KESELARASAN ARSITEKTUR DAN STRUKTUR PADA KONSTRUKSI BANGUNAN TAHAN GEMPA

Disajikan pada Seminar Teknologi
Fakultas Teknik Arsitektur
Universitas Katholik Soegijapranata Semarang

Dr. Ir. Antonius, MT

Universitas Islam Sultan Agung
Jurusan Teknik Sipil

TUJUAN PERENCANAAN STRUKTUR

a) Kuat ⟺ strength → Ultimit capacity

b) Kaku ⟺ serviceability → Deflection, kekangan, beban dll

c) Daktail ⟺ survival → Tahan gempa, deformability

d) Stabil ⟺ geometri → Secondary effect

Sistem LRFD:

$$\phi M_n \geq M_u$$

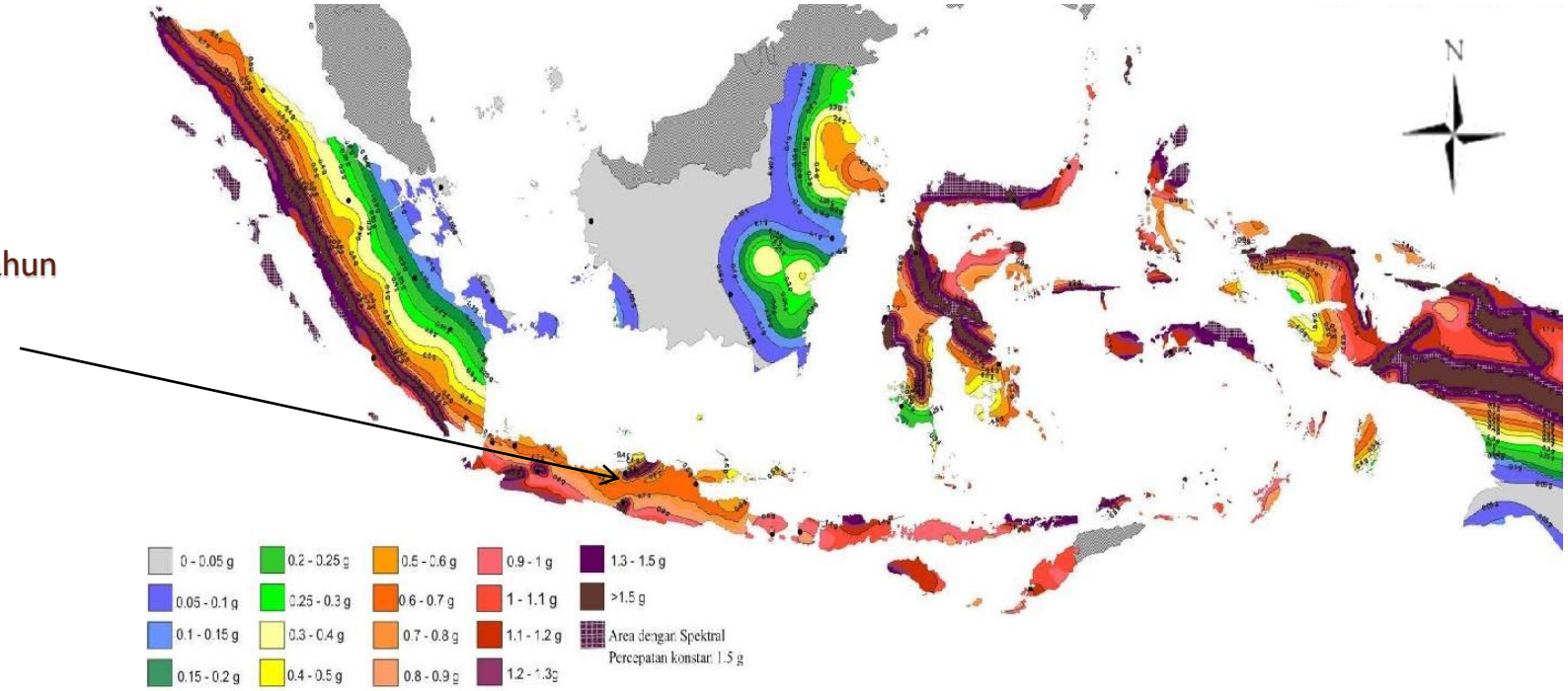
$$\phi P_n \geq P_u$$

$$\phi V_n \geq V_u$$

PERENCANAAN STRUKTUR TAHAN GEMPA

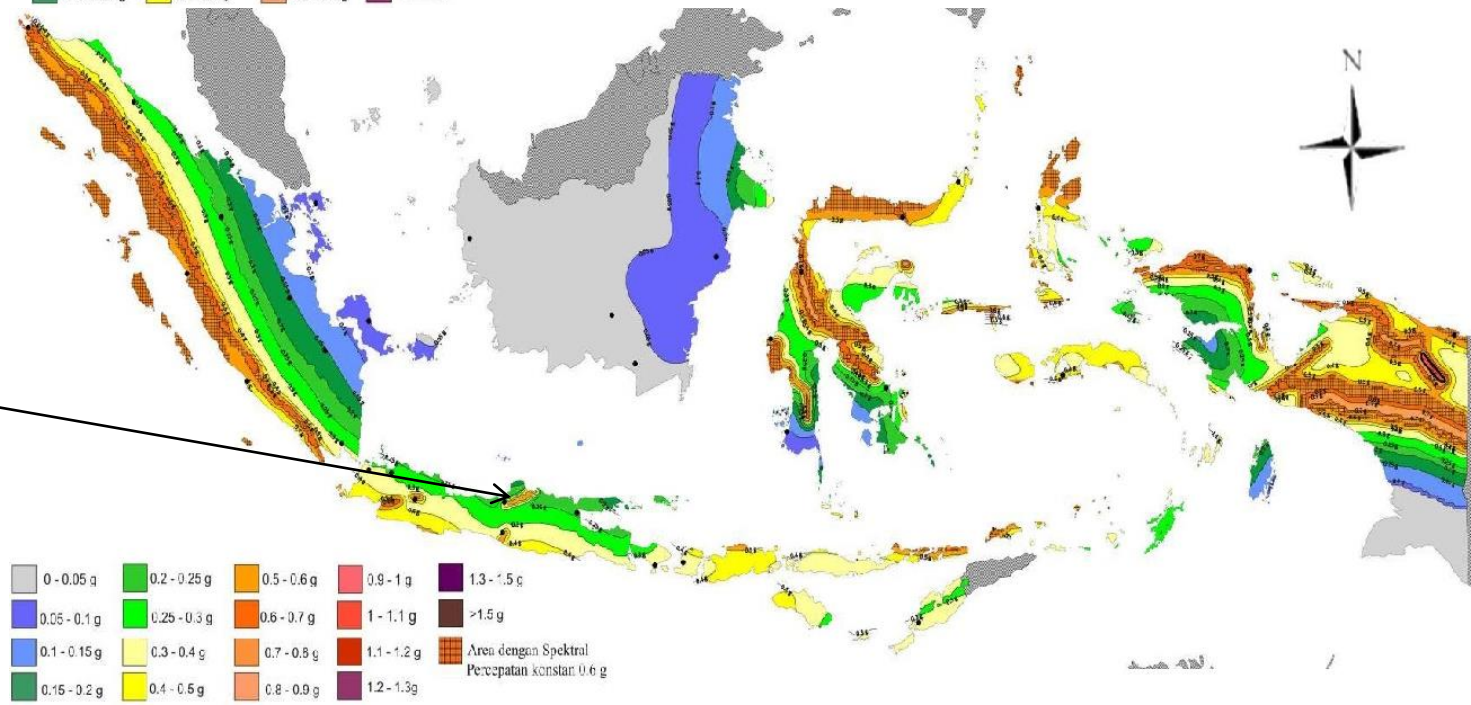
Ss

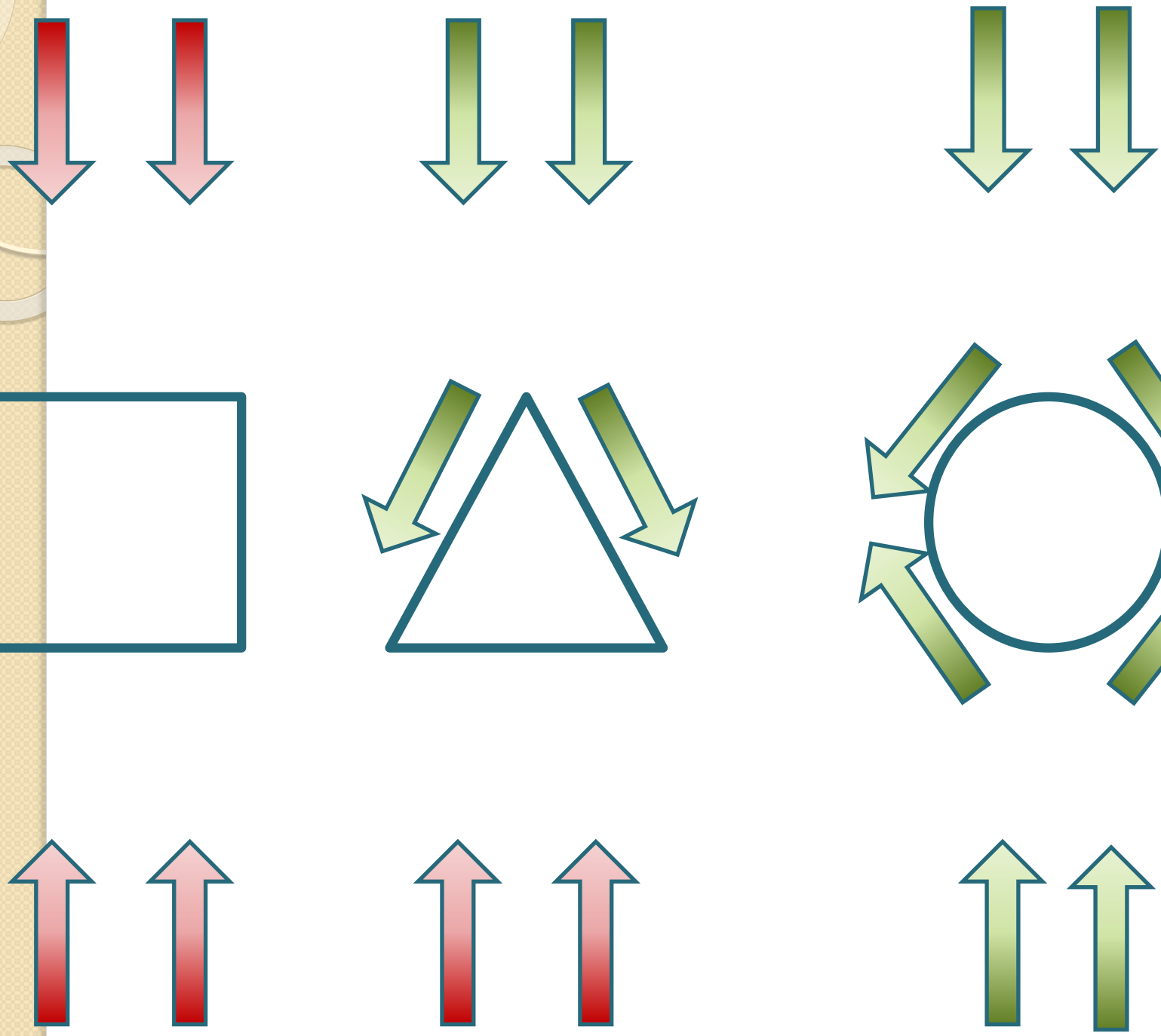
PGA, 2% dalam 50 tahun
(redaman 5%)



S1

Respons Spektra
Percepatan pada
0.20detik

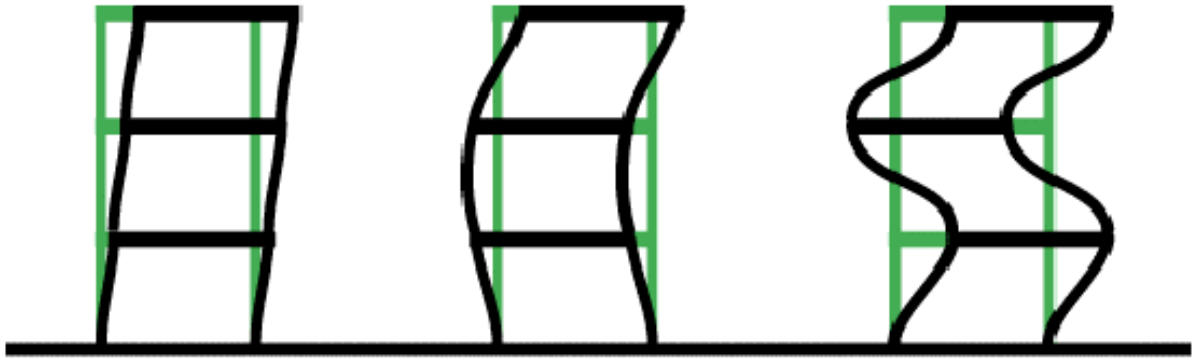




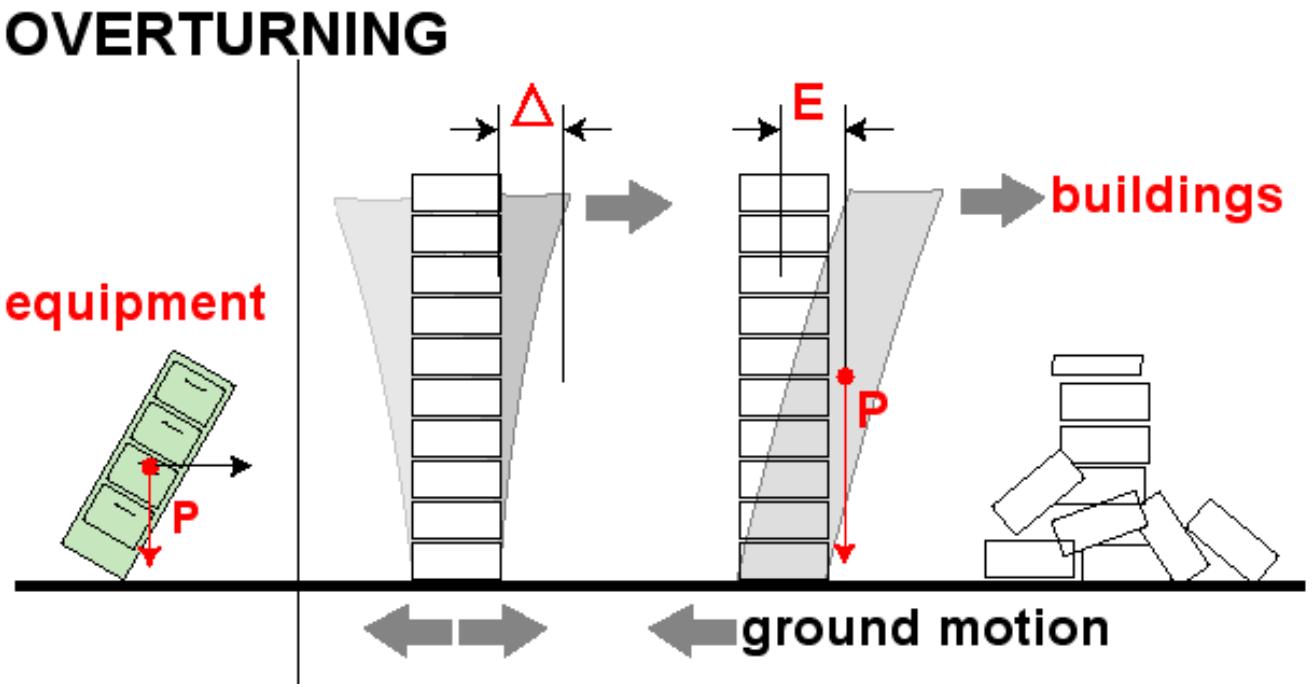
Mode Getar

MODES OF VIBRATION

Tall buildings will undergo several modes of vibration, but for seismic purposes (except for very tall buildings) the fundamental period, or first mode is usually the most significant.



