



Building Science and Imperfection

Managing Risk in Building Enclosures
Christy Cronin, Building Science Corporation



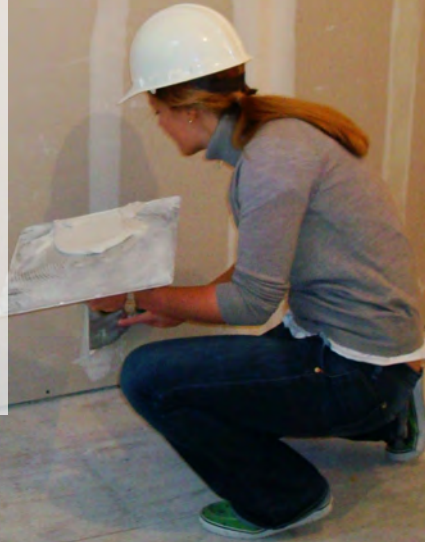
Out of the crooked timber of humanity no straight thing was ever made.

– Immanuel Kant

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Five Approaches to Risk Mitigation in Building Enclosures

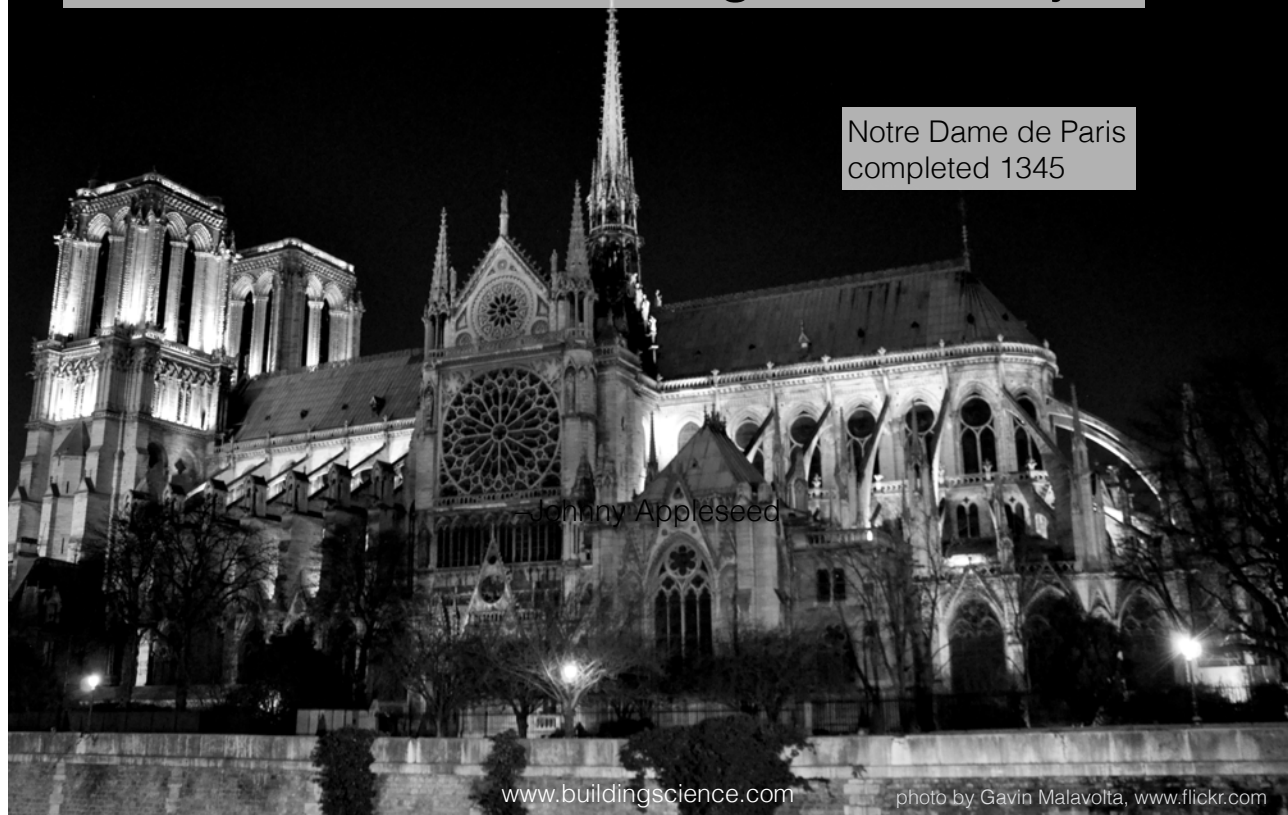
1. Buildings are complicated
2. Think in terms of functions, not products
3. Water shedding is different than waterproofing
4. Decide what is inside and what is outside
5. Mock-ups and pre-installation meetings are really important



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Construction time throughout history

Notre Dame de Paris
completed 1345



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photo by Gavin Malavolta, www.flickr.com

Construction time throughout history



One World Trade Center
8 years

photo by Joe Mabel, www.wikipedia.org



Empire State Building
410 days

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Pyramid at Giza
~20 years

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Changes in building materials



moisture tolerance of
modern building
materials varies



cavity walls use
more materials than
mass walls

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Larger, higher quality homes...

Occupant Reported Housing Defects	1973	2005
Lack some plumbing	4.7%	1.7%
Exposed wiring	4.0%	0.6%
Holes in floors	2.0%	0.9%
Open cracks or holes in walls or ceilings	6.0%	4.8%
Leaks from roof	7.9%	5.4%
Leaks in basement	29.6%	10.9%

	1973	2005
Homes with A/C	~50%	~90%
Bathrooms per home	1.89	2.47

Data from U.S. Department of Housing American Housing Survey; http://www.huduser.gov/datasets/ahs/ahs_taskc.pdf

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... for about the same cost

	1973	2010
Median Size of New Homes	1,525 SF	2,169
Median Sale Price of New Homes	\$32,708	\$221,241
Inflation Adjusted Price/SF to 2010 Dollars)	\$103	\$102

Data from U.S. Census
 Data on size from: www.census.gov/const/C25Ann/sfttotalmedavgsqft.pdf
 Data on price from: www.census.gov/construction/nrs/pdf/uspricemon.pdf

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Diversity of building types



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Buildings are complicated.



