

# Yüksek Yapıların Tasarımı

*Gebze Teknik Üniversitesi, 2017*

Yüksek Yapılara Giriş, Taşıyıcı Sistemler

Dr. Barış Erkuş (İTÜ)

# Yüksek Yapıların Tasarımı

## 1. BÖLÜM: Tasarım Konuları (3 Hafta)

- Yüksek Yapılara Giriş
- Taşıyıcı Sistemler
- Taslak Deprem Yönetmeliği Kapsamında Tasarım
- Sünme ve Rötire Etkileri
- Yapısal Elemanların Davranışı ve Tasarımı
  - Betonarme ve Çelik Bağ Kirişleri
  - Burkulması Engellenmiş Çelik Çapraz
  - Kompozit Kolon
- Rüzgar Yükleri Altında Davranış ve Konfor
- Yüksek Yapı Tasarımında Dikkat Edilmesi Gereken Hususlar
- Özel Konular

## 2. BÖLÜM: Performansa Dayalı Tasarım ve Uygulamalar (3 Hafta)

- Yapısal Elemanların Doğrusal Olmayan Davranışı ve Modellenmesi
  - Bağ Kirişleri
  - Betonarme Perde Duvar
  - Kiriş ve Kolon Plastik Mafsal Modelleri
  - Dışdestek Sistemleri
- PERFORM 3D Örneği – 1. Örnek:
  - Betonarme Perde Duvar Çekirdek
  - Çelik Bağ Kiriş
  - Kompozit Kolon
  - Deprem Analizleri ve Davranışın İrdelenmesi
- PERFORM 3D Örneği – 2. Örnek
  - 1. Örnek + Dışdestek Sistemi

# Neden Yüksek Yapılar?

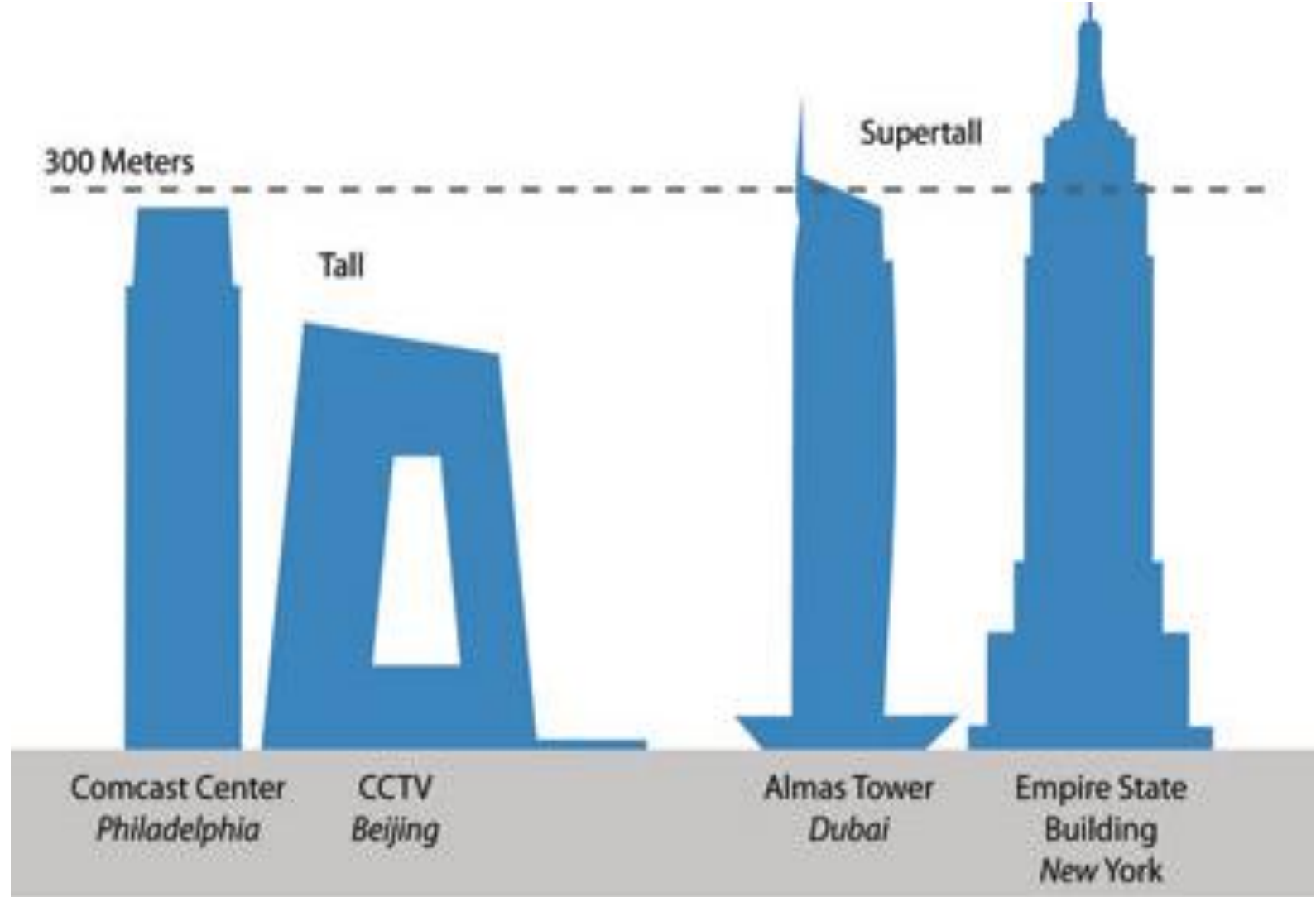
- Yüzölçümü düşük ülkelerde arazi kullanımını
- Emlak / yatırım
- Simgesel yapılar - gelişmişlik algısı
- Mühendislikte yarışma ve zorluk aşma hevesi



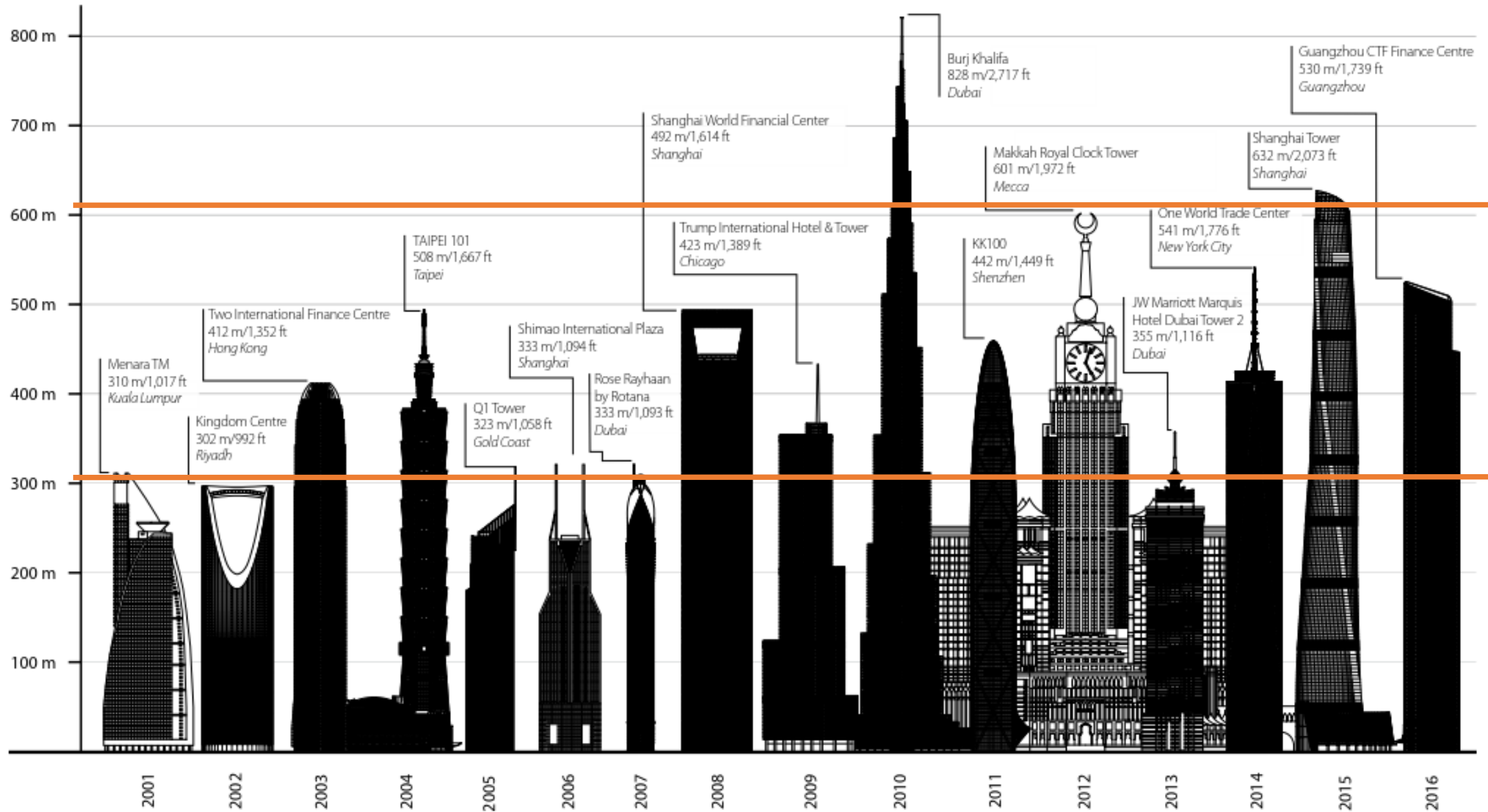
Chicago, ABD

# Yüksek Yapıların Tanımı

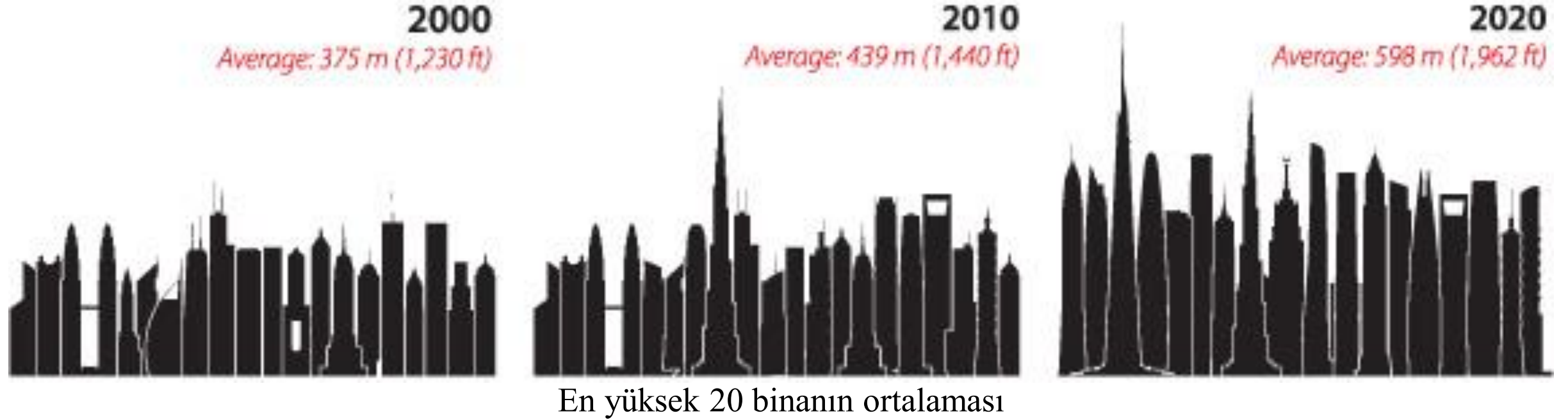
- Council on Tall Buildings and Urban Habitat (CTBUH)
  - Yüksek Binalar: 14 Kat ve üzeri veya 50m ve üzeri
  - Süper Yüksek Binalar: 300m ve üzeri
  - Mega Yüksek Binalar: 600m ve üzeri
- Taslak Türk Deprem Yönetmeliği
  - Yüksek Binalar: 70m ve üzeri



# Yüksek Yapılar – CTBUH Bilgileri

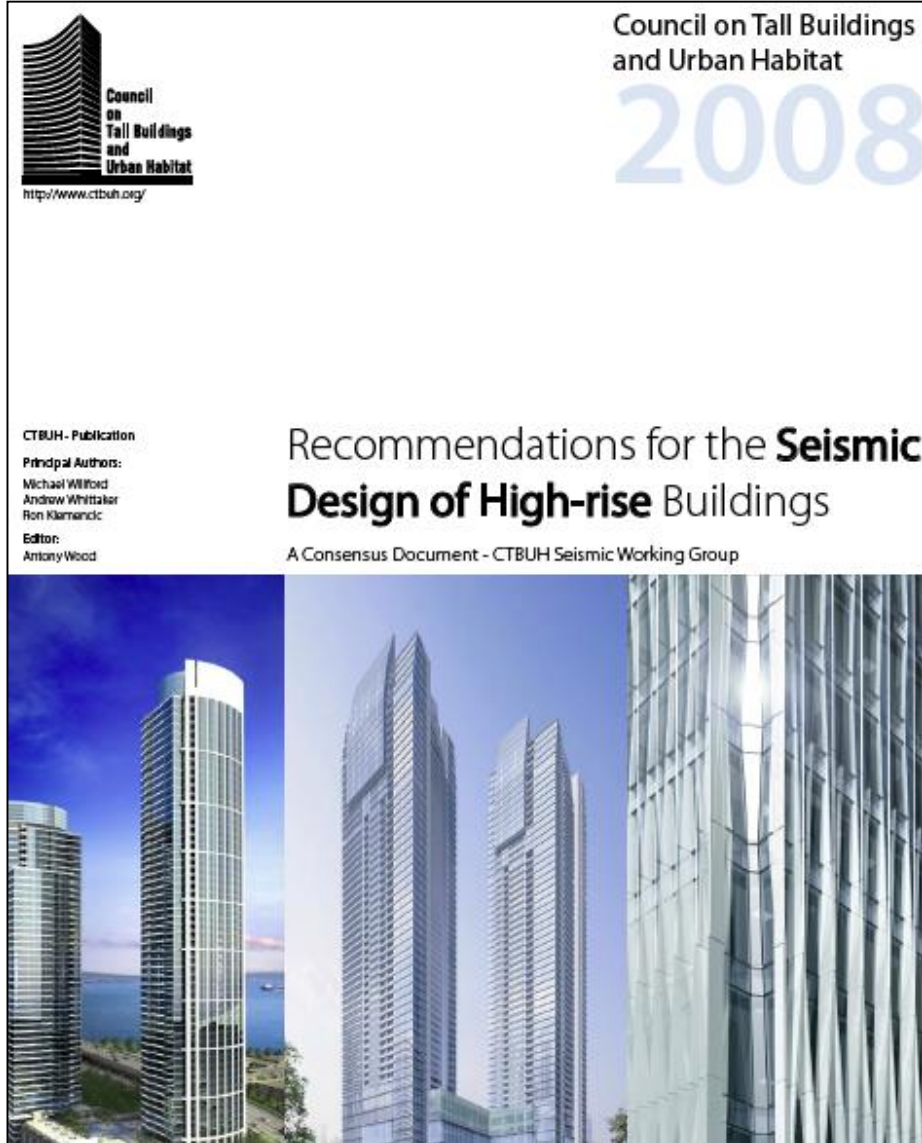


# Yüksek Yapılar – CTBUH Bilgileri



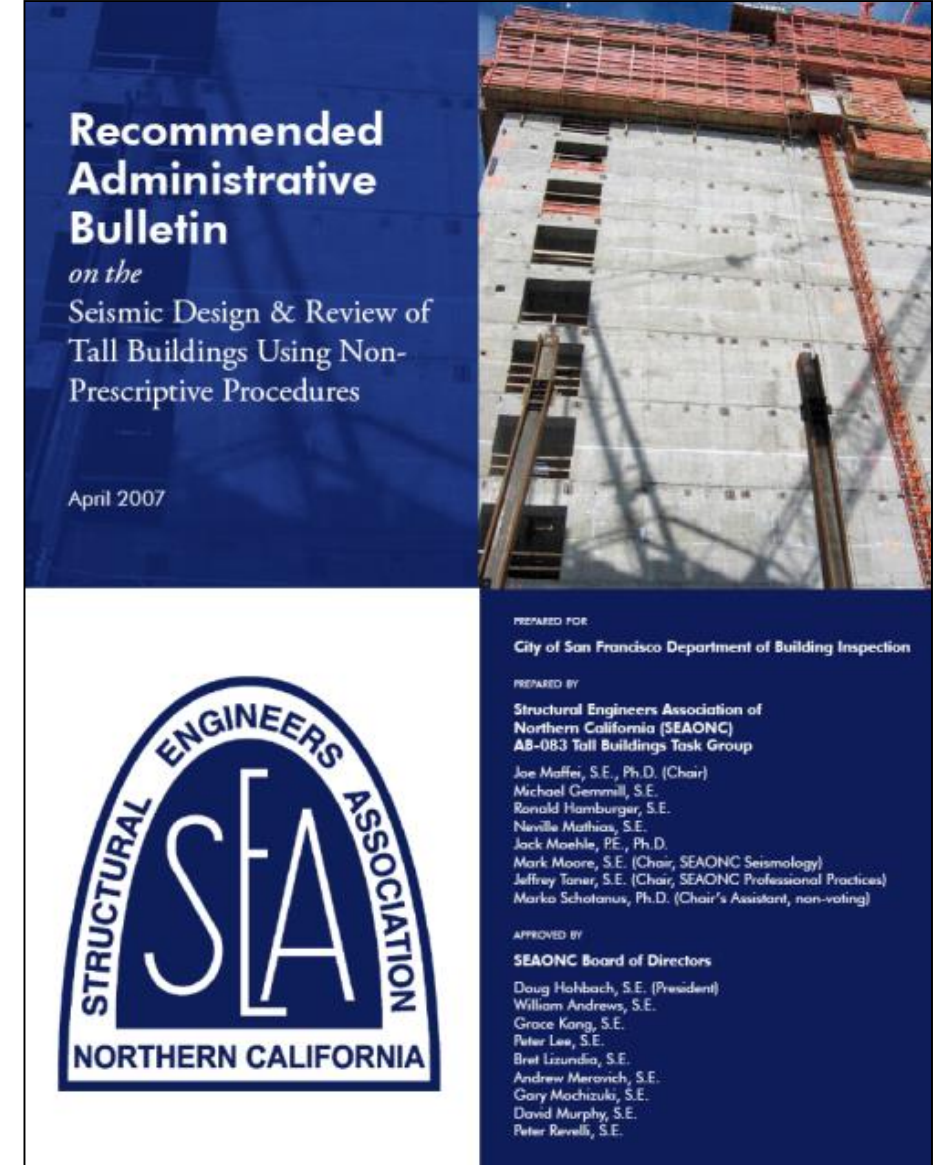
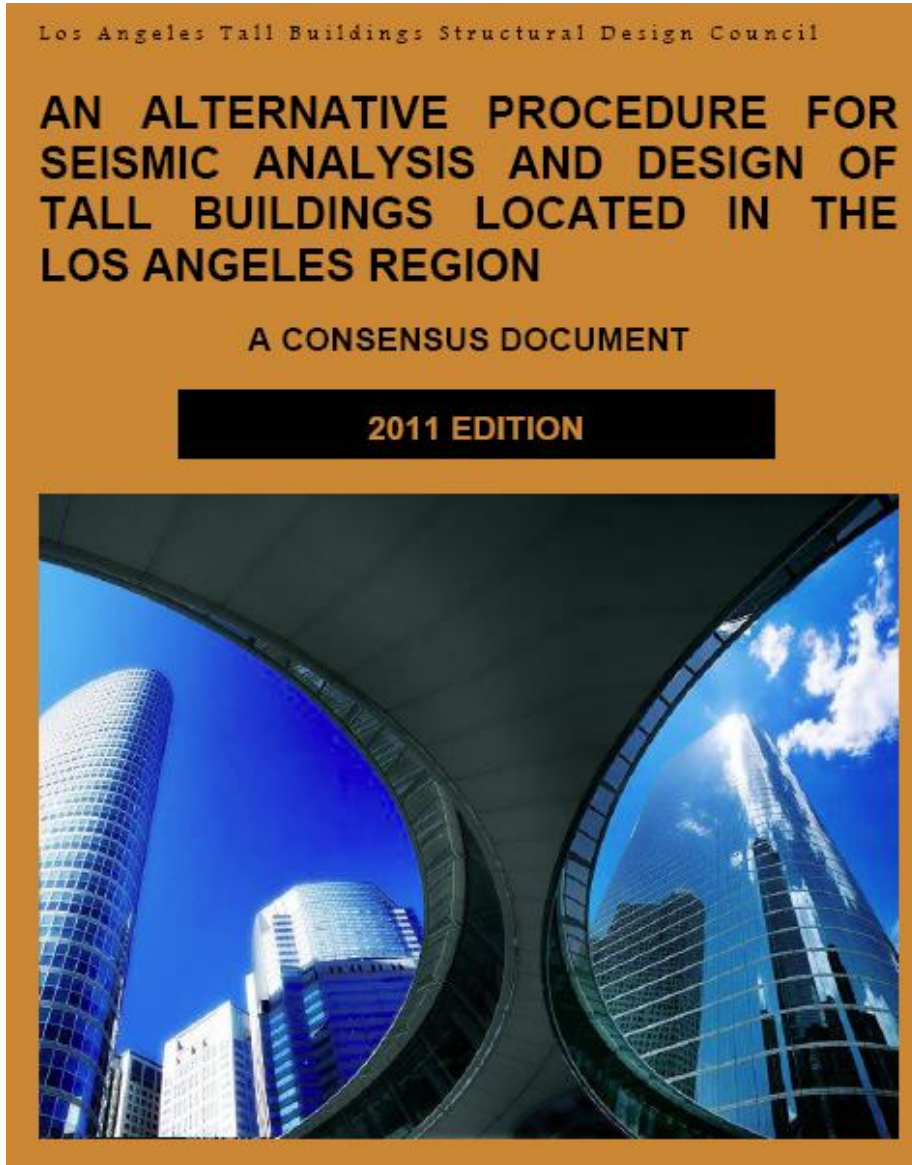
# Kaynaklar

- Council on Tall Buildings and Urban Habitat



# Kaynaklar

- Los Angeles Tall Buildings Structural Design Council, SEAONC-



# Kaynaklar

- PEER, ATC

PEER/ATC **72-1**

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## Modeling and acceptance criteria for seismic design and analysis of tall buildings

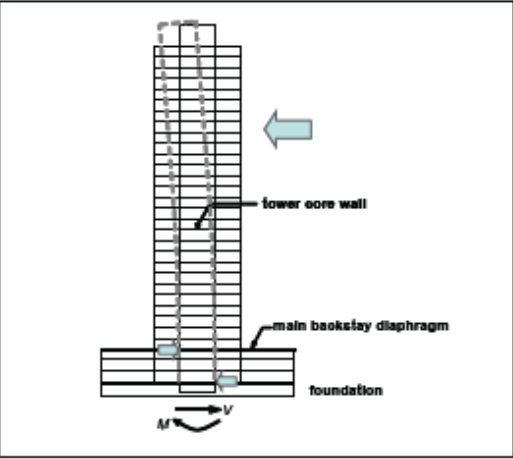




Diagram illustrating the modeling and acceptance criteria for seismic design and analysis of tall buildings. The diagram shows a cross-section of a tall building with a lower core wall, main backbone diaphragm, and foundation. A blue arrow indicates lateral force, and a curved arrow at the base indicates moment and shear.

**ATC** Applied Technology Council

 Pacific Earthquake Engineering Research Center

# TBI




## Tall Buildings Initiative

### Guidelines for Performance-Based Seismic Design of Tall Buildings

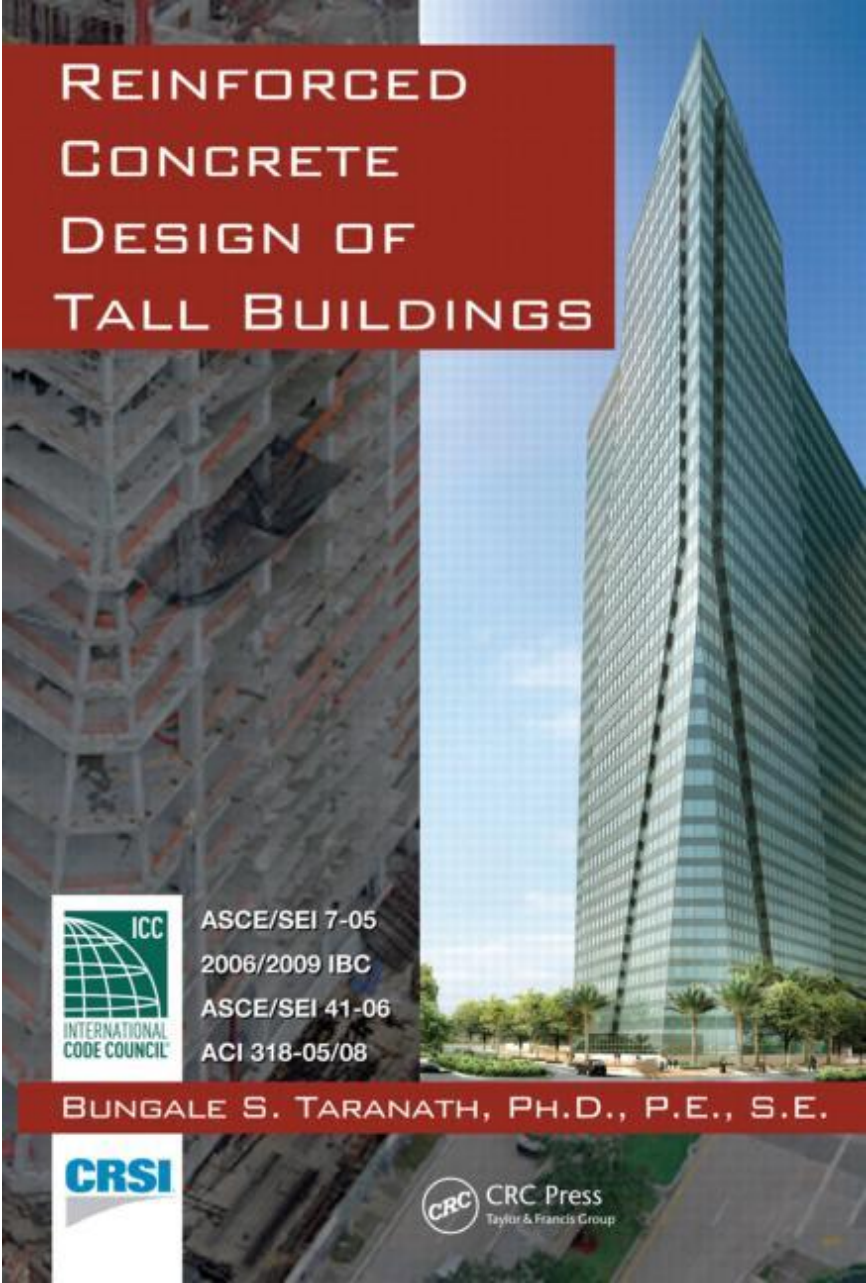
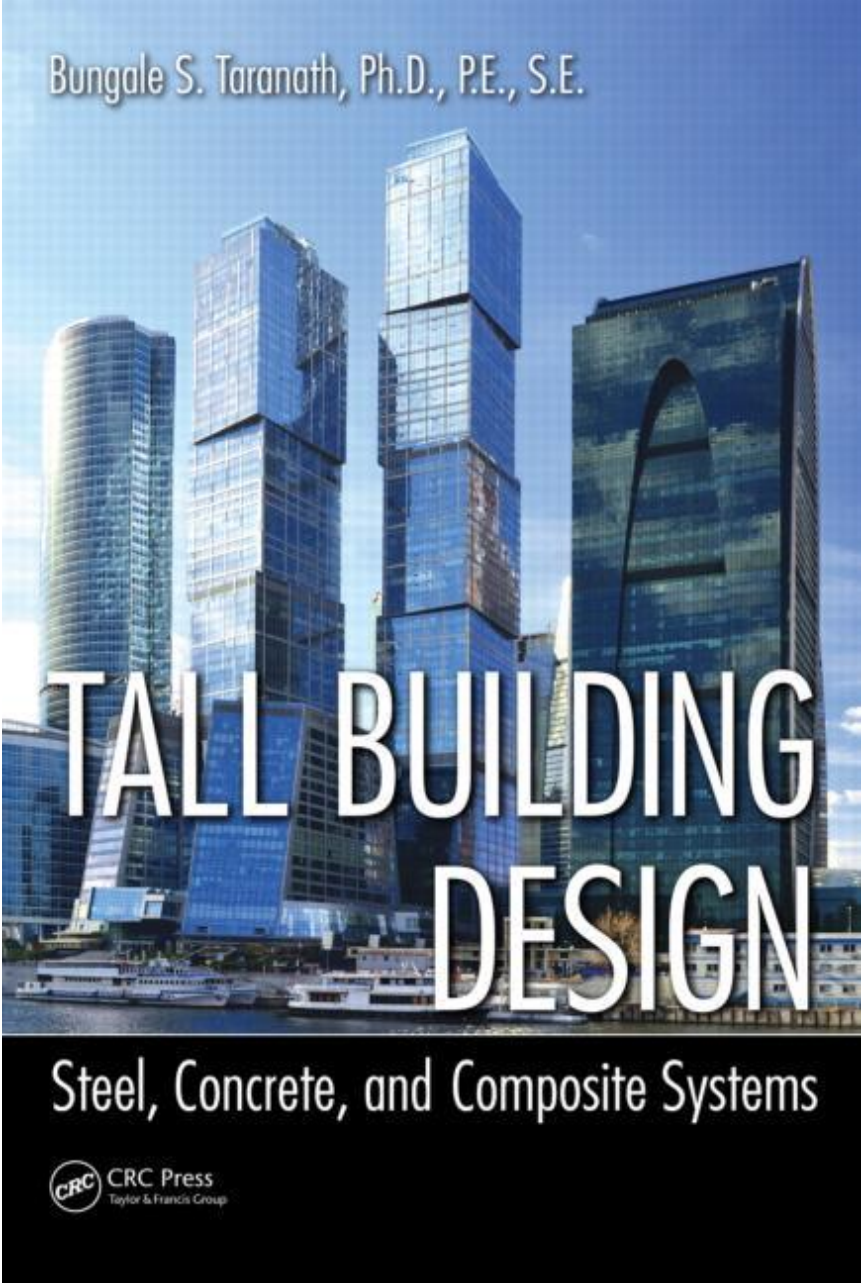
Version 1.0  
November 2010

Developed by  
Pacific Earthquake Engineering Research Center  
Report No. 2010/05

Sponsored by  
Charles Pankow Foundation  
California Seismic Safety Commission  
California Emergency Management Agency  
Los Angeles Department of Building and Safety

