



Clarifying Frequently Misunderstood Wind Provisions





1976 EDITION

23.F, 23.G, 23.H

TABLE NO. 23-F—WIND PRESSURES FOR VARIOUS HEIGHT ZONES ABOVE GROUND*


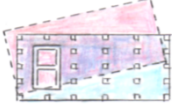
HEIGHT ZONES (ft. high)	WIND-PRESSURE-MAP AREA (Squads per square foot)					
	30	25	20	15	10	5
Less than 30	15	20	25	30	35	40
30 to 60	20	25	30	35	40	45
60 to 90	25	30	40	45	50	55
100 to 499	30	40	45	55	60	70
500 to 1199	35	45	55	60	80	90
1200 and over	40	50	60	70	80	100



By Emily Guglielmo, SE
Martin/Martin, Inc.

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Frequently Misunderstood Wind Provisions

- Enclosure Classification
- Analysis Methods
- Torsional Effects
- Effective Wind Area
- Corner Zones


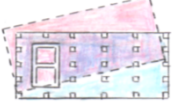








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Frequently Misunderstood Wind Provisions

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3



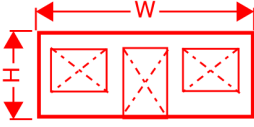
Enclosed, Partially Enclosed, Open?

4

Enclosure Classification (26.2):

Open Building: A building having each wall at least 80% open.

$$A_o \geq 0.8A_g$$



$$A_o = A_1 + A_2 + A_3$$

$$A_g = W \times H$$

5

Enclosure Classification (26.2):

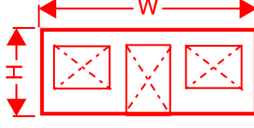
Partially Enclosed Building: A building that complies with both of the following conditions:

1. The total area of openings in a wall > the sum of the openings in the balance of the building envelope (walls and roof) by >10%.

$$A_o \geq 1.10A_{ew}$$
2. The total area of openings in a wall exceeds 4ft² (or 1% of area of that wall), and the % of openings in the balance of the building <20%.

$$A_o > 4 \text{ ft}^2 \text{ OR } > 0.01A_1 \text{ (Whichever is smaller)}$$

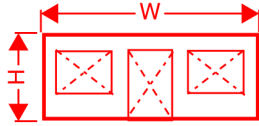
$$\frac{A_{op}}{A_{ep}} \leq 0.20$$



6

Enclosure Classification (26.2):

Enclosed Building: A building that does not comply with the requirements for open or partially enclosed buildings.



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Enclosure Classification (26.2):

Question: What constitutes an opening?

Answer: Doors, operable windows, air intake exhausts, operable louvers, anything designed to be open during design winds.



Question: What about windows in wind-borne debris regions?

Answer: Category II, III, IV buildings in wind-borne debris regions to be protected with impact resistant glazing, impact protective systems.



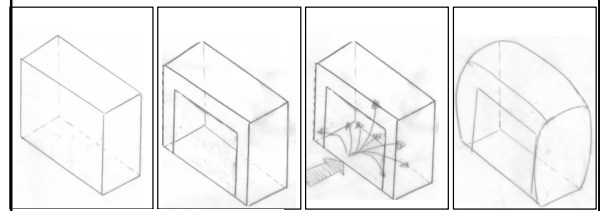
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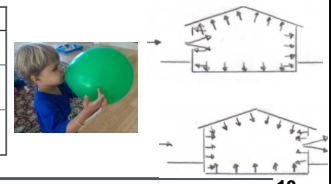


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Enclosure Classification	(GC_{p0})
Open Buildings	0.00
Partially Enclosed Buildings	+0.55 -0.55
Enclosed Buildings	+0.18 -0.18



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Enclosed, Partially Enclosed, Open?

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Open Building: A building having each wall at least 80% open.

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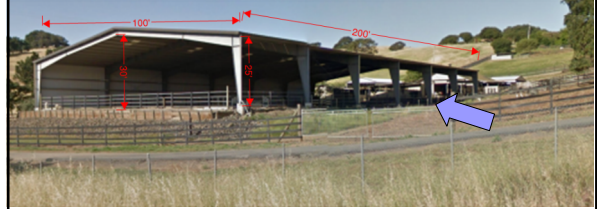


Partially Enclosed Building: A building that complies with *both* of the conditions:

1. The total openings in a wall exceeds the sum of the openings in the balance of the building envelope by >10%.
2. The total area of openings in a wall exceeds $4ft^2$ or 1% of area of that wall, *and* the percentage of openings in the balance of the building envelope $\leq 20\%$.

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Partially Enclosed Building: A building that complies with *both* of the conditions:

1. The total openings in a wall exceeds the sum of the areas of openings in the balance of the building envelope by >10%.

Windward wall: $200\text{ ft} \times 25\text{ ft} = 5,000\text{ ft}^2$ Balance of building

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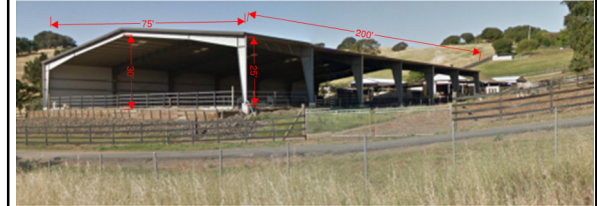
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Enclosed Building: A building that does not comply with the requirements for open or partially enclosed buildings.