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- David Shrigley, *The Essential David Shrigley*

Think in terms of functions, not products

Basic Enclosure Functions*

Support: resist and transfer physical forces

Control: control mass and energy flows

Rain and soil moisture (drainage plane, capillary break, etc.)

Air (continuous air barrier)

Heat (continuous layer of insulation)

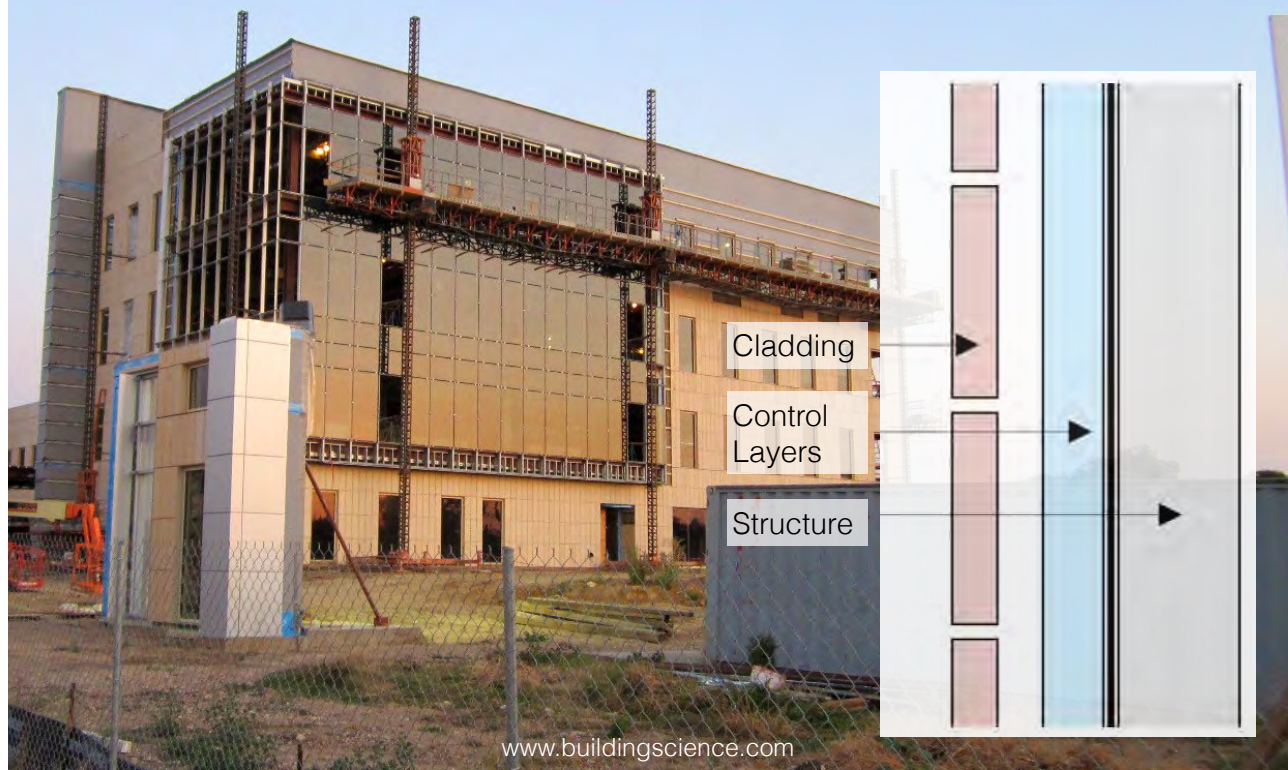
Vapor (balance of wetting & drying)

Finish: interior and exterior surfaces for people

* Text quoted from John Straube

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The Perfect Wall



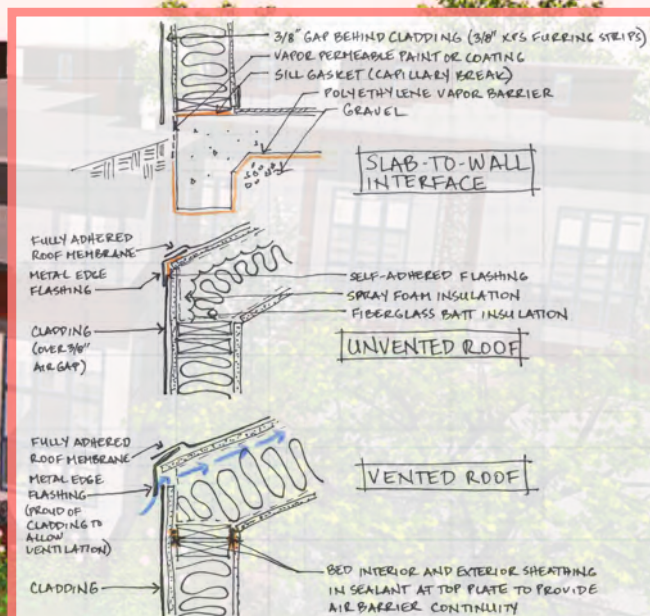
... the perfect slab...