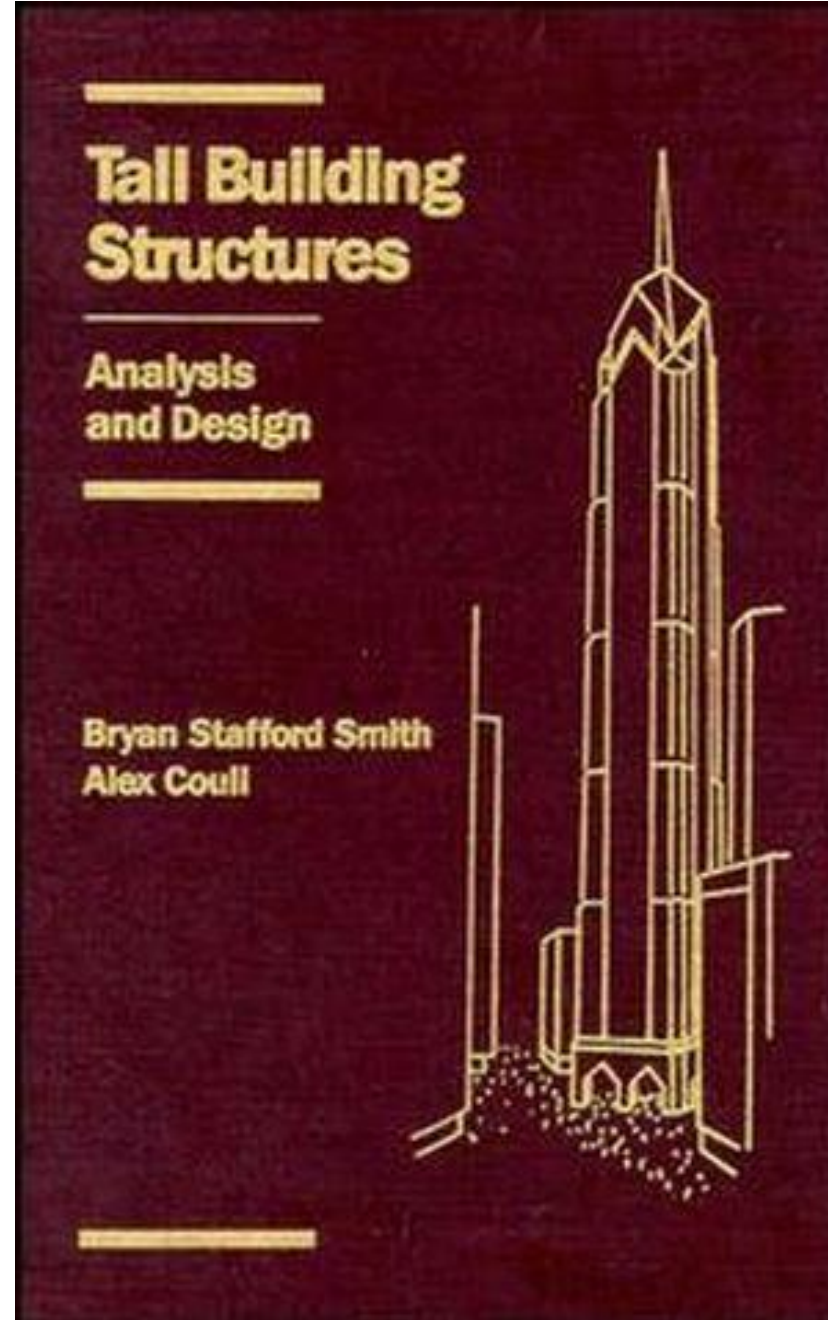
 PEER

•Taranath



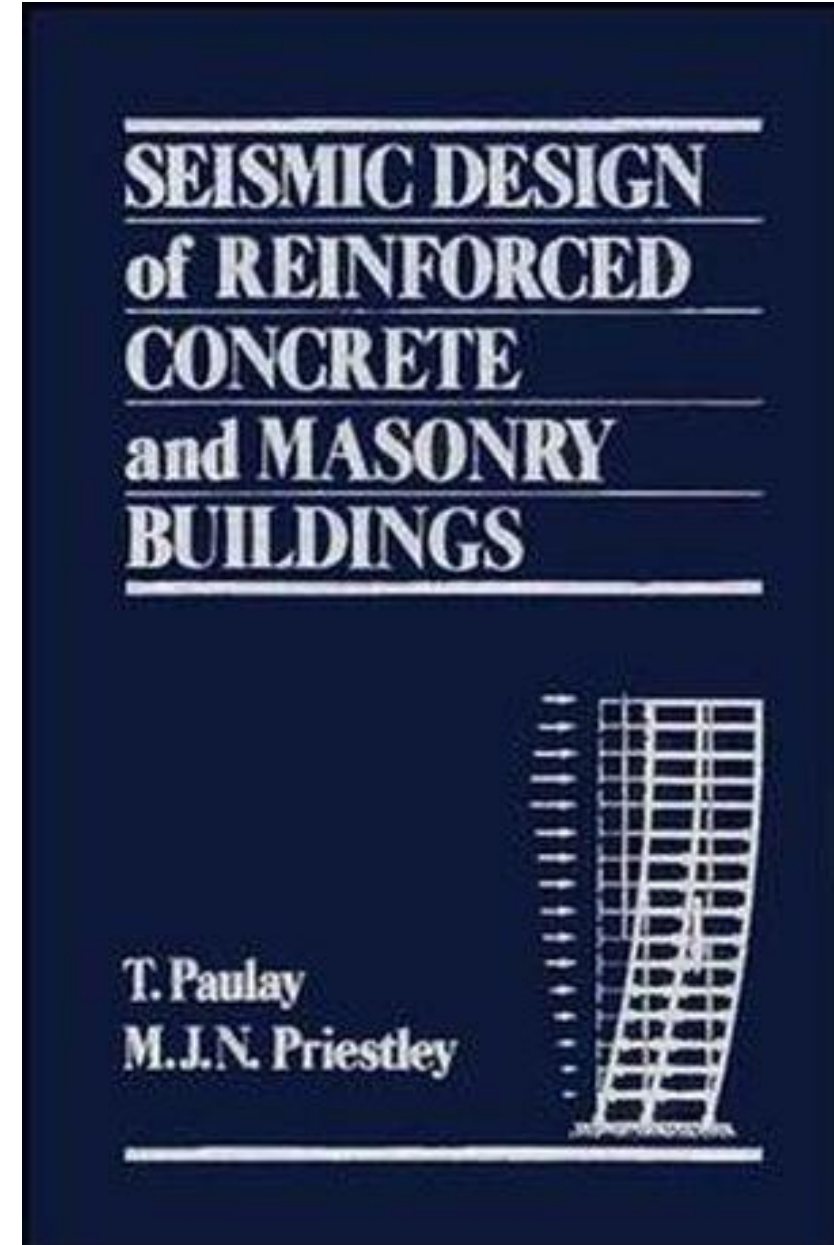
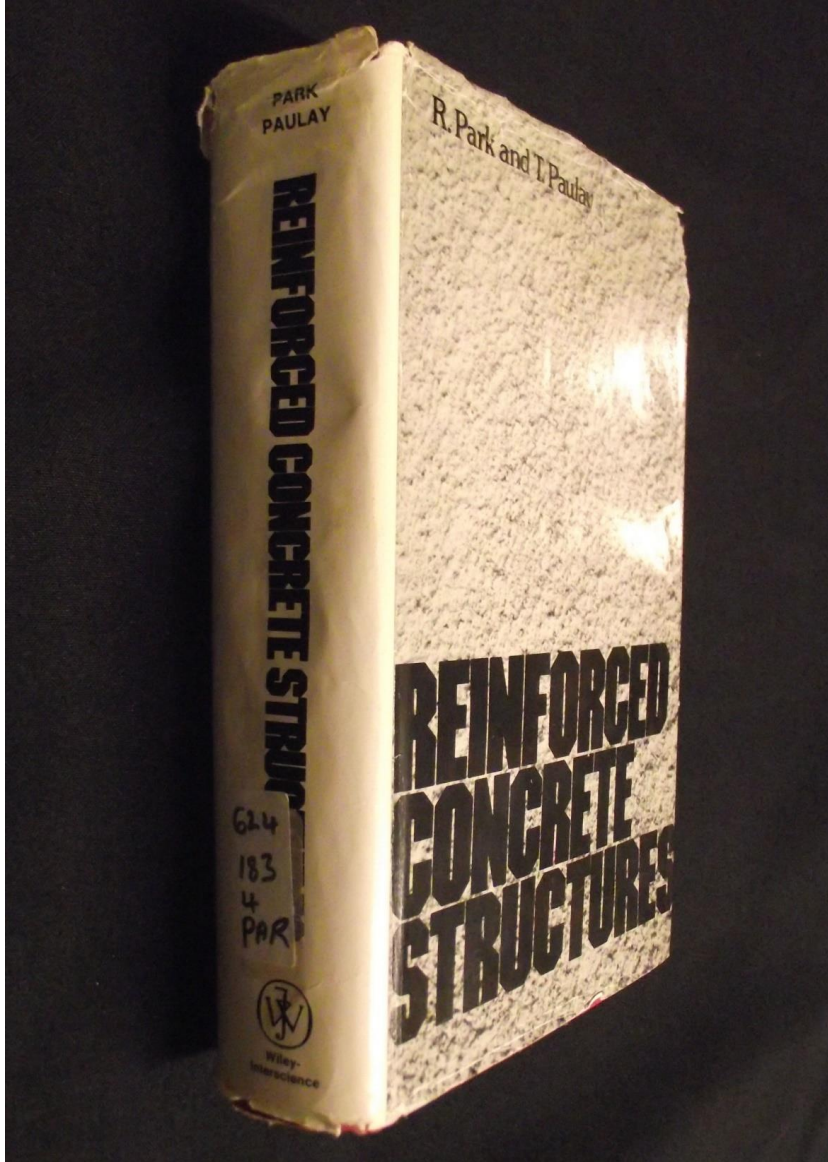
# Kaynaklar

- Stafford Smith



# Kaynaklar

- Park, Paulay, Priestley



# Kaynaklar

- NIST, NEHRP Guidelines



**NEHRP Seismic Design Technical Brief No. 2**



## **Seismic Design of Steel Special Moment Frames:**

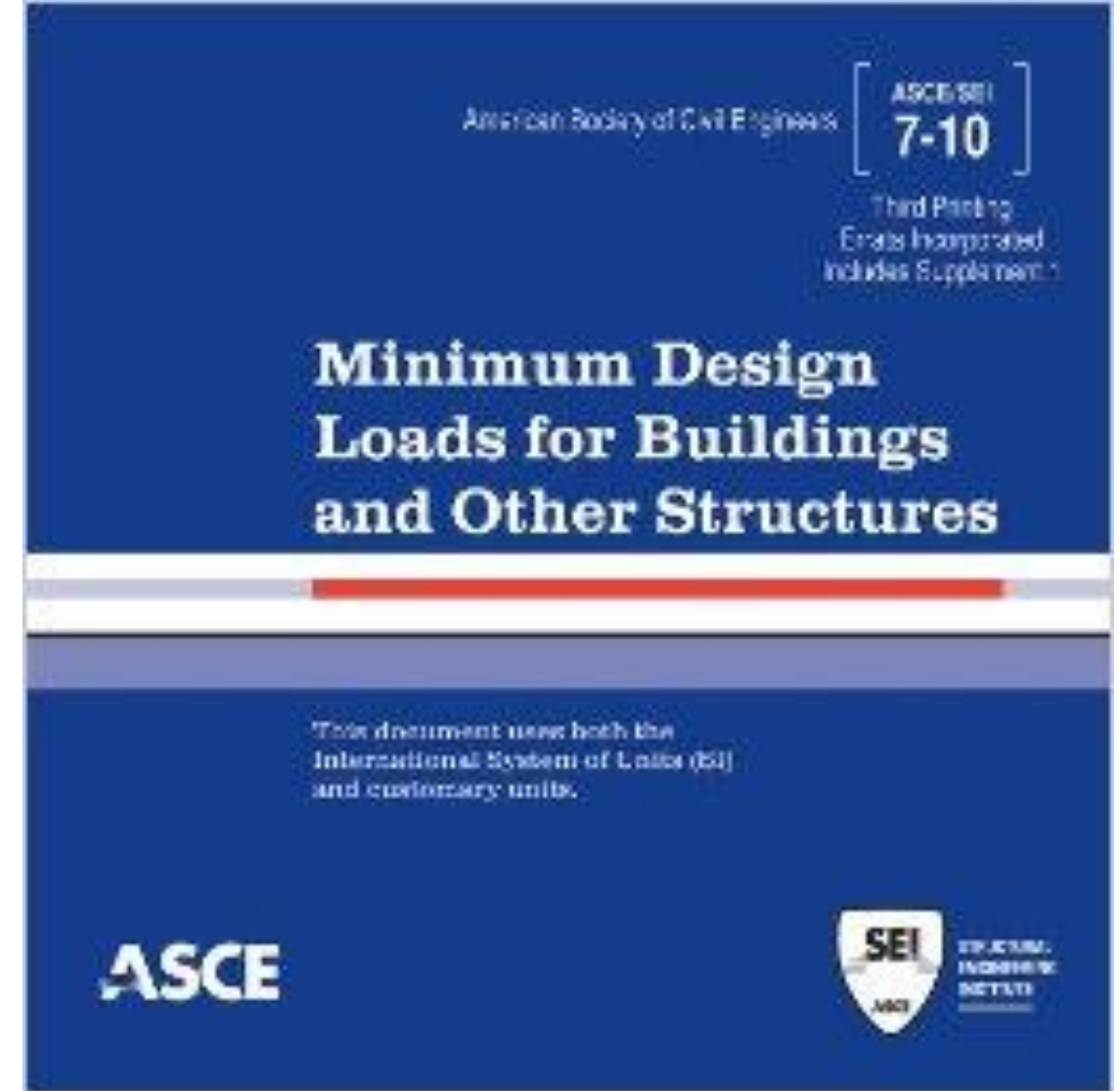
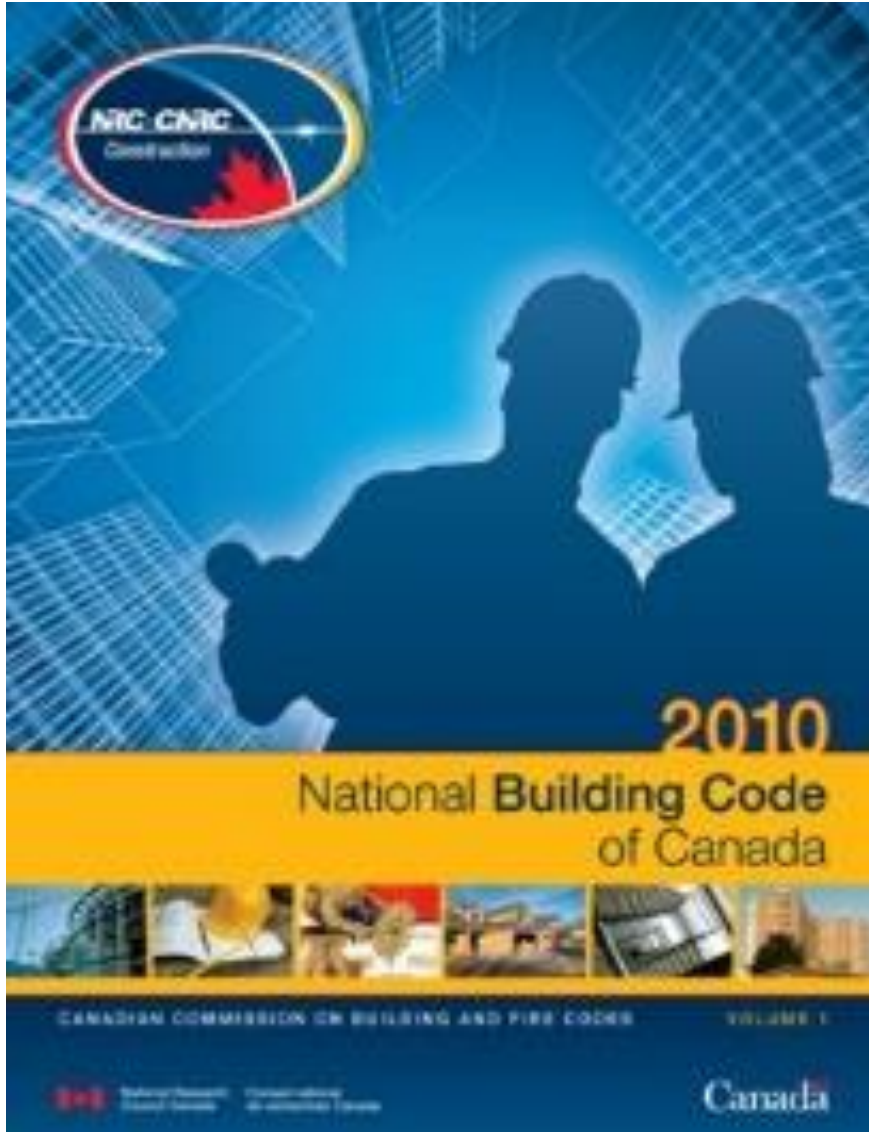
**A Guide for Practicing Engineers**

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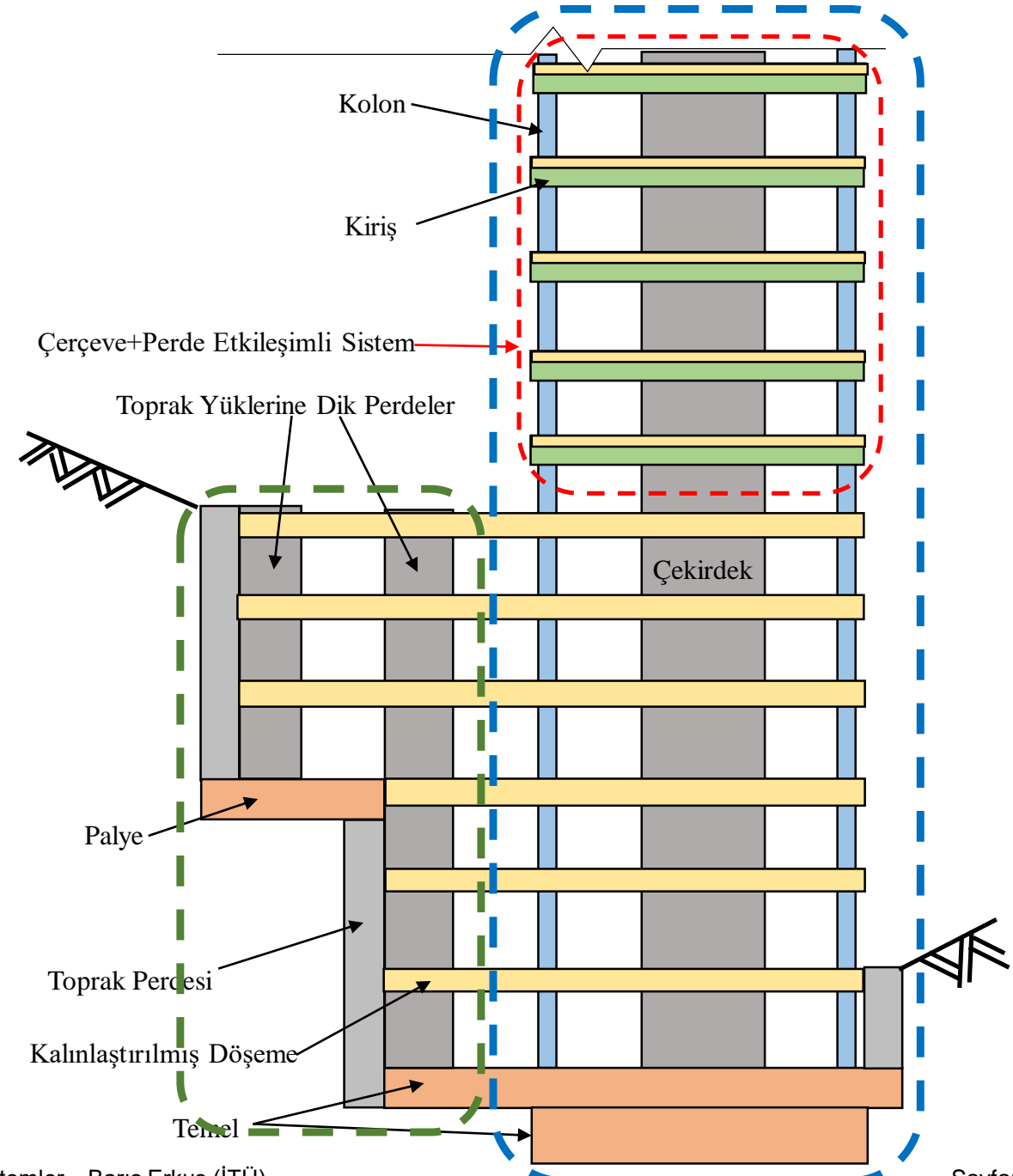
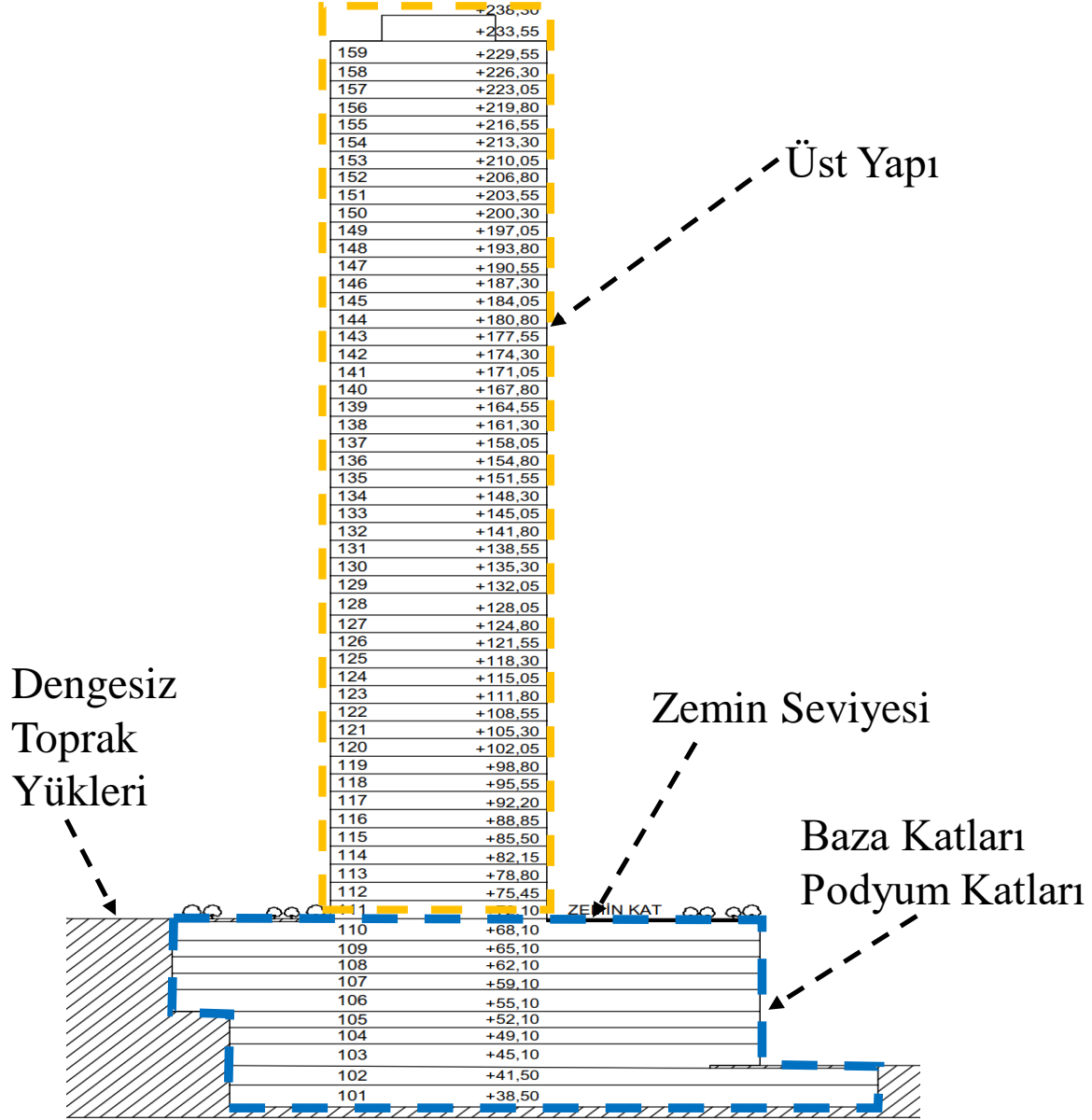
**Ronald O. Hamburger  
Helmut Krawinkler  
James O. Malley  
Scott M. Adan**

