Putting It Together in Attached Housing Units

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Outline

- Introductions
- Context & Issues / BG
- Solutions / PD
- Q&A

Context:
What are attached housing units?

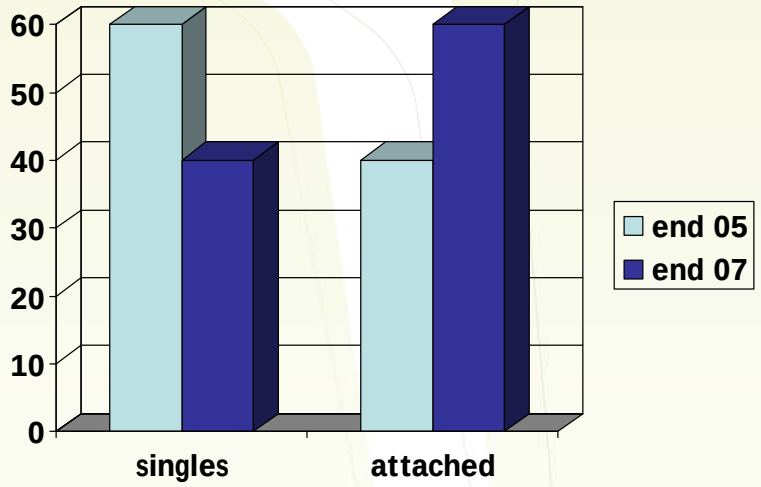
- 3 floors or less with common walls and/or floors
- Towns, rows and semi's (freehold),
- Stacked (walk-up condominiums) – (US IRC ?)

- More affordable
- Higher densities

Context: Market Share Increasing

- Two years share reversal
- One Ottawa builder (1200)
- Suburbs
- Percent of sales

- Should focus on attached
- Bigger opportunity
- More need for improvement



Context: Myth Busters

- The Belief:
- Towns and stacked more energy efficient form
  - Generally smaller
  - less exposed walls and windows
  - less exposed floors and ceilings
- The Reality:
- Can be worse than singles – (area basis)
  - Less effective insulation
  - Less efficient mechanicals
  - Much higher rates of air leakage

Insulation & Mechanical

- Windows and doors on end walls
  - subtract framing – room for insulation?
  - Effective R-val of R19 wall,
  - 23% framing: 15.7
  - 33% framing: 14.2
- Smaller units, smaller loads
  - space constrained equipment
  - less efficient heating, less efficient cooling

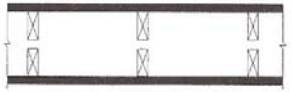
Fire & Sound Requirements

	Party Walls	Common Floors	Standard
Fire	1 hr US – 1 hr both	1 hr	CAN/ULC-S101-M ASTM E 119
Sound	>STC 50, 55 rec >45 (US)	>STC 50, 55 rec Impact IIC, 55	ASTM E 336 Impact ASTM E 492
Flame Spread US exp insul	<150 <200 (US) <25	<150 <200 (US) <25	CAN/ULC-S102-M ASTM E 84
Smoke US exp insul	<450 <150	<450 <150	CAN/ULC-S102-M ASTM E 84
Air Leakage	none	none	

