Towards Airtightness

The Contractor’s Role in Designing & Constructing the Air Barrier System

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A Contractor’s Perspective…

• Commissioning = Quality Process

• Testing for sure, but a whole lot more...

• Contractor can play a major – and positive – role throughout the commissioning process
Contractor Has a Role Throughout…

• Contractor’s Role in Design of AB System
  – Selection of Air Barrier Approach
  – Selection of Primary Air Barrier Material
  – Selection of Air Barrier Approach & Material – A Case Study
  – Constructability of the AB System
  – Design Impacts on AB System Implementation

• Contractor’s Role in Construction of AB System
  – Coordination of the Work – A Case Study

• Contractor’s Role in Testing of AB System

• Discussion & Conclusion
Contractor Has a Role Throughout…

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Contractor’s Role in Testing of ABS

• The commissioning process culminates in the air leakage testing program used to assess compliance with established air barrier performance requirements

• In some cases, requirements are included in project specifications
  – Continuous AB requirement – and air leakage test requirements – now included in specifications for some projects in Oregon
  – Requirements specified at assembly level on some projects and at whole building level on others
Contractor’s Role in Testing of ABS

- AB requirements now included in numerous state and local jurisdiction codes

- For projects in Washington state, a continuous air barrier system is now required by 2009 WSEC & 2009 SEC

- Air leakage testing is also required...
Code Requirements in Washington State

• WSEC/SEC requires:
  – “…the building envelope be designed and constructed with a continuous air barrier to control air leakage into, or out of, the conditioned space.”
  – “…all air barrier components of each assembly shall be clearly identified on construction documents and the joints, interconnections and penetrations of the air barrier components shall be detailed.”
Code Requirements in Washington State

- WSEC requires whole building air leakage testing for buildings over five stories.

- SEC requires whole building testing at all buildings governed by the SEC.

- Both codes state that compliance shall be confirmed by testing completed building and demonstrating air leakage rate of building does not exceed 0.40 cfm/sf @ 1.57psf /75 Pa.
Code Requirements in Washington State

• Strict compliance not currently required...
• Current requirement: buildings must be tested and test results reported prior to issuance of certificate of occupancy
• Whole building testing conducted in accordance with ASTM E 779 or approved sim. test
• Air leakage rate reported as normalized value, in cfm/sf @ 1.57 psf/75 Pa over total area of building envelope air pressure boundary
Code Requirements in Washington State

• Code requirements have effectively imposed the testing component of air barrier commissioning on the construction industry in Washington state

• How will these code requirements be received by industry?

• How will these code requirements transform design and construction of air barriers as we move into the future...
Assembly Testing

- Relatively straightforward...

- Mockups

- In-situ testing
  - 100 sq.ft. sections of exterior wall, randomly selected

- ASTM E 783
Whole Building Testing

• A very different matter...

• Coordination required between contractor & commissioning agent can be extensive

• Much depends on when testing is conducted
Whole Building Testing

• Substantial completion is ideal time to test from testing and construction coordination standpoint
  – All building systems complete
  – Users have not yet occupied building
  – Coordination between commissioning agent and contractor is typically minimal
Potential Problems

• If building’s air leakage rate exceeds the requirements, then what is to be done?
• Remedial work likely will be required
  – Who pays the cost of remedial work?
  – Is the excess leakage related to design problem or construction problem?
  – If construction problem, which trade(s) responsible?
• Potential for conflict and disputes is significant
• With “test at completion” whole building test approach, QA & QC measures have not been well-utilized
Assembly Testing during Construction

• AB assembly testing during course of construction can be useful; however, this type of testing does not include key conditions and interfaces that often lead to large amounts of air leakage

• Building that passes assembly tests may not pass whole building test if leakage is occurring at intersections of assemblies, or at atypical penetrations in walls or roofs outside scope of assembly testing process
Whole Building Testing during Construction

• Greater degree of QA/QC can be provided by whole building testing during course of construction

• While whole building air barrier system may not be complete, air barrier system at smaller zones within the building may be complete, or near completion
Whole Building Testing during Construction

• This type of testing can be complex due to variable nature of a given building under construction
  – Systems are only partially complete, creating many difficulties for testing

• Substantial coordination required between commissioning agent and contractor

• Intentional and unintentional openings in the building enclosure, as well as the zone enclosure, must be identified and assessed
Whole Building Testing during Construction

• Zone enclosure includes interior floors or walls not designed for airtightness but must be made airtight to allow for a meaningful test

• Light frame buildings
  – Hollow floor and wall assemblies
  – More difficult to isolate into smaller zones that can be tested

• Heavy frame buildings
  – Typically have solid floors, often have solid walls
  – Much easier to isolate into smaller zones for testing
Discussion

• **What level of airtightness is achievable broadly across the industry?**

• Lots of airtightness data for small buildings...

