

Massachusetts
State Building Code
7th Edition

STRUCTURAL PROVISIONS

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February 11, 2009



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Basic Criterion

- Follow national practice to the extent reasonable
- For loads, follow ASCE 7-02, wherever possible
- For materials, make applicable structural codes the basic requirement



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Materials Chapters

- Chapter 22 Steel of IBC refers to structural standards as primary requirements
- Chapter 19 Concrete - ACI 318-02
- Chapter 21 Masonry – ACI 530/530.1-05
- Chapter 23 Wood – NDS 2005; shear walls per IBC or per AF&PA SDPWS 2005



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Load Combinations

- Generally follow ASCE 7-02
- Exception: ASD lateral load combination



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Load Combinations for Lateral Load

LRFD

$$1.2D + (1.6W \text{ or } 1.0E) + f_1L + 0.5S$$

$$0.9D + (1.6W \text{ or } 1.0E)$$

ASD

No allowable stress increase for wind
or earthquake (same as ASCE 7-02)

$$2/3[1.2D + (1.6W \text{ or } 1.0E) + f_1L + 0.5S]$$

$$0.6D + (W \text{ or } 0.7E)$$



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Load Factor for Wind

- Increased from 1.3 to 1.6 (6th Ed to 7th Ed)
- Wind load decreased by Directionality Factor
- For buildings, Directionality Factor = 0.85

- $1.3 \times 1/0.85 = 1.53$ rounded up to 1.6



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Wind Speeds

- Change from Fastest Mile of Wind to 3 Second Gust Speed
- Gust factors changed from >1 to <1

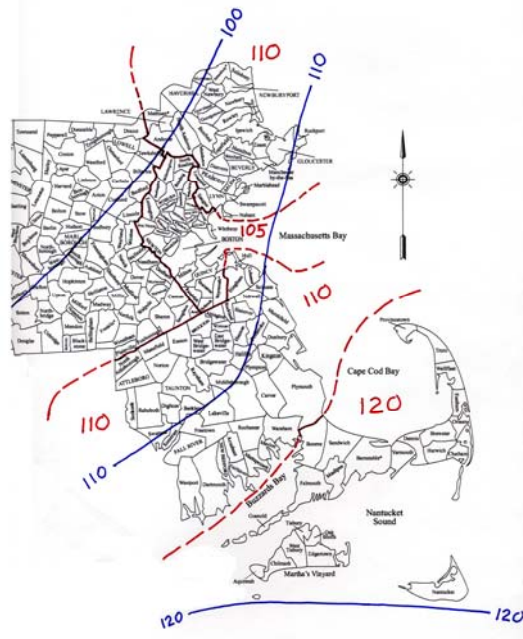
Equivalent Wind Speeds MPH							
Fastest Mile	70	75	80	85	90	100	105
3 Second Gust	85	90	100	105	110	120	125



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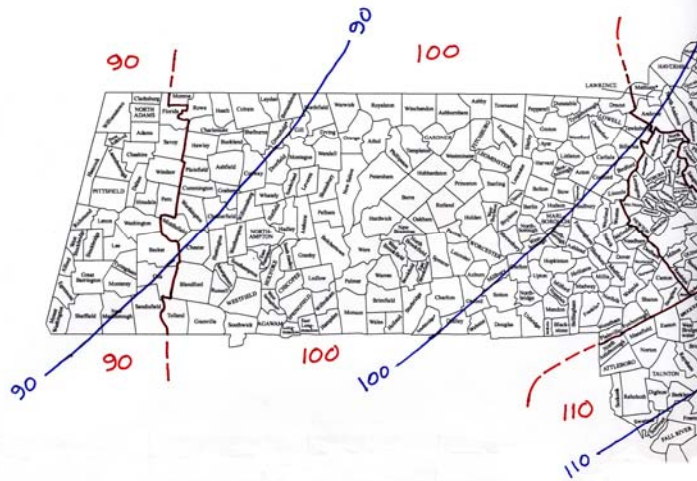
7th Ed SBC
3 Second Gust
Wind Speeds
Eastern MA



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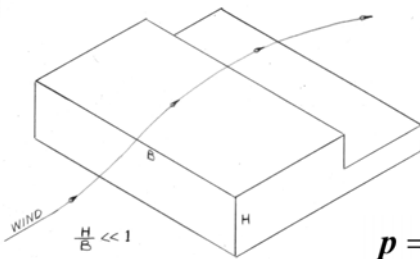
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7th Ed SBC
 3 Second Gust
 Wind Speeds
 Western MA