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Partially Enclosed Building: A building that complies with *both* of the conditions:

1. The total openings in a wall exceeds the sum of the areas of openings in the balance of the building envelope by >10%.

$200\text{ ft} \times 25\text{ ft} = 5,000\text{ ft}^2 > 1.10[2(75\text{ ft} \times 30\text{ ft})] = 4,950\text{ ft}^2$

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Partially Enclosed Building: A building that complies with *both* of the conditions:


2. The total area of openings in a wall that receives positive external pressure exceeds $4ft^2$ or 1% of area of that wall, and the percentage of openings in the balance of the building envelope is less than 20%.

$$\frac{75\text{ ft} \times 30\text{ ft} \times 2}{75\text{ ft} \times 30\text{ ft} \times 2 + 200\text{ ft} \times 25\text{ ft} + 200\text{ ft} \times 75\text{ ft}} = .18 < .20 \quad \checkmark$$

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ASCE 7-16?





Is this enclosed, partially enclosed, *partially open*, or open building?

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ASCE 7-16?

Partially Open

Partially Enclosed

ASCE 7-10

Enclosed

Partially Enclosed

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Table 26.13-1 Main Wind Force Resisting System and Components and Cladding (All Heights): Internal Pressure Coefficient, (G_{ci}), for Enclosed, Partially Enclosed, Partially Open, and Open Buildings (Walls and Roof)

Enclosure Classification	Criteria for Enclosure Classification	Internal Pressure	Internal Pressure Coefficient, (G_{ci})
Enclosed buildings	A_v is less than the smaller of $0.01A_v$ or 4 sq ft (0.37 m) and $A_{v1}/A_v \leq 0.2$	Moderate	+0.18
			-0.18
Partially enclosed buildings	$A_v > 1.1A_v$ and $A_v >$ the lesser of $0.01A_v$ or 4 sq ft (0.37 m) and $A_{v1}/A_v \leq 0.2$	High	-0.55
			-0.55
Partially open buildings	A building that does not comply with Enclosed, Partially Enclosed, or Open classifications	Moderate	-0.18
			-0.18
Open buildings	Each wall is at least 80% open	Negligible	0.00

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Enclosed, Partially Enclosed, Open?

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Enclosed, Partially Enclosed, Open?

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Enclosed, Partially Enclosed, Open?

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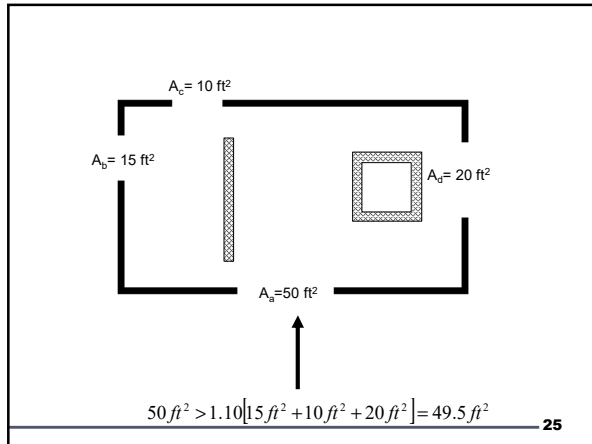
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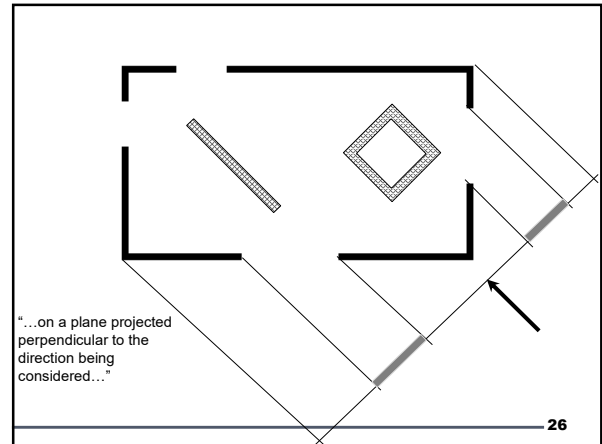
Enclosed, Partially Enclosed, Open?

