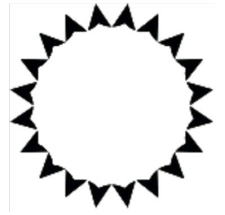




*PEF2603*  
*Estruturas na Arquitetura III*  
*- Sistemas Reticulados e Laminares*



# *Pórticos*

*(Aula 3 - 10/04/2023)*

*Professores*

*Ruy Marcelo Pauletti, Leila Meneghetti Valverdes, Luís A. G. Bitencourt Jr.*

*Convidado: Arq. Márcio Sequeira*

*Os 'skylines' das grandes cidades evidenciam os pórticos (especialmente os edifícios multipavimentos) como o sistema estrutural fortemente predominante.*

*Os demais sistemas estruturais têm aplicações notáveis, mas relativamente restritas.*

*Hong Kong, China: Metro/Urban Population: 7.0 million*



*Chicago, USA: Metro/Urban Population: 9.0 million*



*New York City, USA : Metro/Urban Population: 18.0 million*





*Shanghai, China: Metro/Urban Population: 14.0 million*



*Singapore: Metro/Urban Population: 4.3 million*





*Kuala Lumpur, Malaysia: Metro/Urban Population: 1.5 million*



*Shenzhen, China: Metro/Urban Population: 6 millions*



*Doha, Qatar /Urban Population: 1.5 million*

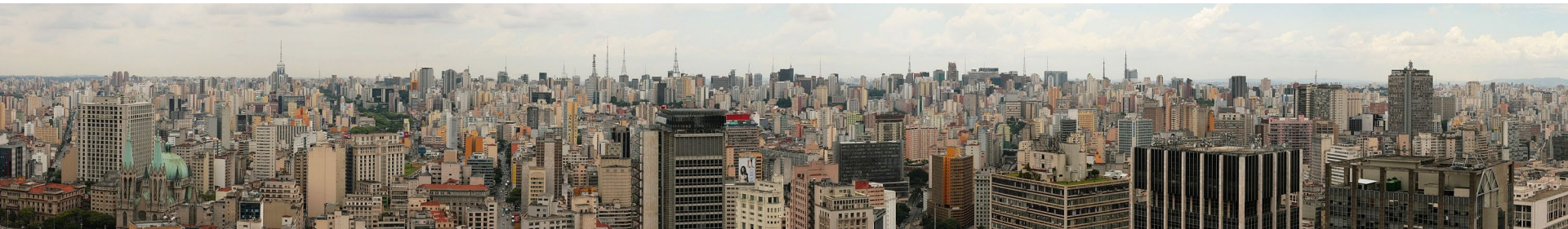


*Dubai, United Emirates: /Urban Population: 1.6 million*



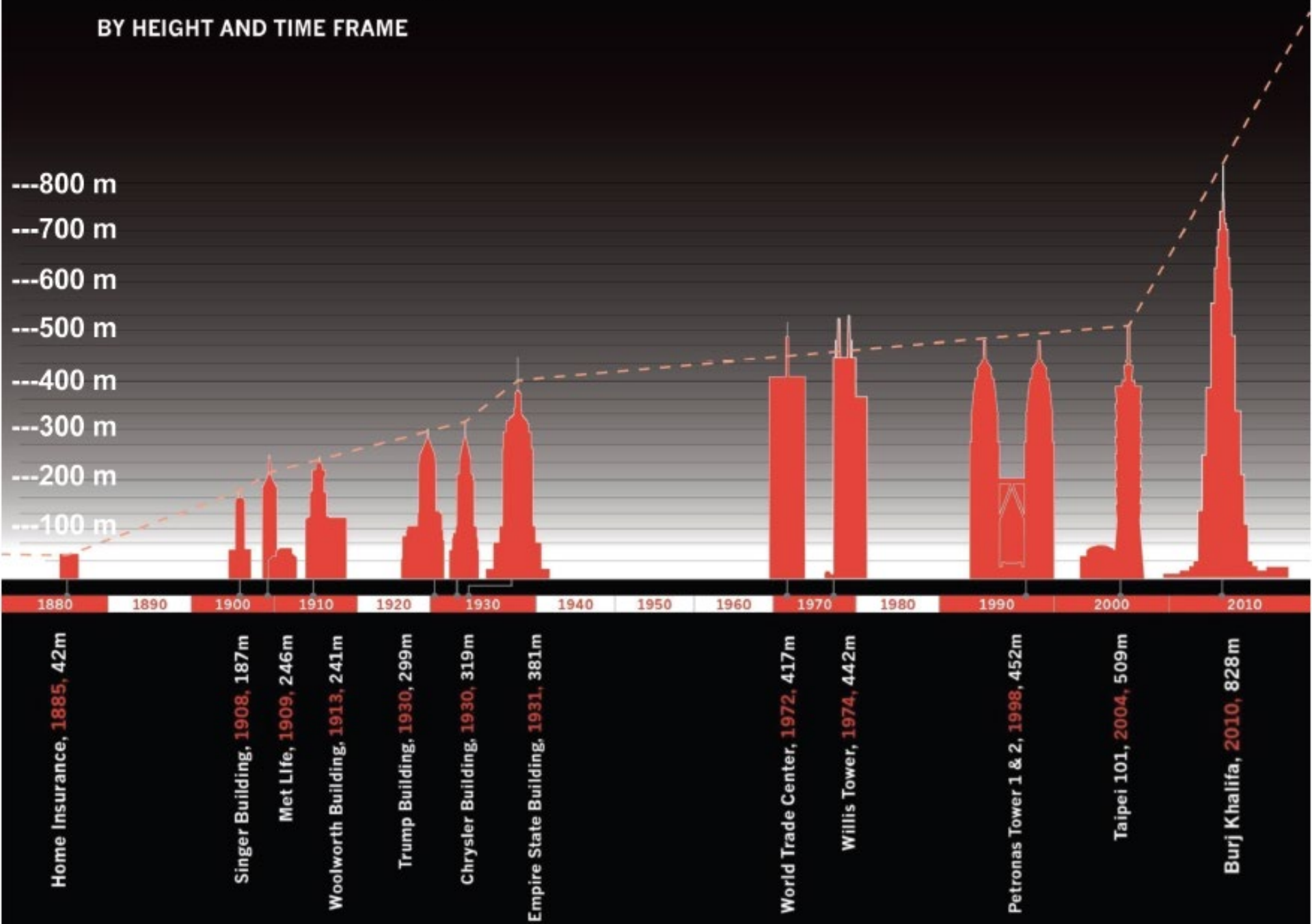


*São Paulo, Brazil /Urban Population: 12.4 million*



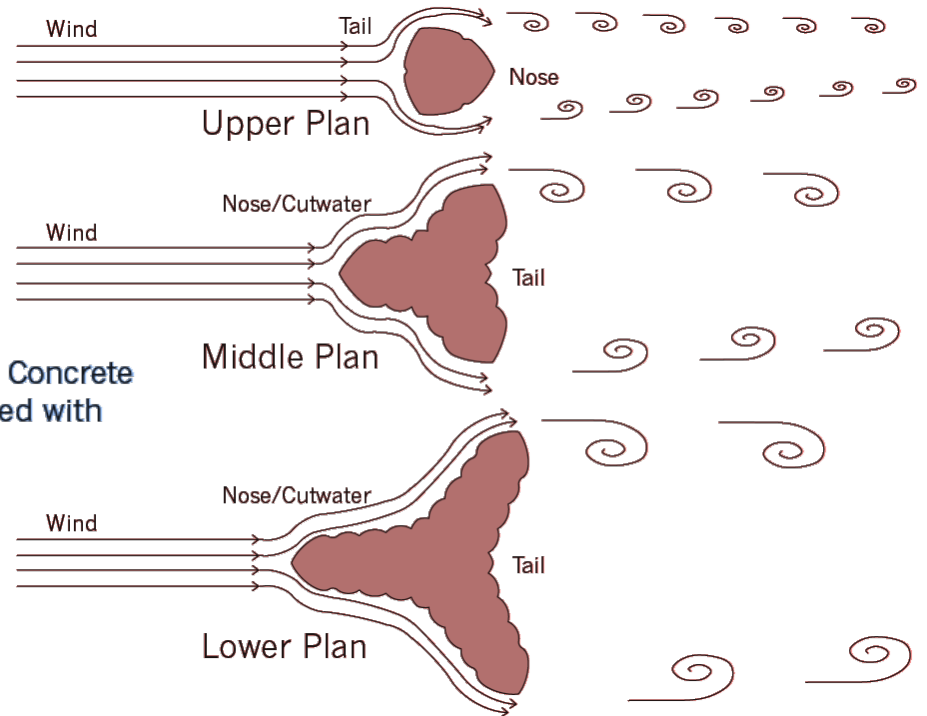
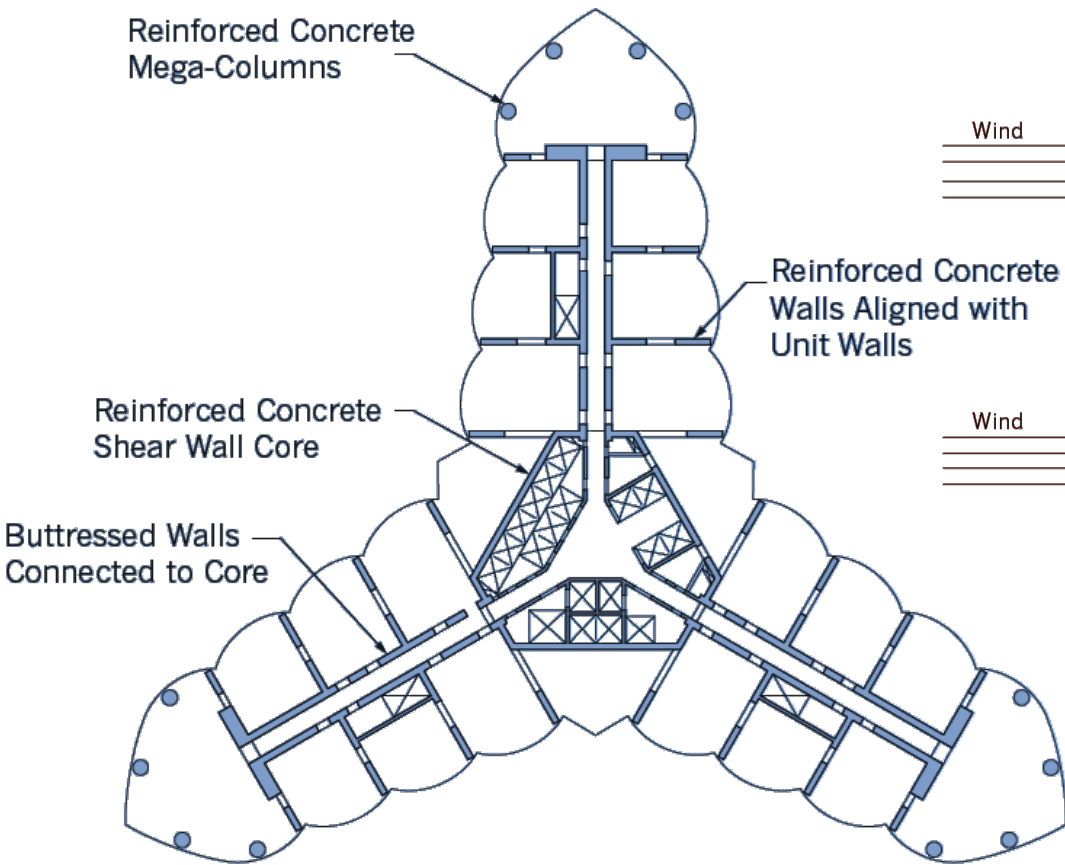
# SKYSCRAPERS

