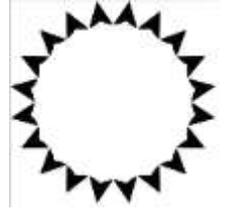




*PEF2602*  
*Estruturas na Arquitetura I I - Sistemas Reticulados*



# *Pórticos*

*(Aula 11 - 05/11/2018)*

*Professores*

*Ruy Marcelo Pauletti, Leila Meneghetti Valverdes, Luís Antônio Bittencourt Jr.*

*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*



*Adaptado de "The Top 15 Skylines in the World v3.0" ([www.diserio.com](http://www.diserio.com))*



*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*



*Tokyo, Japan: Metro/Urban Population: 34.0 million*



*Toronto, Canada: Metro/Urban Population: 5.5 million*



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



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



*Seattle, USA: Metro/Urban Population: 3.7 millions*



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



*Seoul, South Korea: Metro/Urban Population: 22 million*

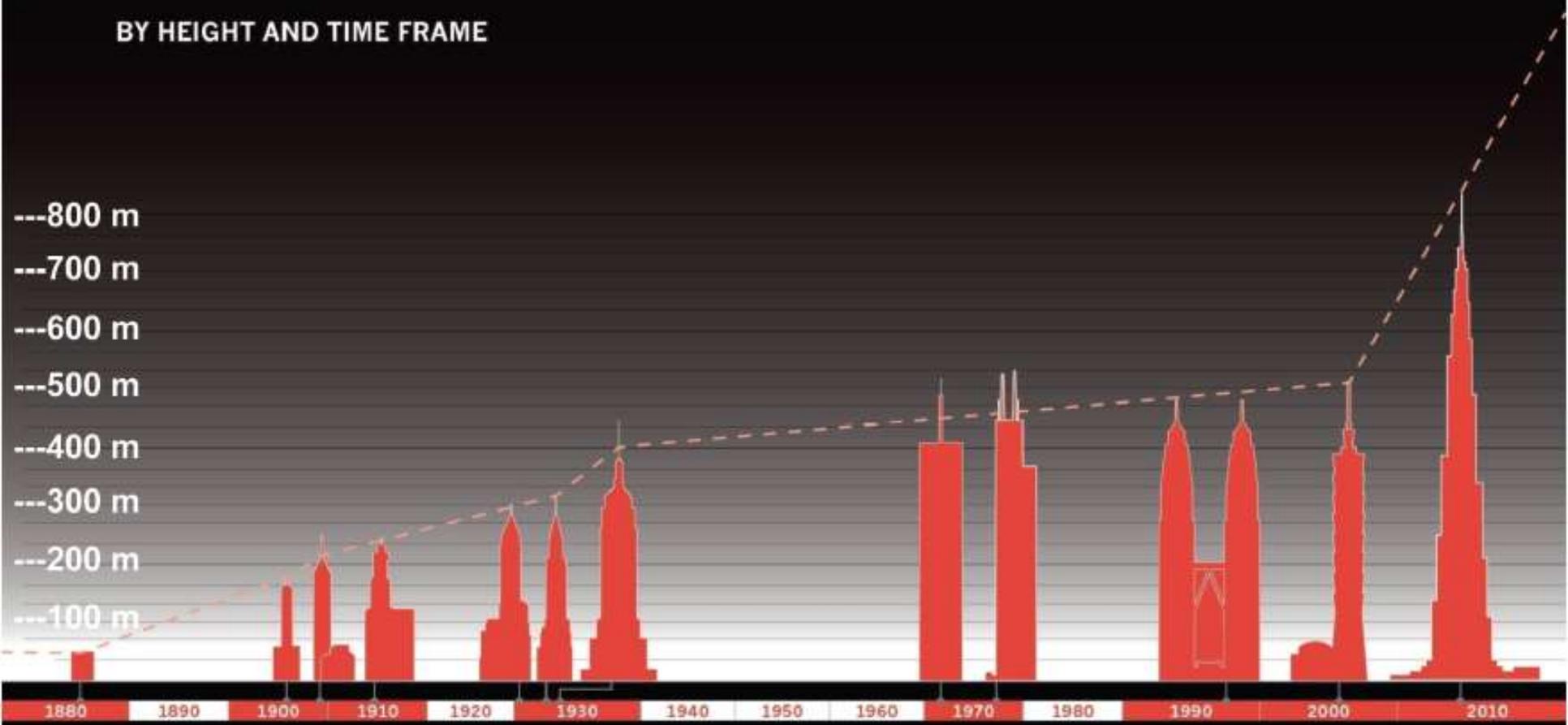


*Sidney, Australia: Metro/Urban Population: 4.2 million*



# SKYSCRAPERS

BY HEIGHT AND TIME FRAME



Home Insurance, 1885, 42m