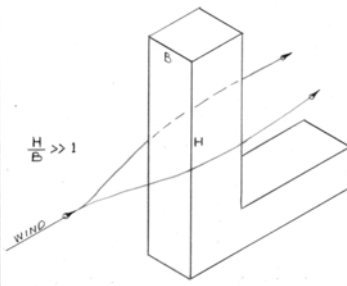
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Wind Flow - H/B Ratio And Wind Pressure Equations

$$p = q_z G C_{pW} - q_h G C_{pL} \quad \text{ASCE 7-02}$$



$$p = q_z G [C_{pW} - C_{pL}] \quad \text{Basis of 6th Ed}$$

p = the resultant pressure,
 psf, at height z , ft
 h = the roof height, ft
 q_z = velocity pressure at ht. z

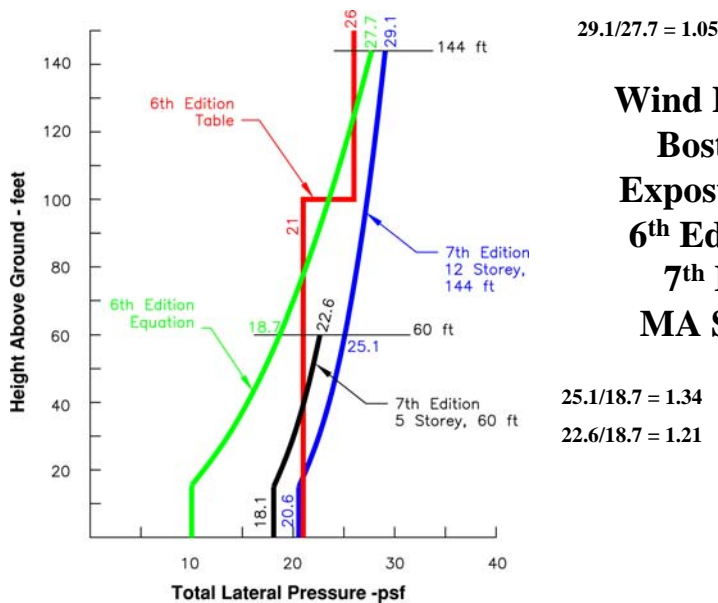


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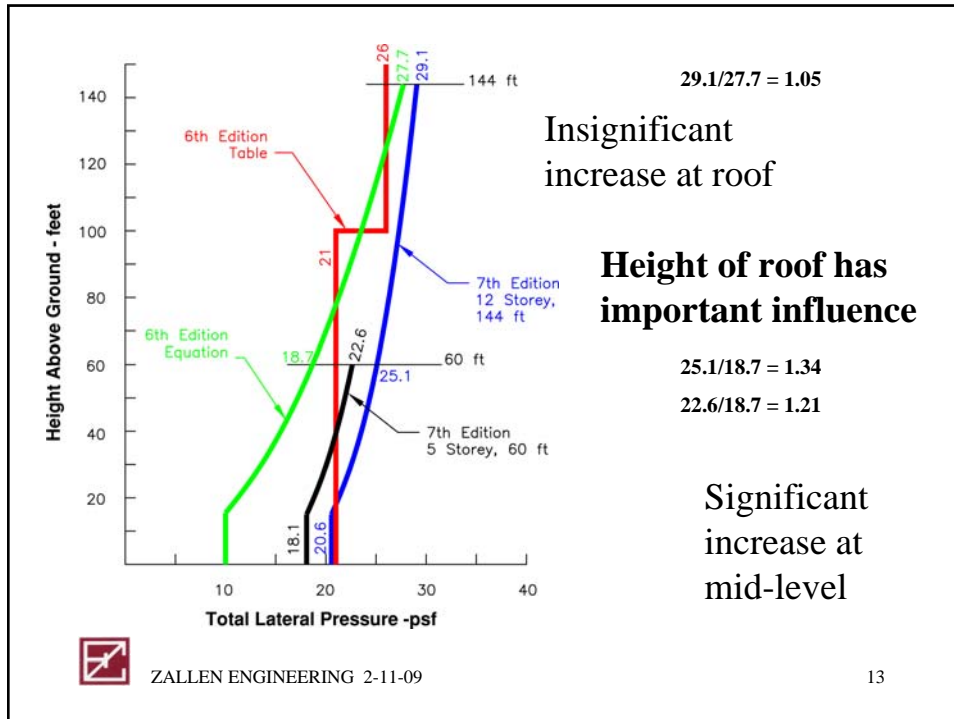
Wind Load Examples