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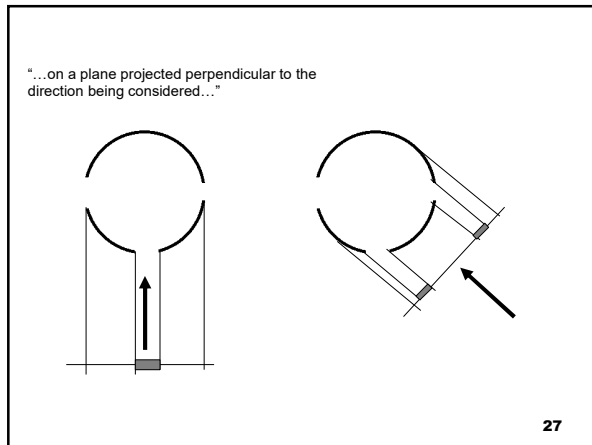
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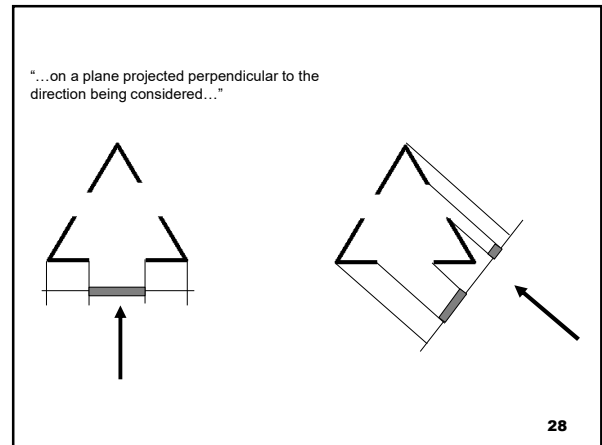
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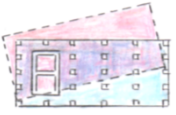

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Frequently Misunderstood Wind Provisions

- Enclosure Classification
- Analysis Methods
- Torsional Effects
- Effective Wind Area
- Corner Zones

ASCE


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Wind Design Methods

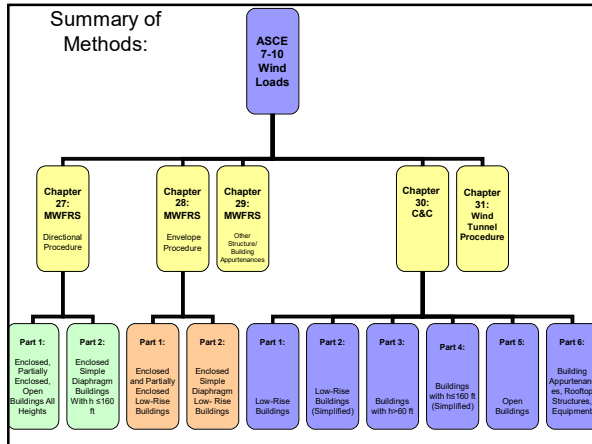
Question: What is the difference between all the Methods (analytical, simplified, directional, envelope, wind tunnel, all-heights) for calculating wind loads? Which one should I use?

Answer:

- Main Wind Force Resisting System (MWFRS) v. Components & Cladding (C&C)
- Building Height < 60 ft v. Building Height > 60 ft
- Enclosed v. Partially Enclosed v. Open
- Flexible v. Rigid Building
- Parapet v. Wall/ Roof
- Building v. Sign/ Mechanical Equipment/ Rooftop Structures
- Regular v. Irregular Building
- Roof Configuration
- Simple Diaphragm



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Wind Design Methods

Question: What's the difference between Analytical (Method 2)/ Simplified (Method 1) [ASCE 7-05] and Directional/ Envelope [ASCE 7-10]?

Answer:

Analytical/ Method 2 (ASCE 7-05) = Directional (ASCE 7-10) Chapter 27	Simplified/ Method 1 (ASCE 7-05) = Envelope (ASCE 7-10) Chapter 28
Pressure coefficients reflect actual loading on each surface as a function of wind direction.	Pressure coefficients represent "pseudo" loading that envelope the desired moment, shear...

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Wind Design Methods

Simplified/ Method 1 (ASCE 7-05) = Envelope (ASCE 7-10) Chapter 28

Pressure coefficients represent "pseudo" loading that envelope the desired moment, shear...