Rated Assemblies

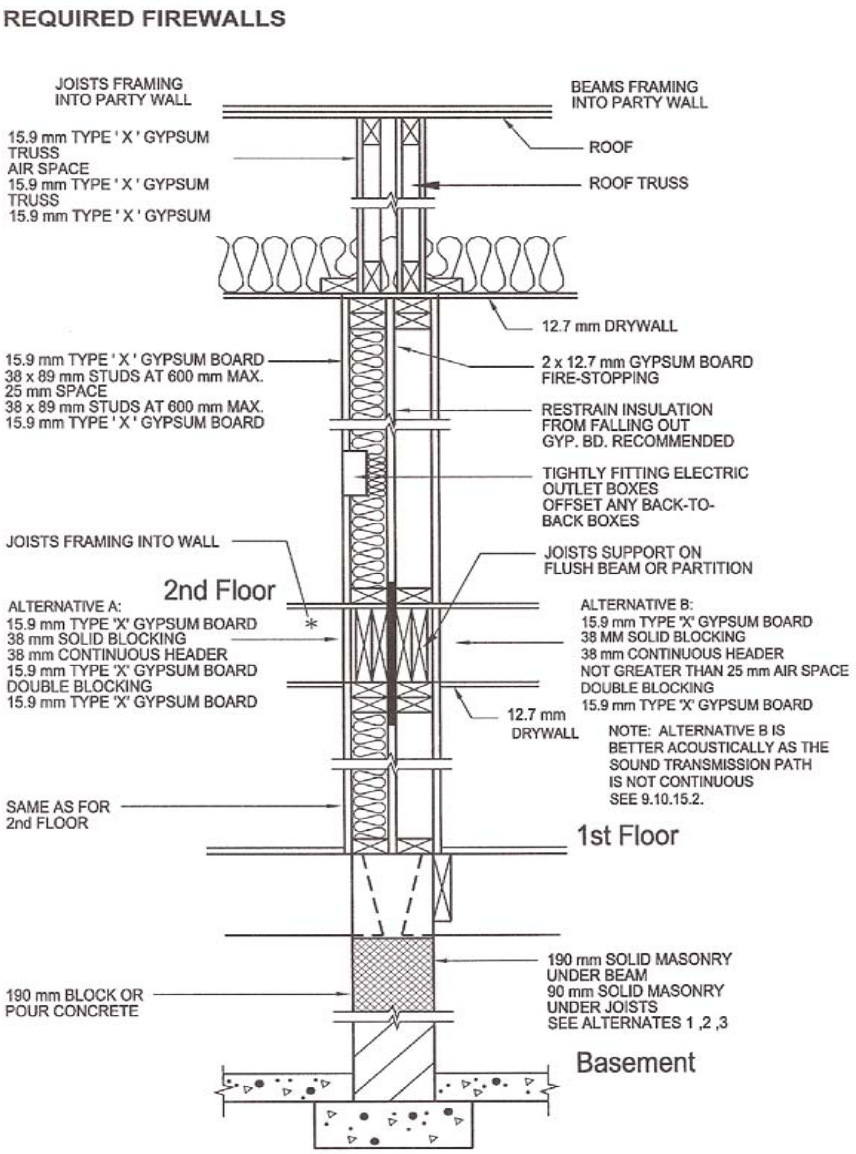
- Pre- rated for sound and fire
- Look up in Code (in Canada)

Table 8.1 (Continued)

Type of Wall	Wall Number	Description	Fire Resistance Rating[1]		Typical Sound Transmission Class[1][2][3]
			Load-bearing	Non-load-bearing	
	W15	• two rows 38 mm x 89 mm studs, each spaced 400 mm or 600 mm o.c. on separate 38 mm x 89 mm plates set 25 mm apart • with or without absorptive material • 2 layers of gypsum board on each side			
	W15a	W15 with • 89 mm thick absorptive material on each side[4][8] • 15.9 mm Type X gypsum board[5]	1.5 h	2 h	66
	W15b	W15 with • 89 mm thick absorptive material on each side[4][8] • 12.7 mm Type X gypsum board[5]	1 h	1.5 h	65
	W15c	W15 with • 89 mm thick absorptive material on each side[4][8] • 12.7 mm regular gypsum board[5]	45 min	1 h	61
	W15d	W15 with • 89 mm thick absorptive material on one side only[4][8] • 15.9 mm Type X gypsum board[5]	1.5 h	2 h	62
	W15e	W15 with • 89 mm thick absorptive material on one side only[4][8] • 15.9 mm Type X gypsum board[5]	1 h	1.5 h	60
	W15f	W15 with • 89 mm thick absorptive material on one side only[4][8] • 12.7 mm Type X gypsum board[5]	45 min	1 h	57
	W15g	W15 with • no absorptive material • 15.9 mm Type X gypsum board[5]	1.5 h	2 h	56
	W15h	W15 with • no absorptive material • 12.7 mm Type X gypsum board[5]	1 h	1.5 h	55
Column 1	2	3	4	5	6

Rated Assemblies

- double 2x4 wall, 1” separation - typical



Other Fire Requirements

- Continuous
  - Everywhere, floor platforms, abutting walls, attic, around elec
- Firestops in concealed spaces
  - Each floor, attic
  - Metal, coreboard
- Cover foam plastics
  - gypsum bd or approved finish

