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Garage Door and Commercial Door Wind Load Guide Based on the 2010 National Building Code of Canada

DASMA (the Door & Access Systems Manufacturers Association) has created a ***GARAGE DOOR WIND LOAD GUIDE*** based on the 2010 National Building Code of Canada wind load requirements. The guide is intended to be used by code officials, engineers, architects, builders, owners, insurance companies and other interested parties. The Wind Load Guide also references a DASMA test procedure (ANSI/DASMA 108), which may be used by manufacturers to determine structural load performance of a garage door.

The guide is published by the Commercial & Residential Garage Door Division of DASMA, which represents an estimated 95% of all sectional garage doors sold in the United States and which is also well represented in Canada. The Division's Technical Committee, the best technical talent in the garage door industry, developed these tables based on the latest civil engineering and building code criteria.

The DASMA members believe the ***DASMA GARAGE DOOR WIND LOAD GUIDE*** will improve understanding of the issues related to garage doors and wind loads. DASMA continues to monitor developments regarding wind loads and the building codes in general, and continues to develop solutions to problems, which affect the garage door industry. Please contact DASMA with any questions or comments.

GARAGE DOOR WIND LOAD GUIDE
BASED ON THE 2010 NATIONAL BUILDING CODE OF CANADA (ENGLISH UNITS)

Mean Roof Height	Door Size	Design pressures, Pounds per Square Foot (PSF)					
Up To 25 Feet	Single	**9.3**	**12.8**	**16.9**	**21.6**	**26.8**	**32.7**
	9' x 7'	-9.8	-13.4	-17.8	-22.7	-28.2	-34.4
	Double	**9.1**	**12.5**	**16.5**	**21.1**	**26.2**	**32.0**
	16' x 7'	-9.5	-13.1	-17.4	-22.2	-27.6	-33.7
	Wind Speeds, MPH						
	Mean Hourly	41	48	55	62	69	77
	Fastest Mile	**50**	**60**	**70**	**80**	**90**	**100**
	Peak Gust	62	73	84	95	106	116

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Notes:

- Doors larger than 100 sq. ft. should use the 16 x7 loads. Doors less than 100 sq. ft. may be interpolated.
- Negative pressures assume door has 2 ft. of width in building's end zone.
- Garage doors evaluated as attached to enclosed buildings with an Importance Factor of 1.0 (Normal).
- Open Terrain: 0.9. Where open terrain is level terrain with scattered buildings, trees or other obstructions, open water or shorelines thereof.
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- Installation details vary. Consult mfr's instructions.

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Up To 25 Feet	Single	**32.7**	**39.1**	**46.0**	**53.3**	**61.1**
	9' x 7'	-34.4	-41.2	-48.5	-56.2	-64.4
	Double	**32.0**	**38.3**	**45.2**	**52.4**	**60.0**
	16' x 7'	-33.7	-40.3	-47.7	-55.3	-63.4
	Wind Speeds, MPH					
	Mean Hourly	77	84	91	98	105
	Fastest Mile	**100**	**110**	**120**	**130**	**140**
	Peak Gust	116	127	138	149	159

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- Installation details vary. Consult mfr's instructions.

Garage Door Wind Load Guide
Based on the 2010 National Building Code of Canada (metric units)

Mean Roof Height	Door Size	.20 kPa	.30 kPa	.40 kPa	.50 kPa	.60 kPa	.70 kPa	.80 kPa
Up To 7.62 m	Single	**.41**	**.62**	**.83**	**1.03**	**1.24**	**1.44**	**1.65**
	2.74m x 2.13m	-.43	-.65	-.87	-1.09	-1.30	-1.52	-1.74
	Double	**.40**	**.60**	**.81**	**1.01**	**1.21**	**1.41**	**1.61**
	4.88m x 2.13m	-.42	-.64	-.85	-1.06	-1.27	-1.49	-1.70
	Wind Speeds (m/s) Mean Hourly	18	22	25	28	31	33	35

Design pressures above are in kilopascals (kPa)

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Garage Door Wind Load Guide
Based on the 2010 National Building Code of Canada (metric units)