LOCAL PURLIN LOAD

TYPICAL INSTANTANEOUS PRESSURE AT ANY POINT

LOCAL FRAME LOAD

ON-LINE COMPUTER SIMULATION OF STRUCTURAL INFLUENCE LINE

MOMENT

SHEAR

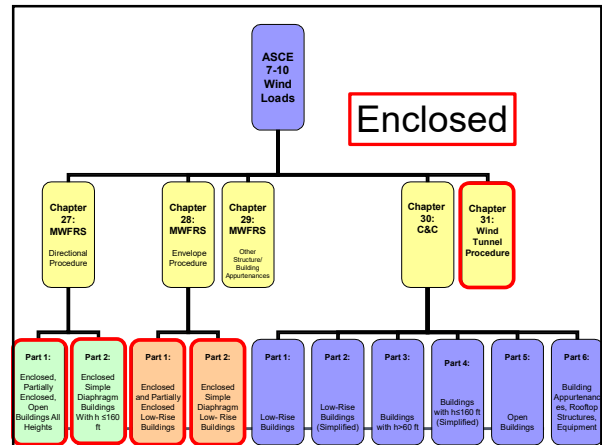
INSTANTANEOUS HORIZONTAL FORCE

UPLIFT

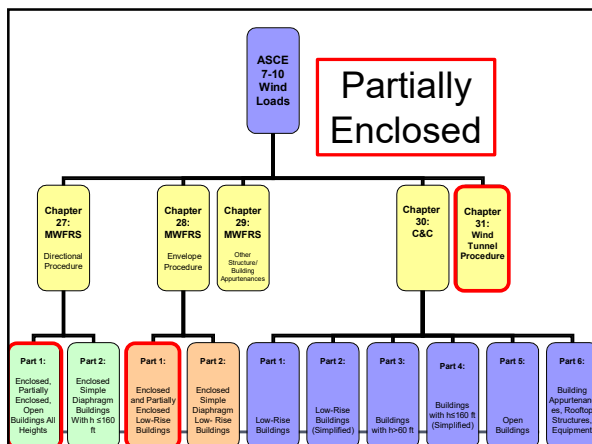
INSTANTANEOUS UPLIFT LOAD

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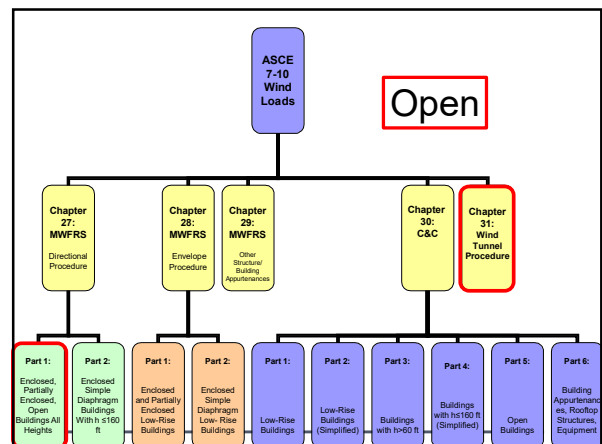
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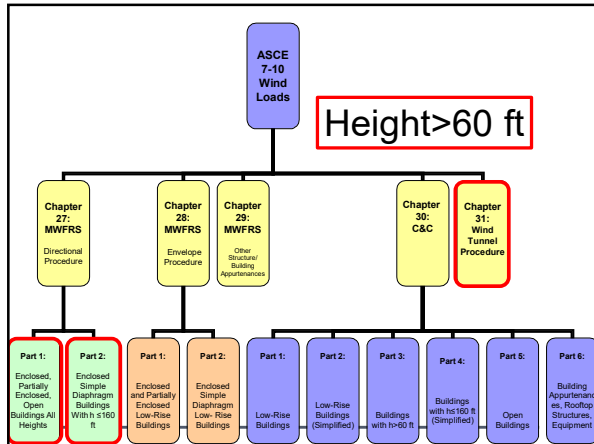
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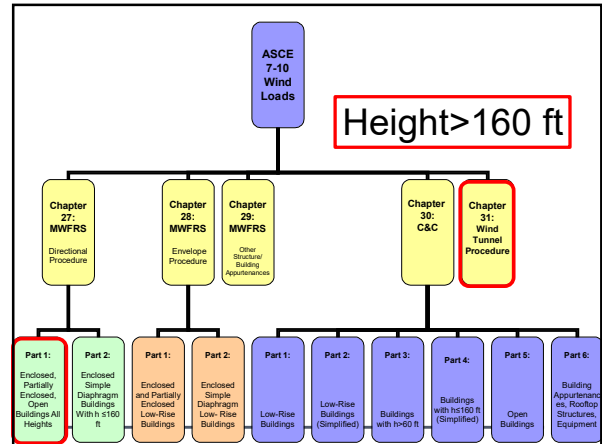
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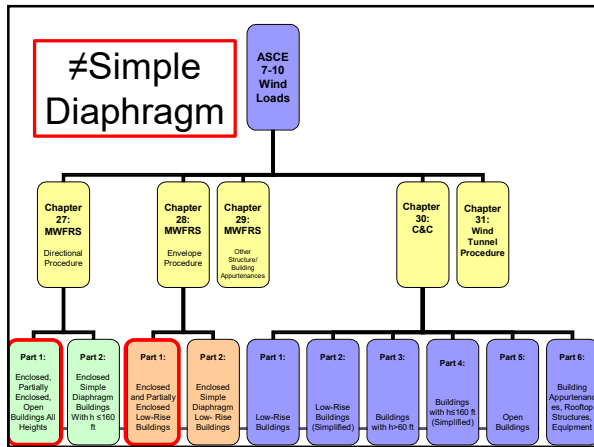
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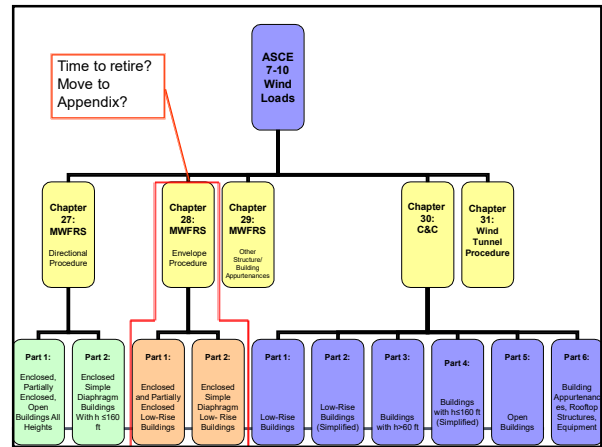
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Frequently Misunderstood Wind Provisions

