BUILDING BALANCED SUSTAINABILITY

From Multi-Storey to High-Rise building

- - - -9 Control Indicators

For Accurate Concrete Structural Design Results

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Content

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0. Introduction

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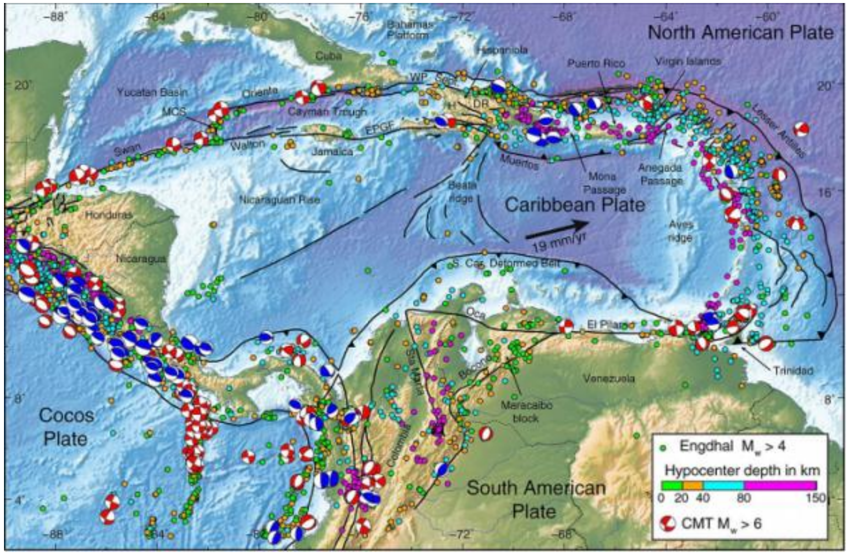

Fig. 1 Seismic map of Caribbean area

Fig. 2 Hurricane map of Caribbean area

Inaccurately designed building structure

Characteristics of High-Rise building structures

Compared with multi-storey building structures, the difficulty in the design of high-rise structures lies in the **reasonable arrangement** of **vertical lateral resistance components** (columns, shear walls, etc.), which are mainly manifested in:

structure type Considerate point	Multi-storey building structure	High-Rise building structure
Dominant load	vertical loads	lateral loads
Form of failure	strength	stiffness & strength
Design method	manual or software	Professional software
Details	normal	complicated

Tablet 1 Summary of control indicators of building structure

structure / type Calculated indicators	multi-storey building structure	High-Rise building tructure
Unit floor area weight	√	√
Axial compression ratio	√	√
Storey drift ratio	√	√
Displacement ratio		√
Period ratio		√
Stiffness ratio		√
Shear capacity ration	√	√
Shear to weight ratio	√	√
Stiffness to weight ratio		√

Note: √ means need check and confirm indicators

1.Unit floor area weight and storey mass ratio
单位重度及质量比

Difinition & Requirments

The unit floor area weight refers to the ratio of the total weight to the total building area of whole building under the load case of the factor is 1.0 (Dead load)+0.5(Live load)and no load reduction is performed.

$$Rms = \frac{\sum_{i=1}^{n} Gi}{\sum_{i=1}^{n} Ai}$$

Where Rms----unit floor area weight

Gi----the total gravity representative value of the level i

Ai----the total building area of the level i

Table 2 Mass per unit area of civil building floors under different structural forms

Structure type	Unit floor area weight, Kn/ m2	Remark
Frame structure frame-shear wall structure	13～15	The live load part is about 2Kn/m2~ 3kn/m2 , which only accounts for 15% ~ 20% of the dead load, and the unfavorable distribution of live load has little influence
Shear wall structure Tube structure	15～17	

According to statistics, for a specific structural form, the ratio is usually within a stable range, which can be used to check if **the input gravity load is correct**, and the correct input gravity load representative value is **the basis** for calculating the **earthquake action** and **other indecators**.

Function

For high-rise building structures, the mass of the floors should be **evenly distributed** along the height, and the mass of the floors should not be greater than **1.5 times** the mass of the adjacent lower floors. If it is not satisfied, vertical irregularities are likely to occur.

There are similar rules in Table 12.3-2 of ASCE7-10.

2.	**Weight (Mass) Irregularity:** Weight (mass) irregularity is defined to exist where the effective mass of any story is more than 150% of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.	Table 12.6-1	D, E, and F

Fig. 3 Weight(Mass) irregularity from ASCE 7-10

2. Axial compression ratio 轴压比

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Difinition & Requirments

The axial compression ratio of column is defined as the ratio of the design value of the combined axial pressure of the column considering the earthquake action to the design value of the concrete compressive strength to the total cross-sectional area of the vertical member,

$$\lambda = \frac{N}{fc * Ac}$$

Where:

λ-----axial pressure ratio

N-----the design value of the total combined axial pressure by the vertical member

fc ---- design value of concrete compressive strength

Ac ---- the total cross-sectional area of the column

Function

The control of the axial compression ratio of vertical members is extremely important in the structural design of high-rise buildings, mainly for the following reasons:

- The axial compression ratio is the main basis for **estimating the column size**
- Requirements for seismic ductility.

Earthquake damage investigations and experimental studies have shown that components with lower axial compression ratio have better ductility, and vice versa, the ductility is poorer

- Requirements for structural safety.