and the perfect roof

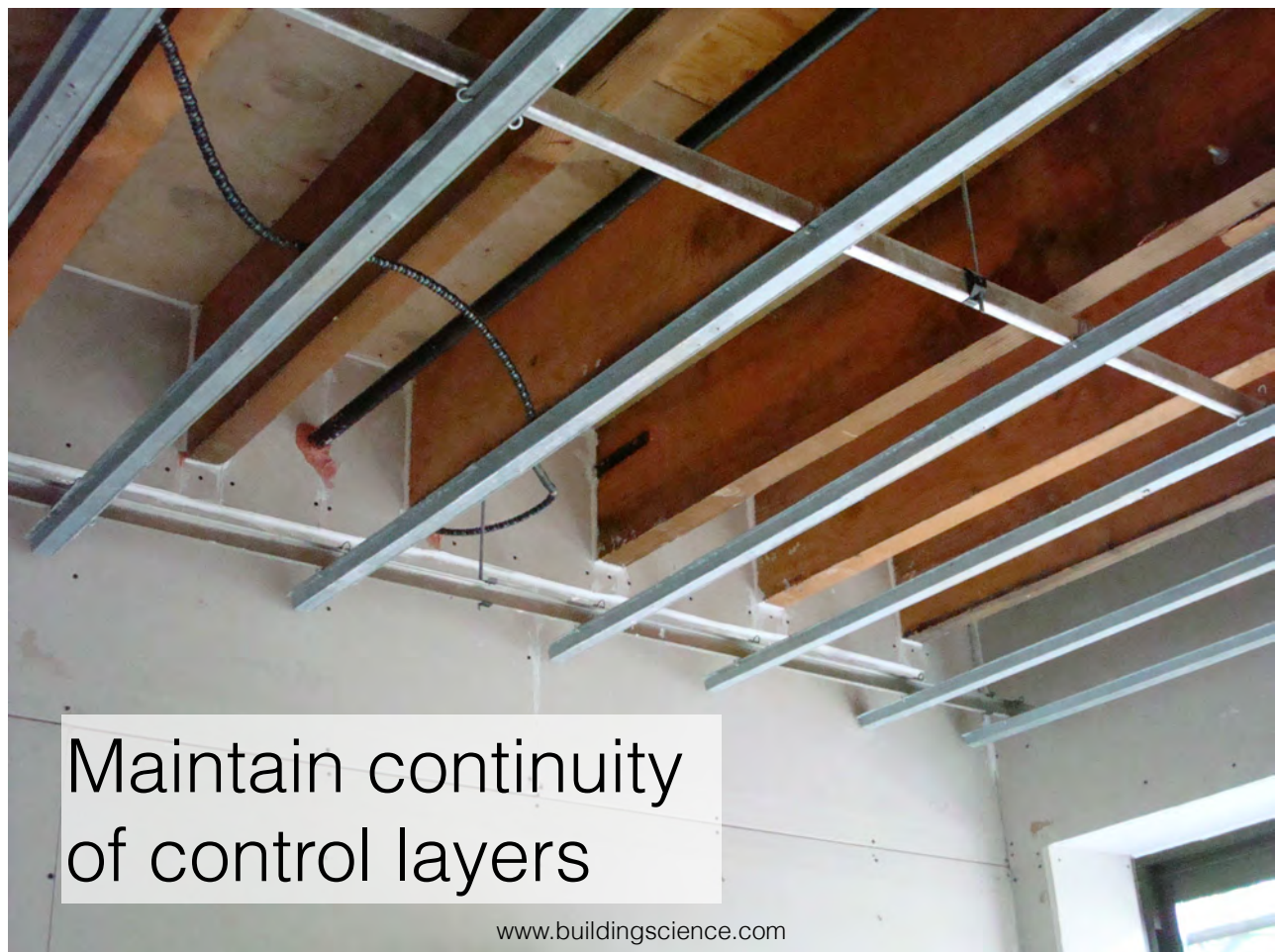


Most walls are not the Perfect Wall

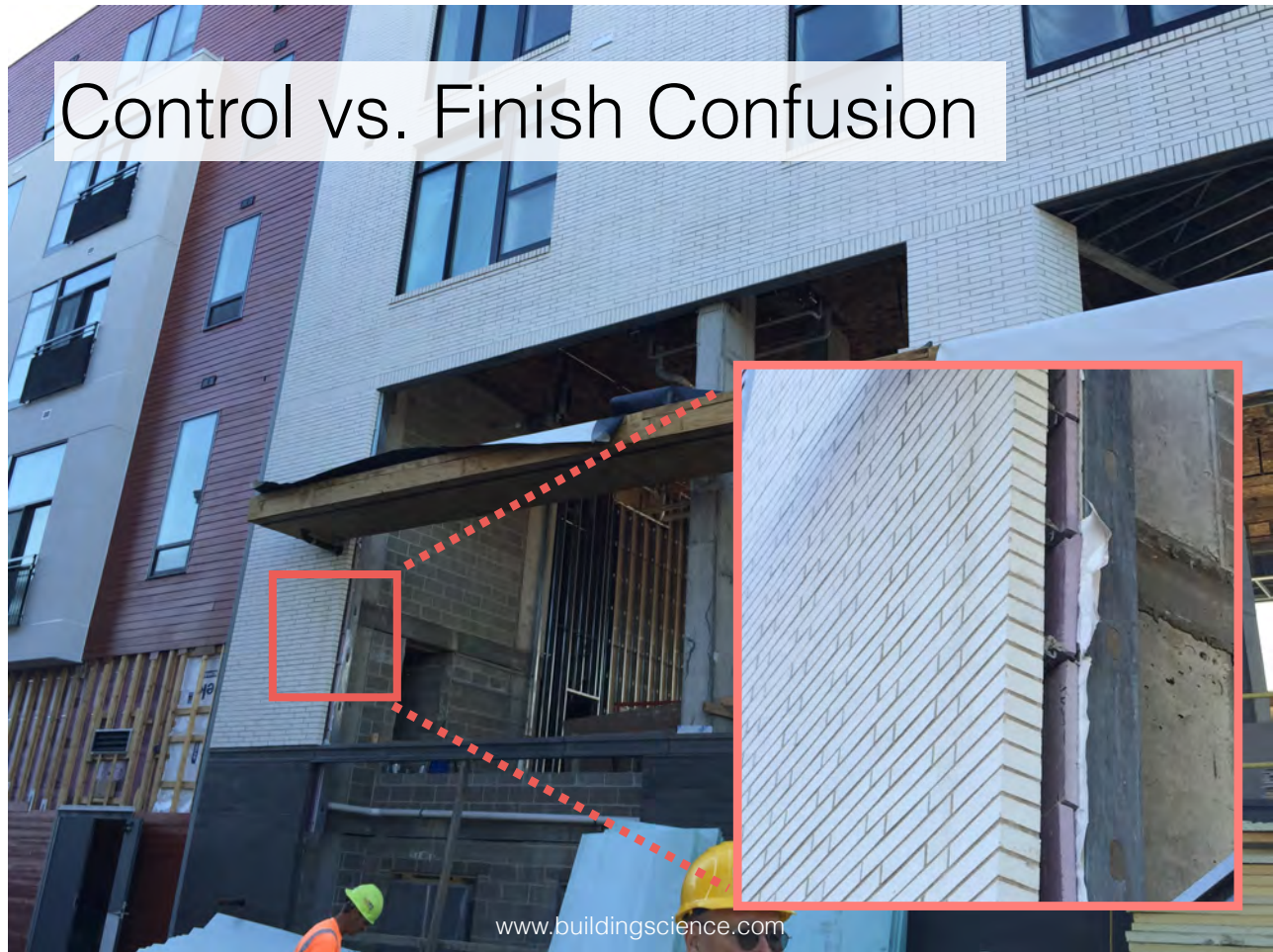
- Maintain continuity of the control layers
- Identify locations of cold surfaces
- Evaluate the wetting & drying potential of moisture sensitive materials