- Enclosure Classification
- Analysis Methods
- Torsional Effects
- Effective Wind Area
- Corner Zones

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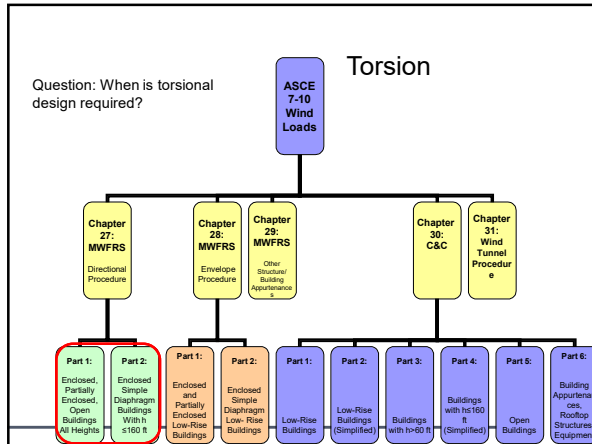
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Torsion

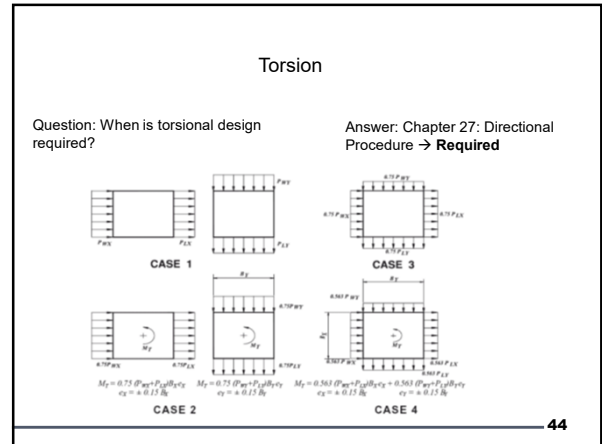
Question: When is torsional design required when performing wind load analysis?

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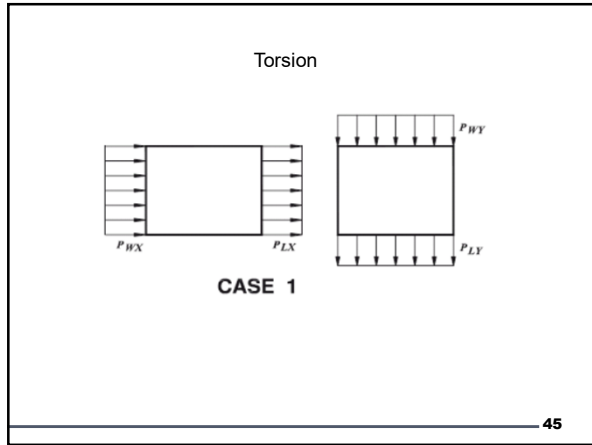
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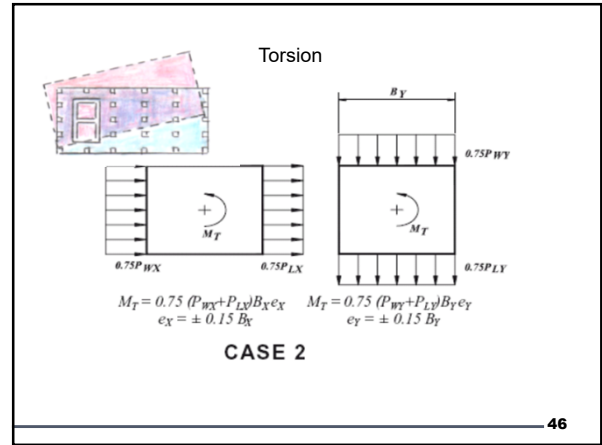
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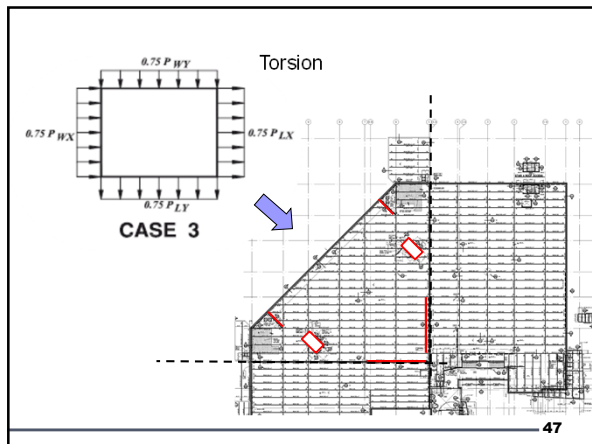
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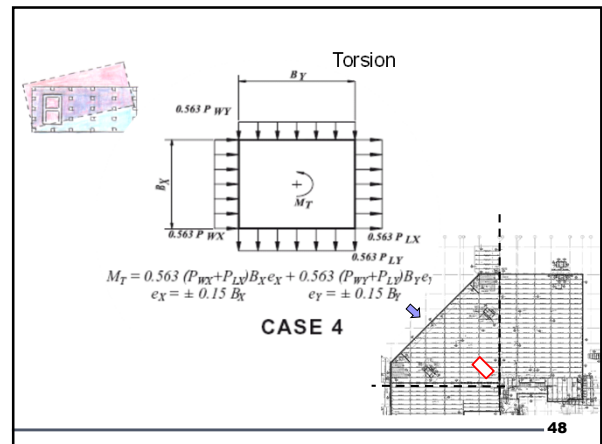
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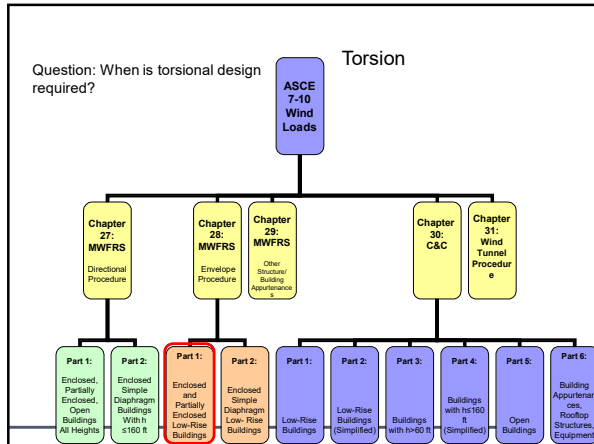
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Question: When is torsional design required?