- Differences between 6th Ed and 7th Ed in Boston
- V=105 mph, 3 second gust speed – 7th Ed
- V=90 mph, fastest mile of wind – 6th Ed
- 12 Story, 144 ft high building
- 5 Story, 60 ft high building



Wind Loads Boston Exposure B 6th Ed and 7th Ed MA SBC

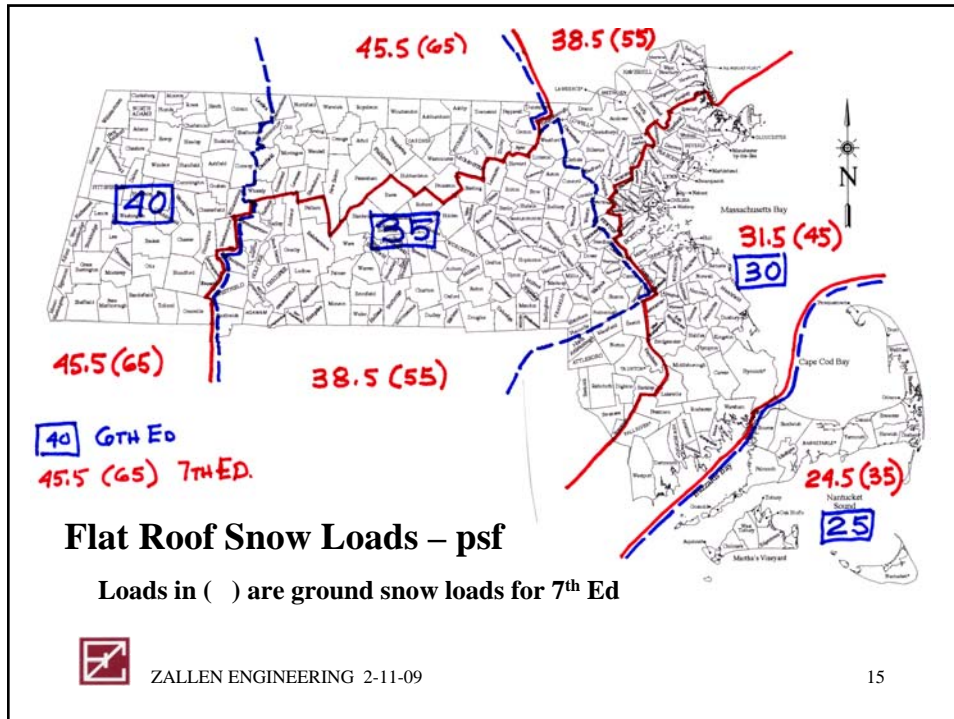




Snow Loads

- 7th Ed gives loads in terms of ground snow load
- 6th Ed gives loads in terms of flat roof snow load
- Flat roof snow load = 0.7 x ground load
- Following map compares 7th Ed roof snow load to 6th Ed roof snow load