Singer Building, 1908, 187m

Met Life, 1909, 246m

Woolworth Building, 1913, 241m

Trump Building, 1930, 299m

Chrysler Building, 1930, 319m

Empire State Building, 1931, 381m

World Trade Center, 1972, 417m

Willis Tower, 1974, 442m

Petronas Tower 1 & 2, 1998, 452m

Taipei 101, 2004, 509m

Burj Khalifa, 2010, 828m

# WORLD'S TALLEST BUILDING



SINGER BUILDING  
1908

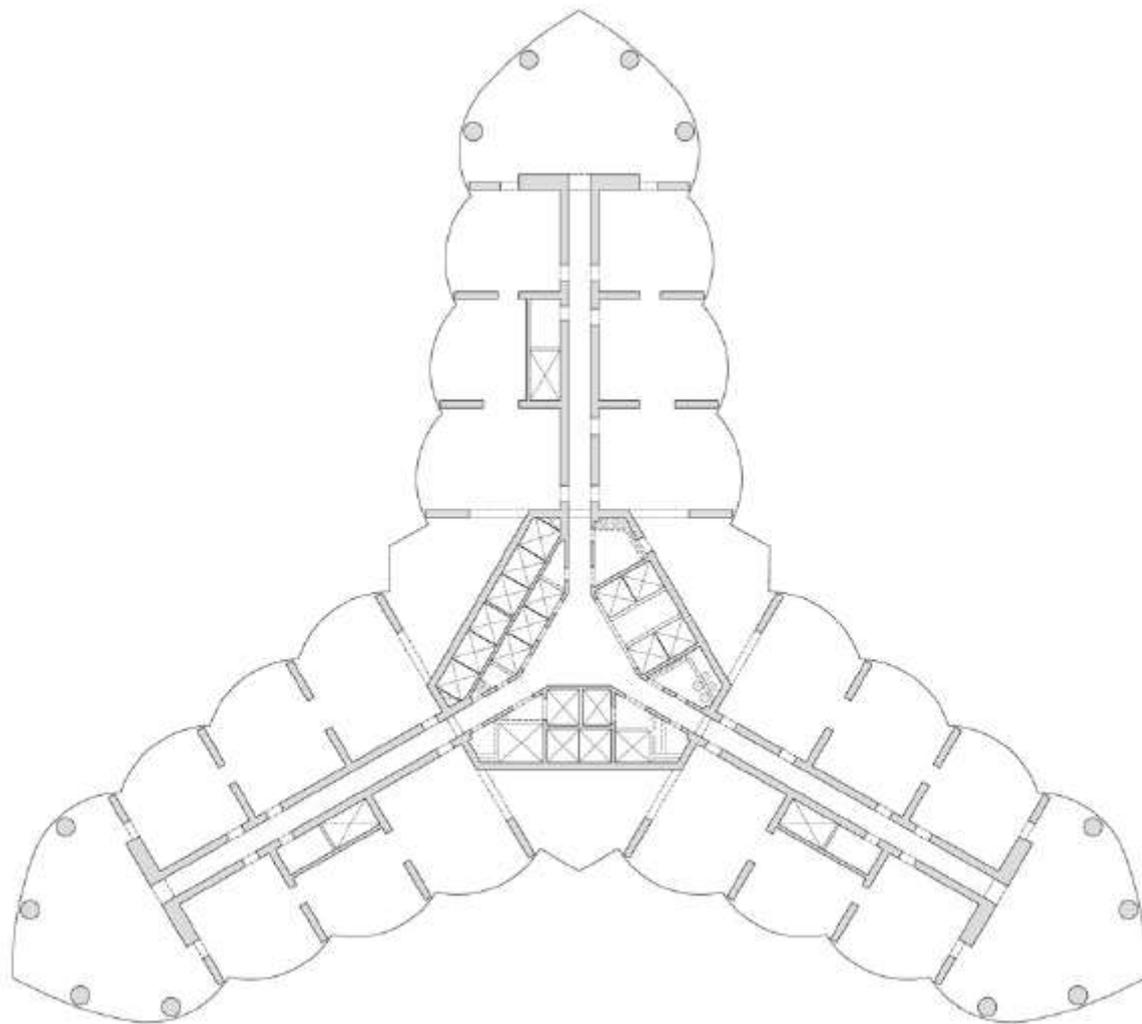
BURJ KHALIFA  
2010





*PEF2602 : Estruturas na Arquitetura I I - Sistemas Reticulados*









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

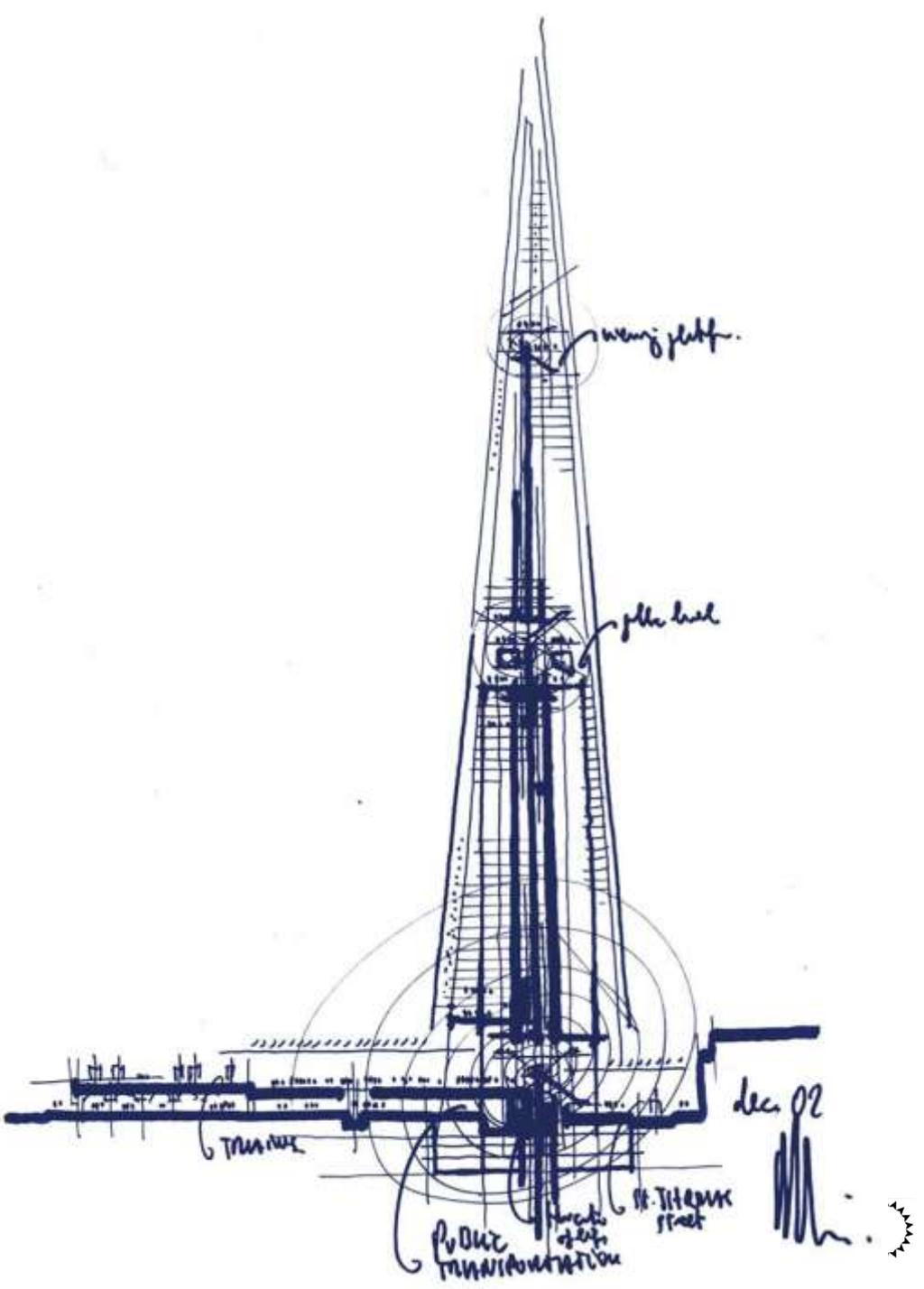


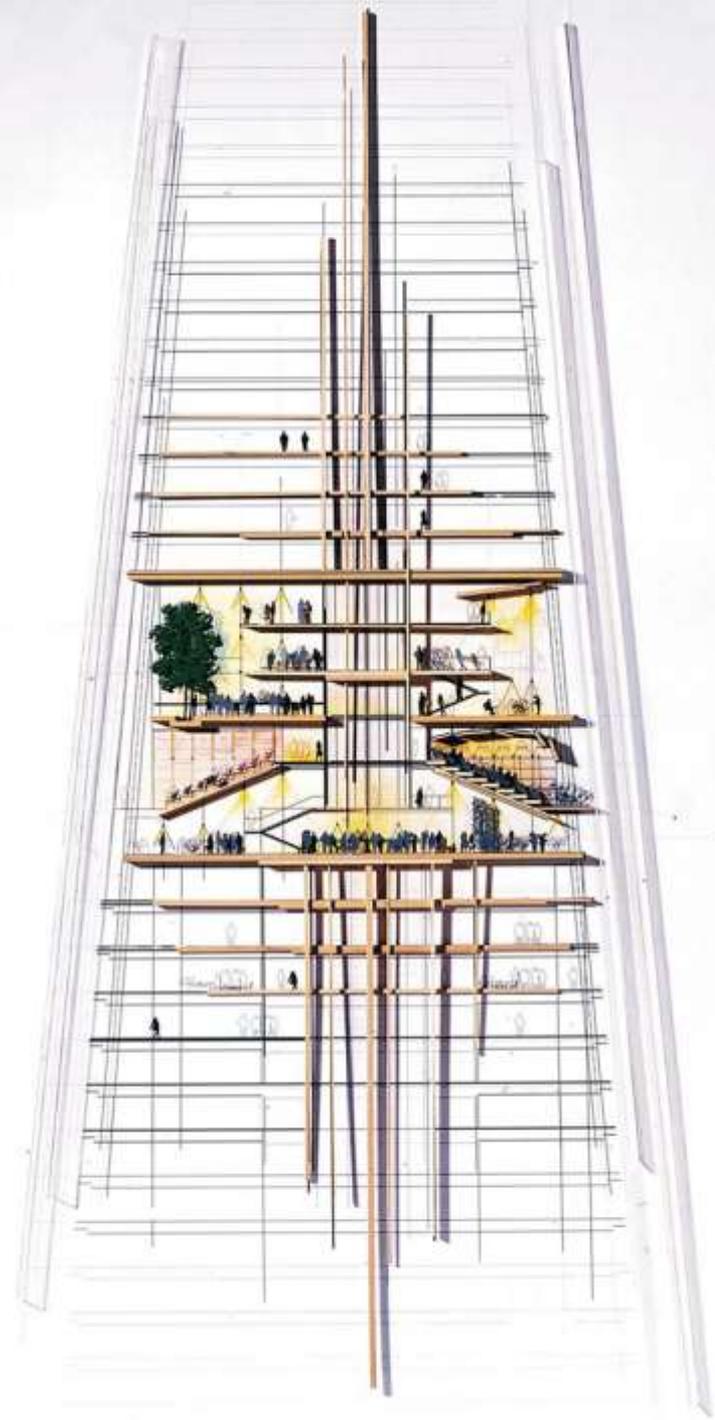
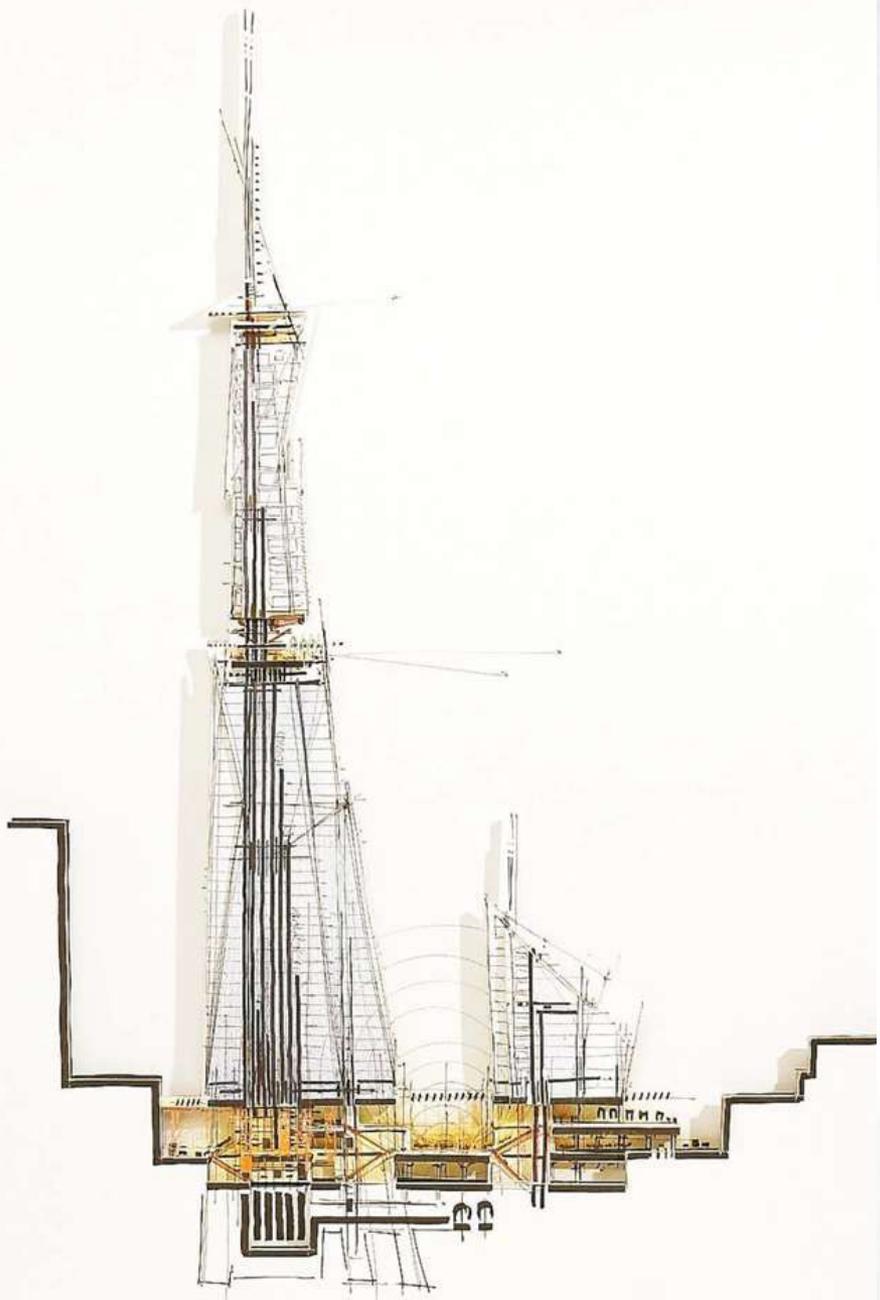






Estri

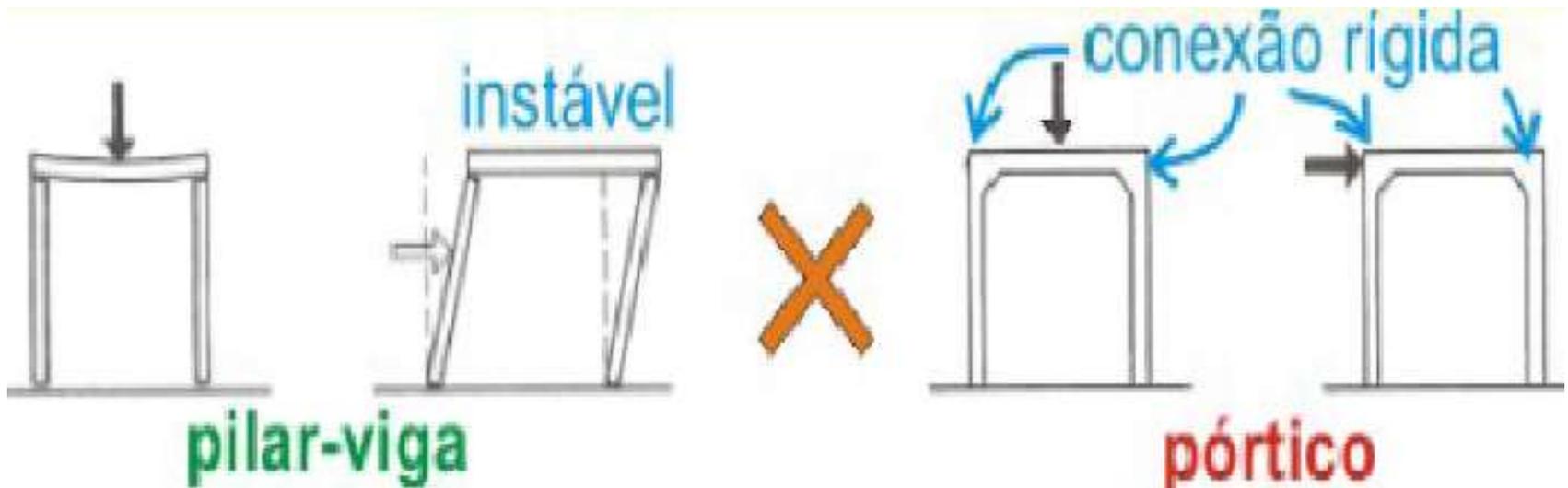




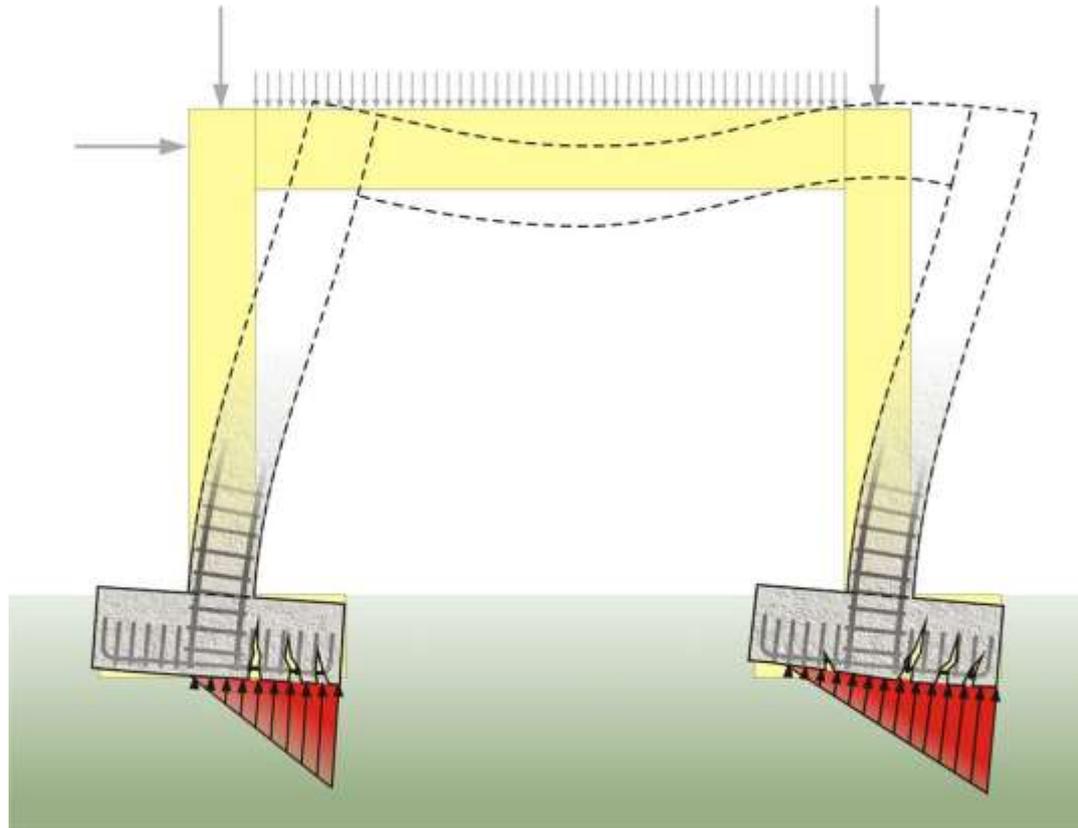
# Pórticos

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').

Os membros de um pórtico são em geral capazes de resistir a esforços normais, cortante e de flexão, e são comumente empregados em padrões repetitivos, resultando em estruturas hiperestáticas.