Keruntuhan Bangunan

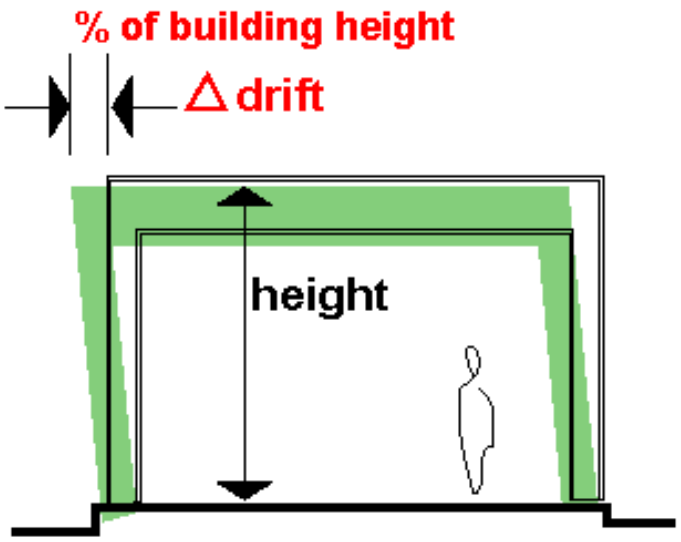


Bangunan jarang mengalami overturning, tapi mengalami keruntuhan total atau sebagian seperti pancake

Drift dan Deformasi

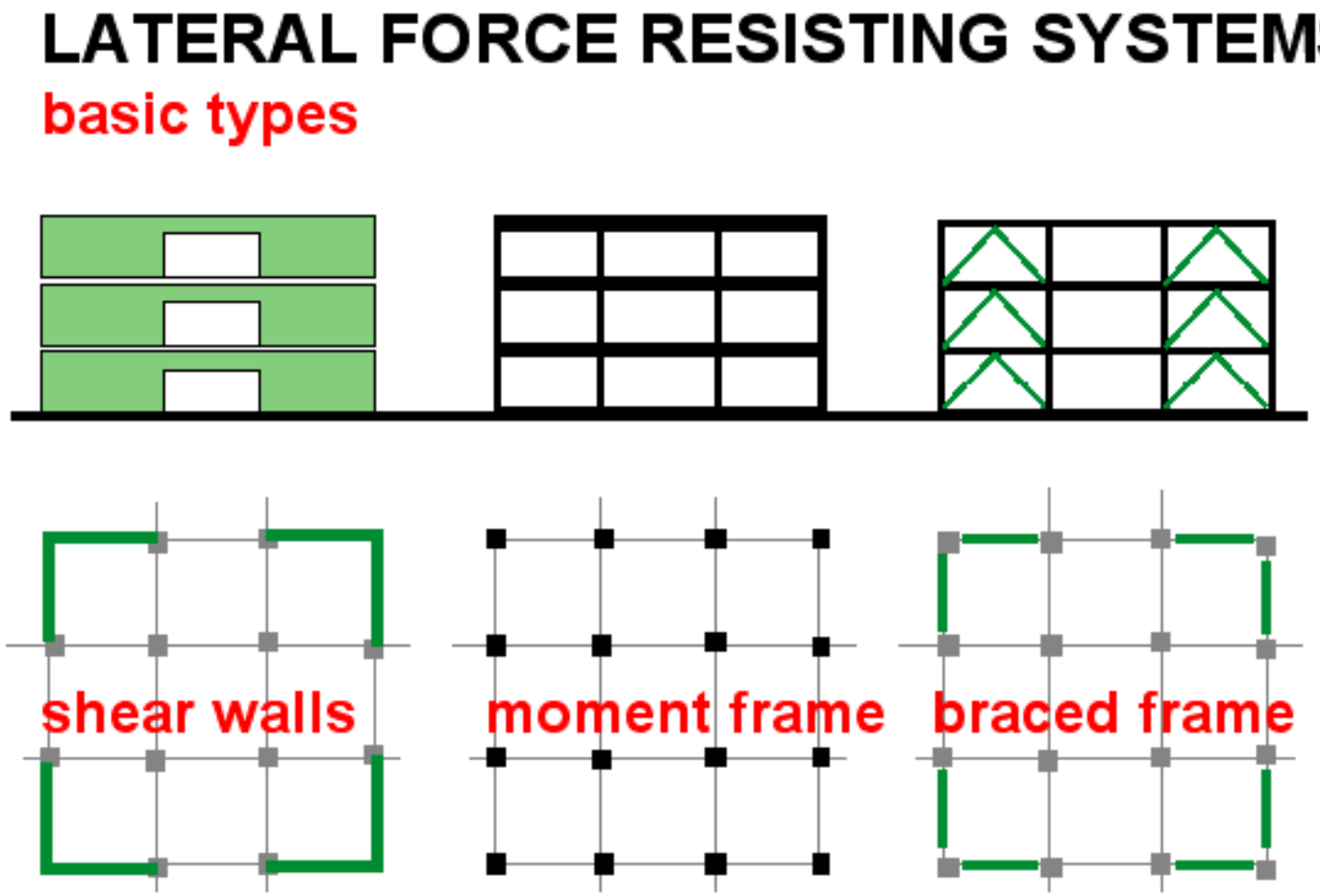
DRIFT and DEFORMATION

story drift ratio



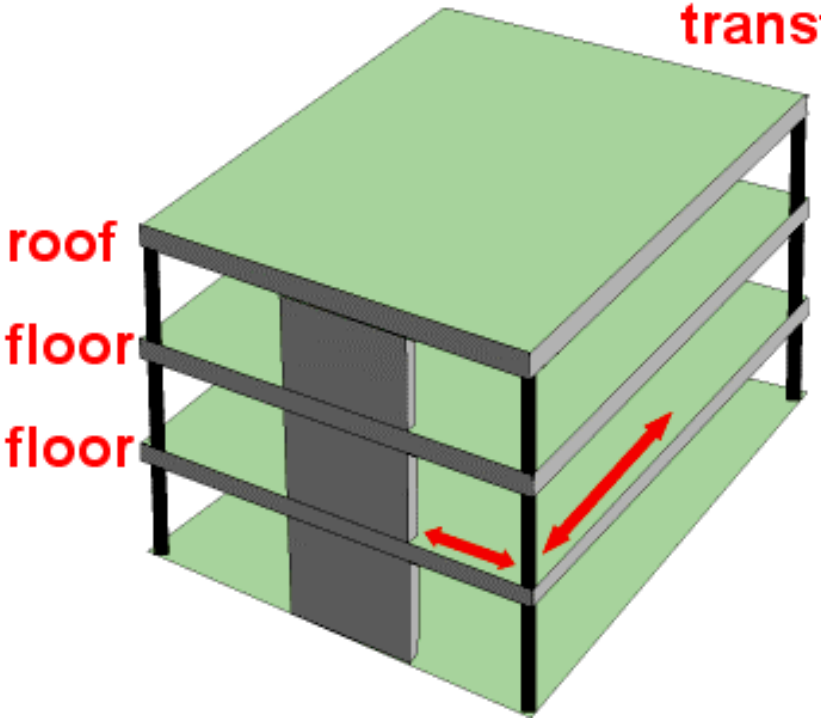
Sistem Struktur Tahan Gempa

Sistem Struktur Dasar



Diafragma

the roof and floor structures
transfer the lateral forces
to the columns and
shear walls



Beberapa Ketentuan Dasar untuk Struktur Beton

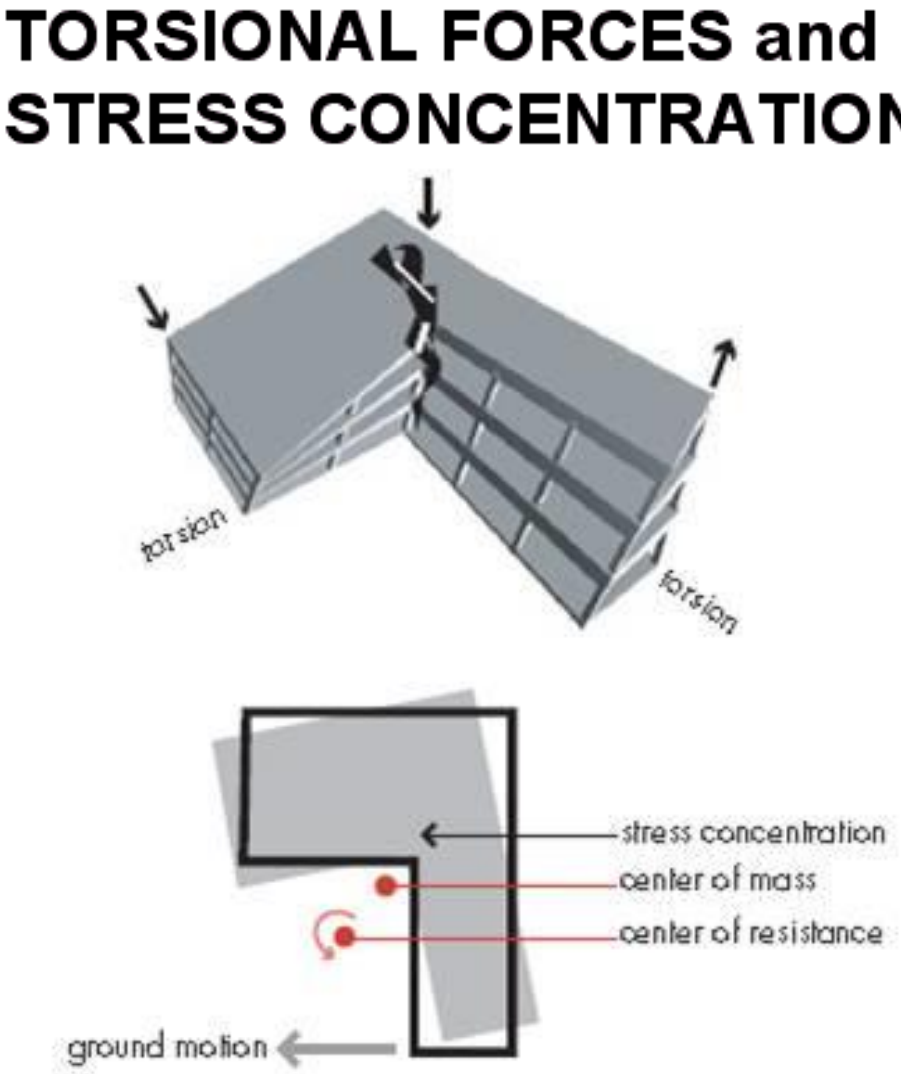
Ketentuan Dasar

- Kuat tekan beton struktural minimum = 17 MPa (K-200);
- Untuk struktur tahan gempa, kuat tekan beton minimum = 20 MPa (K-250);
- Baja tulangan yang digunakan haruslah tulangan ulir. Baja polos hanya diperkenankan untuk tulangan spiral atau tendon;
- Batasan tulangan di atas tidak berlaku untuk jaring kawat baja polos.

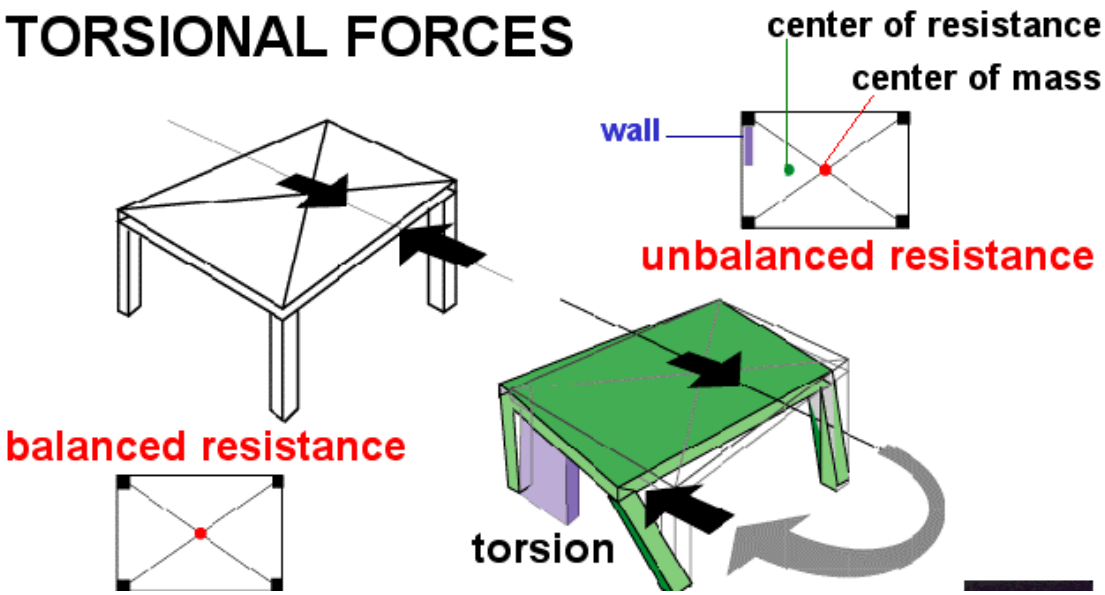
Karakteristik Struktur yang Menghasilkan Perilaku yang Kurang Baik

- Kolom pendek
- Konfigurasi struktur terkait dengan ukuran dan bentuk (regular vs irregular)
- Soft story
- Balok kuat kolom lemah
- Distribusi kekakuan, vertikal maupun horizontal, yang tidak merata
- Komponen non-struktural
- Unreinforced Masonry