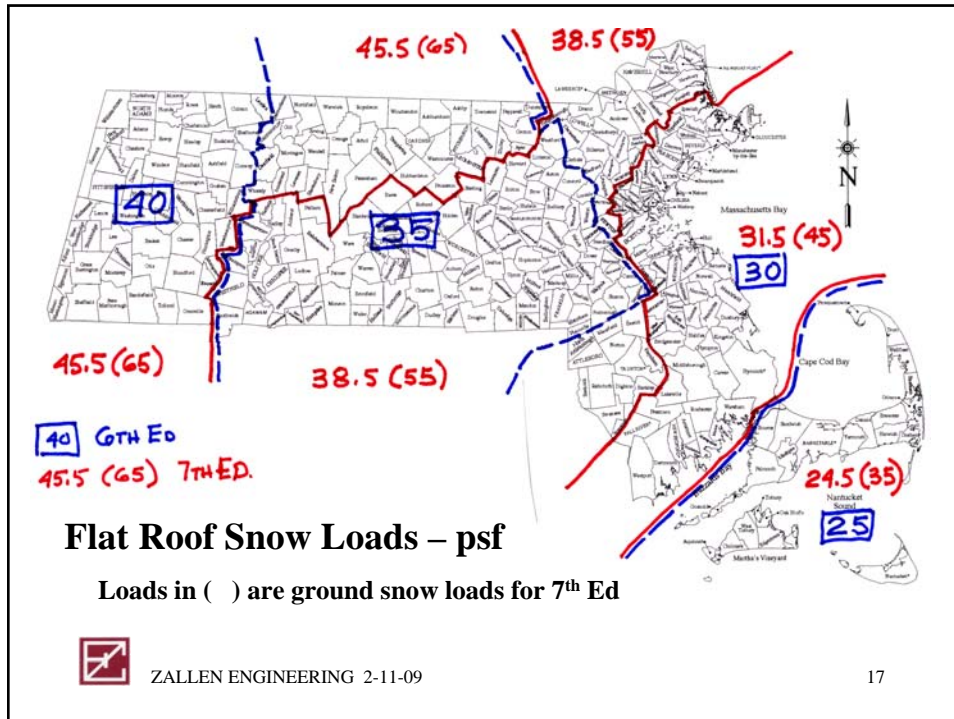
Snow Load Map

- North central loads significantly higher from NH study, due to high elevations
- Loads along Route 128 much higher, from observations by LAC Committee
- Inland SE loads are higher, also from observations of LAC




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Section 3408

Structural Requirements for Alterations, Repairs, Additions & Changes of Use for Existing Buildings

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7th Ed Errata on Line

- Many corrections to 3408
- Corrections in other chapters as well.



Basic principles for structural work for existing buildings

- Old buildings have deteriorated over time and many lateral load resisting elements have been removed or modified
- Many old buildings do not have complete load paths to the foundations for lateral load



Basic principles for structural work for existing buildings

- Allowing a rehabilitation or renovation to these buildings (i.e. a continuation of their use) without a structural upgrade is a danger to the public safety
- All buildings should have a minimum lateral load resistance to protect the public safety



Basic principles for structural work for existing buildings

- To the extent reasonably possible, buildings should have structural systems and details that provide good structural behavior during an earthquake, to increase their survivability
- The greater the changes to a building, the greater should be the lateral load resistance provided



3408 stands alone

- Not affected by other provisions of Chapter 34
- Contains all structural requirements



Basic Requirement – 3408.1.1

- All structural work to be in accordance with code requirements for new construction
- Except loads per 3408
- Except as otherwise provided in 3408



Important Definition

- **Basic Code** – code under which existing building was designed



5 LEVELS OF WORK

- Qualitative triggers for each level of work
- Required lateral load resistance increases for increasing levels of work



Level 1 Work

- Work that does not trigger Level 2 Work
- Amount of work can vary between minor and significant
- No lateral load resistance requirements



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Level 2 Work – General Triggers (Minimum Lateral Resistance)

- For Pre-1975 buildings, architectural/MEP work affecting 20,000 sf or 50% of total floor area
- Change of use for over 35% of floor area
- Increase in total framed floor and roof area from 0% to 10% since 2-28-97
- Increase in effective seismic weight from 0% to 10% since 2-28-97



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Level 2 Work - Structural Triggers (Minimum Lateral Resistance)

Structural work involving:

- >25% of total framed floor and roof area (count trib. area for work on beams or girders)
- >25% of total shear wall area above fdn.
- >25% of total length of columns and diagonal braces (center to center).



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Level 2 Work - Structural Triggers (Minimum Lateral Resistance)

Structural work involving:

- >15% change in the in-plane shear resistance of any floor or roof diaphragm
- >15% change in the in-plane shear resistance of any structural wall
- Removal or reconfiguration of lateral load resisting frames and their foundations
- Exemption: Repair of pile foundations



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Level 2 Work – Lateral Load (Minimum Lateral Resistance)

- Required minimum lateral load resistance:
 - 2/3 Code wind
 - 1% (DL + 0.5 Snow)
- No seismic load requirements



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Level 3 Work – Triggers (Substantial Structural Alterations)

- Removal or reconstruction of 15% to 40% of total framed floor and roof area (count trib. area for work on beams or girders)
- New shear walls or vertical frames providing > 35% of the lateral force resistance required for Level 2 Work



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Level 3 Work – Lateral Load (Substantial Structural Alterations)

