

# Hong Kong Wind Code 2019

- Theory, Practice and Software



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Code of Practice on Wind Effects  
in Hong Kong  
2004



Effective from  
April 2021



Code of Practice on Wind Effects  
in Hong Kong 2019

New  
Features

- Along wind (direct sheltering effect)
- Torsional wind
- Across wind
- Wind acceleration
- ...

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# 1. Introduction

The structures in Hong Kong are significantly influenced by **strong wind** ...

2017年超強颱風“天鴿(Hato)”

2018年超強颱風“山竹(Mangkhut)”



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# 1. Introduction

## Buildings & Building Elements under Typhoon



Super Typhoon: Mangkhut (山竹), 2018  
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# 1. Introduction

## Collapse Analysis and Strengthening Recommendations for Tower Crane Useter JL236-14 Under Typhoon Hato (2017), Hong Kong



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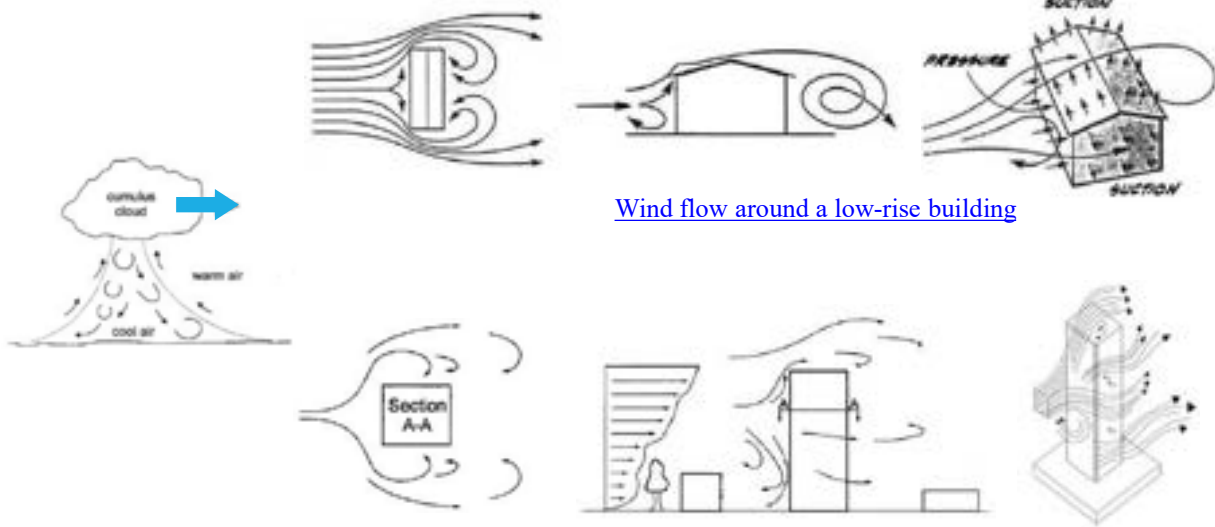
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# 1. Introduction

As an engineer in HK, the first and important task is to correctly consider the **wind loads** !

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# 1. Introduction



Wind flow around a high-rise building

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# 1. Introduction

## Terrain Roughness (地面粗糙度)



A: Open sea    B: Open level, country    C: Suburbs, woodland    D: City centres

Smooth → Rough

### Mean wind profiles vs. Terrain roughness

8.2.1 对于平坦或稍有起伏的地形，风压高度变化系数应根据地面粗糙度类别按表 8.2.1 确定。地面粗糙度可分为 A、B、C、D 四类：A 类指近海海面和高山、海岸、湖岸及沙漠地区；B 类指田野、乡村、丛林、丘陵以及房屋比较稀疏的乡镇；C 类指有密集建筑群的城市市区；D 类指有密集建筑群且房屋较高的城市市区。

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**GB50009-2012**

AS/NZS 1170.2: 2011

## BS EN 1991-1-4 (2005)

### Terrain category 0

Sea, coastal area exposed to the open sea



**Note:** The rougher the surface, the higher the height at which the wind speed attains the value of free stream velocity.

### Terrain category I

Lakes or areas with negligible vegetation and without obstacles



### Terrain category II

Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights



### Terrain category III

Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban towns, permanent forest)



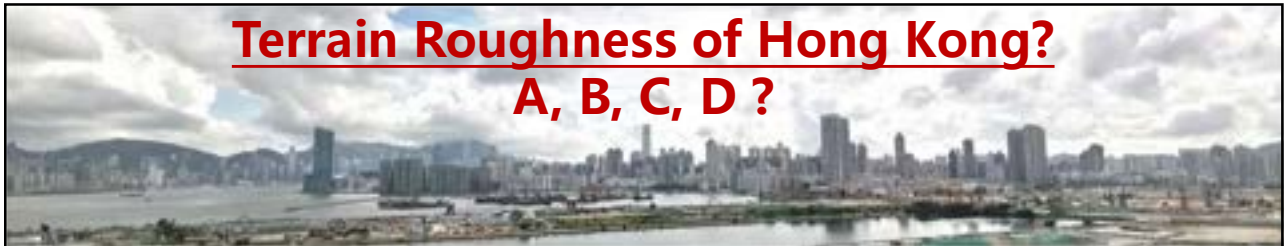
### Terrain category IV

Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m



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## Terrain Roughness of Hong Kong? A, B, C, D?



However, because (i) Hong Kong is close to the sea; (ii) the significant height of most of the buildings; and (iii) the potential effects of complex topography, it was not considered justified to provide detailed adjustment factors for terrain roughness. This is similar to the 2004 Code.

**Category A**

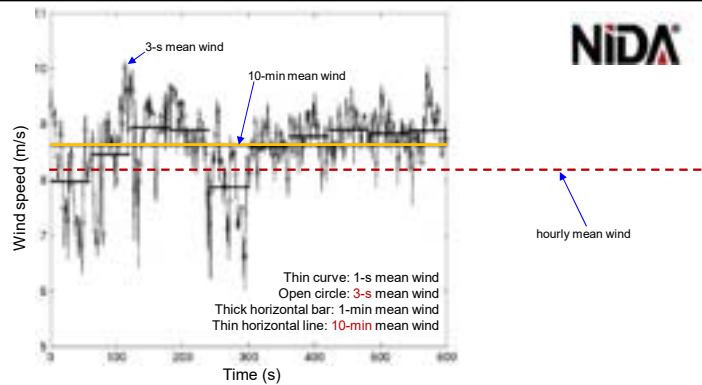
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# 1. Introduction

## Mean Wind Speed

Design Code	Averaging Time 风速时距
HKWC (2004)	3s (static) 1hr (dyna.)
HKWC (2019)	3s
BS 6399-2 (1997)	1hr
BS EN 1991-1-4 (2005)	10min
AS/NZS 1170.2 (2011)	3s
GB50009 (2012)	10min

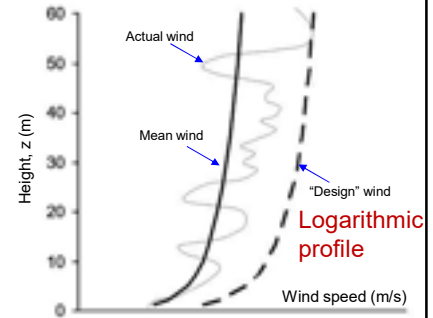


**“Design” Wind Speed**  
= Mean Wind x Scale Factor  
(due to Gust Effect)

### Wind Pressure vs. Wind Speed

$$q = \frac{1}{2} \rho v^2$$

$\rho = 1.2 \text{ kg/m}^3$  (HK, AS/NZS)  
 $\rho = 1.25 \text{ kg/m}^3$  (GB, EC)  
 $\rho = 1.226 \text{ kg/m}^3$  (BS)



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# 1. Introduction

## Wind Speed Profile – Gradient height, wind speed, direction, terrain roughness, ...

Design Code	Wind Speed Profile 风剖面	Remarks
HKWC (2004)	$V_z = 1.05 \bar{v}_g \left( \frac{z}{z_g} \right)^\alpha \left[ 1 + 3.7 I_g \left( \frac{z}{z_g} \right)^{-\alpha} \right]$	$v_g$ = Gradient hourly-mean wind speed = 56.6m/s   59.5m/s (1.05 for Design) $z_g$ = Gradient height = 500m $I_g$ = Turbulent intensity at gradient height = 0.087 $g_v$ = Peak factor = 3.7 $\alpha$ = Power exponent = 0.11 (Open sea condition)
HKWC (2019)	Same as HKWC (2004)	
BS 6399-2 (1997)	$V_s = V_b \times S_a \times S_d \times S_s \times S_p$	$V_b$ = Basic wind speed $S_a$ = Altitude factor $S_d$ = Direction factor $S_s$ = Seasonal factor $S_p$ = Probability factor (1.0)
BS EN 1991-1-4 (2005)	$V_b = c_{dir} \times c_{season} \times V_{b,0}$	$V_b$ = Basic wind speed $V_{b,0}$ = Fundamental value of the basic wind velocity $c_{dir}$ = Directional factor $c_{season}$ = Season factor
AS/NZS 1170.2 (2011)	$V_{sit,\beta} = V_R \times M_d (M_{z,cat} \times M_s \times M_t)$	$V_R$ = 3-s gust wind speed $M_d$ = Directional multiplier $M_{z,cat}$ = Terrain/height multiplier $M_s$ = Shielding multiplier $M_t$ = Topographic multiplier
GB50009 (2012)	$V_z = \mu_z V_0 = \left( \frac{H_i^B}{10} \right)^{2\alpha_s} \left( \frac{10}{H_i^T} \right)^{2\alpha_s} \left( \frac{z}{10} \right)^{2\alpha_i} V_0, (i=A, B, C, D)$	Terrain roughness: A B C D $H_i$ = 300, 350, 450, 500 $\alpha_i$ = 0.12, 0.15, 0.22, 0.30 $V_0$ = basic wind speed

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# 1. Introduction

$$q = \frac{1}{2}\rho v^2$$

Turbulence increased due to surrounding buildings for across-wind



Wind Pressure/Force – (Basic wind) + (Shielding,  $C_p$ , topography, size & dynamic ...)