Torsi dan Konsentrasi Tegangan



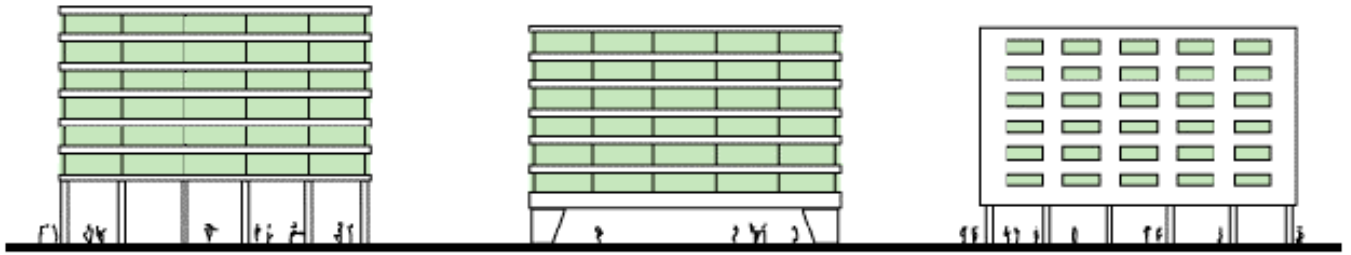
Eksentrisitas



Soft Story

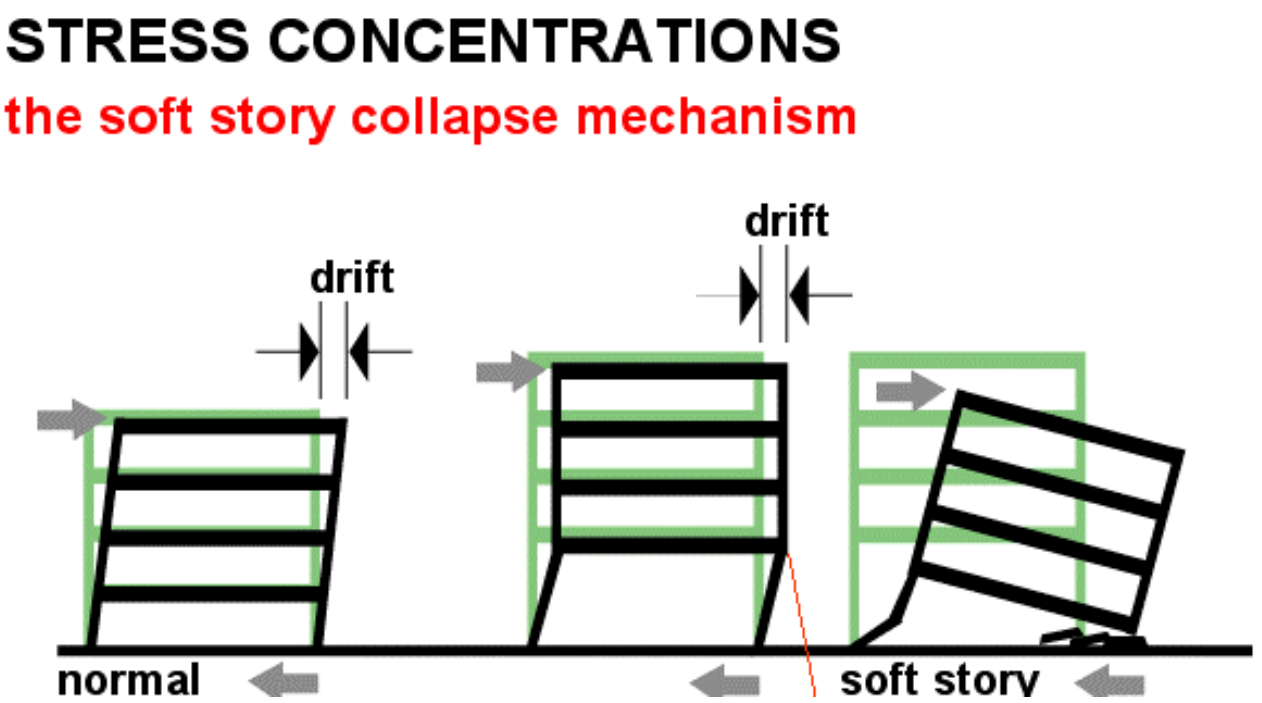
STRESS CONCENTRATIONS

The most serious condition of vertical irregularity is the soft or weak story, in which one story, usually the first with taller, fewer columns, is significantly weaker or more flexible than the stories above.



flexible 1st floor | discontinuity | heavy superstructure

Keruntuhan Soft Story



Contoh Keruntuhan Soft Story

soft stories

KEGAGALAN STRUKTUR AKIBAT EFEK SOFT-STOREY

Gempa Padang 2009

Gempa Padang 2009

Gempa Aceh 2004

Gempa Nias 2009

Gempa Jogja 2006

Gempa Chili

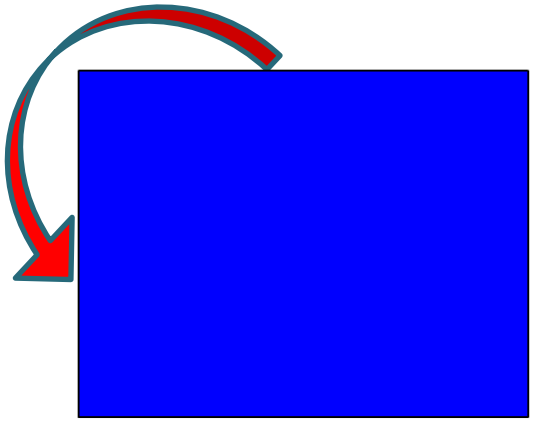
Gempa di Cina (1999)

Gempa di India

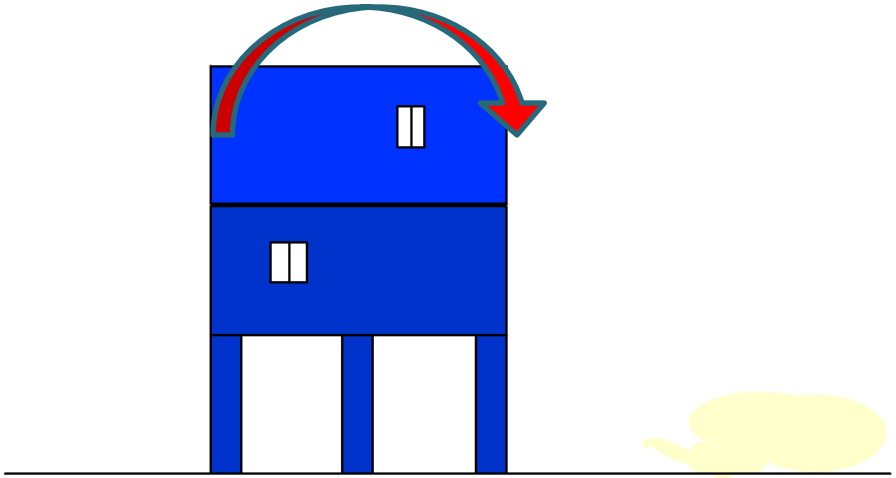
SNI 03-1726-2002 dan SNI 1726-2012:

Definisi struktur gedung tak beraturan adalah terdapat sistem strukur tingkatan lunak (*soft storey*) dalam arah vertikal. Dalam arah tersebut, sistem struktur menurut kedua standar tersebut di atas, *soft storey* didefinisikan sebagai suatu tingkat dimana kekakuan lateralnya kurang dari 70 persen kekakuan lateral tingkat di atasnya atau kurang dari 80 persen kekakuan rata-rata tiga tingkat di atasnya.

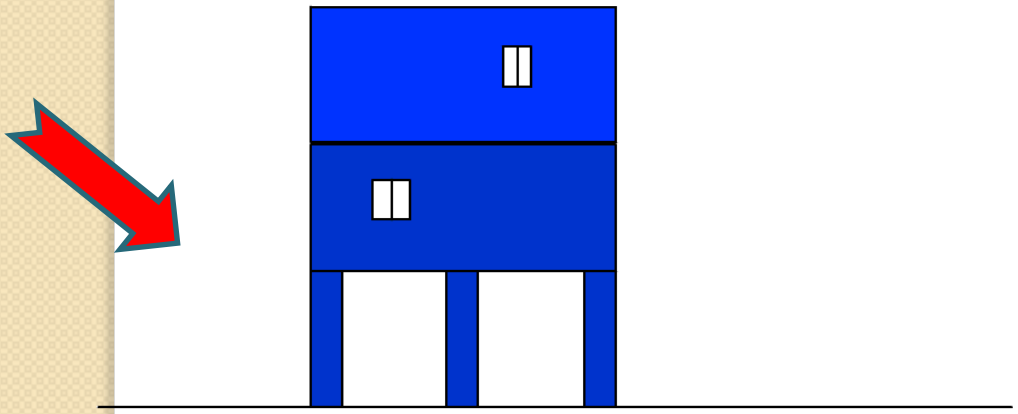
Mekanisme keruntuhan gedung dengan soft-storey



Memutar (Rotation)

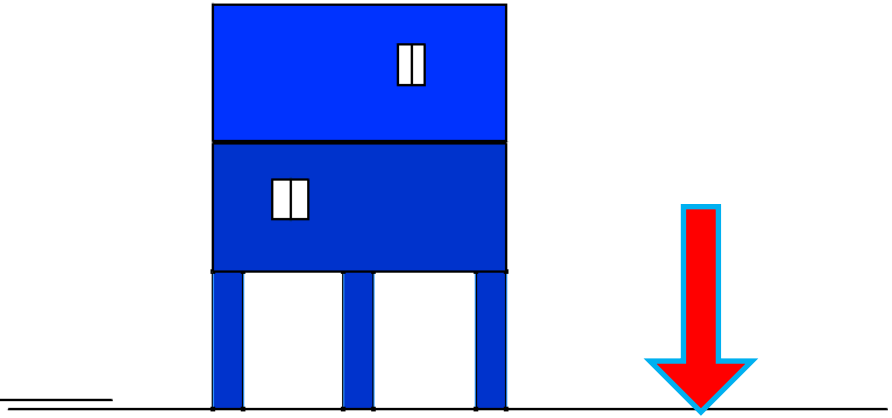


Guling (Overtuning)



Collapse

(Softstory effect)

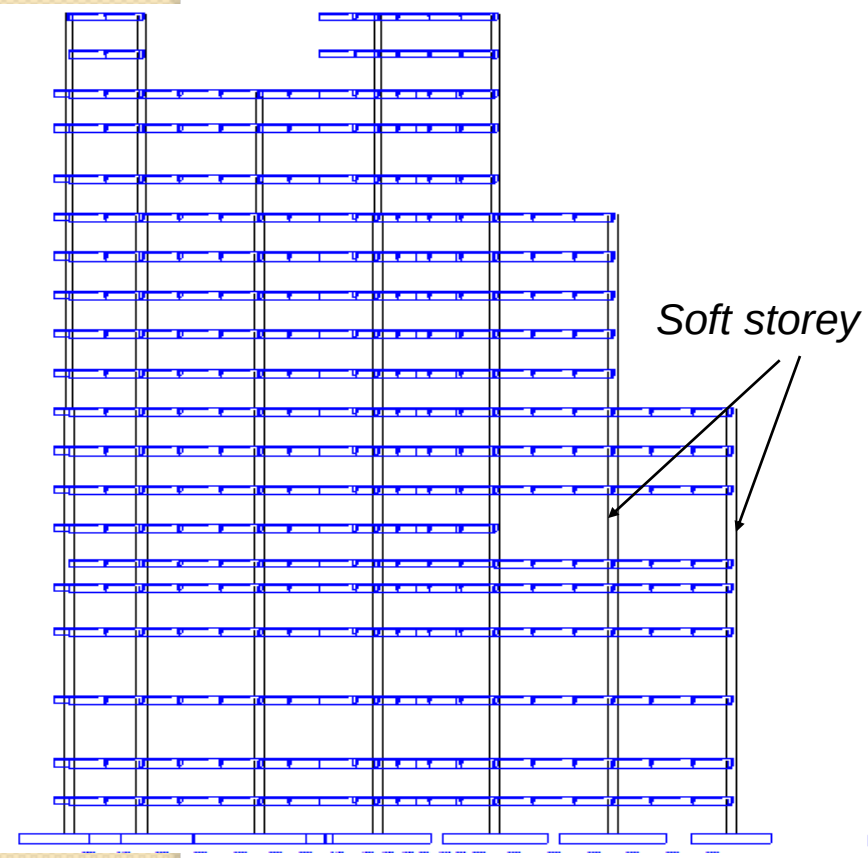


Amblas

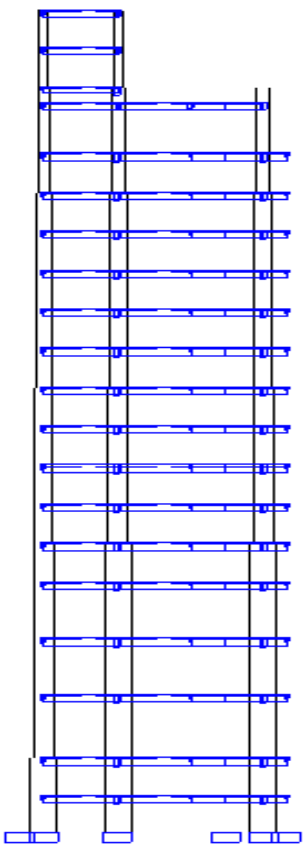
(Liquifaction)

Studi kasus Gedung Tinggi 60 meter (17 Lantai)