Mean Roof Height	Door Size	.80 kPa	.90 kPa	1.00 kPa	1.10 kPa	1.20 kPa	1.30 kPa	1.40 kPa
Up To 7.62 m	Single	**1.65**	**1.86**	**2.06**	**2.27**	**2.48**	**2.68**	**2.89**
	2.74m x 2.13m	-1.74	-1.95	-2.17	-2.39	-2.61	-2.82	-3.04
	Double	**1.61**	**1.81**	**2.02**	**2.22**	**2.42**	**2.62**	**2.82**
	4.88m x 2.13m	-1.70	-1.91	-2.12	-2.34	-2.55	-2.76	-2.97
	Wind Speeds (m/s)							
	Mean Hourly	35	37	39	41	43	45	47

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COMMERCIAL DOOR WIND LOAD GUIDE
BASED ON THE 2010 NATIONAL BUILDING CODE OF CANADA (ENGLISH UNITS)

Mean Roof Height	Door Size	Design pressures, Pounds per Square Foot (PSF)					
Up To 25 Feet	*8' x 8'*	**9.3**	**12.8**	**16.9**	**21.6**	**26.8**	**32.7**
		-9.8	-13.4	-17.8	-22.8	-28.2	-34.5
	10' x 10'	**9.1**	**12.5**	**16.6**	**21.2**	**26.3**	**32.1**
		-9.6	-13.2	-17.5	-22.4	-27.8	-33.9
	Wind Speeds, MPH						
	Mean Hourly	41	48	55	62	69	77
	Fastest Mile	**50**	**60**	**70**	**80**	**90**	**100**
	Peak Gust	62	73	84	95	106	116

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Mean Roof Height	Door Size	Design pressures, Pounds per Square Foot (PSF)				
Up To 25 Feet	*8' x 8'*	**32.7**	**39.1**	**46.0**	**53.3**	**61.1**
		-34.5	-41.2	-48.5	-56.2	-64.4
	10' x 10'	**32.1**	**38.4**	**45.2**	**52.4**	**60.0**
		-33.9	-40.6	-47.7	-55.3	-63.4
	Wind Speeds, MPH					
	Mean Hourly	77	84	91	98	105
	Fastest Mile	**100**	**110**	**120**	**130**	**140**
	Peak Gust	116	127	138	149	159

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COMMERCIAL DOOR WIND LOAD GUIDE
BASED ON THE 2010 NATIONAL BUILDING CODE OF CANADA (METRIC UNITS)

Mean Roof Height	Door Size	.20 kPa	.30 kPa	.40 kPa	.50 kPa	.60 kPa	.70 kPa	.80 kPa
Up To 7.62 m	*2.44m x 2.44m*	**.41**	**.62**	**.82**	**1.03**	**1.24**	**1.44**	**1.65**
		-.43	-.65	-.87	-1.09	-1.3	-1.52	-1.74
	3.05mx 3.05m	**.41**	**.61**	**.81**	**1.01**	**1.22**	**1.42**	**1.62**
		-.43	.64	-.86	-1.07	-1.28	-1.50	-1.71
	Wind Speeds (m/s) Mean Hourly	18	22	25	28	31	33	35

Design pressures above are in kilopascals (kPa)

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Commercial Door Wind Load Guide
Based on the 2010 National Building Code of Canada (Metric units)

Mean Roof Height	Door Size	.80 kPa	.90 kPa	1.00 kPa	1.10 kPa	1.20 kPa	1.30 kPa	1.40 kPa
Up To 7.62 m	*2.44m x 2.44m*	**1.65**	**1.86**	**2.06**	**2.27**	**2.47**	**2.68**	**2.89**
		-1.74	-1.96	-2.17	-2.39	-2.61	-2.82	-3.04
	3.05mx 3.05m	**1.62**	**1.82**	**2.03**	**2.23**	**2.43**	**2.63**	**2.84**
		-1.71	-1.92	-2.14	-2.35	-2.57	-2.78	-2.99
	Wind Speeds (m/s) Mean Hourly	35	37	39	41	43	45	47

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Wind Load Calculation Steps and Example, Using Garage Door Wind Load Design Pressures Based on the 2010 National Building Code of Canada

Conversions:

- 1 PSF = 48 Pascals
- meters to feet: multiply by 3.28
- kPa to PSF: multiply by 20.9
- kPa to Mean Hourly Wind speed (m/s): (see below for reference)

  $q = \frac{1}{2}\, p\, V^2$

  q = .00064645 v^2 or v = (1546.9*q) ^0.5
  - Where, q = mean hourly reference velocity pressure, kPa
  - Where, v = mean hourly wind speed, m/s
- meters/sec to MPH: multiply by 2.2361
- mean hourly wind speed to fastest mile wind speed: Use ASCE 7 to determine factor

Step 1: Determine Specified Load and Effects for Wind
Specified Wind Load calculations to be based off of Volume 2, 4.1.7, page 4-16 based off information derived from Volume 2, 4.1.2.1(1)(W), page 4-2. See Step 3.