• Data for large buildings not yet fully developed...
  – Is 0.40 cfm/sf the right target? **0.25 cfm/sf?**

• Individual building designs are highly varied
  – Should this factor into the airtightness standard?

• Should requirements be different for rehab vs. new construction?
Data and the Establishment of Standards

• More data is needed...

• Conversely, standards can be established and industry will go through learning curve to determine how to meet those standards

• As long as standards are voluntary, this is a reasonable and viable approach
The Evolution from Standards to Codes

• Things change when voluntary standards become mandatory codes...
• Voluntary standards allow teams to make choices
• As airtightness standards incorporated into code, choice disappears
• Owners and their design and construction teams must be prepared to meet the performance requirements established in the code regardless of their understanding of the implications of these requirements
The Seattle / Washington Approach

• Approach taken by Washington state code officials is a good middle ground:
  – Requires air leakage testing, but not compliance

• Over a number of years, this approach will provide what is currently missing: *data gathered from a wide range of building types and large number of buildings*

• Allows industry in Washington state time to evolve, to understand implications of performance requirements, and determine what measures required to meet those requirements
Discussion

• Should building codes include requirements for airtightness?

• *If established, should requirements be qualitative or quantitative?*
Qualitative vs. Quantitative Requirements

• Qualitative requirements (i.e. requirements calling for provision of a continuous air barrier system, clearly indicated in drawings) are much more critical to achieving airtightness than quantitative requirements (i.e. air leakage testing)

• Quantitative requirements are worthless and potentially problematic if qualitative requirements are not also established

• Qualitative requirements – if embraced by design teams and enforced by building officials – can produce a high level of airtightness without imposing quantitative requirements
Qualitative vs. Quantitative Requirements

- Testing is useful for diagnostic purposes and to verify compliance with performance requirements; however, whole building air leakage testing is costly for building owners.

- Testing may not be necessary if design team provides a continuous, clearly identified AB system and construction team diligently executes the work in accordance with that design.
Responsibility for Failures

• Placing mandatory quantitative requirements in codes raises questions
  – Which party will be held responsible if building does not comply with requirements?

• It is possible construction team could diligently execute design of AB system for a building and that building could fail to pass the whole building air leakage tests
  – If design of system does not fully and clearly provide for air barrier continuity, which party will be deemed responsible for failure?
The Costs of Failure

• Costs associated with failure likely to be high in many cases
  – Will building receive a certificate of occupancy?
  – Will it be necessary to remove the cladding system so repairs to AB system can be implemented?
  – Are design professionals and contractors ready to absorb these costs?
  – Are owners ready to absorb costs they may incur through higher fees requested by architects and contractors to manage – and price – their respective risks?
How Will Any Given Building “Test?”

• Project teams do not know with certainty how a large building will test for airtightness
  – Will it meet specified performance requirements?
  – Will it meet mandatory code requirements?

• Major difference between setting quantitative performance requirements for materials/components (e.g. concrete) and setting requirements for systems (e.g. ABS)
Conclusions

• Contractor can play a major role in successful implementation of airtightness at buildings

• Proactive, diligent work by contractor – combined with similar effort by design team – likely to result in delivery of functional air barrier systems that add value to buildings
  – Improve comfort
  – Increase durability
  – Reduce energy usage, and costs
Conclusions

• Contractors working in negotiated contract setting likely to provide more proactive support for successful implementation

• Hard bid projects more likely to suffer from inconsistent implementation, increased risk of substantial change orders, and potential conflict regarding which parties bear responsibility for failures
Conclusions

• More data on airtightness of large buildings is needed to establish industry standards that can be reached consistently
  – Not yet clear that construction industry has capability in design or contracting sectors to consistently implement AB systems
  – Understanding is growing, but still relatively limited across industry

• Approach taken by WA state officials is example of how such data can be developed across wide range of building types and project teams
Conclusions

• Qualitative requirements – if embraced by design teams, enforced by building officials, and implemented diligently by construction teams – can produce high level of airtightness without imposing quantitative requirements
Pearl Family Housing
Portland

System (whole building) airtightness: ____ cfm/sf @ 1.57 psf
Questions?
Thank You