- Required lateral load resistance:
 - 100% Code wind load
 - 35% of code seismic load
- Low seismic requirement – results in configuration for good seismic behavior
- Low seismic requirement not significant penalty due to extensive demolition



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Level 4 Work – Triggers (Structurally Attached Additions)

- Additions for 10% to 100% increase in total framed floor and roof area
- Additions for 10% to 100% increase in seismic weight



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Level 4 Work – Lateral Load (Structurally Attached Additions)

Wind Load: 100% Code

Seismic Load: Sliding scale:



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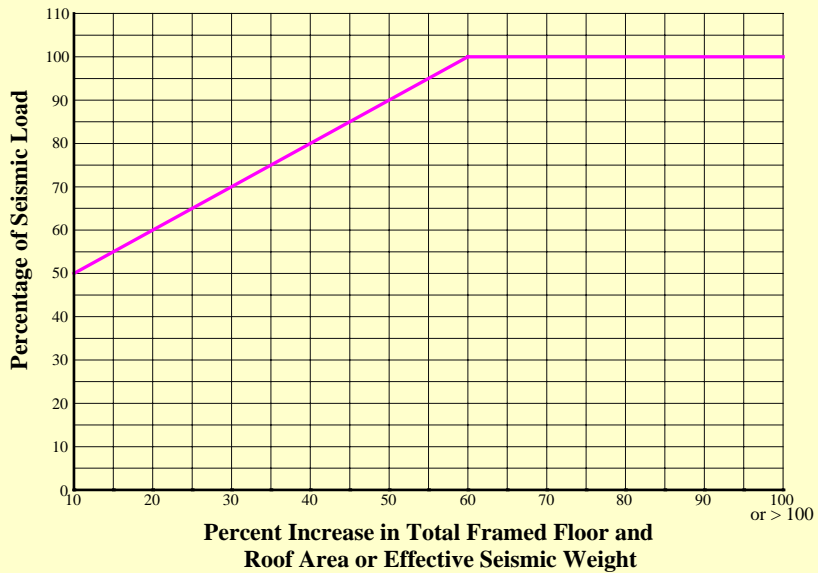


Figure 3408-1
1-16-05



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Level 5 Work – Triggers

(Extensive Alterations or Additions)

- Removal or reconstruction of > 40% of total framed floor and roof area (count trib. area for work on beams or girders)
- Additions > 100% of existing framed floor and roof area
- Additions > 100% of existing seismic weight



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Level 5 Work – Lateral Loads

(Extensive Alterations or Additions)

- 100% Code wind load
- 100% Code seismic load



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Restricted Uses

- Approach entirely different from 6th Edition
- Uses are designated restricted on basis of:
 - Hazard to public safety of use itself
 - Total number of occupants
- Change occupancy to restricted use – requires Level 5 Work
- Only Level 1 and 2 Work permitted for existing restricted use; otherwise Level 5 Work



Restricted Uses

- A1, A2, A4, A5 with more than 600 people
- A3 with more than 1200 people
- H
- I2 (hospitals and nursing homes) with more than 400 people
- I3 (restrained)
- Seismic Use Group III (post-earthquake operational)



Business Use to School

- Not restricted use in 7th Ed for less than 1200 occupants. No seismic design required, assuming Level 2 Work
- Requires seismic design in 6th Ed – change of use from Hazard Index < 4 to Hazard Index > 4



Historic Buildings Wind and Seismic Load

House Museums (Fully Preserved in 6th Ed):

- No wind, no seismic load required

Preserved (Partially Preserved in 6th Ed):

- Wind and seismic load required



Structural Investigation

- Level 1 limited to areas where work is done
- Level 2 No geotechnical exploration required if no shear walls nor vertical frames are added and no visual distress to foundations
- Otherwise, similar to 6th edition



Existing URM Walls

- Can be reused for all levels of work
- Special criteria for walls expected to crack due to in-plane load for Levels 4 and 5 Work
- For $h/t > 18$, strong backs required
- Parapets with $h/t > 3$: tiebacks required



Existing URM Walls

- Can be used with new construction if:
 - isolated from in-plane shear from new building
 - wall can resist in-plane loads due to own mass



References

- Go to www.zallenengineering.com and select *Building Codes*, for:
 - This presentation
 - Commentary on 780 CMR 3408 (Structural Provisions for Chapter 34, Existing Buildings)
 - Wind and snow load commentary