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Control vs. Finish Confusion



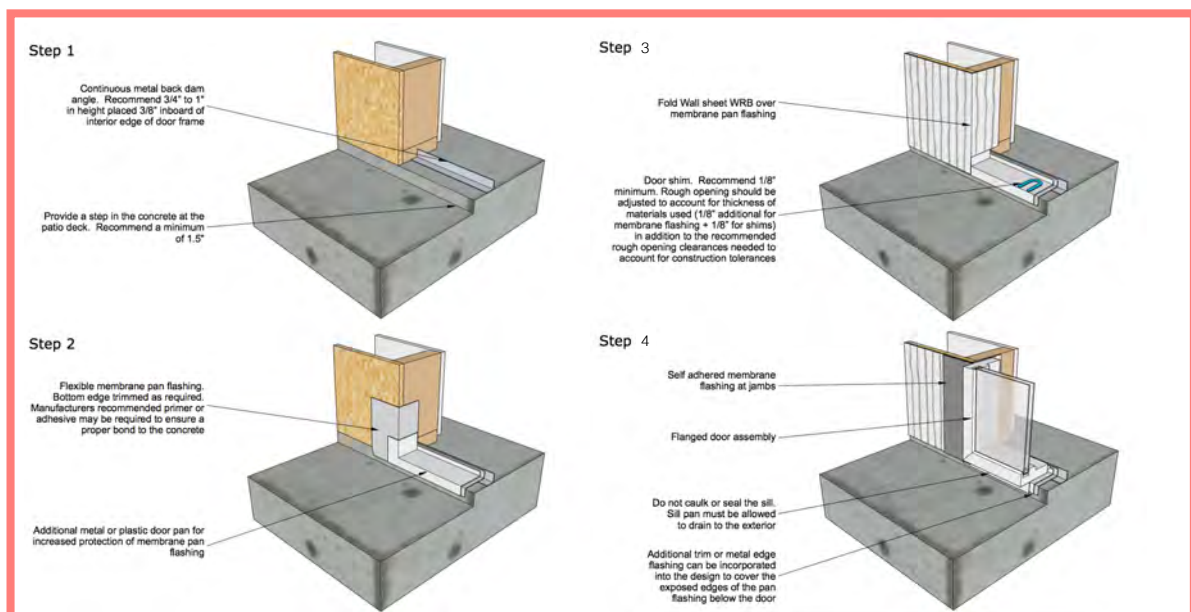
Control vs. Finish Confusion





Water shedding vs. waterproofing

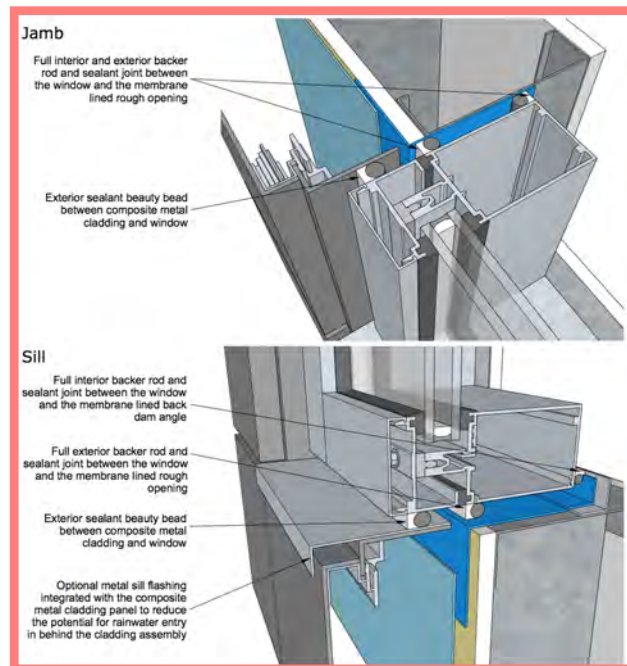
Balcony door flashing installation sequence



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Water shedding vs. waterproofing