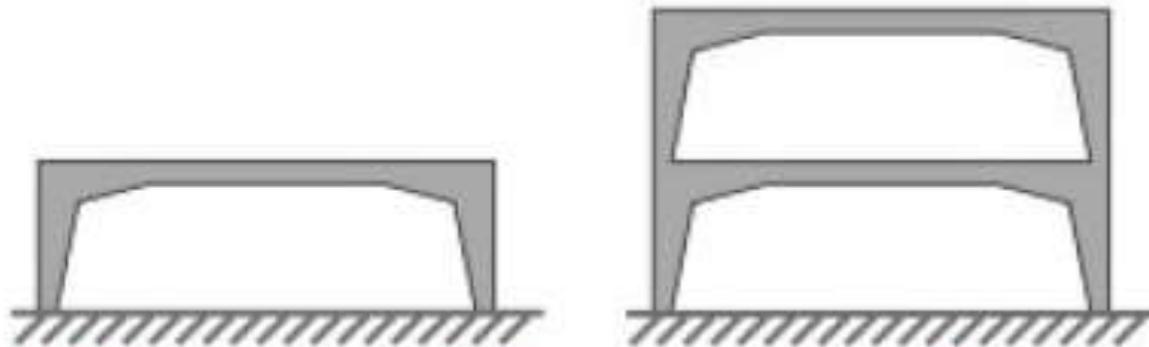


# Pórticos





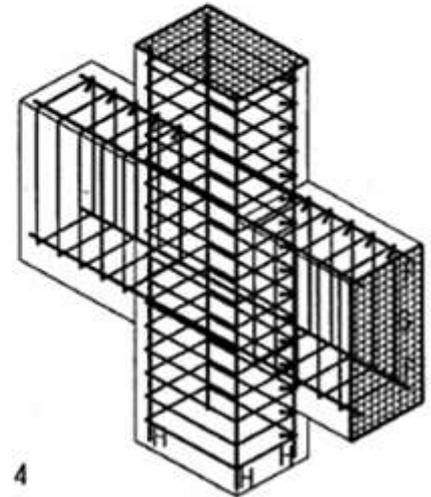
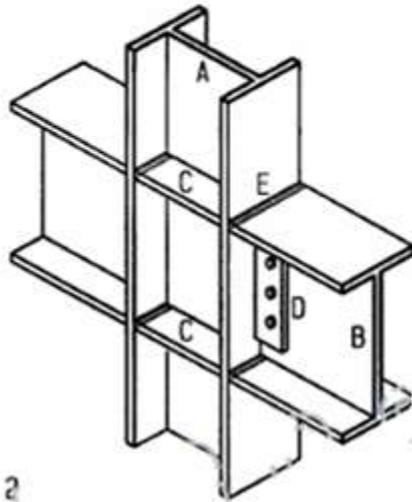
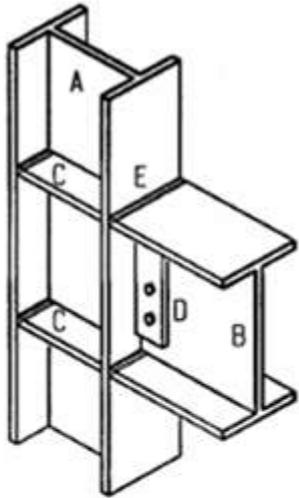
## Pórticos Metálicos