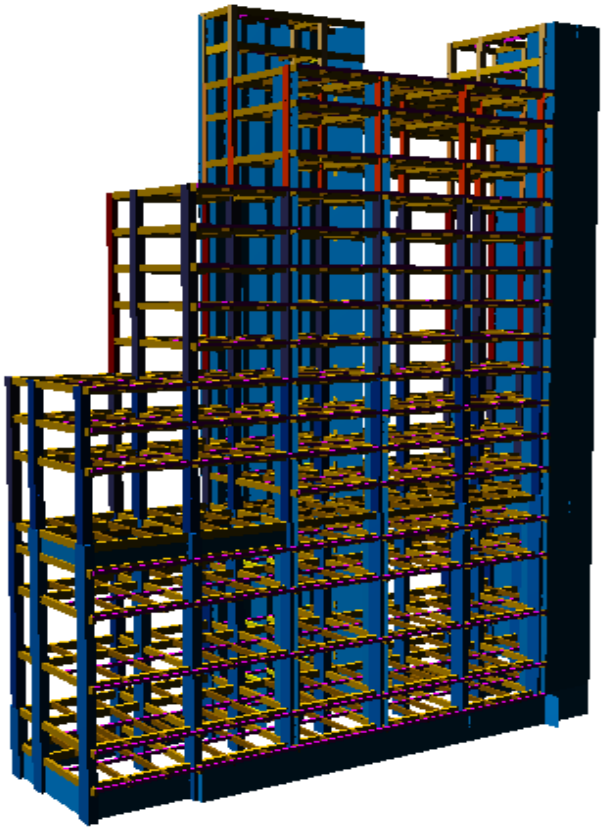
Struktur dengan Soft-Storey



Arah z

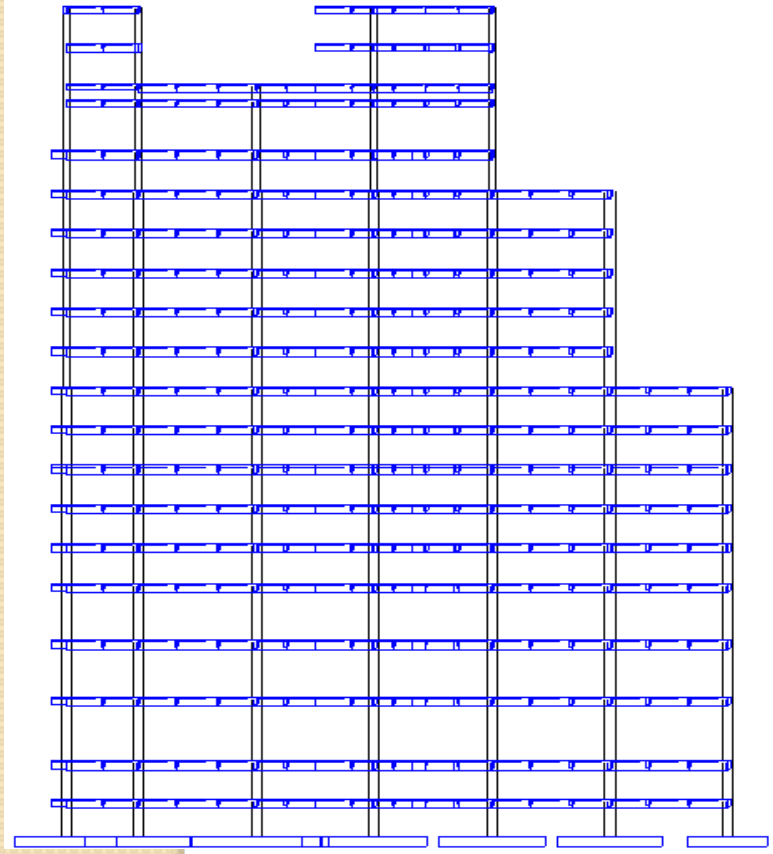


Arah y

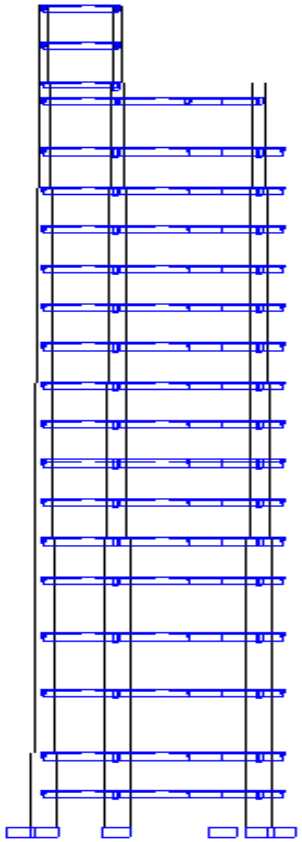


Isometri

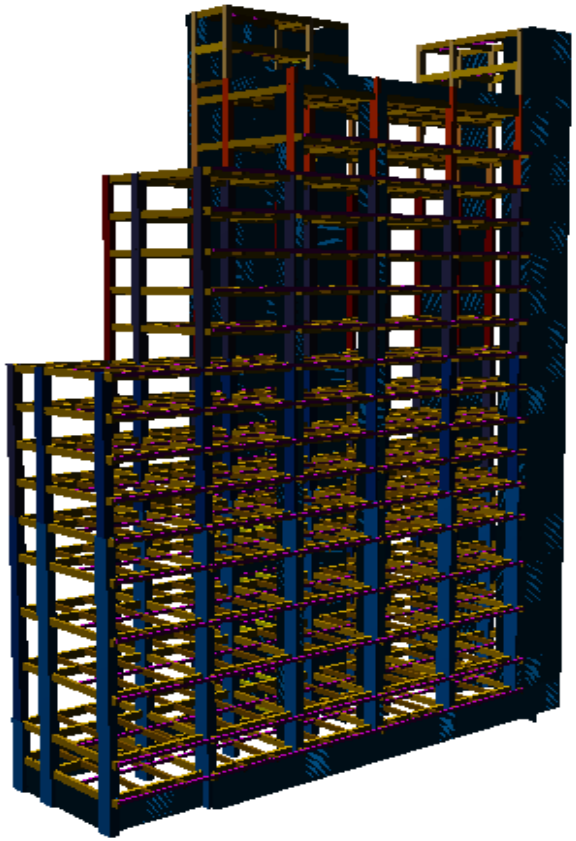
Struktur Tanpa Soft-Storey



Arah z



Arah y



Isometri

Material dan pembebanan
beton bertulang, K-350 (f’c~30 MPa)
baja tulangan utama : deform mutu BJTD40.
Standar utama perencanaan:
Beton bertulang : SNI 03-2847-2002
Terhadap gempa : SNI 03-1726-2002 dan SNI 1726-2012.

Dimensi

Kolom semakin ke atas semakin kecil

-kolom lantai 1 sampai 7 : 400/1000,

- lantai 8 sampai 15 : 400/800,

- kolom lantai di atasnya : 400/600.

- Balok induk : 350/750 dan balok anak 200/600.

- Plat lantai tipikal dengan tebal 120 mm yang dianggap sebagai diafragma kaku pada sistim struktur rangka.

- Dinding geser menerus sampai lantai paling atas.

• Struktur gedung terletak di kota Semarang (zona gempa 3)

• Peta gempa SNI 1726-2012

• Desain Sistem Rangka Pemikul Momen Khusus (SRPMK) dirangkai dengan dinding geser maupun spandrel di beberapa bagian.

• Faktor reduksi gempa (R) : 8,5 (Tabel 3. Pasal 4.3.6 SNI 03-1726-2002),

• Analisis dinamik dilakukan berdasarkan ragam respon spektrum, dimana digunakan metoda Modal Analisis untuk menentukan respon struktur antar tingkat.

•Kondisi tanah : kategori tanah lunak.

•Percepatan puncak di batuan dasar = 0,2 g,

•Ao = 0,34g, Tc = 1 detik (untuk tanah lunak),

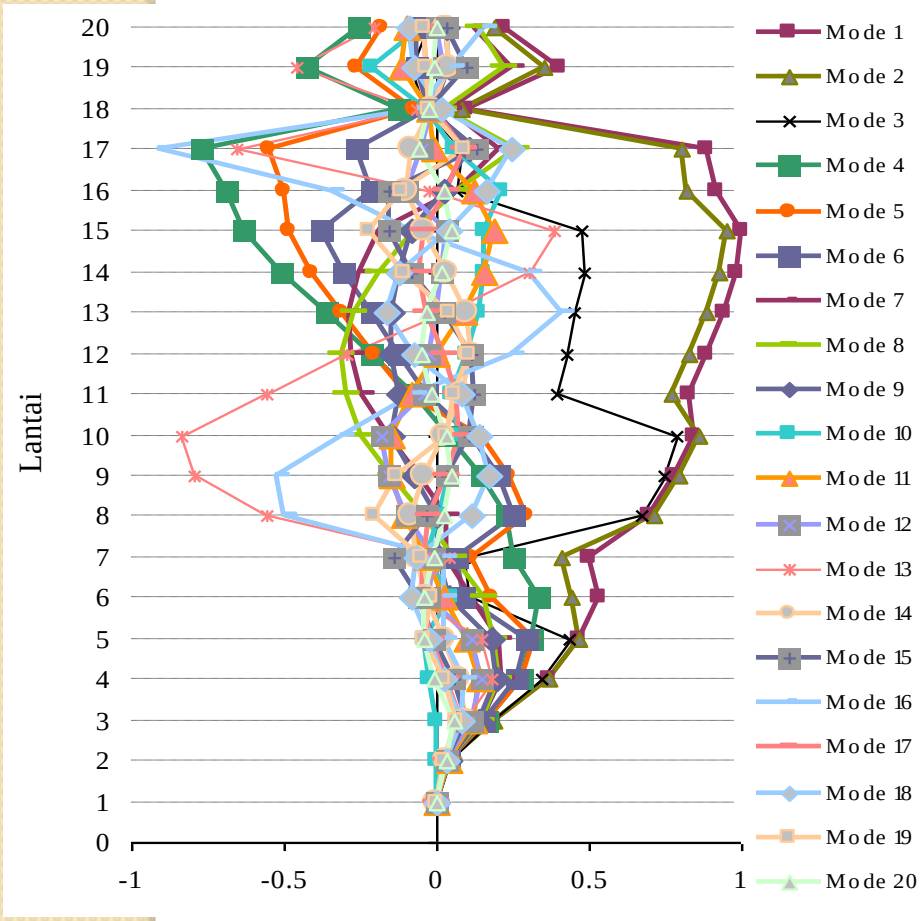
•Am = 2,5 Ao= 0,9, Ar = Am x Tc = 0,9 (Tabel 6. Pasal 4.7.6).

•Fungsi gedung termasuk gedung umum, I = 1,0.

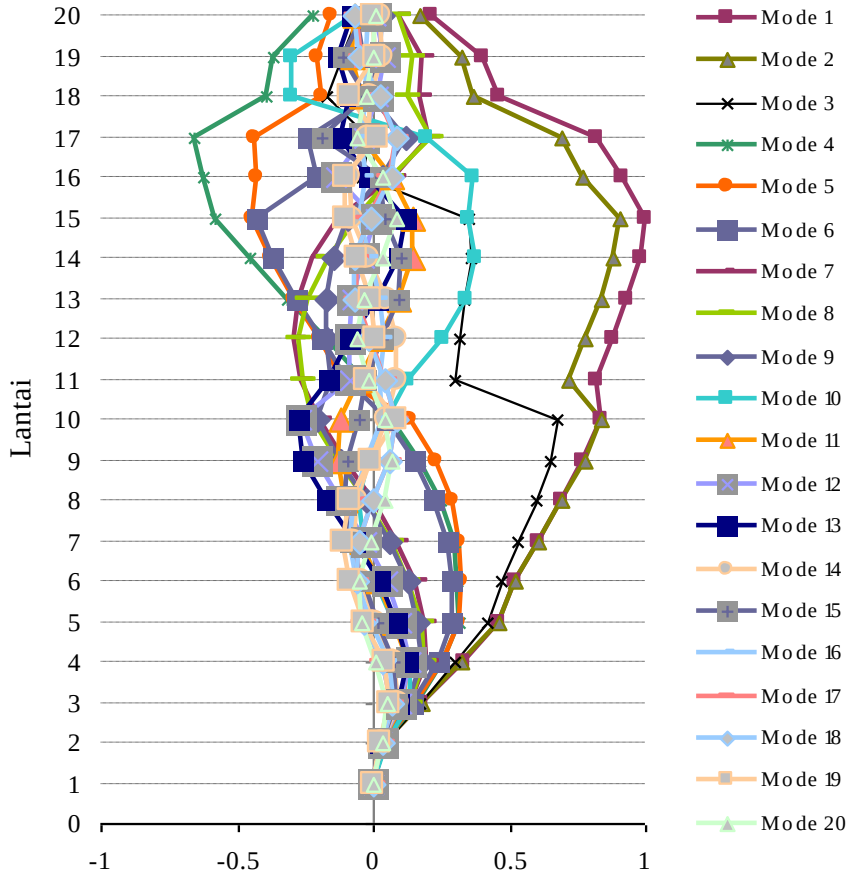
•L/B= 45/12,5=3,6 > 3, maka ditambahkan beban horizontal terpusat sebesar 0,1V di lantai tingkat paling atas.

•Analisis maupun pembahasan yang diuraikan adalah pada arah y (arah lemah), karena respon struktur akibat beban gempa dominan dalam arah tsb.