Torsion

Answer: Chapter 28: Part 1 → **Required**

Table 28-4-1 External Pressure Coefficients (GC)

Table 28-4-2 External Pressure Coefficients (GC)

Basic Load Cases

Torsional Load Cases

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Question: When is torsional design required?

Torsion

Answer: Chapter 28: Part 1 → **Required**

Table 28-4-1 External Pressure Coefficients (GC)

Table 28-4-2 External Pressure Coefficients (GC)

Basic Load Cases

Torsional Load Cases

51

Question: When is torsional design required?

Torsion

Answer: Chapter 28: Part 1 → **Required**

5. For the torsional load cases shown below, the pressures in zones designated with a "T" (1T, 2T, 3T, 4T, 5T, 6T) shall be 25% of the full design wind pressures (zones 1, 2, 3, 4, 5, 6).
Exception: One story buildings with h less than or equal to 30 ft (9.1m), buildings two stories or less framed with light frame construction, and buildings two stories or less designed with flexible diaphragms need not be designed for the torsional load cases.
Torsional loading shall apply to all eight basic load patterns using the figures below applied at each Windward Corner.

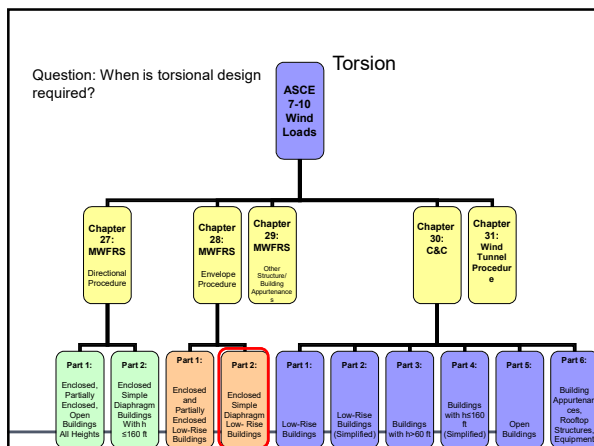
Table 28-4-1 External Pressure Coefficients (GC)

Table 28-4-2 External Pressure Coefficients (GC)

Basic Load Cases

Torsional Load Cases

52



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Question: When is torsional design required?

Torsion

Answer: Chapter 28: Part 2 → **Not Required**

28.2 Conditions
For the design of MWFRS the building shall comply with all of the following conditions:

8. The building is exempted from torsional load cases as indicated in Note 5 of Fig. 28.4-1, or the torsional load cases defined in Note 5 do not control the design of any of the MWFRS of the building.

in the wake of upwind obstructions warrant special consideration.

7. The building has an approximately symmetrical cross-section in each direction with either a flat roof or a gable or hip roof with $\theta \leq 45^\circ$.

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Torsion

Question: When is torsional design required? Answer: A new option in ASCE 7-10... Appendix D.

**Appendix D
BUILDINGS EXEMPTED FROM TORSIONAL WIND LOAD CASES**

CASE 1

CASE 3

CASE 2

$M_y = 0.75 (P_{wy} + P_{wx}) B_x c_y$
 $c_y = 0.15 B_x$

CASE 4

$M_y = 0.75 (P_{wy} + P_{wx}) B_x c_y$
 $c_y = 0.15 B_x$

55

55

Torsion

When can I ignore torsion?

D1.1: One and Two Stories

- One-story buildings $h \leq 30$ ft
- Two-story buildings with light-frame construction
- Two-story buildings with flexible diaphragms

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Torsion

When can I ignore torsion?