# Kaynaklar

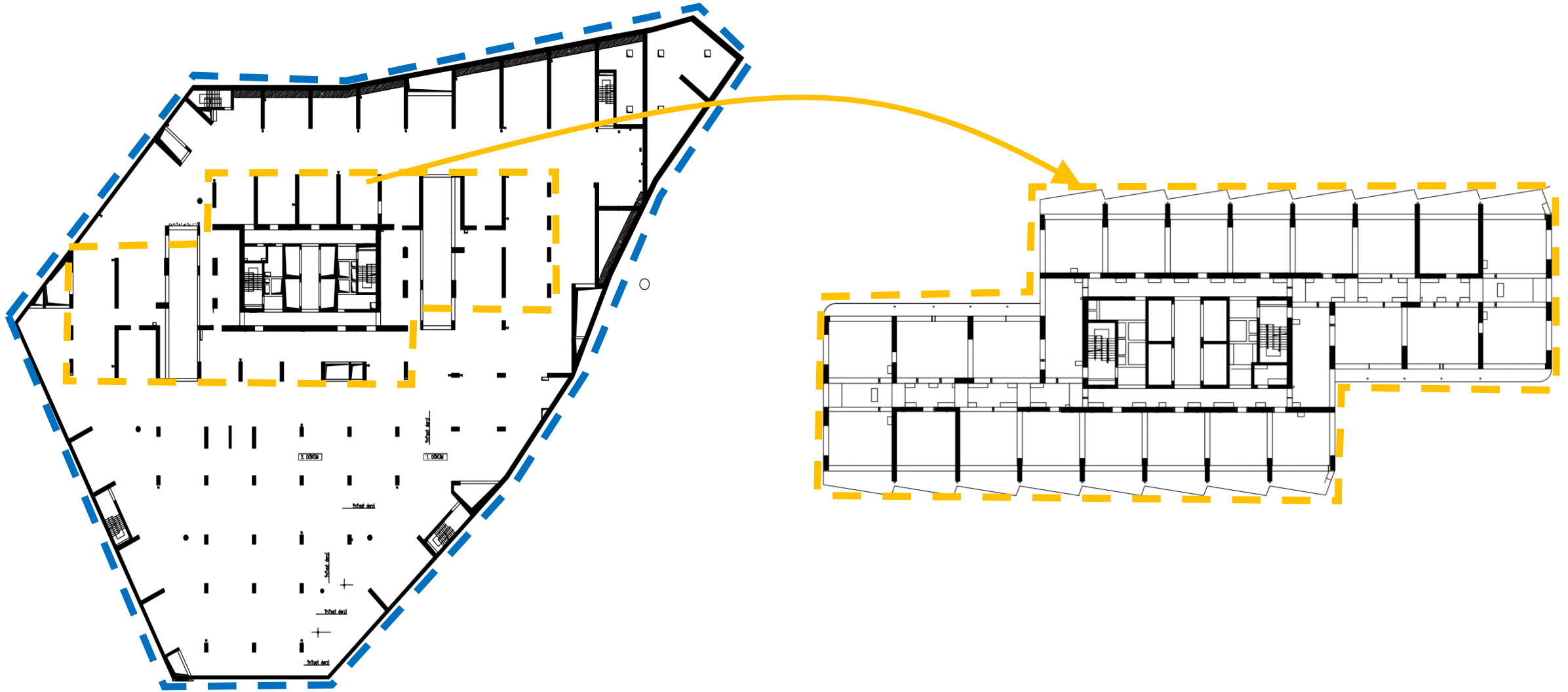
- NBCC, ASCE 7-10



# Yüksek Binalar



# Yüksek Binalar

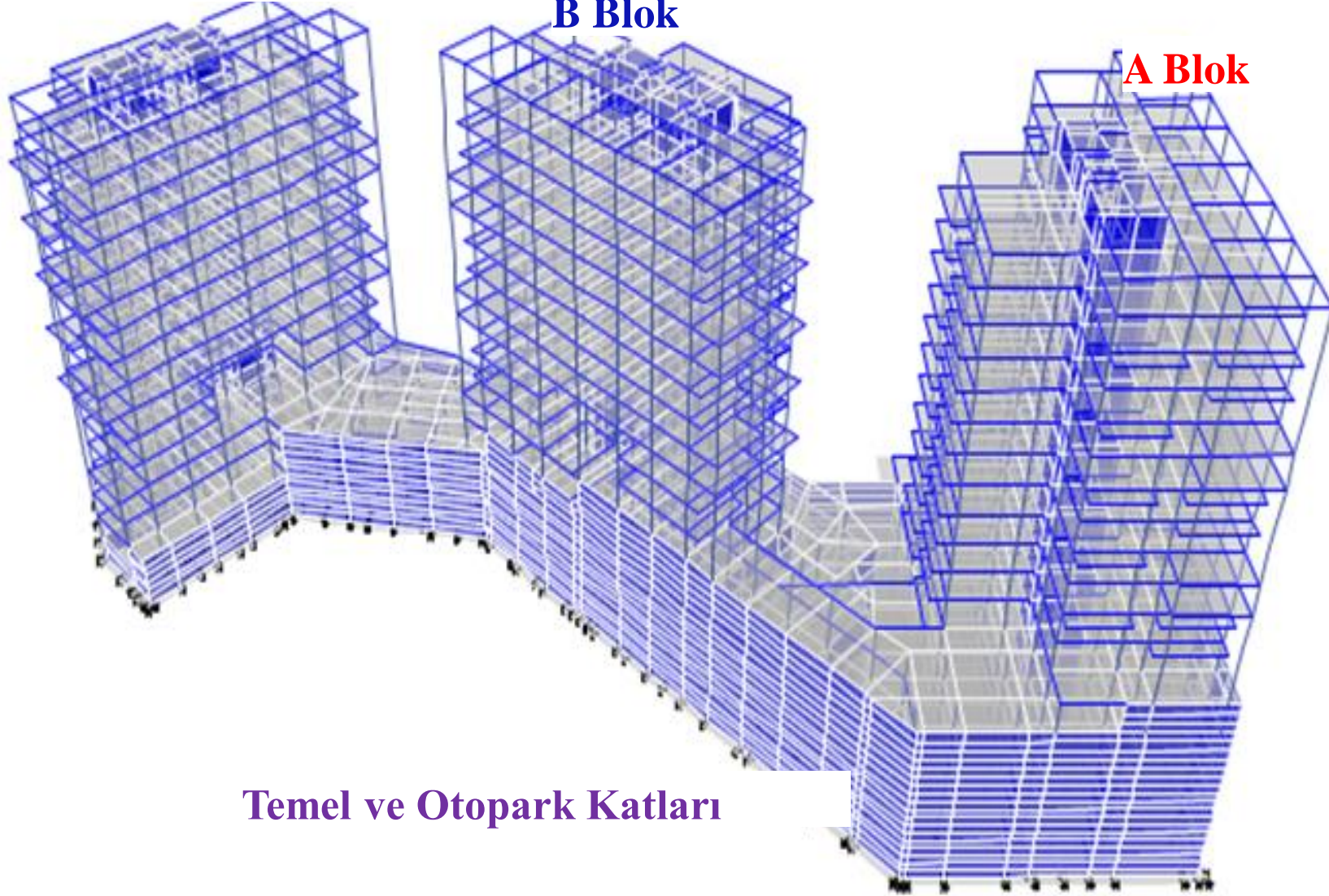


# Birden Fazla Bina Olması Durumu

C Blok

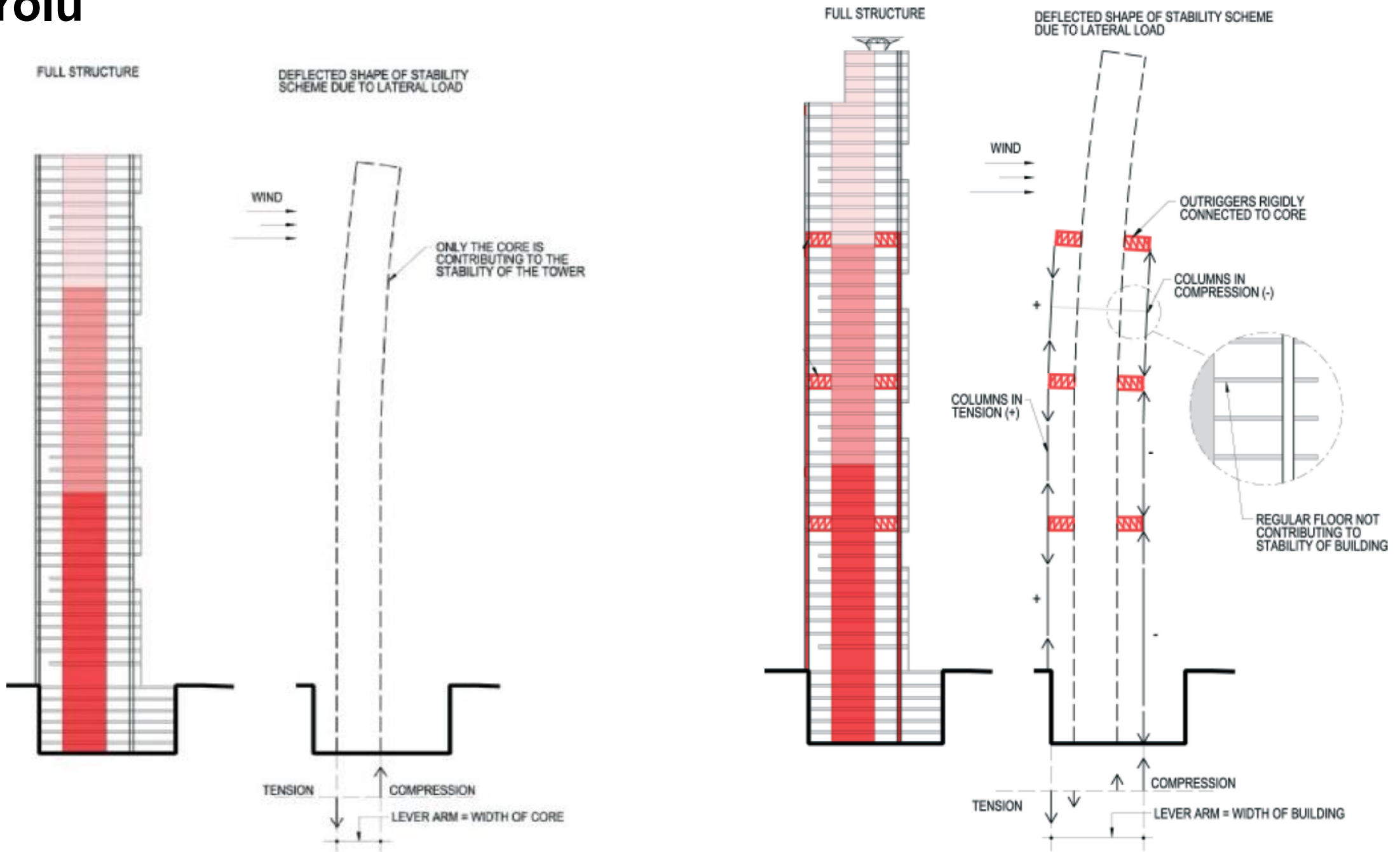
B Blok

A Blok



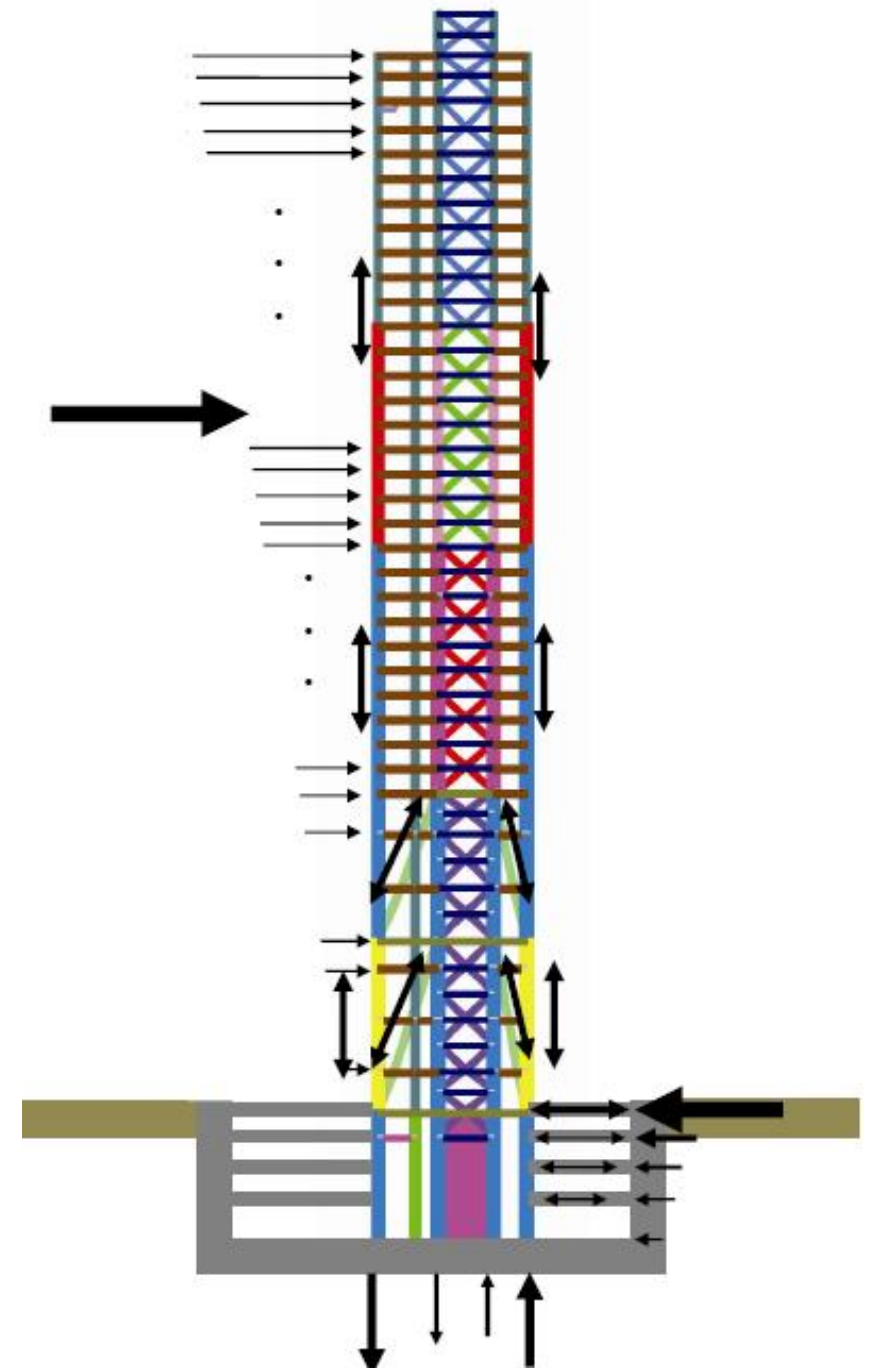
Temel ve Otopark Katları

# Yük Yolu

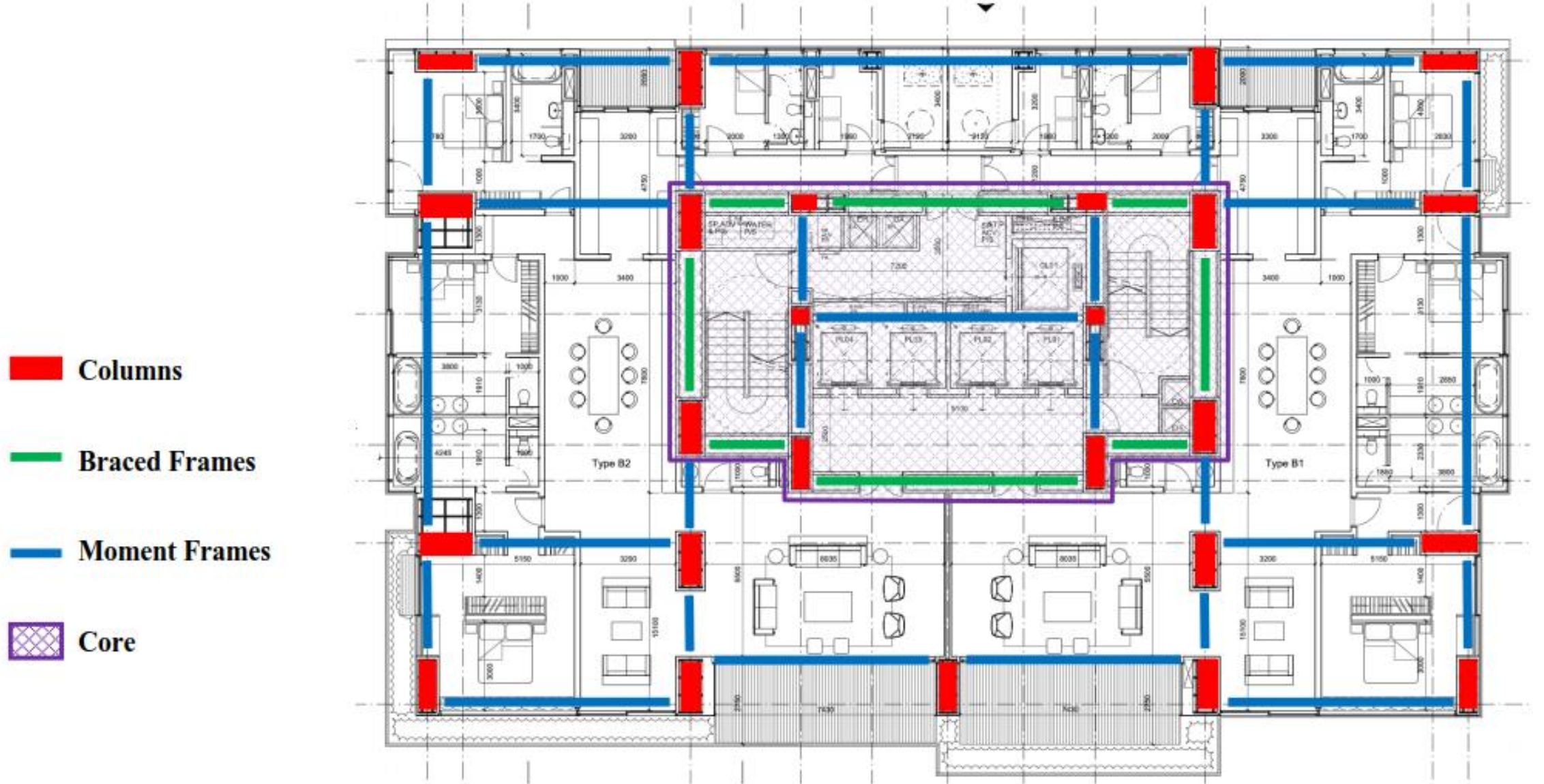


# Taşıyıcı Sistemler

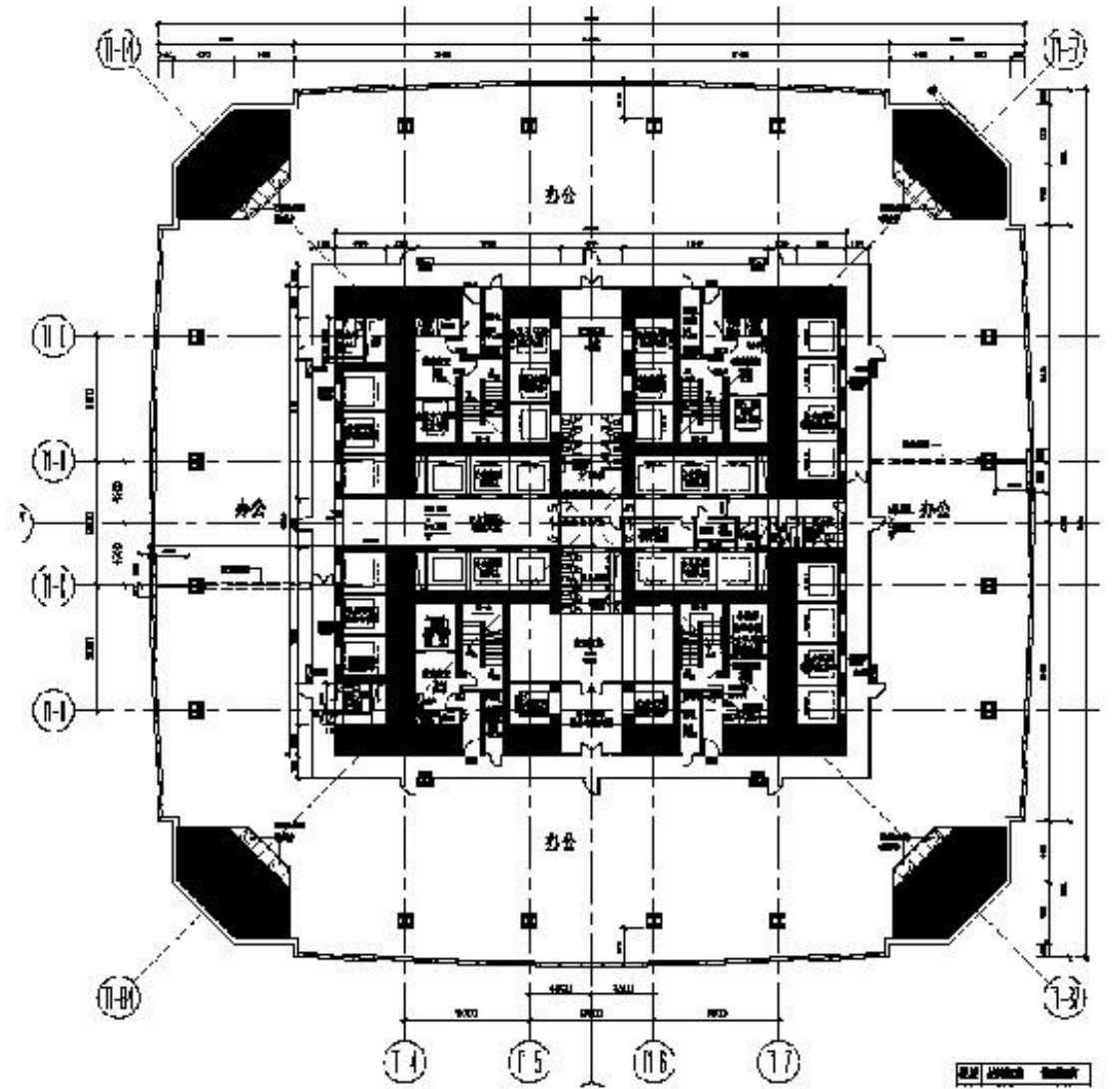
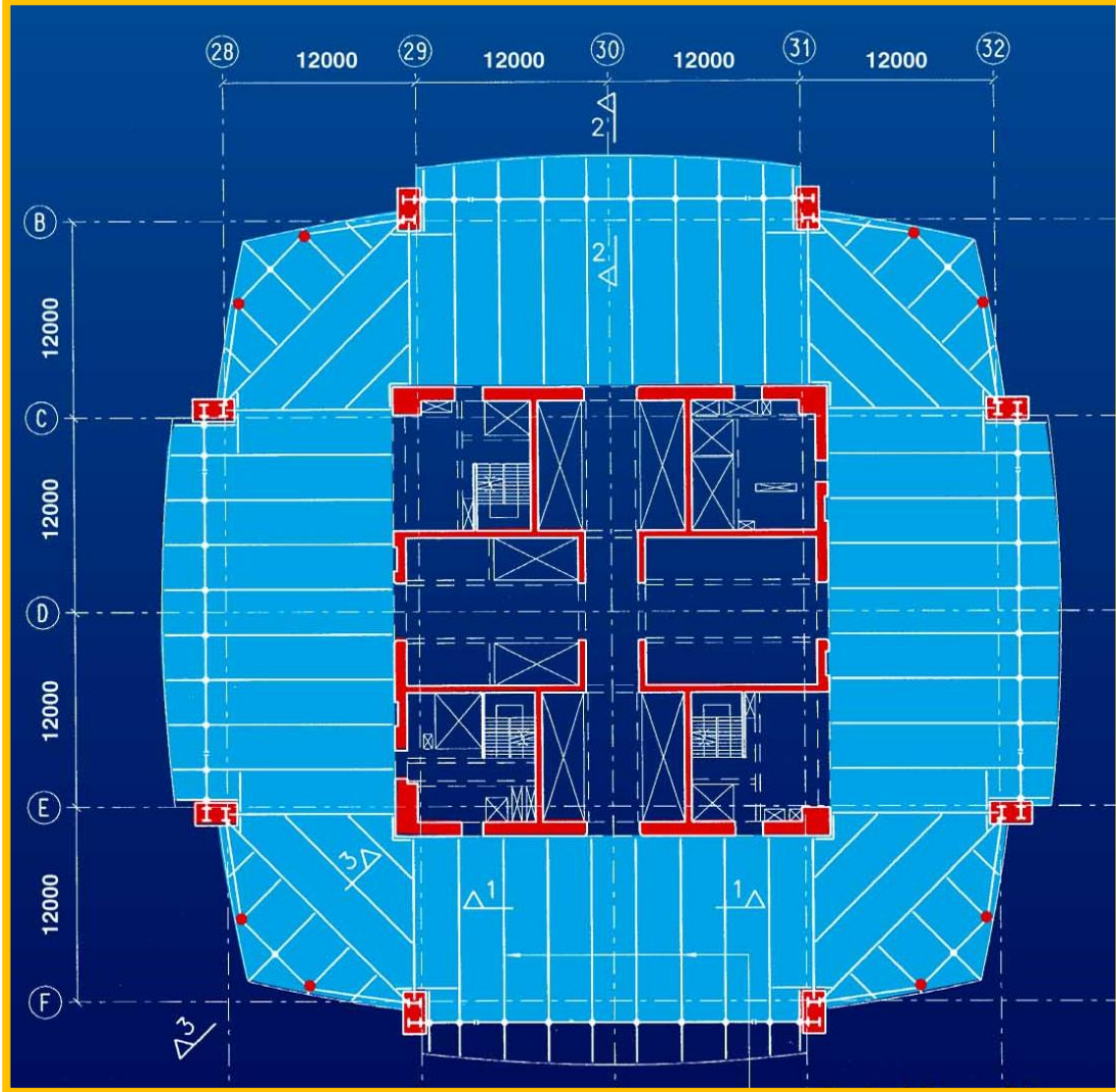
- Düşey Sistem (Gravity)
- Yanal Sistem (Lateral)
- Temel Sistemi
- Dengesiz Toprak Yükleri için Sistem
- Derin Kazı Sistemi



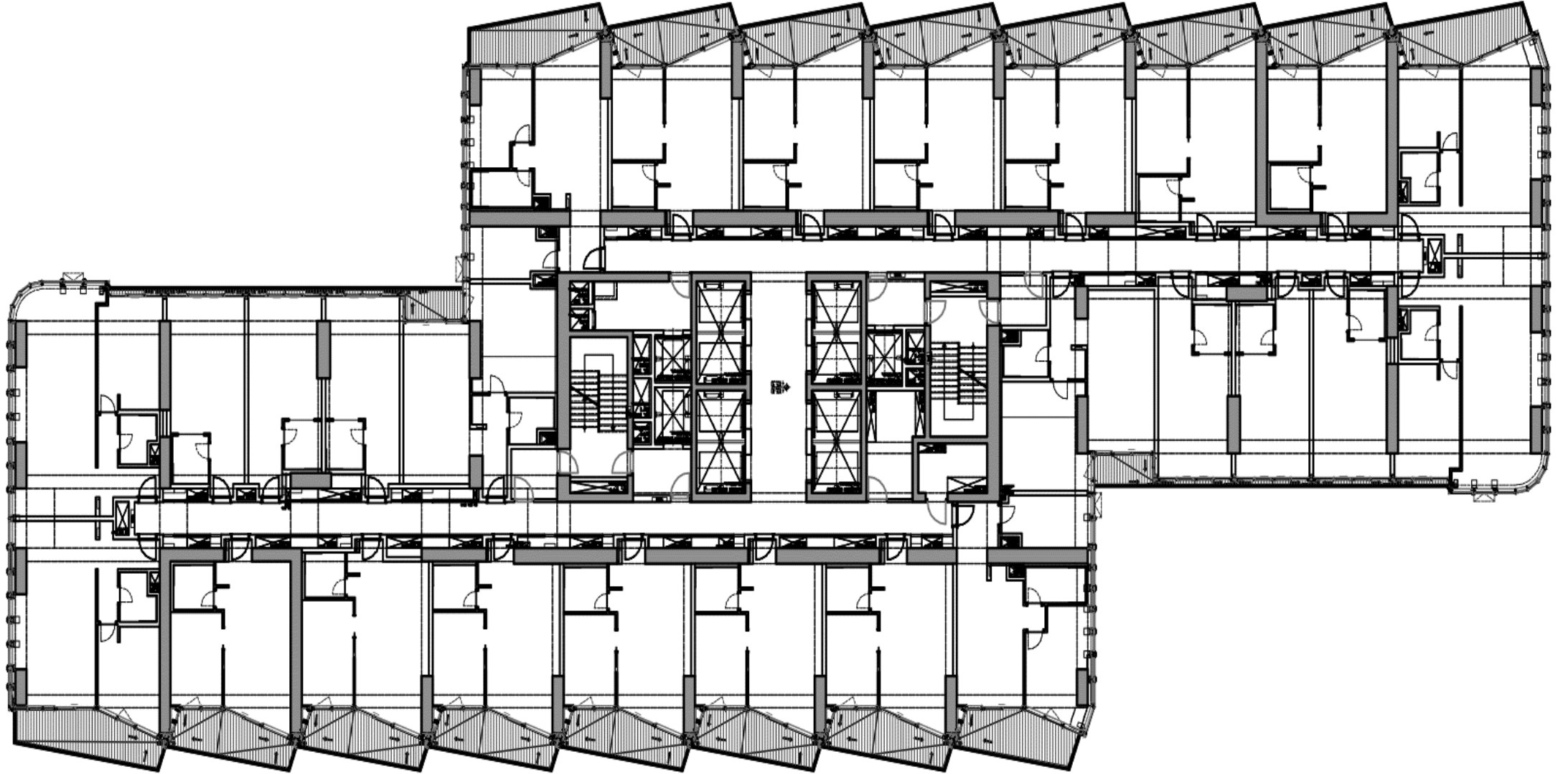
# Yüksek Bina Mimarisi



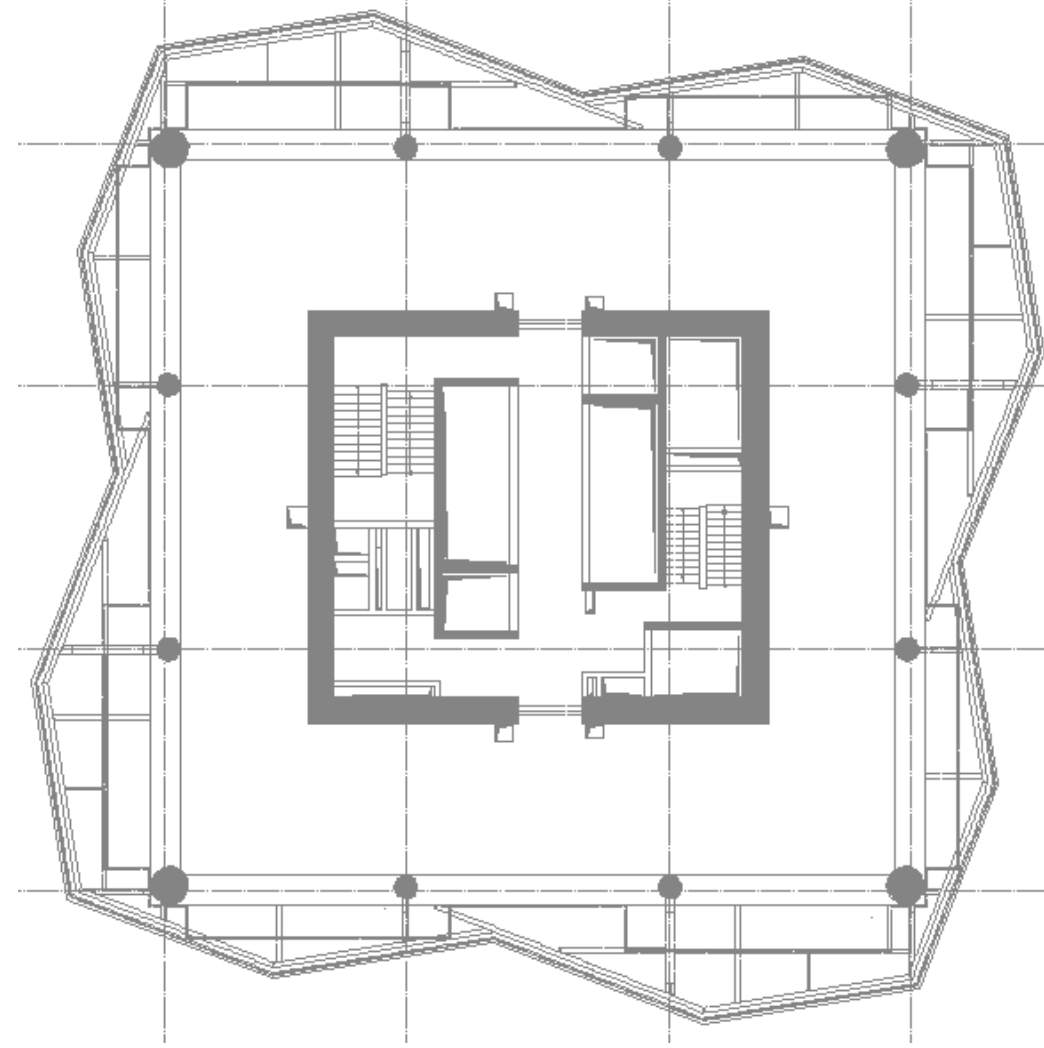
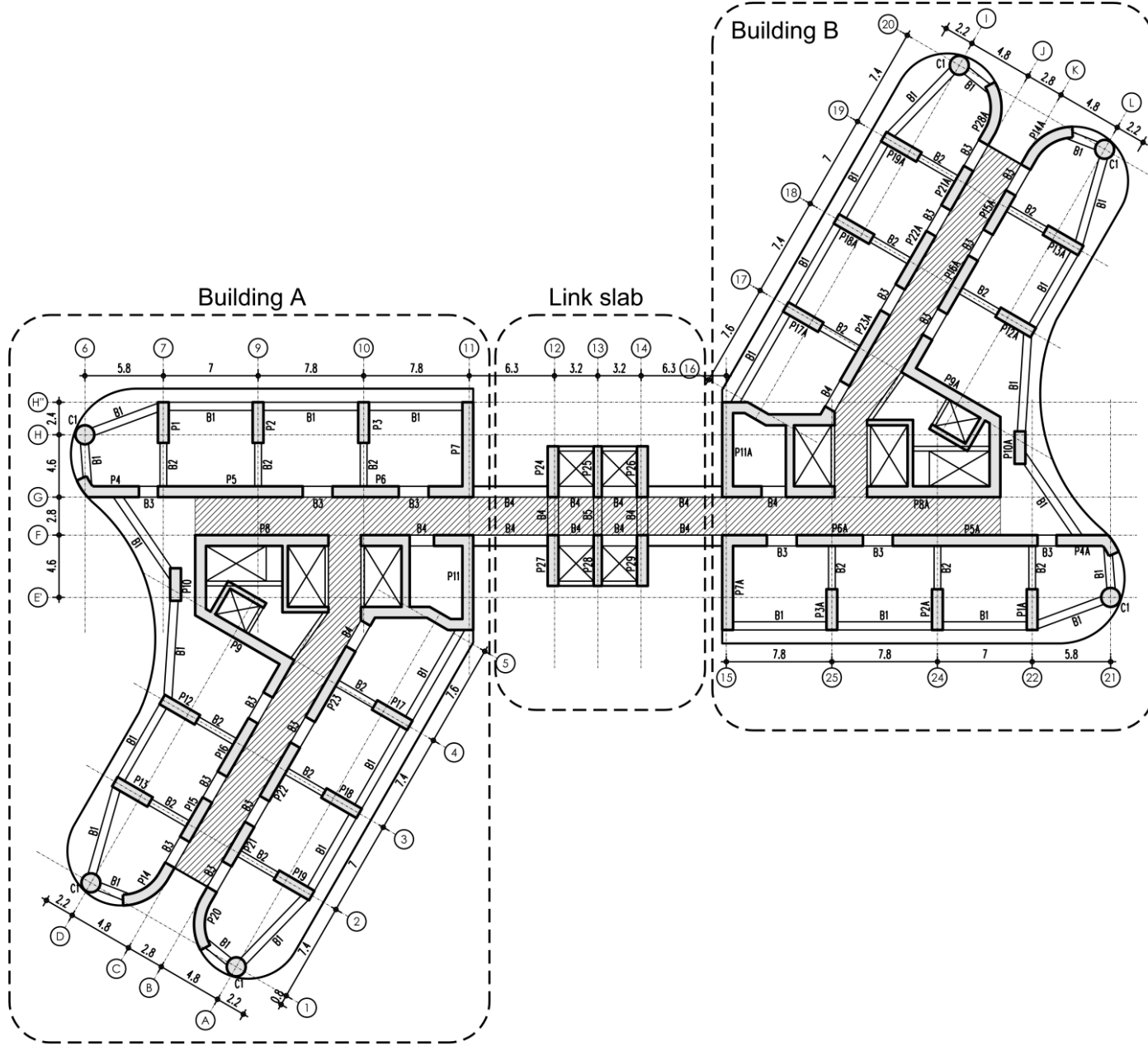
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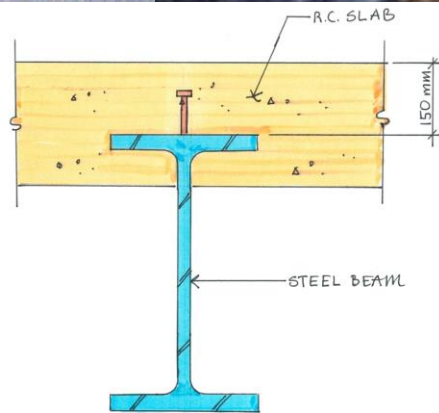
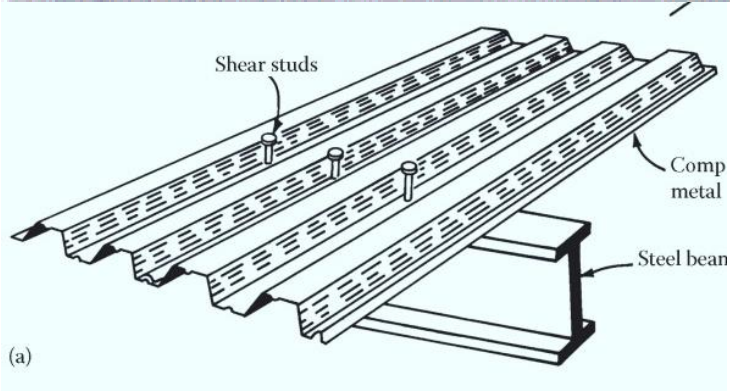
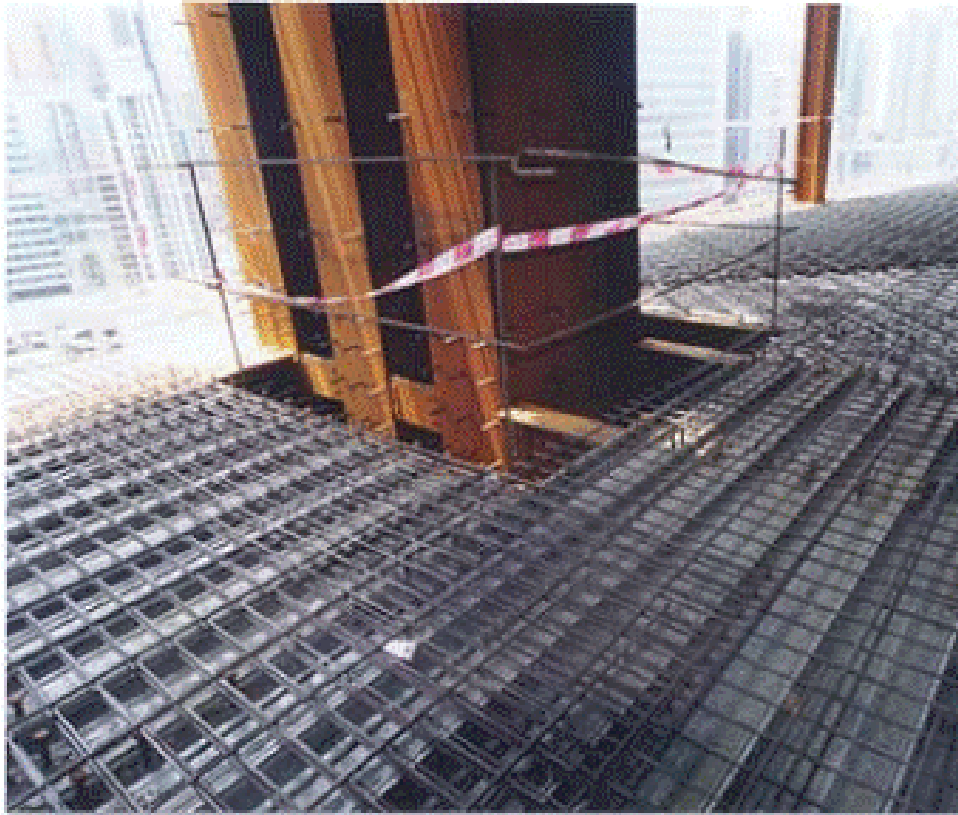
# Yüksek Bina Mimarisi