MODUS GETAR

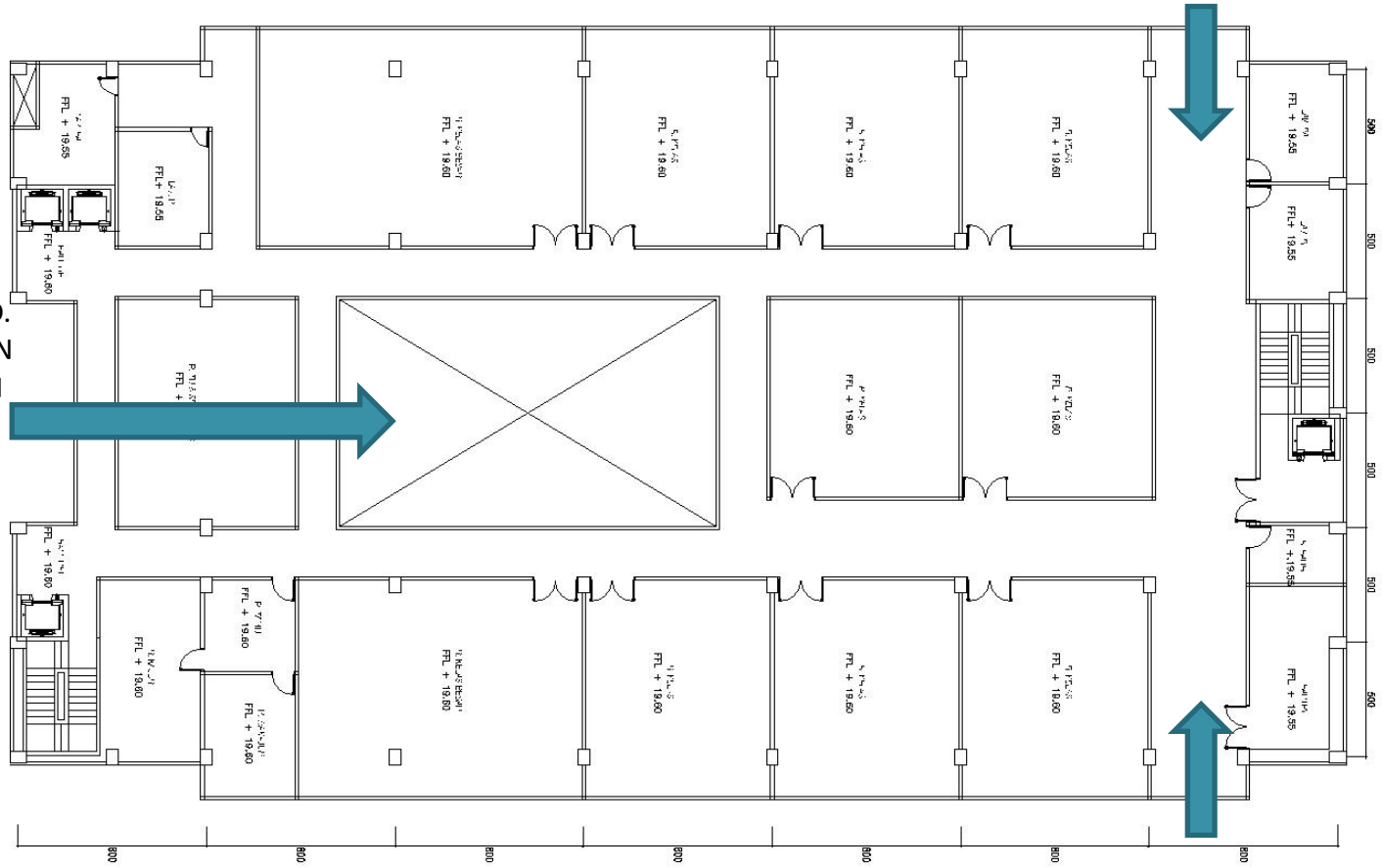


(a) Struktur gedung dengan *soft storey*

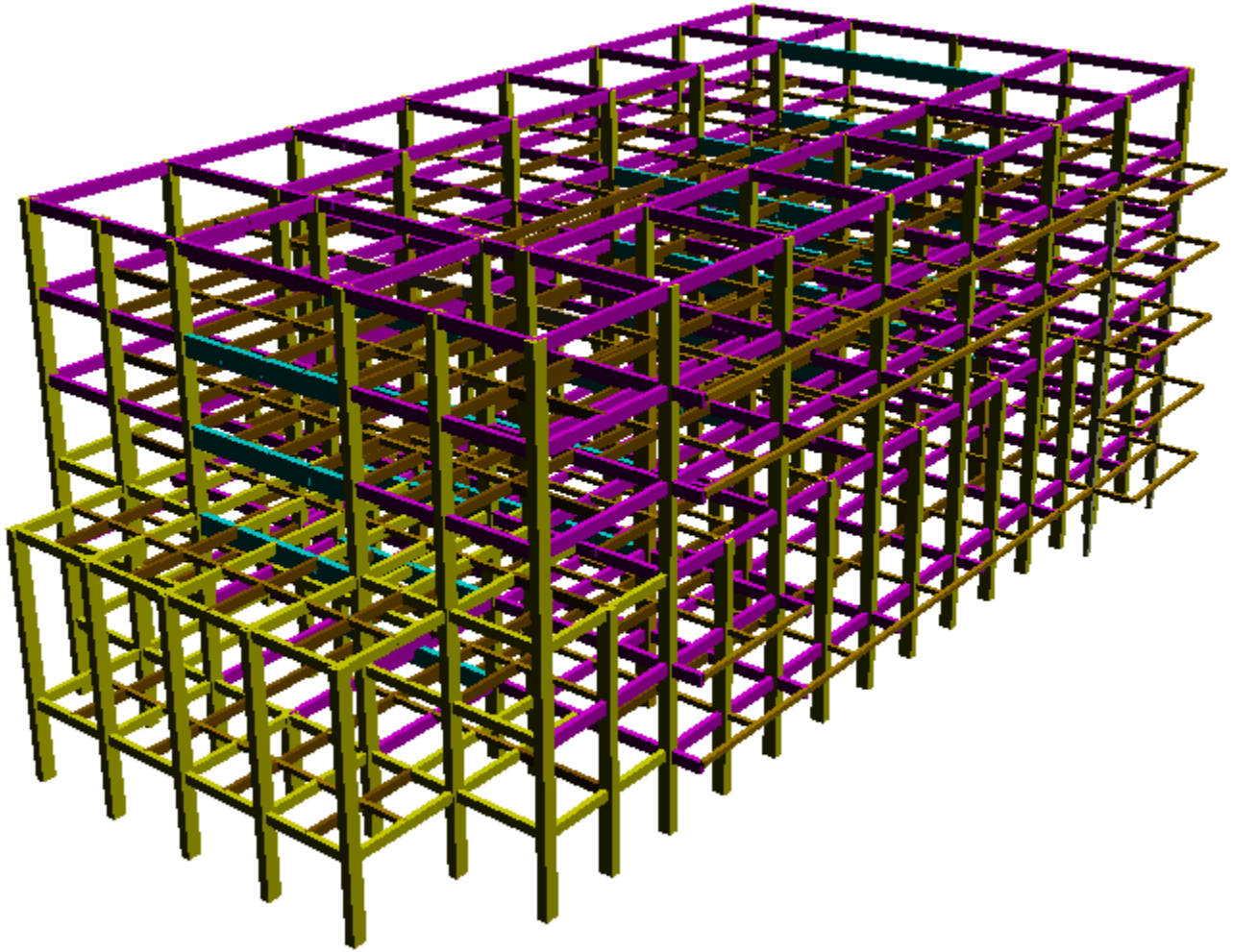


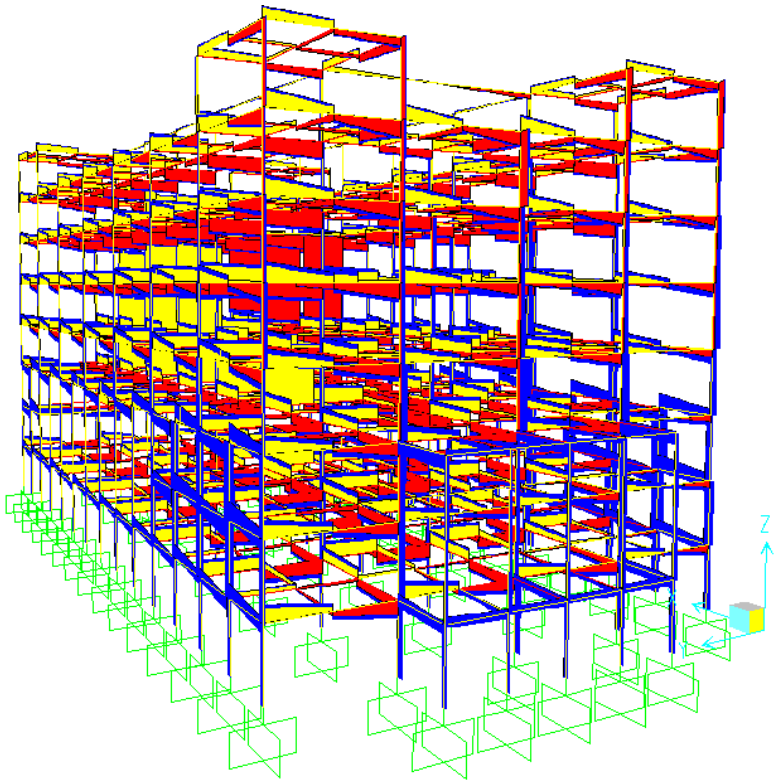
(b) Struktur gedung non-*soft storey*

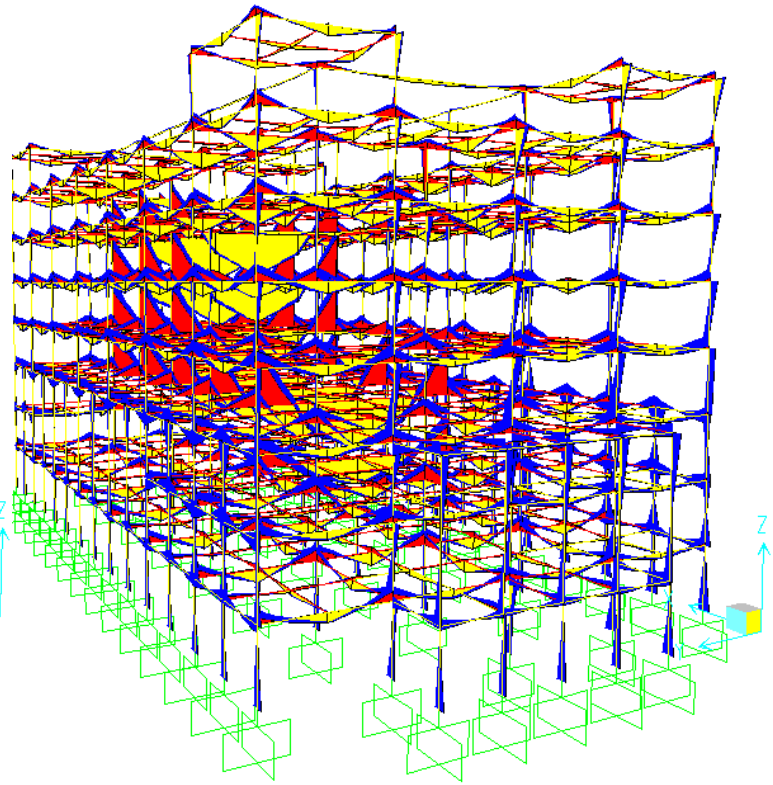
ADA VOID DAN BID. BUKAAN DI BAGIAN MUKA BANGUNAN SBG CROSS VENTILATION, PENYEBAR PENCAHAYAAN ALAMI