Step 2: Determine Importance Categories for Buildings
Assumed Importance Category to be "Normal" based off of Volume 2, Table 4.1.7.1, as suggested by Volume 2, 4.1.2.1(3), page 4-2.

Step 3: Determine Calculation Method – Static Procedure
Refer to User's Guide, Commentary I, and Volume 2, Appendix A, page A-50, to use with Volume 2, 4.1.7.1(1), page 4-16.

- User's Guide, Wind Load Calculation Procedure, Paragraph 2, give the Static Procedure to be used for cladding
- User's Guide, Wind Load Calculation Procedure, Paragraph 5, suggests use of the flow chart in User's Guide Figure I-1, page I-2.

Step 4: Determine Basic Formulas
Basic equations of specified external and internal pressures are illustrated in Volume 2, 4.1.7.1(1) and (3), pages 4-16 and 4-17.

Specified External Surface Pressure $p = I_w q C_e C_g C_p$ where p is in kPa

Specified Internal Surface Pressure $p_i = I_w q C_e C_{gi} C_{pi}$ where p_i is in kPa

p = specified external pressure
p_i = specified internal pressure
I_W = importance factor for wind load (internal & external)
q = reference velocity pressure, kPa (internal & external)
C_e = Exposure Factor, dimensionless (external only)
C_g = Gust Effect Factor, dimensionless (external only)
C_p = External Pressure Coefficient, dimensionless (external only)
C_{gi} = Internal Gust Effect Factor, dimensionless (internal only)
C_{pi} = Internal Pressure Coefficient, dimensionless (internal only)

Step 5: Determine the Importance Factor, I_W

The importance factor for wind load is provided in Volume 2, Table 4.1.7.1. Based on Step 2 above, the Importance Category is "Normal". Use ULS (Ultimate Limit States), as specified in Volume 2, 4.1.3.1(1)(a), page 4-3. Thus, the Importance Factor = 1.0.

Step 6a: Determine Reference Wind Pressure, q

- The reference velocity pressure, q, shall be based on a probability of being exceeded in any one year of 1 in 50.
- Reference wind pressure, q, is also discussed in Commentary I, page I-3, paragraph 6, where by 1 in 50 is commonly used.
- Paragraph 6 also refers to Volume 2, Appendix C, page C-8 for wind velocity pressures, q, calculated in Pascals using the following equation:
    - $q = \frac{1}{2} p V^2$
    - $q = .00064645\ v^2$ or $v = (1546.9 \ \text{x}\ q)^{0.5}$
        - Where q = mean hourly reference velocity pressure, kPa
        - v = mean hourly wind speed, m/s
    - Or use Table C-1 on page C-10 for Wind Speed conversions

Step 6b: Determine Reference Velocity Pressure Range

Volume 2, Appendix C, Table C-2, pages C-13 through C-38 provides design data for selected locations in Canada. Determine lowest and highest 1/50 Hourly Wind Pressure in kPa. Information to be used in TDS-155u charts.

Lowest 1/50 mean hourly q value = 0.30 kPa {several places}
Highest 1/50 mean hourly q value = 1.23 kPa {Resolution Island, Nunavut}

Show chart from 0.30 kPa to 1.30 kPa in 0.10 kPa increments

Step 6c: Determine Hourly Wind Pressures, based on 1/50, for the job-specific Province and Location.

- For example: Toronto (City Hall), Ontario Hourly Wind Pressure is 0.44 kPa (Volume 2, Table C-2, page C-29). To convert to m/s, go to Table C-1, page C-10, or use the equation in Step 6a above.

Step 7: Determine Exposure Factor, C_e

The exposure factor Ce is found in Volume 2, 4.1.7.1(5)(a) and (b), page 4-17, which refers to Volume 2, Appendix A, which refers to Commentary I, page I-4.