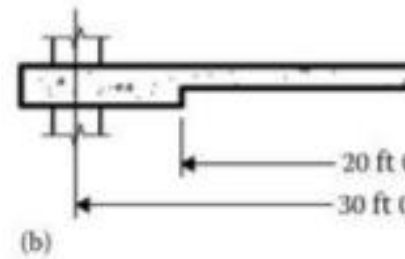
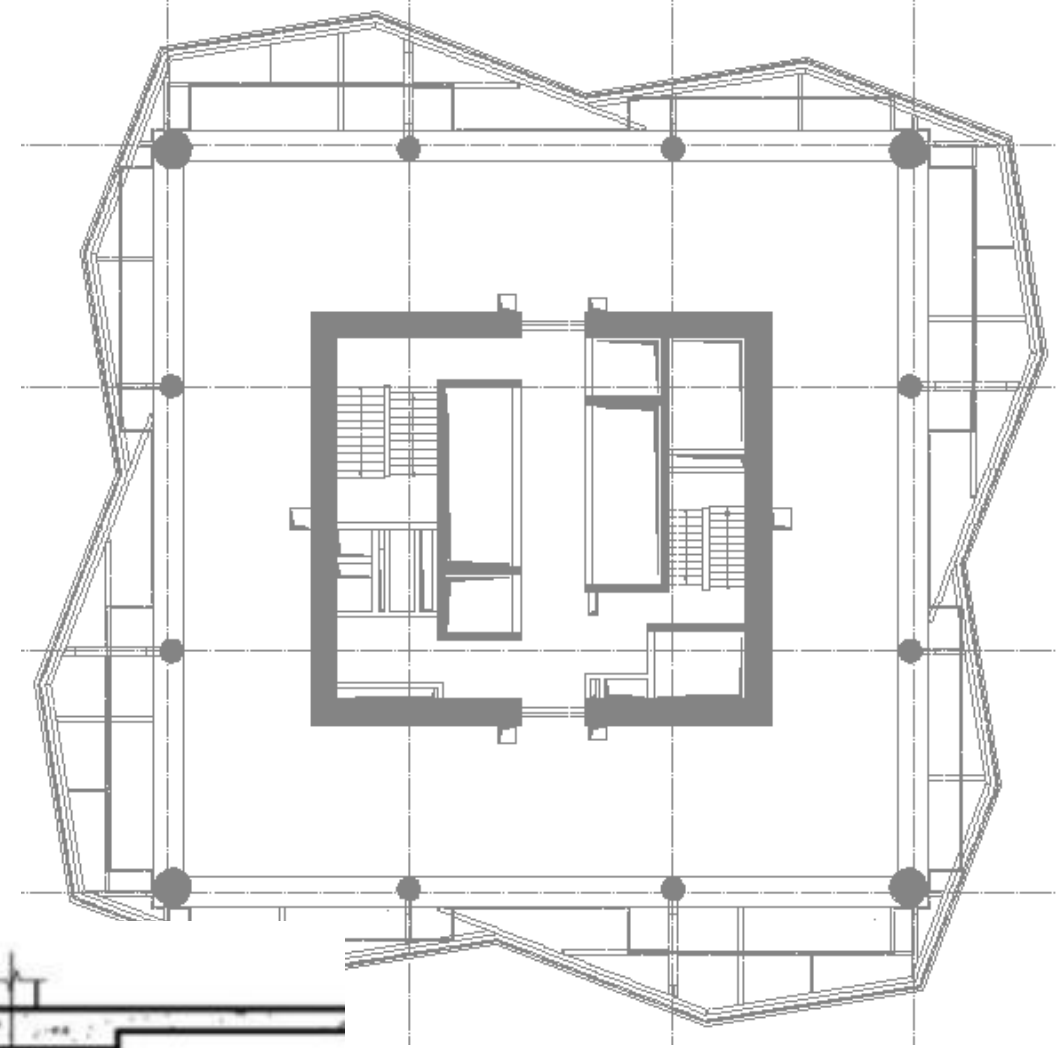
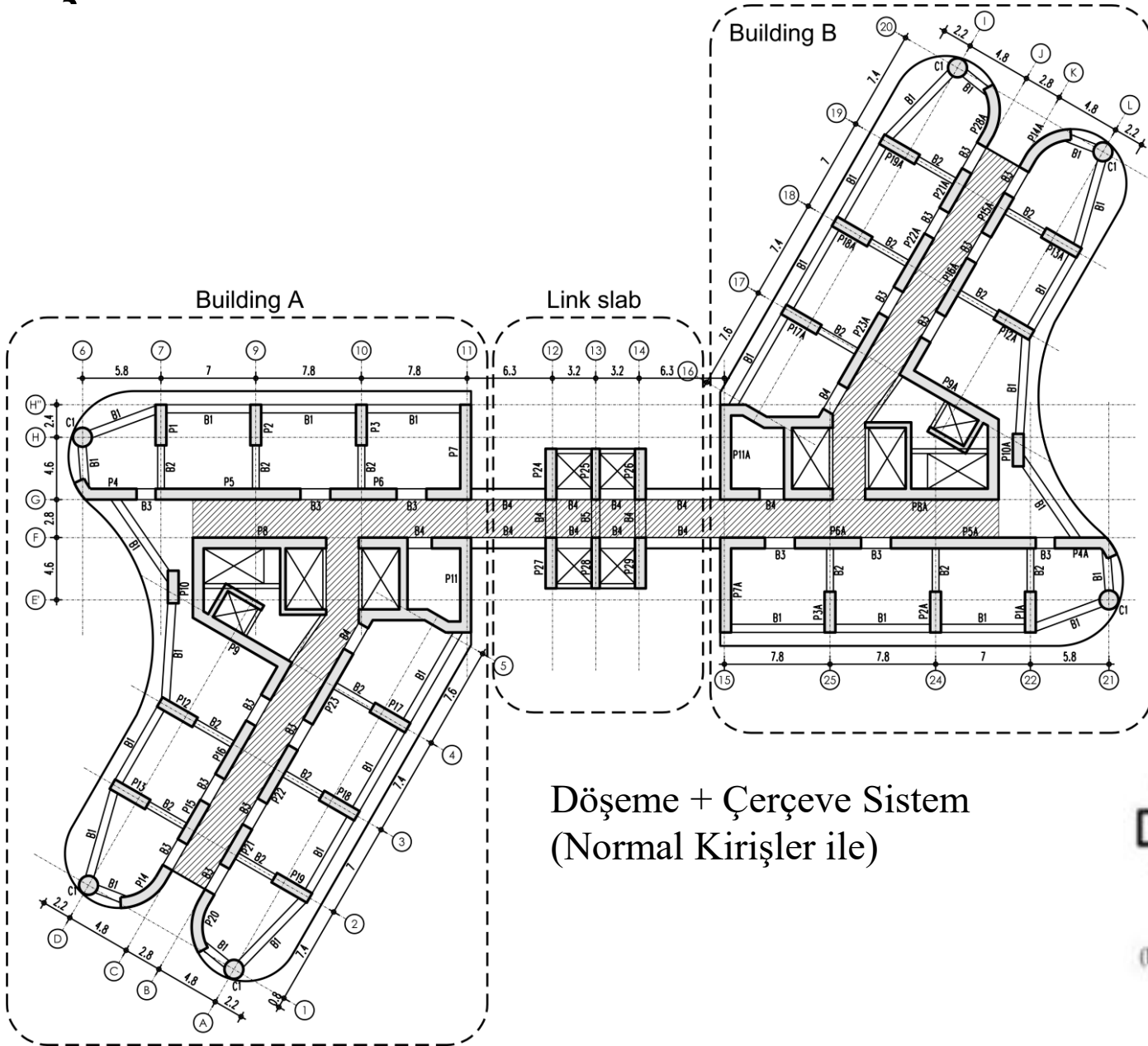
# Yüksek Bina Mimarisi



# Düşey Sistem: Döşeme



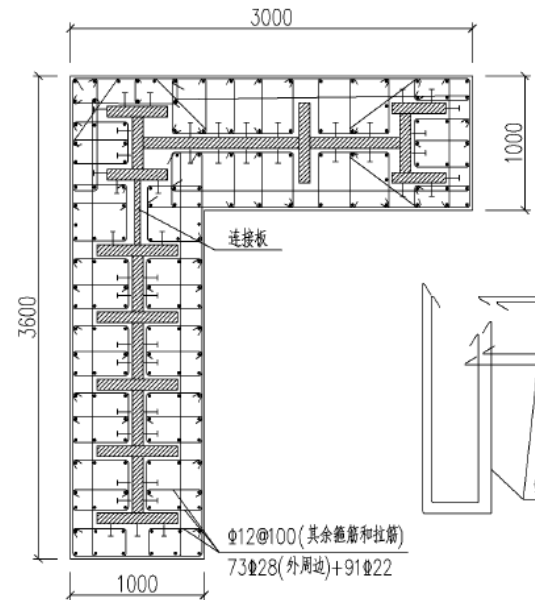
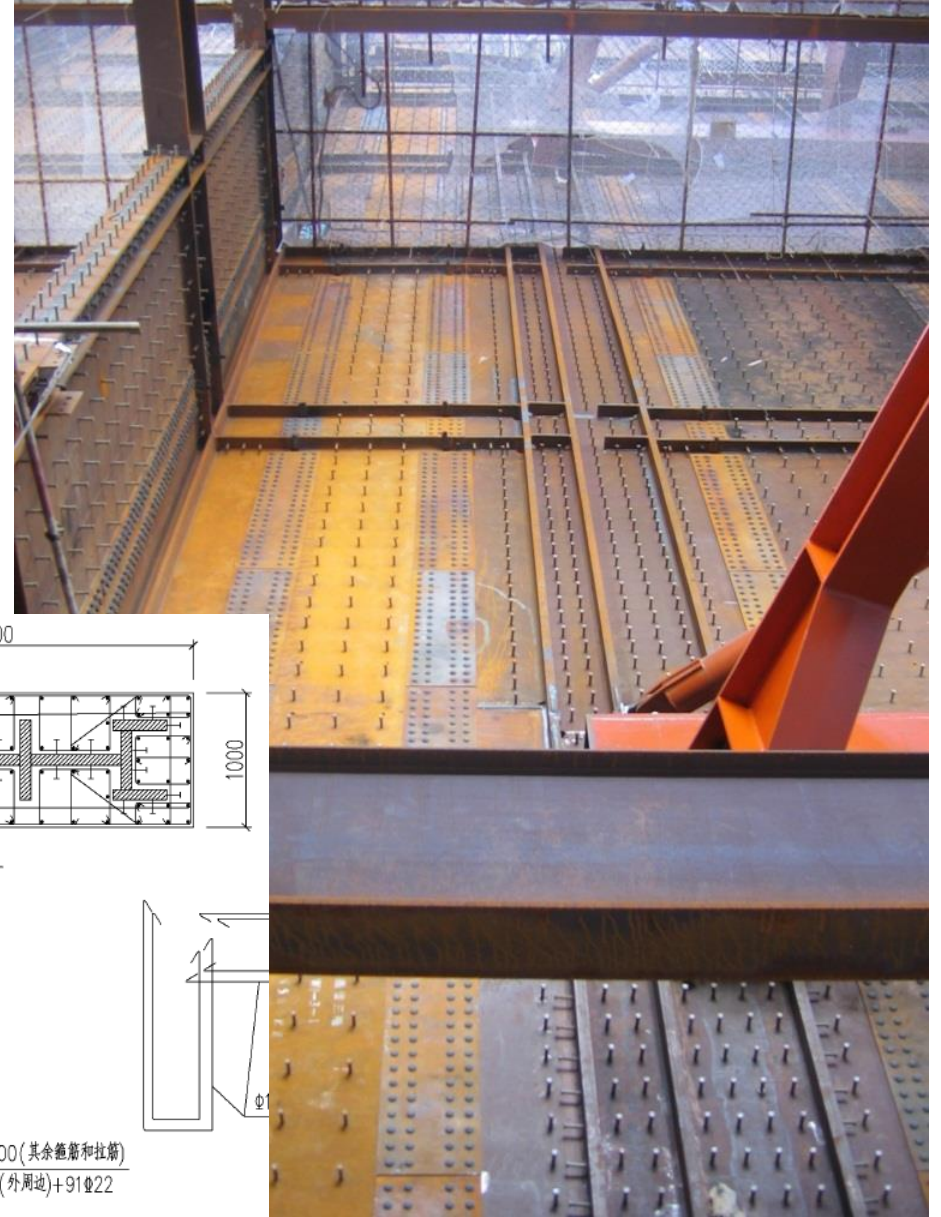
# Döşeme Sistemi



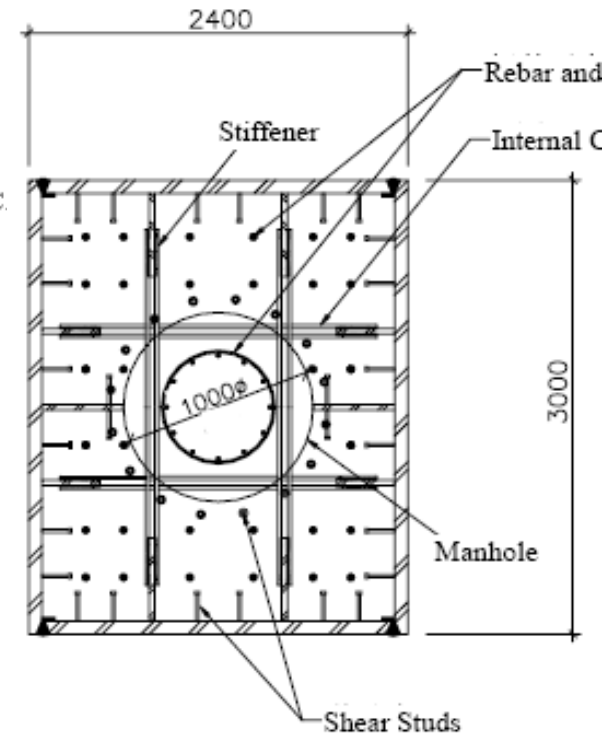
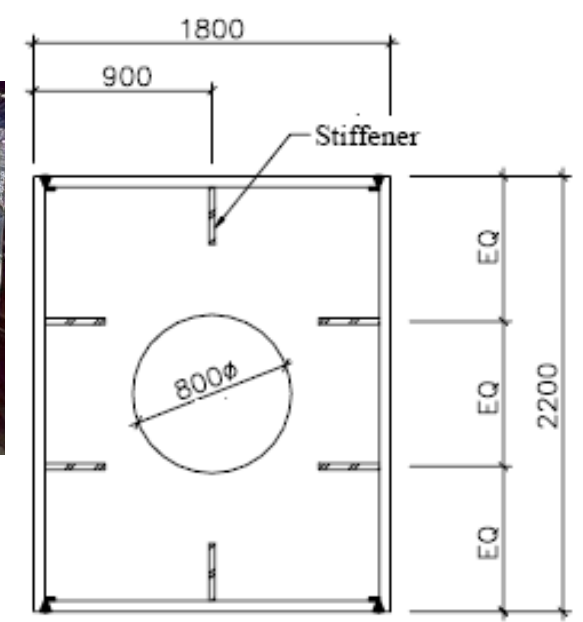
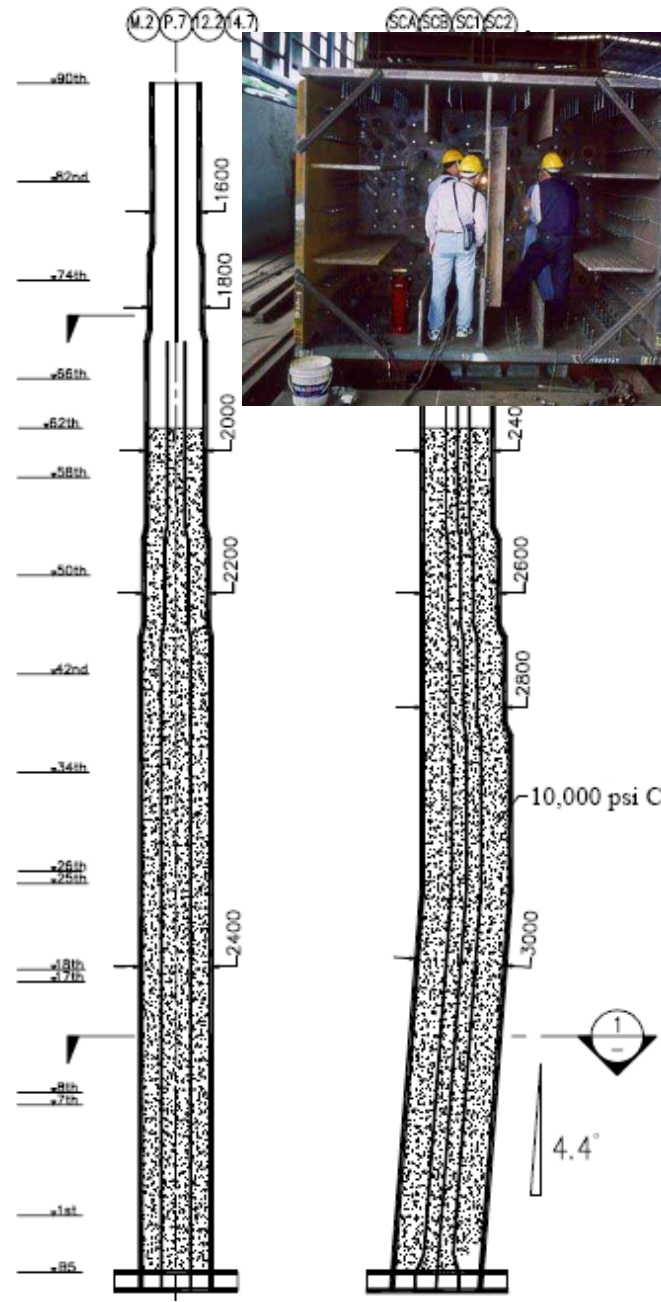
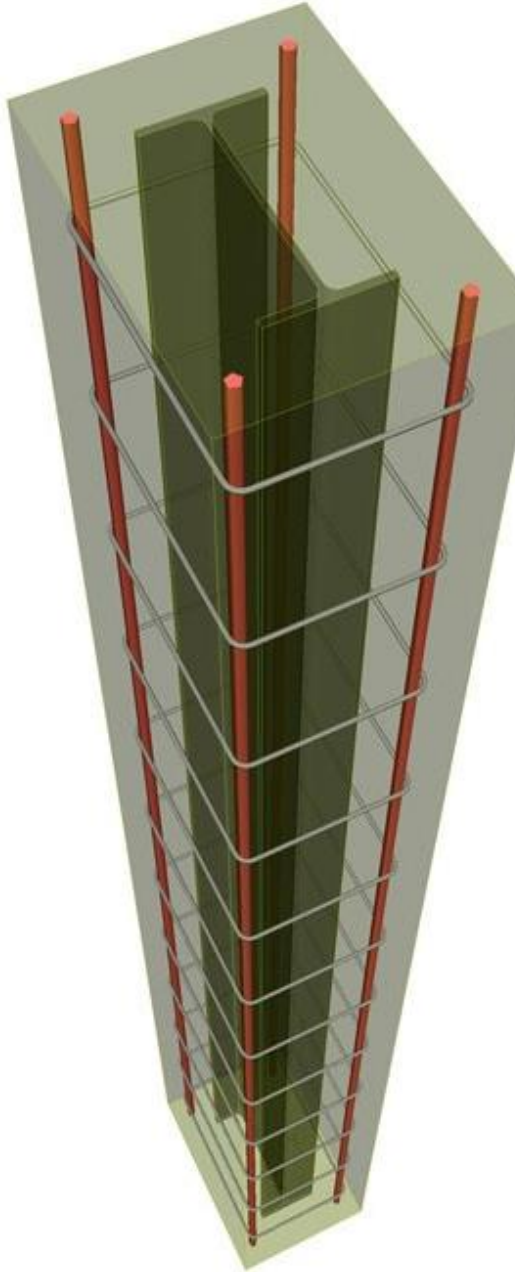
Band beam system

Mantar Döşeme + Bant Kirişi  
(Yatık Kiriş ile)

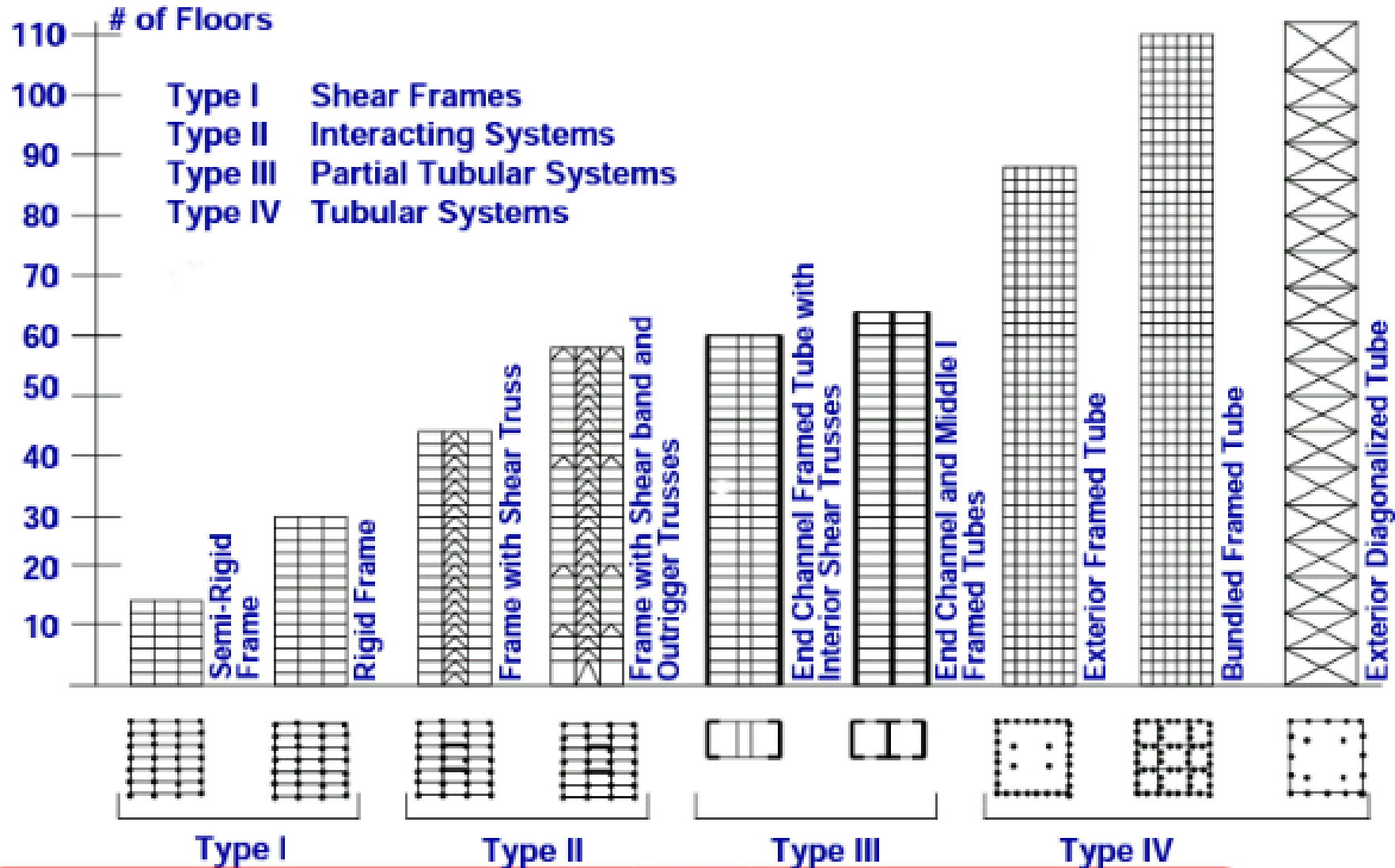
# Düşey Sistem: Çekirdek



# Düşey Sistem: Kolon



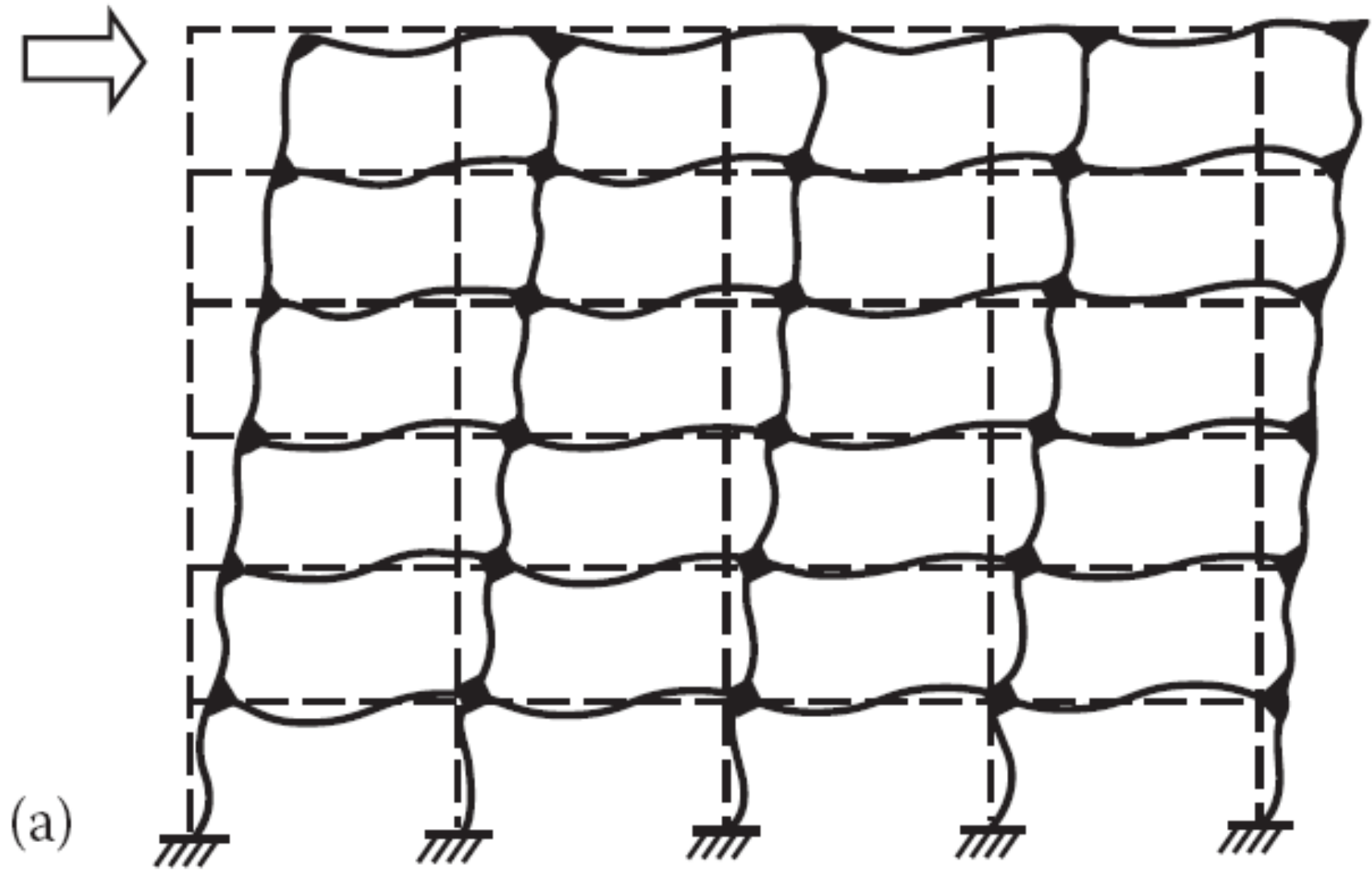
## Evolution of Structural Systems



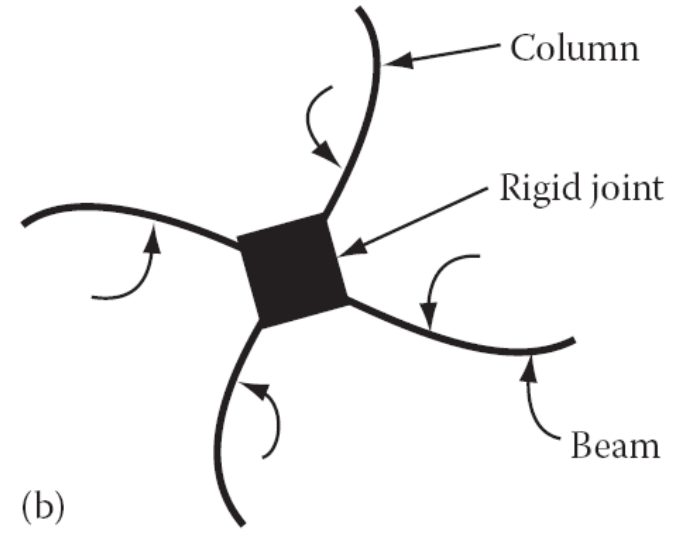
# Yanal Sistem – Betonarme Yapılar

Structural systems for concrete buildings													
No.	System	Number of stories											Ultra-tall buildings 120–200 stories
		0	10	20	30	40	50	60	70	80	90	100	
1	Flat slab and columns	████████████████████											
2	Flat slab and shear walls	██████████████████											
3	Flat slab, shear walls and columns	██████████████████											
4	Coupled shear walls and beams	██████████████████											
5	Rigid frame	██████████████████											
6	Widely spaced perimeter tube	██████████████████											
7	Rigid frame with haunch girders	██████████████████											
8	Core supported structures	██████████████████											
9	Shear wall—frame	██████████████████											
10	Shear wall—Haunch girder frame	██████████████████											
11	Closely spaced perimeter tube	██████████████████											
12	Perimeter tube and interior core walls	██████████████████											
13	Exterior diagonal tube	██████████████████											
14	Modular tubes, and spine wall systems with outrigger and belt walls	██████████████████											