Design Code	Wind Pressure / Force	Remarks
HKWC (2004)	Static: $F = C_f q_z A_z \times S_f$ ; $q_z = \frac{1}{2} \rho V_z^2$ ; ( $S_f \leftarrow S_d$ ) Dynamic: $F = G \times C_f \bar{q}_z A_z \times S_f$ ; $G = 1 + 2I_s \sqrt{g^2 B + g^2 SE / \zeta}$	$C_f$ = Force & pressure coefficient $G$ = Dynamic magnification factor
HKWC (2019)	$W_z = Q_z C_f S_{q,z} B$ ; $Q_z = Q_{o,z} S_t S_\theta$ ; $Q_{o,z} = 3/7 (Z_e / 500)^{0.16}$ $I_{o,z} = 0.087 (Z_e / 500)^{-0.11}$ ; $I_{o,z} = [4 - \frac{6H_e}{H}] 0.087 (Z_e / 500)^{-0.11}$	$Q_z$ = Design wind reference pressure $S_t$ = Topography effect $S_\theta$ = Directional wind effect (0.8 to 0.85) $C_f$ = Force & pressure coefficient $S_{q,z}$ = Size and dynamic factor
BS 6399-2 (1997)	$p_e = q_s \times C_{pe} \times C_s$ ; $q_s = 0.613 V_e^2$ $V_e = V_s \times S_b$ ; $V_s = V_b \times S_d \times S_g \times S_p$	$C_{pe}$ = External pressure coefficient for the building surface $C_s$ = Size effect factor for external pressures $S_b$ = Terrain and building factor ...
BS EN 1991-1-4 (2005)	$F_w = c_s c_d \times c_f \times q_p(z) \times A$ $q_p(z) = [1 + 7 I_v(z)] \times \frac{1}{2} \rho \times V_m^2(z)$ $V_m(z) = c_r(z) \times c_0(z) \times V_b$ ; $V_b = c_{dir} \times c_{season} \times V_{b,0}$	$c_s c_d$ = Structural factor $c_s$ = Size factor (reduction effect) $c_d$ = Dynamic factor (increasing effect) $c_f$ = Force coefficient for structure or structural element $c_r$ = Roughness factor $c_0$ = Orography factor
AS/NZS 1170.2 (2011)	$p = (0.5 \rho) V_{dir,\theta}^2 \times C_{fpe} \times C_{dyn}$ ; $V_{dir,\theta} = MAX(V_{dir,\theta})$ $V_{dir,\theta} = V_R \times M_d (M_{z,dir} \times M_s \times M_f)$	$C_{fpe}$ = Aerodynamic shape factor $C_{dyn}$ = Dynamic response factor
GB50009 (2012)	$w_k = \beta_z \mu_s \mu_w w_0$ $\beta_z = 1 + 2g I_{10} B_z \sqrt{1+R^2}$ ; $\mu_z = \left(\frac{H_z}{10}\right)^{2\alpha_s} \left(\frac{10}{H_z}\right)^{2\alpha_t} \left(\frac{z}{10}\right)^{2\alpha_a}$	$\beta_z$ = Gust wind factor; $R$ = Resonance effect $\mu_s$ = Shape factor $\mu_w$ = Altitude factor $w_0$ = Basic wind pressure

# 1. Introduction

## Wind Effects on Structures

- **Static Forces (For design purpose)**

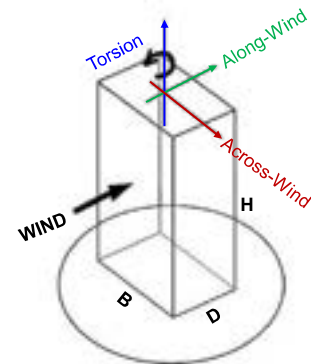
- (1) Similar to dead loads, live loads, ...
- (2) Along-wind, cross-wind, torsional force

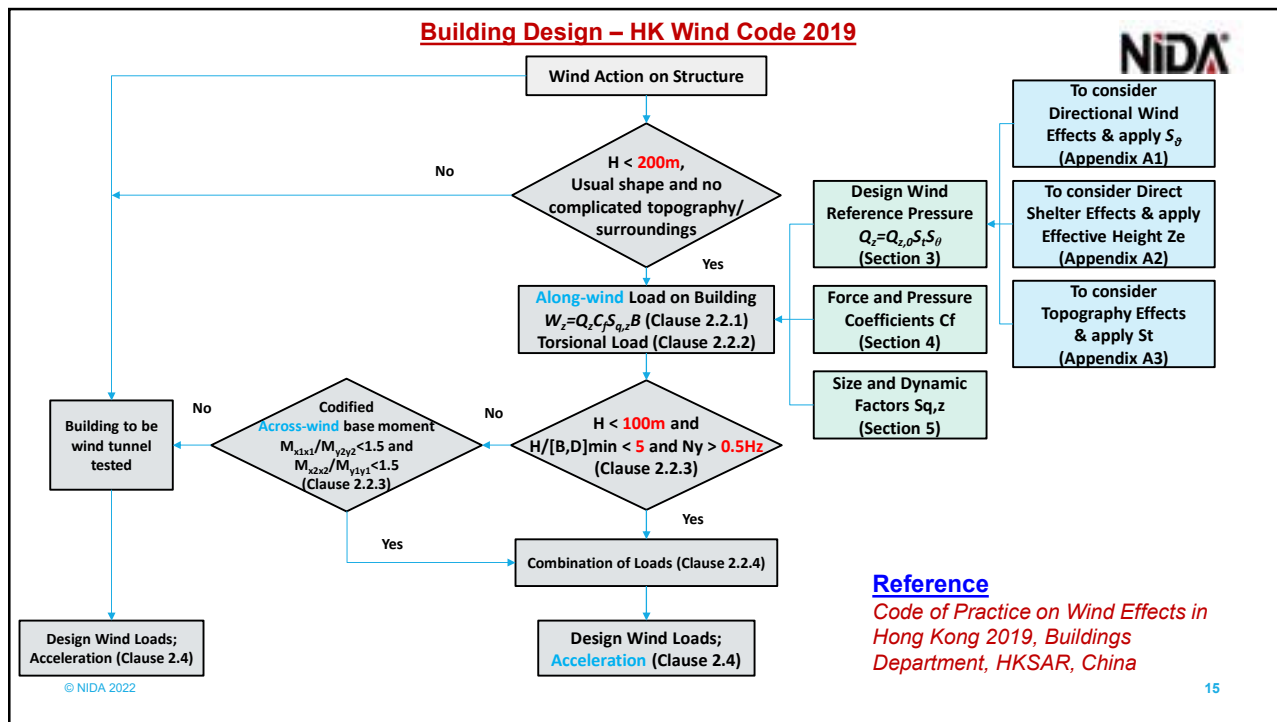
- ➔ **Wind (Direction, Season, Terrain Roughness, Shelter, Topography)**
- ➔ **Dimension & Shape of Structure (B, D, H, etc.)**

- **Dynamic Forces**

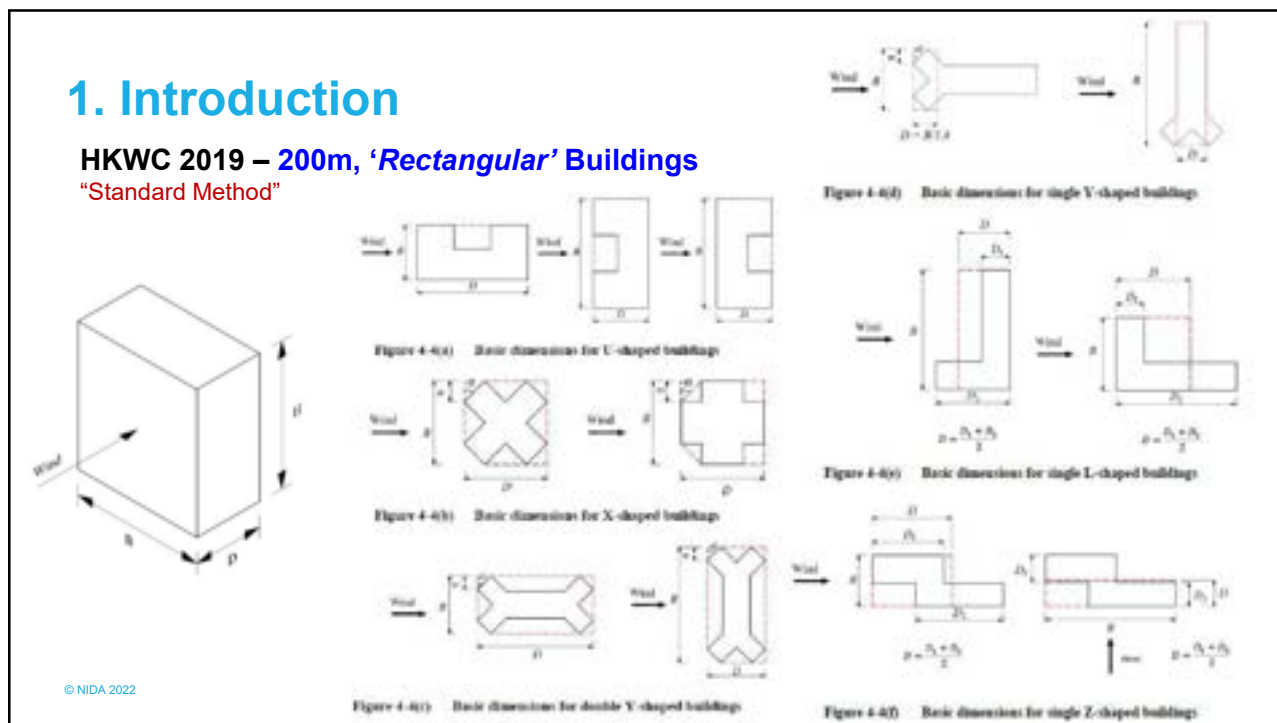
- (1) High-rise, long-span, slender structures
- (2) Additional inertia forces
- (3) Dynamic motions
- (4) Peak acceleration limit – occupant comfort level [*Wind-induced Vibration*]

- ➔ **Wind (Direction, Season, Terrain Roughness, Shelter, Topography)**
- ➔ **Dimension & Shape of Structure (B, D, H, etc.)**
- ➔ **Dynamic Properties of Structure (Natural Frequency – Mass & Stiffness, Damping Ratio)**





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# 1. Introduction

## HKWC 2019 – 200m, ‘Non-Rectangular’ Buildings ?

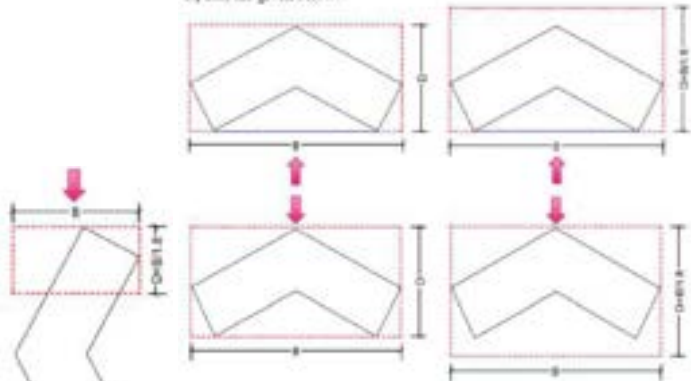
For shapes not covered in the Code, similar rules may be applied as below:

- (a) The principle of the enclosing rectangle may be used to assess the effective breadth,  $B$ , for any wind direction.
- (b) Re-entrant surfaces should be ignored for buildings with  $H/B \geq 1$ . Assume a straight line (as the blue line in the figures below) on plan between extremes of each cross-section.
- (c) Clause 4.2.3 may be used to assess the effect of windward faces not normal to the wind.
- (d) The effective depth,  $D$ , should be based on the minimum dimension in the direction of the wind, near the extremes of the cross-sectional breadth. Where surfaces are not parallel to the wind,  $D$  should be taken as the depth of the enclosed rectangle or  $B/1.8$ , whichever is the smaller in determining the rough B/D ratio where the force coefficients in Figure 4-2 reach their peaks.
- (e) In general it is necessary to calculate the above for at least four wind directions, each approximately at right-angles.