If the vertical member meets the requirements of the axial compression ratio limit, its normal section (axial compression, small eccentric compression) generally does not need to calculate the reinforcement, and the actual longitudinal reinforcement of the vertical member of the column and wall need meet **the minimum reinforcement** ratio of different seismic rating structure, then leaves a good room for structural safety.

- When the axial compression ratio index is not satisfied, the **wall and column section** can be increased or the **concrete strength grade** can be increased.

Table 3 Limits of column axial pressure ratio

structure type	Seismic rating			
	level 1	level 2	level 3	level 4
Frame structure	0.65	0.75	0.85	—
Slab column-shear wall, frame-shear wall,Frame-core shell, tube-in-tube structure	0.75	0.85	0.90	0.95
Partial frame-supported shear wall structure	0.60	0.70	—	

There is no similar concept of column axial pressure ratio in ASCE code.

3. Storey drift ratio 层间位移角

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Difinition & Requirments

The storey drift ratio is an indicator used to control **the macroscopic rigidity**（宏观刚度） of high-rise building. High-rise building structures must have a certain degree of rigidity to **avoid cracking of concrete wall or columns**. In the work condition of calculation by **elastic method**, the ratio could be calculated by following equation, and the influence of accidental eccentricity can not be considered in the calculation.

$$\theta i = \frac{\Delta \mu i}{hi}$$

Where:

θi ----- level i storey drift ratio

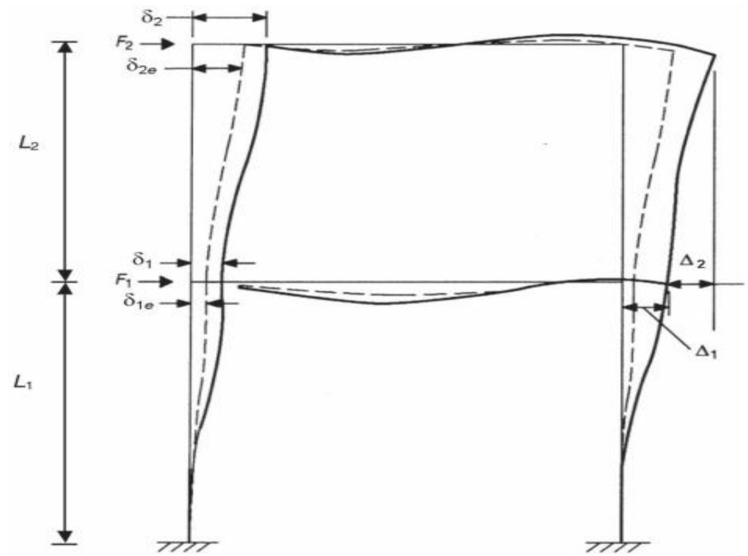
$\Delta\mu$ ----The maximum horizontal displacement of the level i is calculated according to the elastic method in frequent earthquakes or wind loads

h ------Height of the level i

Table 4 Limits for the ratio of maximum displacement between floors to story height

Structural system	Max △ μ / h
Frame	1/550
Frame - Shear Wall Frame Core TubeSlab Column - Shear Wall	1/800
Tube in tube	1/1000
Transfer layer except frame structure	1/1000

When storey drift ratio does not meet the specification requirements, it can be adjusted by increasing the number of walls, adjusting the length of the walls or adjusting the thickness of the walls.



Note: Δ_i = story drift; Δ_i / L_i = story drift ratio; δ_x = total displacement; i = level under consideration.

Story Level 1: F_1 = strength-level design earthquake force; δ_{1e} = elastic displacement computed under strength-level design earthquake forces; $\delta_1 = C_d \delta_{1e} / I_E$ = amplified displacement; $\Delta_1 = \delta_1 \leq \Delta_a$ (Table 12.12-1).

Story Level 2: F_2 = strength-level design earthquake force; δ_{2e} = elastic displacement computed under strength-level design earthquake forces; $\delta_2 = C_d \delta_{2e} / I_E$ = amplified displacement; $\Delta_2 = C_d(\delta_{2e} - \delta_{1e}) / I_E \leq \Delta_a$ (Table 12.12-1).

Figure 12.8-2. Story drift determination.

Fig. 4 Storey drift determination from ASCE 7-10

Table 12.12-1. Allowable Story Drift, Δ_a.

Structure	Risk Category		
	I or II	III	IV
Structures, other than masonry shear wall structures, four stories or less above the base as defined in Section 11.2, with interior walls, partitions, and ceilings that have been designed to accommodate the drifts associated with the Design Earthquake Displacements	$0.025h_{sx}$[a]	$0.020h_{sx}$	$0.015h_{sx}$
Masonry cantilever shear wall structures[b]	$0.010h_{sx}$	$0.010h_{sx}$	$0.010h_{sx}$
Other masonry shear wall structures	$0.007h_{sx}$	$0.007h_{sx}$	$0.007h_{sx}$
All other structures	$0.020h_{sx}$	$0.015h_{sx}$	$0.010h_{sx}$

[a] There shall be no drift limit for single-story structures in which the interior walls, partitions, and ceilings have been designed to accommodate story drifts associated with the Design Earthquake Displacement. The structural separation requirement of Section 12.12.3 is not waived.

[b] Structures in which the basic structural system consists of masonry shear walls designed as vertical elements cantilevered from their base or foundation support that are so constructed that moment transfer between shear walls (coupling) is negligible.