# Çerçeve Sistem

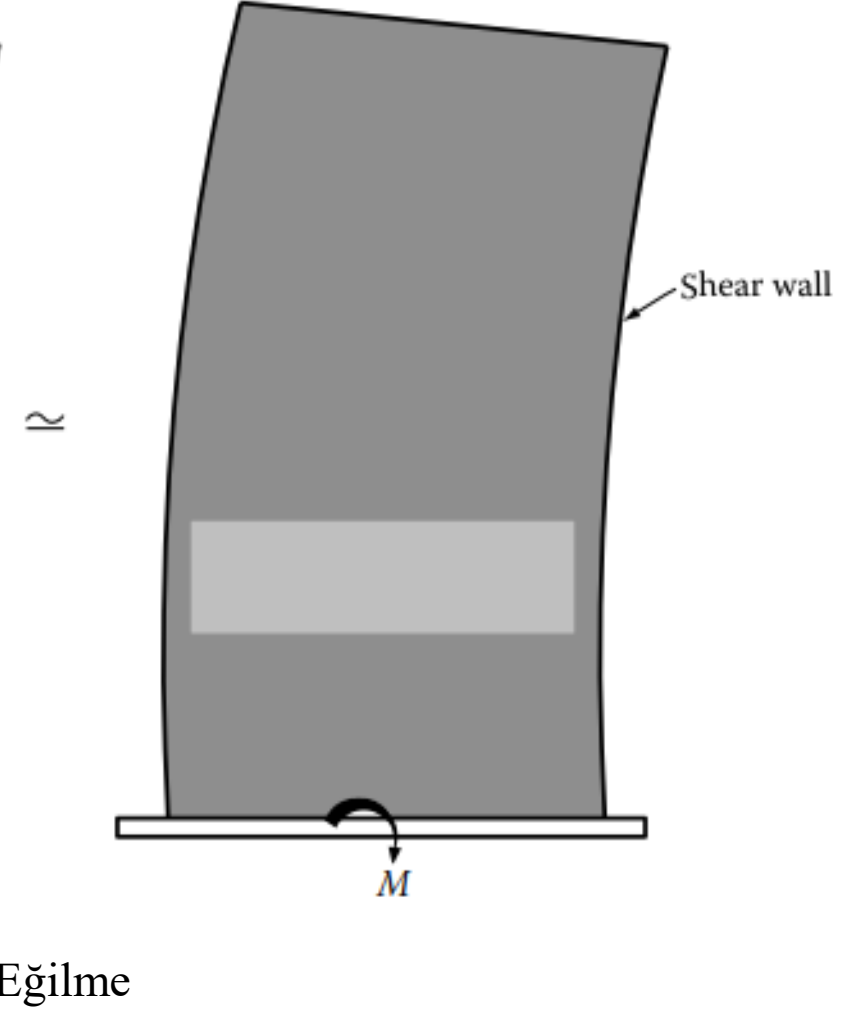
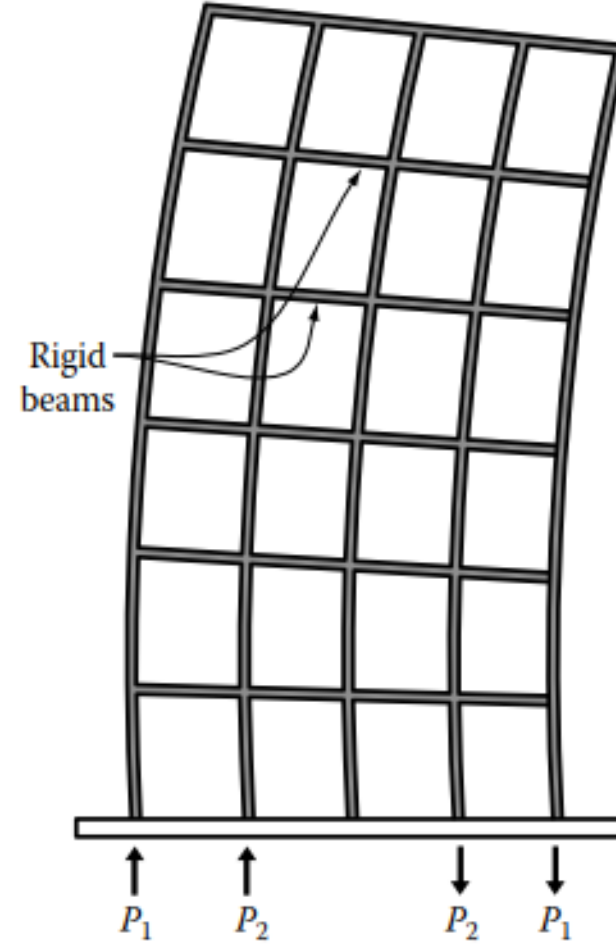
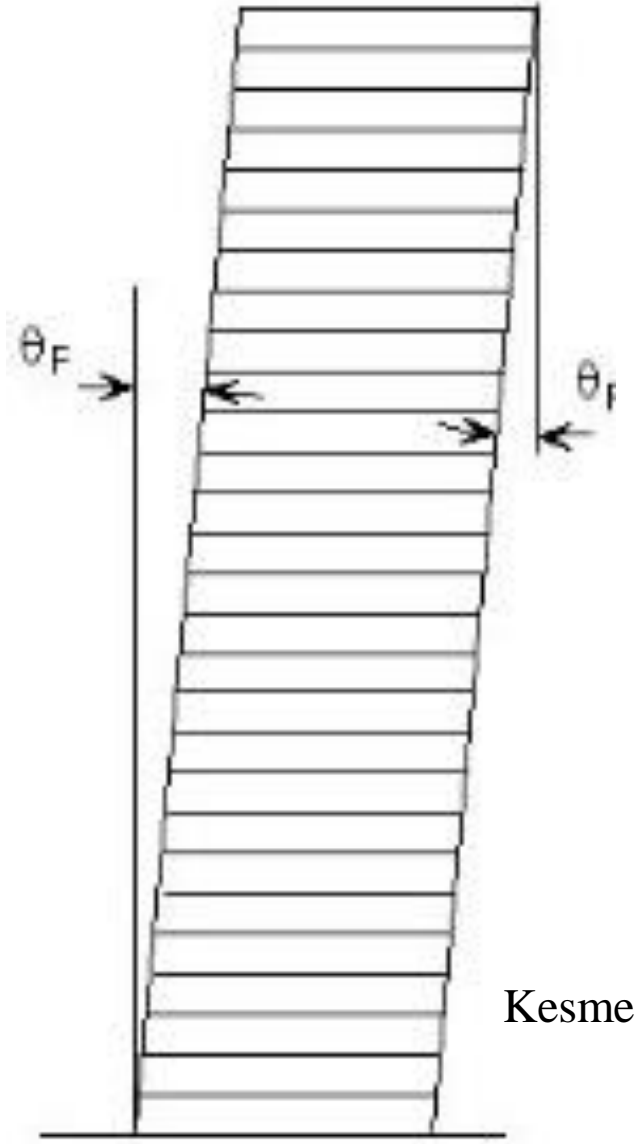


(a)

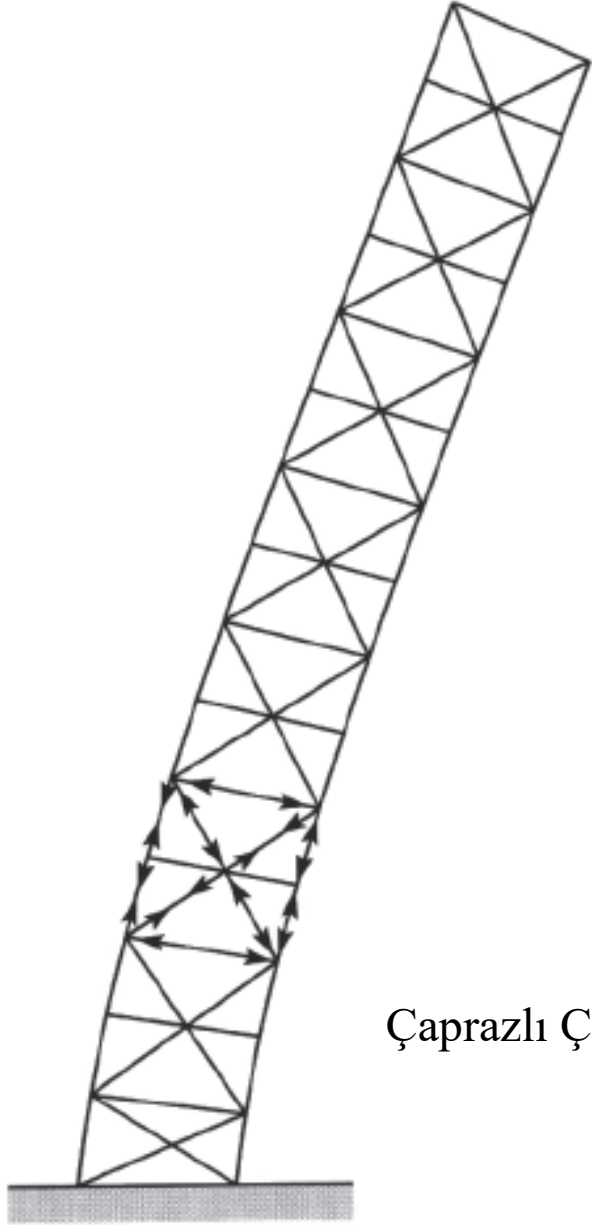


(b)

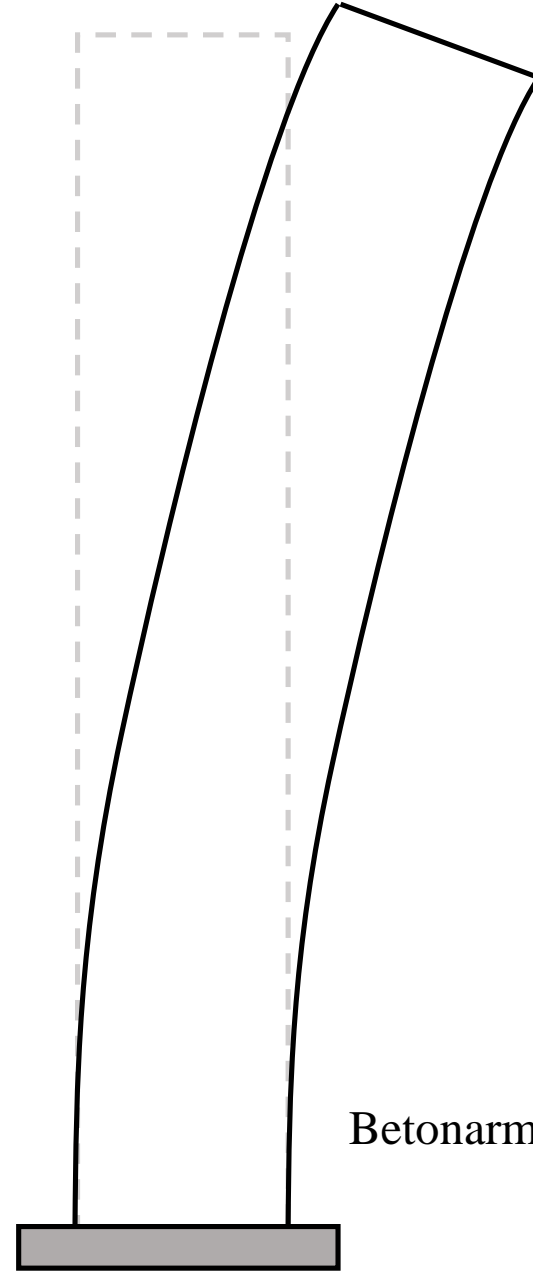
# Çerçeve



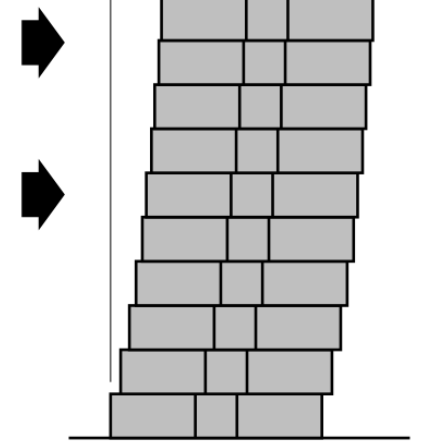
# Perde Duvar



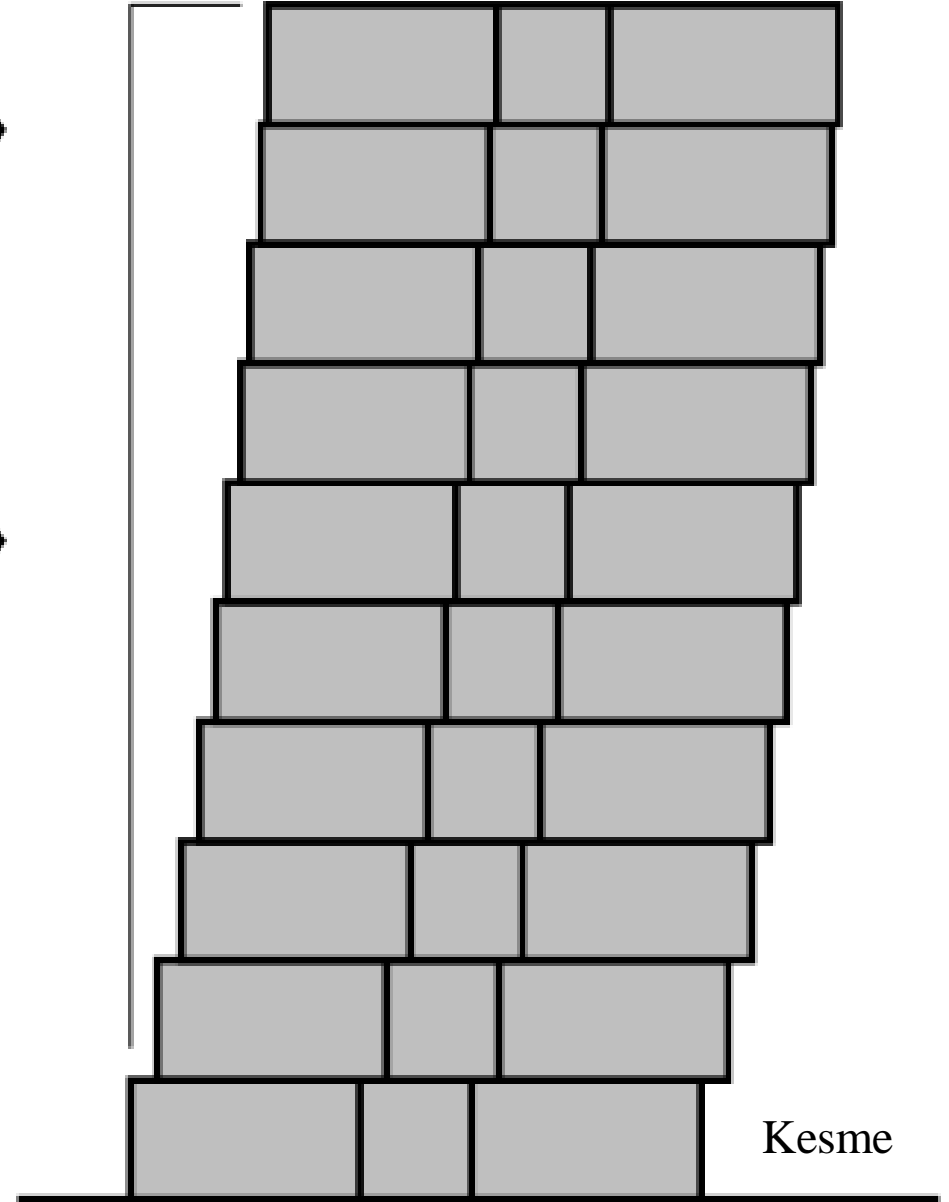
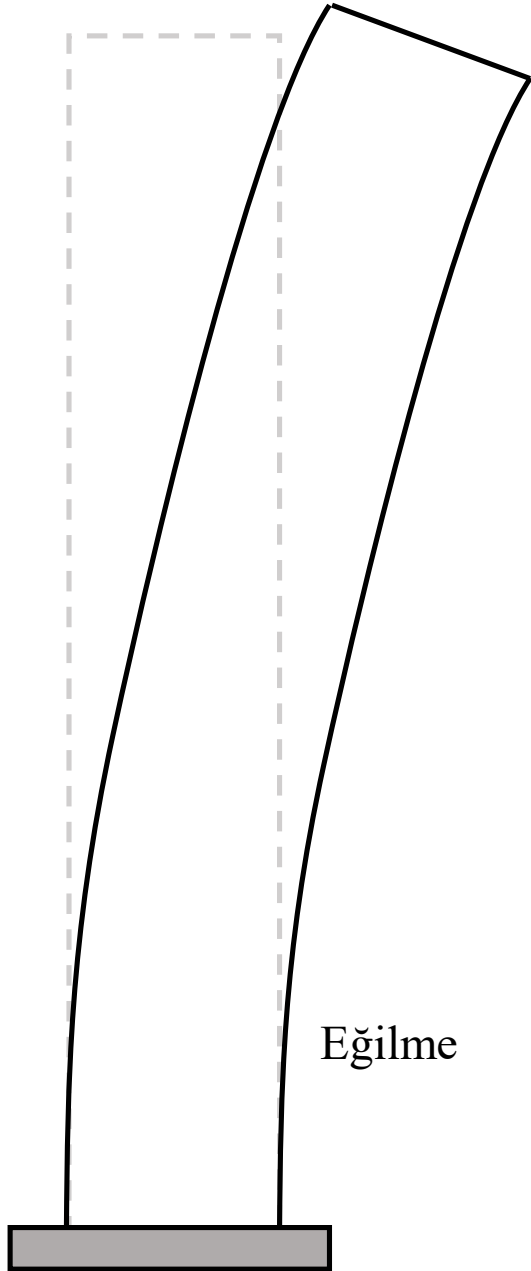
Çaprazlı Çelik



Betonarme Perde



# Perde Duvar

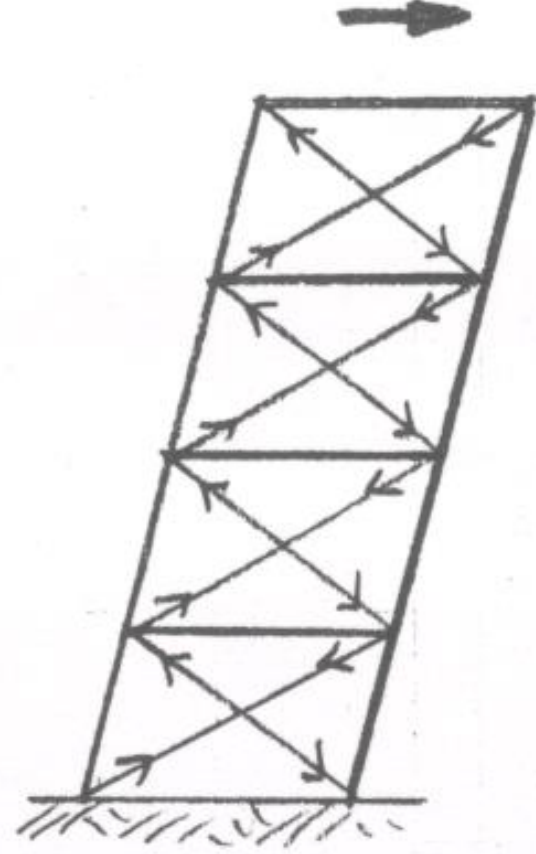


# Perde Duvar



Eğilme

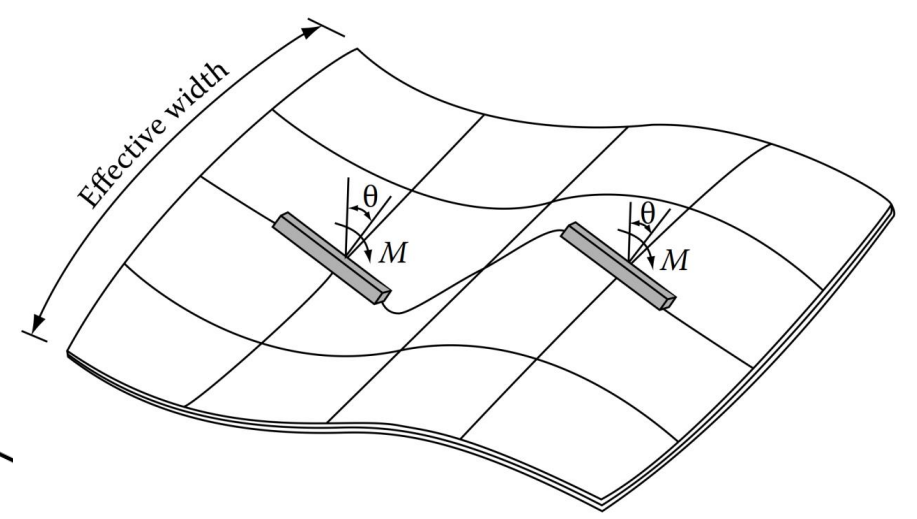
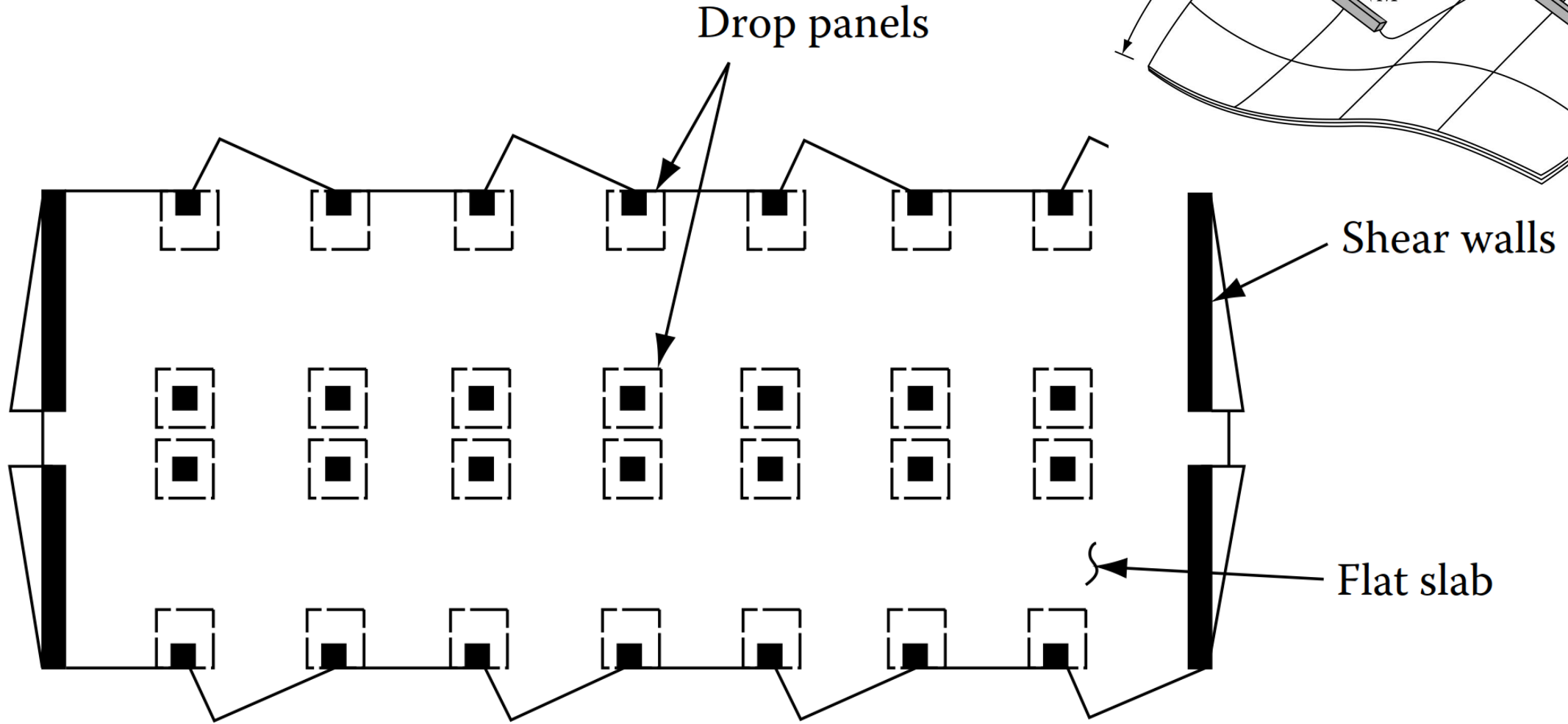
Bending



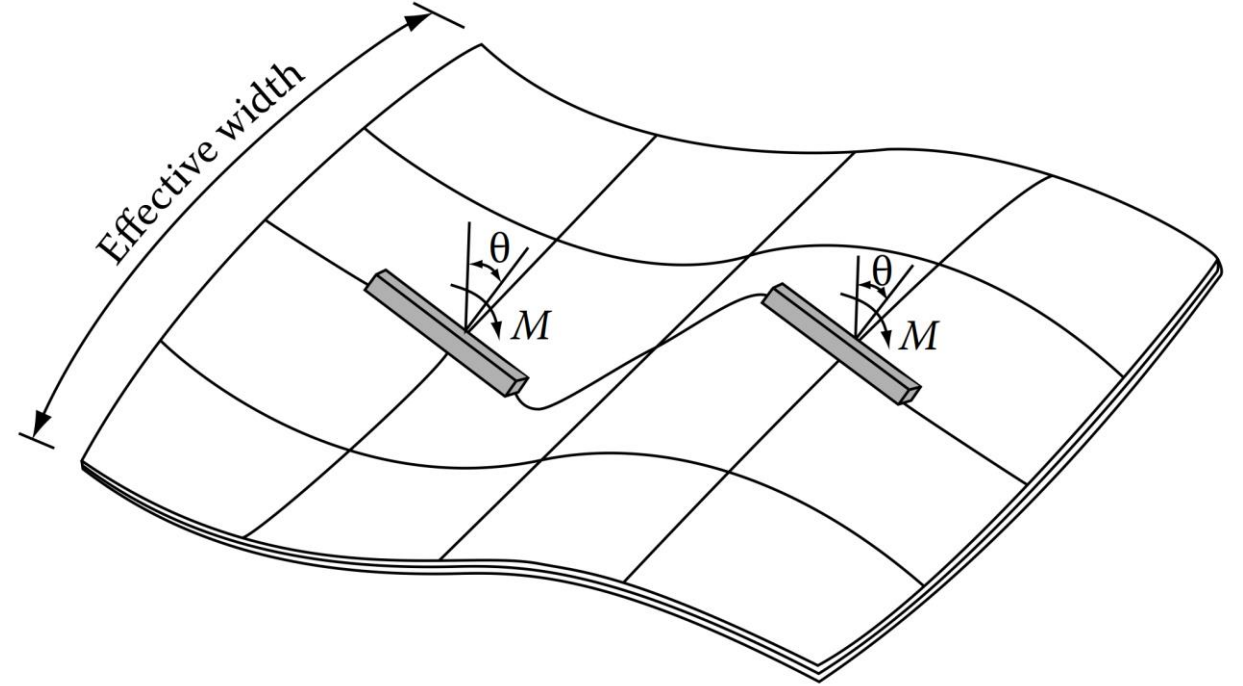
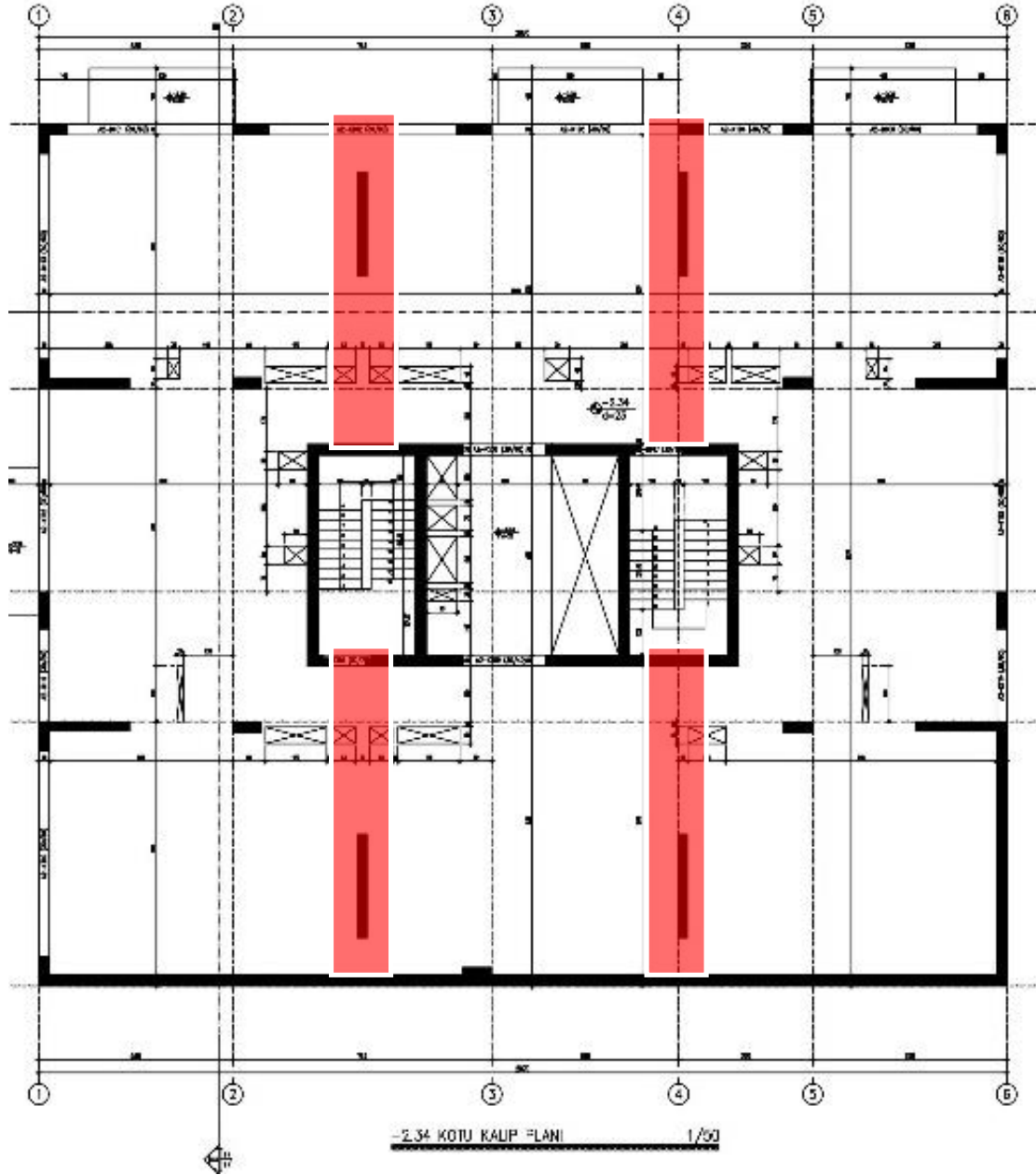
Kesme