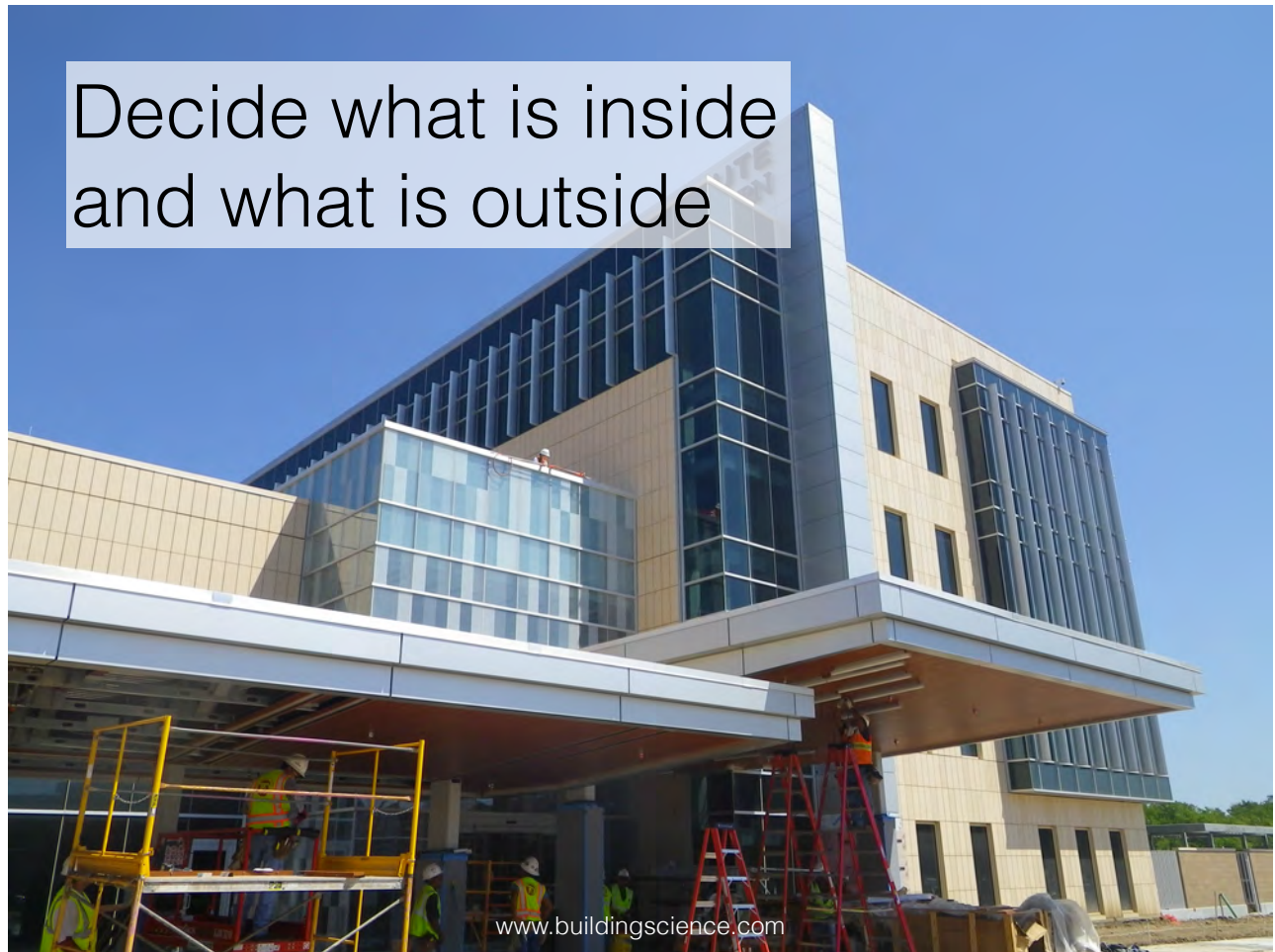
Window installation:
Flexible membrane flashings are waterproofing;
metal flashings are water shedding