Air Leakage

- ON typical singles: 0.3 cfm50/ft2 (3.6 ACH50)
- Attached towns and stacks 0.5 cfm50 (6-10 ACH50)
- Why?
- No continuous air barrier requirement / performance
- 1” gap – air conduit
- Non finished gypsum bd at:
  - Floor rims, bulkheads, drop floors, steel posts and beams, floor over garages, tubs and showers

Consequences of High Rates of Air Leakage

- Energy
- Sound
- IAQ
  - Pressure imbalances drive leakage from adjacent units with odour, stale air
- Air leakage
  - Increases energy consumption for heating and cooling
  - Can cause condensation, mould

Air Sealing

- Seal ducts to limit interior pressure imbalances
- Better use of foams and sealants at framing stage – cover w/ gyp bd,
- Apply after exposes spot caulks and sealants
- Confirm methods with Building Official

Solutions

- Handover to Paul Duffy

Background on Air Tightness of Single Family Energy Star Homes in Canada

- Single Family Energy Star Homes in Ontario must meet an air tightness requirement of:

$0.2\ cfm_{50}/ft^2$ boundary area

or

$1.4\ cm^2$ per m^2

- Testing can be carried out by a single operator using a single blower door fan

- On a typical single family house (e.g. 2500 ft^2 of floor area) this roughly translates to 2.5 ACH_{50}

Background on Air Tightness of Multi Family Energy Star Homes in Canada

- Some leakage in multi family homes (e.g. from an adjacent unit) carries no energy penalty
- Air tightness measures can be more difficult to implement in party wall construction
  - Combustibility issues
  - Code has no continuous air barrier requirement for party walls/floors
- Fire safety measures generally target protecting the structure, not air tightness measures to control smoke

Setting an Air Tightness Limit for Multi Family Buildings

- Take a “reasonable” approach to fire safety
  - Protect all structural elements as required
  - Close all major openings behind bulkheads, bathtubs, false walls, etc.

- Ensure exterior envelope air barrier is tied into the party walls/floors

- Test townhouse blocks in various configurations to compare multi-unit tests to single unit test results.

Air Tightness Test Results for Multi Family Buildings

- Testing of a 4 door row (Individual Tests)

Unit	1	2	3	4
ACH50	5.23	5.03	5.14	5.20
ELA10 (in2)	675	751	806	661
NLA10 (in2/100ft2)	1.75	1.95	2.10	1.72
CFM50	1242	1196	1223	1237

Air Tightness Test Results for Multi Family Buildings

- Testing of a 4 door row (Middle door of 3 door simult. tests)

Unit	2	3
ACH50	4.18	3.49
ELA10 (in2)	5.20	553
NLA10 (in2/100ft2)	1.35	1.44
CFM50	994	830

Air Tightness Test Results for Multi Family Buildings

- Party wall leakage represents approximately 30% of total of individual tests
- On an interim basis the multi family air tightness test requirements were set at:

$0.29\ cfm_{50}/ft^2$ boundary area

or

$2.00\ cm^2$ per m^2 of enclosure area

- Since they were based on row townhouse unit tests these requirements did not take into account more complex intersection details for stacked townhouse units… this produced great anxiety as to whether it was possible to meet the requirements in stacked townhouses.

Other Issues in Multi Family Buildings

- Unit sizes tend to be much smaller—some builders are producing units with less than 600 ft^2 of living space
- HVAC loads are such that there is a limited selection of efficient equipment able to deliver heating and cooling to such spaces.
- There is limited wall space available for exhaust venting and/or air intakes.
- Mechanical equipment ends up being put into “closets”. This has issues with respect to combustion air, etc.

Why Build Attached and Stacked Units???

- Better affordability
- More efficient use of land and other resources
- More environmentally appropriate?
- New virtually untapped markets

Solutions - Daniels FirstHome Projects

- Projects include stacked towns as well as stacked back-to-back units.
- Units range from 550 ft^2 to 1100 ft^2
- Many units have attached garages
- Units feature gas heating and hot water with humidistat controlled ventilation
- No common areas in the building (I.e. no corridors and lobbies.)

Typical Stacked Townhouse Block

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Typical Stacked/Back-to-Back Townhouse Block

Air Tightness Issues — Party Walls and Floors

Bulkheads, Drop Ceilings and False Walls

- Assemblies include
  - Concrete toppings on floors
  - Multiple layers of drywall
  - Strapping and resilient channels
- Points to consider
  - Plane of air tightness
  - Key connection points
  - Sequencing
  - Penetrations through assemblies
  - Structural support and attachment with acoustical uncoupling

Air Tightness Issues — Party Walls and Floors

Bulkheads, Drop Ceilings and False Walls

- Solution included
  - Detailed training and orientation of several trades
  - Multiple “prep” steps to ensure plane of air-tightness is continuous
  - Patching and repair of penetrations that cannot be avoided.