BY HEIGHT AND TIME FRAME

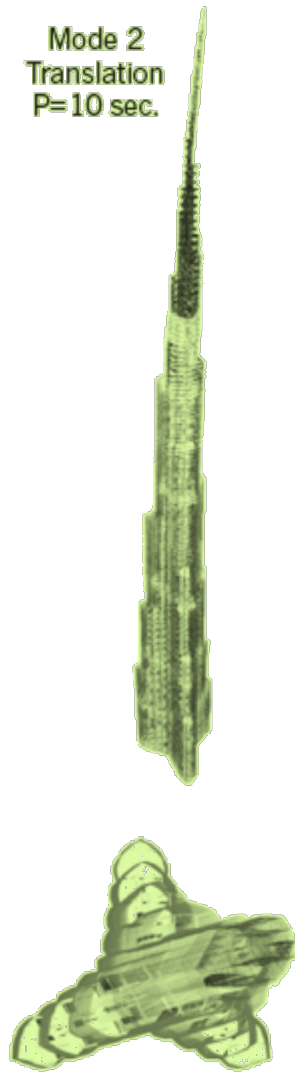
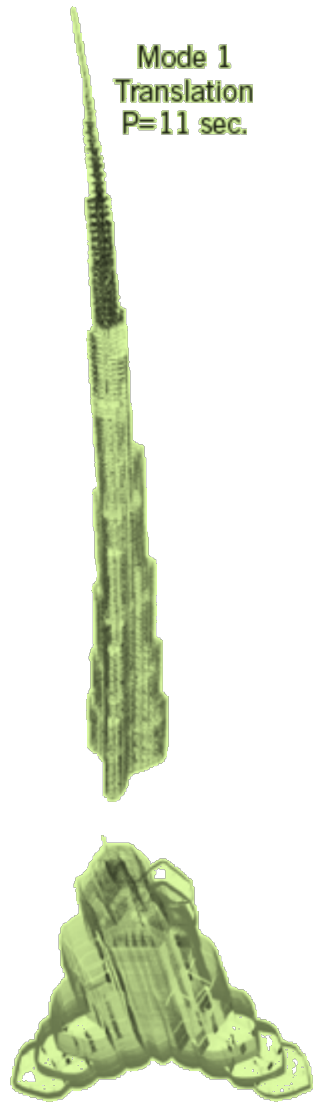












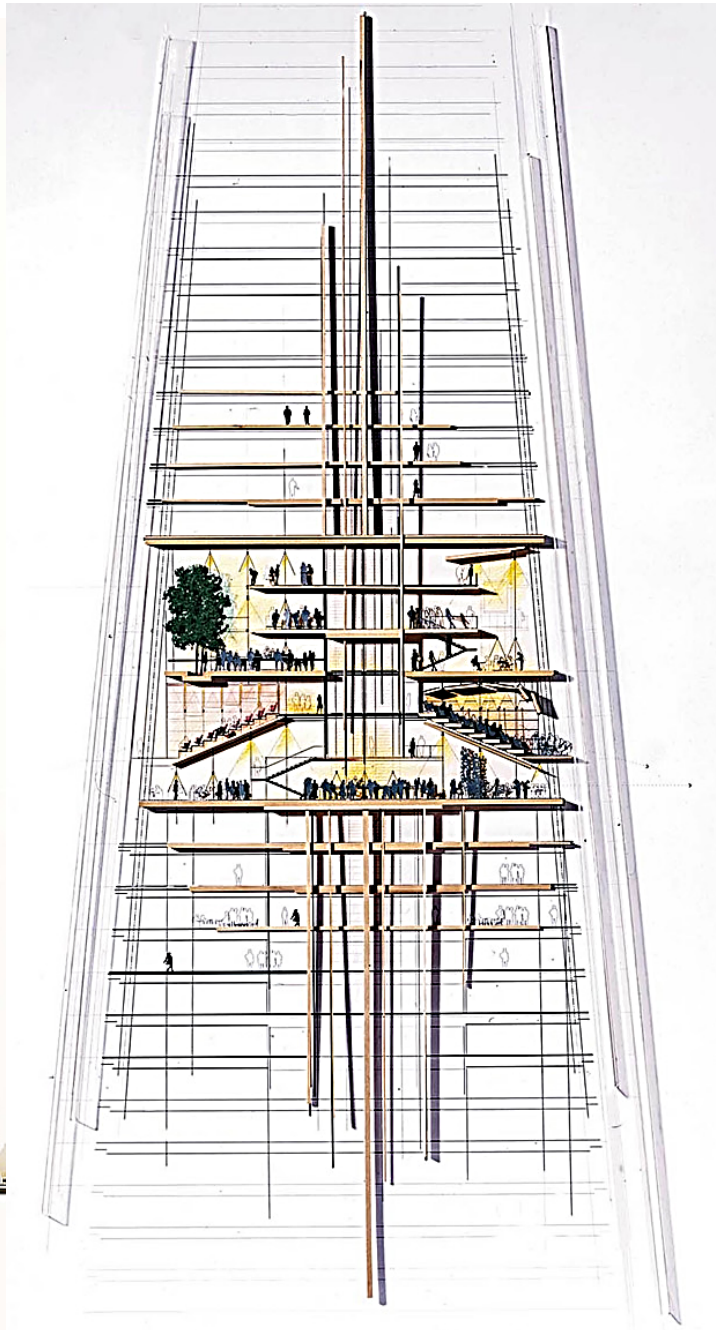
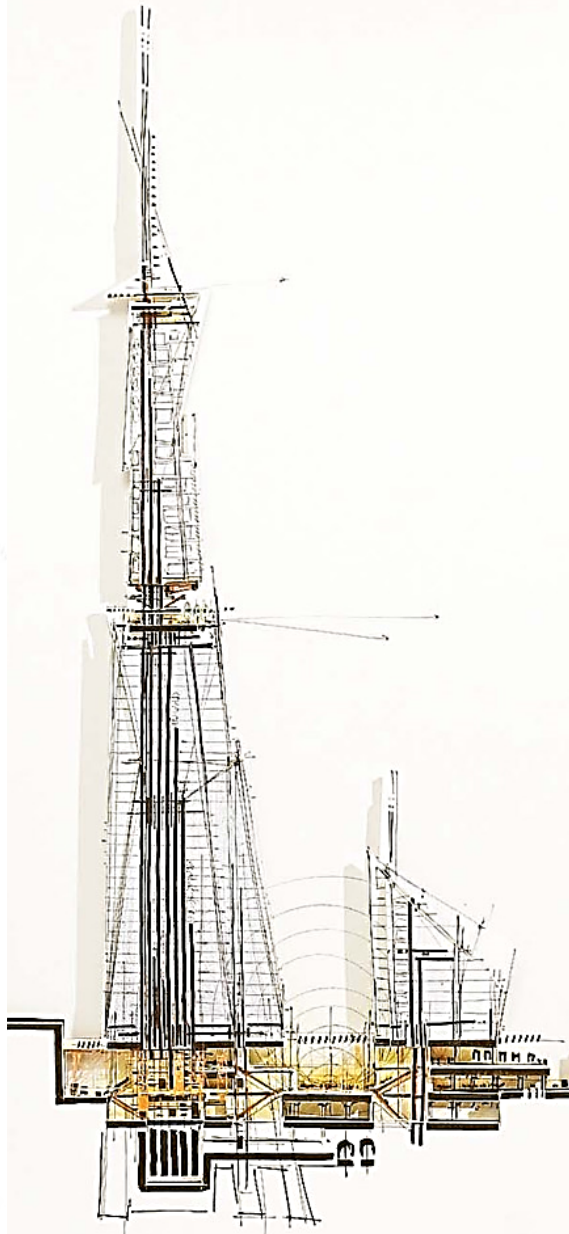
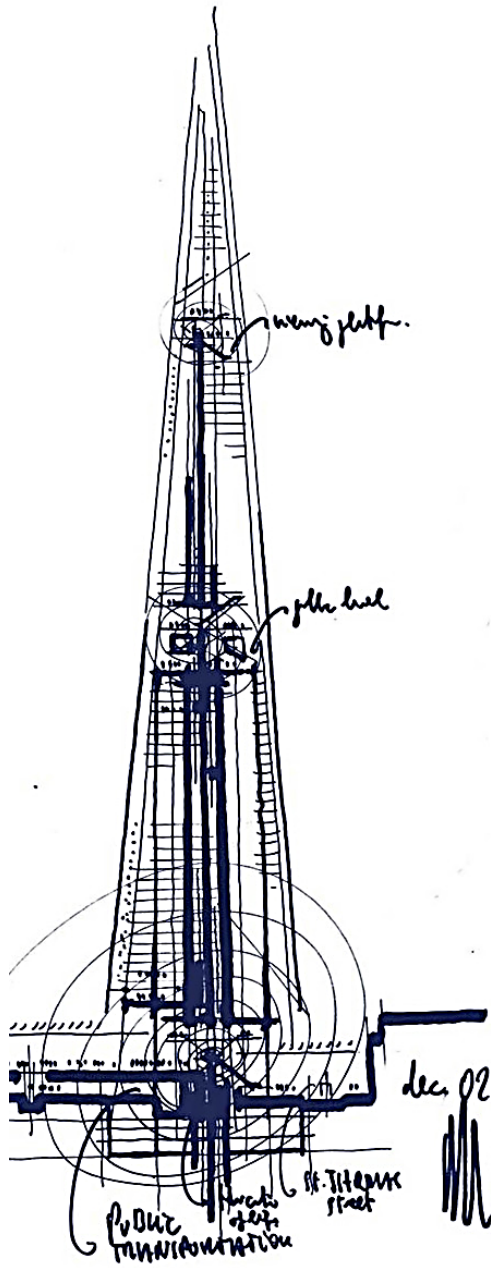




**The Shard – London - 2012**  
**Renzo Piano - height: 306m / 72 public floors / 87 total**











**Evolution Tower,  
Moscou, 2014  
246mm, 55 pavimentos  
Tony Kettle**







Moscow, 2020











## PLATINA 220

Com 172 metros e 50 pavimentos, o Edifício Platina 220, na Zona Leste supera o Mirante do Vale, no Centro, e se torna o maior de São Paulo, mas está longe dos maiores do Brasil, localizados em Balneário Camboriú (SC)

### Prédio multiuso

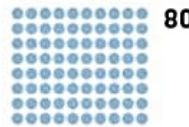
#### CORPORATIVO

50 LAJES CORPORATIVAS DE 250 M<sup>2</sup> A 500 M<sup>2</sup>, COM POSSIBILIDADE DE JUNÇÃO

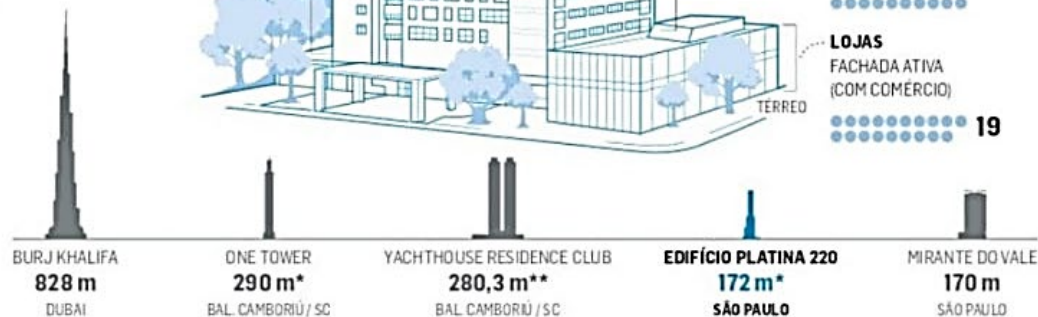


#### RESIDENCIAL

APARTAMENTOS COMPACTOS DE 35 M<sup>2</sup> E 57 M<sup>2</sup>, COM POSSIBILIDADE DE JUNÇÃO



### Comparativo



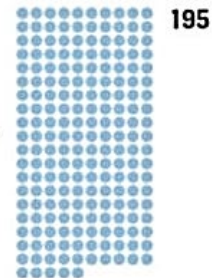
\*NÃO SÃO CONSIDERADOS "COMPLETOS" AINDA. \*\*TORRES GÊMEAS