## Pórticos em Concreto Armado



# Nós de Pórticos

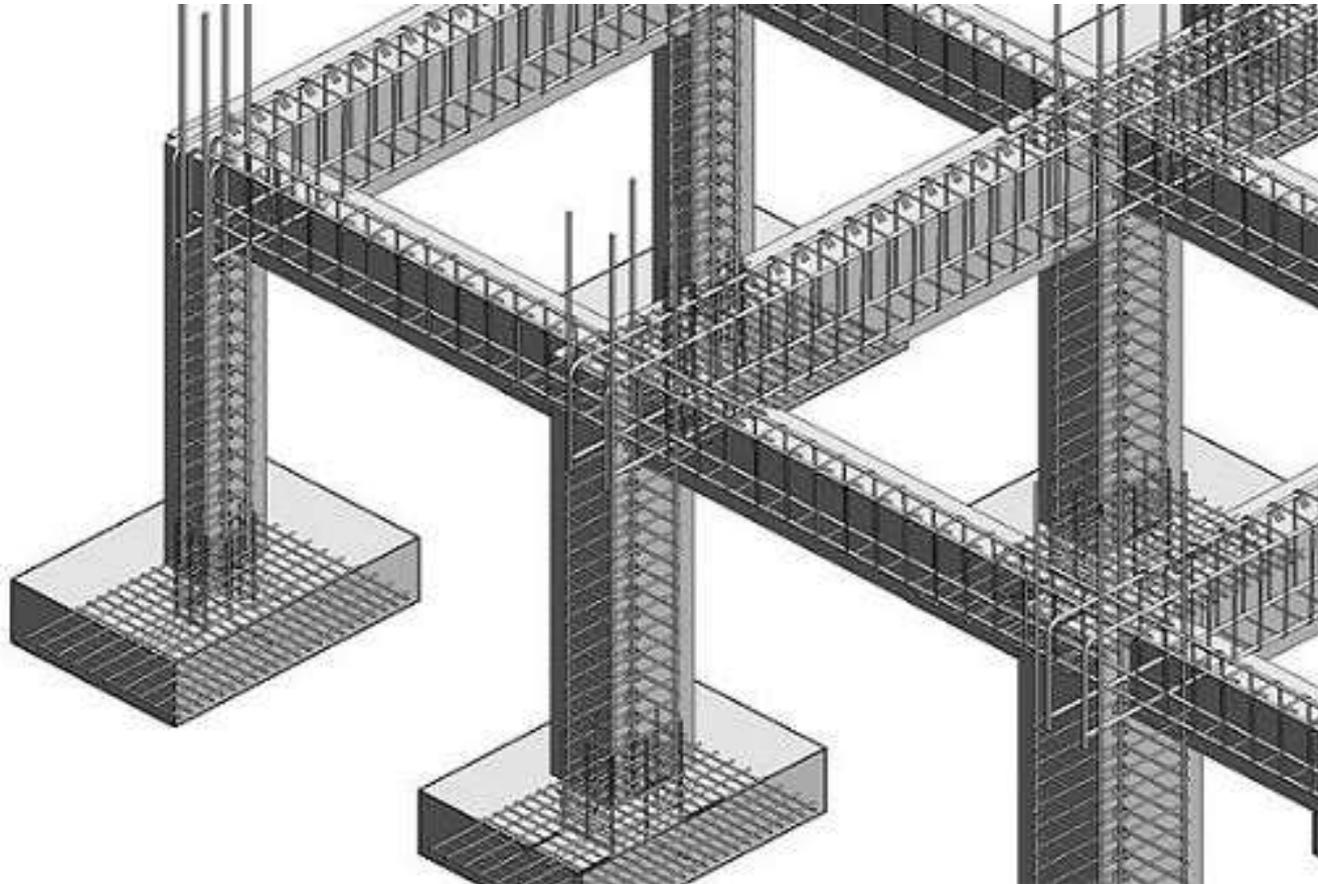


*Estruturas Metálicas*

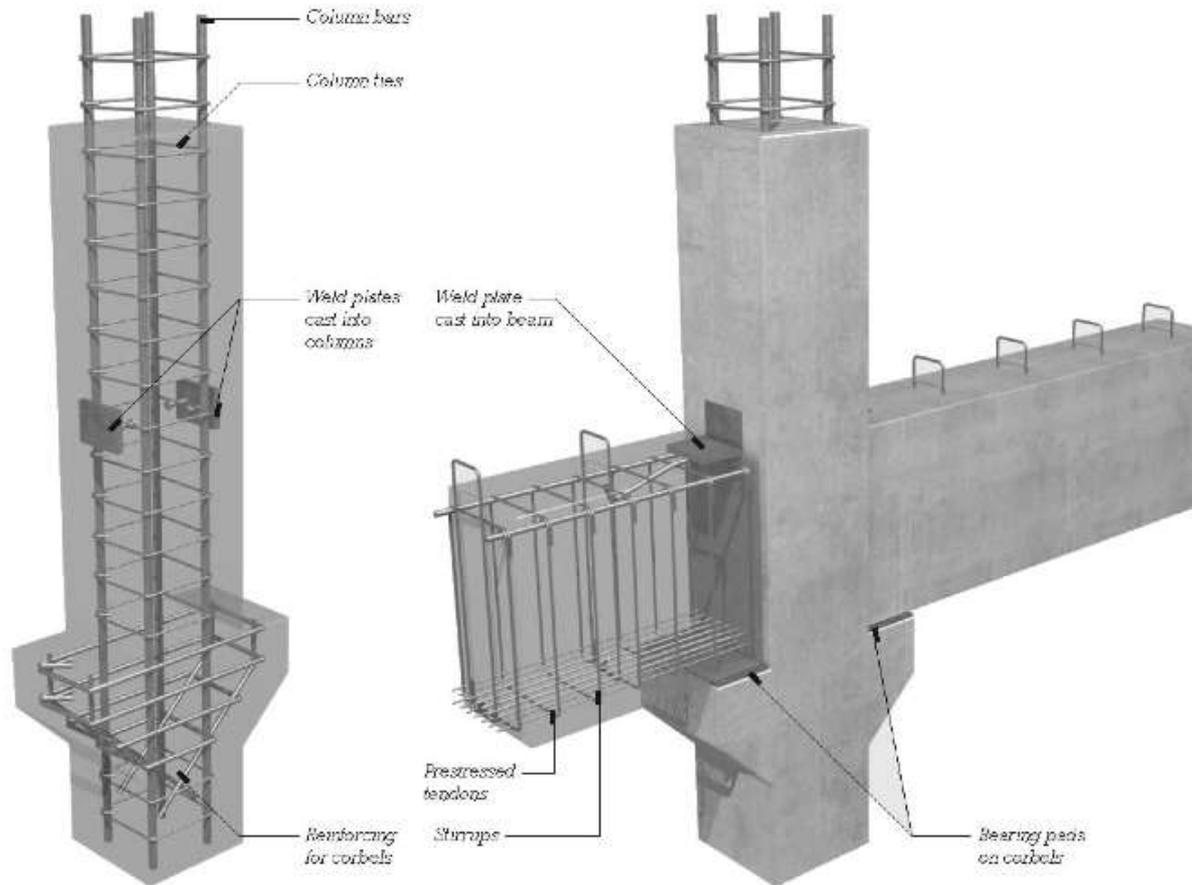
*Concreto Armado*



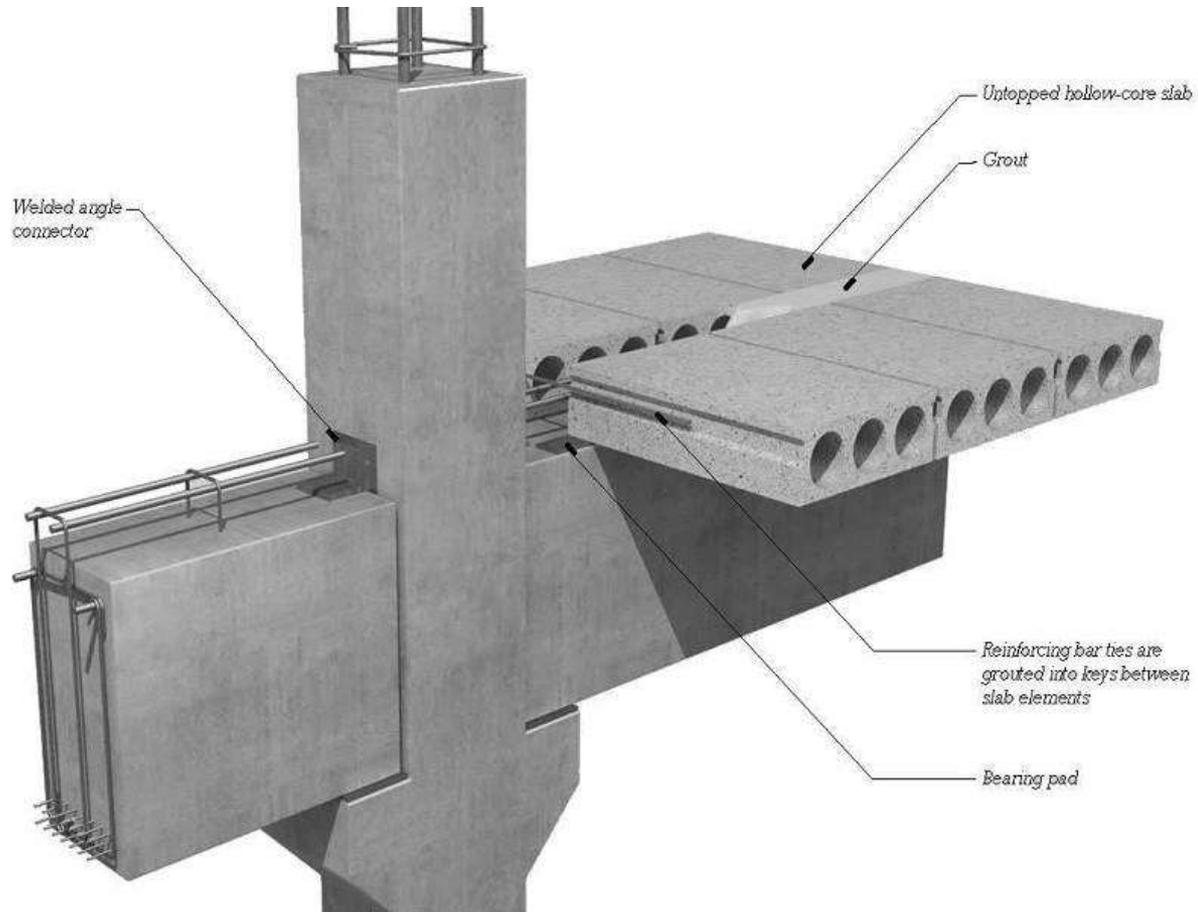
# *Pórticos de concreto armado*



# Pórticos de concreto armado pré-moldado



# Pórticos de concreto armado pré-moldado

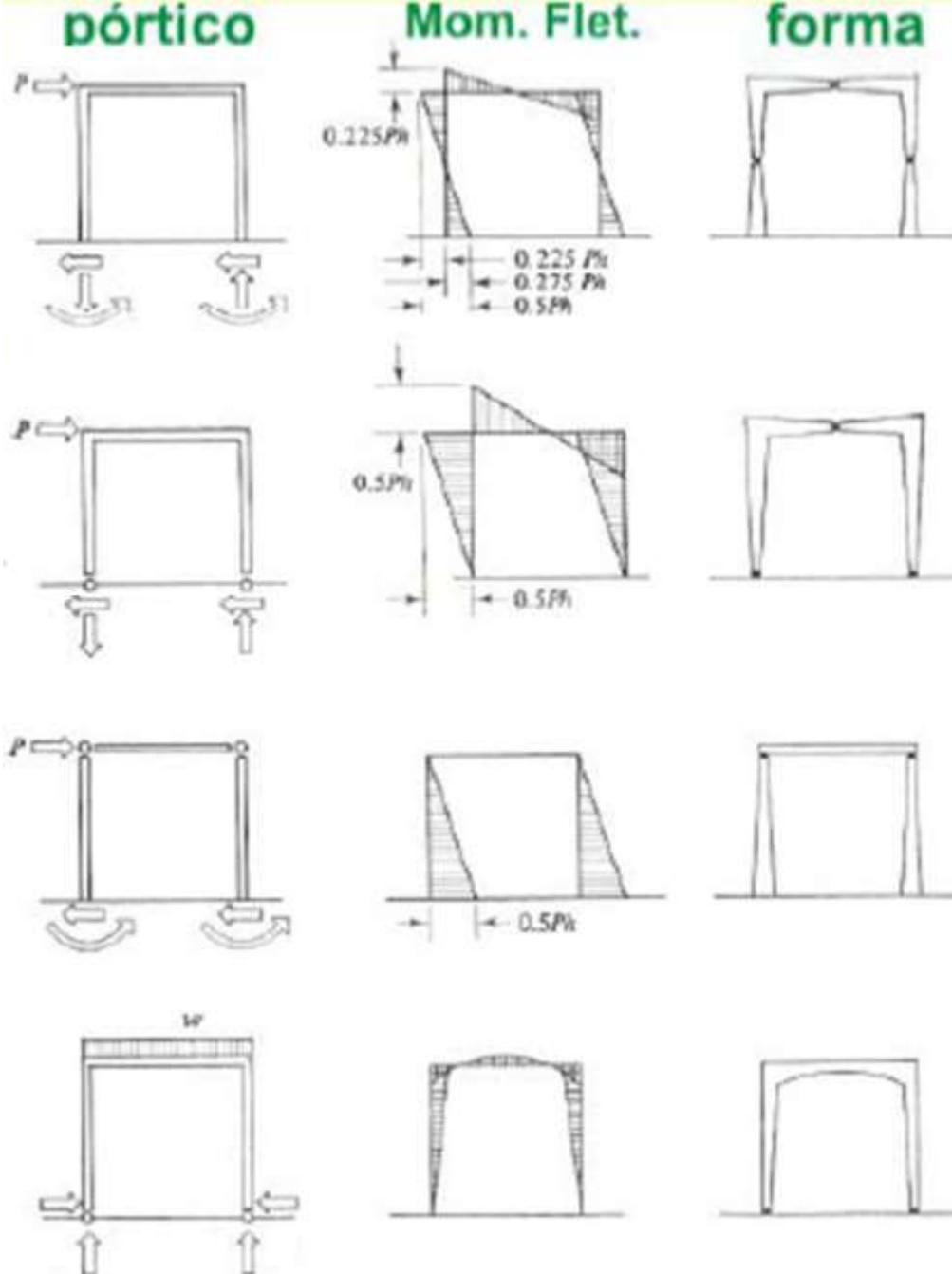


A distribuição dos esforços em um pórtico depende fortemente da vinculação da estrutura!

Juntas podem ser inseridas, tomando partido dos pontos de momento fletor nulo!

Nota: nesta figura, os momentos fletores estão desenhados conforme a convenção americana (do lado comprimido).

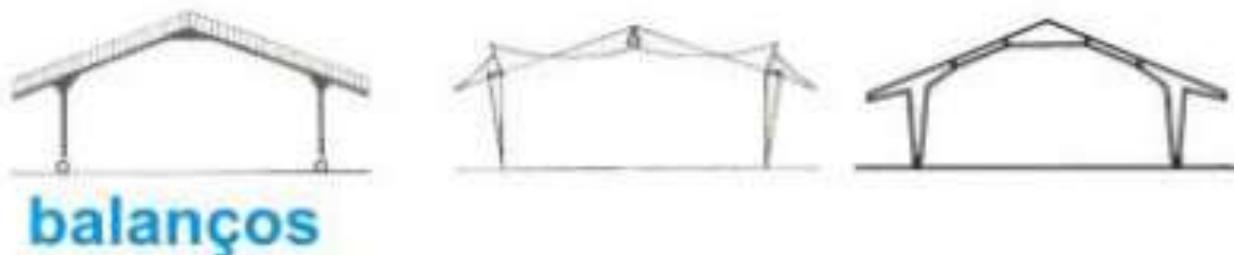
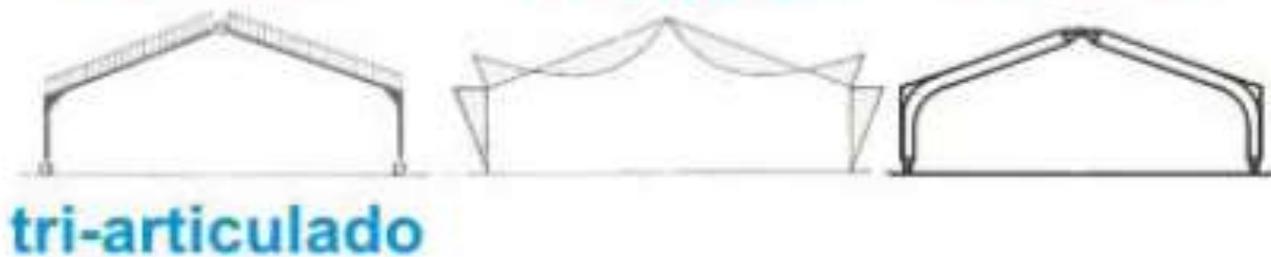
Ref. Shodek, Structures, 1992.