Shear

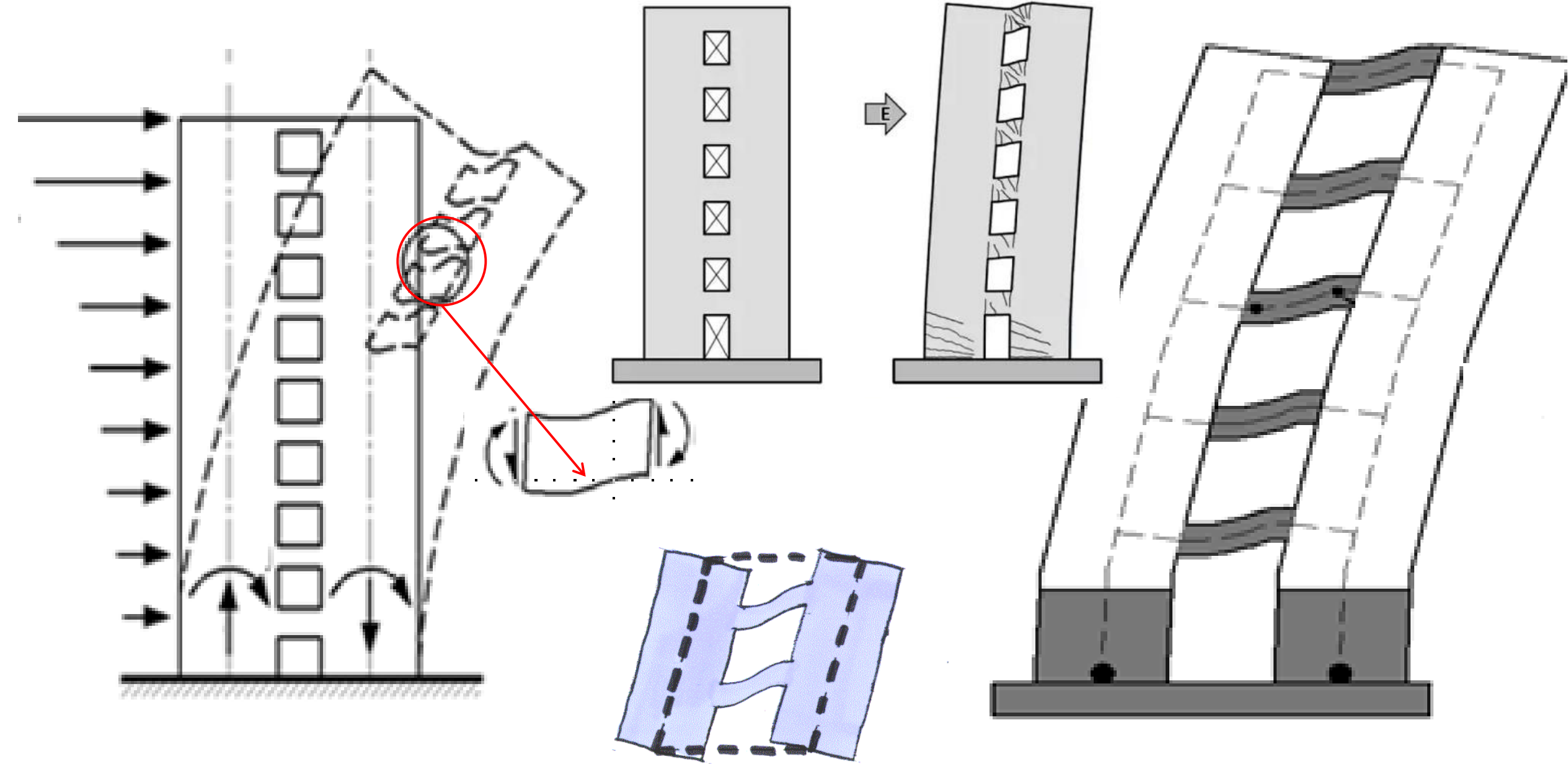
# Perde Duvar + Mantar Döşeme



# Perde Duvar + Mantar Döşeme



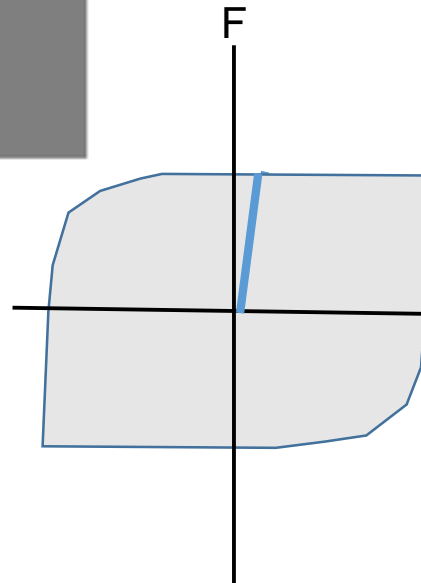
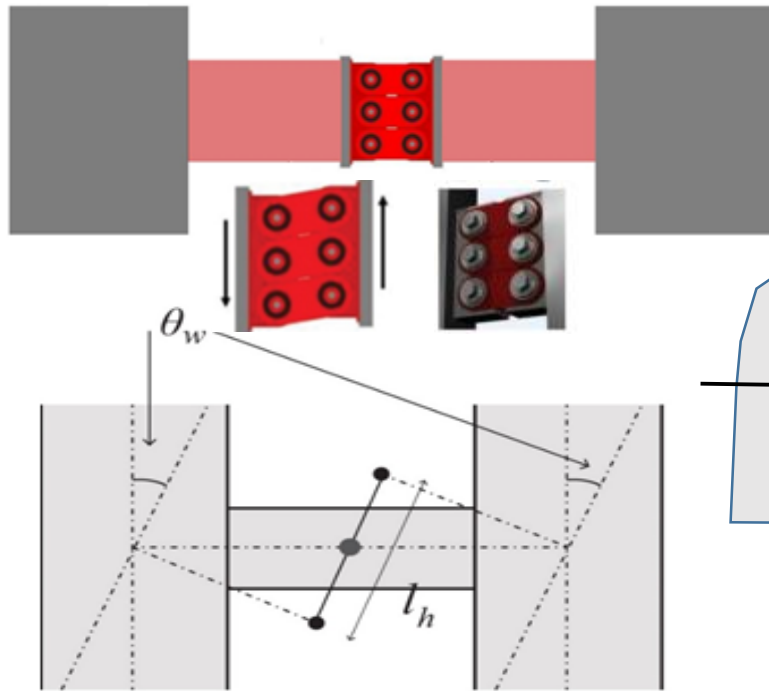
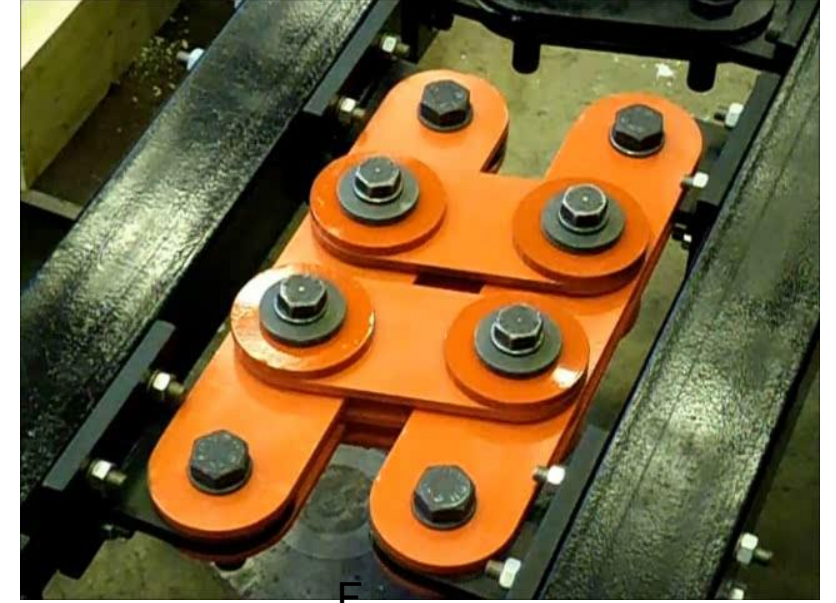
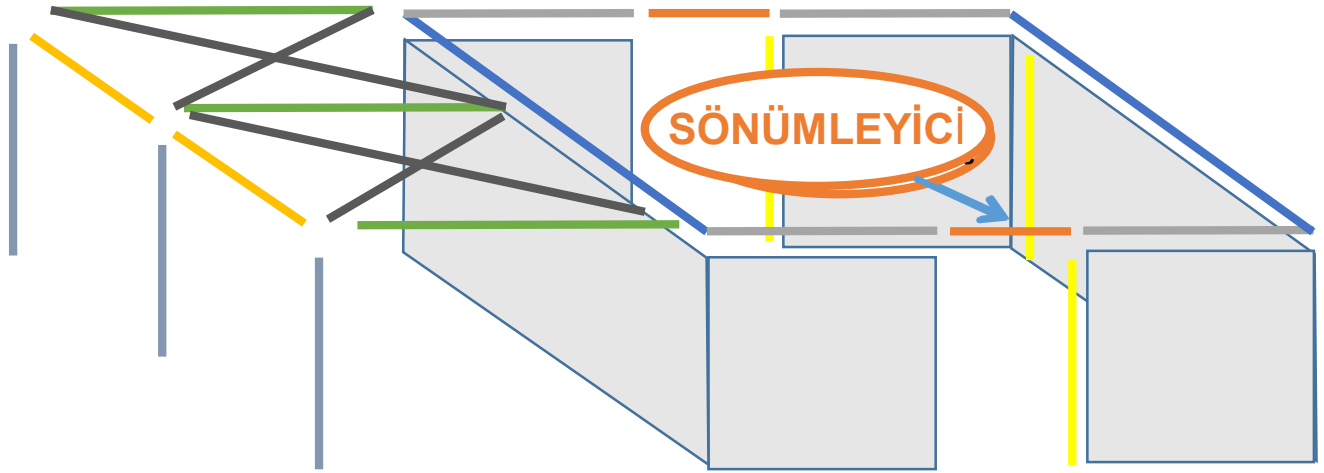
# Bağlı Perde Duvarlar (Coupled Shear Walls)



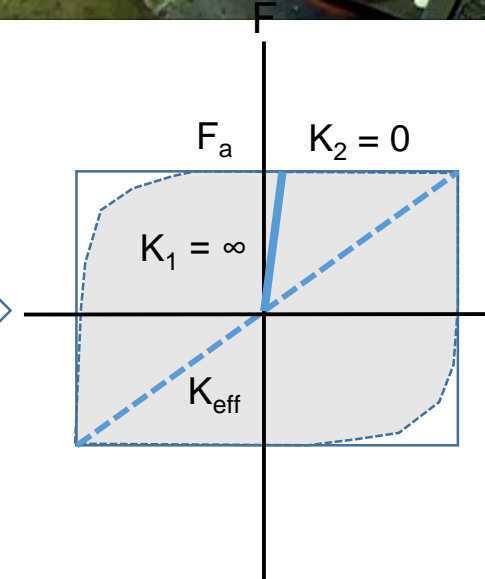




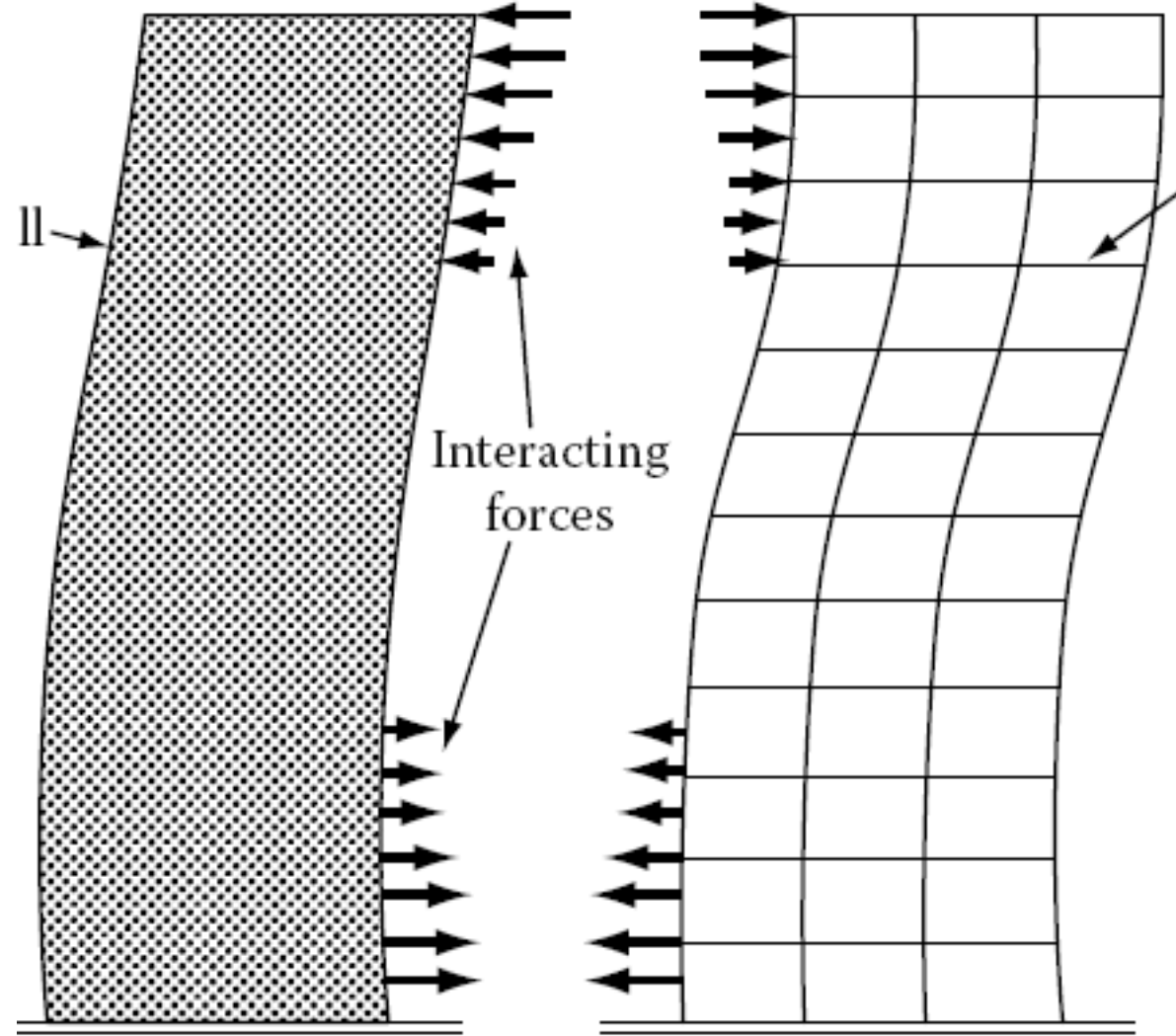
# Sönümleyici Sistem: Doğrusal Olmayan Modelleme



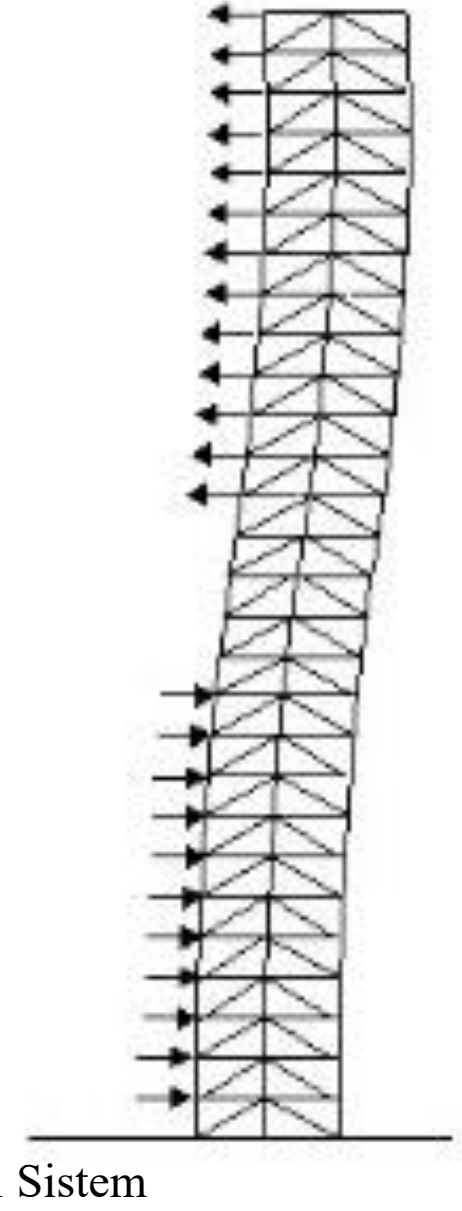
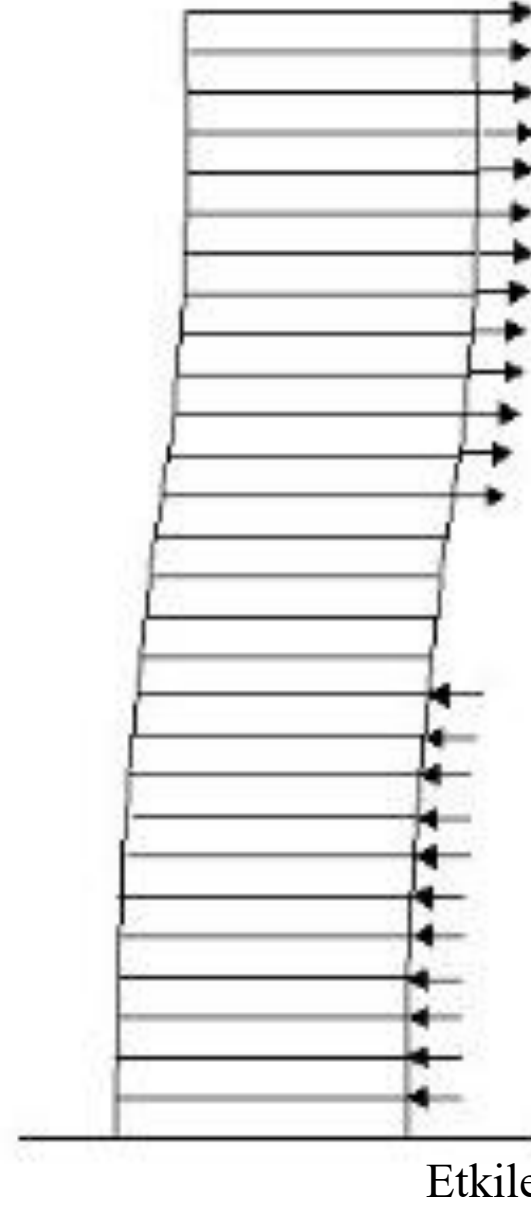
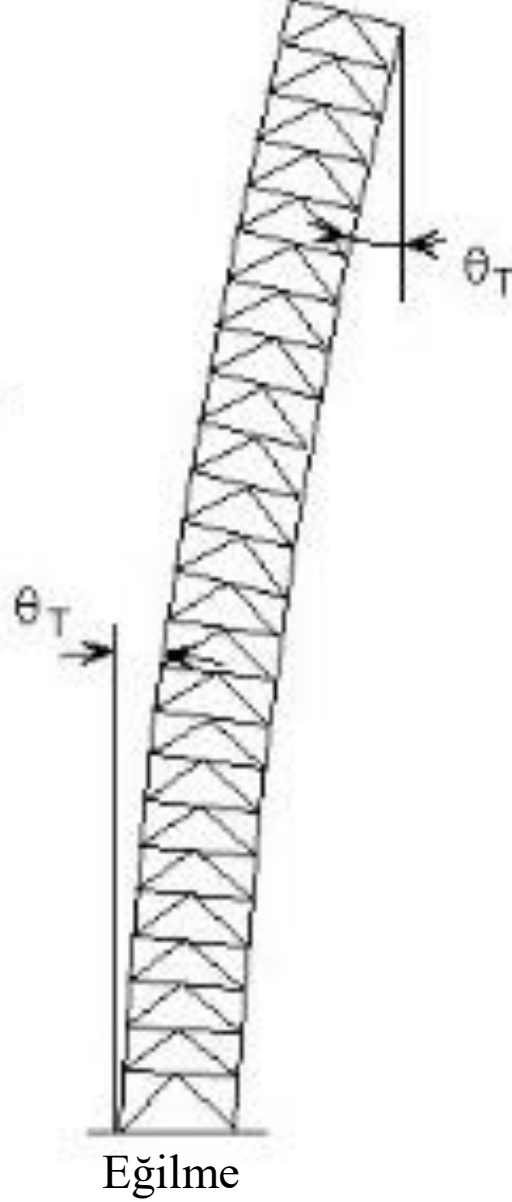
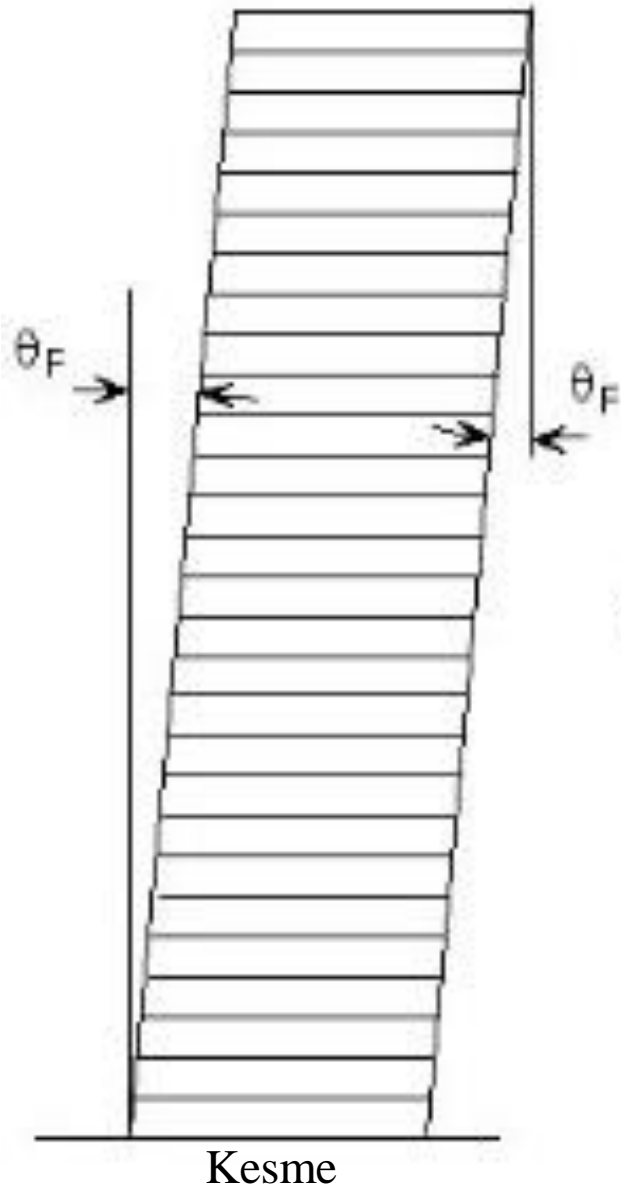
D Yaklaşım



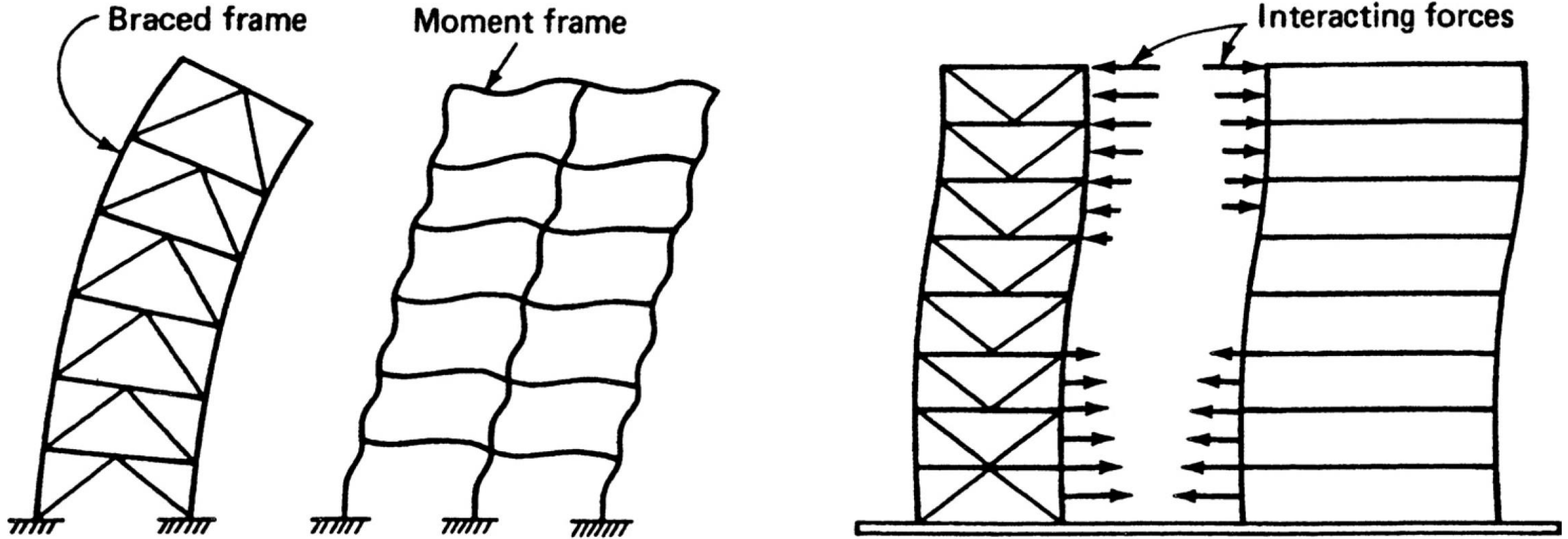
# Etkileşimli Perde+ Çerçeve



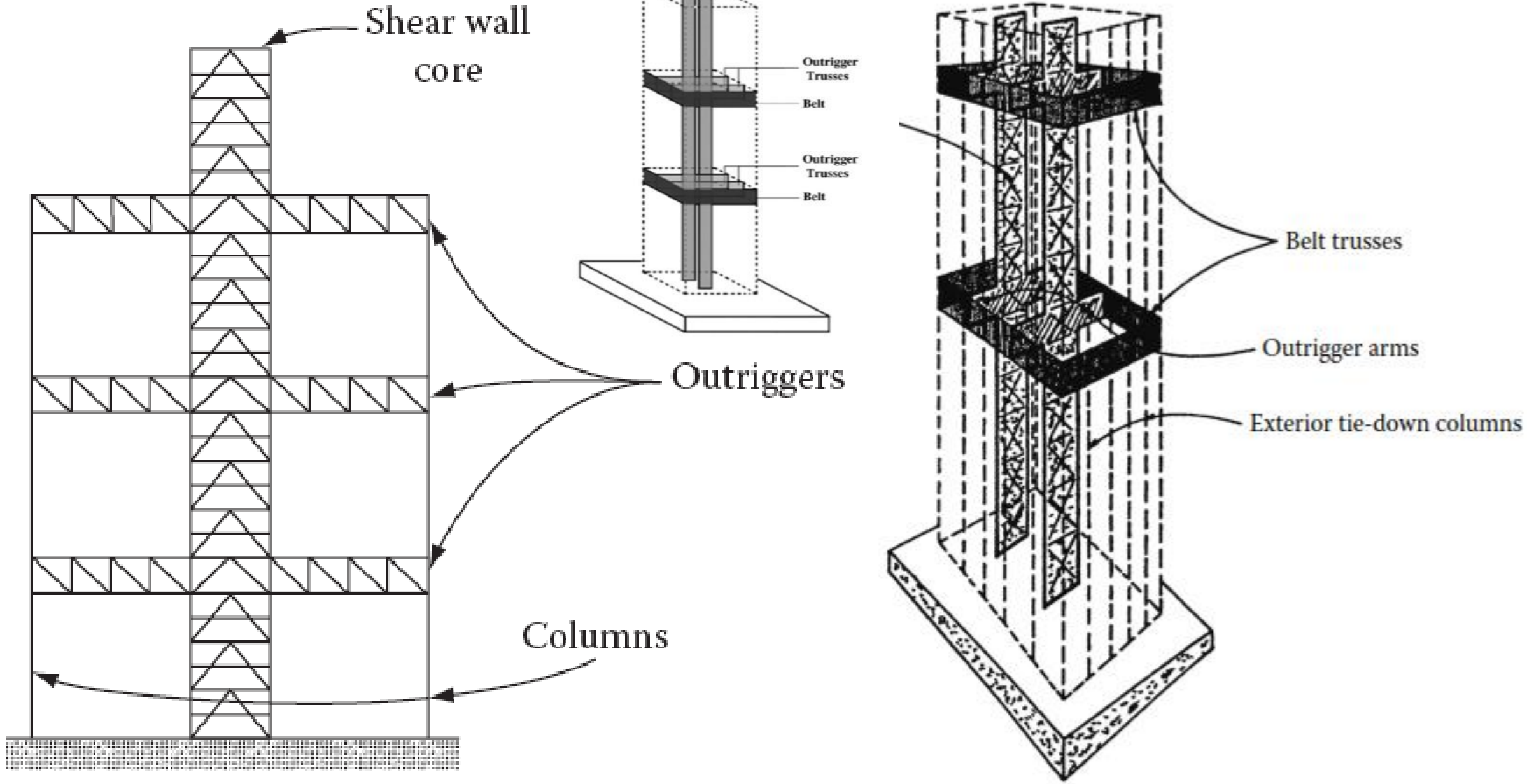
# Etkileşimli Perde+ Çerçeve



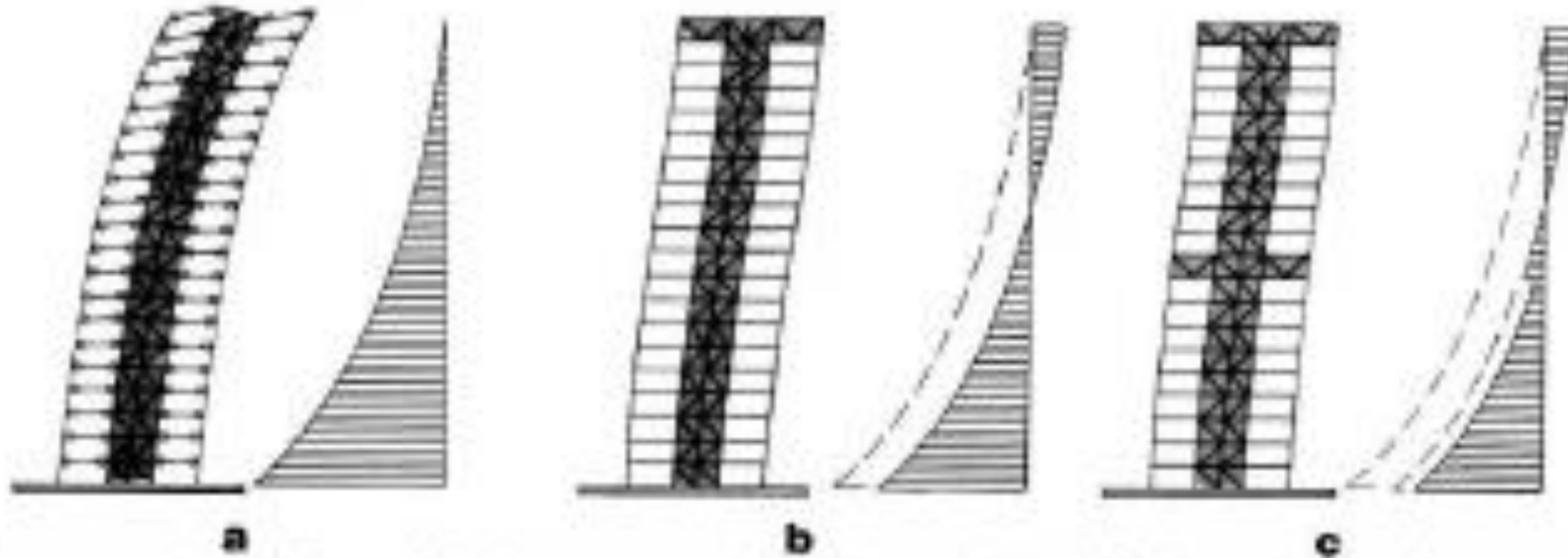
# Etkileşimli Perde+ Çerçeve



# Dışdestek (Outrigger) Sistemi

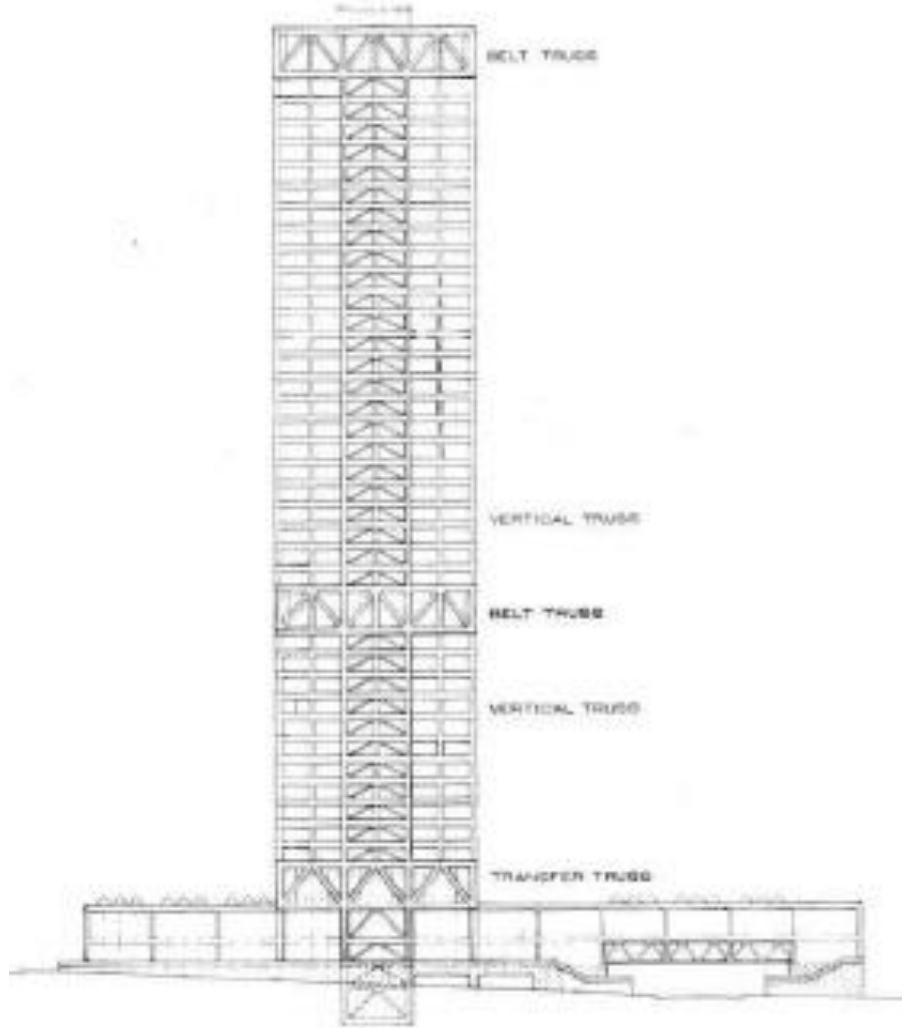


# Dışdestek (Outrigger) Sistemi



Diagrams illustrate the effect of belt truss and outriggers in stiffening a core-frame structure. On the right, the bending moment decreases in response to increasing stiffness provided by the belt trusses.