### Onde fica



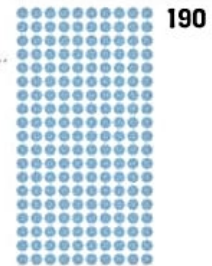
#### COMERCIAL

SALAS DE 26 M<sup>2</sup> A 49 M<sup>2</sup>, COM POSSIBILIDADE DE JUNÇÃO



#### HOTEL

UNIDADES DE 19 M<sup>2</sup> A 49 M<sup>2</sup>



#### LOJAS

FACHADA ATIVA (COM COMÉRCIO)

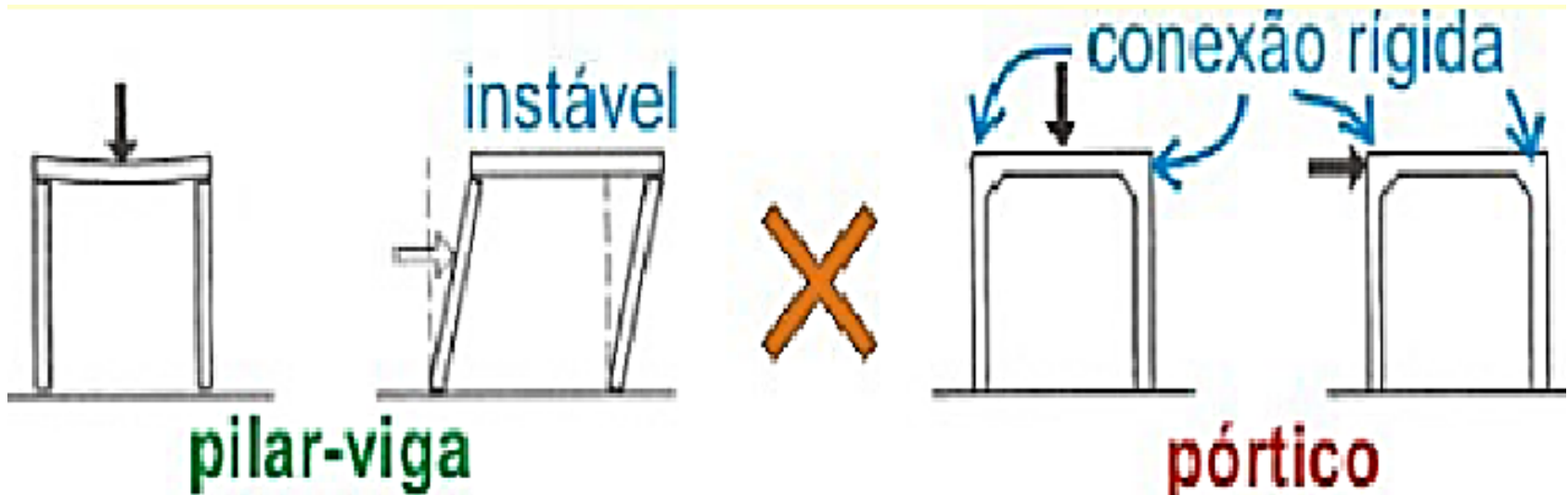


FONTES: PORTE ENGENHARIA E URBANISMO - CTBLH / INF OGRÁFICO: ESTADÃO

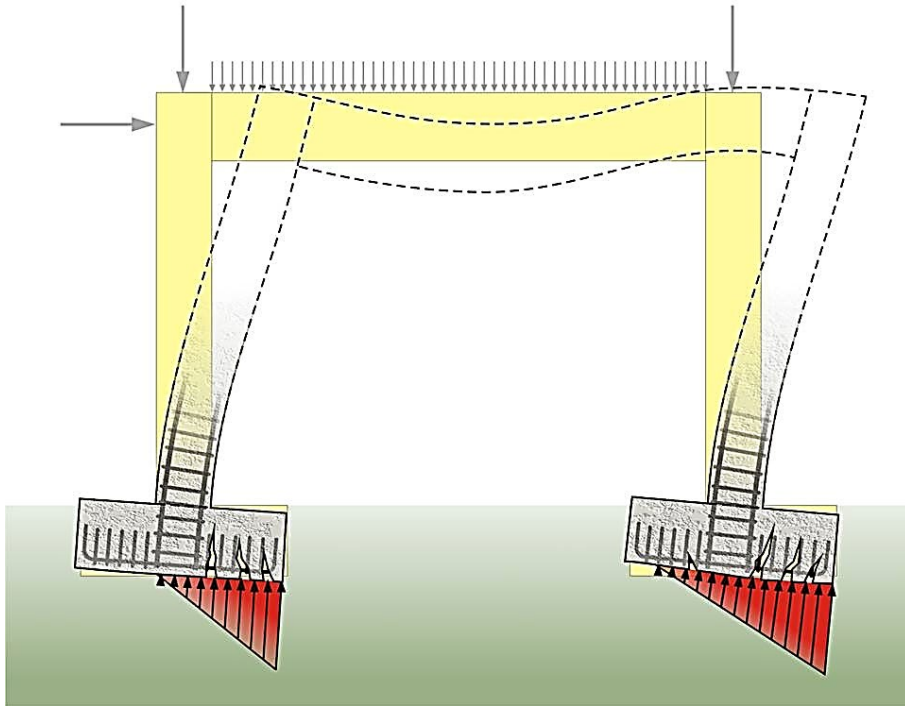


# Pórticos

Sistemas reticulados compostos por elementos lineares resistentes à força normal, à flexão e à torção, e conectados por suas extremidades de forma a não permitir rotações relativas ('conexões rígidas').

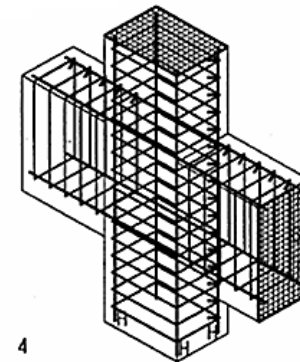
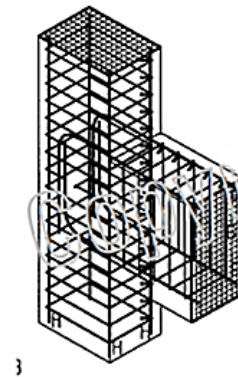
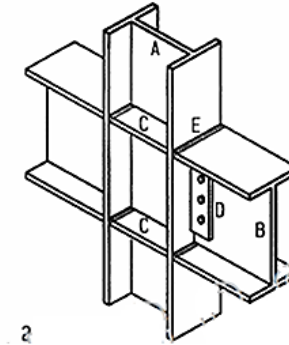
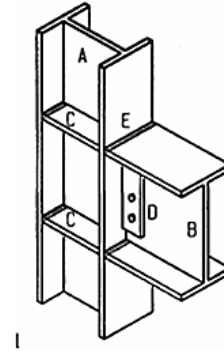