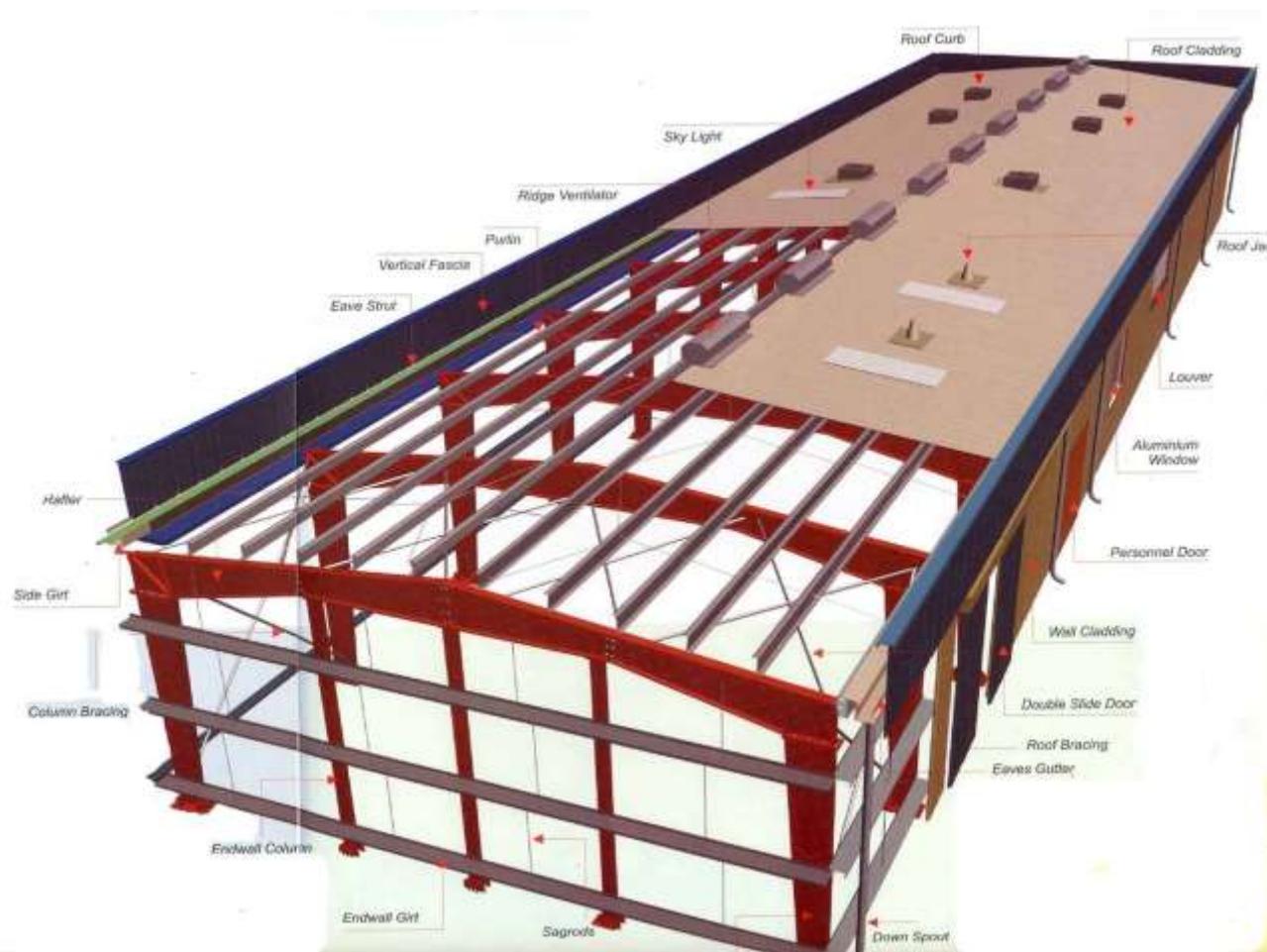
**pórtico**

**Momentos  
Fletores**

**forma**

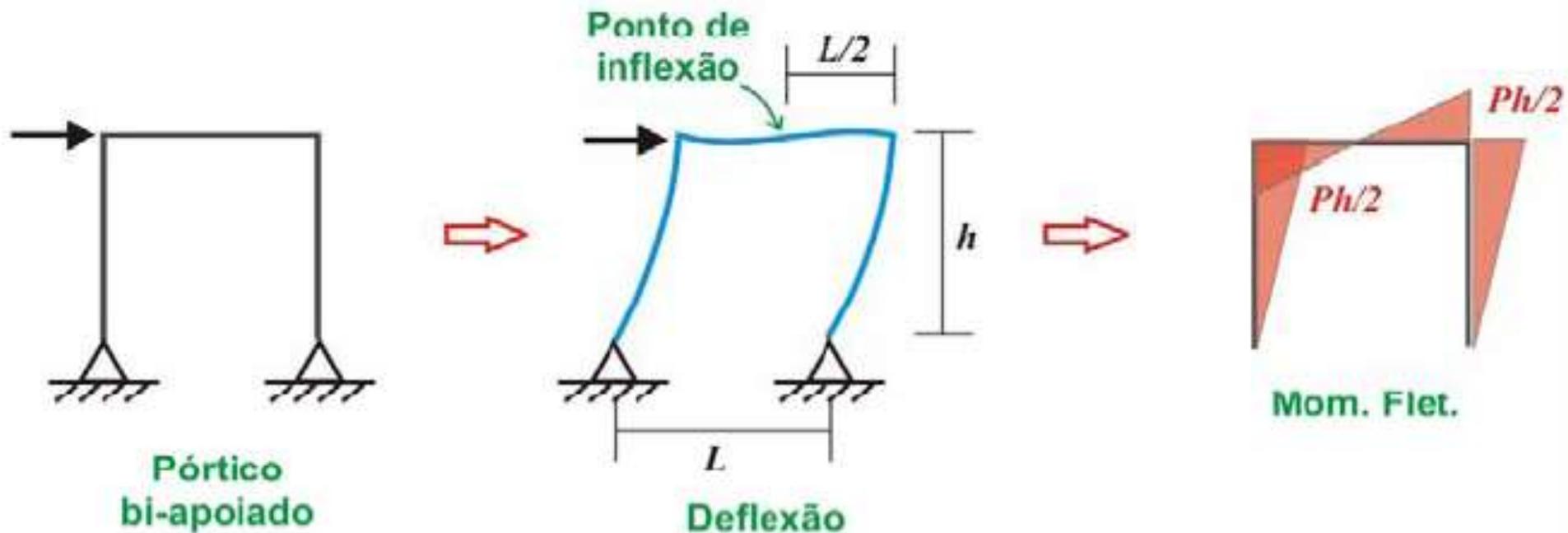


# Pavilhão industrial típico – sucessão de pórticos planos contraventados



# Estudo qualitativo de pórticos planos simples

## Pórtico biarticulado sujeito a carga lateral

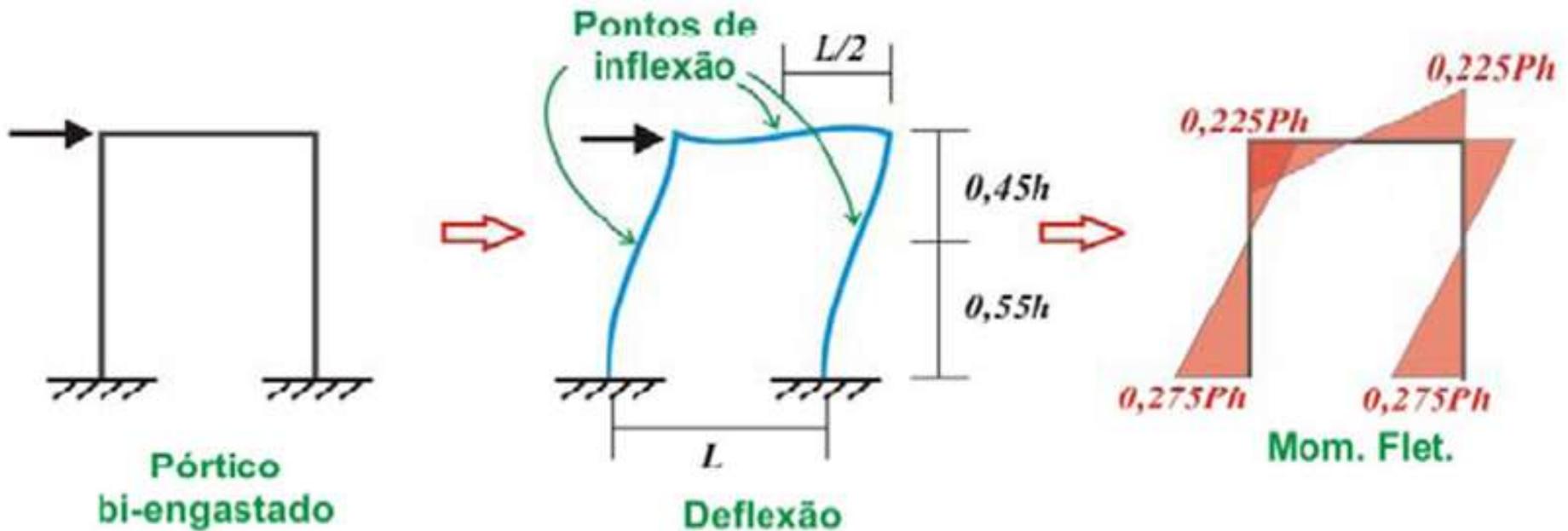


Nota: a posição assumida para o ponto de articulação decorre da anti-simetria do problema



# Estudo qualitativo de pórticos planos simples

## Pórtico biengastado sujeito a carga lateral

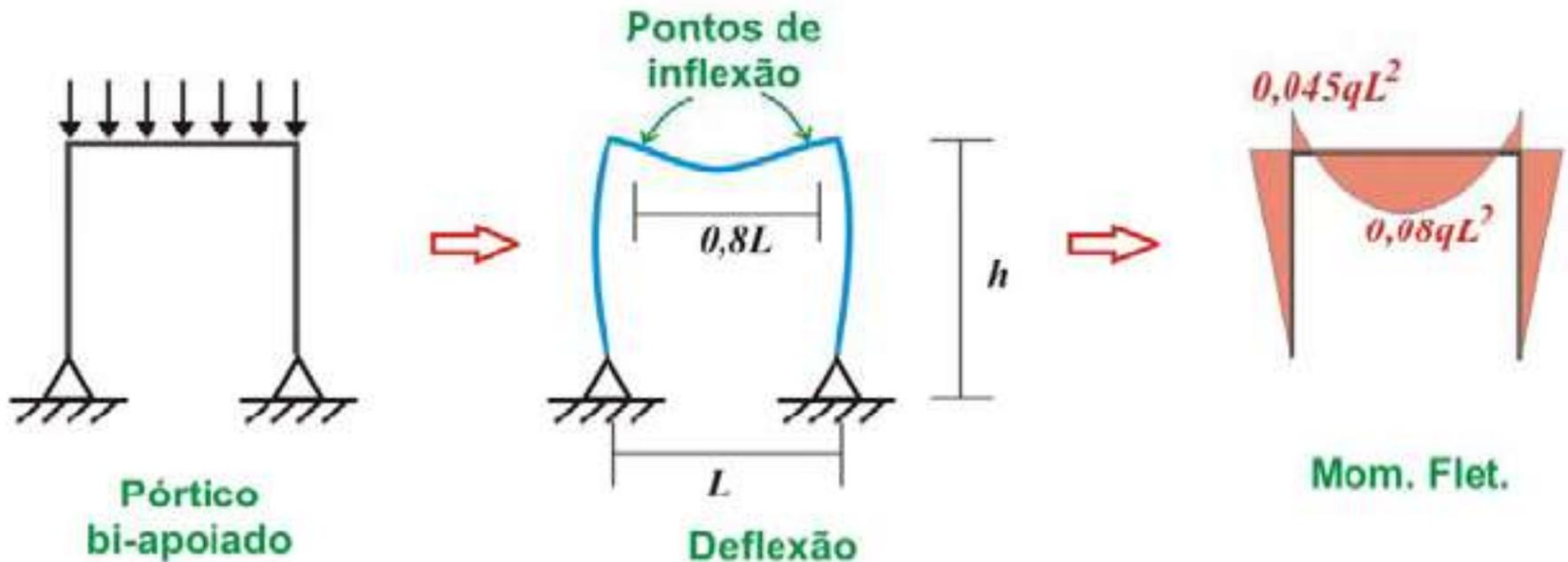


Nota: a posição assumida para os pontos de articulação decorrem de se considerar barras com a mesma rigidez à flexão



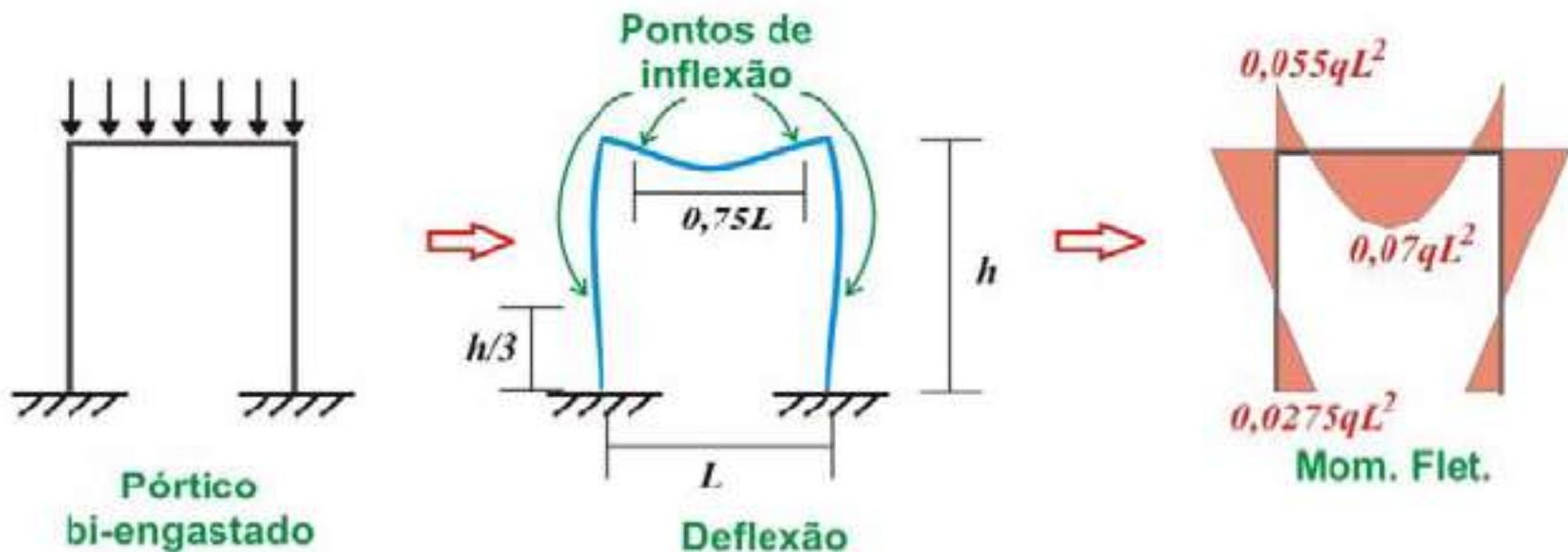
# Estudo qualitativo de pórticos planos simples

## Pórtico biarticulado sujeito a carga vertical



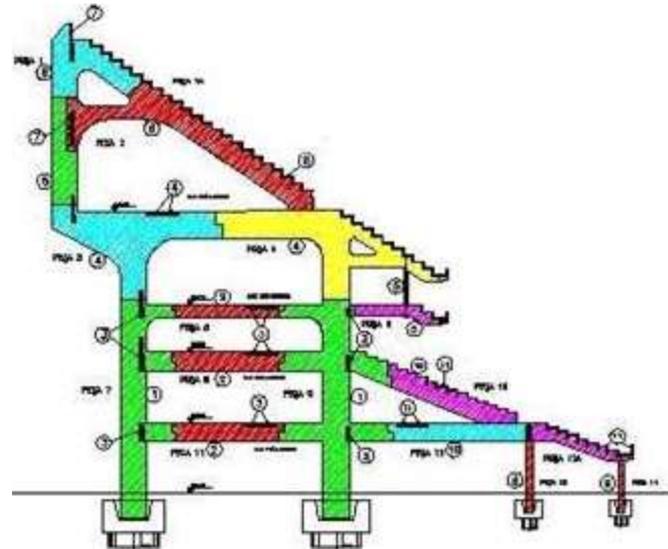
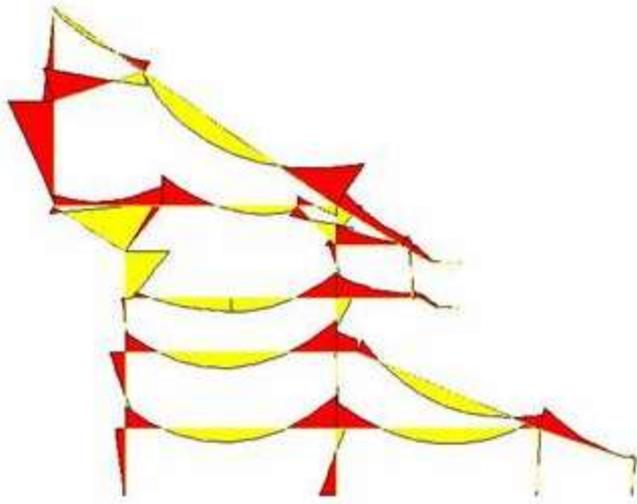
# Estudo qualitativo de pórticos planos simples

## Pórtico biengastado sujeito à carga vertical



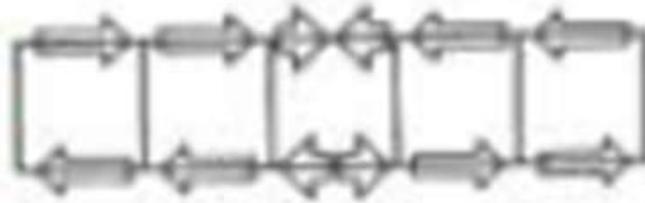
# Pórtico de concreto pré-moldado

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

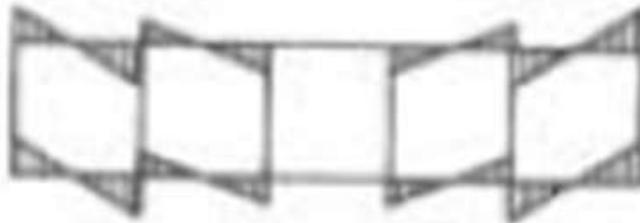
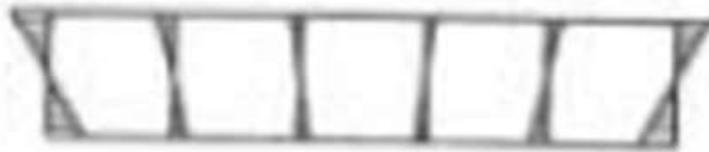