Notes: h_{sx} is the story height below level x. For seismic force-resisting systems solely comprising moment frames in Seismic Design Categories D, E, and F, the allowable story drift shall comply with the requirements of Section 12.12.1.1.

Fig. 5 Storey drift determination limitation from ASCE 7-10

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Difinition & Requirments

The displacement ratio refers to the maximum horizontal displacement and inter storey displacement of the vertical members of the floor under the specified horizontal earthquake force considering the influence of accidental eccentricity. Generally, high-rise buildings should not be greater than **1.2 times** the average value of the floor, and strictly not be greater than the average value of the floor **1.5 times**

$$\frac{\sigma_A}{\sigma_{avg}} < 1.2$$

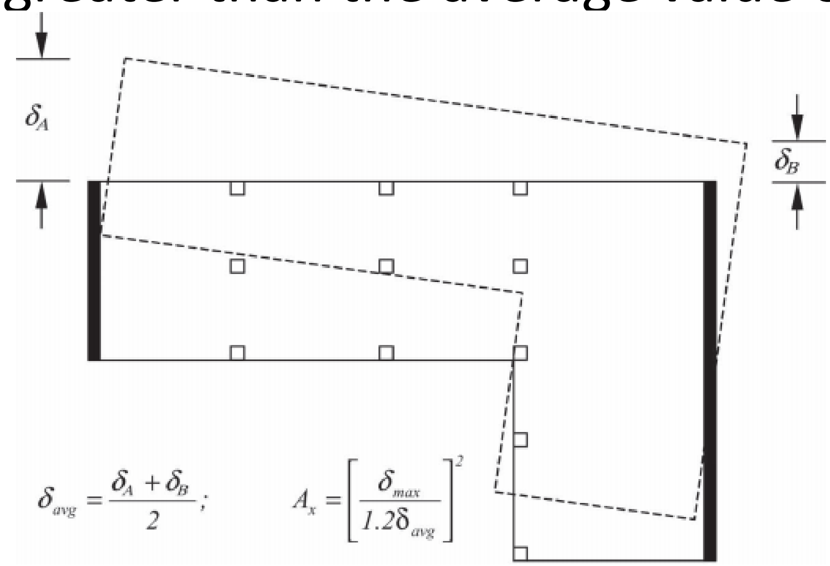

Figure 12.8-1. Torsional amplification factor, A_x.

Fig. 6 Displacement ratio from ASCE 7-10

Function

The displacement ratio is mainly to：

- **limit** the irregularity of the **layout of the structure**
- **avoid excessive eccentricity** 避免产生过大的偏小
- **avoid large torque effects** on the structure

If the torsional displacement ratio does not meet the requirements, it means that the distance between the rigid center of the structure and the mass center is large, the torsional effect is large, and the arrangement of structural lateral force-resistant components is unacceptable. At this time, the plane layout of the structure members can be adjusted to reduce the eccentricity between the center of mass and the center of rigidity.

If the structural displacement ratio does not meet the specification requirements, the following measures can be taken to adjust:

1） Adjust the positions of the **center of mass** and the **center of stiffness** of the structural plane and make them **as close as possible**.

2） Where the **displacement is large**, **the section of the member is increased to increase the stiffness**, and where the displacement is small, the section of the member is reduced to reduce the stiffness.

3） During the adjustment, it is necessary to a**djust the floor and the down floors of the displacement ratio**, and not only the insufficient floor.

4） If the above methods are not work, only the arrangement of structural beams and columns or walls can be adjusted

Table 12.3-1 Horizontal Structural Irregularities

Type	Description	Reference Section	Seismic Design Category Application
1a.	**Torsional Irregularity:** Torsional irregularity is defined to exist where the maximum story drift, computed including accidental torsion with $A_x = 1.0$, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. Torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.	12.3.3.4 12.7.3 12.8.4.3 12.12.1 Table 12.6-1 Section 16.2.2	D, E, and F B, C, D, E, and F C, D, E, and F C, D, E, and F D, E, and F B, C, D, E, and F
1b.	**Extreme Torsional Irregularity:** Extreme torsional irregularity is defined to exist where the maximum story drift, computed including accidental torsion with $A_x = 1.0$, at one end of the structure transverse to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Extreme torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.	12.3.3.1 12.3.3.4 12.7.3 12.8.4.3 12.12.1 Table 12.6-1 Section 16.2.2	E and F D B, C, and D C and D C and D D B, C, and D

Fig. 7 Torsional irregularity from ASCE 7-10

5. Period ratio 周期比

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Difinition & Requirments

The period ratio refers to the ratio of the first natural vibration period **Tt dominated by structural torsion** to the first natural vibration period **T1 dominated by translation**, and generally high-rise buildings should not be greater than **0.9**.

$$\frac{T_t}{T_1} \leq 0.9$$

This index is mainly to **limit minimun the torsional stiffness** of the structure from being too weak, so that the structure has the necessary torsional stiffness and reduce the adverse effects of torsion on the structure. The rigidity is small, the torsional effect is too large, and the arrangement of structural lateral force-resistant components is unreasonable.

If the structural period ratio does not meet the requirements, it can be adjusted by **modifying the structural layout** and **improving the torsional stiffness** of the structure.