# Pórticos



# Nós de Pórticos

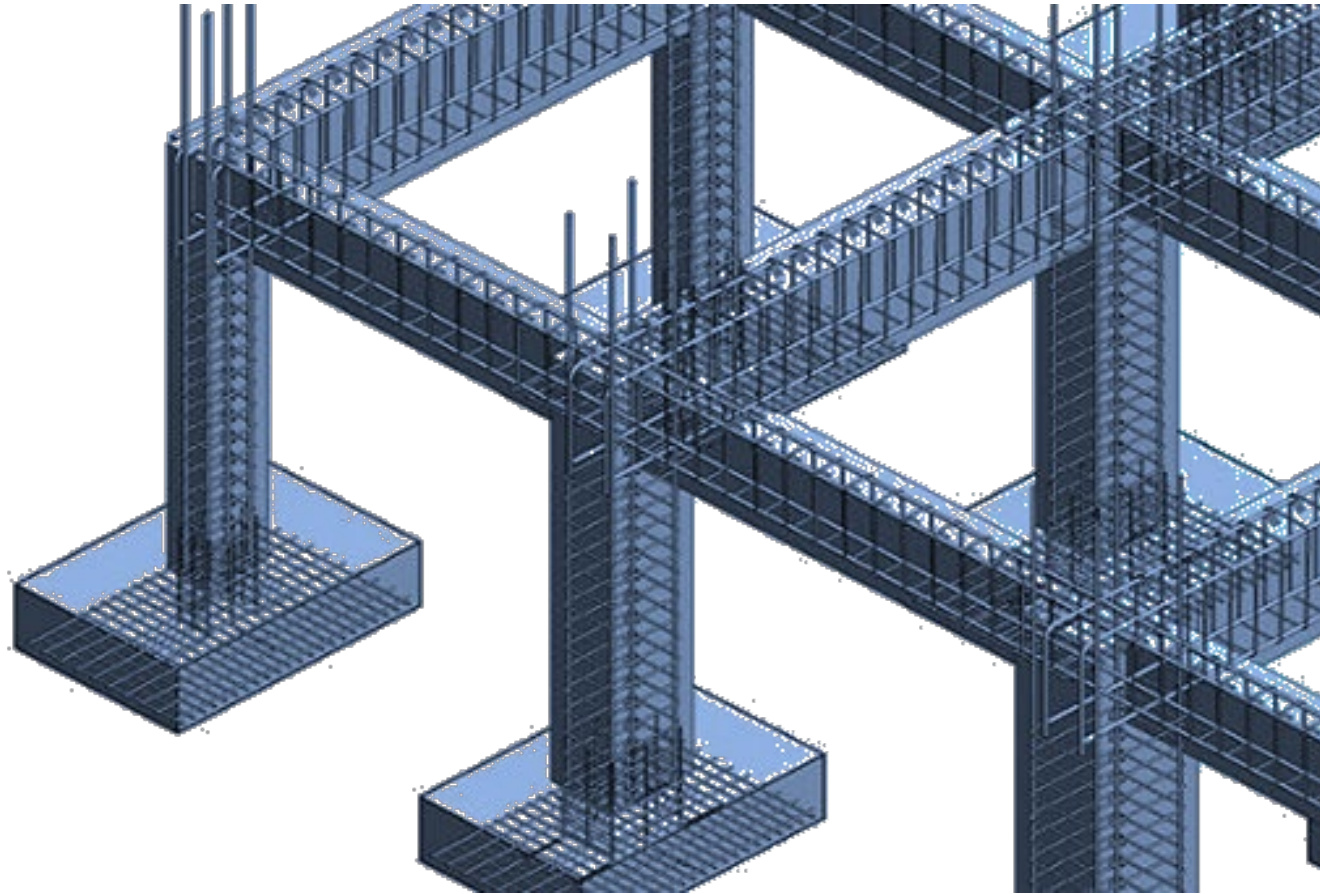
## Estruturas Metálicas



## Concreto Armado

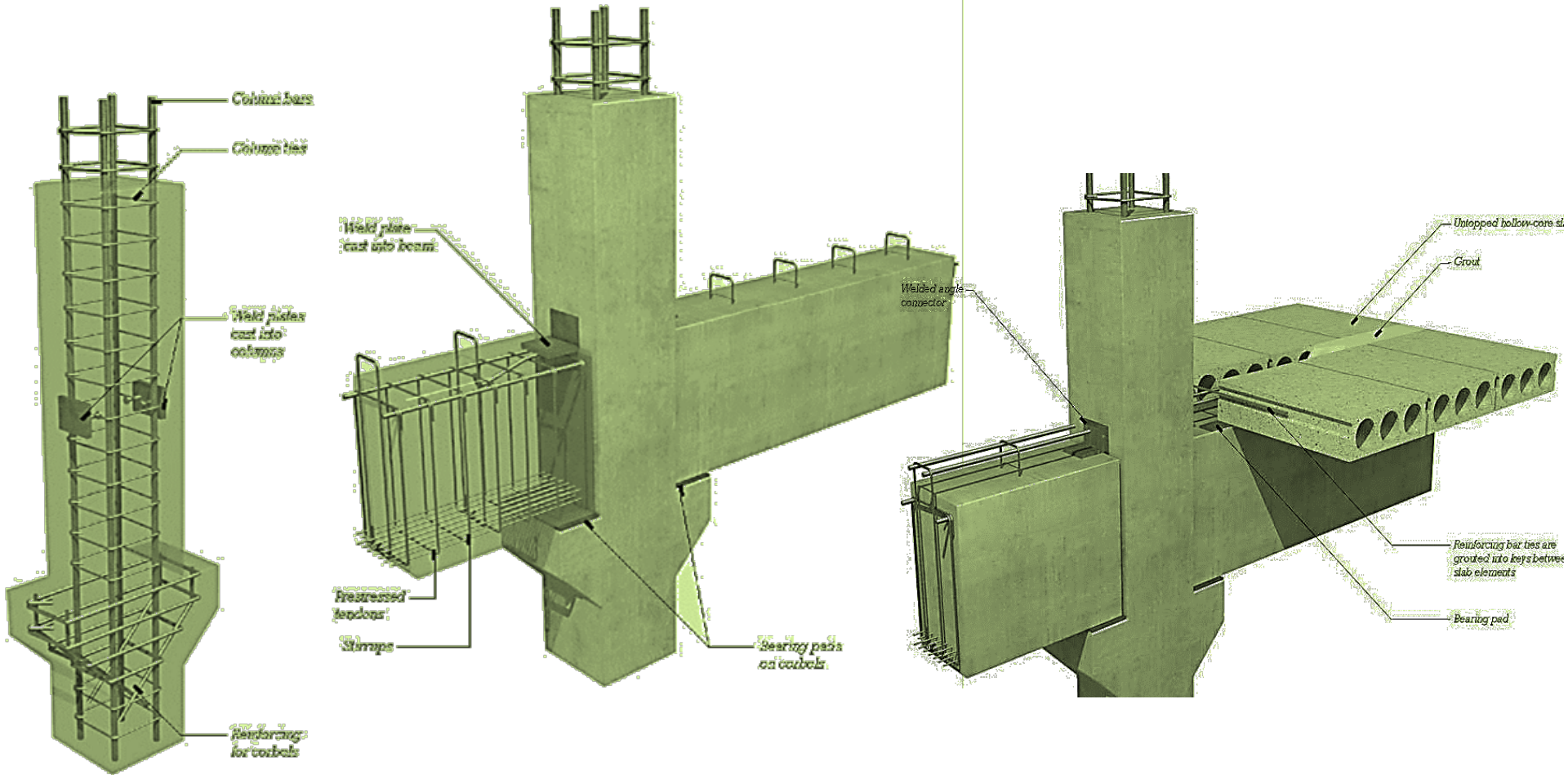


## *Pórticos de concreto armado*





# Pórticos de concreto armado pré-moldado



**pórtico**

**Momentos  
Fletores**

**forma**



**tri-articulado**



**bi-articulado**

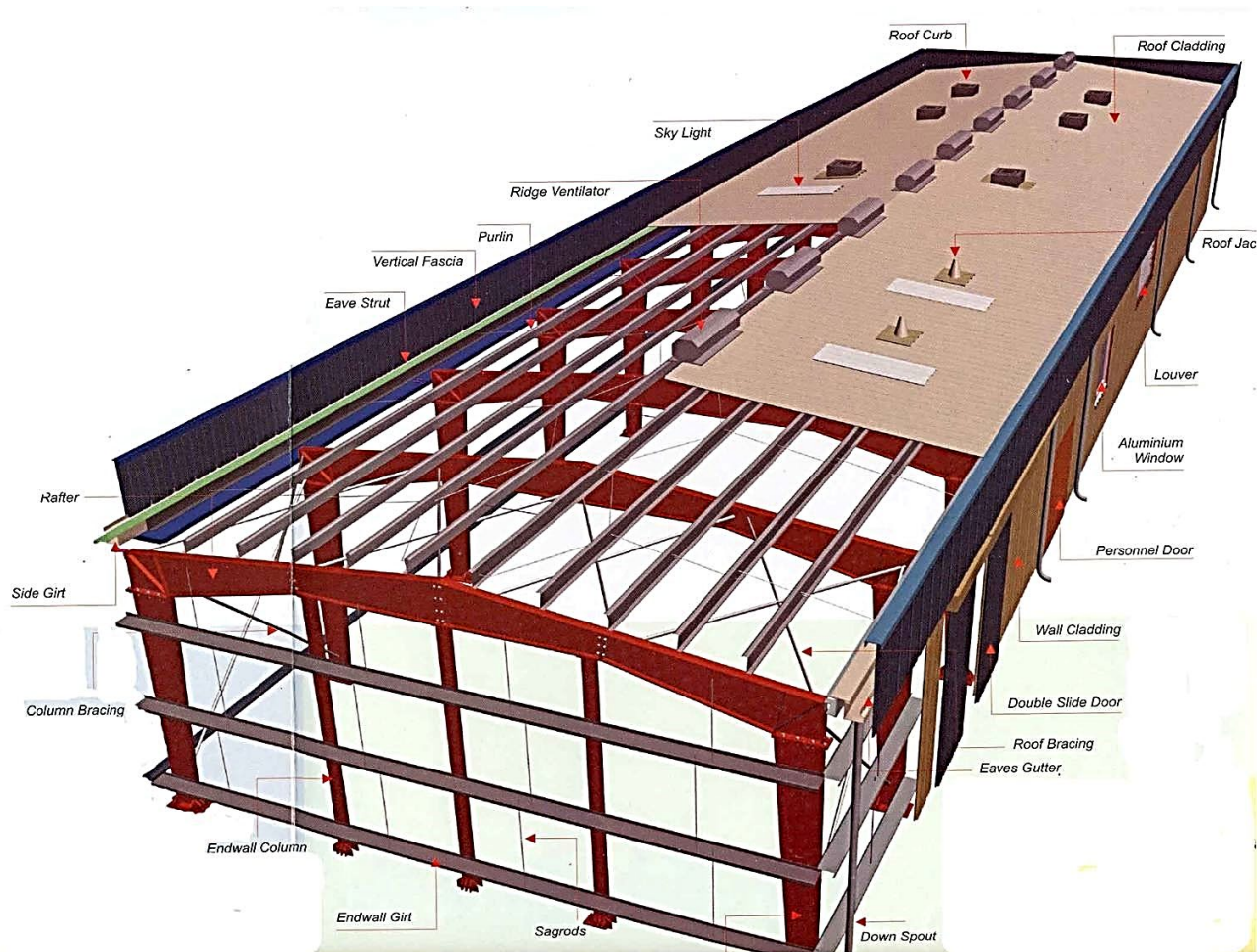


**balanços**



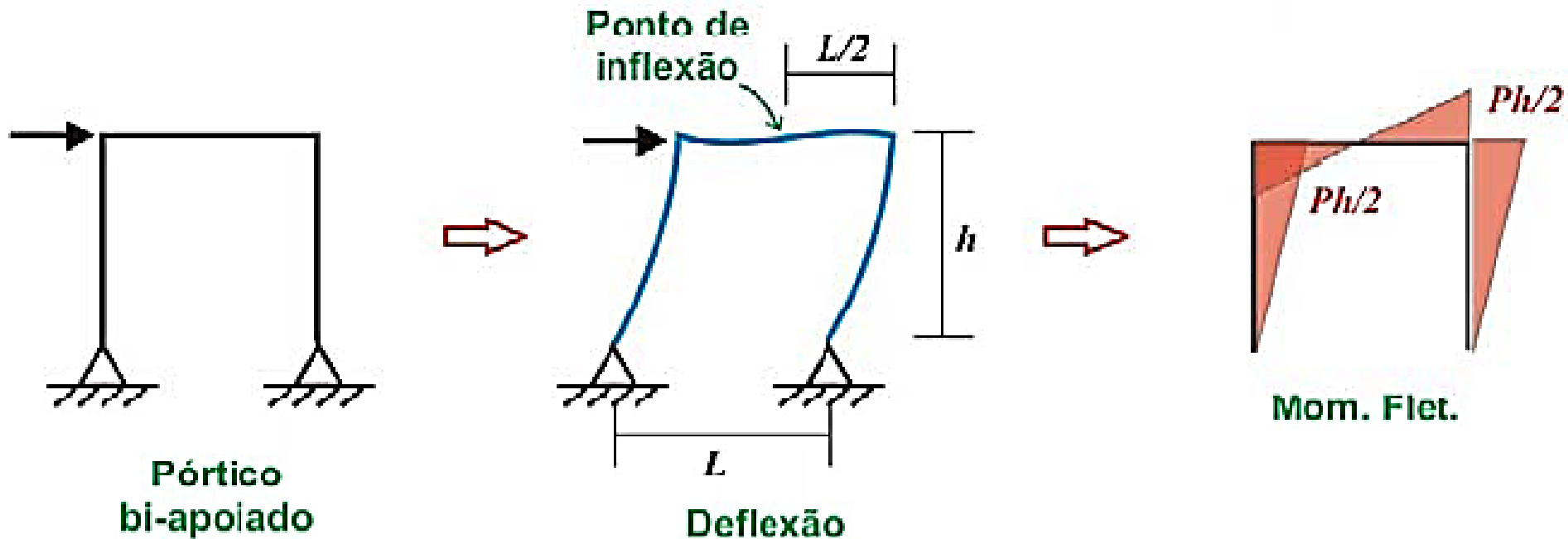


# Pavilhão industrial típico – sucessão de pórticos planos contraventados



# Estudo qualitativo de pórticos planos simples

## Pórtico biarticulado sujeito a carga lateral



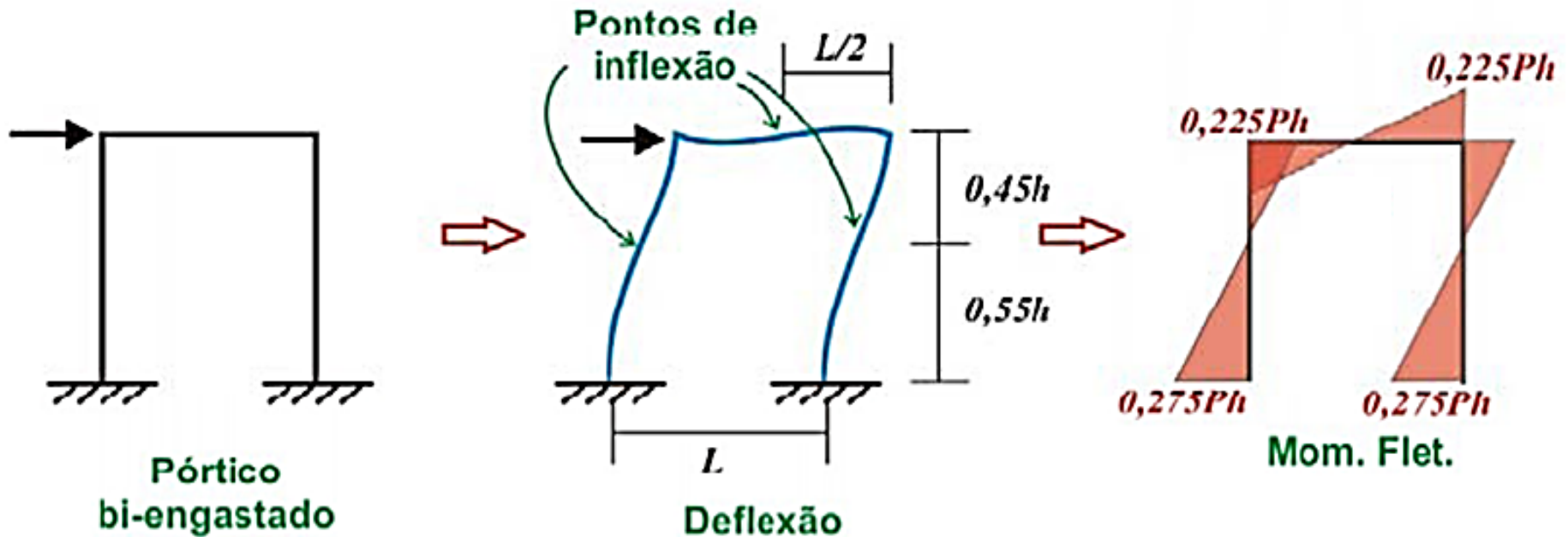
Nota: a posição assumida para o ponto de articulação decorre da anti-simetria do problema