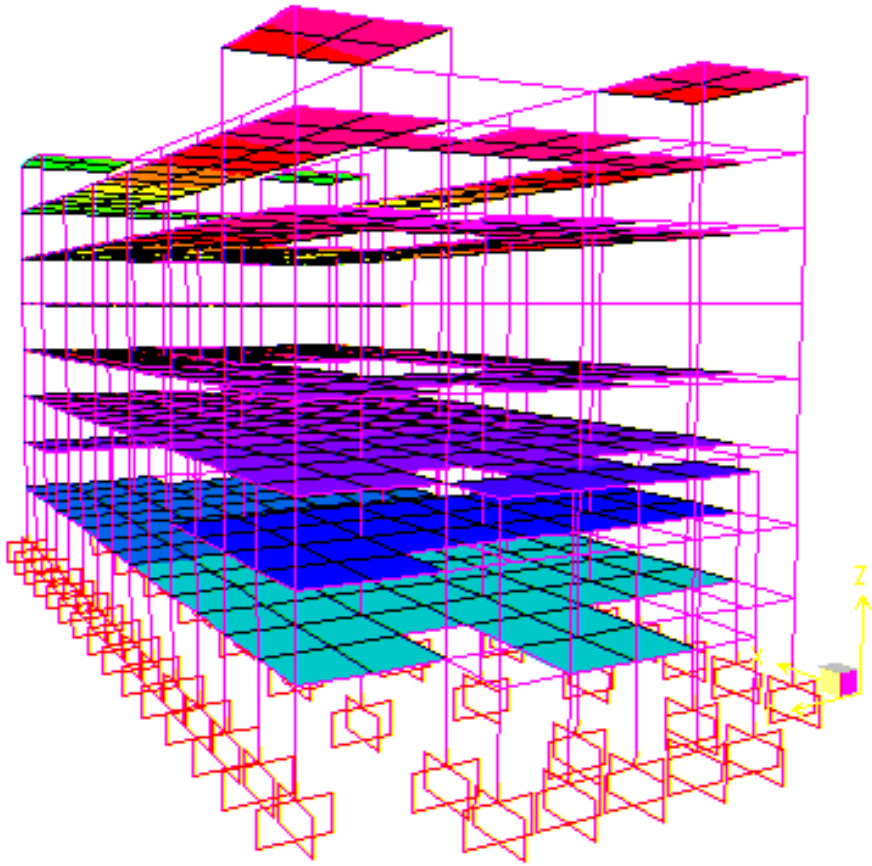


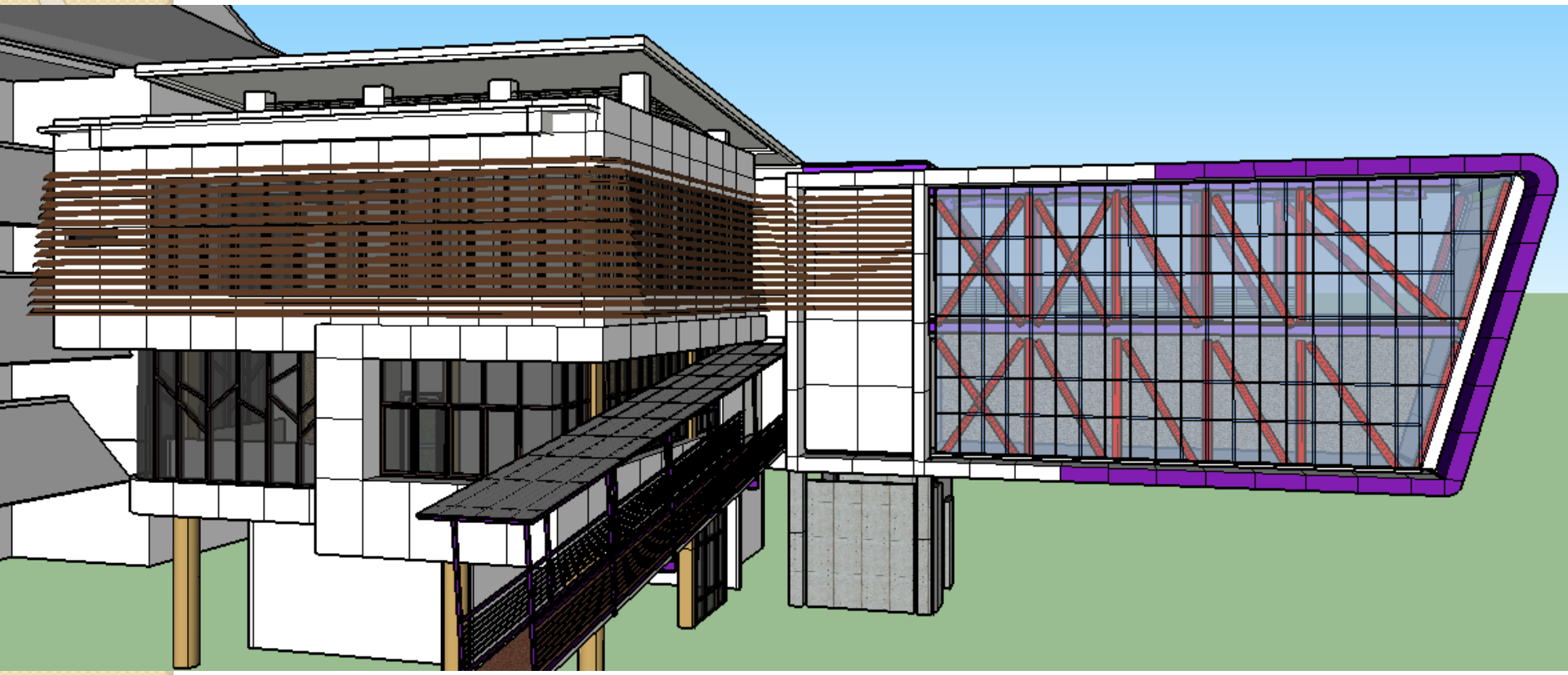
IDEALISASI SISTEM STRUKTUR

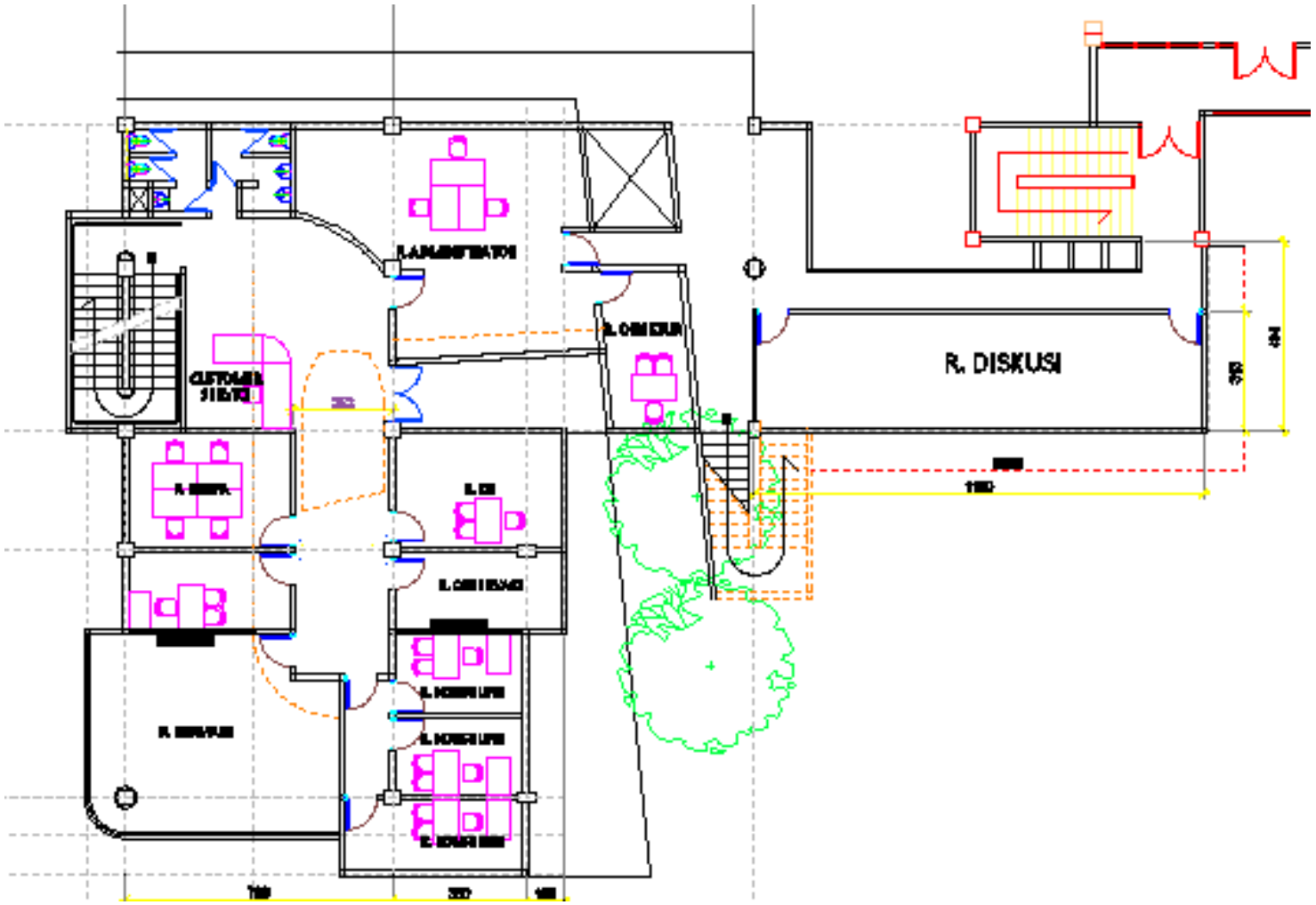



Z

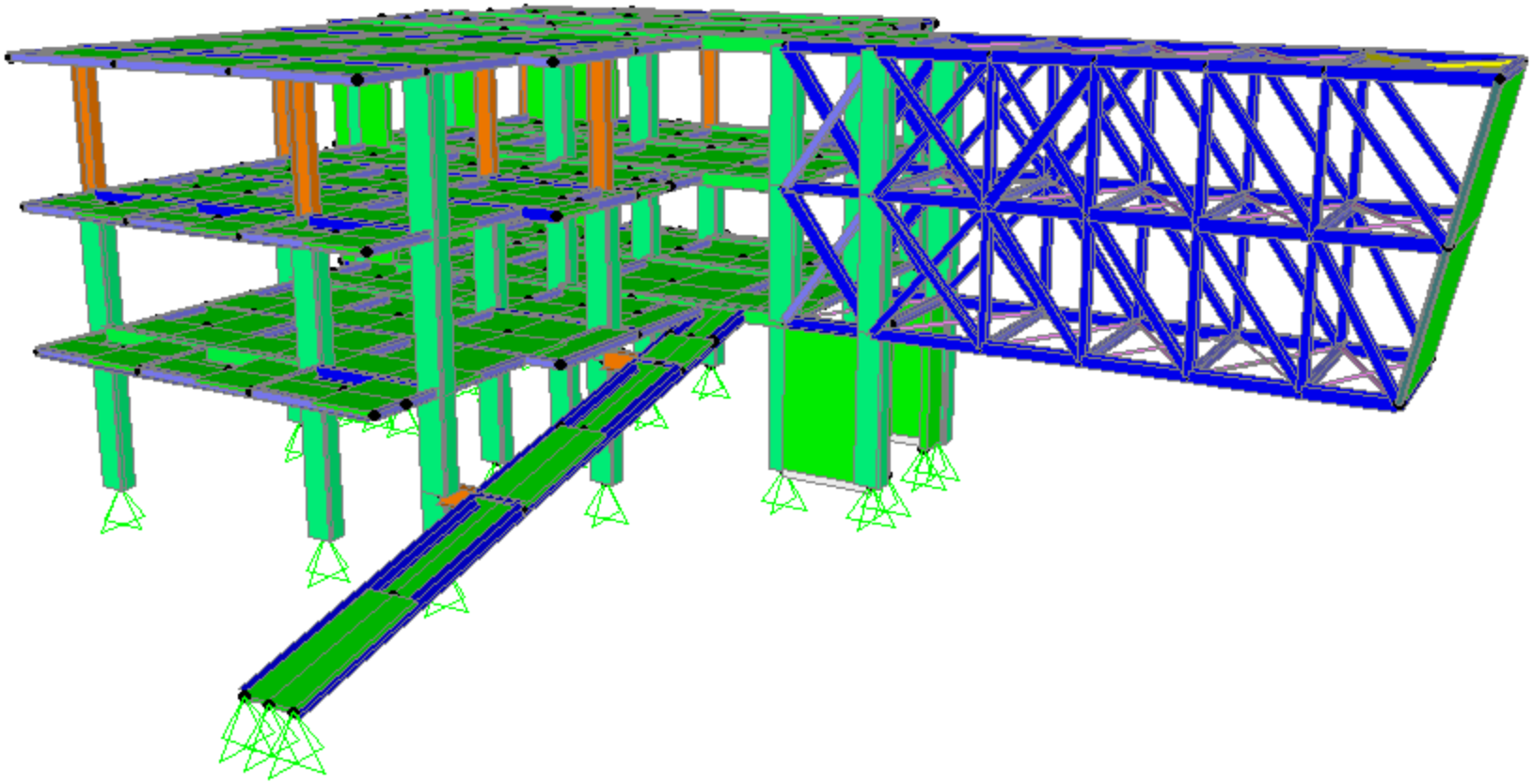

Z

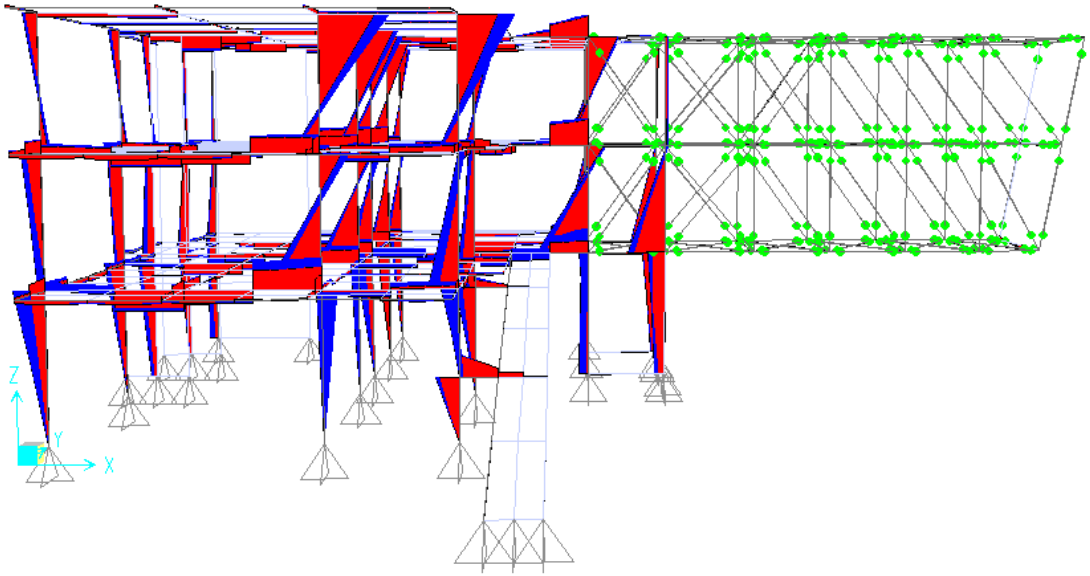

Z

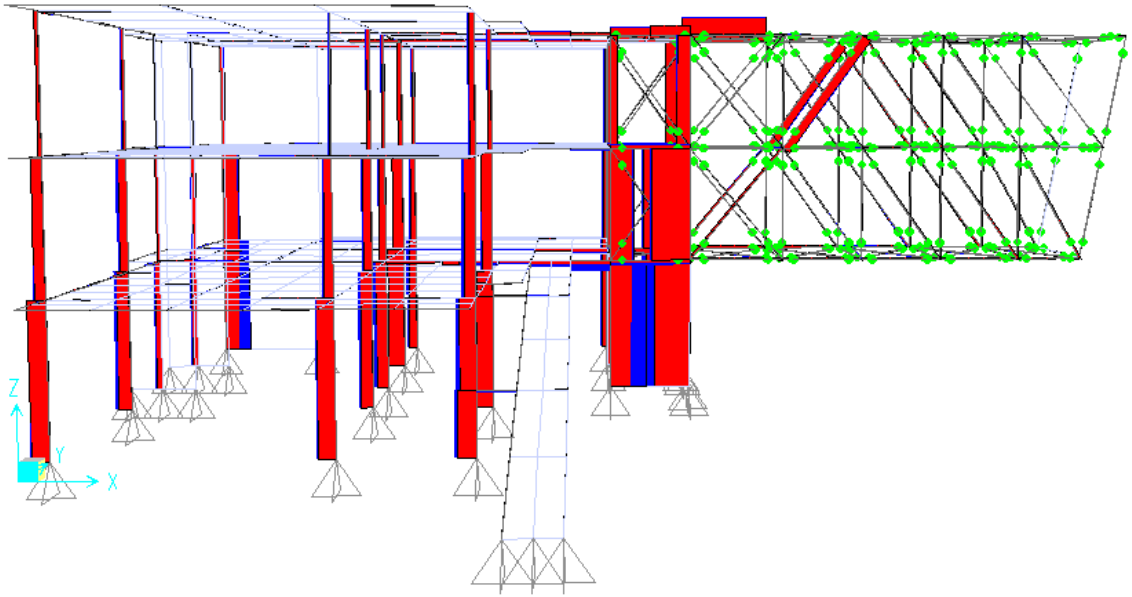


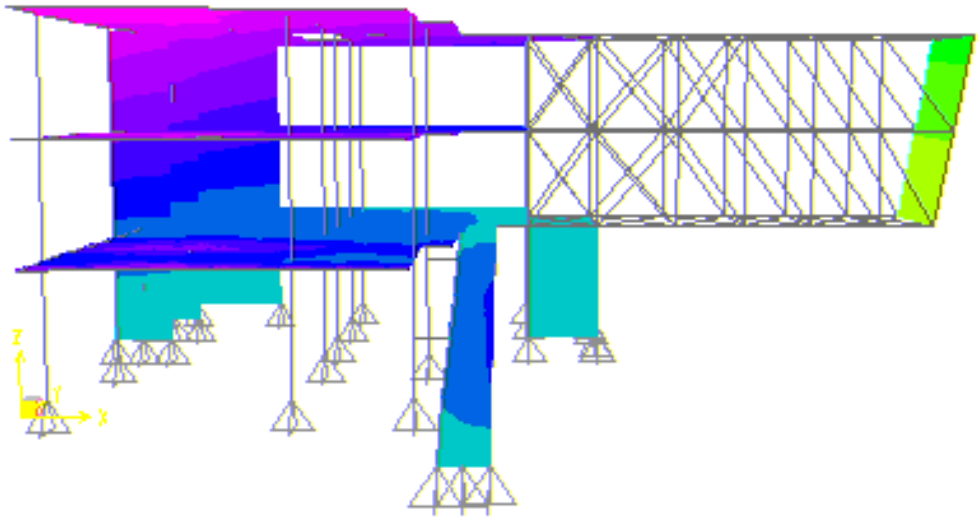

R. DISKUSI