●Since the lateral force members on the periphery of the structure contribute the most to the torsional stiffness of the structure, the adjustment principle is to **strengthen the outer walls** of the structure, Rigidity of columns or beams, or appropriately **weakening the stiffness of intermediate walls and columns of the structure**

●using the inverse relationship between structural stiffness and period, rationally arrange lateral force-resistant components, and **strengthen the stiffness in the direction of period** (including transitional direction and torsional direction) **that needs to be reduced**, **Weakening the stiffness in the direction of period that needs to be increase**.

6. Stiffness ratio 刚度比

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Difinition & Requirments

Stiffness ratio means that the lateral stiffness of **the lower floor** of a high-rise building **should be greater** than the lateral stiffness of **the upper floor**, otherwise the deformation will concentrate on the lower floor with less stiffness and form a structurally weak storey, so the lateral stiffness ratio of the lower storey to the adjacent upper storey should be limited .

For **frame structures**, the lateral stiffness ratio γ1 between a storey and its adjacent upper storey can be calculated by the following formula , and the ratio of this storey to the adjacent upper storey should not be less than **0.7**, and the ratio to the average stiffness of the adjacent upper three stories should not be less than **0.8**.

$$\gamma_1 = \frac{V_i \Delta_{i+1}}{V_{i+1} \Delta_i}$$

Where γ_1---- floor lateral stiffness ratio

V_i V_{i+1}----Standard value of seismic shear force of the i-th layer and i+th layer (kN)

Δ_i Δ_{i+1}----Interstory displacement of the i-th layer and the i+th layer under the action of the earthquake (m)

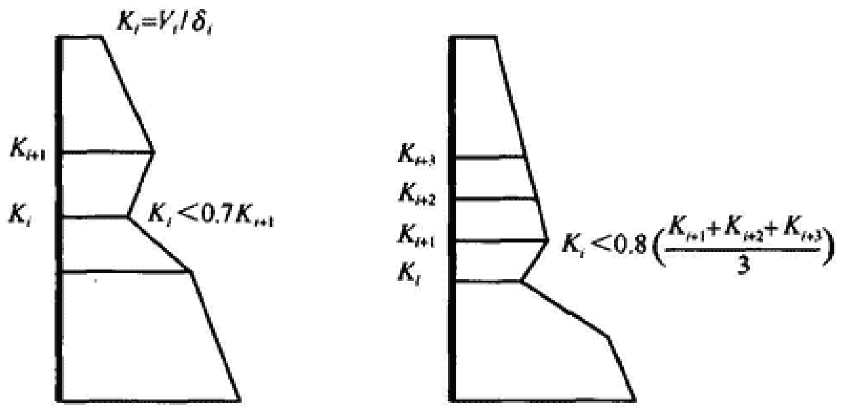

Fig. 7 Stiffness ratio requirements schematic diagram

Table 12.3-2 Vertical Structural Irregularities

Type	Description	Reference Section	Seismic Design Category Application
1a.	**Stiffness-Soft Story Irregularity:** Stiffness-soft story irregularity is defined to exist where there is a story in which the lateral stiffness is less than 70% of that in the story above or less than 80% of the average stiffness of the three stories above.	Table 12.6-1	D, E, and F
1b.	**Stiffness-Extreme Soft Story Irregularity:** Stiffness-extreme soft story irregularity is defined to exist where there is a story in which the lateral stiffness is less than 60% of that in the story above or less than 70% of the average stiffness of the three stories above.	12.3.3.1 Table 12.6-1	E and F D, E, and F

Fig. 8 Stiffness requirements from ASCE 7-10

For **other structures**, the lateral stiffness ratioγ_2 between a story and its adjacent upper storey can be calculated by the following formula , and the ratio of this storey to the adjacent upper storey should not be less than **0.9**

The ratio should not be less than **1.1** when the height of this storey is greater than 1.5 times the height of the adjacent upper storey

for the **embedded storey** at the bottom of the structure, the ratio should not be less than **1.5**.

$$\gamma_2 = \frac{V_i \Delta_{i+1}}{V_{i+1} \Delta_i} \frac{h_i}{h_{i+1}}$$

Where γ_2----- consider the storey height correction floor lateral stiffness ratio

7. Shear capacity ratio 受剪承载力之比

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Difinition & Requirments

The shear bearing capacity of a floor (inter-story shear bearing capacity) refers to the **sum of the shear bearing capacity of all lateral force-resisting members of the floor**, including columns, shear walls, and diagonal braces, in the direction of the considered horizontal earthquake action.

Controlling the ratio of the shear bearing capacity of the floors is also to **avoid the vertical irregularity of the structure** and the **emergence of weak floors**. The adjustment method is to reasonably control the storey height, improve the lateral force bearing capacity of the wall, column and other components of the storey, adjust the reinforcement, etc. For structures with weak storey, the seismic shear force of the storey should be amplified by **1.25 times**.