Explanatory Notes to the Code of Practice on Wind Effects in Hong Kong 2019

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Selected examples to illustrate the rule  $D = \min(D_{Enclosed-Rect}, B/1.8)$  are given below:



$$D = \min(D_{Enclosed-Rect}, B/1.8)$$

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# 2. Along-Wind Forces

## Design Wind Pressure

HKWC 2019

Static & Dynamic:

$$W_z = Q_z C_f S_{q,z} B$$

$$Q_z = Q_{o,z} S_t S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_{o,z} S_t (S_\theta S_{q,z}) \times C_f B$$

HKWC 2004

Static:  $W_z = q_z S_t \times C_f B$

$$q_z = \frac{1}{2} \rho V_z^2$$

Dynamic:  $W_z = \bar{q}_z S_t G \times C_f B$

$$\bar{q}_z = \frac{1}{2} \rho \bar{V}_z^2$$

$$G = 1 + 2I_h \sqrt{g_v^2 B + g_s^2 SE / \zeta}$$

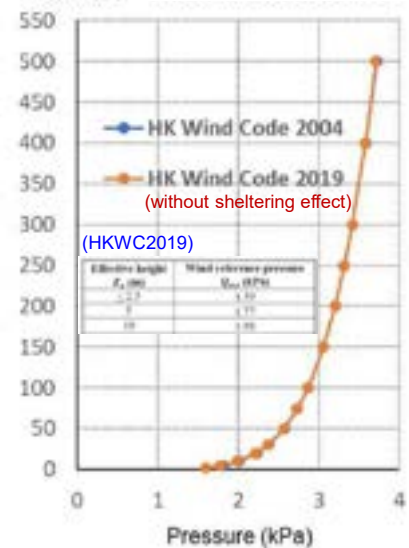
$$W_z = q_z S_t \times C_f B$$

$(S_t \leftarrow S_a)$

$Z_g = 500m$  – Gradient height, at which the ground friction influence becomes insignificant.

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Height (m) Reference Wind Pressure



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## 2. Along-Wind Forces

### Design Wind Pressure

Static & Dynamic:

$$W_z = Q_z C_f S_{q,z} B$$

$$Q_z = Q_{o,z} S_t S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

Static:  $W_z = q_z S_t \times C_f B$

$$q_z = \frac{1}{2} \rho V_z^2$$

Dynamic:  $W_z = \bar{q}_z S_t G \times C_f B$

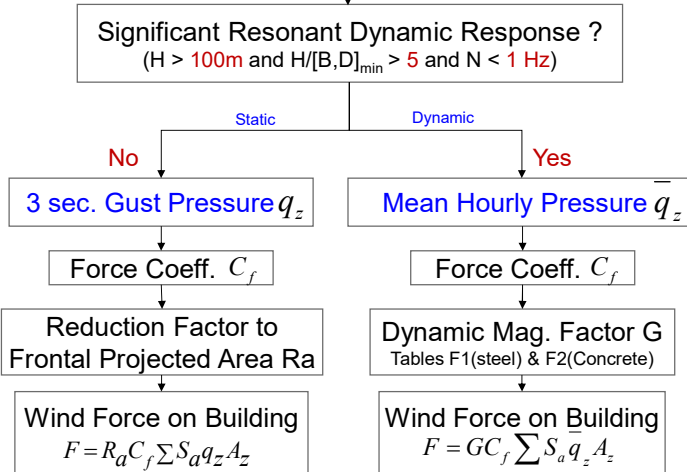
$$\bar{q}_z = \frac{1}{2} \rho \bar{V}_z^2$$

$$G = 1 + 2I_h \sqrt{g_v^2 B + g_f^2 S E / \zeta}$$

HKWC 2019

HKWC 2004

### HKWC 2004



## 2. Along-Wind Forces

### Directionality Factor $S_\theta$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta$$

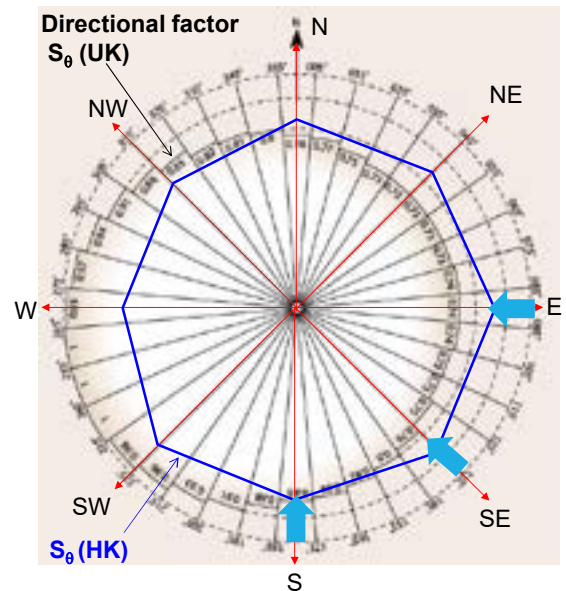
$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

Wind Direction	Direction factor, $S_\theta$
N	0.82
NE	0.84
E	0.85
SE	0.85
S	0.85
SW	0.84
W	0.82
NW	0.80

**Note:**

- Rectangular buildings:  $S_\theta = 0.8$  to  $0.85$
- Linear interpolation is allowed
- Maximum  $S_\theta$  within a sector should be adopted.
- Circular buildings :  $S_\theta = 1$



(From Wind actions to BS EN 1991-1-4)

## 2. Along-Wind Forces

### Topography Factor $S_t$ (HKWC 2019)

( $S_t \leftarrow S_a$ )

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

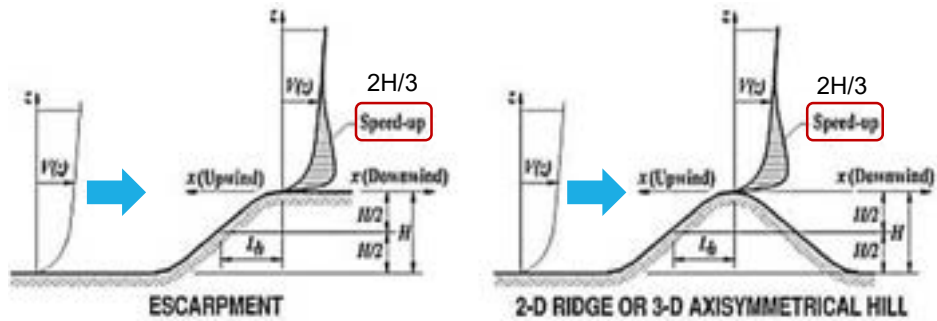
- Wind speed increases when blowing up the windward slope of a hill.
- When the topography is significant, the design wind pressure will be increased by multiplication with a topography factor  $S_t$ .
- Local topography is considered significant when a site is located within the topography significant zone.

#### Wind Tunnel Testing:

$$S_t = \left\{ \frac{[V_z(1+3.7I_{v,z})]_{Topography}}{[V_z(1+3.7I_{v,z})]_{Approach}} \right\}^2$$

#### Turbulence Intensity:

$$I_{v,z} = \frac{\text{Standard Deviation}}{\text{Mean Velocity}} = \frac{\sigma_z}{V_z}$$



(From ASCE 7-16)

## 2. Along-Wind Forces

### Topography Factor $S_t$ (HKWC 2019)

( $S_t \leftarrow S_a$ )

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

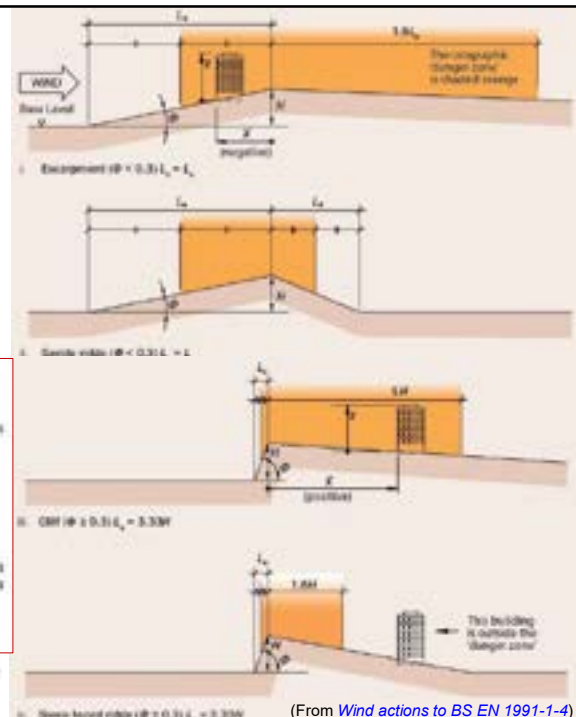
If a topographic adjustment is not required, then  $S_t = 1.0$ .  
 Otherwise,  $S_t$ , the topographic multiplier of wind pressure, is calculated as below:  

$$S_t = \left[ 1 + \frac{2\psi_s s^2}{1 + 3.7I_{v,z}} \right]^2$$
 - Equation A3-1  $S_t \geq 1.0$   
 Where:  
 $\psi_s$  is the topographic location factor given in Figures A3-2(a, b or c) or calculated with the Equations A3-2 to A3-11.  
 $s$  and  $L_{s,d}$  should be calculated at height,  $Z = 2/3H$ .  
 $L_{s,d}$  may be taken as  $L_{s,d}$  in Equations 3-3 or 3-4.

$\psi_s$  is the maximum slope for a quarter of the hill height in the top half of the hill on the windward side.  
 $\psi_s$  is the minimum of  $\psi_s$  or 0.5.

$$S_t = \left\{ \frac{[V_z(1+3.7I_{v,z})]_{Topography}}{[V_z(1+3.7I_{v,z})]_{Approach}} \right\}^2$$

$$S_t = \left\{ \frac{1+3.7I_{v,z}+2\psi_s s^2}{1+3.7I_{v,z}} \right\}^2$$



(From Wind actions to BS EN 1991-1-4)

## 2. Along-Wind Forces

### Topography Factor $S_t$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta \quad S_t = \left\{ 1 + \frac{2\psi_e s}{1 + 3.7I_{v,z}} \right\}^2$$

$\psi_u$  is the maximum slope for a quarter of the hill-height in the top half of the hill on the windward side.  
 $\psi_d$  is the minimum of  $\psi_u$  or 0.3  $\psi_e = \min(\psi_u, 0.3)$

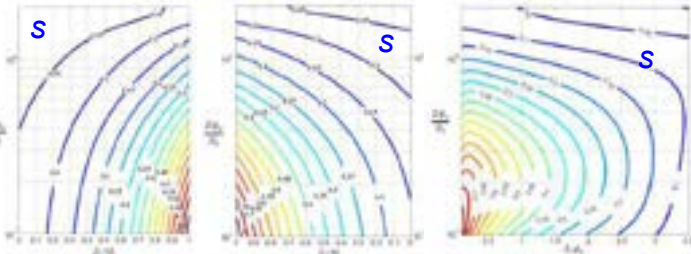


Fig. A3-1(a) & (b)  
(Orange color)

Fig. A3-1(a)  
(Blue color)

Fig. A3-1(b)  
(Blue color)