- **Use 0.9** for open terrain
- **Use 0.7** for rough terrain

Step 8: Determine combined External Pressure Coefficient and Gust Effect Factor, C_pC_g

- Although the gust effect factor, C_g, is specified in Volume 2, 4.1.7.1(6)(b) as $C_g = 2.5$ for cladding, the external pressure coefficient, C_p, is not specified as a standalone coefficient.
- Commentary I, page I-10, paragraph 20, suggests combining C_p and C_g for low-rise ($H \leq 20$ m) structures, and refers to paragraphs 25-28, pages I-11 through I-12.
- Paragraphs 25-28 refers to Figures I-7 to I-14 for C_pC_g values
- Figure I-8, page I-14, gives external peak composite pressure-gust coefficients on individual walls for the design of structural components and cladding
    - End-zone width, z, is assumed to be 1.22 m (4 ft)
    - C_pC_g calculations will be based on the following logarithms:

A	log A	Neg. *CpCg*. End	Neg. *CpCg*, int.	Pos. *CpCg*, end or int.
1	0	-2.10	-1.80	1.75
50	1.69897	-1.50	-1.50	1.30
CpCg / log A slope:		.35312	.17658	-.26487

Equation to determine Negative C_pC_g, End Surface: -2.10+.35312 log A
Equation to determine Negative C_pC_g, Interior Surface: -1.80+.17658 log A
Equation to determine Positive C_pC_g, End or Interior Surface: 1.75-.26487 log A

Step 9: Determine Internal Gust Effect Factor, C_{gi}

The internal gust effect factor, C_{gi}, is 2.0 as determined by Volume 2, 4.1.7.1(6)(c), page 4-17. $C_{gi} = 2.0$ or a value determined by detailed calculations. This is also stipulated in Commentary I, page I-10, paragraph 22. $C_{gi} = 2.0$ will be used without going through detailed calculations.

Step 10: Determine Internal Pressure Coefficient, C_{pi}

The internal pressure coefficient, C_{pi}, is discussed in Commentary I, page I-22, paragraph 31. The internal pressure coefficient, C_{pi}, is broken down into three categories. Category 3 should be used for "buildings with large or significant openings through which gust could be transmitted to the interior" (e.g. garage doors).

- **Use 0.7** in conjunction with positive C_pC_g values
- **Use -0.7** in conjunction with negative C_pC_g values

Step 11: Determine Maximum Positive and Negative Surface Pressure Formulas:

Specified External Surface Pressure $p = I_w q C_e C_g C_p$ where p is in kPa
Specified Internal Surface Pressure $p_i = I_w q C_e C_{gi} C_{pi}$ where p_i is in kPa
A = Garage Door Surface Area

- **Positive, open terrain:**

p = q (C_e) [(positive C_pC_g x A) + (C_{pi})(C_{gi})]
$$p = q(0.9)[(1.75 - .26487 \log A) + (0.7)(2.0)]$$

- **Positive, rough terrain:**

p = q (C_e) [(positive C_pC_g x A) + (C_{pi})(C_{gi})]

$$p = q(0.7)[(1.75 - .26487 \log A) + (0.7)(2.0)]$$

- **Negative, end surface, open terrain:**

p = q (C_e) [(neg. end C_pC_g x A) - (C_{pi})(C_{gi})]
$$p = q(0.9)[(-2.10 + .35312 \log A) - (0.7)(2.0)]$$

- **Negative, end surface, rough terrain:**

p = q (C_e) [(neg. end C_pC_g x A) - (C_{pi})(C_{gi})]
$$p = q(0.7)[(-2.10 + .35312 \log A) - (0.7)(2.0)]$$

- **Negative, interior surface, open terrain:**

p = q (C_e) [(neg. int. C_pC_g x A) -(C_{pi})(C_{gi})]

$$p = q(0.9)[(-1.80 + .17658 \log A) - (0.7)(2.0)]$$

- **Negative, interior surface, rough terrain:**

p = q (C_e) [(neg. int. C_pC_g x A) - (C_{pi})(C_{gi})]

$$p = q(0.7)[(-1.80 + .17658 \log A) - (0.7)(2.0)]$$

Example:

- A 4.88 m (16 ft) width by 2.13 m (7 ft) height garage door is to be installed in an attached garage to a house with a combined rectangular footprint layout of 24.39 m (80 ft) by 12.20 m (40 ft).
- The mean roof height of the home is 7.62 m (25 ft),
- The roof slope is 4:12,
- The vertical edge of the garage door opening is located 0.61m (2 ft) from one of the corners of the house.
- The home is located in Toronto, Ontario,
- The local Building Code requires the use of the 2010 NBC of Canada,
- The home is in rough terrain.