# Vigas Vierendeel.

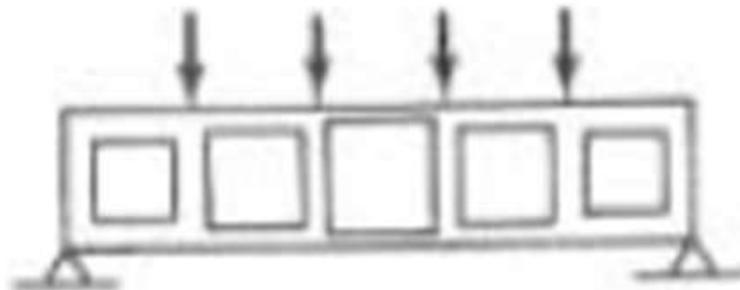
Forças normais

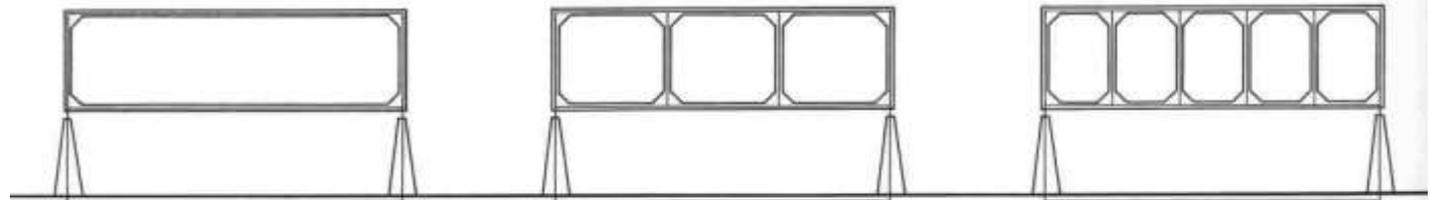


Momentos fletores



Forma





Pórtico de un vano

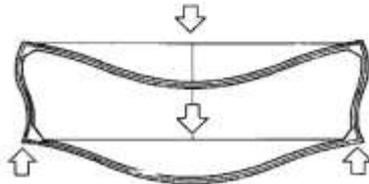
Pórtico de un vano

Pórtico de tres vanos

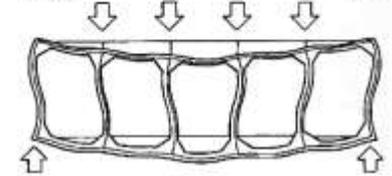
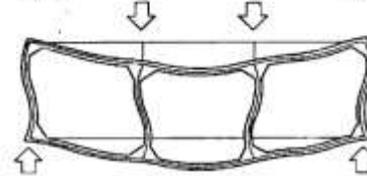
Pórtico de tres vanos

Pórtico de cinco vanos

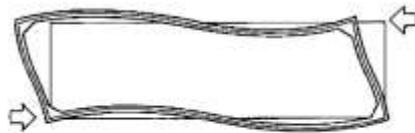
Pórtico de cinco vanos



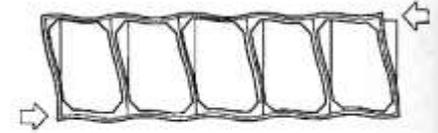
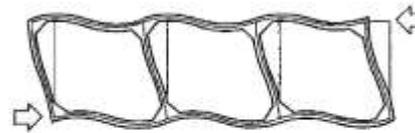
Deformación bajo carga vertical



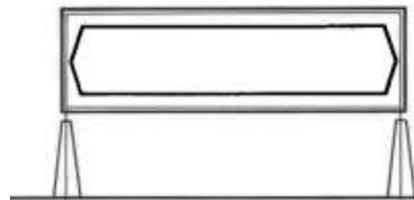
Curva de deflexión bajo carga vertical



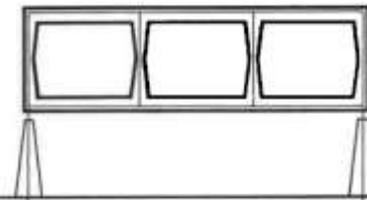
Deformación bajo carga horizontal



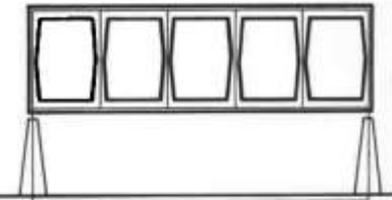
Curva de deflexión bajo carga horizontal



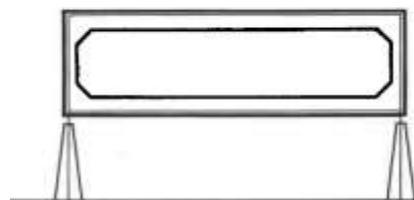
Forma estructural con acentuación del punto de menor flexión



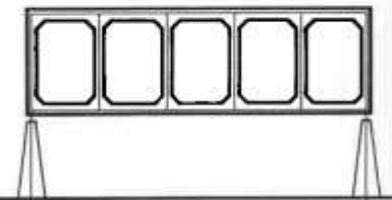
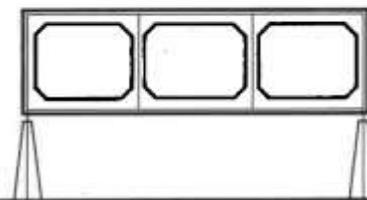
Forma estructural enfatizando o lugar de mínimos esfuerzos de flexión



H. Engel, *Sistemas Estructurais*, 1997.

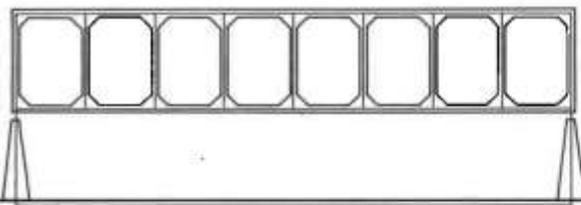


Forma estructural con acentuación de la rigidización en las esquinas



Forma estructural enfatizando o endurecimiento dos cantos

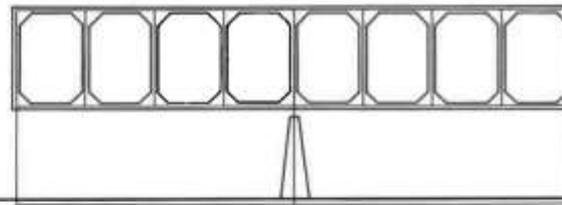




sistema estructural  
sistema estructural

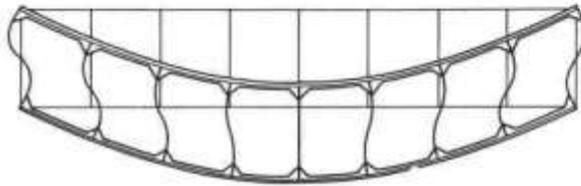
Pórtico de varios vanos  
sobre dos pilares

Pórtico de vários vãos  
apoiado nas extremidades



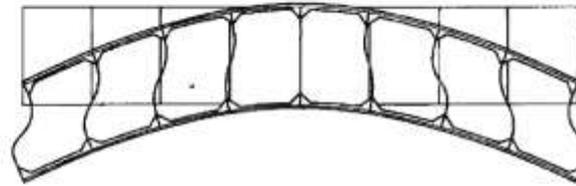
Pórtico de varios vanos  
sobre un pilar

Pórtico de vários vãos  
sobre apoio central

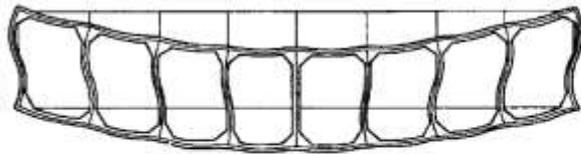


deformación  
deflexão

estructura con pilares em rigidez a flexión

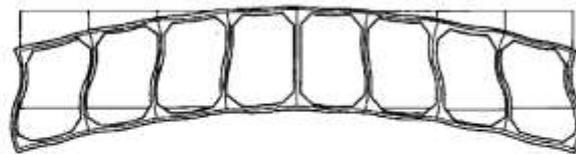


sistema com colunas sem resistência à flexão

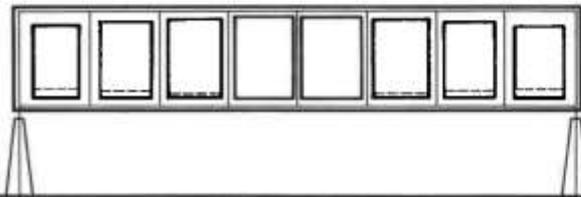


deformación  
deflexão

estructura con pilares resistentes a flexión

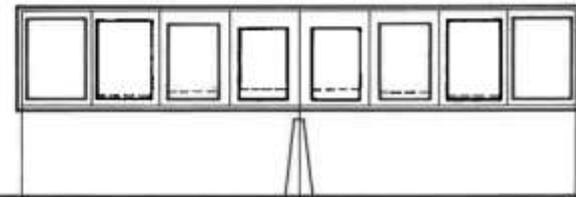


sistema com colunas resistentes à flexão

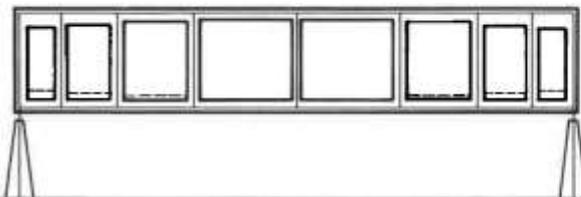


forma típica de la  
estructura  
forma estrutural típica

Ensanchamiento de los montantes hacia los apoyos en un pórtico  
de vanos de igual luz

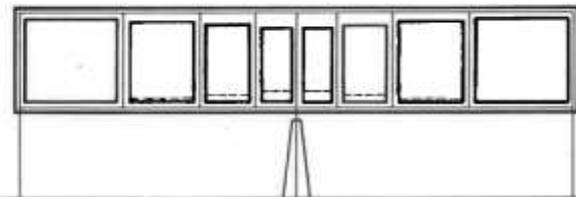


Aumento da seção da coluna em direção aos apoios  
com espaçamento regular entre colunas



forma típica de la  
estructura  
forma estrutural típica

Reducción de la luz de los vanos más cercanos a los apoyos, manteniendo  
los montantes constantes



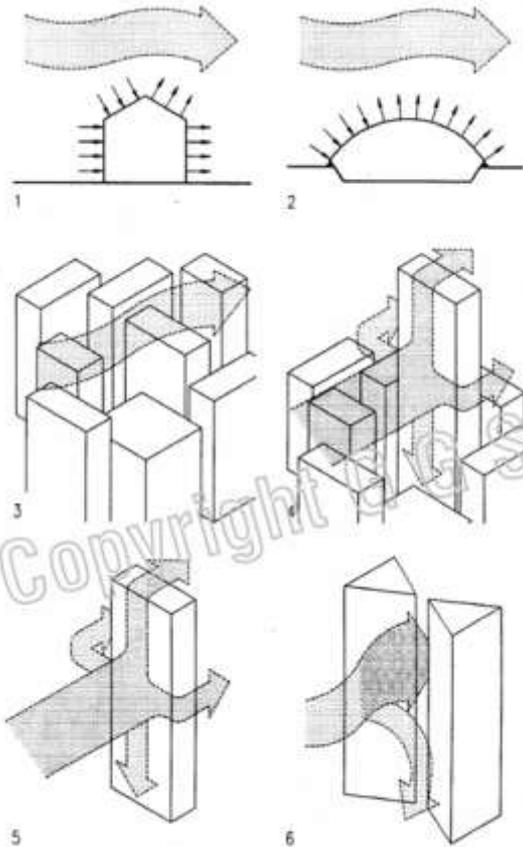
Redução da largura dos vãos mais próximos aos apoios, com colunas  
de mesma seção