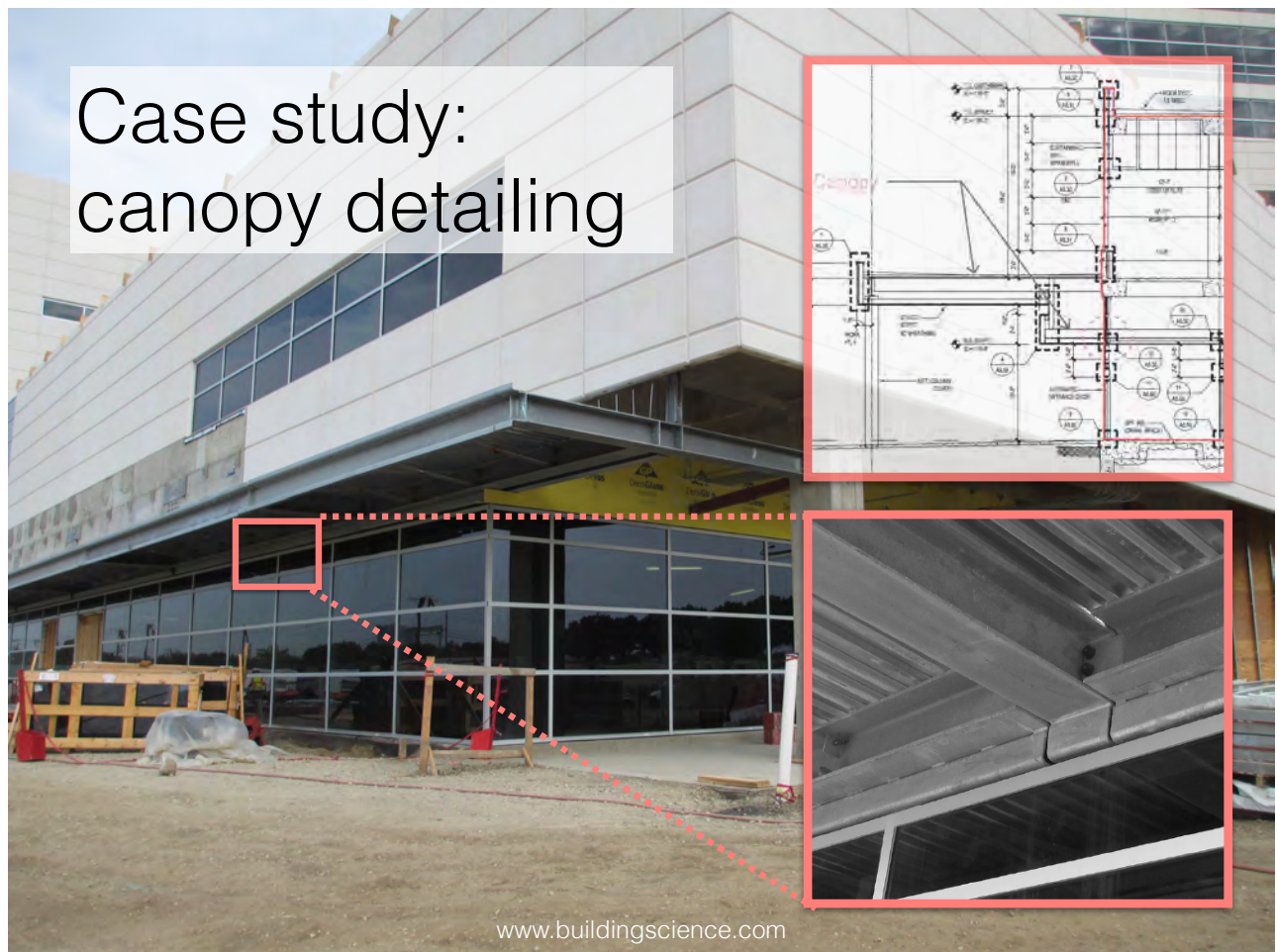
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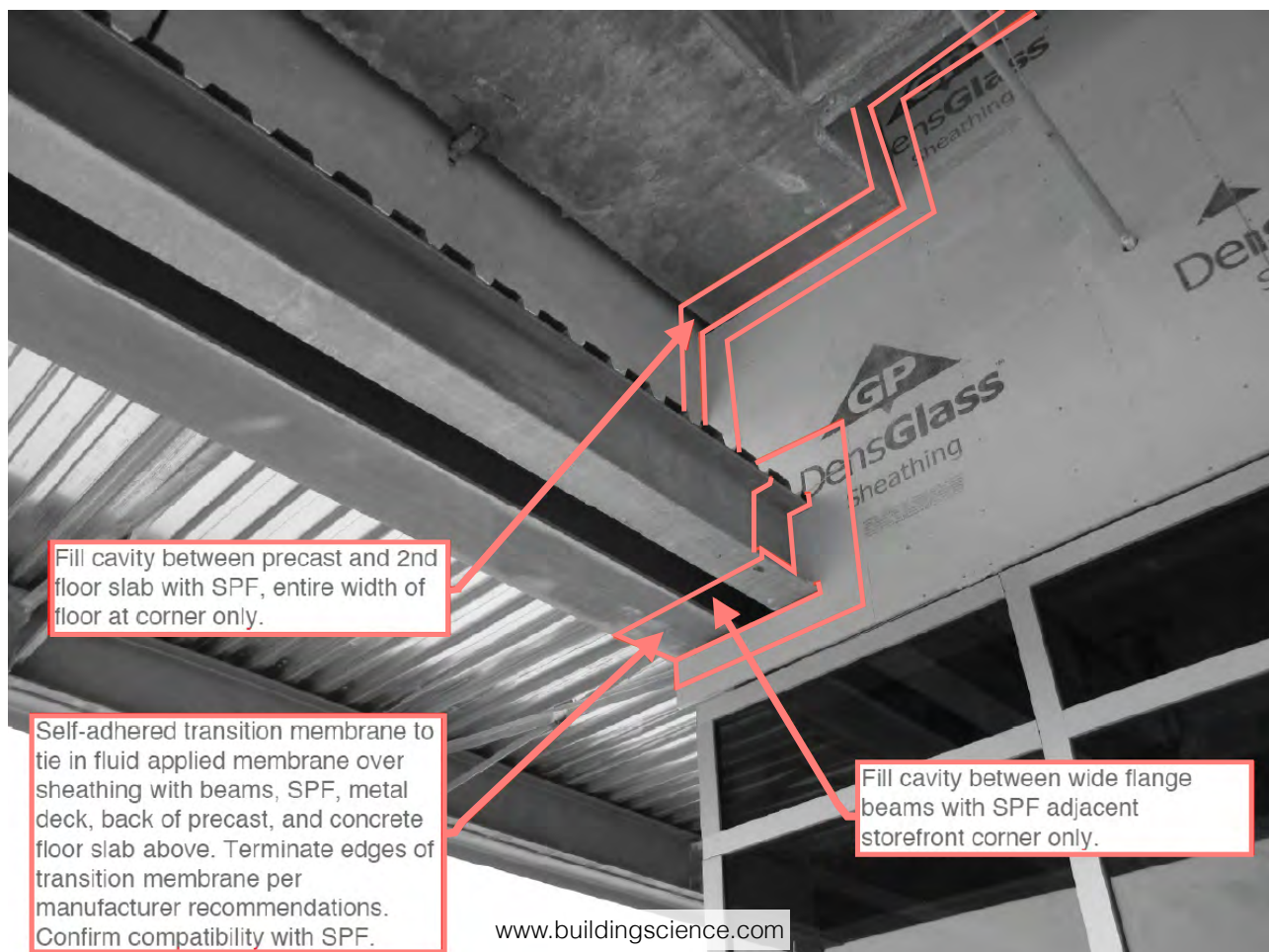
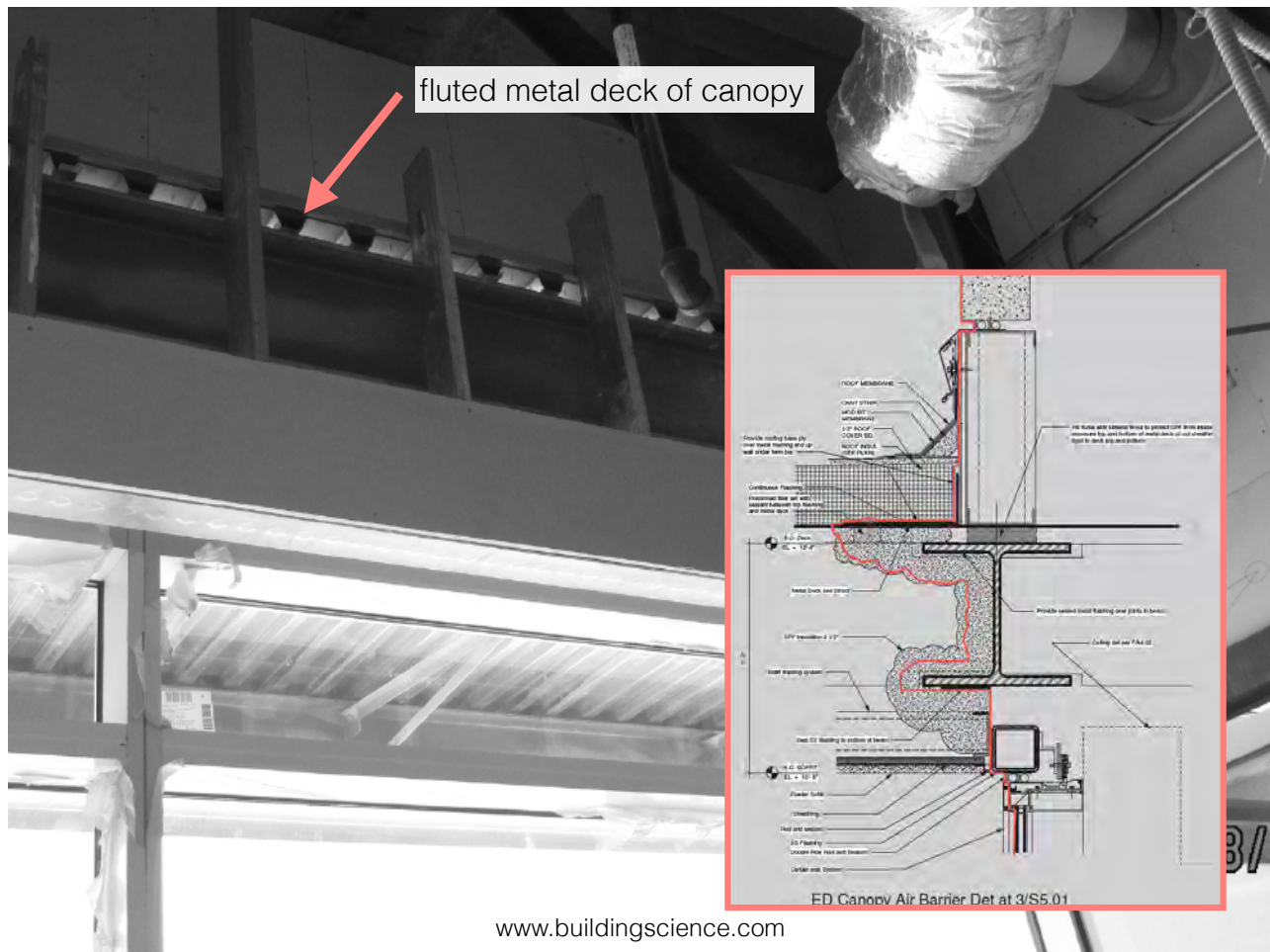