© NIDA 2022  $Z_t / H_t \geq 0.5$

$X_t < 1.5H_t / \psi_e$

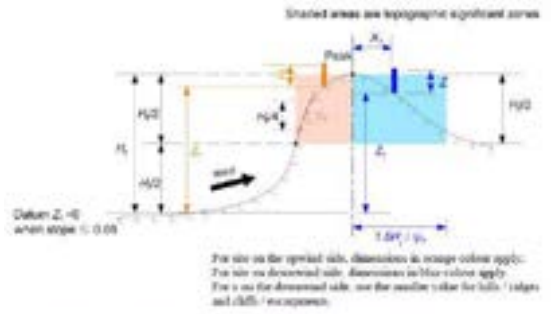


Figure A3-1(a) Definition of topographic dimensions for hills and ridges

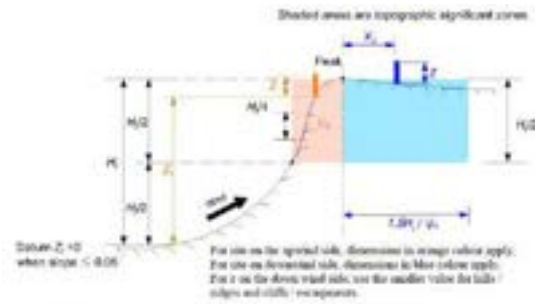


Figure A3-1(b) Definition of topographic dimensions for valleys and escarpments

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## 2. Along-Wind Forces

### Sheltering Effect (HKWC 2019)

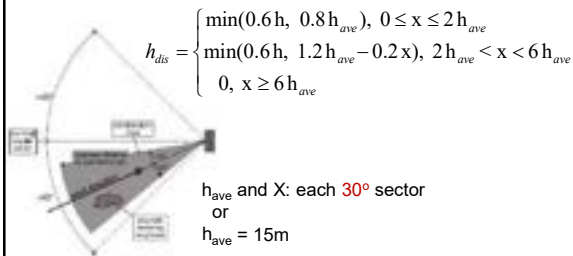
#### Effective Height $Z_e$

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

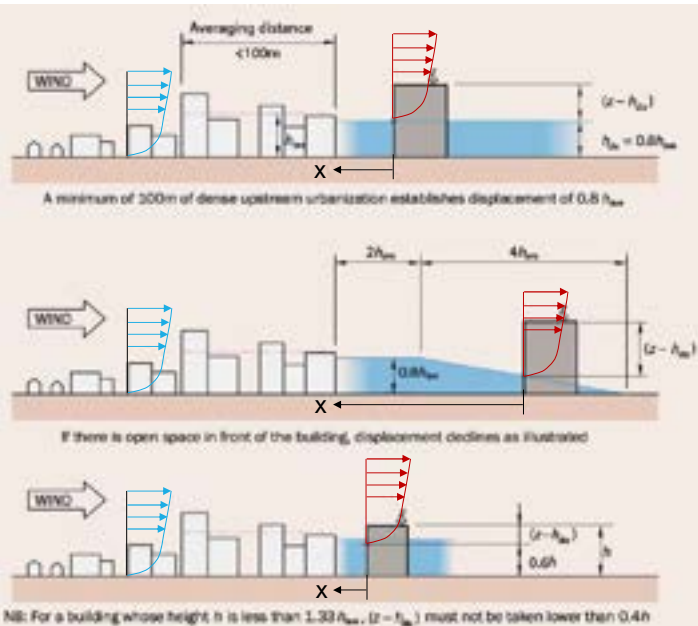
$$W_z = Q_z C_f S_{q,z} B$$

BS EN 1991-1-4



From *Wind actions to BS EN 1991-1-4*  
 Same approach in *BS6399*

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## 2. Along-Wind Forces

Sheltering Effect (HKWC 2019)



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Kai Tak, Hong Kong



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## 2. Along-Wind Forces

Sheltering Effect (HKWC 2019)  
Effective Height  $Z_e$

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

- Step 1: Calculate displacement height of each building

$$H_{d,i} = \min \left\{ \begin{array}{l} 0.8H_i \\ 1.2H_i - 0.2X_i, \text{ but } \geq 0 \\ 0.75H \end{array} \right.$$

- Step 2: Calculate displacement height of each sector

$$H_d = \frac{\sum H_{d,i} \alpha_{e,i}}{\sum \alpha_{e,i}}$$

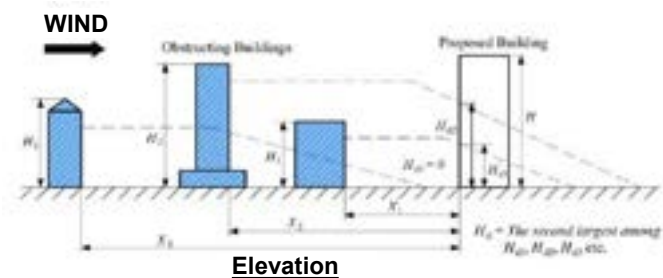
- Step 3: Calculate effective height of each sector

$$Z_e = \begin{cases} Z - H_d, & H_d / Z \leq 0.75 \\ 0.25 Z, & H_d / Z > 0.75 \end{cases}$$

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From HKWC 2019

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Note: Buildings in the same building lot shall be treated as a whole, when evaluating the direct sheltering effect for the determination of the most beneficial building(s) to be removed.

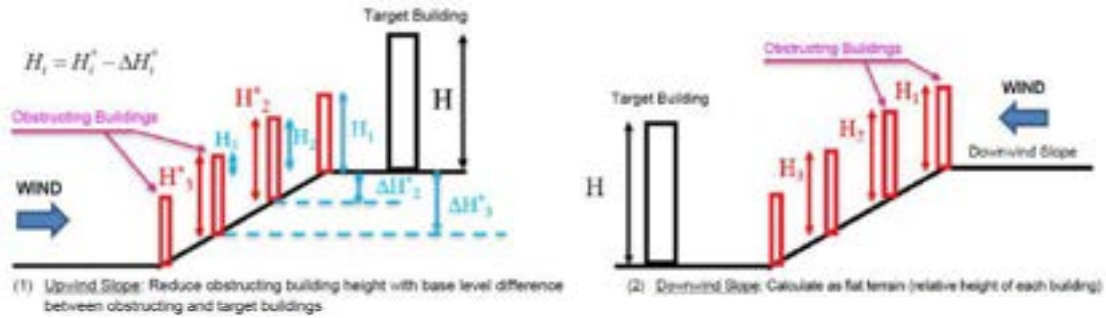
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## 2. Along-Wind Forces

Sheltering Effect (HKWC 2019)  
**Effective Height  $Z_e$**



**Reduce Height !**

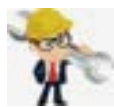
**NO Reduction !**

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## 2. Along-Wind Forces

Sheltering Effect (HKWC 2019)  
**Effective Height  $Z_e$**

An **algorithm** is developed by Nida Team to quickly determine the effective height.

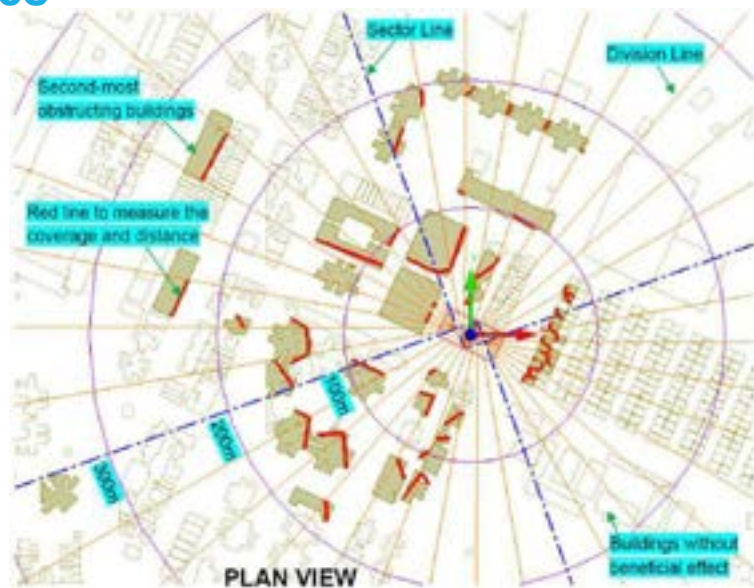


**7~14 Days**  
 Hand Calculation



**< 5 Seconds**  
 Nida Wind

- **Fast**
- **High accuracy**
- **No human error**



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## 2. Along-Wind Forces

### Size & Dynamic Factor $S_{q,z}$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta \quad (\text{Structural factor } c_s c_d - \text{EC1})$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

$$S_{q,z} = S_{q,h} - 1.2[S_{q,h} - (\frac{10}{H})^{0.14}](1 - \frac{Z}{H}) \quad N_x = 46 / H \quad (H < 100m)$$

$$S_{q,h} = 0.5 + \sqrt{(S_{s(L_{0.5p}=B)} - 0.5)^2 + \frac{0.25}{B^{0.5} H N_x^2 \xi_x}} \quad \text{--Modal analysis}$$

$X$  : Aligned with along-wind direction

$N_x$  = Fundamental frequency **Stiffness: [K]**  
**Mass: [M]**

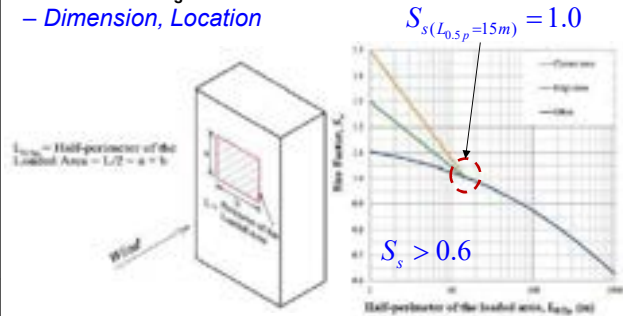
$\xi_x$  = Damping ratio

HKWC 2004

$$G = 1 + 2I_h \sqrt{g_v^2 B + g_f^2 SE} / \zeta > 1$$

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### Size Factor $S_s$ : – Dimension, Location



### Other zones and for Overall Wind Loads

$$S_{r=L_{0.5p}} = \text{Exp}(0.17 - 0.07 L_{0.5p}^{0.32}) \quad \text{Equation C1-1a}$$

### Edge zones if $L_{0.5p} < 15m$

$$S_{r=L_{0.5p}} = 1.3 - \log_e(L_{0.5p}) / 9.0 > 1.0 \quad \text{Equation C1-1b}$$

### Corner zones if $L_{0.5p} < 15m$

$$S_{r=L_{0.5p}} = 1.5 + \log_e(L_{0.5p}) / 5.4 > 1.0 \quad \text{Equation C1-1c}$$

$\log_e(\cdot)$  or  $\ln(\cdot)$  From HKWC 2019

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## 2. Along-Wind Forces

### Size & Dynamic Factor $S_{q,z}$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta \quad (\text{Structural factor } c_s c_d - \text{EC1})$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

$$S_{q,z} = S_{q,h} - 1.2[S_{q,h} - (\frac{10}{H})^{0.14}](1 - \frac{Z}{H}) \quad N_x = 46 / H \quad (H < 100m)$$

$$S_{q,h} = 0.5 + \sqrt{(S_{s(L_{0.5p}=B)} - 0.5)^2 + \frac{0.25}{B^{0.5} H N_x^2 \xi_x}} \quad \text{--Modal analysis}$$

$X$  : Aligned with along-wind direction

$N_x$  = Fundamental frequency **Stiffness: [K]**  
**Mass: [M]**

$\xi_x$  = Damping ratio

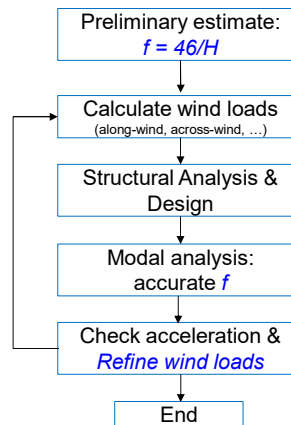
HKWC 2004

$$G = 1 + 2I_h \sqrt{g_v^2 B + g_f^2 SE} / \zeta > 1$$

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**Modal Analysis** is used to determine the dynamic properties of systems in the frequency domain.