Generally, the inter-story shear capacity of the floor shear structure of a high-rise building should not be less than **80%** of the shear capacity of the adjacent upper story, and strictly should not be less than **65%** of the shear capacity of the adjacent upper story

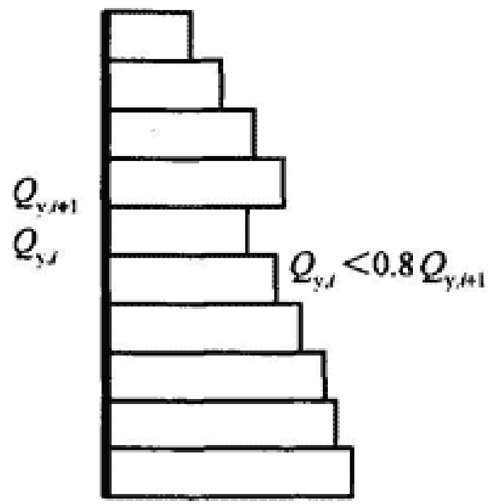

Fig. 9 Shear capacity ratio requirements schematic diagram

5a.	**Discontinuity in Lateral Strength–Weak Story Irregularity:** Discontinuity in lateral strength–weak story irregularity is defined to exist where the story lateral strength is less than 80% of that in the story above. The story lateral strength is the total lateral strength of all seismic-resisting elements sharing the story shear for the direction under consideration.	12.3.3.1 Table 12.6-1	E and F D, E, and F
5b.	**Discontinuity in Lateral Strength–Extreme Weak Story Irregularity:** Discontinuity in lateral strength–extreme weak story irregularity is defined to exist where the story lateral strength is less than 65% of that in the story above. The story strength is the total strength of all seismic-resisting elements sharing the story shear for the direction under consideration.	12.3.3.1 12.3.3.2 Table 12.6-1	D, E, and F B and C D, E, and F

Fig. 10 Shear capacity ratio requirements from ASCE 7-10

4.	**In-Plane Discontinuity in Vertical Lateral Force-Resisting Element Irregularity:** In-plane discontinuity in vertical lateral force-resisting elements irregularity is defined to exist where there is an in-plane offset of a vertical seismic force-resisting element resulting in overturning demands on a supporting beam, column, truss, or slab.	12.3.3.3 12.3.3.4 Table 12.6-1	B, C, D, E, and F D, E, and F D, E, and F

Fig. 11 Shear capacity ratio requirements from ASCE 7-10

8. Shear to weight ratio 剪重比

Difinition & Requirments

The shear to weight ratio requires that the structure bear sufficient seismic action, and the design **cannot be less than the specified minimum seismic shear force**. Since the seismic influence coefficient decreases rapidly in the long-period period, for structures with **a fundamental period greater than 3.5s**, the calculated structural effect under horizontal earthquake action may be **too small**. For long-period structures, the ground motion velocity and displacement in the dynamic seismic action may have a greater impact on the damage of the structure, but the modal decomposition response spectrum method used in the code cannot yet estimate this.

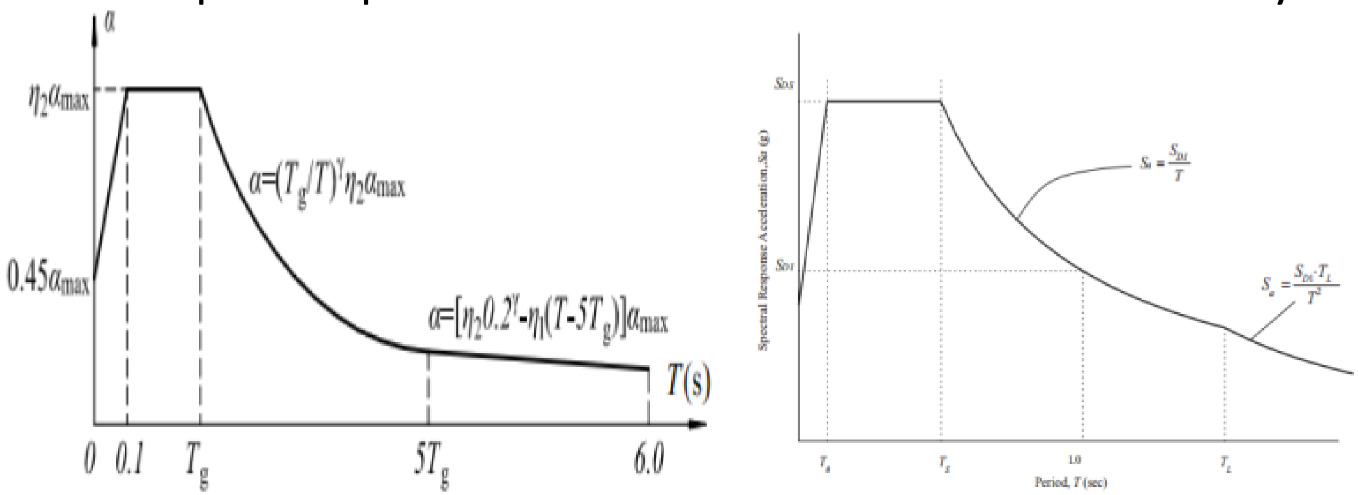

Fig. 10 Design response spectrum comparison (L---China code, R----ASCE)

Minimum Seismic Shear Coefficient, for the sake of structural safety, the requirements for the total horizontal seismic shear force of the structure and the **minimum value of the horizontal seismic shear force** of each floor are put forward. The China nation code stipulates that the horizontal seismic shear force of any floor of the structure should meet the following Form requirements:

$$V_{EKi} > \lambda \sum_{j=i}^{n} G_i$$

Where V_{EKi}---floor shear force corresponding to the standard value of horizontal earthquake action on the i-th floor

λ-----Shear coefficient, its value is not less than the following table, for vertical weak layers, it should be multiplied by a coefficient of 1.15

G_i----Representative value of gravity load on layer j

Table 5 Minimum seismic shear coefficient values of floors

category(Richter Scale,Magnitude)	6	7	8	9
Structures with obvious torsional effect or fundamental period less than 3.5s	0.008	0.016 (0.024)	0.032 (0.048)	0.064
Structures with a fundamental period greater than 5s	0.006	0.012 (0.018)	0.024 (0.036)	0.048

It should be noted that when the standard value of the floor seismic horizontal shear force obtained by calculation and analysis is **less than the minimum floor horizontal shear force**, the corresponding shear force of the floor at this part can be adjusted and increased to meet the requirements, but the adjustment increase range should not be greater than **1.2~1.3** ;

If the adjustment increase is greater than 1.3, the structural layout and section size should be adjusted first to increase the structural rigidity to meet the needs of structural stability and bearing capacity.

