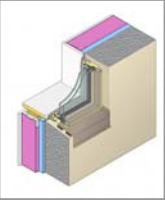


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→ Study of Poured-In-Place Concrete Wall Performance in Coastal British Columbia




CMHC **SCHE** **Environmental Protection Office**

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AGENDA

- Types of 'Concrete' Walls
- Water Penetration Control Strategies
- Focus on Poured In Place Concrete Walls

CONTEXT



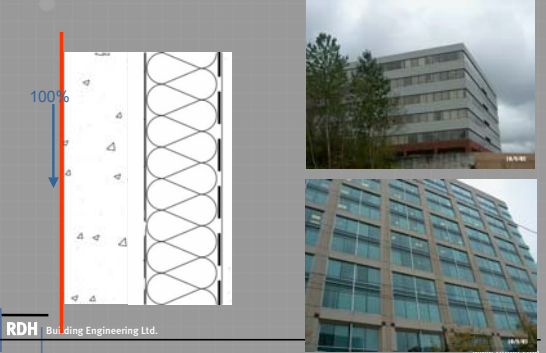
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Types of Concrete Wall Assemblies

- Precast Concrete Cladding
 - › Rainscreen or face seal (barrier) assemblies
 - › Panels unrestrained and therefore minimal cracking anticipated
 - › Rainscreen or face seal joints
- Tilt-Up Concrete Panels
 - › Typically face seal (barrier) assemblies
 - › Panels unrestrained and therefore minimal cracking anticipated
 - › Rainscreen or face seal joints
- Poured in Place Concrete
 - › Improved face seal with some mass wall characteristics
 - › Restrained nature of poured-in-place concrete elements leads to more cracking
 - › Poured-in-place means cold joints that need to be addressed differently than open joints between panels


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Face Seal Precast Cladding



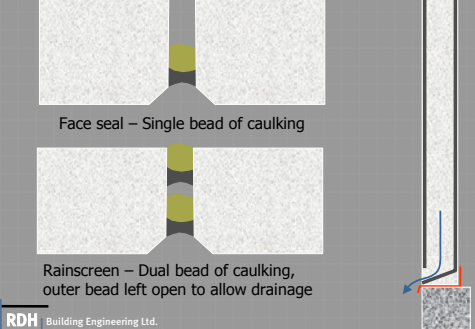
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Face Seal Precast – Tilt-Up



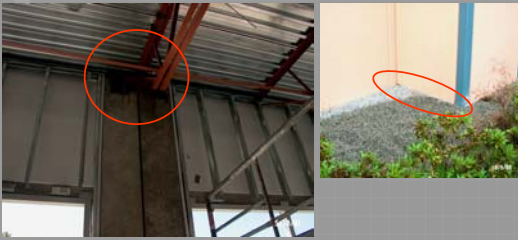
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Joints in Precast Concrete



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Face Seal Precast – Tilt-Up



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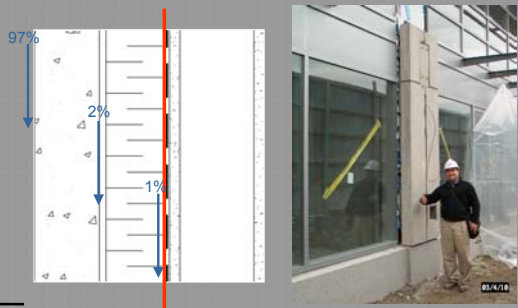
Joints in Precast Concrete

Good Trades!?



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Rainscreen Precast Concrete Cladding




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Poured-In-Place Concrete Walls



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Insulation in Stud Space Only



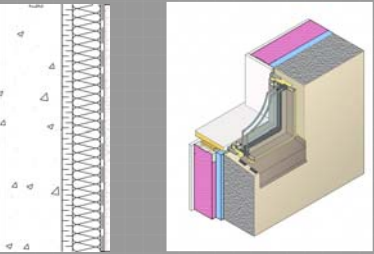
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Insulation Against Concrete



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Insulation Against Concrete and In Stud Space



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Case Studies

→ Look at variety of buildings to identify range of performance issues that need to be addressed



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Performance Issues - Condensation



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Performance Issues – Construction Joints



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Performance Issues - Cracks



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Performance Issues - Staining




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Performance Issues – Leakage at Interfaces



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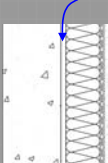
Performance Issues – Damage Within Wall



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Performance Issues – Air Movement