# Estudo qualitativo de pórticos planos simples

## Pórtico biengastado sujeito a carga lateral

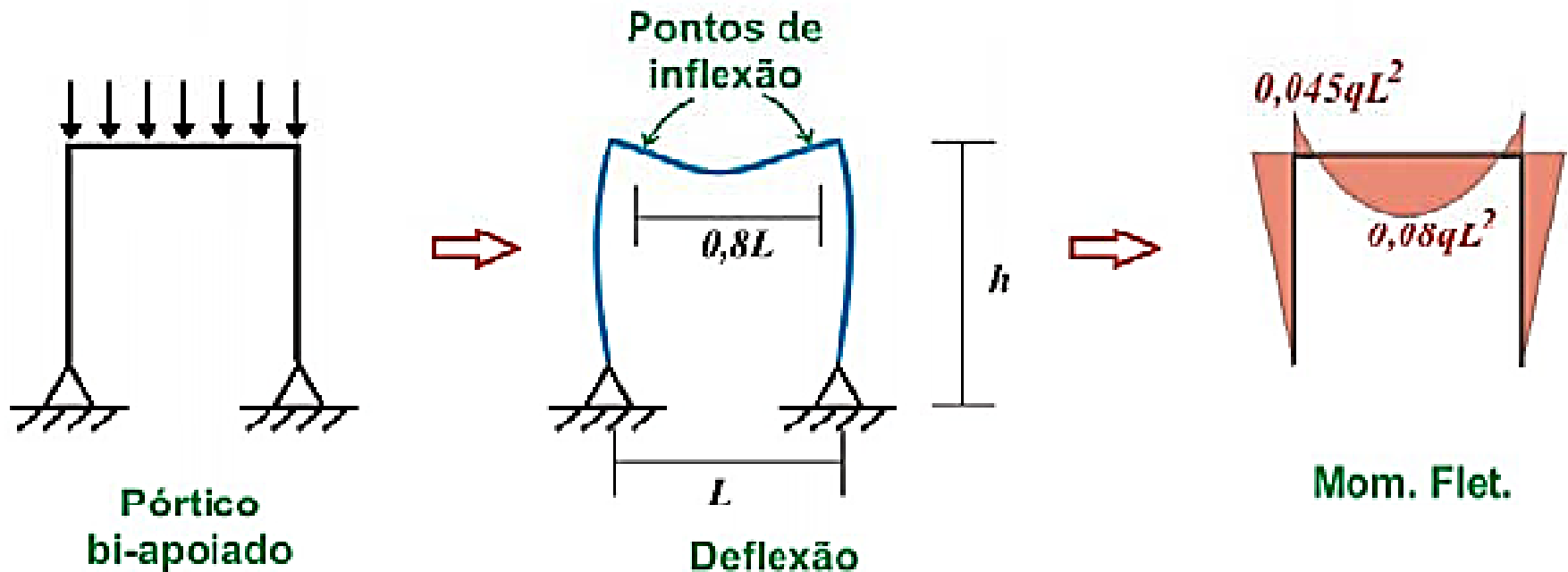


Nota: a posição assumida para os pontos de articulação decorrem de se considerar barras com a mesma rigidez à flexão



# Estudo qualitativo de pórticos planos simples

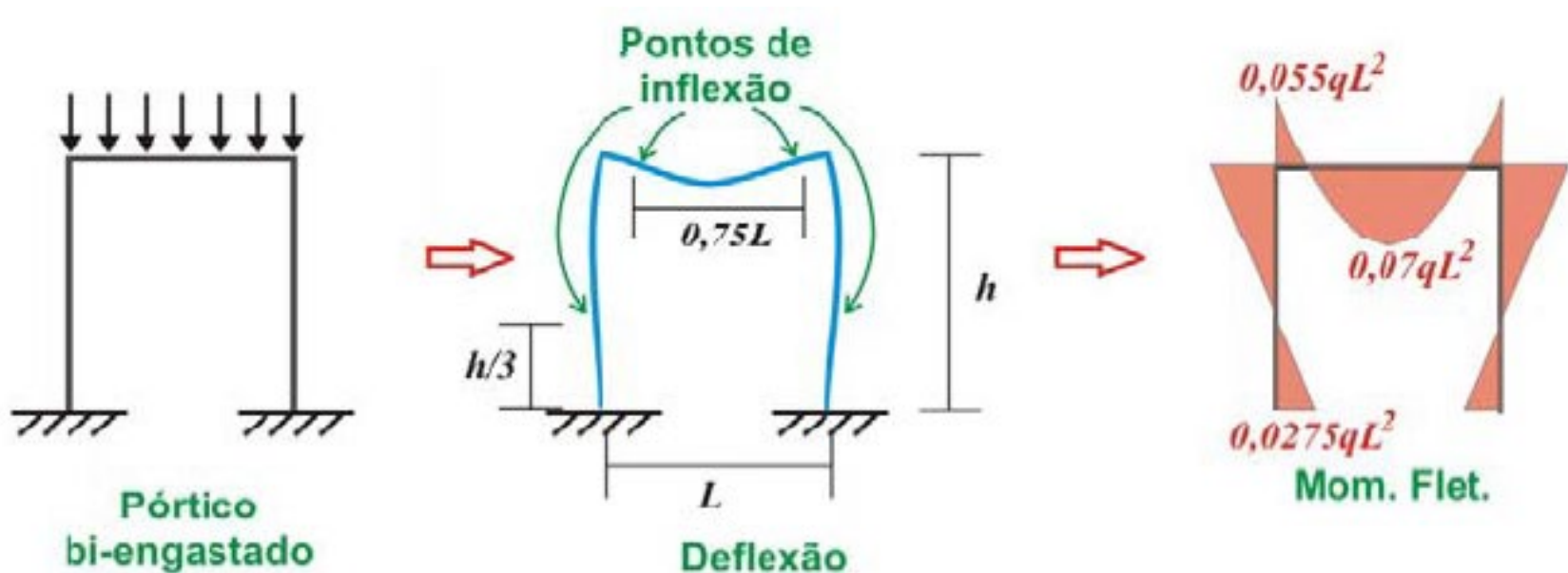
## Pórtico biarticulado sujeito a carga vertical





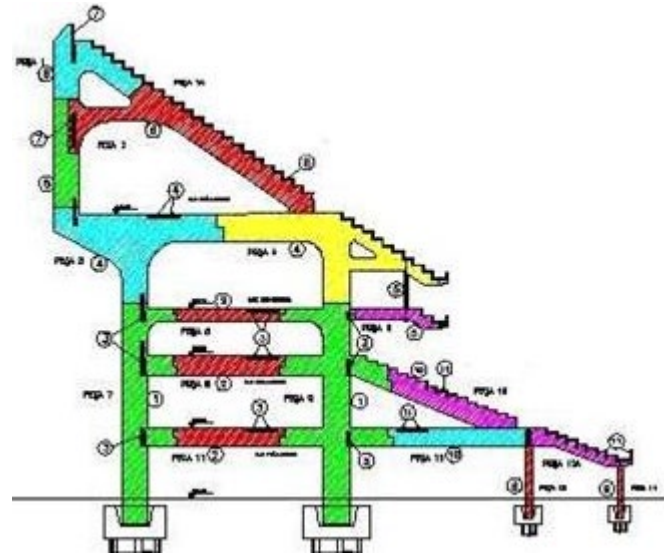
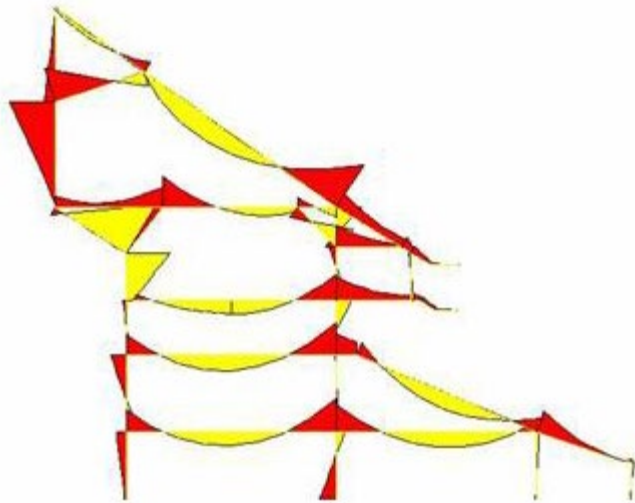
# Estudo qualitativo de pórticos planos simples

## Pórtico biengastado sujeito à carga vertical



# Pórtico de concreto pré-moldado

(Estádio Olímpico João Havelange – ou Engenhão, ou Estádio Nilton Santos, 2007).