# Dışdestek (Outrigger) Sistemi

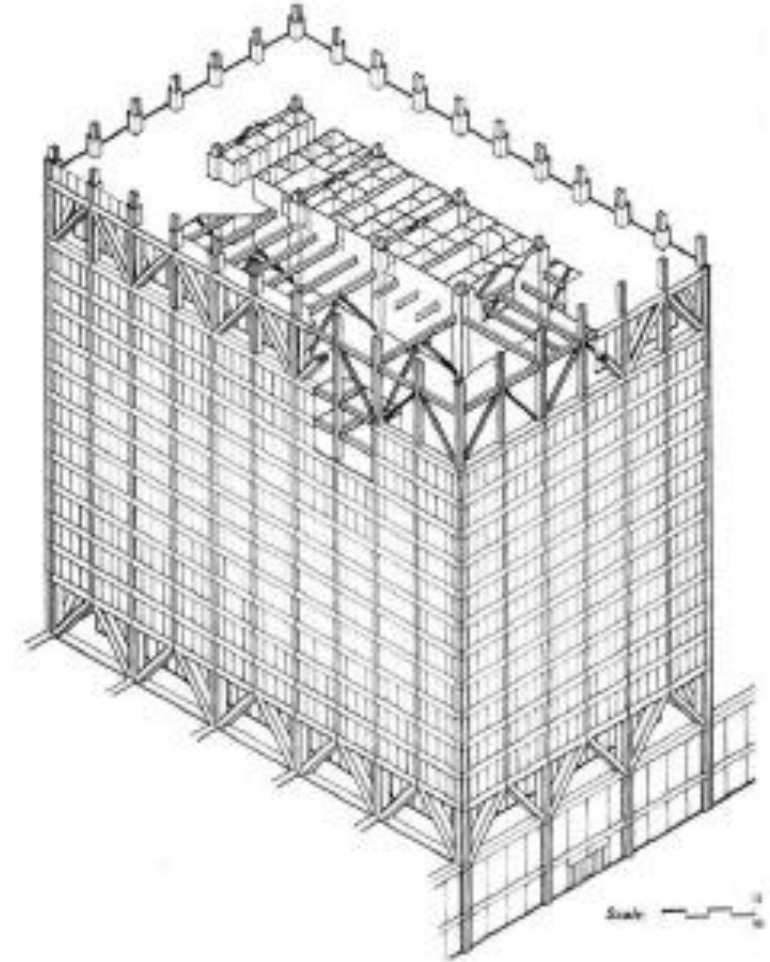


First Wisconsin Center

An example of a steel frame with a belt truss and outrigger system at the 15th and 41st floors, and a transfer truss at the 3rd level. Note that the outrigger trusses are in the direction of the wind only indicating that wind resistance in the longitudinal direction is provided only by the stiffness of the frame.

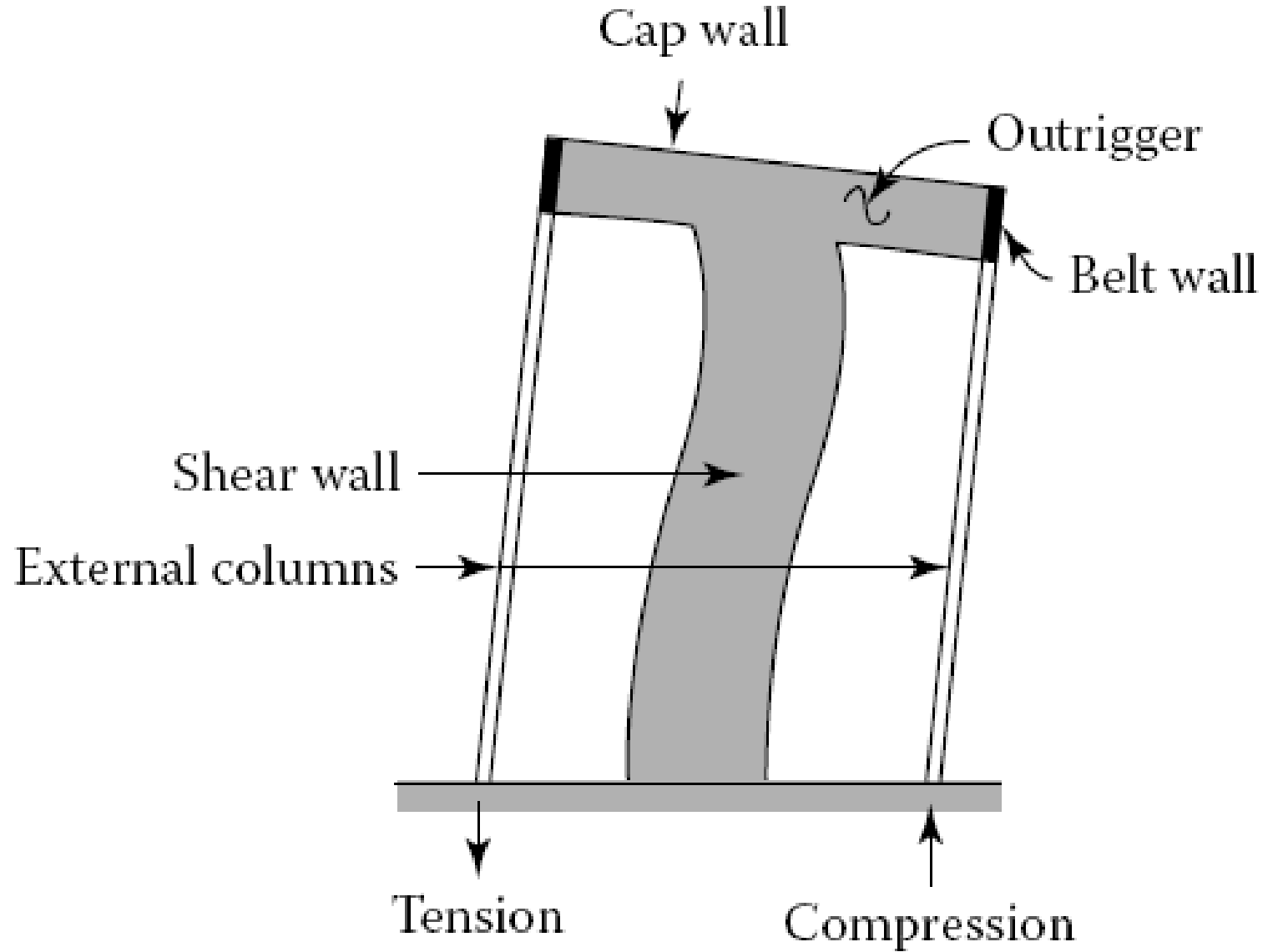
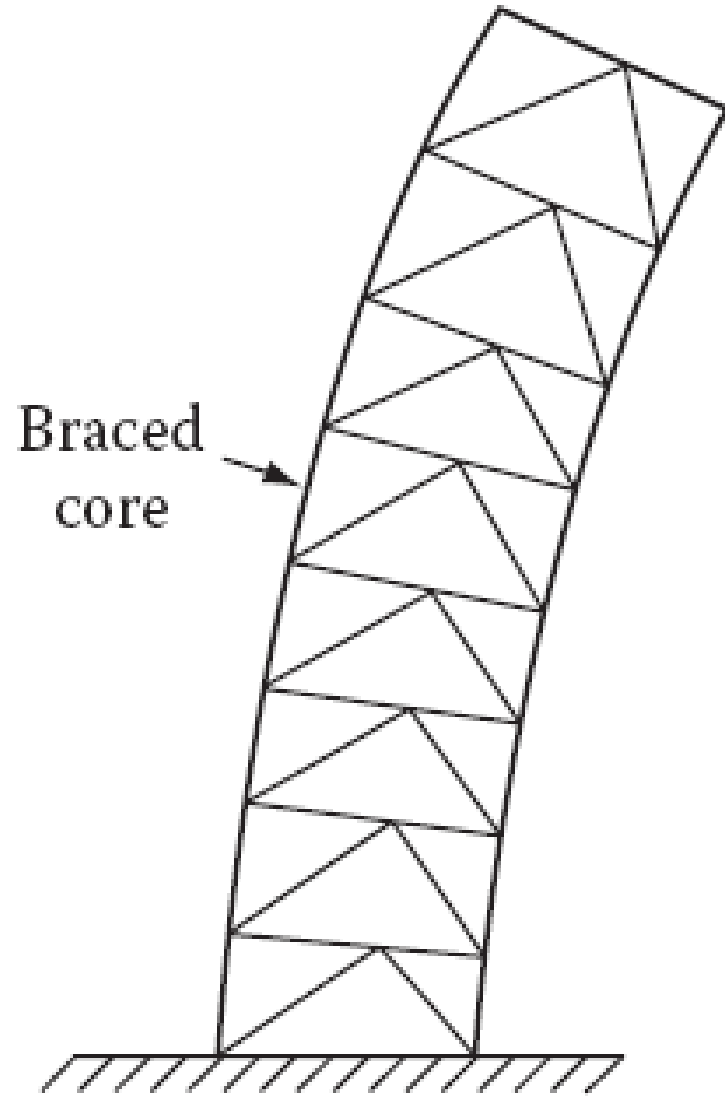


Skidmore Owings & Merrill

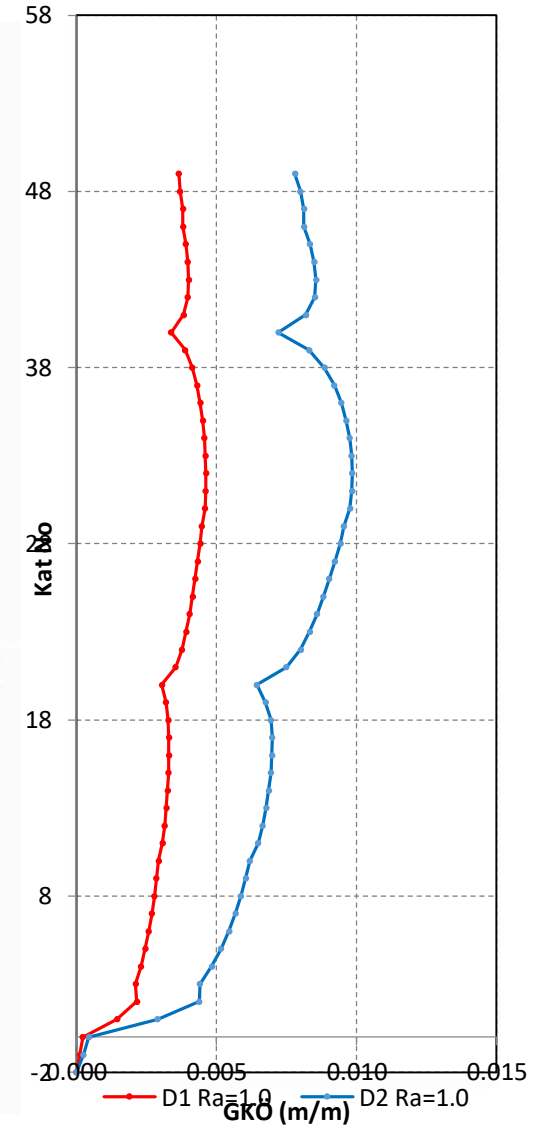
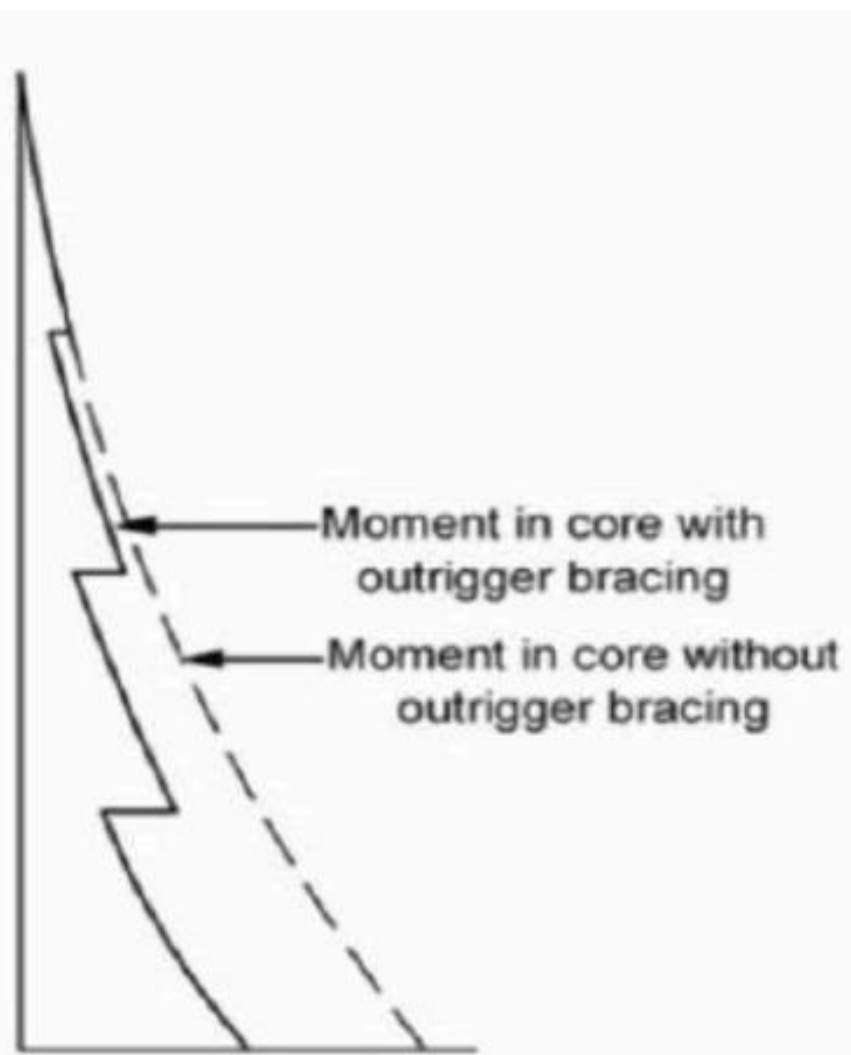
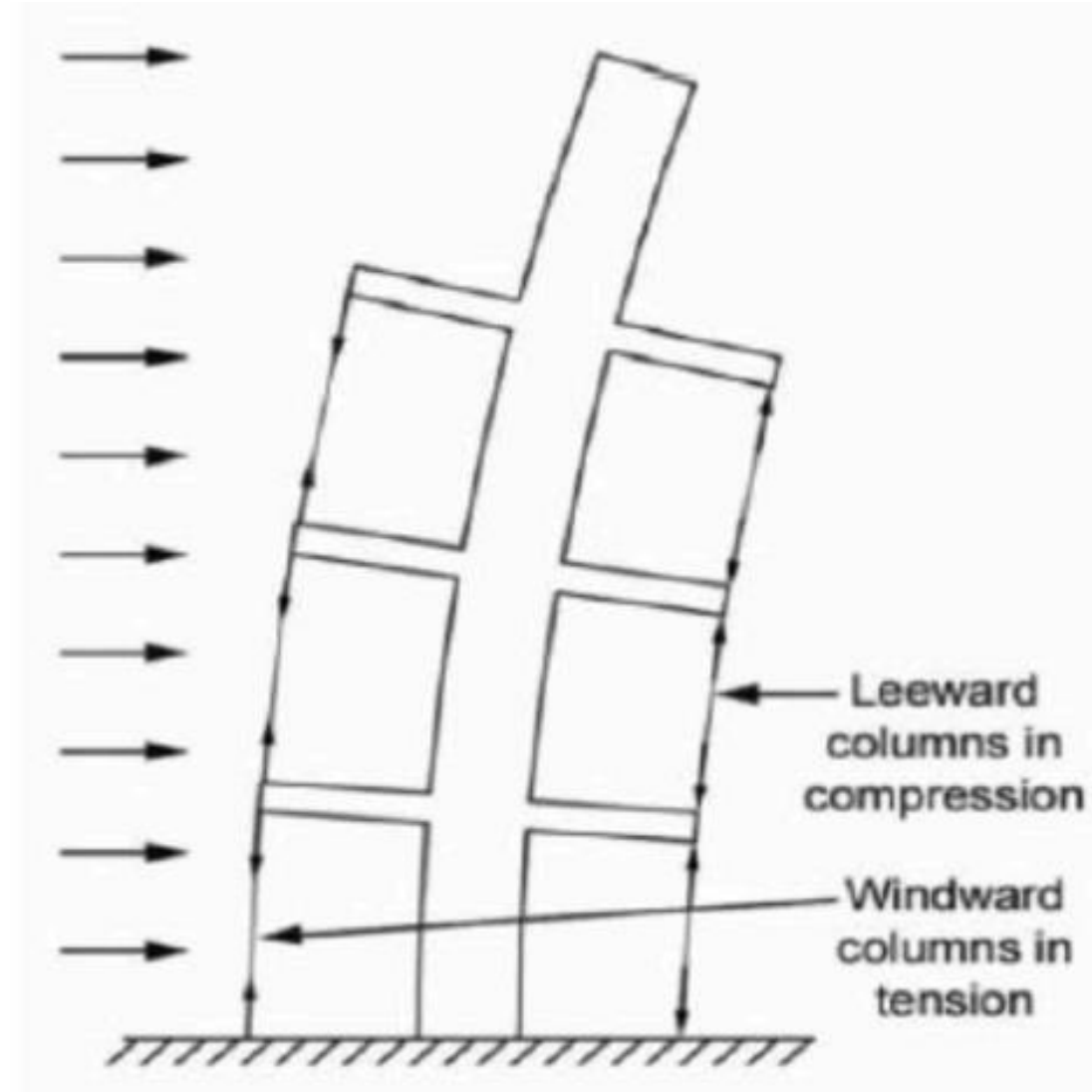


Milwaukee, Wisconsin 1974

# Yanal Sistemler – Outrigger



# Dışdestek (Outrigger) Sistemi



# Dışdestek (Outrigger) Sistemi

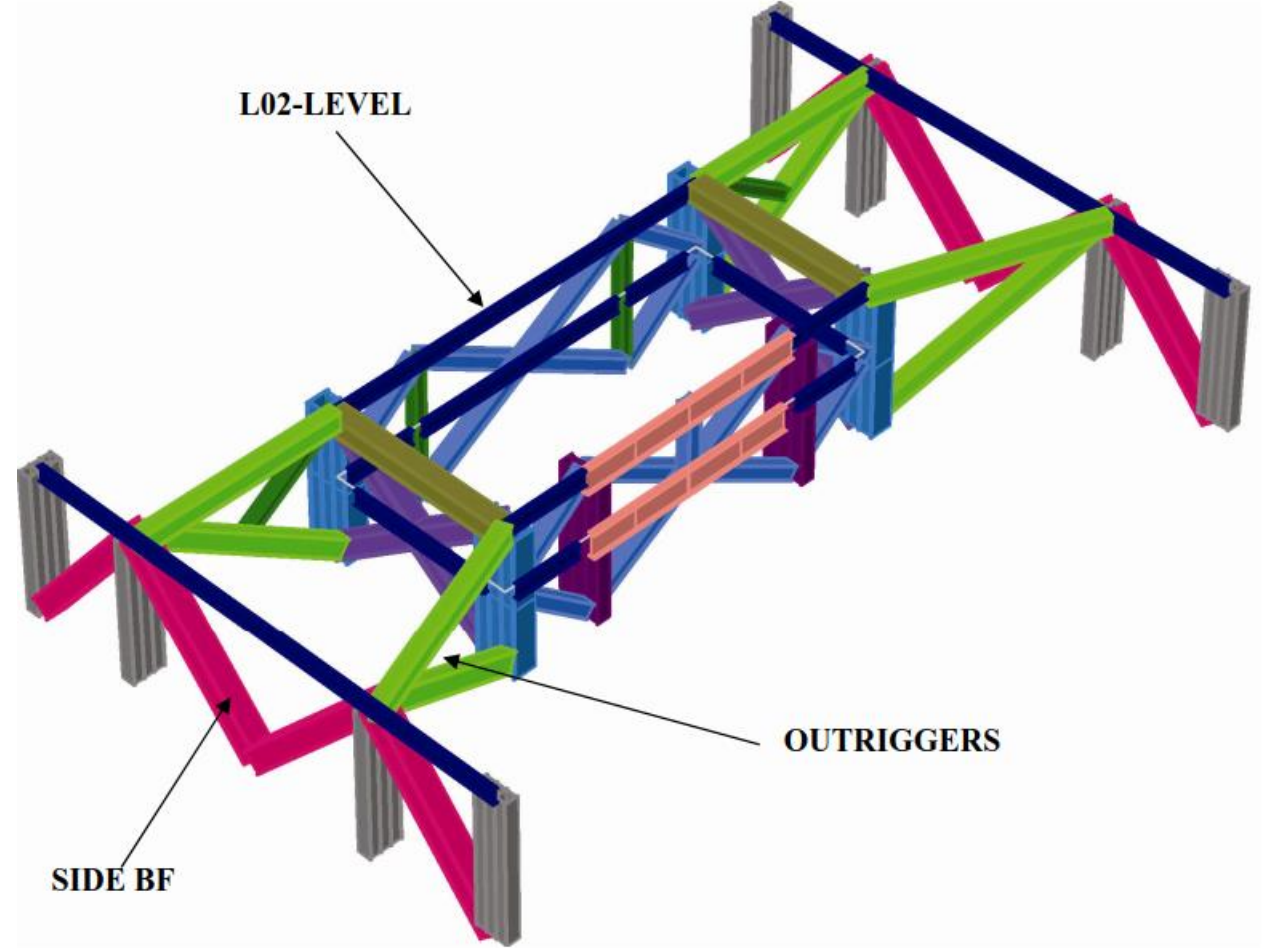
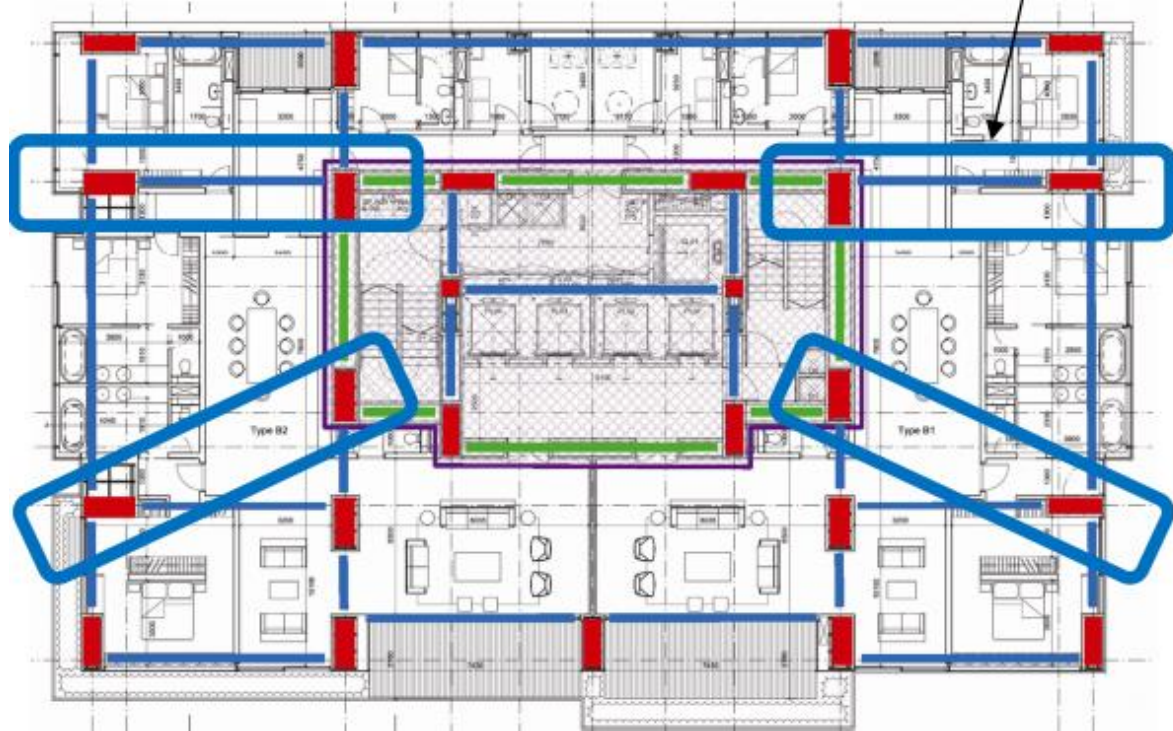
Columns

Braced Frames

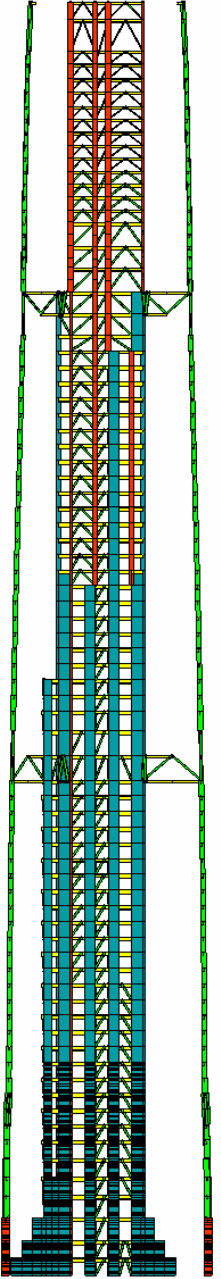
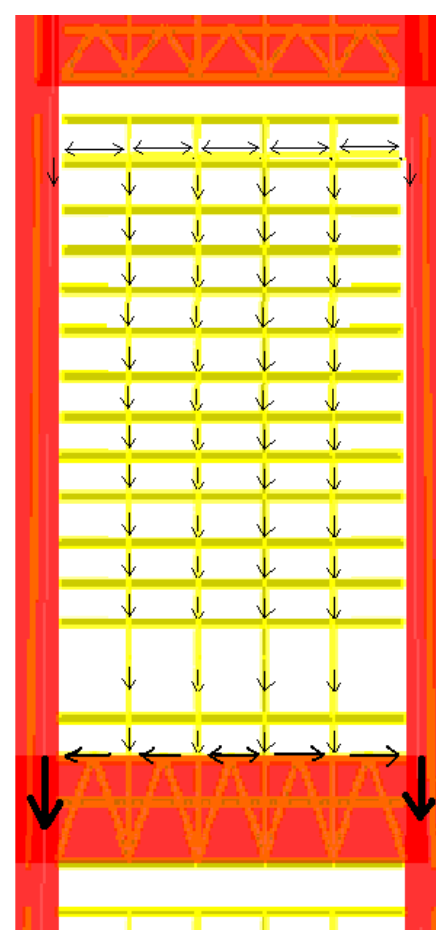
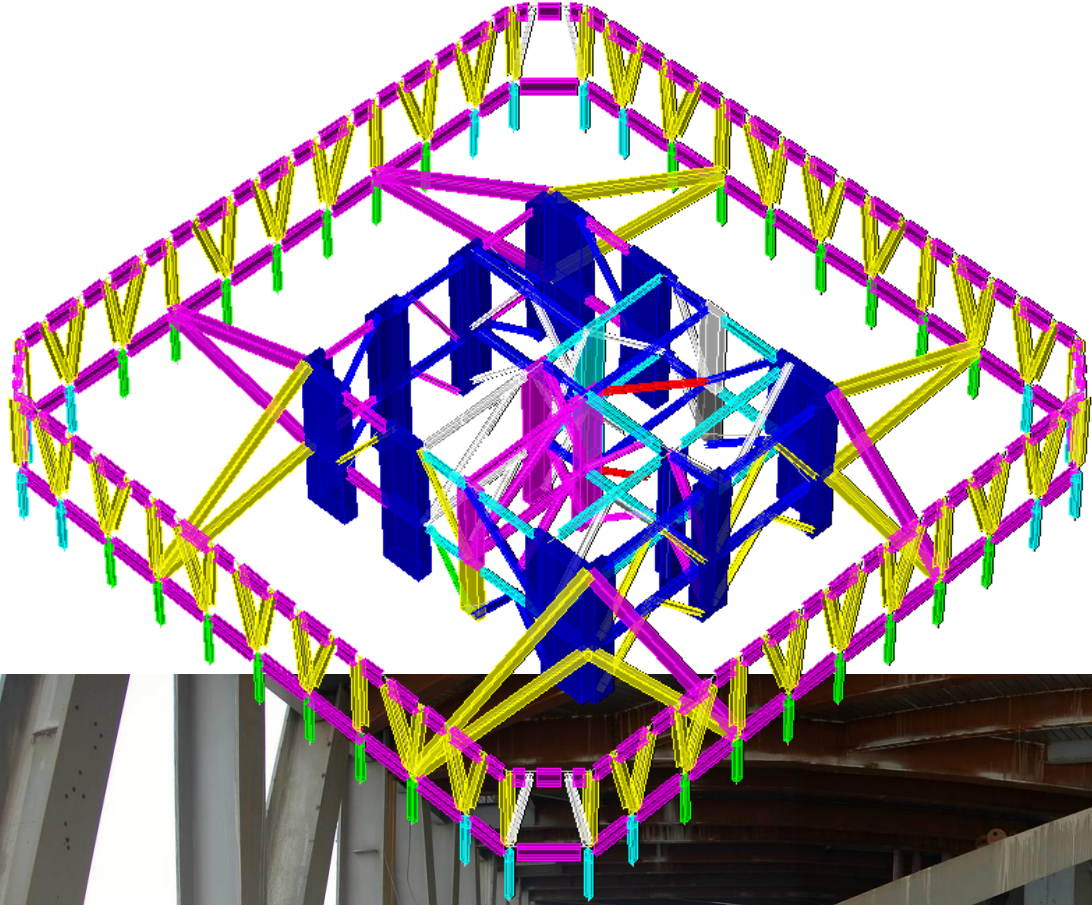
Moment Frames