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12.8 EQUIVALENT LATERAL FORCE (ELF) PROCEDURE

12.8.1 Seismic Base Shear The seismic base shear, V, in a given direction shall be determined in accordance with the following equation:

$$V = C_s W \qquad (12.8\text{-}1)$$

where

C_s = The seismic response coefficient determined in accordance with Section 12.8.1.1, and

W = The effective seismic weight per Section 12.7.2.

Fig. 12 Shear capacity equation requirements from ASCE 7-10

9. Rigidity to weight ratio 刚重比

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Difinition & Requirments

The rigidity to weight ratio refers to the ratio of the lateral stiffness of the structure to the gravity load, which is mainly used to **control the stability of the structure**, so as to **avoid the overall instability under the action of wind load or earthquake**. If it is too small, the **second-order effect** of gravity is prone to occur, and if the rigidity-to-weight ratio is too large, it means that the economical efficiency of the structure is poor, and the section of walls and columns can be appropriately reduced.

The analysis shows that for general high-rise building structures, the influence of the second-order **deflection effect is relatively small**, and **the P-Δ effect caused by structural lateral displacement and gravity load is more obvious**. Therefore, the stability design of high-rise building structural components is mainly Control and check the effect of gravity load and its P-Δ effect on the performance degradation of structural components under the action of wind or earthquake, and the possible instability of structural components caused by this.

Generally, when the structure of a high-rise building meets the requirements of the following formula, the adverse effects of the second-order effect of gravity may not be considered in the elastic calculation and analysis.

For frame structures:

$$D_I \geq 20\sum_{i=1}^{n} G_i/h_i$$

For shear wall structures, frame-shear wall structures, slab-column-shear wall structures, and cylinder structures:

$$EJ_d \geq 2.7H^2 \sum_{i=1}^{n} G_i$$

Where EJ_d ---- elastic equivalent lateral stiffness in the direction of a major axis of the structure

H----building height

G_i G_j ---- Design values of the gravity load of the level i and the level i respectively

h_i ---- the height of the house on the level i

D_i ---- the elastic equivalent lateral stiffness of the level i which can be taken as the ratio of the shear force of the floor to the inter-story displacement

n ---- the total number of layers of structure calculation

The overall stability of high-rise building structures shall meet the following requirements:

Framework

$$D_I \geq 10\sum_{i=1}^{n} G_i/h_i$$

Shear wall structure, frame-shear wall structure, and cylinder structure shall meet the following requirements:

$$EJ_d \geq 1.4H^2 \sum_{i=1}^{n} G_i$$

When the stiffness-to-weight ratio of a high-rise building structure is in the following range, the adverse effects of the second-order effect of gravity on the internal force and displacement of the structure under the action of horizontal force need to be considered in the calculation of structural elasticity.

Framework

$$20\sum_{i=1}^{n} G_i/h_i \geq D_I \geq 10\sum_{i=1}^{n} G_i/h_i$$

Shear wall structure, frame-shear wall structure, and cylinder structure shall meet the following requirements:

$$2.7H^2 \sum_{i=1}^{n} G_i \geq EJ_d \geq 1.4H^2 \sum_{i=1}^{n} G_i$$

10. Conclusion & Work Case

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Society and economic development will lead to changes in demand. In recent years, the construction industry in Jamaica has achieved considerable development and progress. The emergence and promotion of **high-rise buildings** is an **irreversible trend**.

At the same time, the structural design of high-rise buildings is a complicated process. Structural engineers need **open mind**, not only to be familiar with the requirements of the code, but also to continuously **accumulate design experience** to improve the design quality and ensure the sustainable and stable development of high-rise buildings.

This paper analyzes the **nine commonly used indicators** in the calculation and analysis of high-rise building structure design, hoping to provide some help for the further development of high-rise buildings in Jamaica.

This article is mainly based on **Chinese building codes**, and those with similar regulations on American Standard are also listed as a reference.

