degree Days.
- **Wall Components (from exterior to interior):**

a) Exterior air film; R-0.17 (RSI 0,03)
b) Brick 3.5'' (89 mm); R-0.42 (RSI 0,07)
c) 1 inch air space (25 mm), R-1.0 (RSI 0,18)
d) 1''(25 mm) extruded polystyrene rigid insulating sheathing R-5 (RSI 0,88), water vapor permeance <60 ng/Pa s m2
e) 2"x6" wood studs @16" c.c (38 x 140 mm @ 400 mm c.c.); R-6 (RSI 1,06) for wood studs
f) 5.5" Glass fiber batt insulation in the stud cavity (140 mm); R-19.0 (RSI 3,34)
g) 6 Mil Polyethylene vapor barrier; (R/RSI=0)
h) 1" x 4" vertical wood strapping @ 24" c.c. (19x89 mm @ 600 mm c.c.); R-1.0 (RSI 0,18) for the air space that is achieved with strapping
i) ½ " Gypsum board (12,7 mm); R-0.45 (RSI 0,08)
j) Interior air film ; R-0.68 (RSI 0,12)

1) Calculate the **Nominal** thermal resistance for the wall assembly (R or RSI):_____(5 pts)

2) Calculate the **Effective** thermal resistance for the wall assembly using the Parallel Planes method (Use Formula on last page in R or RSI)
_____(6 pts)

3) Calculate the outboard to inboard ratio to verify compliance to Code for use of low permeance insulating sheathing (<60 ng/Pa s m2): _____(3 pts)

4) Can we use the exterior low permeance insulating sheathing in this wall assembly built in Laval, Quebec? _____
Why? _____
_____(2 pts)

Calculations:

QUESTION # 9 **(8 points)**

Name the 4 basic principles of acoustics to incorporate in a wood stud separating wall assembly that will help significantly reduce sound transmission through the assembly.

1)_____
2)_____
3)_____
4)_____

Question 10. **(12 points)**

True or False

1) A 6 Mil polyethylene vapor barrier can be installed on the cold side of an exterior wall assembly built in Québec? _____

2) Combustible foam plastic insulations can be left exposed in an area that is not designated as a living space (ex. A crawl space)? _____

3) Insulating a foundation wall on the exterior side reduces the risk of condensation on the interior face (warm in winter side) and increases its durability? _____

4) It is possible to build a Net Zero Home one that produces as much energy as it consumes _____

5) The thermal resistance of an extruded polystyrene rigid insulation board is lower than that of an expanded polystyrene rigid insulation board (on an R value per inch basis)_____

6) Medium density polyurethane spray foam insulation can act as the principal component of an exterior air barrier system_____

Question 11. **(6 points)**

Let's compare two types of rigid foam insulations. Extruded polystyrene (XPS) to Expanded polystyrene (EPS):

1. Which product has a lower water absorption (% by volume)? _____

2. Which product has a higher compressive strength? _____

3. Which product can be used as a principal component in an exterior air barrier system? _____

Question 12.

(4 points)

Choose two air barrier materials from the list below (circle the best answers):

a) Semi rigid mineral fiber insulation

b) 6 Mil polyethylene vapor barrier.

c) Expanded polystyrene foam board with no membrane

d) Extruded polystyrene foam board

Question 13.

(4 points)

Name four principal requirements for an effective air barrier system in a building:

1) _____

2) _____

3) _____

4) _____

Question 14.

(3 points)

(Fill in the blank)

The Quebec Construction Code 2005, defines a vapor barrier material as one that has a maximum water vapor permeance value of **_____ng Pa/sm2**

Formulas and notes:

R x 0,1761 = RSI
RSI x 5,678 = R

RSI_{eff} = 100/ [(% area framing/$RSI_{tot\ framing}$) + (% area cavity/$RSI_{tot\ cavity}$)]

Table A-9.36.2.4.(1)A.
Framing and Cavity Percentages for Typical Wood-frame Assemblies(1)

Wood-frame Assemblies		Frame Spacing, mm o.c.									
		304		406		488		610		1220	
		% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity
Floors	lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	I-joists and truss	–	–	9	91	7.5	92.5	6	94	–	–
Roofs/ Ceilings	ceilings with typical trusses	–	–	14	86	12.5	87.5	11	89	–	–
	ceilings with raised heel trusses	–	–	10	90	8.5	91.5	7	93	–	–
	roofs with lumber rafters and ceilings with lumber joists	–	–	13	87	11.5	88.5	10	90	–	–
	roofs with I-joist rafters and ceilings with I-joists	–	–	9	91	7.5	92.5	6	94	–	–
	roofs with structural insulated panels (SIPs)	–	–	–	–	–	–	–	–	9	91
Walls	typical wood-frame	24.5	75.5	23	77	21.5	78.5	20	80	–	–
	advanced wood-frame with double top plate(2)	–	–	19	81	17.5	82.5	16	84	–	–
	SIPs	–	–	–	–	–	–	–	–	14	86
	basement wood-frame inside concrete foundation wall	–	–	16	84	14.5	85.5	13	87	–	–