H. Engel, Sistemas  
Estruturais, 1997.

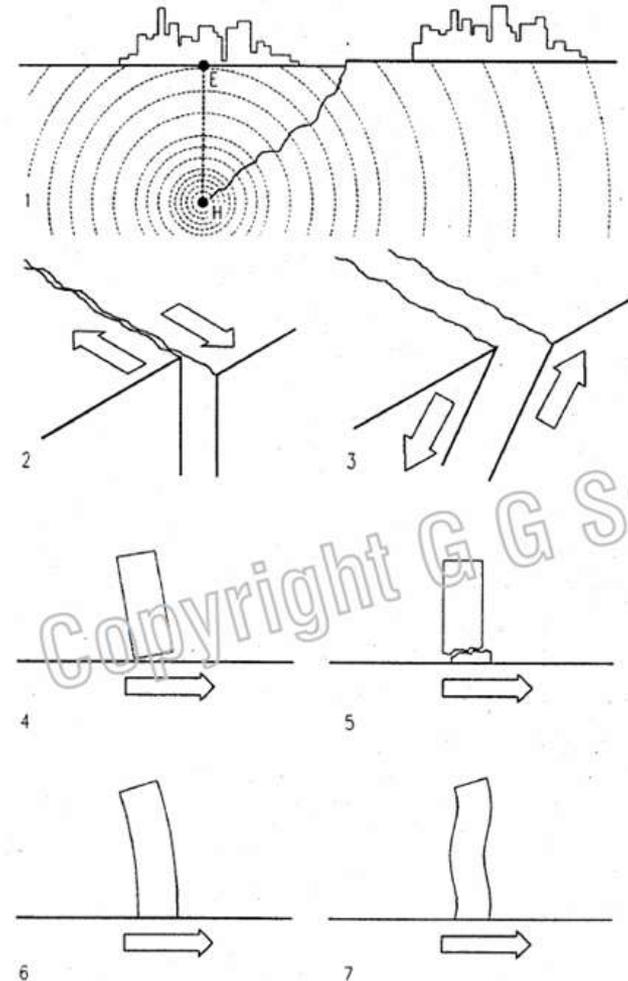


# Cargas Laterais

## Ventos

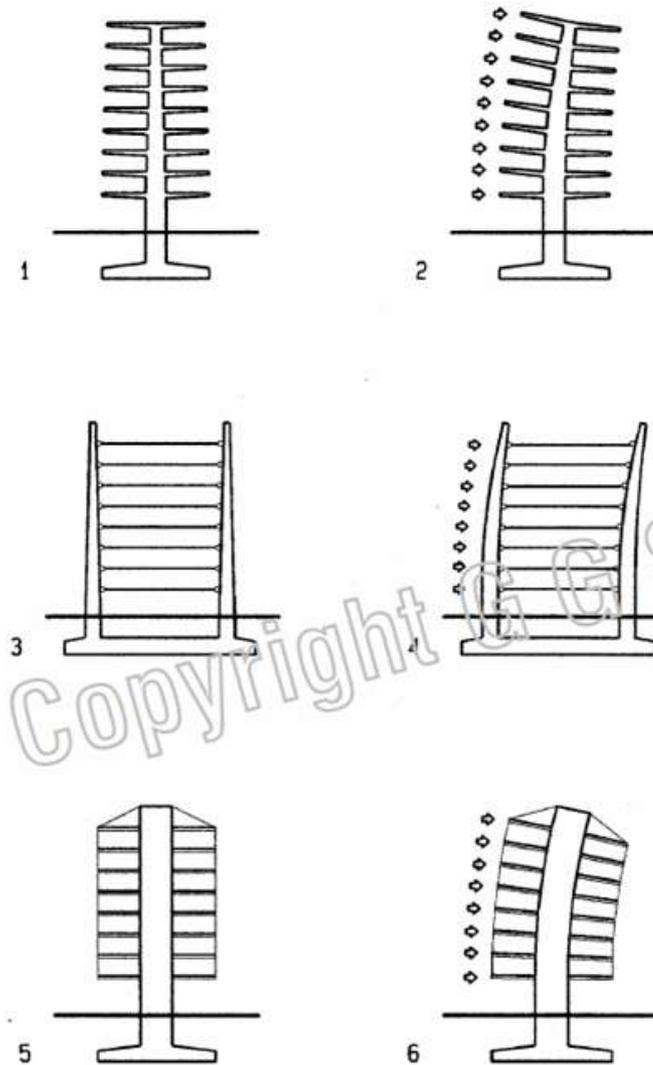
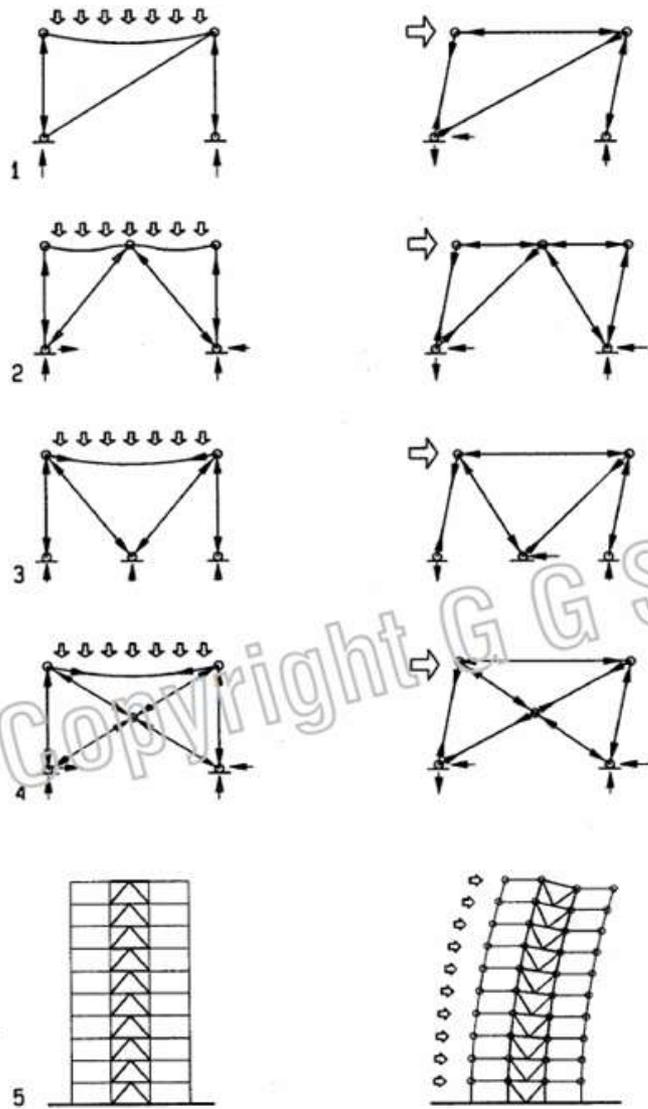


## Terremotos



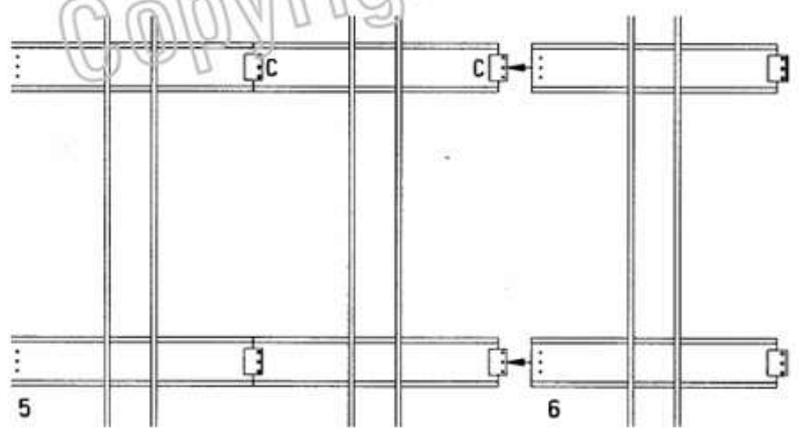
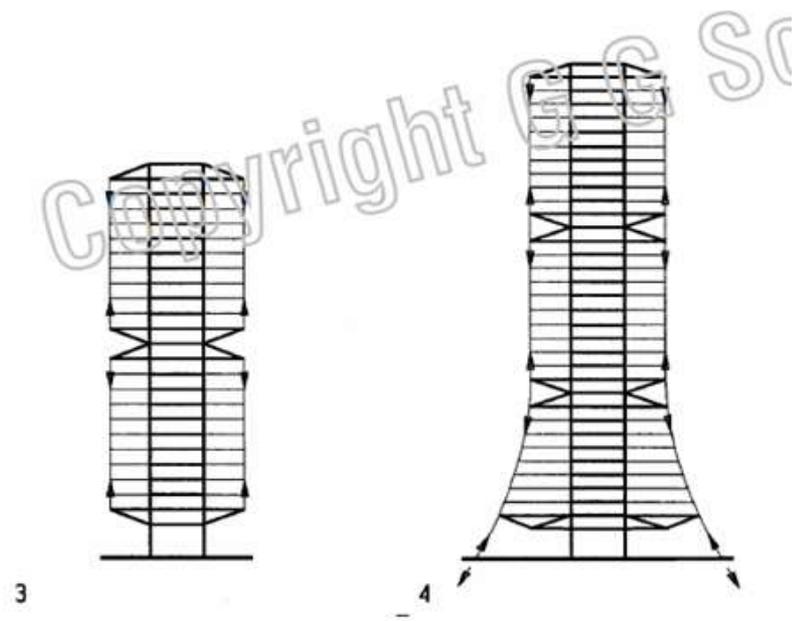
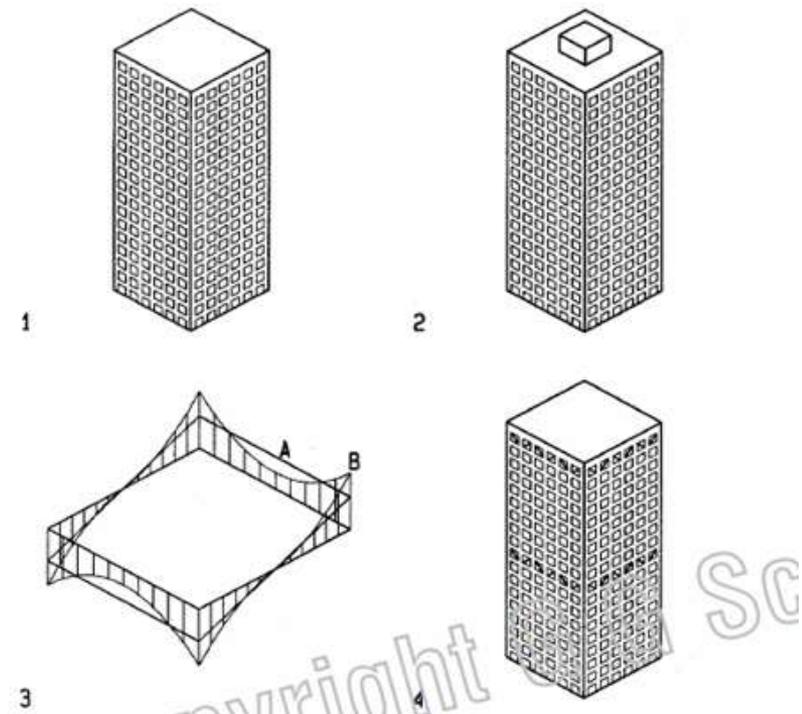
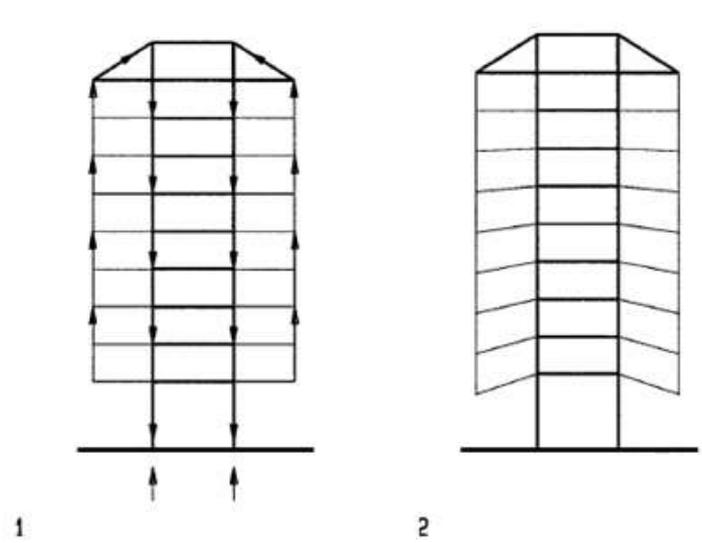
Figuras extraídas de 'Architectural Structures', G.G. Schierle, 1990-2006





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





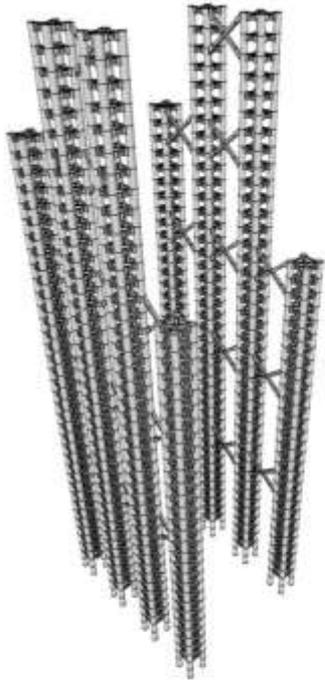
Figuras extraídas de 'Architectural Structures', G.G. Schierle, 1990-2006



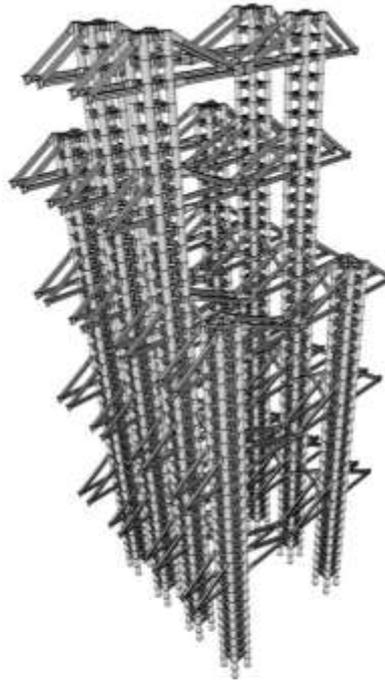
*Hong Kong and Shanghai Bank Headquarters,  
Hong Kong, Foster + Partners, 1986*



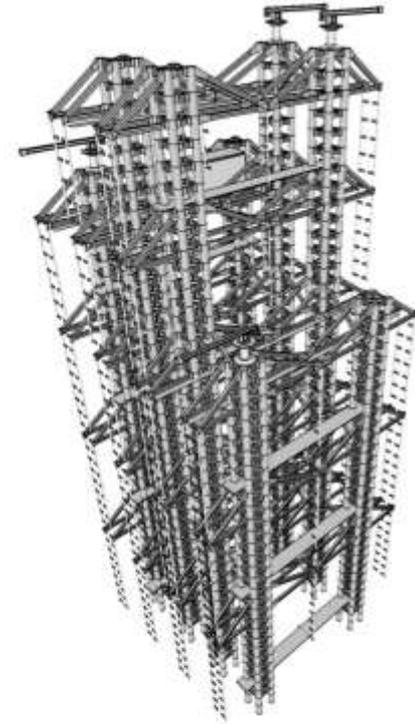
# Hong Kong and Shanghai Bank Headquarters, Hong Kong, Foster + Partners, 1986