D1.2: Controlled by Seismic Design

D1.2.1 Not flexible diaphragms:

- Center of mass $\pm 15\%$ geometric center, and
- Seismic story shear > 1.5 Wind story shear

Seismic

Wind

≥ 1.5 times

D1.2.2 Flexible diaphragms:

- Seismic forces in LFRS > 1.5 Wind forces in LFRS

≥ 1.5 times

57

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Torsion

When can I ignore torsion?

D1.3: "Torsionally Regular" Structures

BUILDING, TORSIONALLY REGULAR UNDER WIND LOAD: A building with the MWFRS about each principal axis proportioned so that the maximum displacement at each story under Case 2, the torsional wind load case, of Fig. 27.4-8, does not exceed the maximum displacement at the same location under Case 1 of Fig. 27.4-8, the basic wind load case.

$M_y = 0.75 (P_{wy} + P_{wx}) B_x c_y$
 $c_y = 0.15 B_x$

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58

Torsion

When can I ignore torsion?

D1.4: Flexible Diaphragms Designed for Increased Wind Loading

→ Scale MWFRS wind load by 1.5

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Torsion

When can I ignore torsion?


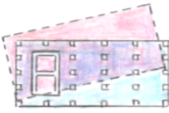

D1.5: Case A, B, C, D, E, F (well distributed lateral system)

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Frequently Misunderstood Wind Provisions

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Component and Cladding: Effective Wind Area

Question: What's the difference between effective wind area and tributary area?

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Component and Cladding: Effective Wind Area


Question: Roof trusses are 30' long and are 4'-0" OC. What is the effective wind area?

Answer:

A) $30' \times 4' = 120 \text{ ft}^2$

B) $30' \times \frac{30'}{3} = 300 \text{ ft}^2$

EFFECTIVE WIND AREA, A: The area used to determine $G C_p$. For component and cladding elements, the effective wind area in Figs. 6-11 through 6-17 and Fig. 6-19 is the **area multiplied by an effective width that shall not be less than three times the panel length**. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.



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Component and Cladding: Effective Wind Area

Question: Roof trusses are 70' long and are 8'-0" OC. What is the effective wind area?

Answer:

A) $70' \times 8' = 560 \text{ ft}^2$

B) $70' \times \frac{70'}{3} = 1,633 \text{ ft}^2$



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Component and Cladding: Effective Wind Area


Question: Metal decking panels are 20' long and 2' wide supported on beams 5' OC. What is the effective wind area?

Answer:

A) $20' \times 2' = 40 \text{ ft}^2$

B) $5' \times 2' = 10 \text{ ft}^2$

C) $5' \times \frac{5'}{3} = 8.3 \text{ ft}^2$



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Component and Cladding: Effective Wind Area

Question: A masonry wall which is grouted and reinforced at 24" OC is 12' tall and 80' long and is supported top and bottom. What is the effective wind area?


Answer:

A) $12' \times 80' = 960 \text{ ft}^2$

B) $12' \times 1' = 12 \text{ ft}^2$

C) $12' \times 2' = 24 \text{ ft}^2$

D) $12' \times \frac{12'}{3} = 48 \text{ ft}^2$



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66

Component and Cladding: Effective Wind Area

Question: Roof trusses span 75' and are spaced at 10' OC. What is the effective wind area?

Answer:
 A) $75 \times 10' = 750 \text{ft}^2$
 B) $75 \times 75' = 1,875 \text{ft}^2$
 3


→ The 750 ft² tributary area is > 700 ft² thus can be designed with MWFRS pressures.



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Continuous Members? Cantilever Members?





Effective Wind Area?
Influence Lines
(Ongoing Discussion in ASCE 7-22)

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Frequently Misunderstood Wind Provisions

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Local Effects: Wind Around A Corner

(Images from FEMA Multi Hazard Seminar)



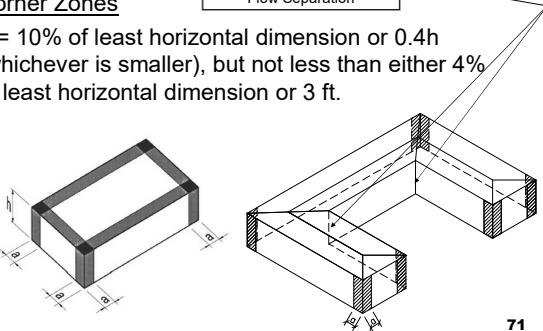
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Corner Zones

Not a corner: Inside Corners Do Not Cause Air-Flow Separation

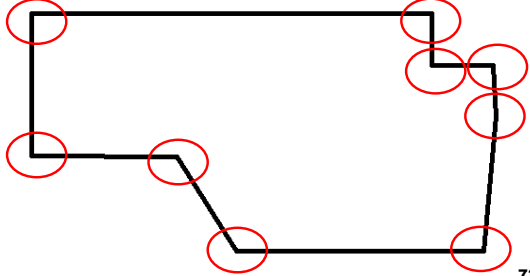
$a = 10\%$ of least horizontal dimension or $0.4h$ (whichever is smaller), but not less than either 4% of least horizontal dimension or 3 ft.