Air Tightness Issues — Complex Intersection Points

Stairwells to Access Upper Units

- Assemblies include
  - Concrete landings
  - Block walls
  - Strapped cavities
  - Drywall finish

- Points to consider
  - Plane of air tightness
  - Key connection points
  - Drying/movement
  - Sequencing
  - Structural support and attachment

Air Tightness Issues— Complex Intersection Points

Stairwells to Access Upper Units

- Solutions included
  - Preparation of drywall in area behind stair s before installation
  - Use of stair as a secondary plane of tightness in case of movement/sealing problems
  - Tie-ins to the concrete topping (plane of air tightness) on the top of the intermediate floor

Solutions - Multiple Inspections

- Identified problems/issues before they were repeated excessively
- Provided on-site resources to assist with solutions
- Changed sequencing if necessary to avoid similar problems elsewhere

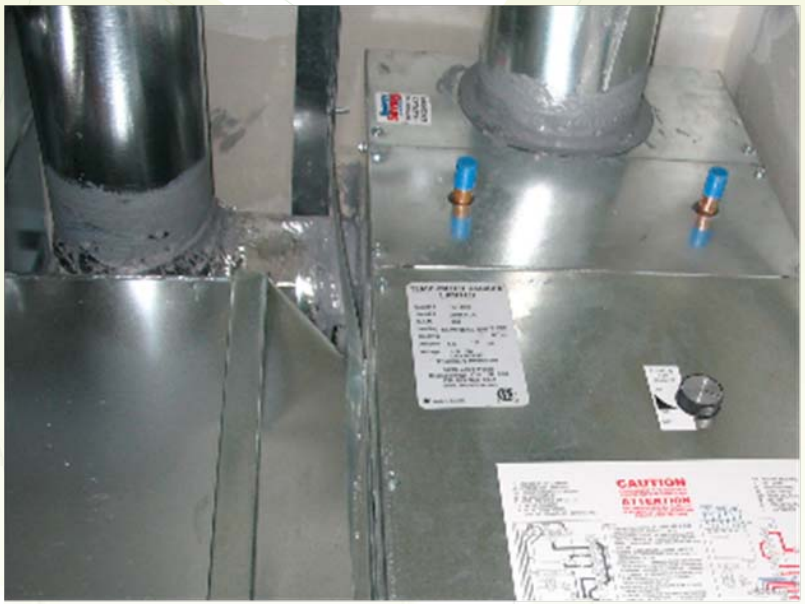
- Points to consider
  - Plane of air tightness
  - Key connection points
  - Drying/movement
  - Sequencing
  - Structural support and attachment

Space Constrained Mechanicals

- Issues include
  - Limited space for air handler, water heating, ventilation
  - Desire to minimize the visual impact of bulkheads chases
  - Relatively small heating and cooling loads
- Points to consider
  - Combustion air
  - Venting requirements / distances
  - Cross contamination of air intakes
  - Higher occupancy / moisture generation

Solutions - Compact Mechanicals

- High velocity air handlers
- Small diameter ductwork
- Combination boilers and/or DHW tanks
- Sealed combustion or direct vent combustion equipment
- Sealed ductwork
- Plastic venting



Results: Daniels FirstHome

- 3 subdivisions complete
- 454 units complete
- Average energy performance Energuide 81
- All but 2 units met air tightness test requirements *on the first test*
- Of the units that failed, both could be "fixed" within 3 hours

Conclusions

- Energy Star townhomes and stacked townhomes were launched as a pilot project
- Energy Star New Homes (Canada) Technical Requirements (Version 3) now include Builder Packages for Low Rise Multi's based on the success of these projects
- Multi's represent a significant percentage (I.e. more than 25%) of Energy Star homes being built in Canada

Results: Daniels FirstHome

- Builder has been very pleased with the results and is bringing forward a program of construction for more than 1000 new units
- Several other builders are bringing forward plans for Energy Star townhomes and stacked townhomes
- Some are using it as a stepping stone to LEED