Conversions:

- 1 PSF = 48 Pascals
- meters to feet: multiply by 3.28
- kPa to PSF: multiply by 20.9
- kPa to Mean Hourly Wind speed (m/s): (see below for reference)

$$q = \frac{1}{2} p V^2$$

q = .00064645 v^2 or v = (1546.9*q) ^0.5

  - Where, q = mean hourly reference velocity pressure, kPa
  - Where, v = mean hourly wind speed, m/s
- m/s to MPH: multiply by 2.2361
- mean hourly wind speed to fastest mile wind speed: Use ASCE 7 to obtain factor

Step 1: Determine Specified Load and Effects for Wind

Specified Wind Load calculations to be based off of Volume 2, 4.1.7, page 4-16 based off information derived from Volume 2, 4.1.2.1(1)(W), page 4-2. See Step 3.

Example: No action

Step 2: Determine Importance Categories for Buildings

Assumed Importance Category "Normal" based off of Vol 2, Table 4.1.7.1, as suggested by Vol 2, 4.1.2.1(3), page 4-2.

Example: Importance Category = Normal

Step 3: Determine Calculation Method – Static Procedure

Refer to User's Guide, Commentary I, and Vol 2, Appendix A, page A-50, to use with Vol 2, 4.1.7.1(1), page 4-16.

- User's Guide, Wind Load Calculation Procedure, Paragraph 2, give the Static Procedure to be used for cladding
- User's Guide, Wind Load Calculation Procedure, Paragraph 5, suggests use of flow chart in User's Guide Figure I-1, page I-2.

Example: Static Procedure used

Step 4: Determine Basic Formulas

Basic equations of specified external and internal pressures illustrated in Vol. 2, 4.1.7.1(1) and (3), pages 4-16 and 4-17.

Specified External Surface Pressure	$p = I_w q C_e C_g C_p$	where p is in kPa
Specified Internal Surface Pressure	$p_i = I_w q C_e C_{gi} C_{pi}$	where p_i is in kPa

p = specified external pressure, p_i = specified internal pressure

I_W = importance factor for wind load (internal & external)

q = reference velocity pressure, kPa (internal & external)

C_e = Exposure Factor, dimensionless (external only)

C_g = Gust Effect Factor, dimensionless (external only)

C_p = External Pressure Coefficient, dimensionless (external only)

C_{gi} = Internal Gust Effect Factor, dimensionless (internal only)

C_{pi} = Internal Pressure Coefficient, dimensionless (internal only)

Example = Use these equations

Step 5: Determine the Importance Factor, I_W

The importance factor for wind load is provided in Volume 2, Table 4.1.7.1. Based on Step 2 above, the Importance Category is "Normal". Use ULS (Ultimate Limit States), as specified in Volume 2, 4.1.3.1(1)(a), page 4-3. Thus, the Importance Factor = 1.0.

Example: $I_w = 1.0$

Step 6a: Determine Reference Velocity Pressure, q

- The reference velocity pressure, q, shall be based on a probability of being exceeded in any one year of 1 in 50.
- Reference wind pressure, q, is also discussed in Commentary I, page I-3, paragraph 6, where by 1 in 50 is commonly used.
- Paragraph 6 also refers to Volume 2, Appendix C, page C-8 for wind velocity pressures, q, calculated in Pascals using the following equation:
  - $q = \frac{1}{2} p V^2$
  - $q = .00064645\, v^2$ or $v = (1546.9 \text{ x } q)^{0.5}$
    - Where q = mean hourly reference velocity pressure, kPa
    - v = mean hourly wind speed, m/s
  - Or use Table C-1 on page C-10 for Wind Speed conversions

Example: q = 0.44 kpa
Reference: Hourly Wind Pressures, 1/50 Column as referenced in Volume 2, Table C-2, page C-29 for Toronto (City Hall), Ontario