Mast



Truss



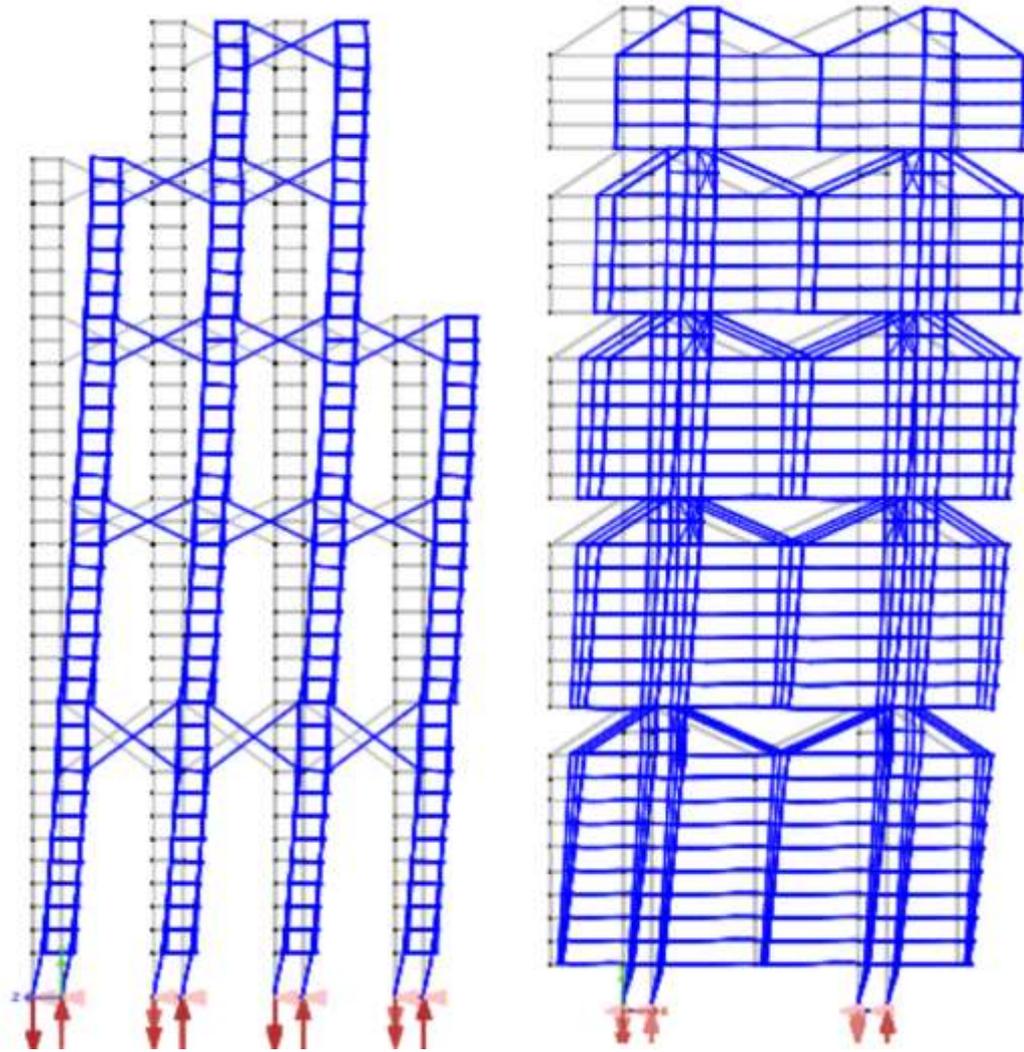
Cantilever

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



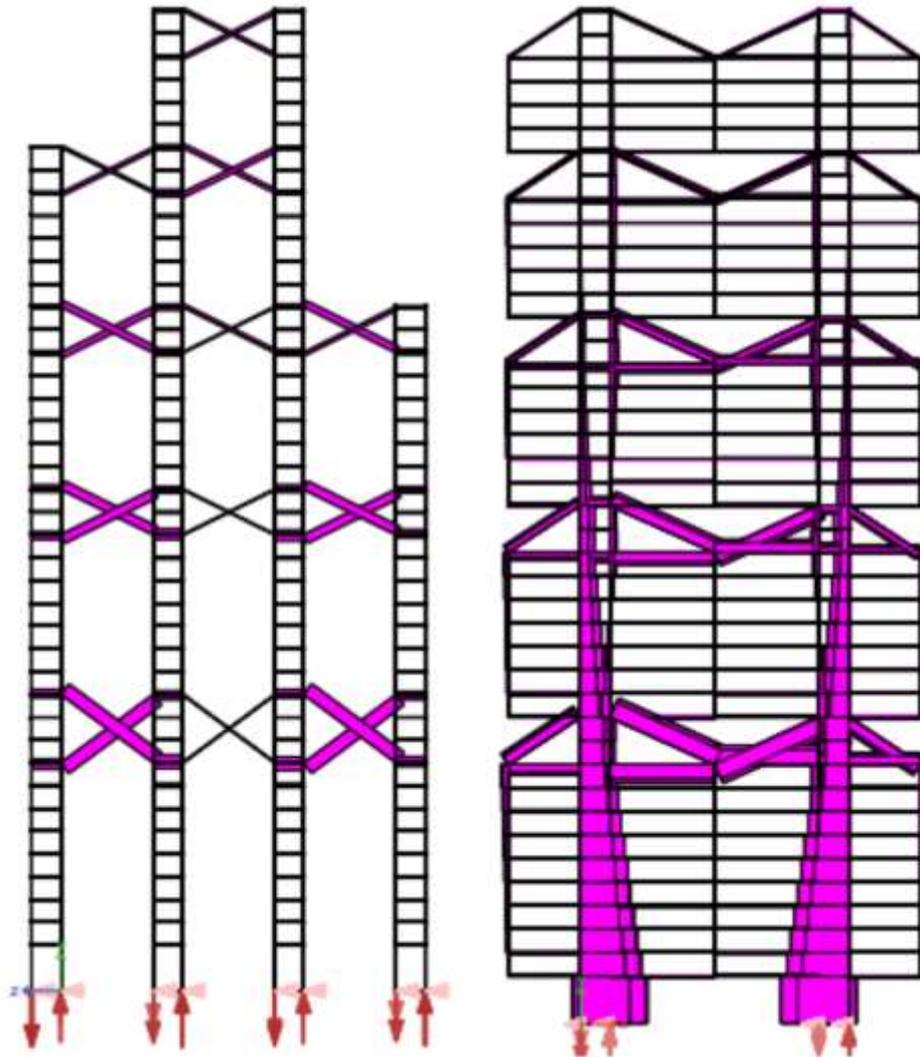
# Deflection Diagram

- a. Front wind
- b. Side wind



# Axial Force Diagram

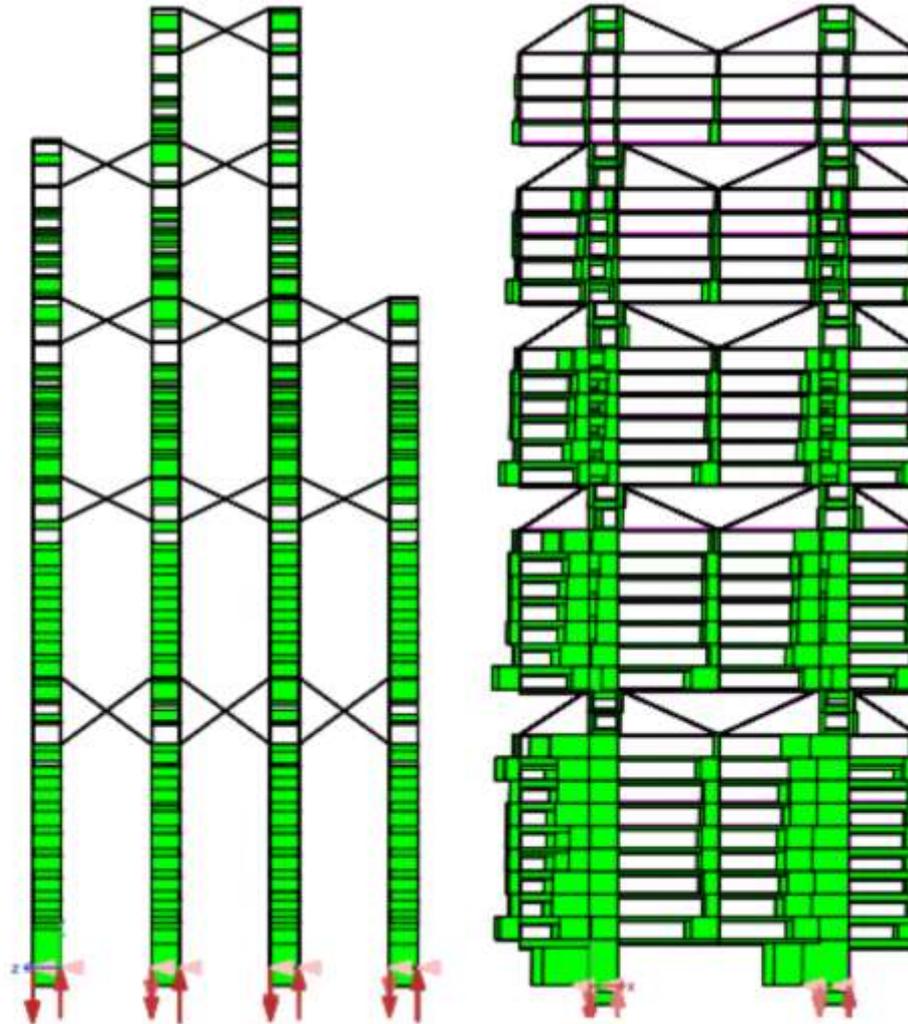
- a. Front wind
- b. Side wind



## Shear Diagram

a. Front wind

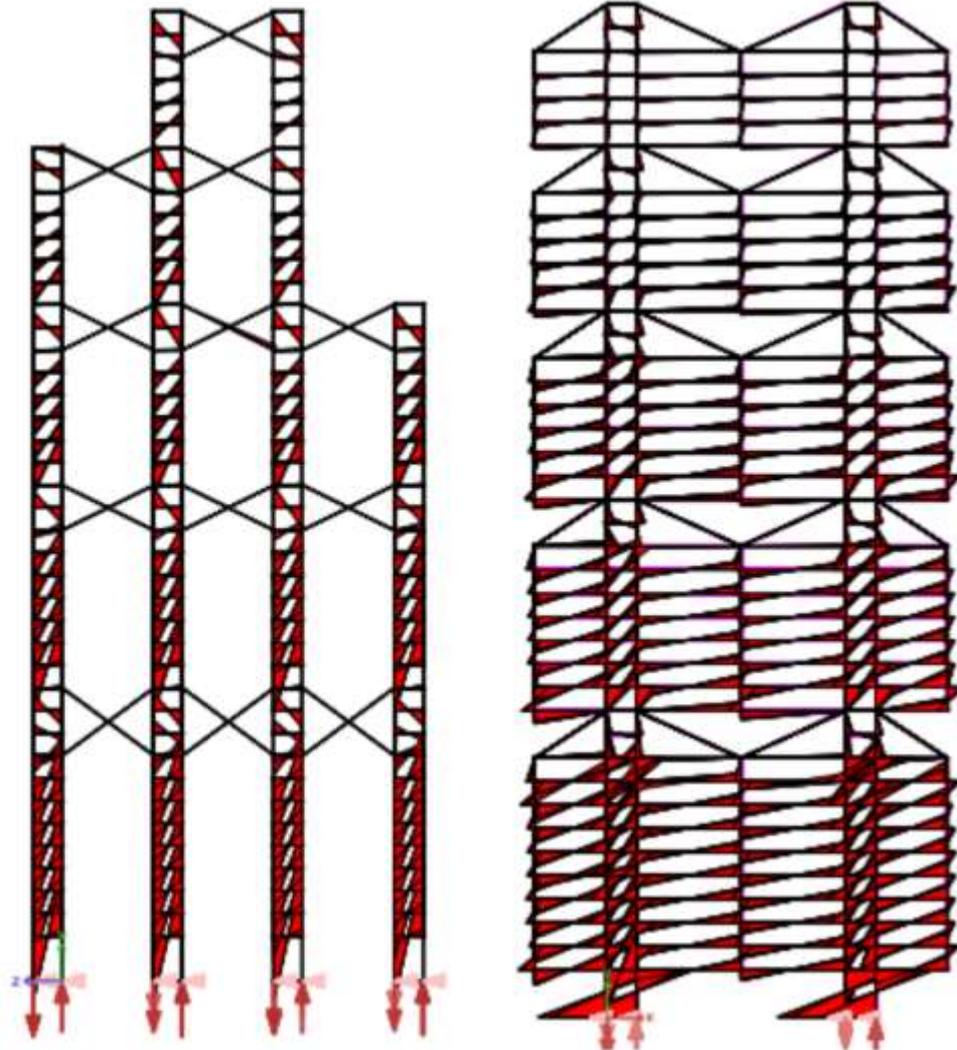
b. Side wind



## Moment Diagram

a. Front wind

b. Side wind



*Broadgate Exchange House, S.O.M.  
Liverpool, London,, 1990*