$$|K_L + \omega^2 M| = 0 \rightarrow \begin{cases} \text{Period: } T = \frac{2\pi}{\omega} \\ \text{Frequency: } f = \frac{1}{T} = \frac{\sqrt{K/M}}{2\pi} \end{cases}$$



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## 2. Along-Wind Forces

### Force Coefficient $C_f$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

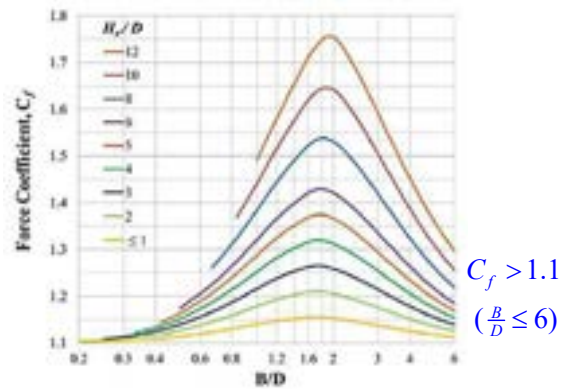
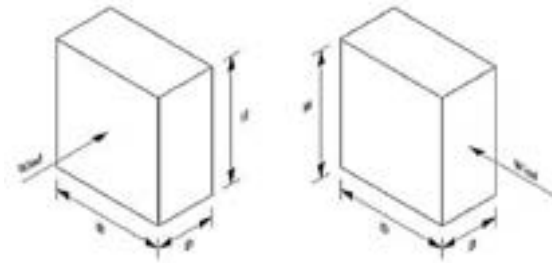
$$C_f = 1.1 + \frac{0.055 \frac{H_e}{D}}{\exp\left\{\left[\ln\left[\left(\frac{0.6B}{D}\right)\left(1 - 0.011 \frac{H_e}{D}\right)\right]\right]^{1.7 - 0.0013\left(\frac{H_e}{D}\right)^2}\right\}}$$

- $H_e$ : Effective building height
- $B$ : Breadth of building
- $D$ : Depth of building

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HKWC 2004: Table D1 & D2

$$C_f = C_h \times C_s$$



From HKWC 2019

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## 2. Along-Wind Forces

### Force Coefficient $C_f$ (HKWC 2019)

$$Q_z = Q_{o,z} S_t \times S_\theta$$

$$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$$

$$W_z = Q_z C_f S_{q,z} B$$

$$C_f = 1.1 + \frac{0.055 \frac{H_e}{D}}{\exp\left\{\left[\ln\left[\left(\frac{0.6B}{D}\right)\left(1 - 0.011 \frac{H_e}{D}\right)\right]\right]^{1.7 - 0.0013\left(\frac{H_e}{D}\right)^2}\right\}}$$

- $H_e$ : Effective building height
- $B$ : Breadth of building
- $D$ : Depth of building

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#### 4.2.2 Effect of Variation of Plan with Height

The force coefficient,  $C_f$ , at a particular height should be calculated using equation 4-1 by adopting local values for  $B$  and  $D$ , the effective building height,  $H_e$ , with  $H_e/D$  equals or less than 12. Steps in plan size affecting less than 10% of  $H$  should be ignored for calculating  $C_f$ . Pressures should be applied to the actual area.

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## Comparison Summary – HK Wind Code: 2019 vs. 2004



Item	HKWC (2019)	HKWC (2004)	Remarks
Wind Pressure ( $W_z$ )	<p>Static &amp; Dynamic:</p> $W_z = Q_z C_f S_{q,z} B$ $Q_z = Q_{o,z} S_t S_\theta$ $Q_{o,z} = 3.7(Z_e / 500)^{0.16}$ <p>➔ <math>W_z = Q_{o,z} S_t (S_\theta S_{q,z}) \times C_f B</math></p>	<p>Static: <math>W_z = q_z S_t \times C_f B</math>; (<math>S_t \leftarrow S_a</math>)</p> $q_z = \frac{1}{2} \rho V_z^2$ <p>Dynamic: <math>W_z = \bar{q}_z S_t G \times C_f B</math>;</p> $\bar{q}_z = \frac{1}{2} \rho \bar{V}_z^2$ $G = 1 + 2I_h \sqrt{g_v^2 B + g_f^2 S E / \zeta}$	/
Reference wind pressure (wind speed profile)	Same as HKWC(2004) ( $Q_{o,z}$ vs. $q_z$ )	Terrain roughness "A" Mean wind speed ( $v_g$ ) = 56.6 m/s	Terrain, wind climate, height
Topography factor ( $S_t$ )	Explicitly Included - <i>Equations changed</i>	Explicitly Included	Topography
Directional factor ( $S_\theta$ )	Explicitly Included (0.8 to 0.85)	<b>Not included</b>	Wind direction
Size factor ( $S_s$ )	Explicitly Included	Explicitly Included	Size of surface
Dynamic factor ( $S_{q,z}$ )	Explicitly Included (with size factor) - <i>Equations changed</i>	Explicitly Included	Dynamic effect
Force coefficient ( $C_f$ )	Explicitly Included - <i>Equations changed</i>	Explicitly Included	Aerodynamic shape

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### 3. Torsional Force

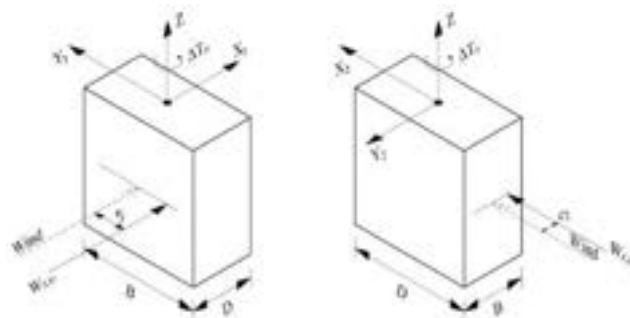
Torsion  $\Delta T_z$  (HKWC 2019)

$$\Delta T_z = \max \begin{cases} e_1 \cdot W_{z,x1} \\ e_2 \cdot W_{z,x2} \end{cases}$$

$W_{z,xi}$  = Along-wind force

$$e = \begin{cases} \pm 0.05B, & \frac{B}{D} \leq 1 \\ \pm 0.20B, & \frac{B}{D} = 6 \end{cases}$$

- $e$ : Offset from geometric centre
- $1 < B/D < 6$ : Linear interpolation
- $B/D > 6$ : Wind tunnel test required



From [HKWC 2019](#)

Generally, tall buildings and slender structures are sensitive to torsional wind.

Check torsional regularity – similar to seismic design.

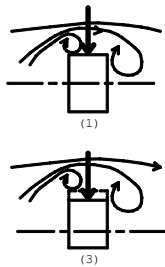
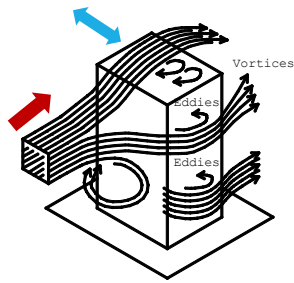
34

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## 4. Across-Wind Base Moment

### Across-Wind

Due to **Vortex Shedding** – Building is displaced, first on one side then on another, thus leading to transverse vibration of the building.



Cross-wind responses are in general very sensitive both to surroundings and to building form. The main source of energy is self-generated vortex shedding.

<https://www.youtube.com/watch?v=rlpUhgfeZPU>

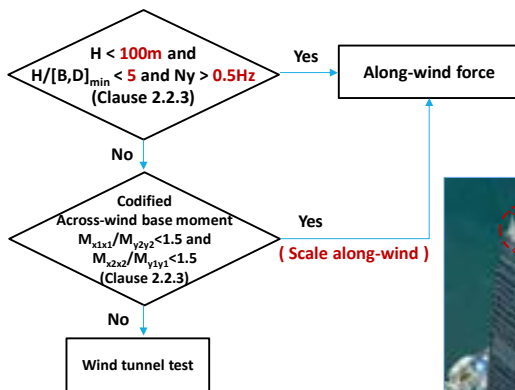
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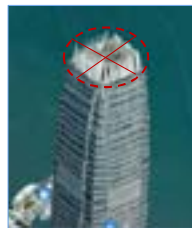
35

## 4. Across-Wind Base Moment

Across-wind base moment at ground level : [HKWC 2019](#)



$$M_{xx,base} = \pm \frac{G_{ry}}{\gamma_w \xi_y^{0.5}} \frac{\rho_a}{N_y^{1.3} (BD)_b^{0.15}} \left( \frac{0.215 \sqrt{2} \gamma_w Q_h / \rho_a}{1 + 3.7 I_{v,h}} \right)^{3.3} \frac{H_b^2}{3}$$



- $G_{ry}$  peak factor on standard deviation of across-wind resonant response in one hour  $= \sqrt{2 \log_e(1800 N_y)}$
- $\gamma_w$  ultimate wind load factor, taken as 1.4
- $\xi_y$  ratio of damping to critical damping in across-wind direction of vibration in Appendix C2
- $\rho_a$  mass density of air, taken as  $1.2 \times 10^{-3} \text{ T/m}^3$
- $N_y$  fundamental frequency for mode mainly aligned with the across-wind direction
- $(BD)_b$  the average plan area of the enclosing rectangle over the top third of the building
- $Q_h$  wind reference pressure,  $Q_h$ , at effective building height,  $H_e$
- $I_{v,h}$  wind turbulence intensity at building height,  $H$ , may be taken as  $I_{v,h}$  in Equation 3-3 or 3-4, from wind tunnel testing, or be calculated by the method of the Engineering Sciences Data Unit (ESDU)
- $H_b$  height of building structure above ground level, but excluding the height of irregular roof features above main roof

The height,  $H_b$ , used for calculation of building accelerations and across-wind base moments may be similarly defined above ground level but is intended to exclude, e.g. sloping roofs and irregular roof plant, forming a small part of the total height and which do not continue the prismatic form of the building below. This relates to the aerodynamic behaviour associated with dynamic across-wind forces, which is strong for prismatic forms but weakens greatly for non-prismatic forms.