# Vigas Vierendeel.

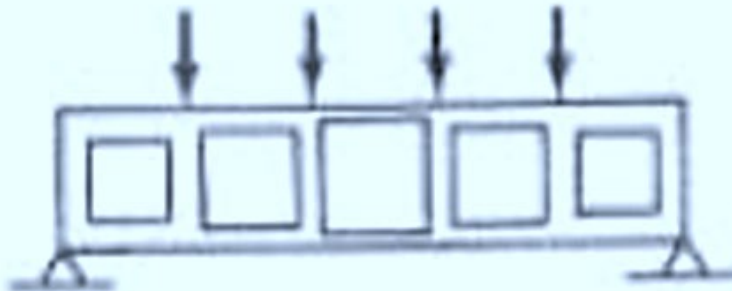
Forças normais



Momentos fletores

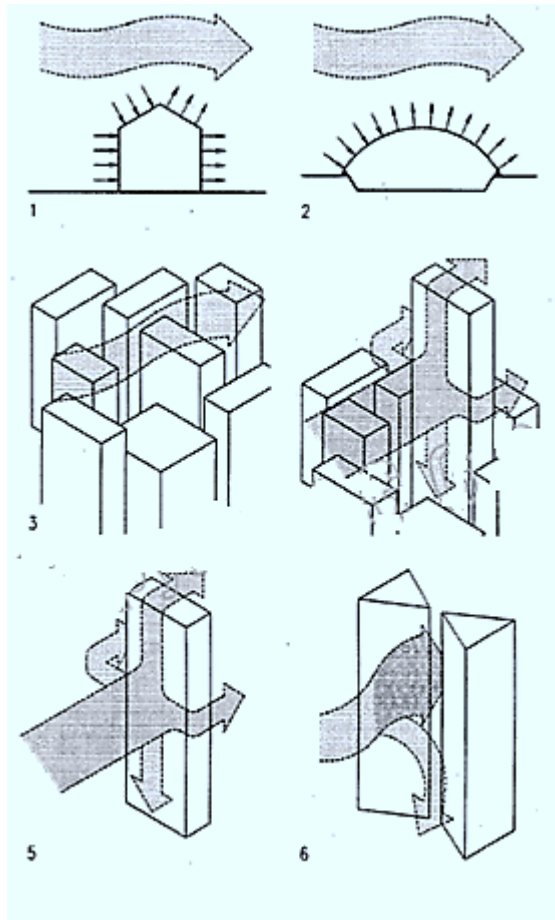


Forma

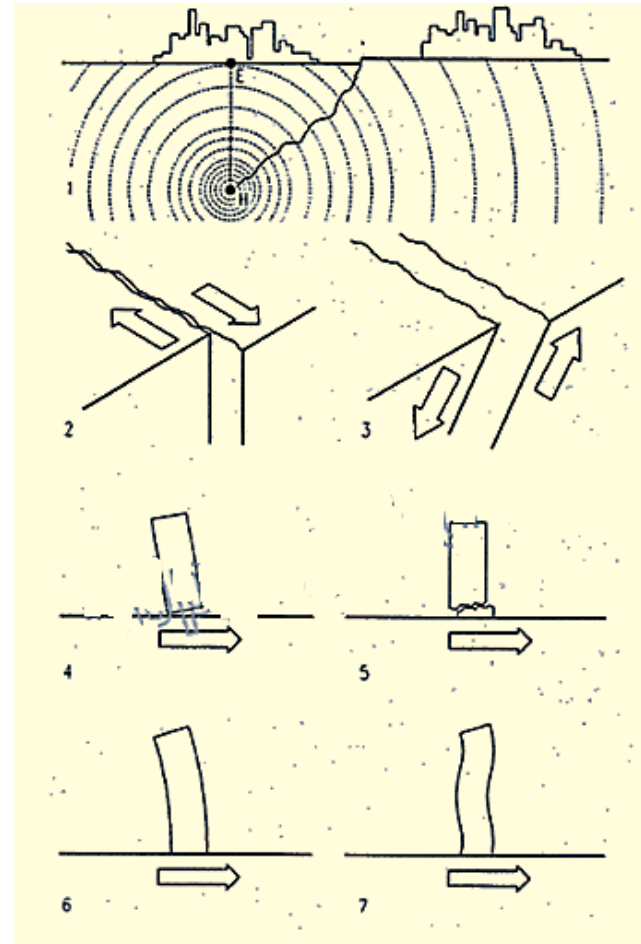


# Cargas Laterais

## Ventos



## Terremotos



Figuras extraídas de 'Architectural Structures', G.G. Schierle, 1990-2006



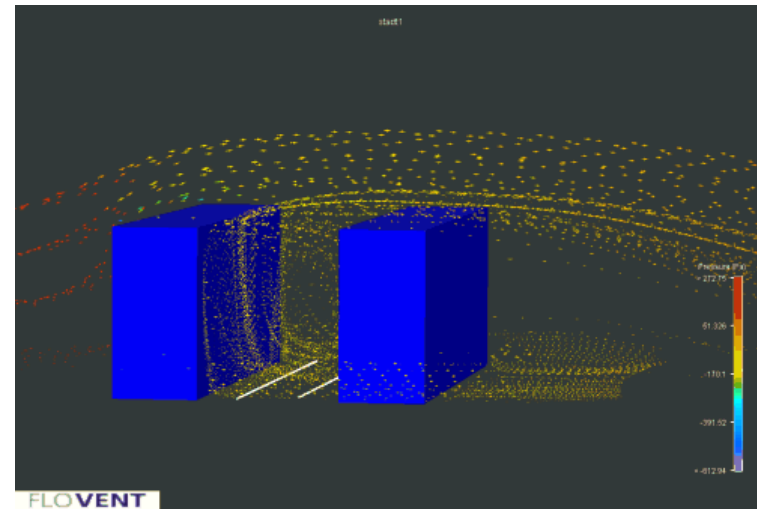
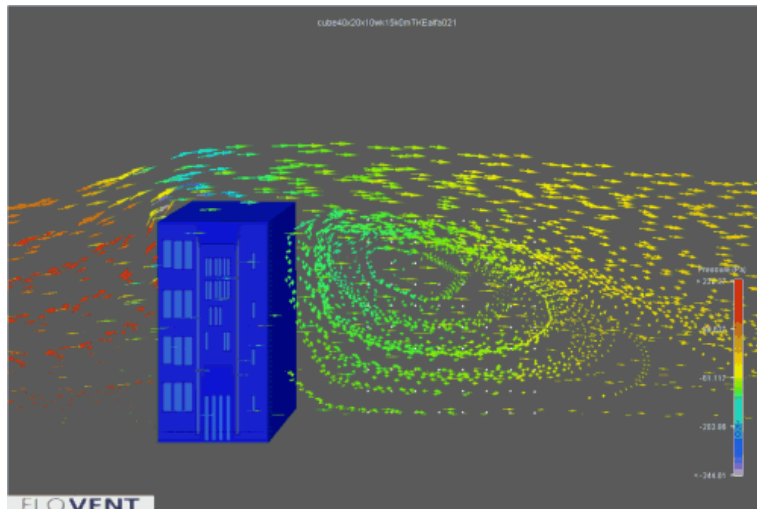
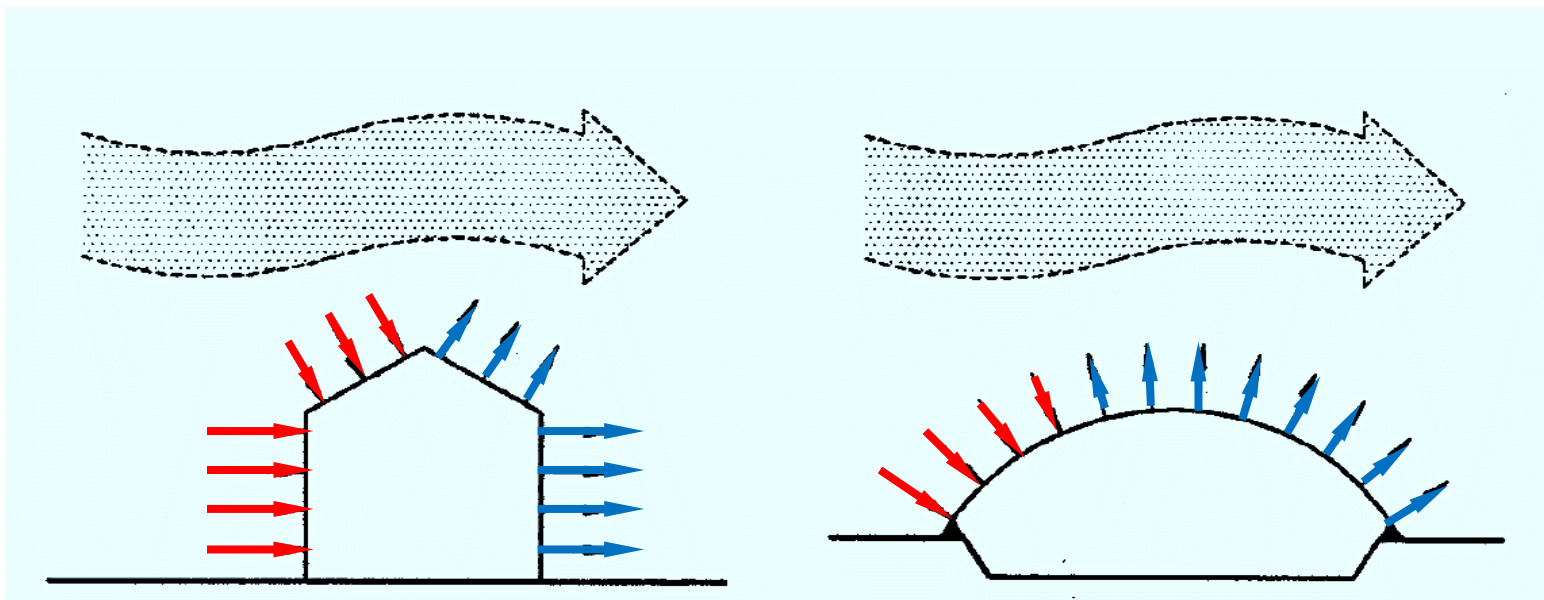


- As cargas devidas ao vento são assunto de PEF2604, onde serão estudadas de forma mais sistemática as diferentes ações sobre as estruturas em geral.



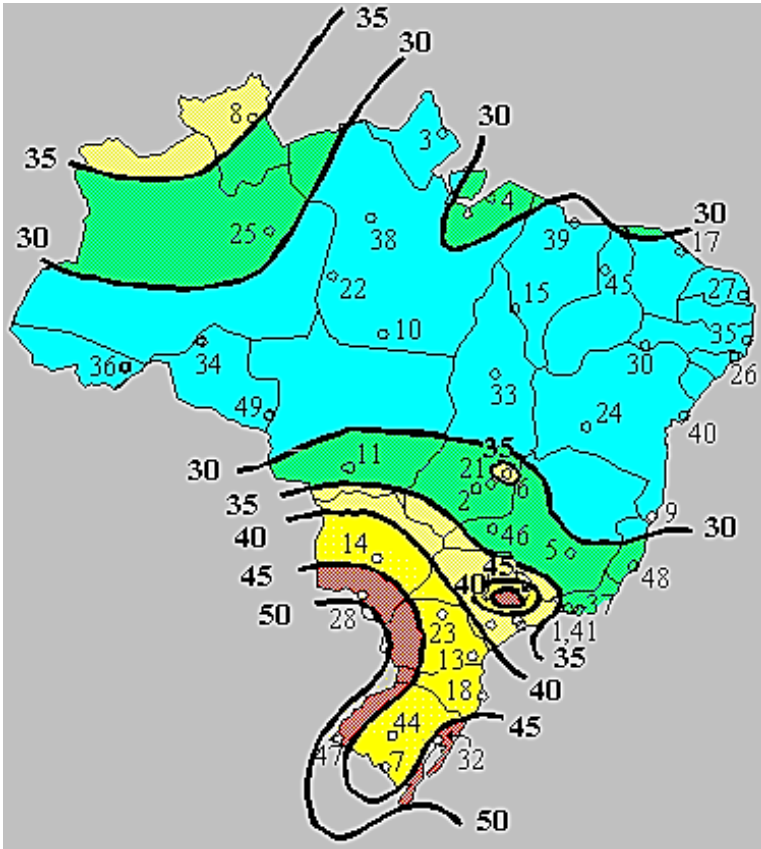
*Ventos densos na costa da Florida, permitindo a visualização de sua trajetória em torno dos edifícios  
(ref. Profs. Marcelo Leão e Moniz de Aragão IME - RJ)*







# Velocidade Básica do Vento no Brasil e pressão dinâmica NBR-6123



Isopletas de velocidade básica do vento  $v_0$  (m/s) conforme a norma NBR-6123

$v_0$ : máxima velocidade média medida sobre 3s, que pode ser excedida em média uma vez em 50 anos, a 10m sobre o nível do terreno, em lugar aberto e plano.