Decide what is inside and what is outside

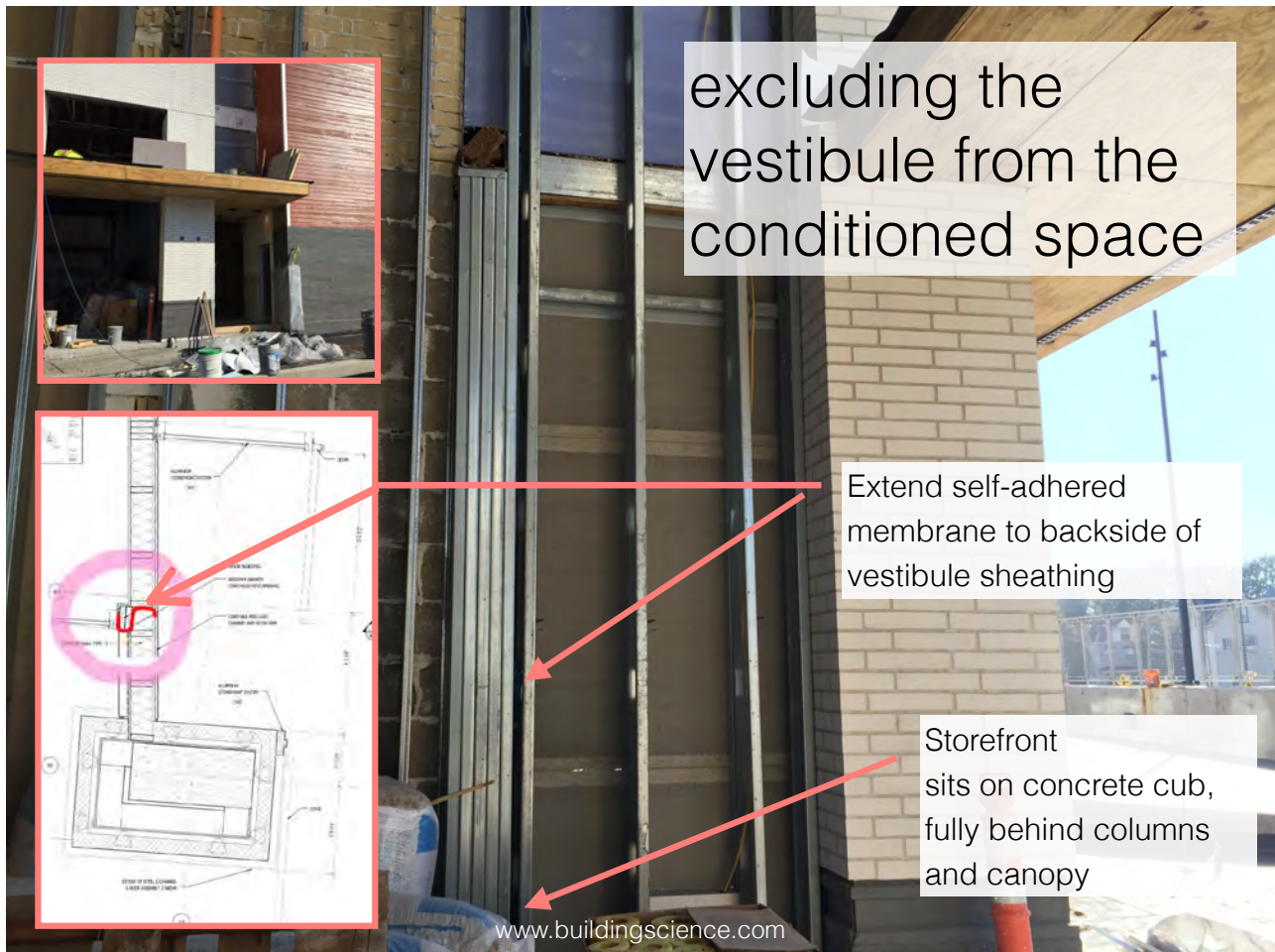
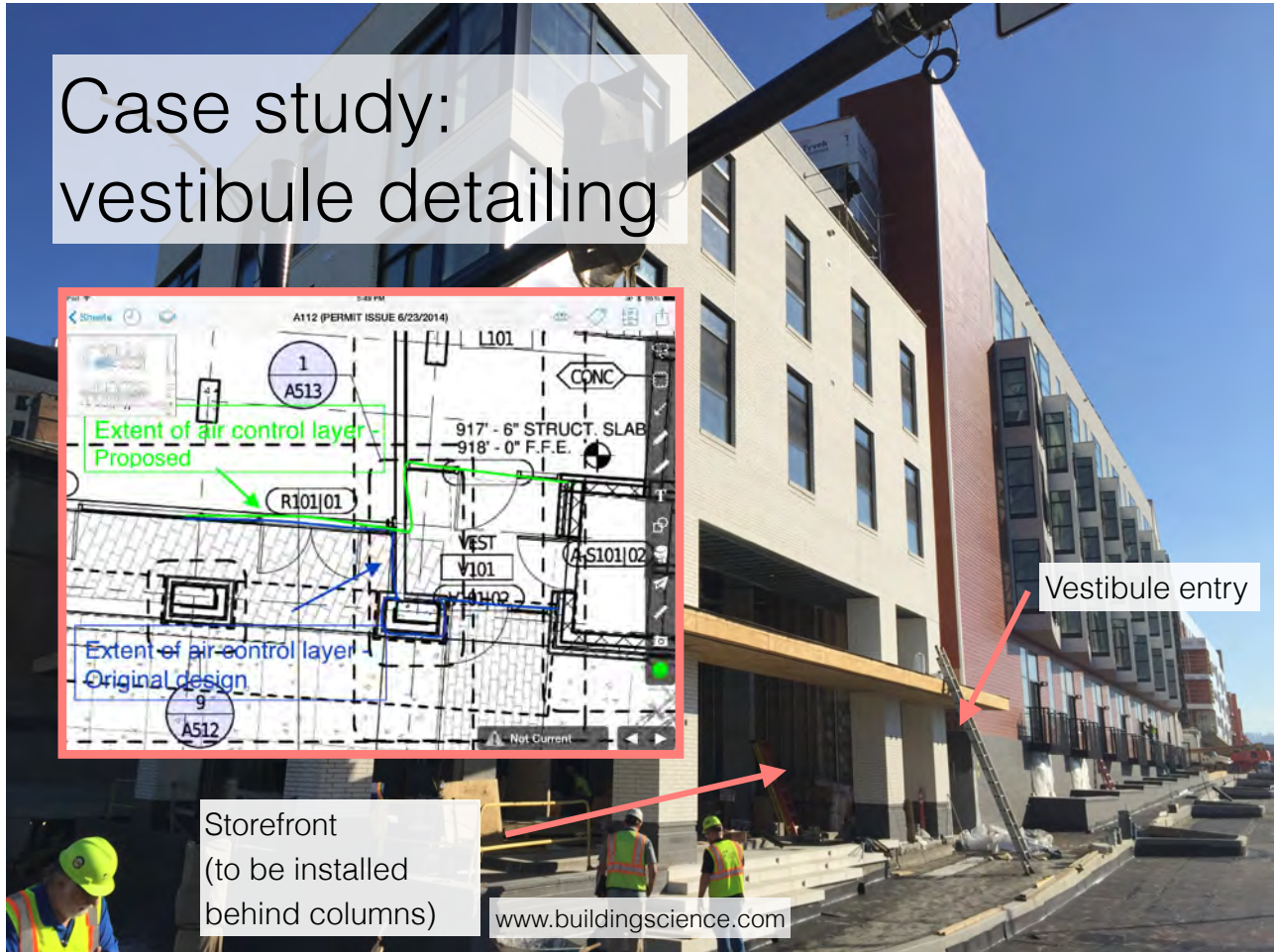
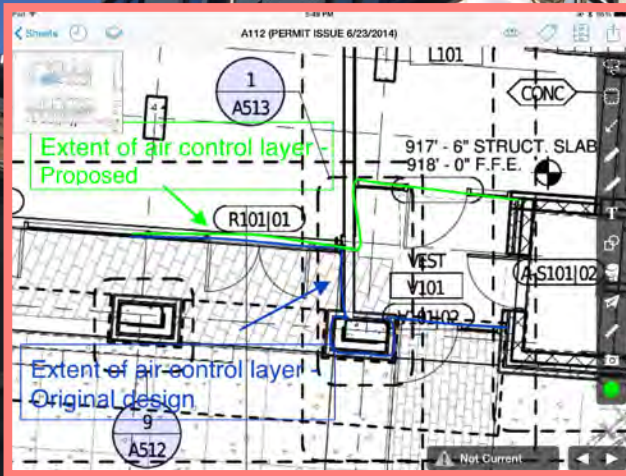