Core

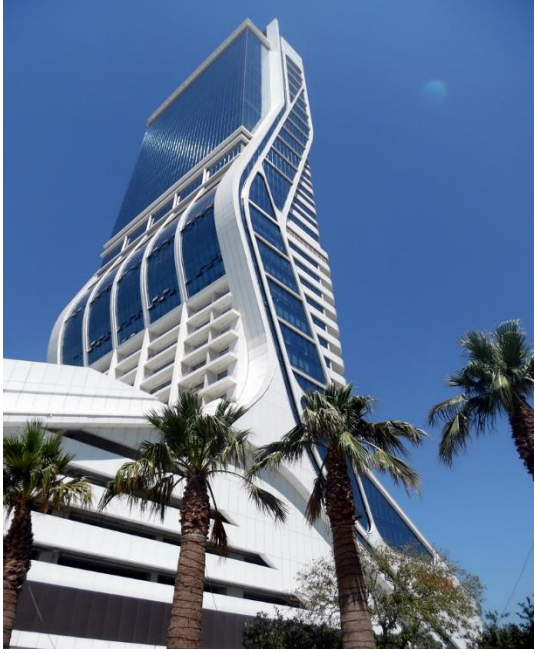
OUTRIGGER  
LOCATIONS



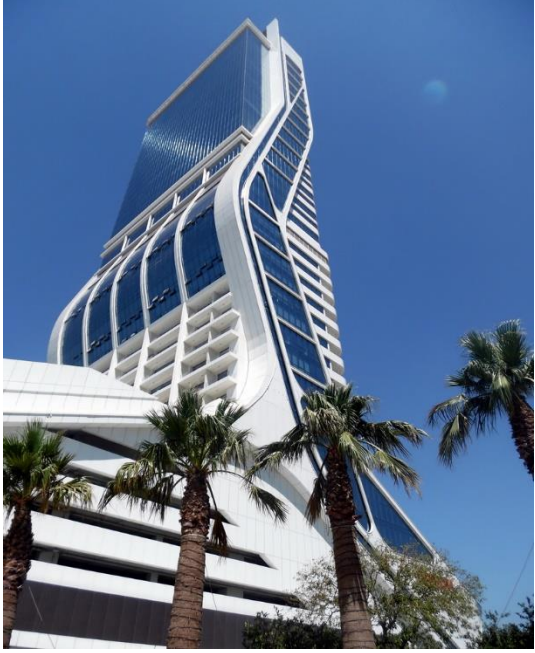
# Dışdestek (Outrigger) Sistemi



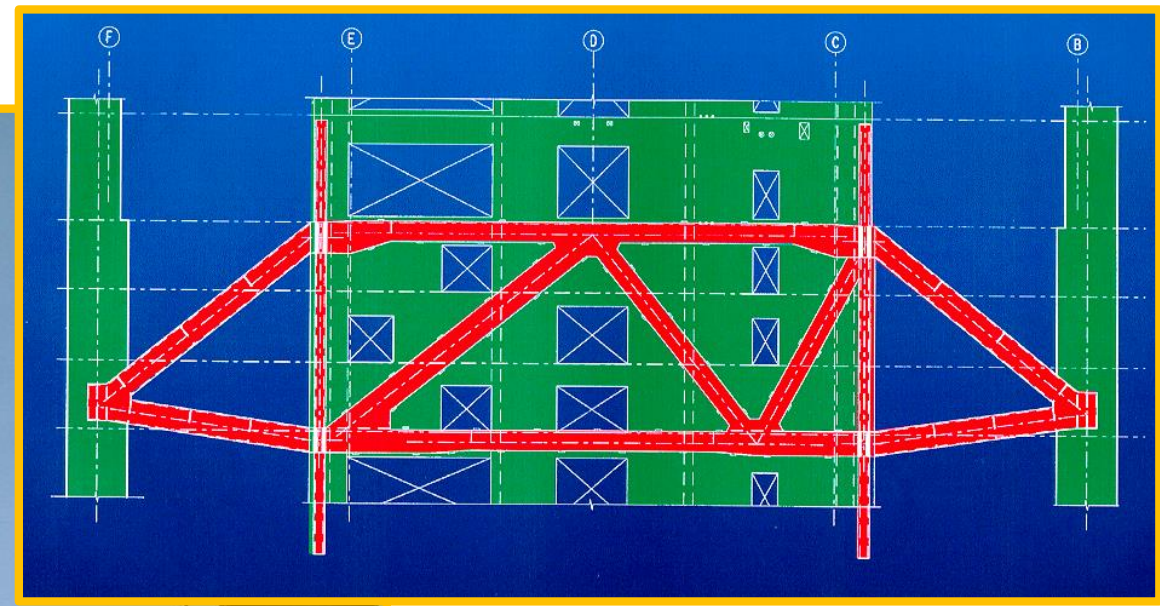
# Dışdestek (Outrigger) Sistemi



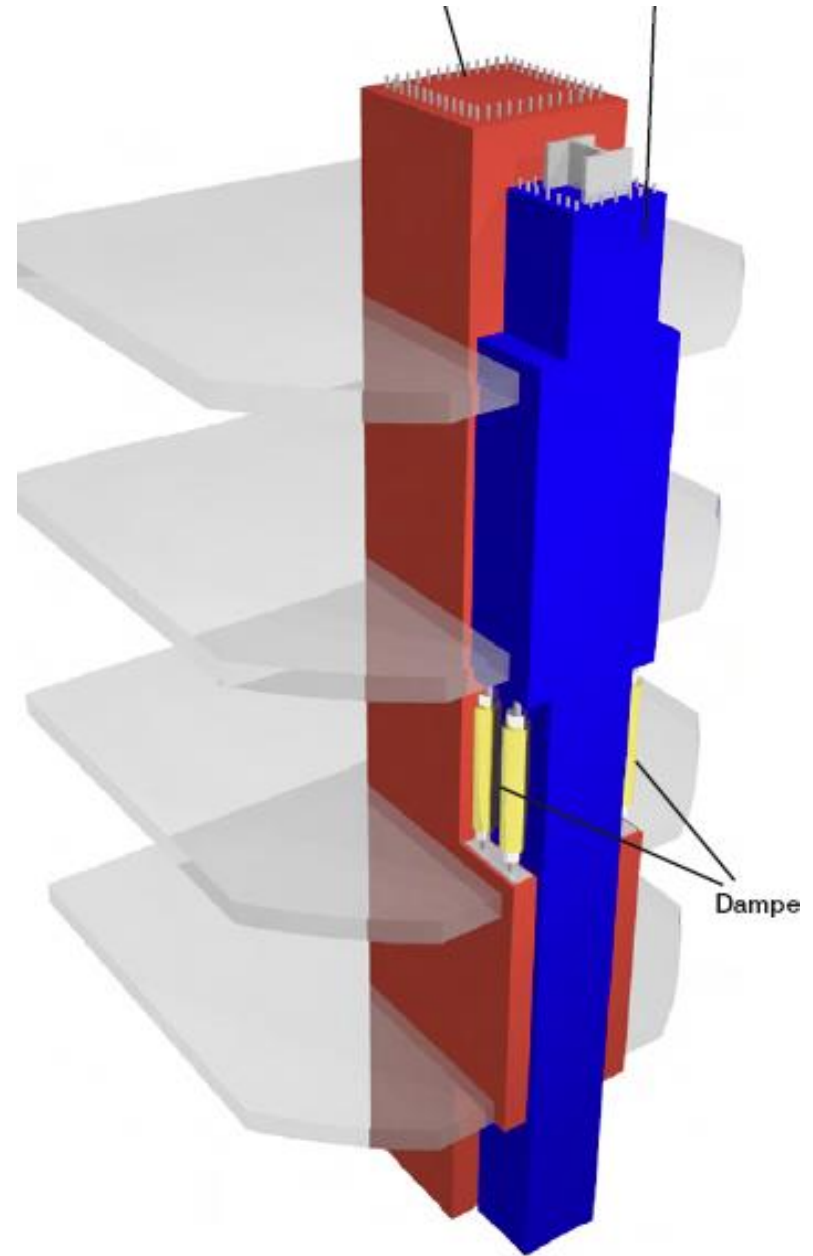
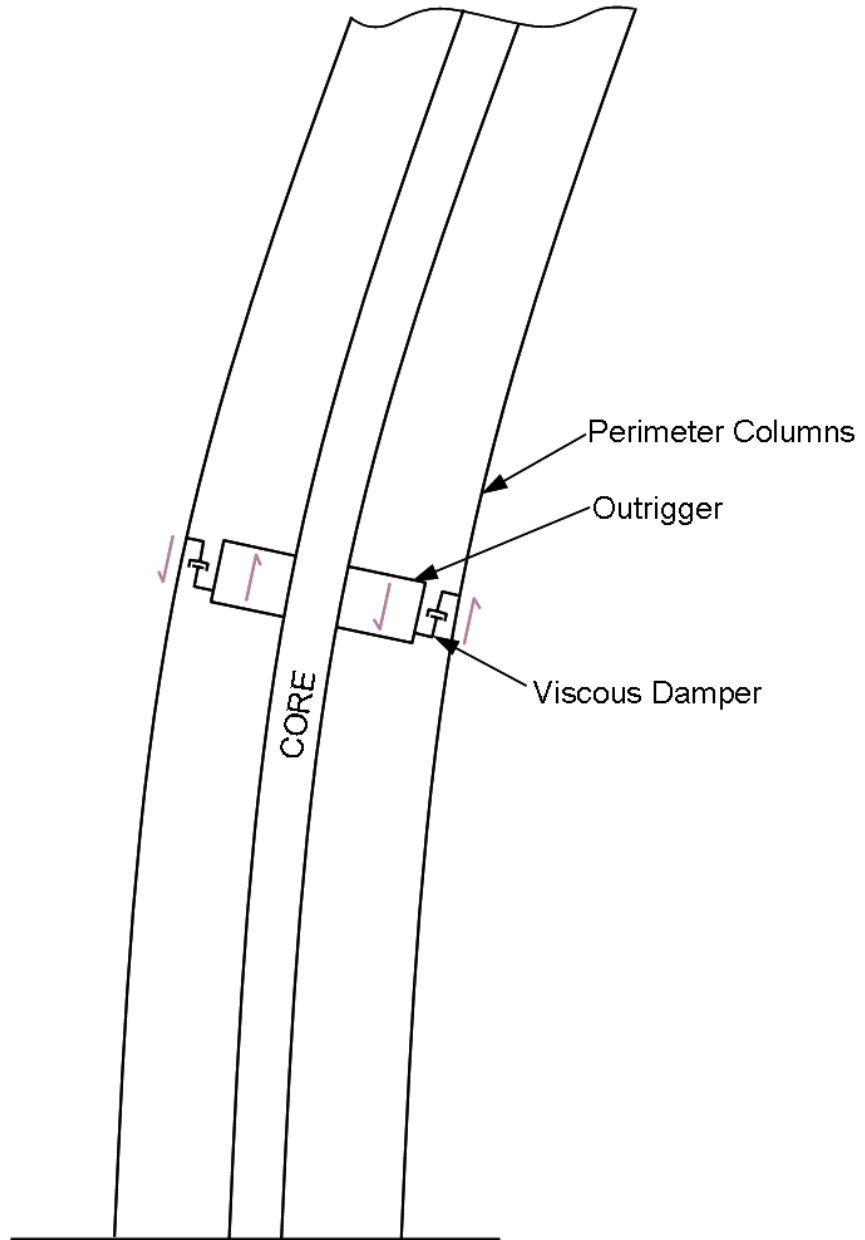
# Dışdestek (Outrigger) Sistemi



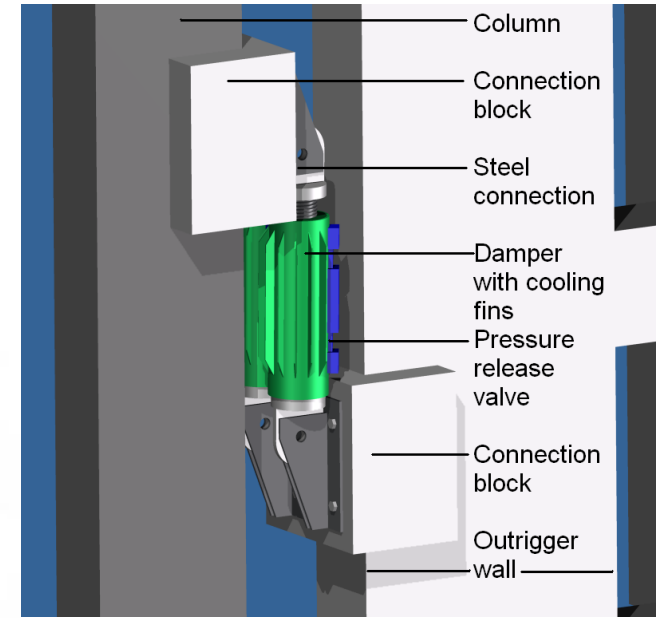
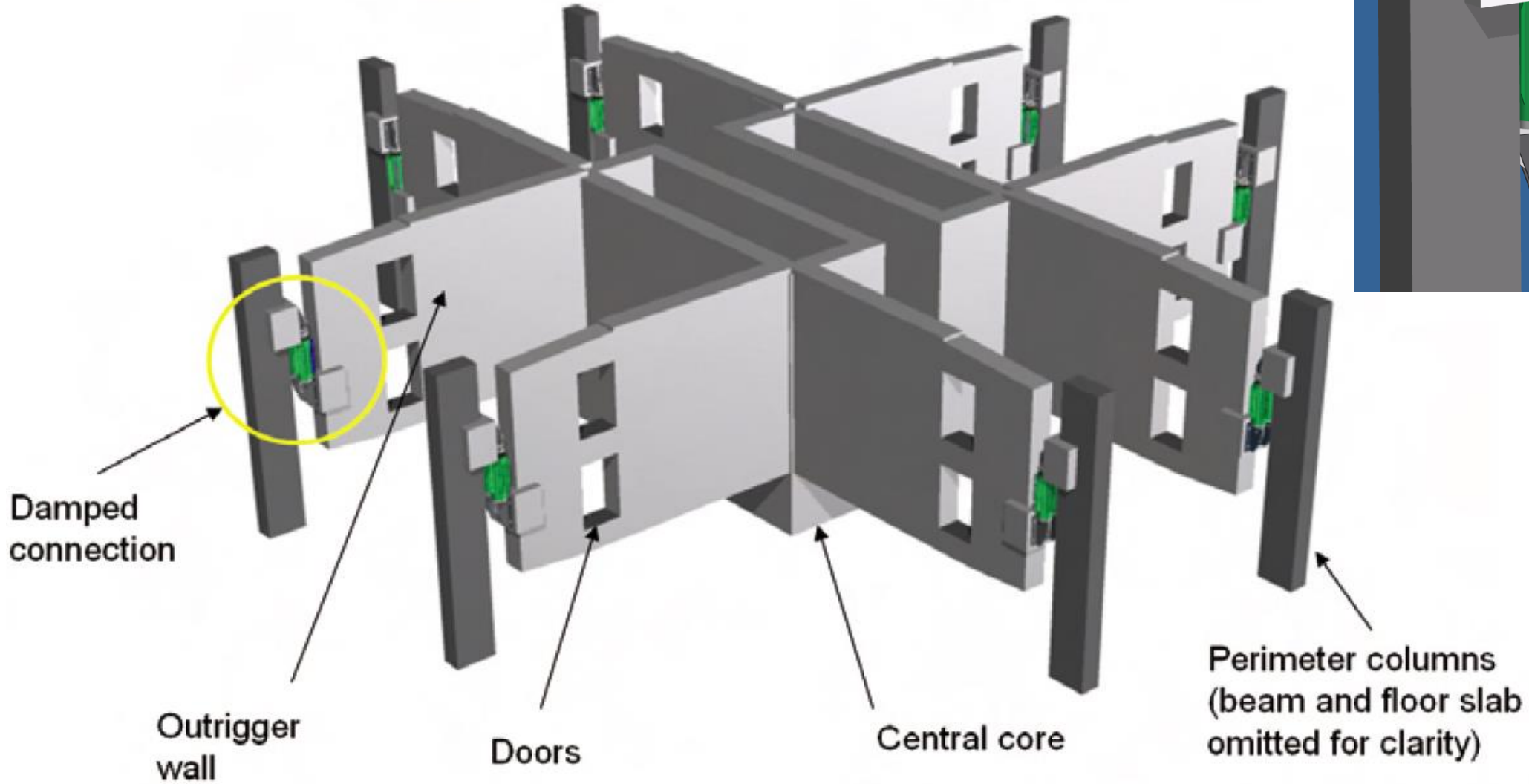
# Dışdestek (Outrigger) Sistemi



# Dışdestek (Outrigger) Sistemi



# Dışdestek (Outrigger) Sistemi



## Analysis and design of framed tube structures for tall concrete buildings

**Fazlur R. Khan** PhD

**Navinchandra R. Amin** BE, MTech

*Skidmore, Owings & Merrill of Chicago*

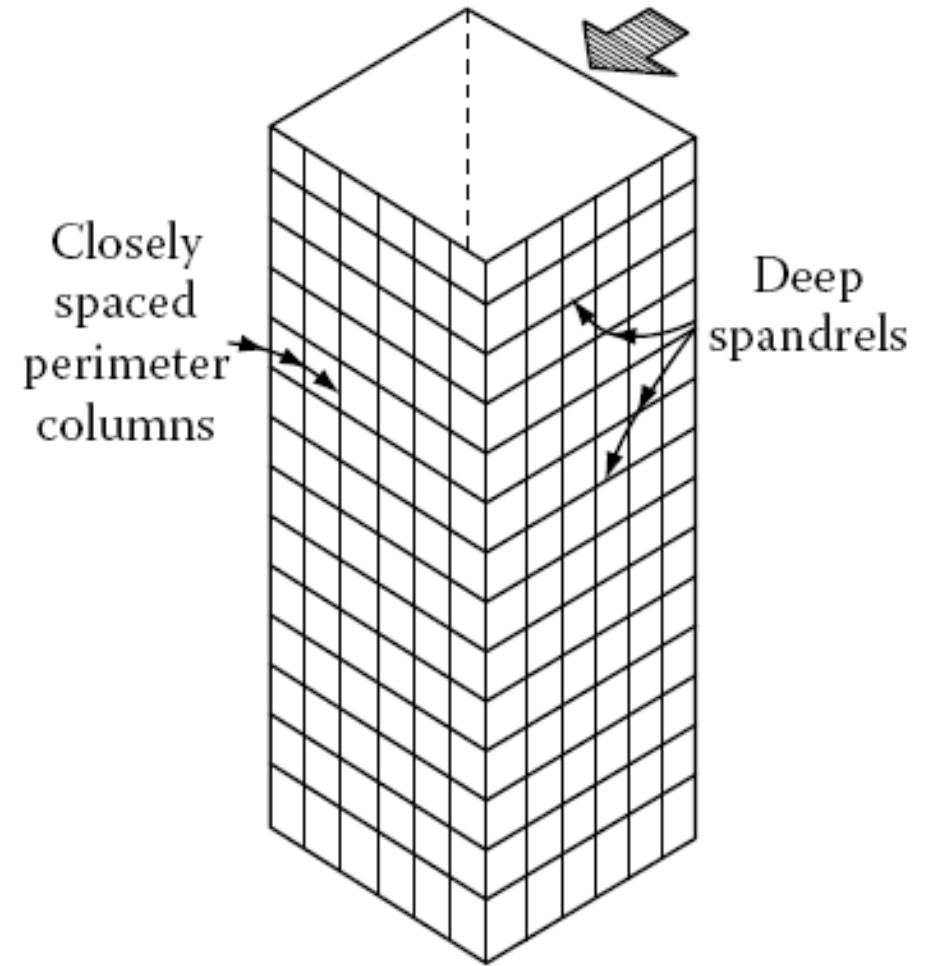
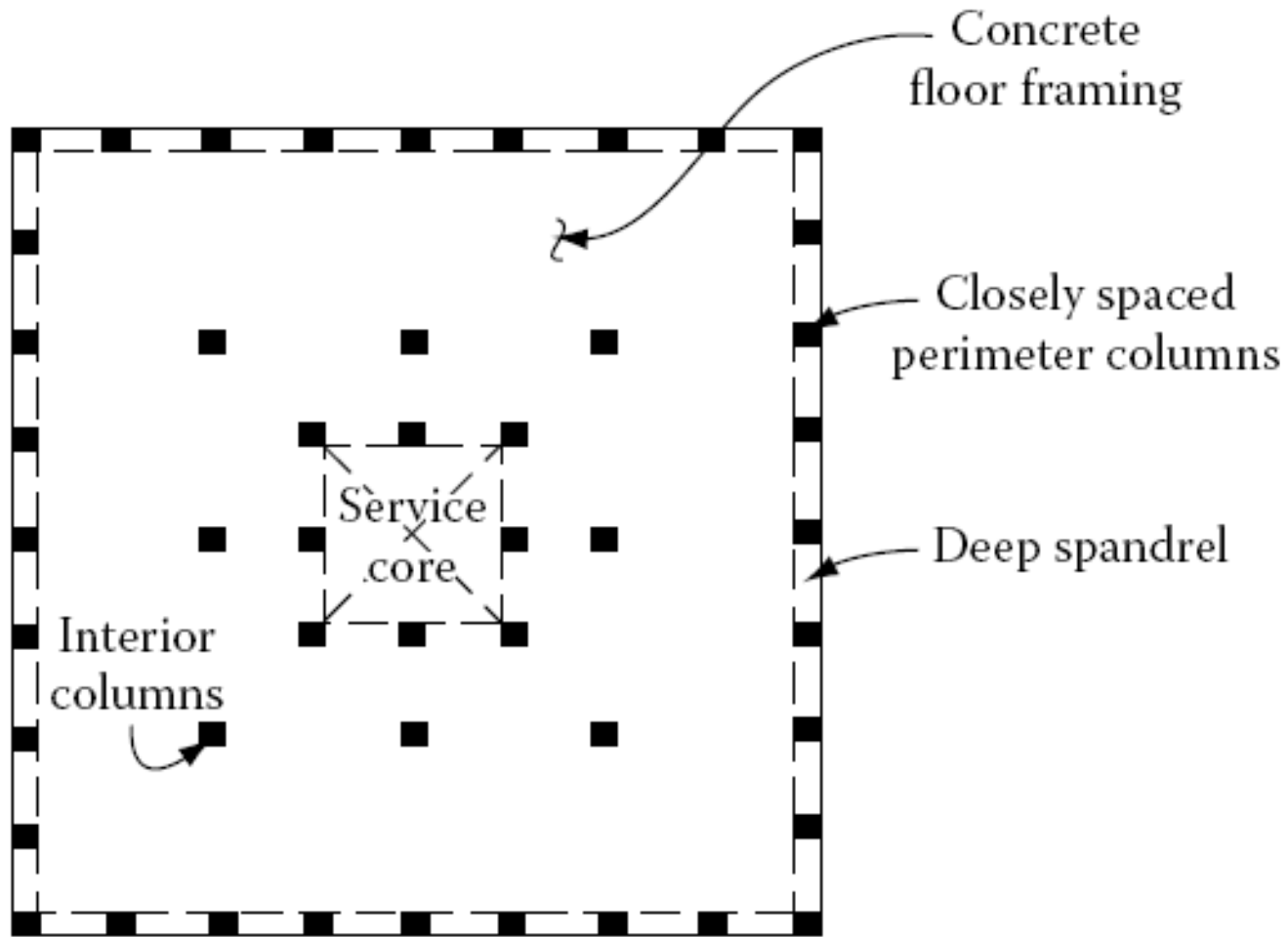


*Dr. Fazlur R. Khan is partner and chief structural engineer of Skidmore, Owings & Merrill, architects and engineers, Chicago, Illinois. He received his Bachelor*

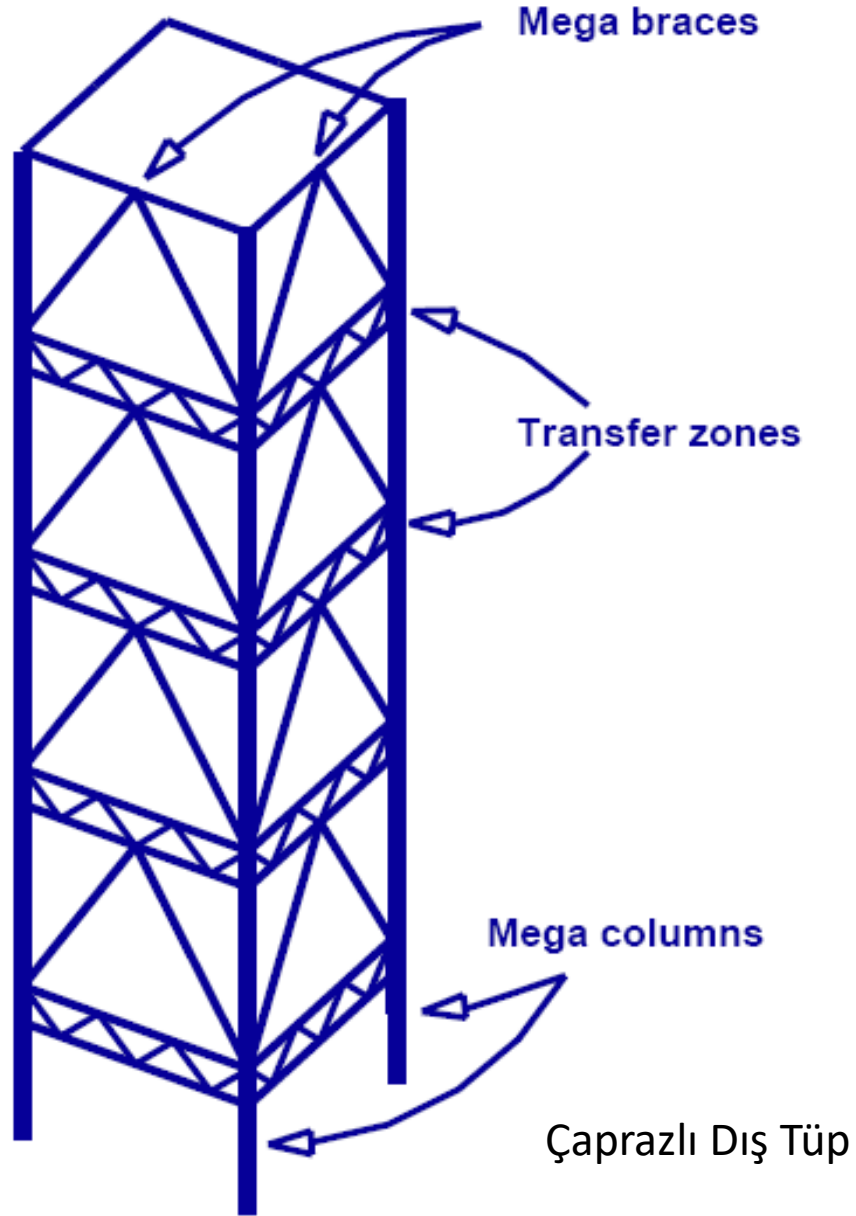


*Fig 2. View of De Witt Chestnut Apartment Building*

# Yanal Sistemler – Tüp Sistemleri

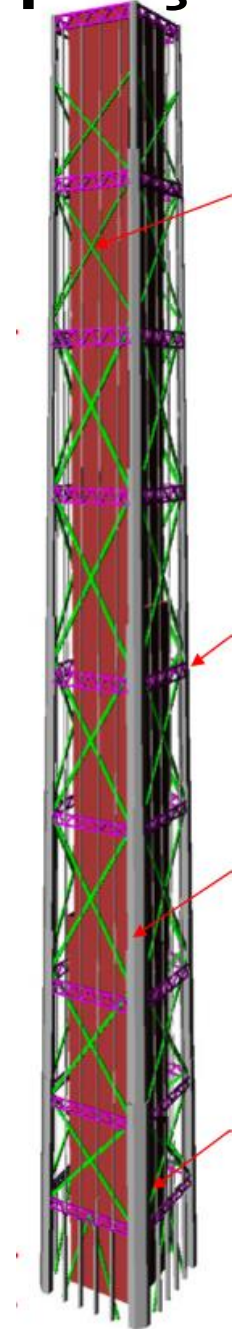


# Yanal Sistemler – Tüp Sistemleri



Diagrid Dış Tüp

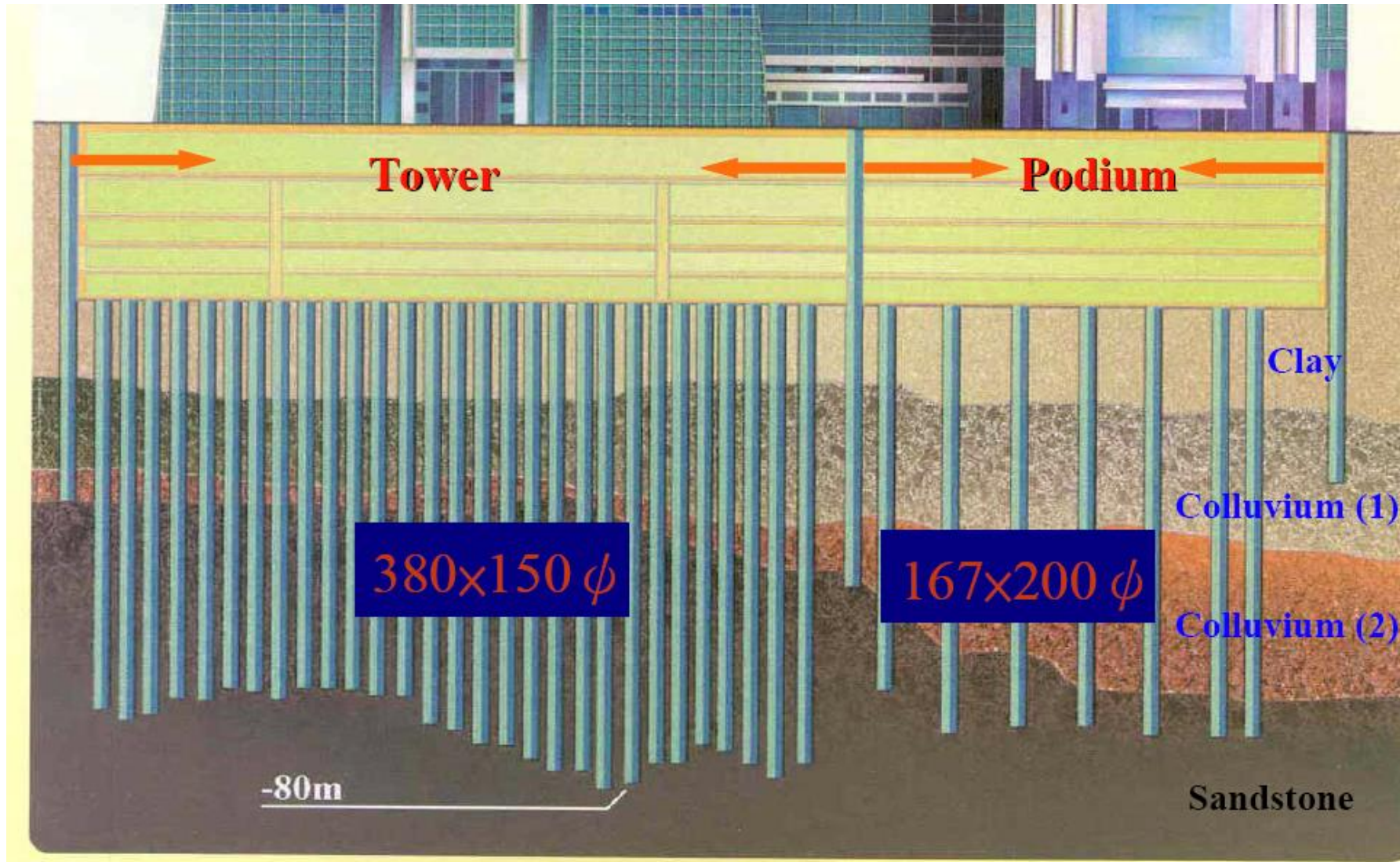
# Yanal Sistemler – Tüp + Çekirdek Sistemler



- Dışta tüp sistemi, içte çekirdek bulunur
- Dış tüp, genelde mega çaprazlı çerçevedir
- Yanal yüklerin büyük bölümü dış tüp tarafından alınır
- Dış ve iç sistem arasındaki yanıl yük dağılımını döşemeler ile sağlanır

# Temel Sistemleri

- Radye Temeller, Kazık temeller



# Derin Kazı Sistemleri

- Derin temel kazıları – Destek sistemi tasarımı (ELS Design)