velocidade característica do vento (m/s):

$$V_k = v_0 S_1 S_2 S_3$$

Fator topográfico

Fator estatístico, ligado à segurança, responsabilidade e vida útil da estrutura

Fator de rugosidade do terreno e dimensões da edificação

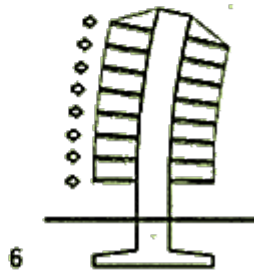
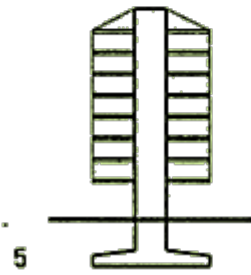
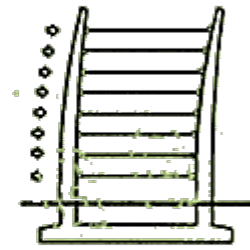
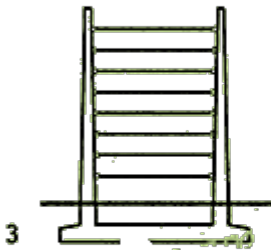
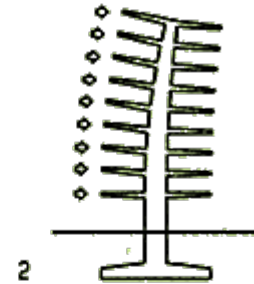
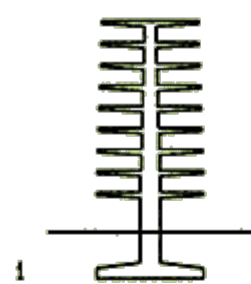
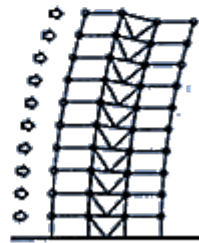
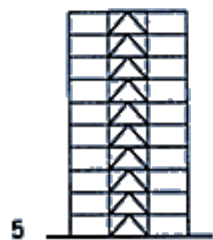
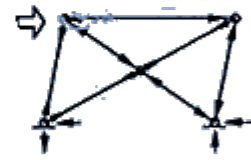
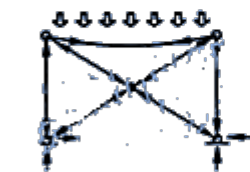
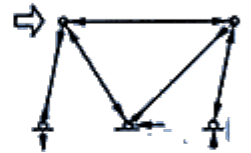
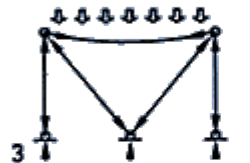
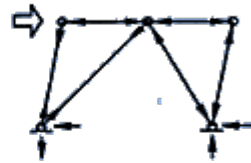
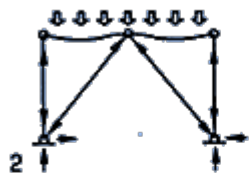
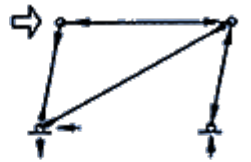
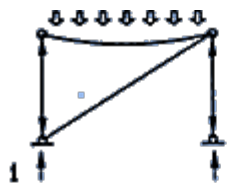
Pressão dinâmica do vento (N/m<sup>2</sup>):

$$q = \frac{1}{2} \rho_0 v_k^2 = 0,613 v_k^2$$

Coefficientes de pressão para geometrias típicas:

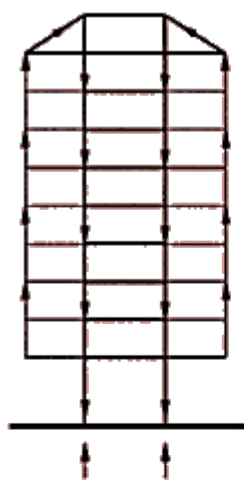
Tabela 5 - Coeficientes de pressão e de forma, externos, para telhados com duas águas, simétricos, em edificações de planta retangular

| Altura relativa   | $\theta$ | Valores de $C_{pe}$ para |      |                    |      | $c_{pe}$ médio |      |      |      |
|---|----------|--------------------------|------|--------------------|------|----------------|------|------|------|
|   |          | $\alpha = 90^\circ$ (A)  |      | $\alpha = 0^\circ$ |      |                |      |      |      |
|   |          | EF                       | GH   | EG                 | FH   |                |      |      |      |
| <br>$\frac{b}{h} \leq \frac{1}{2}$                              | 0°       | -0,8                     | -0,4 | -0,8               | -0,4 | -2,0           | -2,0 | -2,0 | --   |
|   | 5°       | -0,9                     | -0,4 | -0,8               | -0,4 | -1,4           | -1,2 | -1,2 | -1,0 |
|   | 10°      | -1,2                     | -0,4 | -0,8               | -0,6 | -1,4           | -1,4 | -1,4 | -1,2 |
|   | 15°      | -1,0                     | -0,4 | -0,8               | -0,6 | -1,4           | -1,2 | -1,2 | -1,2 |
|   | 20°      | -0,4                     | -0,4 | -0,7               | -0,6 | -1,0           | -1,0 | -1,0 | -1,2 |
|   | 30°      | 0                        | -0,4 | -0,7               | -0,6 | -0,8           | -0,8 | -0,8 | -1,1 |
| 45°   | +0,3     | -0,5                     | -0,7 | -0,6               |      |                |      | -1,1 |      |
| 60°   | +0,7     | -0,6                     | -0,7 | -0,6               |      |                |      | -1,1 |      |
| <br>$\frac{1}{2} \frac{b}{h} \leq \frac{a}{h} \leq \frac{3}{2}$ | 0°       | -0,8                     | -0,6 | -1,0               | -0,6 | -2,0           | -2,0 | -2,0 | --   |
|   | 5°       | -0,9                     | -0,6 | -0,9               | -0,6 | -2,0           | -2,0 | -1,5 | -1,0 |
|   | 10°      | -1,1                     | -0,6 | -0,8               | -0,6 | -2,0           | -2,0 | -1,5 | -1,2 |
|   | 15°      | -1,0                     | -0,6 | -0,8               | -0,6 | -1,8           | -1,5 | -1,5 | -1,2 |
|   | 20°      | -0,7                     | -0,5 | -0,8               | -0,6 | -1,5           | -1,5 | -1,5 | -1,0 |
|   | 30°      | -0,2                     | -0,5 | -0,8               | -0,8 | -1,0           | -1,0 | -1,0 | -1,0 |
| 45°   | +0,2     | -0,5                     | -0,8 | -0,8               |      |                |      |      |      |
| 60°   | +0,6     | -0,5                     | -0,8 | -0,8               |      |                |      |      |      |
| <br>$\frac{3}{2} \frac{b}{h} \leq e$                            | 0°       | -0,8                     | -0,6 | -0,9               | -0,7 | -2,0           | -2,0 | -2,0 | --   |
|   | 5°       | -0,8                     | -0,6 | -0,8               | -0,8 | -2,0           | -2,0 | -1,5 | -1,0 |
|   | 10°      | -0,8                     | -0,6 | -0,8               | -0,8 | -2,0           | -2,0 | -1,5 | -1,2 |
|   | 15°      | -0,8                     | -0,6 | -0,8               | -0,8 | -1,8           | -1,8 | -1,5 | -1,2 |
|   | 20°      | -0,8                     | -0,6 | -0,8               | -0,8 | -1,5           | -1,5 | -1,5 | -1,2 |
|   | 30°      | -1,0                     | -0,5 | -0,8               | -0,7 | -1,5           | -1,5 | -1,5 | -1,2 |
| 40°   | -0,2     | -0,5                     | -0,8 | -0,7               | -1,0 | -1,0           | -1,0 | -1,0 |      |
| 50°   | +0,2     | -0,5                     | -0,8 | -0,7               |      |                |      |      |      |
| 60°   | +0,5     | -0,5                     | -0,8 | -0,7               |      |                |      |      |      |

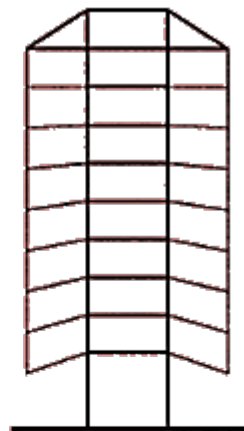


Figuras extraídas de 'Architectural Structures', G.G. Schierle, 1990-2006

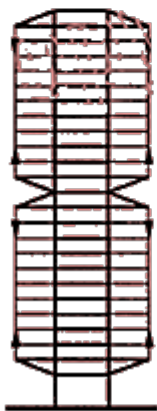




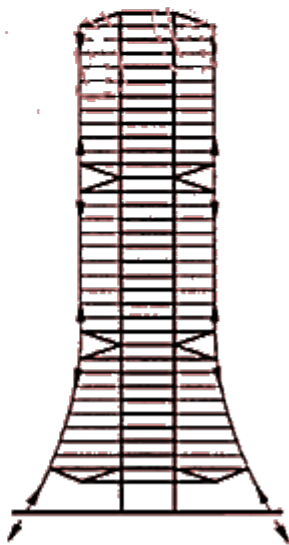
1



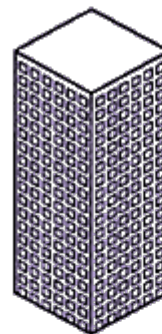
2



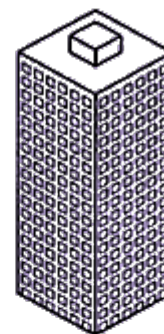
3



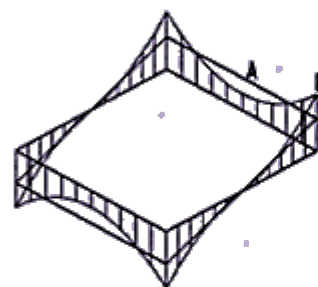
4



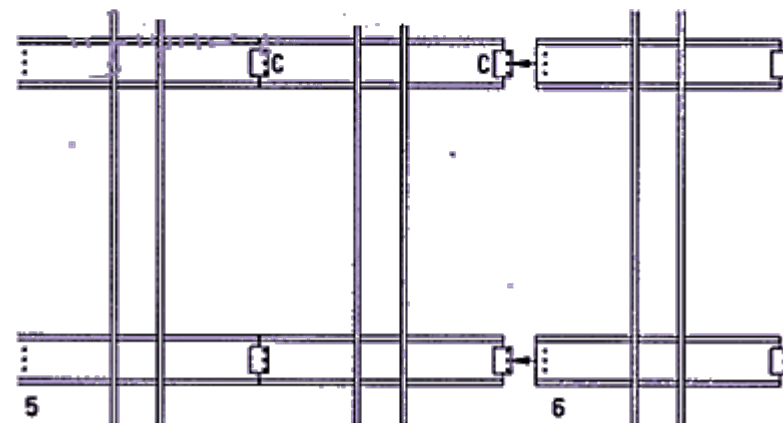
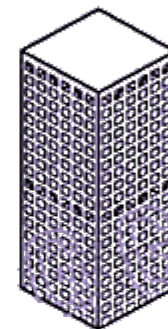
1



2



3



5

6

Figuras extraídas de 'Architectural Structures', G.G. Schierle, 1990-2006

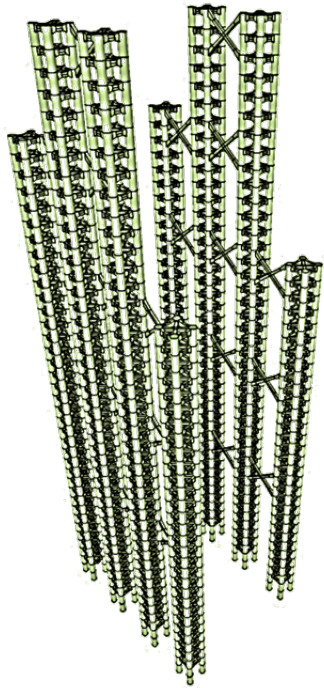




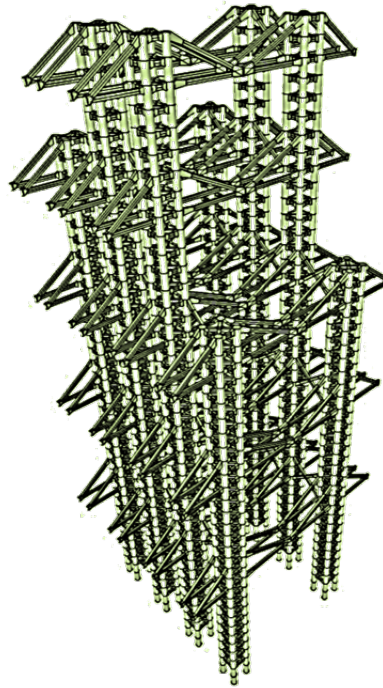
# Hong Kong and Shanghai Bank Headquarters, Hong Kong, Foster + Partners, 1986