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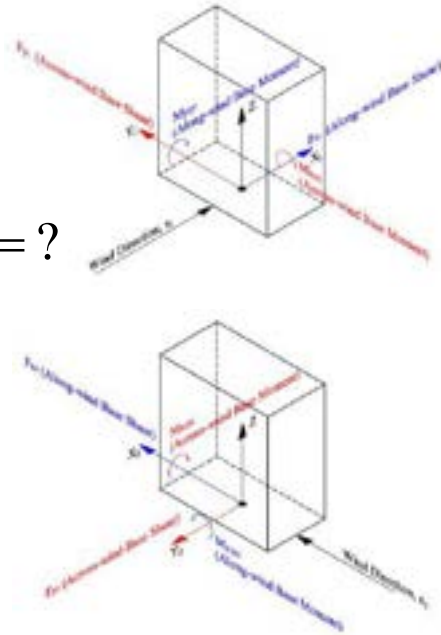
18

## 4. Across-Wind Base Moment

Increase along-wind force

$$\left\{ \begin{aligned} f_1 &= \frac{\max(M_{-x1x1}, M_{+x1x1})}{|M_{-y2y2}|} > 1 \Rightarrow W_{z,-x2} \times \max(f_1, f_2) \\ f_2 &= \frac{\max(M_{-x1x1}, M_{+x1x1})}{|M_{+y2y2}|} > 1 \Rightarrow W_{z,+x2} \times \max(f_1, f_2) \\ f_3 &= \frac{\max(M_{-x2x2}, M_{+x2x2})}{|M_{-y1y1}|} > 1 \Rightarrow W_{z,-x1} \times \max(f_3, f_4) \\ f_4 &= \frac{\max(M_{-x2x2}, M_{+x2x2})}{|M_{+y1y1}|} > 1 \Rightarrow W_{z,+x1} \times \max(f_3, f_4) \end{aligned} \right.$$

$$\frac{M_{\text{across}}}{M_{\text{along}}} = ?$$



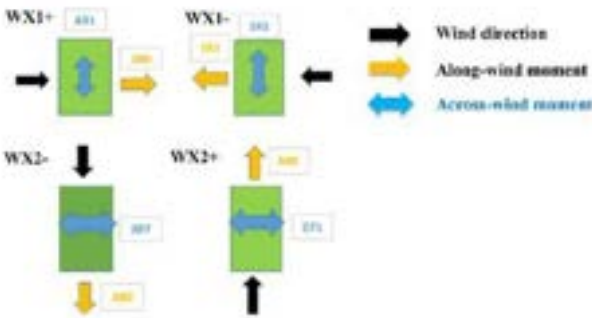
$$\left. \begin{aligned} &\frac{\max(M_{-x1x1}, M_{+x1x1})}{\max(|M_{-y2y2}|, |M_{+y2y2}|)} > 1.5 \\ &\text{or} \\ &\frac{\max(M_{-x2x2}, M_{+x2x2})}{\max(|M_{-y1y1}|, |M_{+y1y1}|)} > 1.5 \end{aligned} \right\} \Rightarrow \text{Wind Tunnel Test}$$

## 4. Across-Wind Base Moment

Worked Example (HKWC 2019)

(1) Provided base moments:

- (a) WX1+: along, 190; across, 431
- (b) WX1-: along, 161; across, 141
- (c) WX2+: along, 340; across, 271
- (d) WX2-: along, 280; across, 207



$$\left. \begin{aligned} &\frac{\max(M_{-x1x1}, M_{+x1x1})}{\max(|M_{-y2y2}|, |M_{+y2y2}|)} > 1.5 \\ &\text{or} \\ &\frac{\max(M_{-x2x2}, M_{+x2x2})}{\max(|M_{-y1y1}|, |M_{+y1y1}|)} > 1.5 \end{aligned} \right\} \Rightarrow \text{Wind Tunnel Test}$$

(2) Check base moments:

Then the following is to be checked whether wind tunnel test is needed:

- (a) WX1:  $(207, 271)_{\text{base}} / (190, 161)_{\text{base}} = 271 / 190 = 1.43 < 1.5$
- (b) WX2:  $(431, 141)_{\text{base}} / (280, 340)_{\text{base}} = 431 / 340 = 1.27 < 1.5$

For both directions, which the across-wind moment is not 50% greater than the along-wind moment; therefore, the Standard Method applies.

Then the following is to be calculated for scaling up the along-wind forces in the corresponding directions:

- (a) WX1+:  $(207, 271)_{\text{base}} / 190 - 271 / 190 = 1.43$
- (b) WX1-:  $(207, 271)_{\text{base}} / 161 - 271 / 161 = 1.68$
- (c) WX2+:  $(431, 141)_{\text{base}} / 340 = 431 / 340 = 1.27$
- (d) WX2-:  $(431, 141)_{\text{base}} / 280 - 431 / 280 = 1.54$

Code of Practice on Wind Effects in Hong Kong 2019  
Buildings Department, HKSAR, China

## 5. Wind Combinations

**Table 2-1** Load combination factors for buildings that may be treated as rectangular

Case	$W_{s,e1}$ = $\text{Min}(W_{s,e1}, W_{s,-e1})$	$W_{s,e2}$ = $\text{Min}(W_{s,e2}, W_{s,-e2})$	$dT_e$
1	$\pm 1.00$	$\pm 0.55$	$\pm 0.55$
2	$\pm 0.55$	$\pm 1.00$	$\pm 0.55$
3	$\pm 0.55$	$\pm 0.55$	$\pm 1.00$

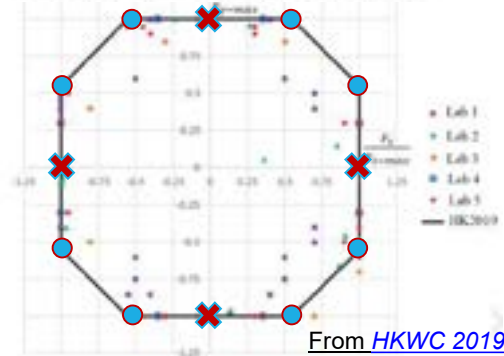
- **With torsional force**  
Number of combinations = 24
- **Without torsional force**  
Number of combinations = 8

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Ignore torsional load case:



- buildings of single storey up to 10m height;
- buildings of up to 70 m height with a peripheral lateral load resisting construction;
- buildings which pass the torsional regularity check. The check is that in each lateral direction  $X_1$  and  $X_2$  in turn, the maximum inter-storey drift in each storey due to the torsion load must be less than 25% of that due to the lateral load (for buildings with a vertically continuous lateral and torsional resisting structure, this check may be made only at the base and at higher storeys where the resisting capacity reduces by more than 25% when compared with nearby storeys); or
- where the torsional inter-storey drift calculated above are not greater than 50% of the lateral drift, the Case 3 in Table 2-1 (primarily torsion) loadcases do not need to be calculated.



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## 6. Min. Loads for Temporary Structures



**Temporary buildings** and associated constructions – 70%

- Not for residency
- Period remained in position  $\leq$  One year

**Hoarding & covered walkway** associated with construction site, contractor shed, bamboo shed, tent or marquee –  $Q_z = 37\% Q_{0,z}$

- Not for residential use
- No other adjustment factor  $S_t S_\theta = 1$

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# 7. Wind Acceleration

## Peak acceleration (HKWC 2019)

$$A_z = \frac{G_{ry}}{\xi_y^{0.5} N_y^{1.3} (BD)_b^{0.15}} \left( \frac{0.215 \sqrt{2S_r Q_h / \rho_a}}{1 + 3.7I_{v,h}} \right)^{3.3} \frac{H_b}{3M_h} \frac{2 + \eta_y}{3} \left( \frac{Z}{H_b} \right)^{\eta_y}$$

### (1) Wind

- $G_{ry}$  peak factor on standard deviation of resonant response in one hour =  $\sqrt{2 \text{Log}_{10}(1800 N_y)}$
- $S_r$  factor on wind pressure for different return period in Appendix A1
- $Q_h$  wind reference pressure,  $Q_z$ , at effective building height,  $H_e$
- $\rho_a$  mass density of air, taken as  $1.2 \times 10^{-3} \text{ T/m}^3$
- $I_{v,h}$  wind turbulence intensity at building height,  $H$ , may be taken as  $I_{v,h}$  in Equation 3-3 or 3-4, from wind tunnel testing, or as calculated by the ESDU method

$M_h$  mass of the building above  $2H_b/3$ . 25% of imposed loads can be added with the dead loads together as the mass source for  $M_h$ . For E&M room, either still follow the rule or use the actual imposed loads together with dead loads for  $M_h$ .

### (2) Structure

- $(BD)_b$  is the plan area of the enclosing rectangle, averaged over the top third of the building, excluding upper level cut-backs. If  $(BD)_b > H^2/9$ , take  $(BD)_b = H^2/9$ .
- $H_b$  height of building structure above ground level, but excluding the height of irregular roof features above main roof
- $\zeta_y$  ratio of damping to critical damping in across-wind direction of vibration in Appendix C2
- $N_y$  fundamental frequency for mode mainly aligned with the across-wind direction
- $M_h$  mass of the building above  $2H_b/3$
- $\eta_y$  parameter used to describe the approximate mode deflection variation with height. Where this is not obtained by comparison with a modal analysis, it may be assumed to be 1.5 for calculation of accelerations within the top quarter height of a building.



# 7. Wind Acceleration

## Peak acceleration (HKWC 2019)

$$A_z = \frac{G_{ry}}{\xi_y^{0.5} N_y^{1.3} (BD)_b^{0.15}} \left( \frac{0.215 \sqrt{2S_r Q_h / \rho_a}}{1 + 3.7I_{v,h}} \right)^{3.3} \frac{H_b}{3M_h} \frac{2 + \eta_y}{3} \left( \frac{Z}{H_b} \right)^{\eta_y}$$

### (1) Wind

- $G_{ry}$  peak factor on standard deviation of resonant response in one hour =  $\sqrt{2 \text{Log}_{10}(1800 N_y)}$
- $S_r$  factor on wind pressure for different return period in Appendix A1
- $Q_h$  wind reference pressure,  $Q_z$ , at effective building height,  $H_e$
- $\rho_a$  mass density of air, taken as  $1.2 \times 10^{-3} \text{ T/m}^3$
- $I_{v,h}$  wind turbulence intensity at building height,  $H$ , may be taken as  $I_{v,h}$  in Equation 3-3 or 3-4, from wind tunnel testing, or as calculated by the ESDU method

$\eta_y$  mode deflection variation with height in the across-wind direction =  $(Z/H)^{\eta_y}$ . This is typically in the range 1.0-2.0 for buildings, determined by comparison with modal analysis.

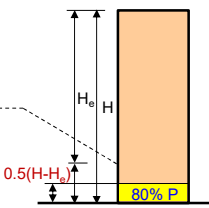
### (2) Structure

- $(BD)_b$  is the plan area of the enclosing rectangle, averaged over the top third of the building, excluding upper level cut-backs. If  $(BD)_b > H^2/9$ , take  $(BD)_b = H^2/9$ .
- $H_b$  height of building structure above ground level, but excluding the height of irregular roof features above main roof
- $\zeta_y$  ratio of damping to critical damping in across-wind direction of vibration in Appendix C2
- $N_y$  fundamental frequency for mode mainly aligned with the across-wind direction
- $M_h$  mass of the building above  $2H_b/3$
- $\eta_y$  parameter used to describe the approximate mode deflection variation with height. Where this is not obtained by comparison with a modal analysis, it may be assumed to be 1.5 for calculation of accelerations within the top quarter height of a building.