Case study: canopy detailing



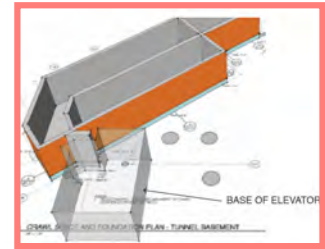
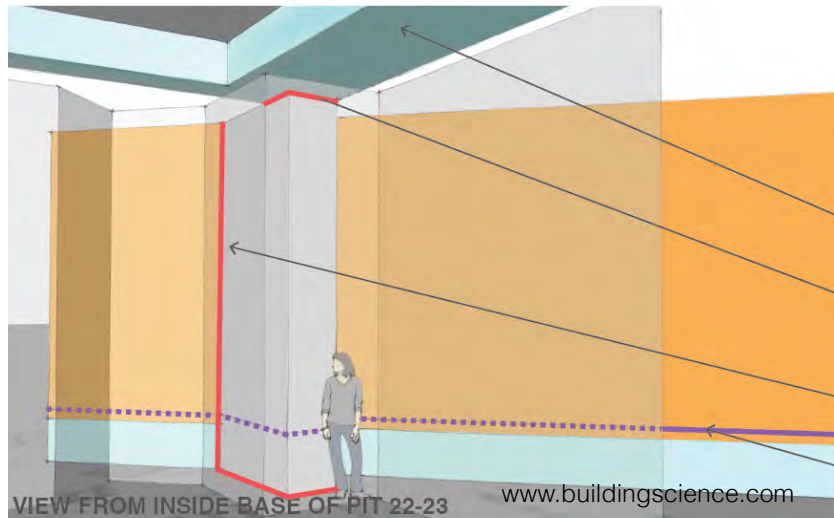


Case study: vestibule detailing





Case study:
below-grade



- PREPRUFE BELOW ELEVATOR PIT 22-23
- INTEGRATION OF STEM WALL WP & ELEVATOR PIT W
- INTEGRATION OF STEM WALL WP & TUNNEL WP
- COLD JOINT

VIEW FROM INSIDE BASE OF PIT 22-23

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Mock-ups and pre-installation meetings are important

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