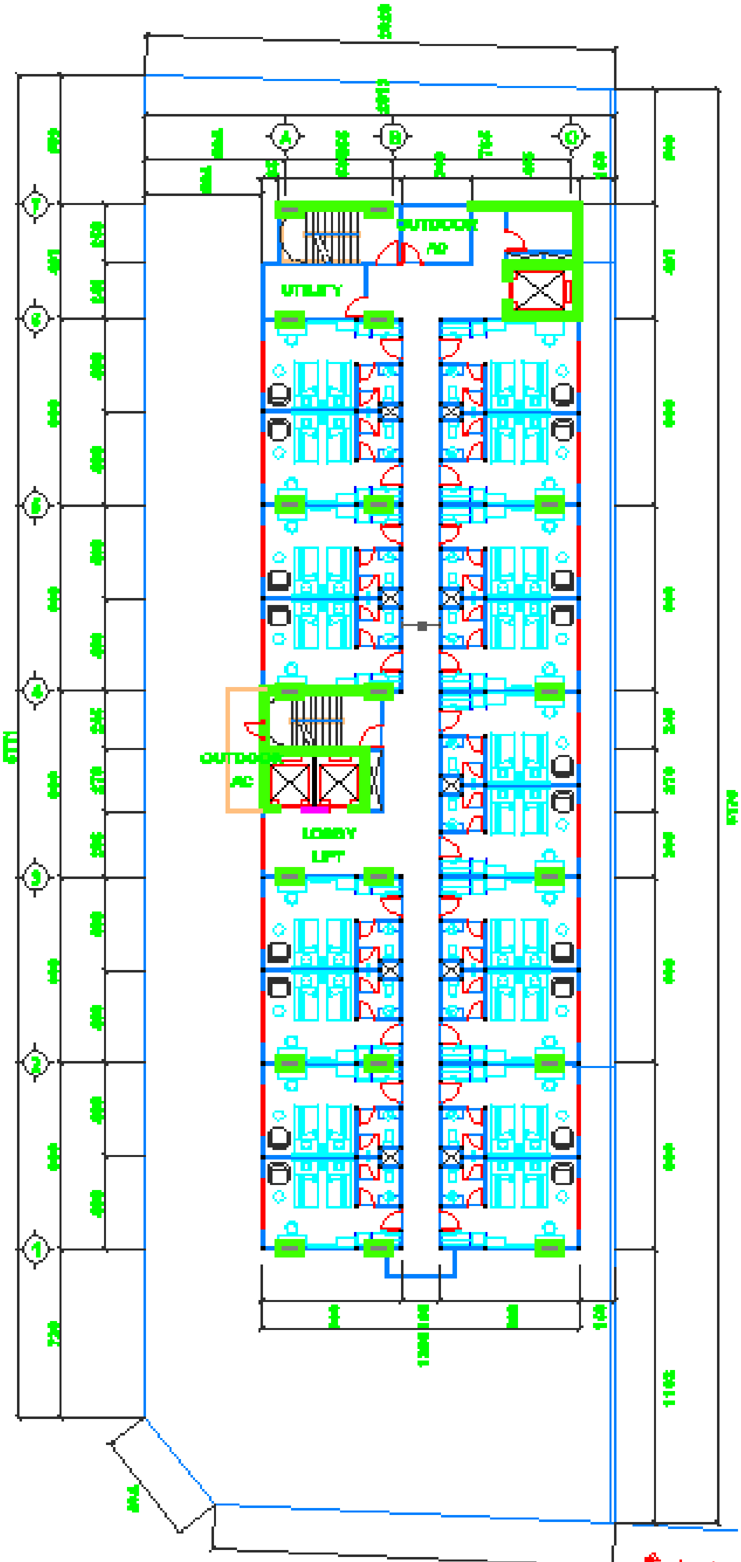
IDEALISASI SISTEM STRUKTUR




Z
Y
X


Z
Y
X


Z
Y
X

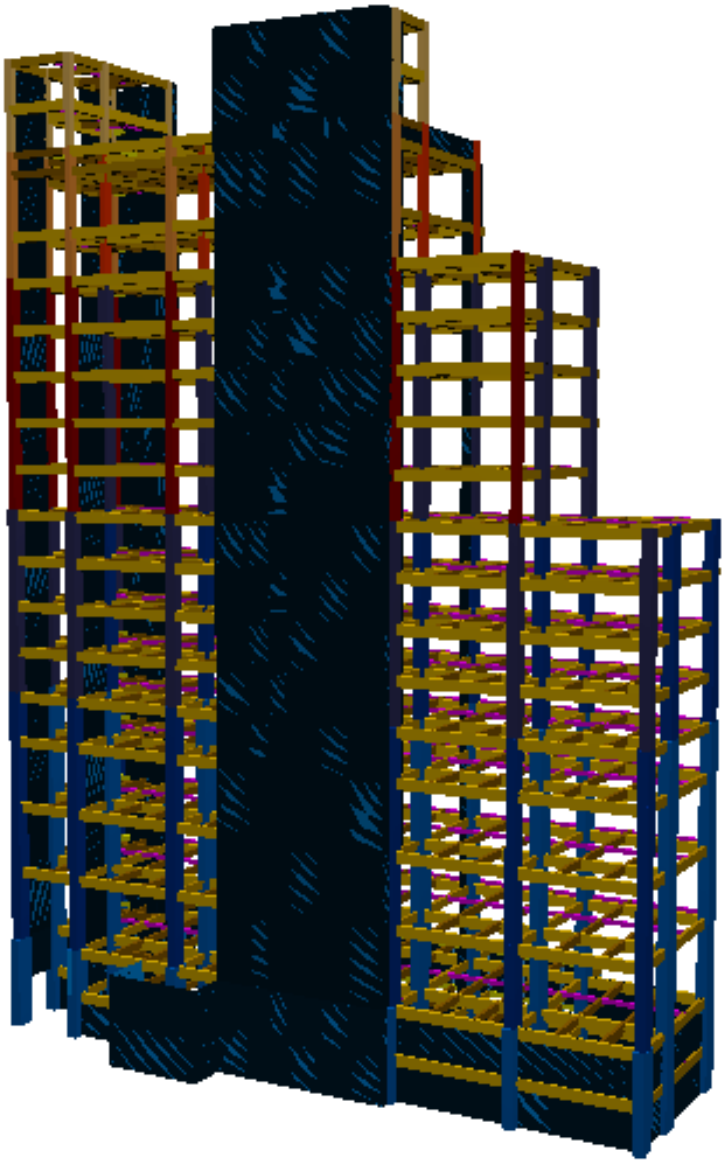


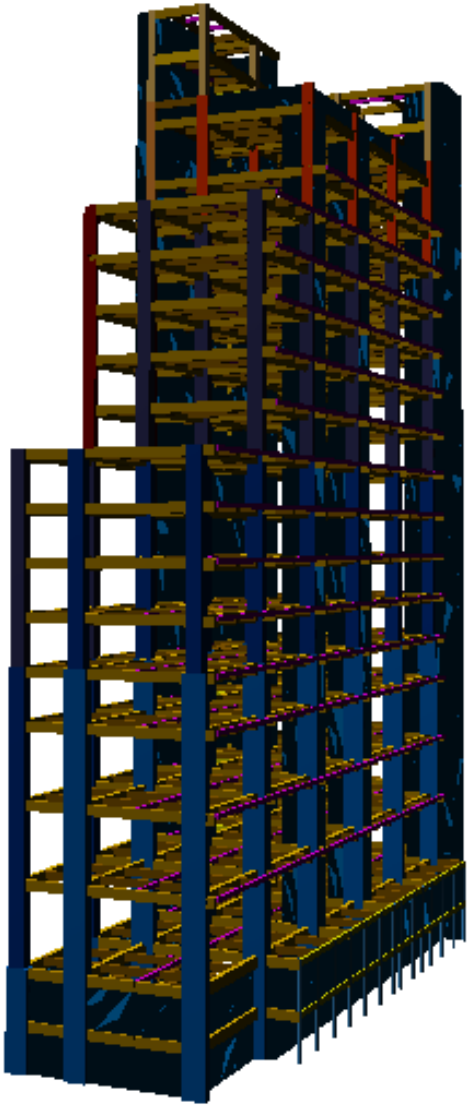
6TH – 9TH FLOOR PLAN

ROOMS : 18 ROOMS/FLOOR

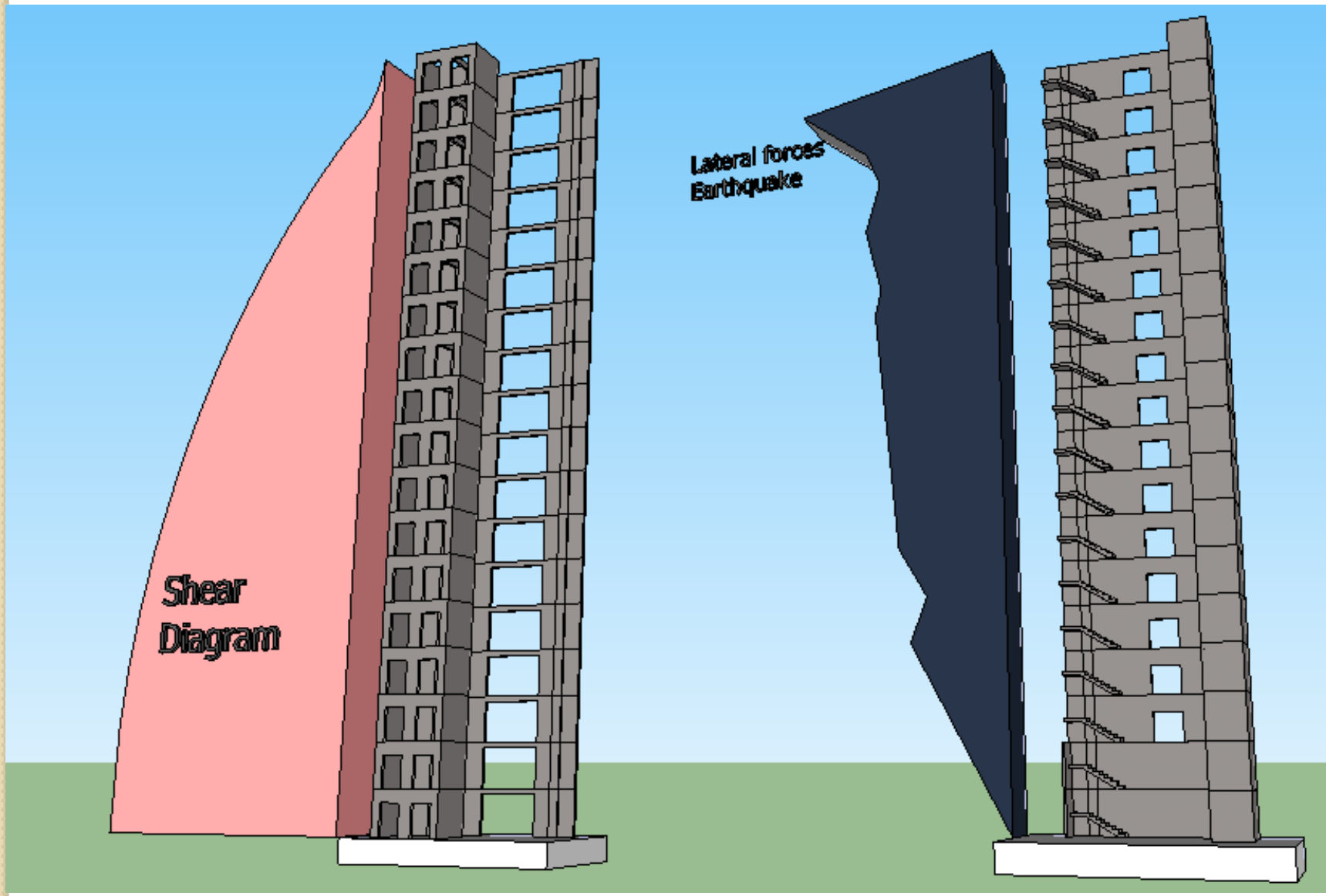
FLOOR AREA : 616.59 m2

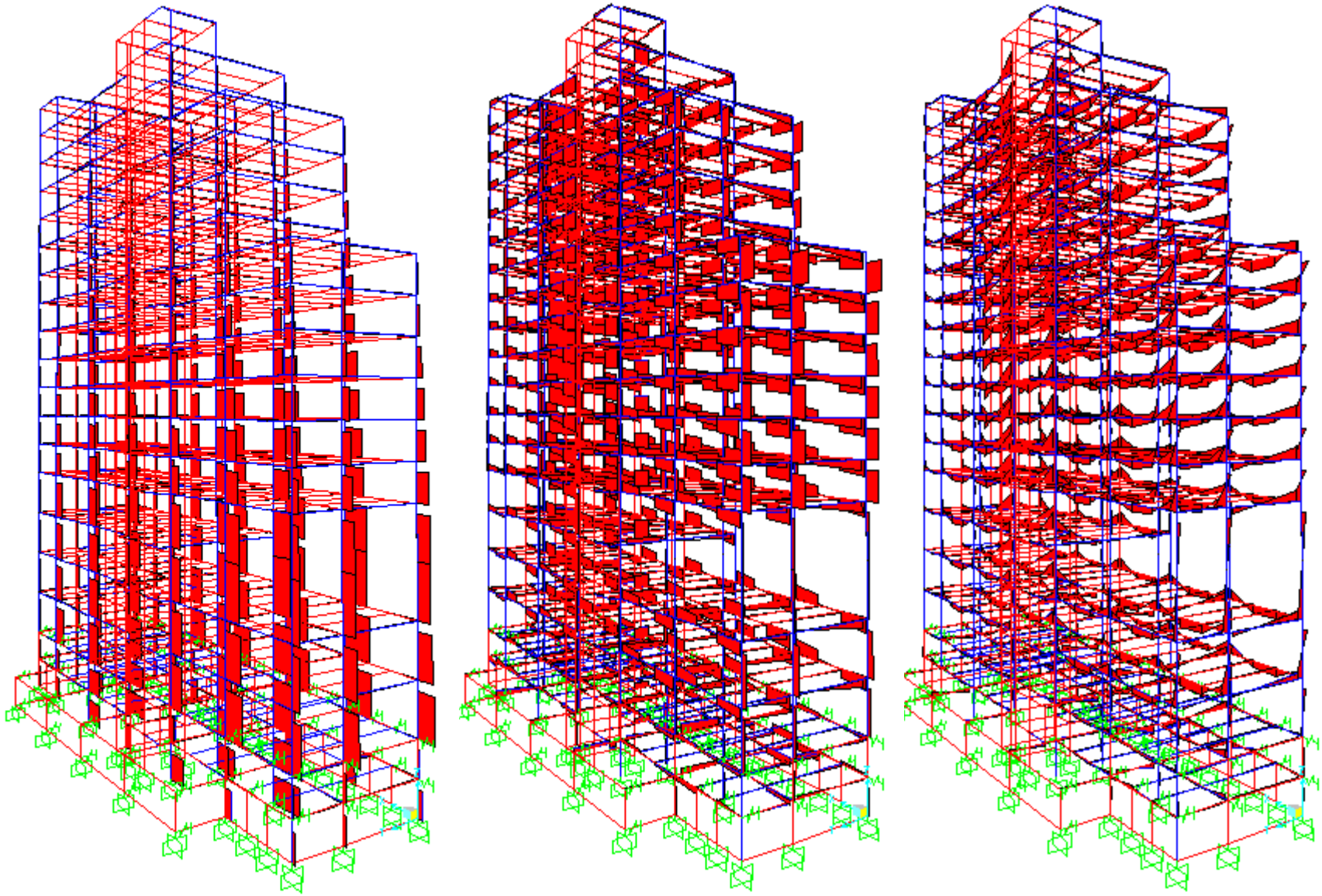
CONTOH DESAIN STRUKTUR TERHADAP GEMPA