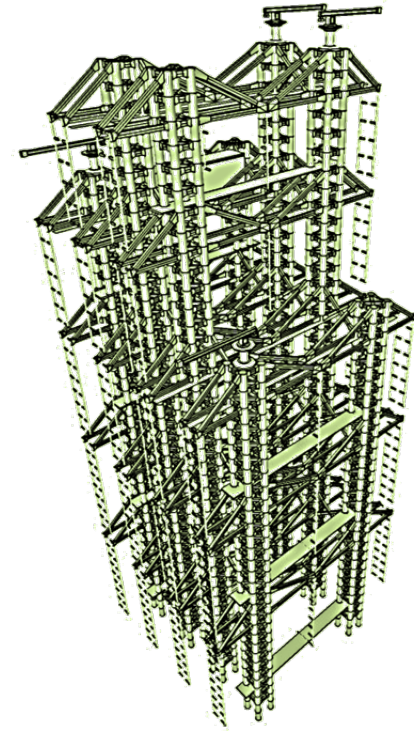
# Hong Kong and Shanghai Bank Headquarters, Hong Kong, Foster + Partners, 1986



Mast



Truss



Cantilever

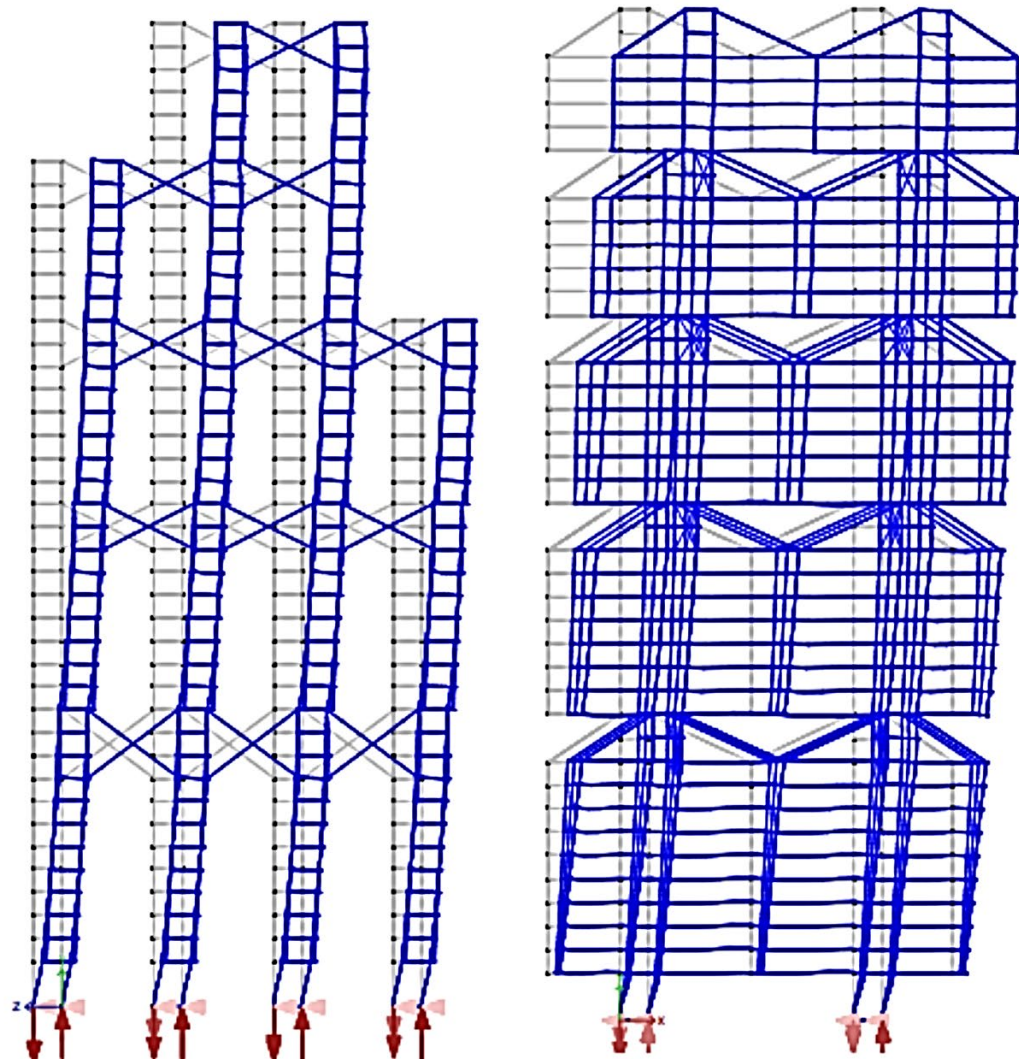
Ref.: 'HSBC - Hong Kong and Shanghai Banking Corporation',  
Yiming Guan, Yang Cao, Fu Chen,





## Deflection Diagram

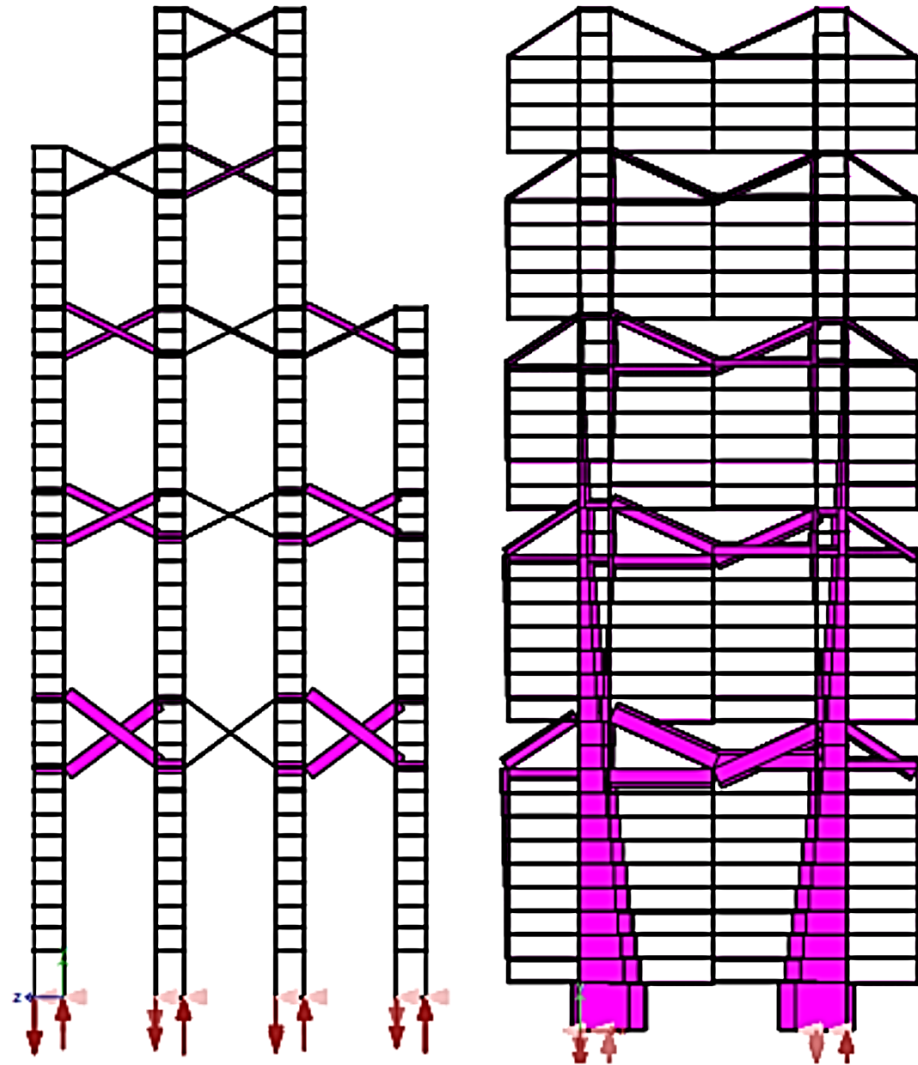
- a. Front wind
- b. Side wind





# Axial Force Diagram

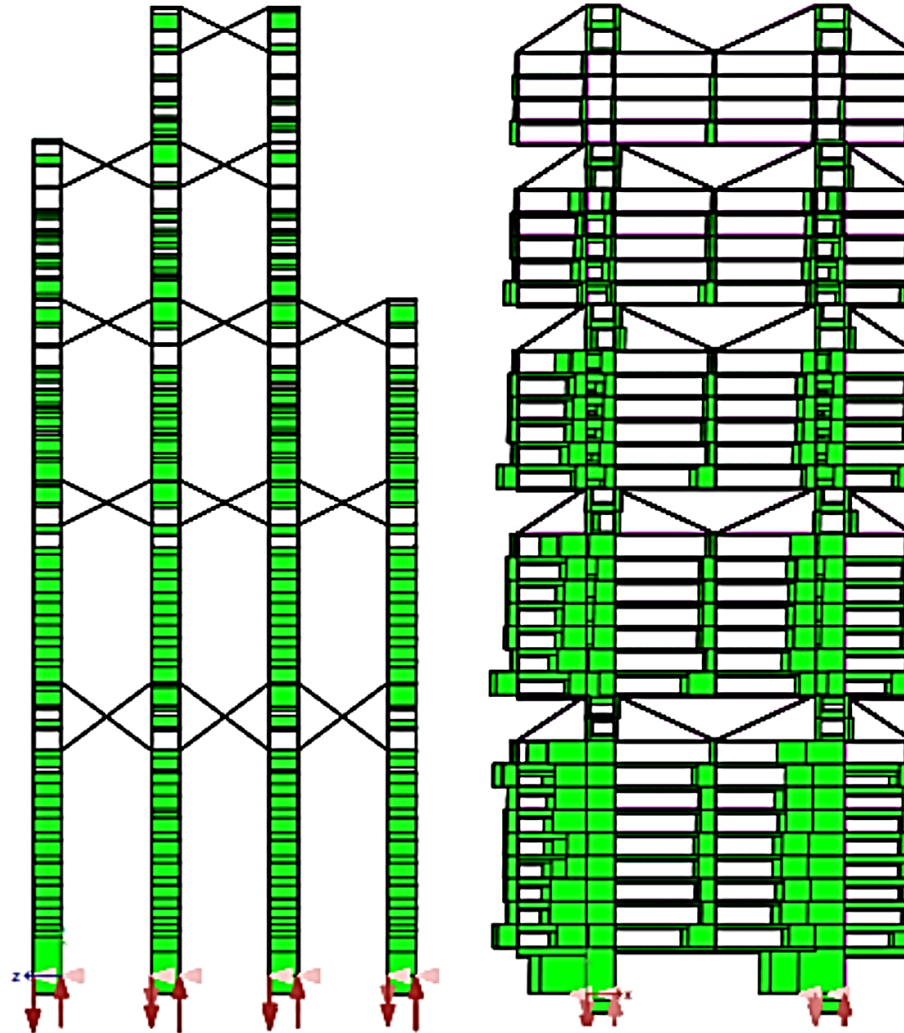
- a. Front wind
- b. Side wind



## Shear Diagram

a. Front wind

b. Side wind



## Moment Diagram

a. Front wind

b. Side wind