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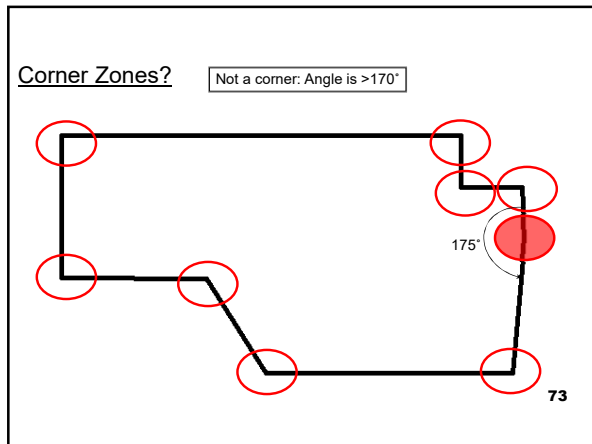
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Corner Zones?

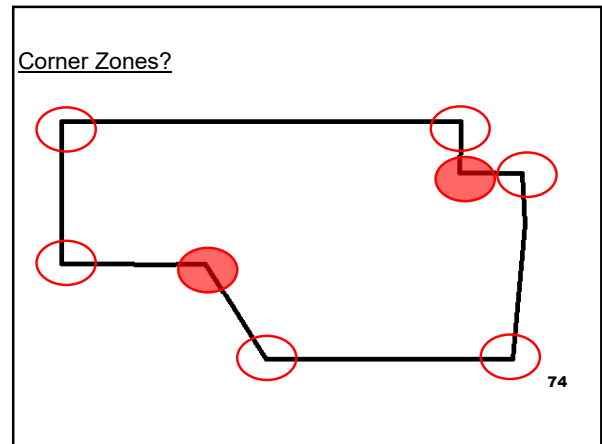


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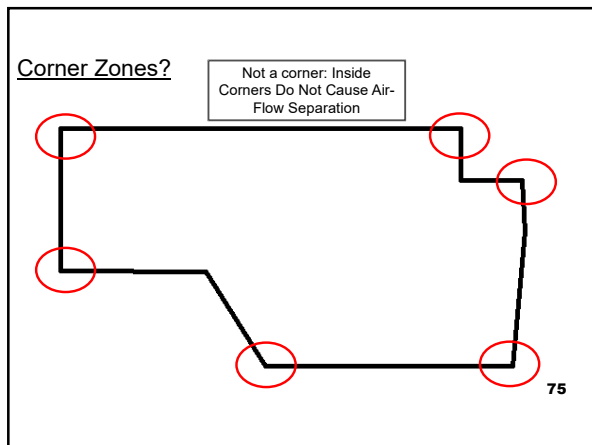
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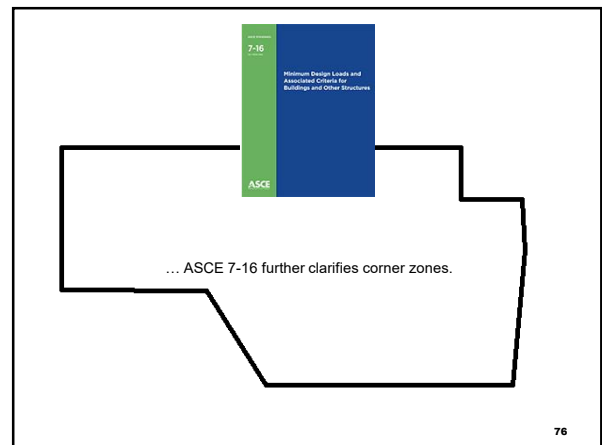
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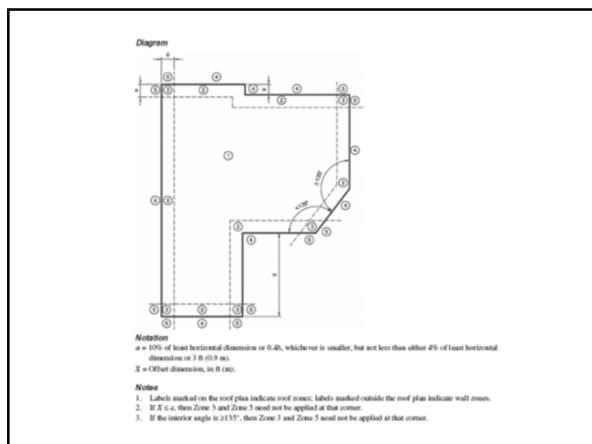
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1976 EDITION 23-F, 23-G, 23-H

TABLE NO. 23-F—WIND PRESSURES FOR VARIOUS HEIGHT ZONES ABOVE GROUND*

HEIGHT ZONES (ft)	WIND-PRESSURE-AREA AREA (square ft)				
	30	25	20	15	10
Less than 30	15	20	25	30	35
30 to 49	20	25	30	35	40
50 to 99	25	30	40	50	60
100 to 499	30	40	45	55	70
500 to 1199	35	45	55	60	80
1200 and over	40	50	60	70	90

Summary:

- 1) Consider the intent of the code before trying to apply the language.
- 2) Does maintaining all Analysis Methods help or hurt?
- 3) There are attempts to simplify the code, make it more user friendly.

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