- Air flow into cavity between studs and concrete
 - Partition walls, electrical outlets, dropped ceilings
 - Driving force to drive air into cavity
- Solution
 - Insulate back side of concrete

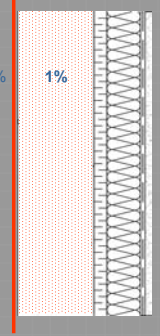


AIR FLOW INTO CAVITY CAN RESULT IN CONDENSATION ON INSIDE SURFACE OF CONCRETE

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Rain Penetration Control Strategy

- For uncracked wall area rain penetration control relies on:
 - Water shedding at the surface of the concrete
 - Concrete absorbing moisture and subsequent drying to the exterior
- Redundancy is achieved
- What happens at cold joints and cracks?



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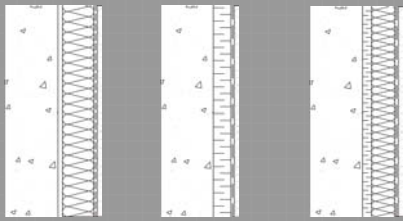
What Happens at Cold Joints and Cracks?

- Restrained nature of poured-in-place concrete elements leads to more cracking
- Poured-in-place means cold joints that need to be addressed differently than open joints between panels
- Joints and cracks are essentially holes through the concrete
- Challenge is achieving 'redundancy' or second line of defense at cold joints and cracks
 - Coating will not bridge any significant crack in a durable manner
- Focus on:
 - Reducing size, frequency and exposure conditions for joints and cracks
 - Controlling location of cracking
 - Good concrete mix design, and placement techniques
 - Providing a durable (redundancy) seal where joint or crack occurs

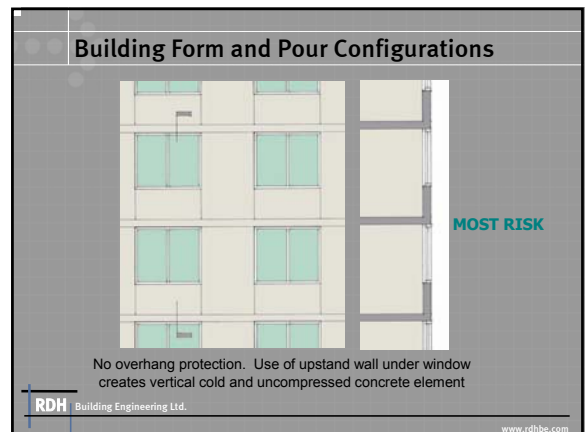
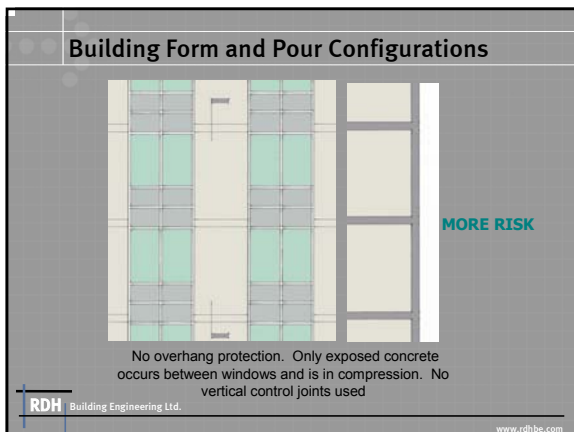
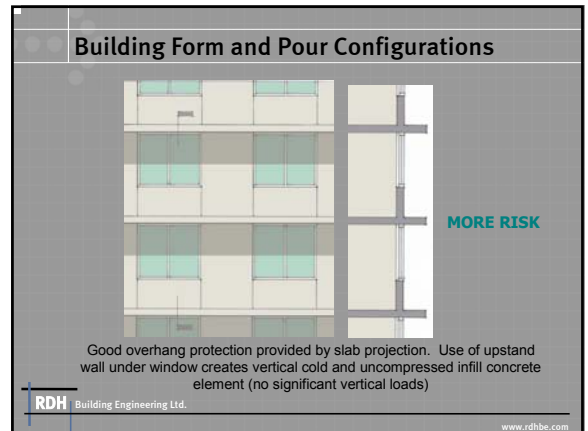
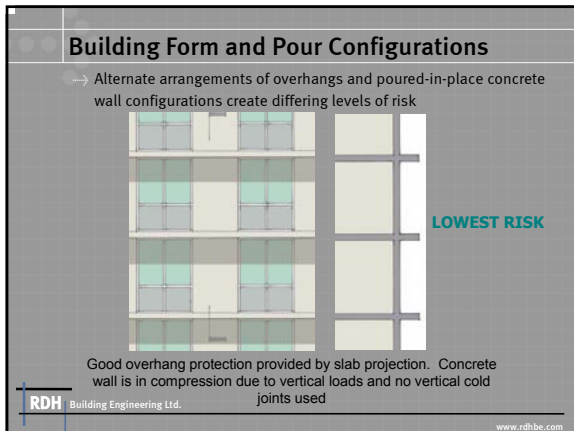
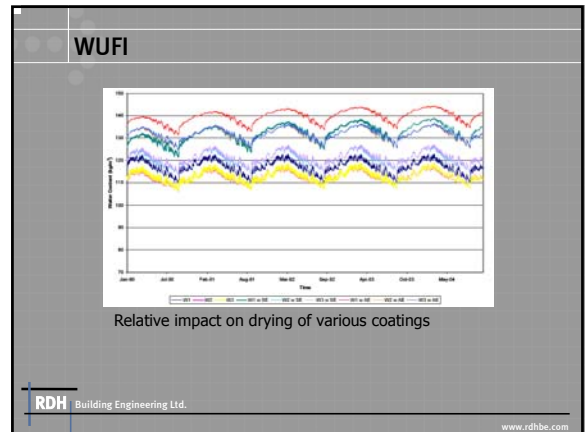
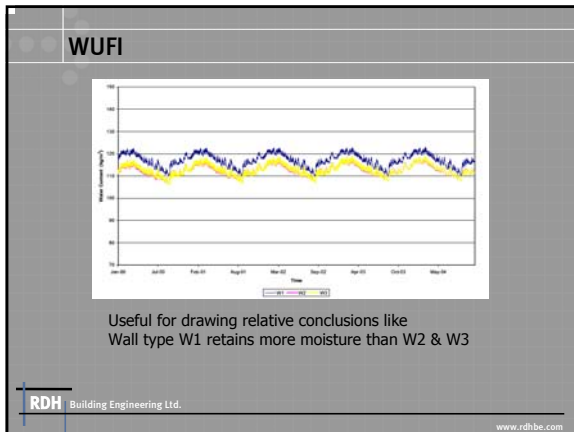
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Analysis of Walls