## 8. Wind Action on Building Elements

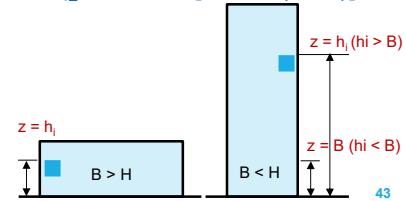
Building Design (HKWC2019)	Element Design (HKWC2019)	Element Design (HKWC2004)
$Q_z = Q_{o,z} S_t \times S_s$	$Q_z = Q_{o,z} S_t \times S_\theta$	$Q_z = q_z S_t \quad (S_t \leftarrow S_a)$
$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$	$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$	$(q_z = Q_{o,z})$
$P_z = Q_z C_p S_{q,z}$	$P = Q_z C_p S_s \rightarrow Q_h C_p S_s$	$P_z = Q_z C_p$



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- Wind reference pressure – sheltering, topography, wind direction;
- Wind pressure is normally determined by building height;
- Net pressure on solid surface;
- $P = P_e - P_i$  for surface with openings;
- $S_s$  may be larger than 1.0;
- Cladding pressure can be reduced by 20%, below a height of  $0.5(H - H_e)$  ;

- Net pressure on solid surface;
- No size factor included;
- $q_z : z = \max[hi, \min(B, H)]$

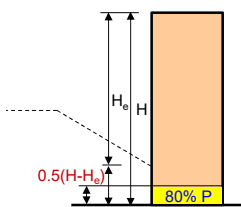


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## 8. Wind Action on Building Elements

Element Design (HKWC2019)
$Q_z = Q_{o,z} S_t \times S_\theta$
$Q_{o,z} = 3.7(Z_e / 500)^{0.16}$
$P = Q_z C_p S_s \rightarrow Q_h C_p S_s$

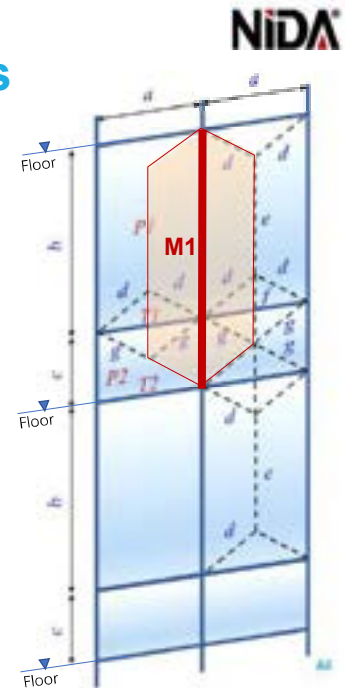
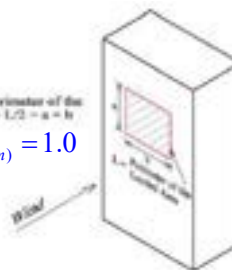


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Size Factor,  $S_s$

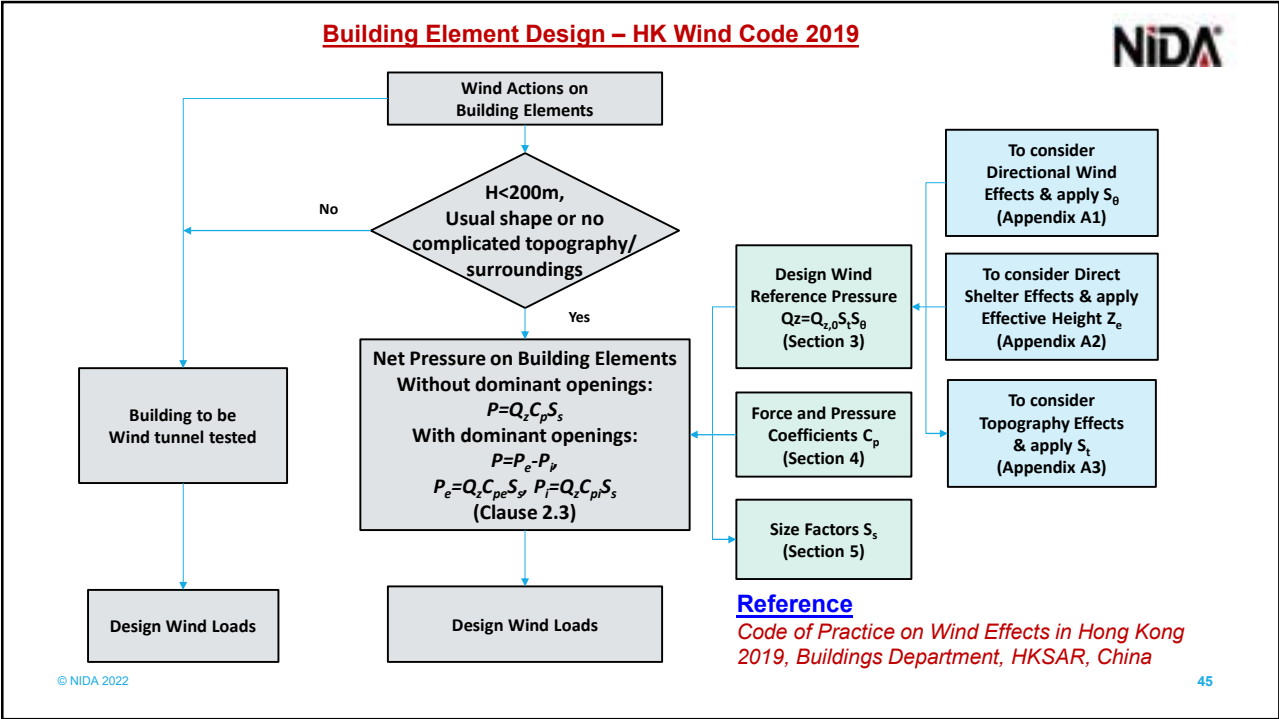
Element	Half-perimeter, $L_{0.5p}$
Mullion M1	$(2d+2e+2f+2g)/2$

$L_{0.5p}$  = Half-perimeter of the Limited Area =  $L/2 = a + b$   
 $S_s(L_{0.5p}=15m) = 1.0$



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## 9. Wind Tunnel Test

**Minimum adopted wind loads from a test**

**Minimum Loads in Sheltered Locations**

Where particular adjoining or surrounding buildings could provide significant shelter (determined in Appendix A2 as the buildings that provide most shelter in each wind direction), the effect on overall building loads due to their possible removal should also be considered.

New buildings should resist a minimum of 80% of the load of the Standard Method. This limitation can be relaxed to 70% of the along-wind load of the Standard Method, if additional wind tunnel testing is conducted with significant sheltering obstructions removed (in a Removal Testing Configuration) and the adopted wind loads are not lower than 80% of the additional testing results.

The principle for removal of sheltering obstruction is that the building / building lot that provides the most significant sheltering (i.e. the most beneficial building) in each wind direction should be considered for removal. The procedure for determining the most significant sheltering obstruction is provided in Appendix A2.

New buildings beyond the scope of the Code should resist a minimum of 80% of the load obtained from the Removal Testing Configuration. The adopted wind loads should not be lower than 70% of the along-wind load of the Standard Method.

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John D. Holmes (2001), Wind Loading of Structures

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## 10. Limitation of Standard Method

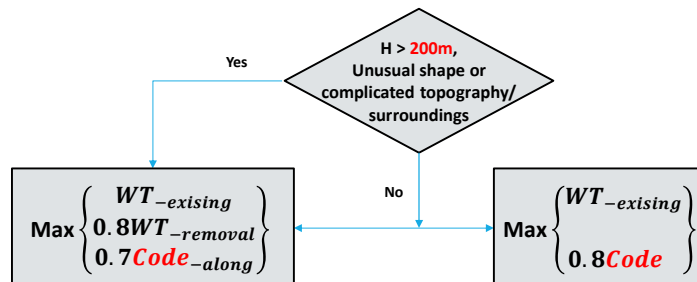
The Standard Method is applicable to typical buildings with a height up to 200m. The wind tunnel testing method should be used for any of the following conditions:

- (a) buildings of height exceeding 200m;
- (b) buildings having an unusual shape not covered by this Code;
- (c) buildings in locations where complicated local topography or surroundings adversely affect the wind conditions;
- (d) buildings with codified across-wind moment substantially larger than the along-wind moment as detailed in clause 2.2.3;  $\frac{M_{across}}{M_{along}} > 1.5$   
or
- (e) buildings with B/D > 6, except for those satisfying the conditions in clause 2.2.4 so that the torsional load cases can be neglected.

Wind  
Tunnel  
Test

## 10. Limitation of Standard Method

Minimum adopted wind loads from a test



**Even Wind Tunnel Test method is adopted,  
the Standard Method is still needed to  
check the minimum wind loads from test !**

# 11. Computing Wind Engineering

## Computing Wind Engineering (CWE) – Numerical Wind Tunnel

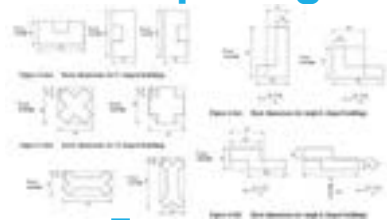
Based on Computational Fluid Dynamics (CFD)

	Physical Wind Tunnel Test	Numerical Wind Tunnel Test (CFD)
Time	Long (months)	Fast (days)
Cost	High	Low
Resolution	Poor (few sample points)	High (high sampling and mapping of results)
Accuracy	Moderate/High	Moderate/High
Reporting	Abstract	Direct/relatable
Turbulence	High resolution	Moderate/abstract resolution
Regulation	High acceptance	Growing acceptance (i.e. Eurocodes now permit CFD for Structural Load Calculations)

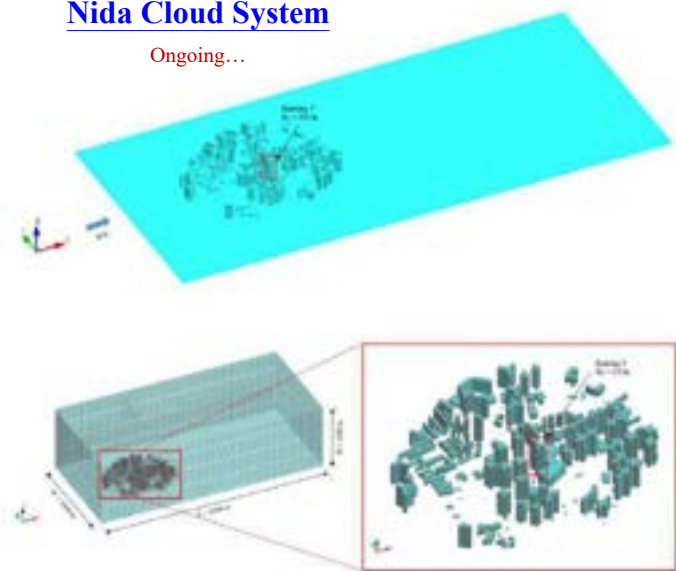
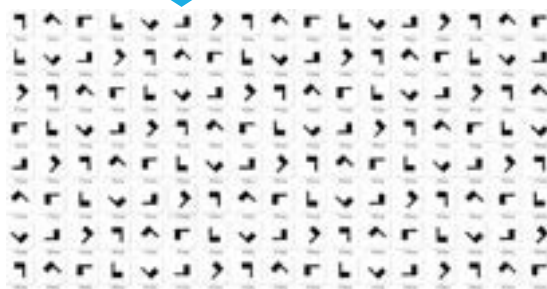
# 11. Computing Wind Engineering

## Nida Cloud System

Ongoing...



Identification of Building Shapes and Dimensions by Deep Learning



## 12. Worked Example

The first openly available program complied with New Wind Code 2019 to save time of engineers and to improve productivity of engineers in Hong Kong.