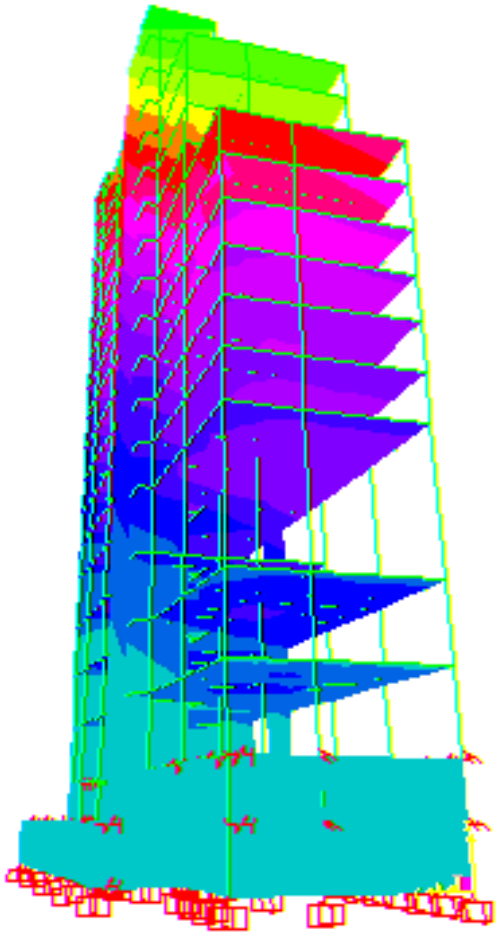


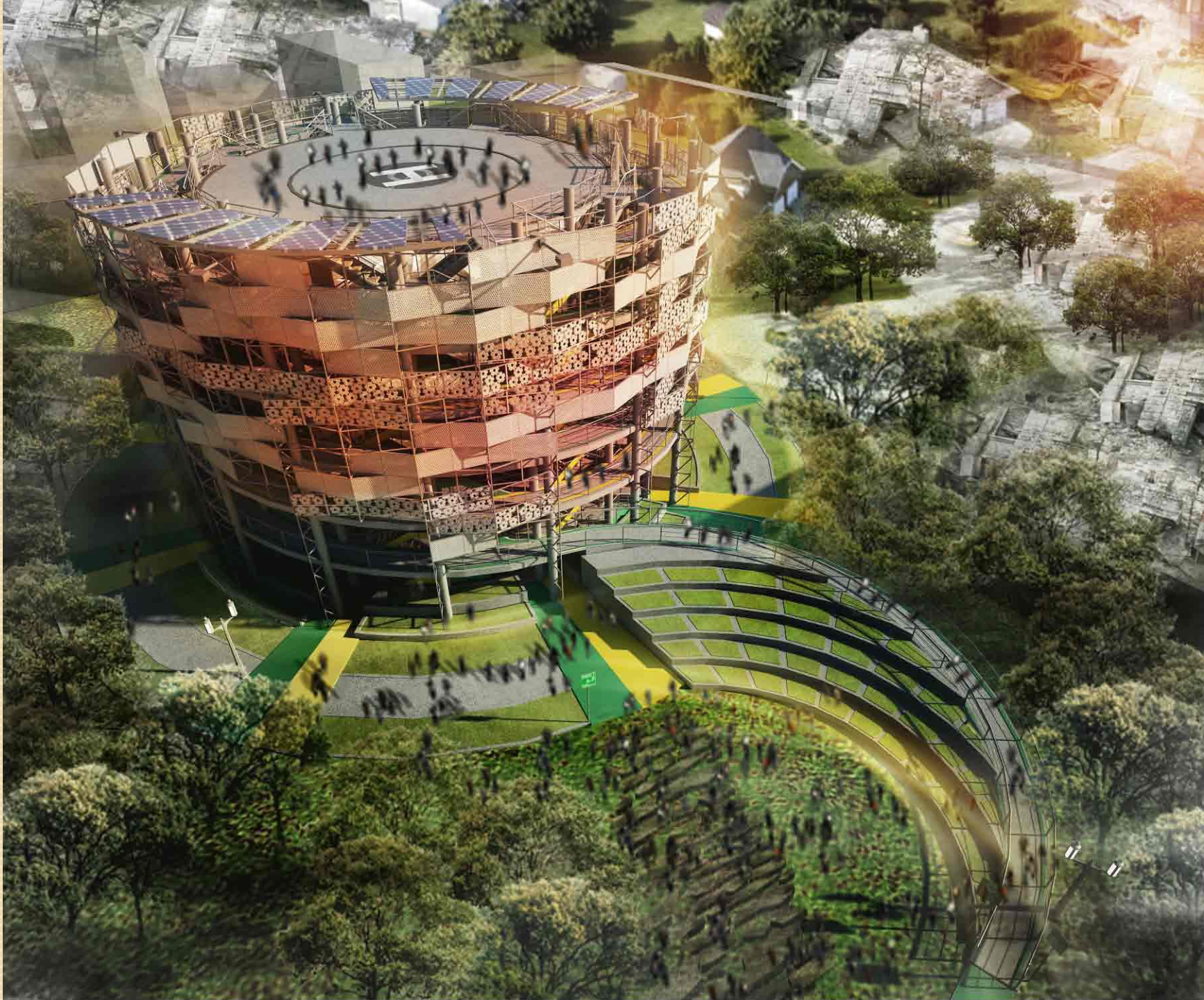


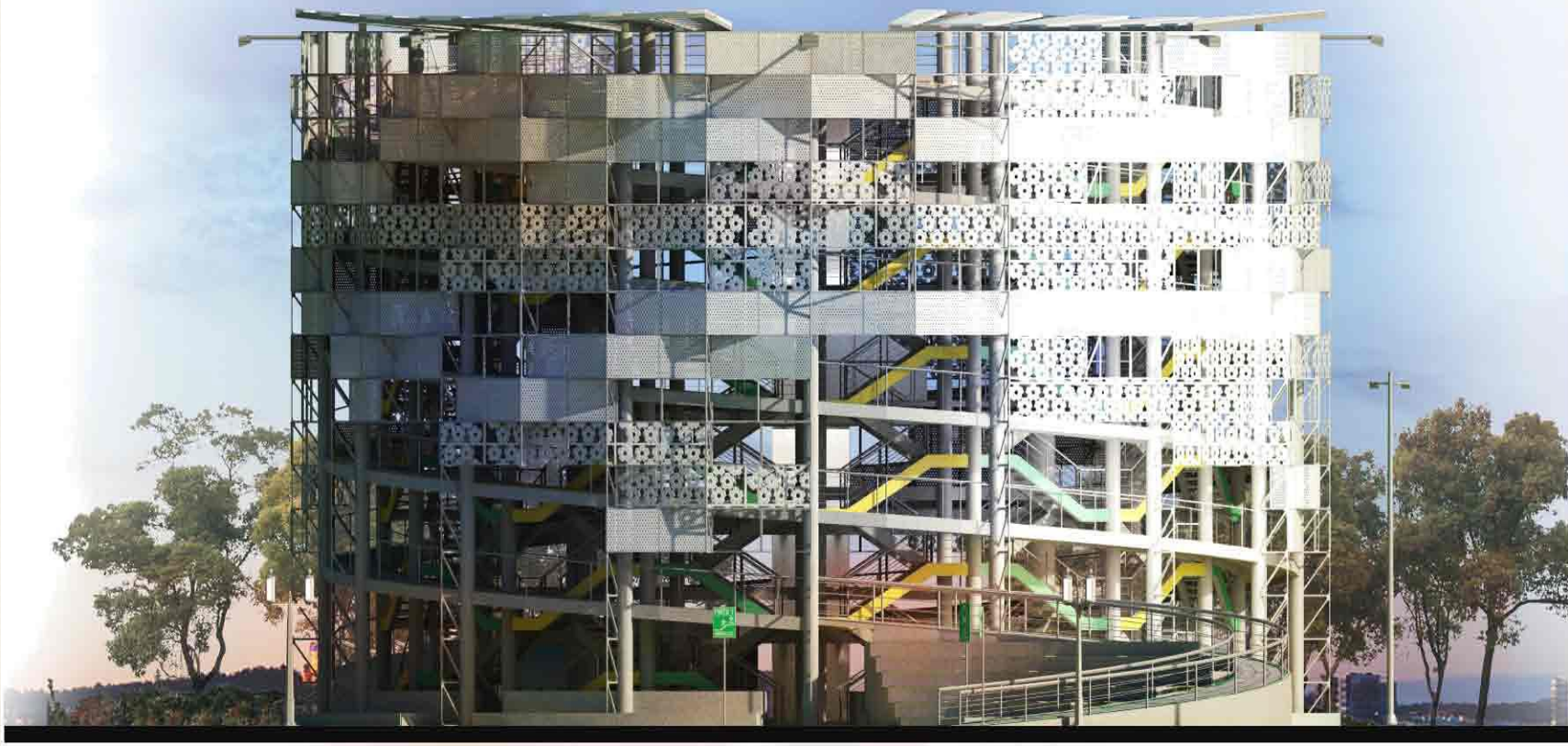
BASE SHEAR



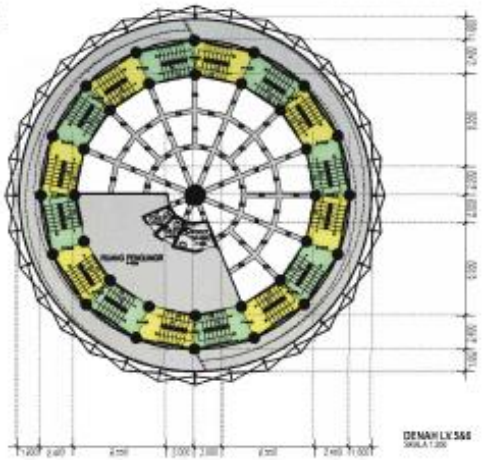


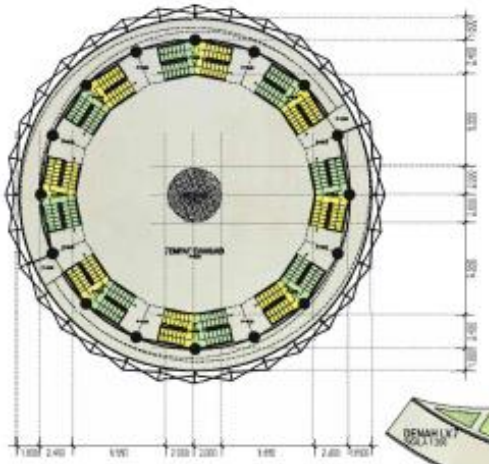


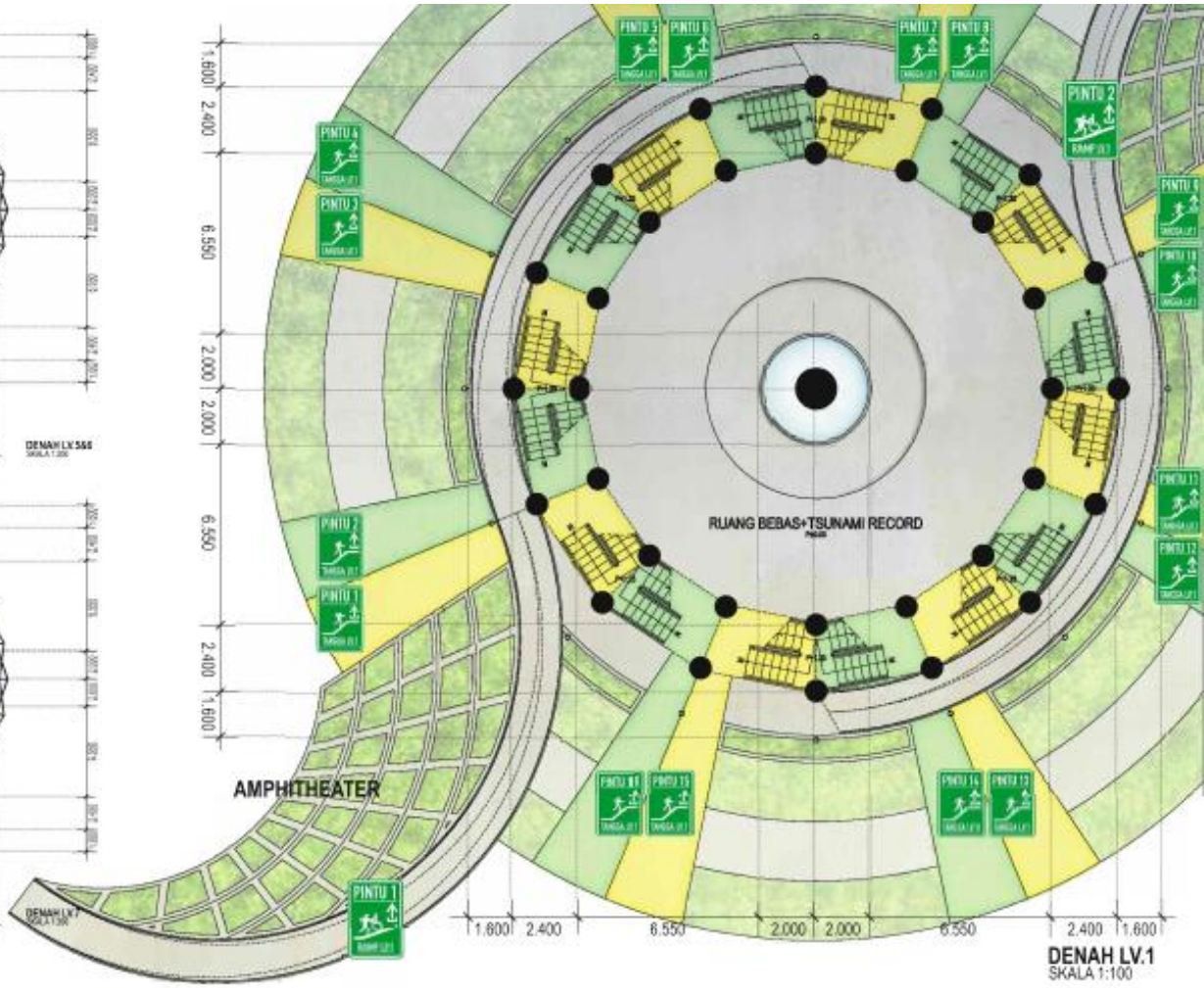




DENAH
LAYOUT PLAN







DENAH LV.1
SKALA 1:100

IDEALISASI SISTEM STRUKTUR