Conversions, if needed:

- kPa to Mean Hourly Wind Speed (m/s) (see Step 6c below for reference)
  - 0.44 kpa = 24.0 m/s
- Mean Hourly Wind Speed (m/s) to Mean Hourly Wind Speed (MPH)
  - 24.0 m/s x 2.2361 MPH = 53.7 MPH
- kPa to Fastest Mile Wind Speed (MPH)
  - $113 \text{ x } (0.44 \text{ kpa})^{1/2} = 75$ MPH

Step 6b: Determine Reference Velocity Pressure Range

Volume 2, Appendix C, Table C-2, pages C-13 through C-38 provides design data for selected locations in Canada. Determine lowest and highest 1/50 Hourly Wind Pressure in kPa. Information to be used in TDS-155u charts.

Lowest 1/50 mean hourly *q* value = 0.30 kPa {several places}
Highest 1/50 mean hourly *q* value = 1.23 kPa {Resolution Island, Nunavut}
Show chart from 0.30 kPa to 1.30 kPa in 0.10 kPa increments

Step 6c: Determine Hourly Wind Pressures, based on 1/50, as specified in your Province and Location.

- For example: Toronto (City Hall), Ontario Hourly Wind Pressure is 0.44 kPa (Volume 2, Table C-2, page C-29). To convert to m/s, go to Table C-1, page C-10, or use the equation in Step 6a above.

Step 7: Determine Exposure Factor, C_e

The exposure factor Ce is found in Volume 2, 4.1.7.1(5)(a) and (b), page 4-17, which refers to Volume 2, Appendix A, which refers to Commentary I, page I-4.

- **Use 0.9** for open terrain
- **Use 0.7** for rough terrain

Example: Toronto, Ontario example is in Rough Terrain…Ce = 0.7

Step 8: Determine combined External Pressure Coefficient and Gust Effect Factor, C_pC_g

- Although the gust effect factor, C_g, is specified in Volume 2, 4.1.7.1(6)(b) as $C_g = 2.5$ for cladding, the external pressure coefficient, C_p, is not specified as a standalone coefficient.
- Commentary I, page I-10, paragraph 20, suggests combining C_p and C_g for low-rise ($H \leq 20$ m) structures, and refers to paragraphs 25-28, pages I-11 through I-12.
- Paragraphs 25-28 refers to Figures I-7 to I-14 for C_pC_g values
- Figure I-8, page I-14, gives external peak composite pressure-gust coefficients on individual walls for the design of structural components and cladding
  - End-zone width, z, is assumed to be 1.22 m (4 ft)
  - C_pC_g calculations will be based on the following logarithms:

A	log A	Neg. *CpCg*. End	Neg. *CpCg*, int.	Pos. *CpCg*, end or int.
1	0	-2.10	-1.80	1.75
50	1.69897	-1.50	-1.50	1.30
CpCg / log A slope:		.35312	.17658	-.26487

Equation to determine Negative C_pC_g, End Surface: -2.10+.35312 log A
Equation to determine Negative C_pC_g, Interior Surface: -1.80+.17658 log A
Equation to determine Positive C_pC_g, End or Interior Surface: 1.75-.26487 log A

Example: Surface Pressure Coefficients:

For this house, the end zone region is defined as 10% of the 12.20 m (40 ft) minimum building dimension, or 1.22 m (4 ft). Since the garage door opening is located 0.61 m (2 ft) from one of the corners of the home, this means that 0.61 m (2 ft) of the garage door opening is in the end zone and 4.27 m (14 ft) of the garage door opening is in the interior zone.

Step 9: Determine Internal Gust Effect Factor, C_{gi}

The internal gust effect factor, C_{gi}, is 2.0 as determined by Volume 2, 4.1.7.1(6)(c), page 4-17. $C_{gi} = 2.0$ or a value determined by detailed calculations. This is also stipulated in Commentary I, page I-10, paragraph 22. $C_{gi} = 2.0$ will be used without going through detailed calculations.

Example: $C_{gi} = 2.0$

Step 10: Determine Internal Pressure Coefficient, C_{pi}

The internal pressure coefficient, C_{pi}, is discussed in Commentary I, page I-22, paragraph 31. The internal pressure coefficient, C_{pi}, is broken down into three categories. Category 3 should be used for "buildings with large or significant openings through which gust could be transmitted to the interior" (e.g. garage doors).