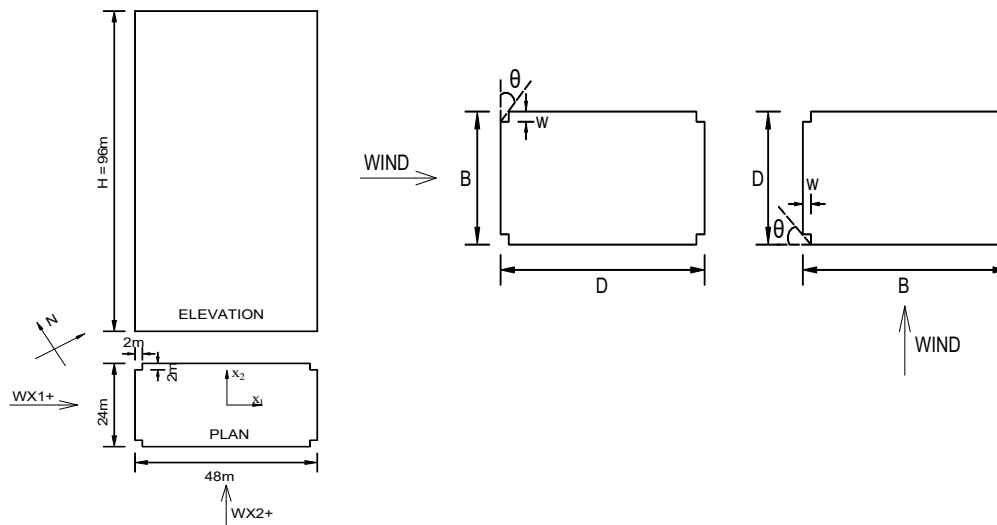
- Step 1: Define Target Building
- Step 2: Define Floor Information
- Step 3: Import Surroundings
- Step 4: Input Parameters to HKWC
- Step 5: Calculate Results
- Step 6: Export Results



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## 12. Worked Example

- A Tall Building (96 m Height, B & D constant along height)



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## 12. Worked Example

### • A Tall Building (96 m Height)

Building Plan: B = 24.000 m  
 Building Plan: D = 48.000 m  
 Building Height: H = 96.000 m < 200 m  
 Building Type: Offices ; RC Building  
 Unusual Shape : NO  
 Complicated Topography/Surroundings : NO

Frequency along WX1+/-:  $Nx1 = 0.600$  Hz  
 Frequency along WX2+/-:  $Nx2 = 0.510$  Hz

Aspect Ratio (Wx1), H / D = 2.00

Aspect Ratio (Wx2), H / B = 4.00

Damping Ratio (Structural Loads):  $\xi_{x1} = 0.030, \xi_{x2} = 0.030$

Damping Ratio (Acceleration):  $\xi_{x1} = 0.020, \xi_{x2} = 0.020$

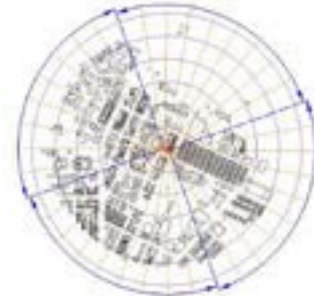
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Directional Wind Effects: S $\theta$



Wind | S $\theta$ (Dir. Factor) | Direction

Wind	S $\theta$ (Dir. Factor)	Direction
WX1+	0.820	NW, W
WX1-	0.850	E, SE
WX2+	0.850	SW, S, W
WX2-	0.850	N, NE, E



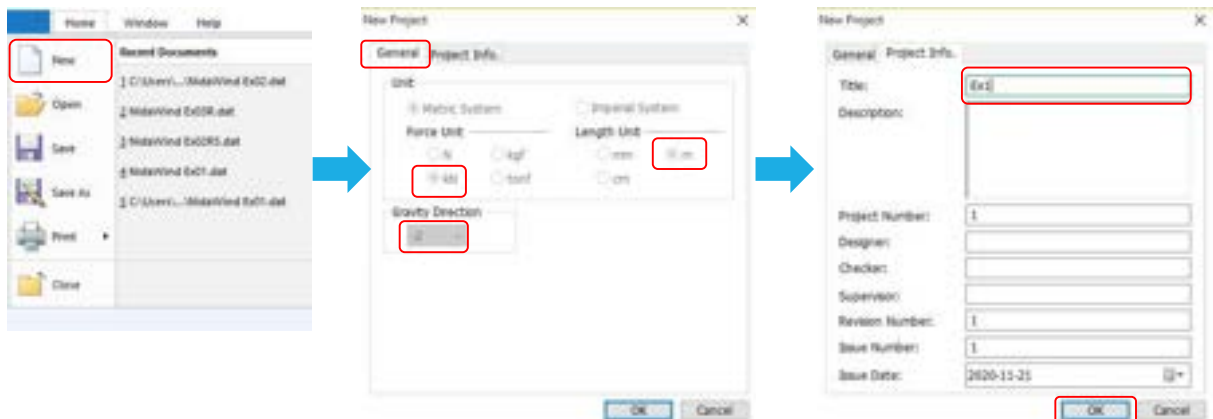
Obtained from modal analysis

Nida Wind can automatically calculate these based on TableC2-1/2 from HKWC 2019

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## Step 1: Define Target Building

### • Create a Model in Program "NIDA Wind"



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# Step1: Define Target Building

- Operations in Nida Wind

1

2

3

Input 3 setting-out points to match NIDA model and the Map

Note: In practical project, the coordinates in HK1980 can be found in the GBP drawing.

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Point	X (m)	Y (m)
1	-22.5	-15
2	22.5	-15
3	22.5	15

Point	X (Northing, m)	Y (Easting, m)
1	827710	820330
2	827620	820325
3	827610	820320

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# Step2: Define Floor Information

- Add Story

1

2

3 Set story name

Note: Only the wind pressure & forces at the story level will be calculated in the program.

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Name	Height (m)	Elevation (m)	Finisht Height (m)
20F	3.300	86.800	0.000
19F	3.300	83.500	0.000
18F	3.300	80.200	0.000
17F	3.300	76.900	0.000
16F	3.300	73.600	0.000
15F	3.300	70.300	0.000
14F	3.300	67.000	0.000
13F	3.300	63.700	0.000
12F	3.300	60.400	0.000
11F	3.300	57.100	0.000
10F	3.300	53.800	0.000
9F	3.300	50.500	0.000
8F	3.300	47.200	0.000
7F	3.300	43.900	0.000
6F	3.300	40.600	0.000

Prefix of Story Name:	Suffix of Story Name:	Number Format:	Number Start at:	Skip number 4, 13, 14, 24, 24, 44 ...
1	F	1, 2, 3, ...	1	<input checked="" type="checkbox"/>

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56

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## NIDA

# Step 3: Import Surroundings

- Import Obstructing Buildings – Direct Shelter Effect

① Import obstructing buildings

② Show buildings (RED building is the target.)

③ Import obstructing buildings

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## NIDA

# Step 4: Input Required Parameters

- Add Wind Function – HKWC2019

No.	Sector	Description	Local Plan
1	WS1+	Wind from Local +R to -R	---
2	WS2	Wind from Local -R to +R	---
3	WS2+	Wind from Local +R to -R	---
4	WS2-	Wind from Local -R to +R	---

① Define local plan of each story for variation of plan with height.

② Effective height is calculated by considering surrounding buildings

③

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## Step 4: Input Required Parameters

- Add Wind Function – HKWC2019

1: HKWC 2019 selection in the top right toolbar.

2: Directionality Factor table with values 0.82, 0.85, 0.85, 0.85 and remarks RW,W, E,SE, SW,S,W, N,W,E.

3: Force Coefficient table with values 0, 0, 0, 0.

4: Size Factor table with values 0, 0, 0, 0.

• Input the parameters to determine the topography factor, directionality factor, force coefficient, size factor, etc.

• Note: Generally, if the factor is greater than zero, it will be used directly; otherwise, put it as 0 and input the parameters to calculate the factor.

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## Step 4: Input Required Parameters

- Add Wind Function – HKWC2019

1: HKWC 2019 selection in the top right toolbar.

2:  Consider Torsional Forces

3: Ultimate Wind Load Factor (yW): 1.4

4: Mass above 27M/3 (M3): 400

• Tick here to activate torsional effect

• Across-wind effect

• Check across-wind acceleration

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## Step 4: Input Required Parameters

- Add Wind Function – HKWC2019

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No.	Mark	Sector	Level Z (m)	Cp	Zone	L0.5p (m)
1	Panel A1-	Ortial	96	-1.4	Edge	7
2	Panel A2-	Ortial	96	-1.4	Edge	4
3	Panel B1-	Ortial	96	-1	Other	7
4	Panel B2-	Ortial	96	-1	Other	4
5	Panel A1+	Ortial	96	1.3	Edge	7
6	Panel A2+	Ortial	96	1.3	Edge	4
7	Panel B1+	Ortial	96	1.1	Other	7
8	Panel B2+	Ortial	96	1.1	Other	4
9	Panel A3-	Ortial	5	-1.4	Edge	7
10	Panel A4-	Ortial	5	-1.4	Edge	4
11	Panel B3-	Ortial	5	-1	Other	7
12	Panel B4-	Ortial	5	-1	Other	4
13	Panel A3+	Ortial	5	1.3	Edge	7
14	Panel A4+	Ortial	5	1.3	Edge	4
15	Panel B3+	Ortial	5	1.1	Other	7
16	Panel B4+	Ortial	5	1.1	Other	4
17	Panel C1-	Ortial	96	-2.2	Corner	7
18	Panel C2-	Ortial	96	-2.2	Corner	4
19	Panel C1+	Ortial	96	-1.8	Edge	7

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## Step 5: Calculate Results

- Show Report & Results

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Level (m)	Pressure (kPa)
96	2.196
92.5	2.179
89	2.158
85.5	2.137
82	2.118
78.5	2.099
75	2.087
71.5	2.066
68	2.045
64.5	2.024
61	2.003
57.5	1.982
54	1.961
50.5	1.940
47	1.919
43.5	1.898
40	1.877
36.5	1.856
33	1.835
29.5	1.814
26	1.793
22.5	1.772
19	1.751
15.5	1.730

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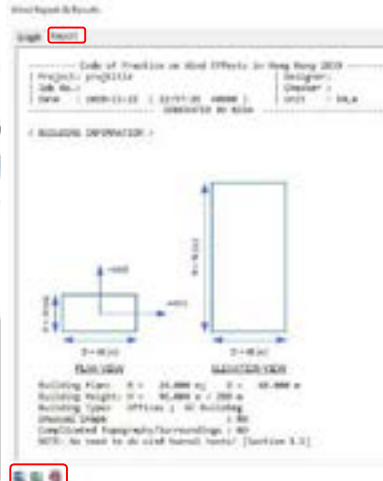
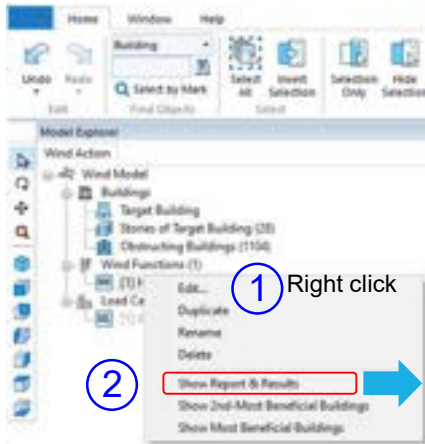
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# Step 6: Export Results

## Design Report

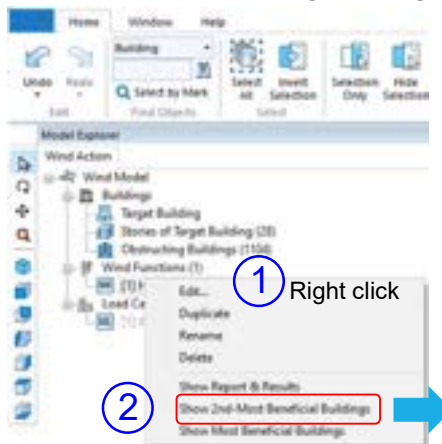
- Show Report & Results



- Export results

# Step 6: Export Results

- Show Valid Obstructing Buildings



## Step 6: Export Results

- Export Wind Loads

The wind loads will be applied to each story.

3

Export wind loads to structural analysis software such as NIDA and ETABS.

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