Real Case in The World

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Work Case

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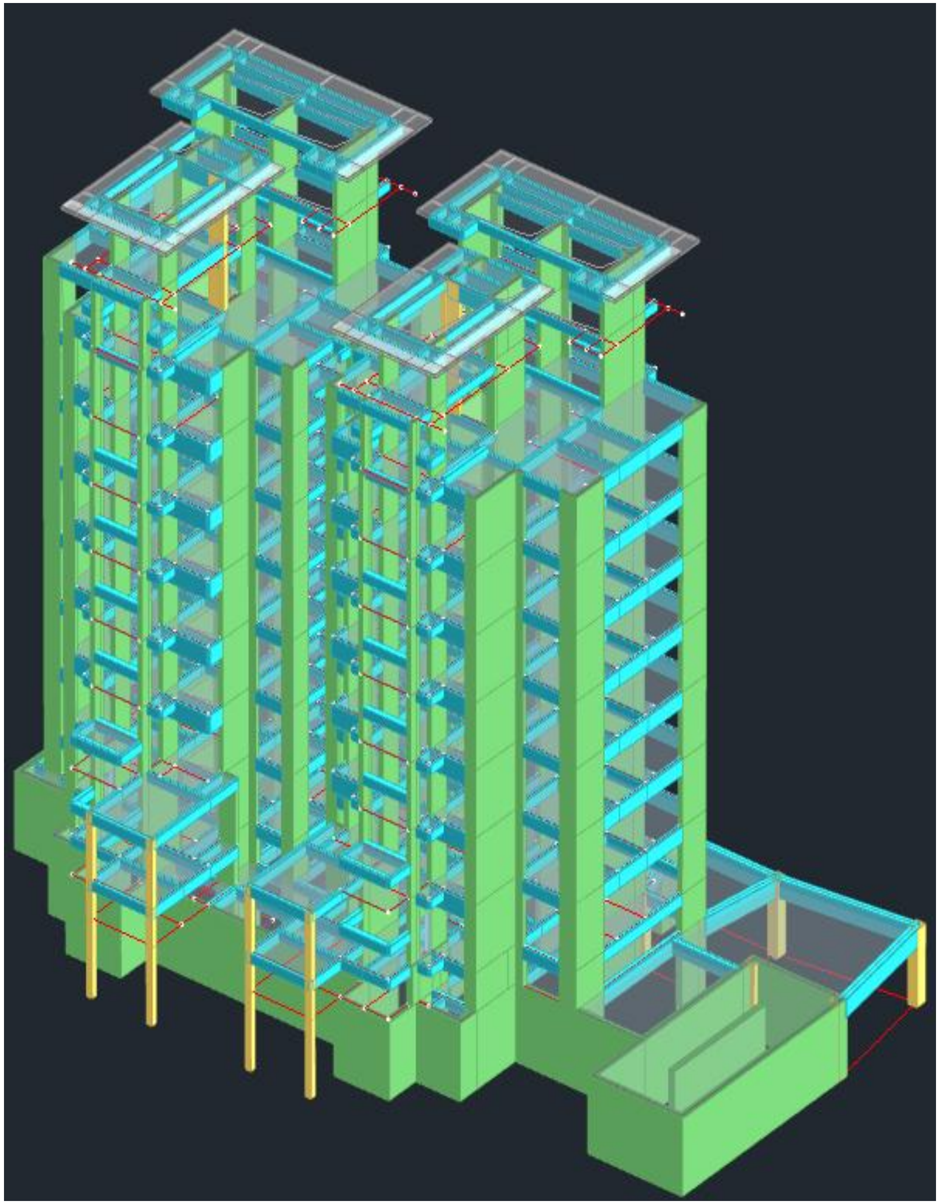
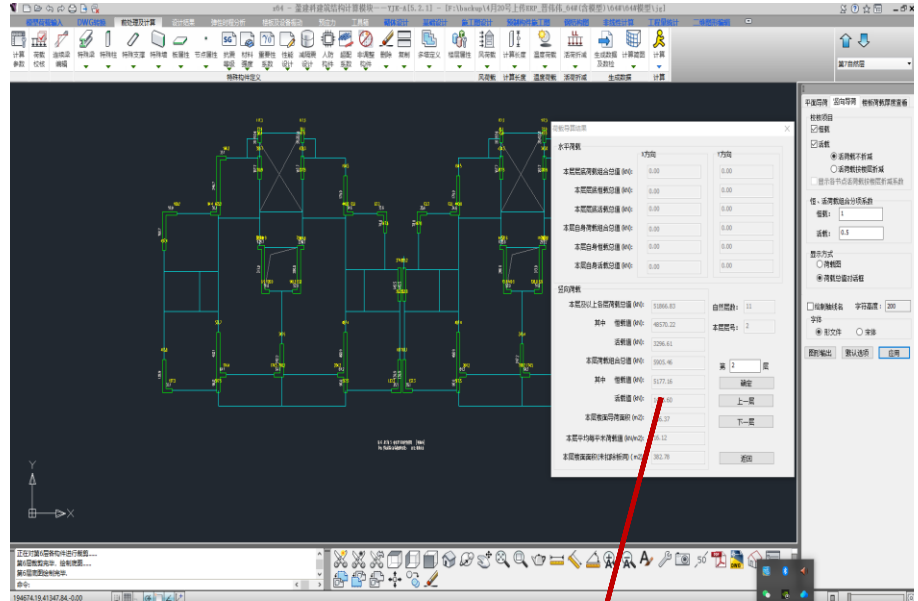
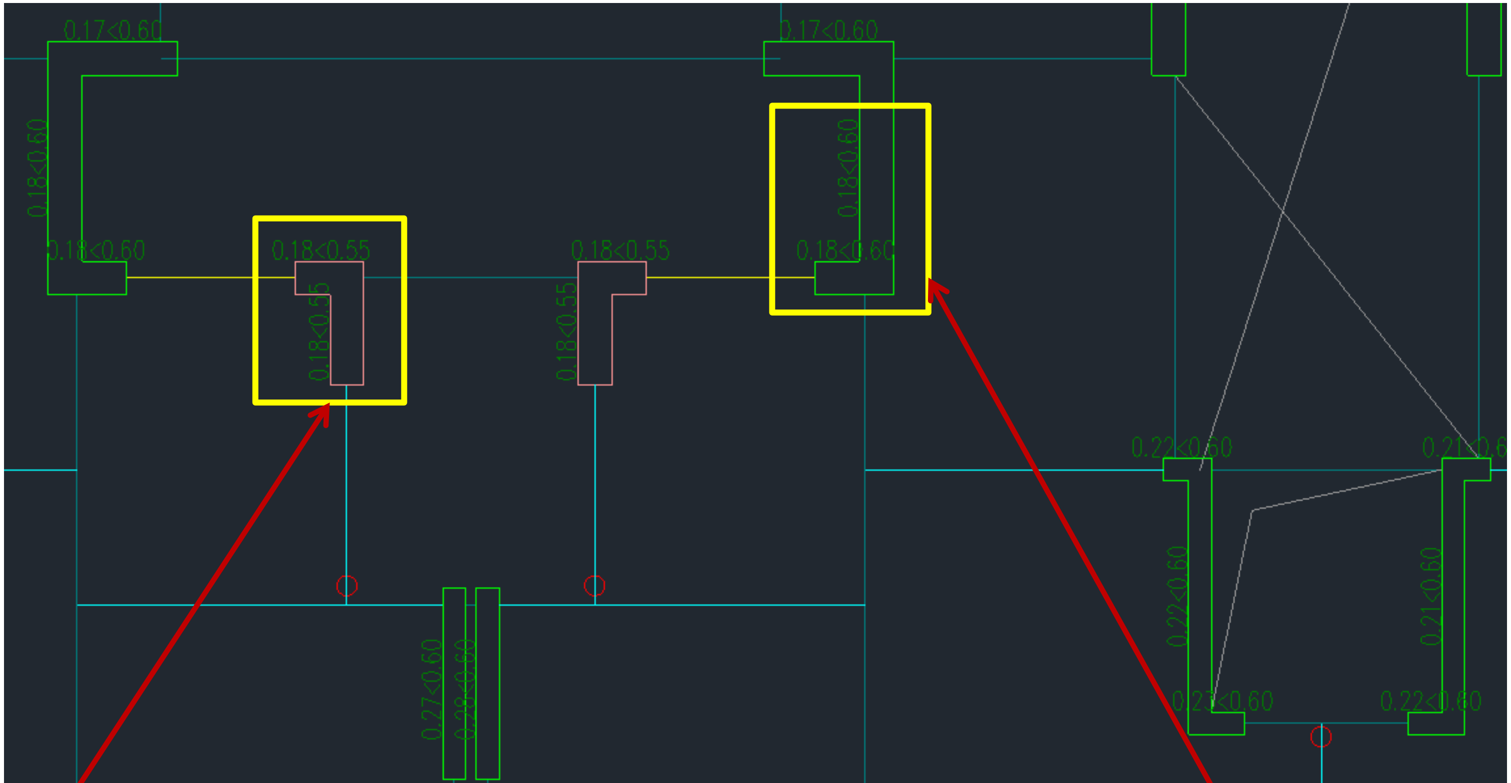