- **Use 0.7** in conjunction with positive C_pC_g values
- **Use -0.7** in conjunction with negative C_pC_g values

Example: $C_{pi} = 0.7$ or $C_{pi} = -0.7$

Step 11: Determine Maximum Positive and Negative Surface Pressure Formulas:

Specified External Surface Pressure	$p = I_w q C_e C_g C_p$	where p is in kPa
Specified Internal Surface Pressure	$p_i = I_w q C_e C_{gi} C_{pi}$	where p_i is in kPa

A = Garage Door Surface Area

Positive, rough terrain: $p = q\,(C_e)\,[(\text{positive } C_pC_g \times A) + (C_{pi})(C_{gi})]$ $p = q(0.7)[(1.75 - .26487 \log A) + (0.7)(2.0)]$	**Positive, open terrain:** $p = q\,(C_e)\,[(\text{positive } C_pC_g \times A) + (C_{pi})(C_{gi})]$ $p = q(0.9)[(1.75 - .26487 \log A) + (0.7)(2.0)]$
Negative, end surface, rough terrain: $p = q\,(C_e)\,[(\text{neg. end } C_pC_g \times A) - (C_{pi})(C_{gi})]$ $p = q(0.7)[(-2.10 + .35312 \log A) - (0.7)(2.0)]$	**Negative, end surface, open terrain:** $p = q\,(C_e)\,[(\text{neg. end } C_pC_g \times A) - (C_{pi})(C_{gi})]$ $p = q(0.9)[(-2.10 + .35312 \log A) - (0.7)(2.0)]$
Negative, interior surface, rough terrain: $p = q\,(C_e)\,[(\text{neg. int. } C_pC_g \times A) - (C_{pi})(C_{gi})]$ $p = q(0.7)[(-1.80 + .17658 \log A) - (0.7)(2.0)]$	**Negative, interior surface, open terrain:** $p = q\,(C_e)\,[(\text{neg. int. } C_pC_g \times A) - (C_{pi})(C_{gi})]$ $p = q(0.9)[(-1.80 + .17658 \log A) - (0.7)(2.0)]$

Example: input all of known factors as outline in "bold" red above

$$p = q\,(C_e)\,[(\quad \text{positive } C_pC_g \quad \times \quad A \quad) + (C_{pi})(C_{gi})]$$

$$+epg = (0.7)[(1.75 - .26487 \log_{10} 10.39) + (0.7)(2.0)] \quad = \quad 2.016$$ for end zone and Interior zone

$$p = q\,(C_e)\,[(\text{negative end } C_pC_g \quad \times A \quad) - (C_{pi})(C_{gi})]$$

$$-epg = (0.7)[(-2.10 + .35312 \log_{10} 10.39) - (0.7)(2.0)] \quad = -2.199$$ for end zone

Note: Technical Data Sheets are information tools only and should not be used as substitutes for instructions from individual manufacturers. Always consult with individual manufacturers for specific recommendations for their products and check the applicable local regulations.

p = q (C_e) [(negative int. C_pC_g x A) - (C_{pi})(C_{gi})]

$$-epg = (0.7)[(-1.80 + .17658\log_{10} 10.39) - (0.7)(2.0)]$$ = -2.114 for interior zone

q = 0.44 kPa for Toronto, Ontario (typical)

Positive Wind Pressure:

- Positive Wind Pressure for end zone and interior zone
  - 0.44 x 2.016 = **0.89 kPa** x 20.9 = **18.6 PSF**

Negative Wind Pressure:

- Negative Wind Pressure for end zone
  - 0.44 x -2.199 = **- 0.97 kPa** x 20.9 = **- 20.3 PSF**
- Negative Wind Pressure for interior zone
  - 0.44 x -2.114 = **- 0.93 kPa** x 20.9 = **- 19.4 PSF**

Weighted Average of Negative Wind Pressure:

- Since 12.5% of the garage door opening is in an end zone, and 87.5% of the garage door opening is in an interior zone, the weighted average negative wind pressure is
  - (-0.97 kPa)(.125) + (-0.93 kPa)(.875) = **-0.93**
  - **-0.93 kPa** x 20.9 = **- 19.4 PSF**