- Analysis using programs like WUFI tell us nothing particularly useful about performance related to the areas of concern with this wall type
 - Cannot analyze what happens when a construction joint or crack leaks



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Thermal Issues

17.7°C 19.1°C 19.1°C

Insulation is placed along the exterior wall surfaces only

The partition walls are insulated to a depth of 400 mm (16 inches) towards the interior

The partition walls are insulated to a depth of 914 mm (3 ft) towards the interior

Exterior Temp -6°C
Interior Temp 21°C

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Thermal Issues

12.1°C 12.3°C

Floor slab to wall intersection of W2

Floor slab to wall intersection or W2 incorporating a concrete eyebrow on the exterior side.

Exterior Temp -6°C
Interior Temp 21°C

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Concrete Wall Priorities

Worst Better Best

Worst Best Better

West Coast Balance

THERMAL PERFORMANCE RATING

WATER PENETRATION RATING

Thermal Issues

Aluminum angle in contact with steel studs (heat sink angle)

Condensation Potential Level	Window Frame Sitting Directly on Concrete Opening	Window Frame Insulated Between Frame and Concrete and Heat Sink Angle Installed
For Exterior Temperature: -6°C		
No Condensation	RH < 29	RH < 36
Minor to Moderate Levels	29 < RH < 44	36 < RH < 45
Severe Levels	RH > 44	RH > 45
For Exterior Temperature: 0°C		
No Condensation	RH < 39	RH < 46
Minor to Moderate Levels	39 < RH < 54	46 < RH < 54
Severe Levels	RH > 54	RH > 54

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Key Points – Poured-In-Place Concrete Walls

- The risky part of a concrete wall assembly from a rain penetration perspective are locations of cracks and joints
- Manage rain penetration at cracks and joints through
 - Building form and pour configurations that limit number of cracks, size of cracks and exposure conditions
 - Concrete mix design and placement techniques that minimize cracking and other imperfections in pour that contribute to leakage
 - Detailing that reflects 2 lines of defense (redundancy)
- Due to the lesser certainty in predicting the location of cracks and the variable damming characteristics of waterstop materials there will always be greater risk of water penetration associated with poured-in-place concrete walls than with most rainscreen wall assemblies
- Water penetration issues are likely to be localized problems
- Thermal issues are important too (energy and condensation)

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