Work Case



Axial Compression Ratio of Part concrete wall

Special shaped column

Seismic rating	Level 1 (Magnitude 9)	Level 1 (Magnitude 6 7 8)	Level 2 / 3
Limits of Axial Compression Ratio of Shear Wall Structure	0.4	0.5	0.6

Work Case

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Indicators 指标名称		Summary info 指标信息
Total mass(ton) 总质量		7035.94
storey mass ratio 质量比		1.12 < [1.5](9层3塔)
Min Stiffness ratio 最小刚度比	X	1.00 > [1.0](11层1塔)
	Y	1.00 > [1.0](11层1塔)
Shear capacity ratio 楼层受剪承载力	X	1.00 > [0.80](11层1塔)
	Y	0.83 > [0.80](10层4塔)
Period ratio 结构自振周期(s)	X	1.0188
	Y	0.7493
	T	0.5930
Effective mass factor 有效质量系数	X	90.05% > [90%]
	Y	93.04% > [90%]
Min Shear to weight ratio 最小剪重比	X	3.20% > [1.60%](3层1塔)
	Y	3.79% > [1.60%](3层1塔)
Max Storey drift ratio(Earthquake) 最大位移角(地震)	X	1/1276 < [1/1000](10层3塔)
	Y	1/1669 < [1/1000](7层1塔)
Max Storey drift ratio(Wind) 最大位移角(风)	X	1/2975 < [1/1000](11层3塔)
	Y	1/5324 < [1/1000](11层1塔)
Max Displacement ratio 最大位移比	X	1.10 < [1.50](3层1塔)
	Y	1.22 < [1.50](7层3塔)
Max inter-storey Displacement ratio 最大层间位移比	X	1.20 < [1.50](11层3塔)
	Y	1.23 < [1.50](5层3塔)
Rigidity to weight ratio 刚重比	X	7.83 > [1.40]
	Y	12.41 > [1.40]

References

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[4] GB 50010-2010 Code for design of concrete structures, 2015

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[6] ACI 318-11 Building Code requirements for structural concrete, 2011

[7] ASCE 7-10 Minimum design loads and associated criteria for buildings and other structures, 2010

BUILDING BALANCED SUSTAINABILITY

Thanks

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