



Sosialisasi Bangunan Tahan Gempa dan Greenbuilding

Dinas Pekerjaan Umum Bina Marga dan Cipta Karya, Provinsi Jawa Tengah, 18 Mei 2017

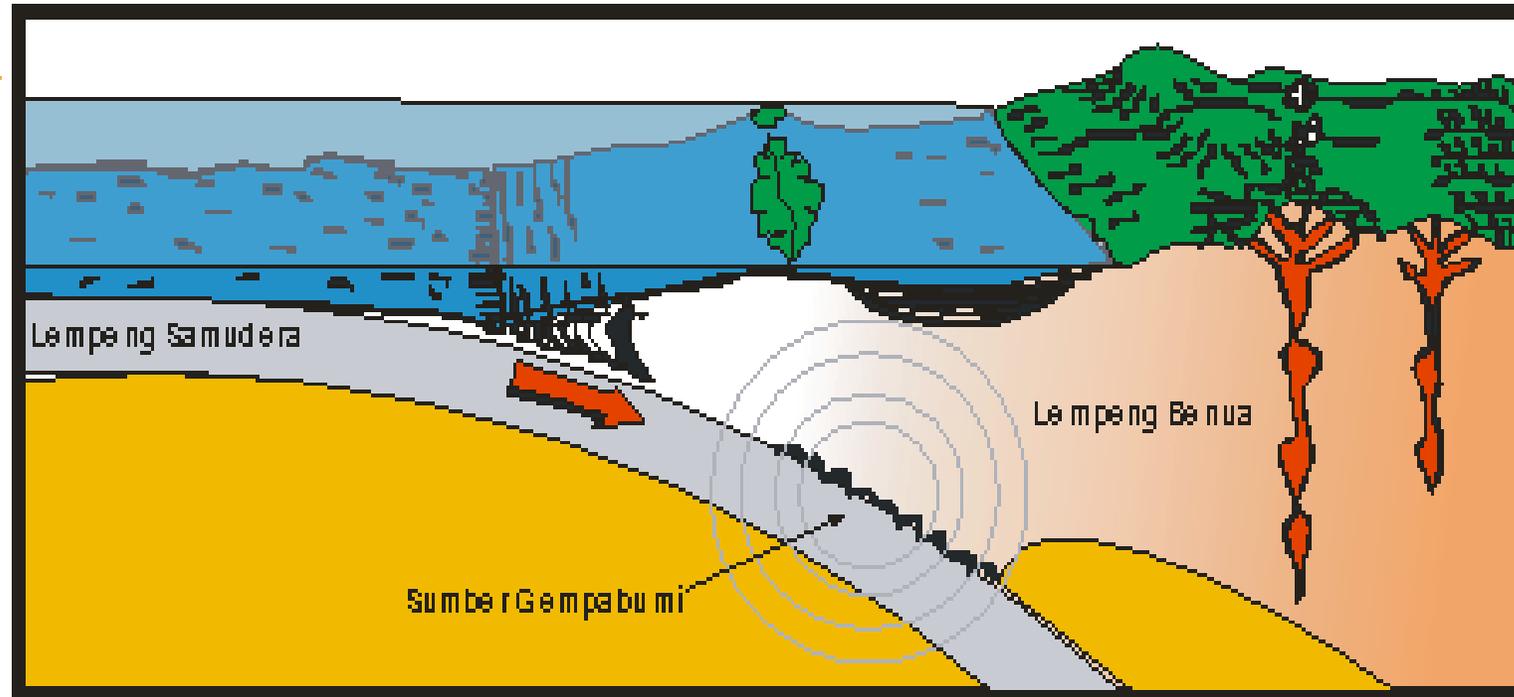
FENOMENA GEMPA DAN PENGARUHNYA PADA BANGUNAN GEDUNG

Oleh:

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**Fakultas Teknik - Universitas Islam Sultan Agung
(UNISSULA)**



Gempa bumi adalah getaran yang terjadi di permukaan bumi akibat pelepasan energi dari dalam bumi secara tiba-tiba yang menciptakan gelombang seismik. Gempa Bumi biasa disebabkan oleh pergerakan kerak Bumi (lempeng Bumi). Gempa Bumi diukur dengan menggunakan alat Seismometer.



PLAT TEKTONIK DAN ARAH PERGESERAN

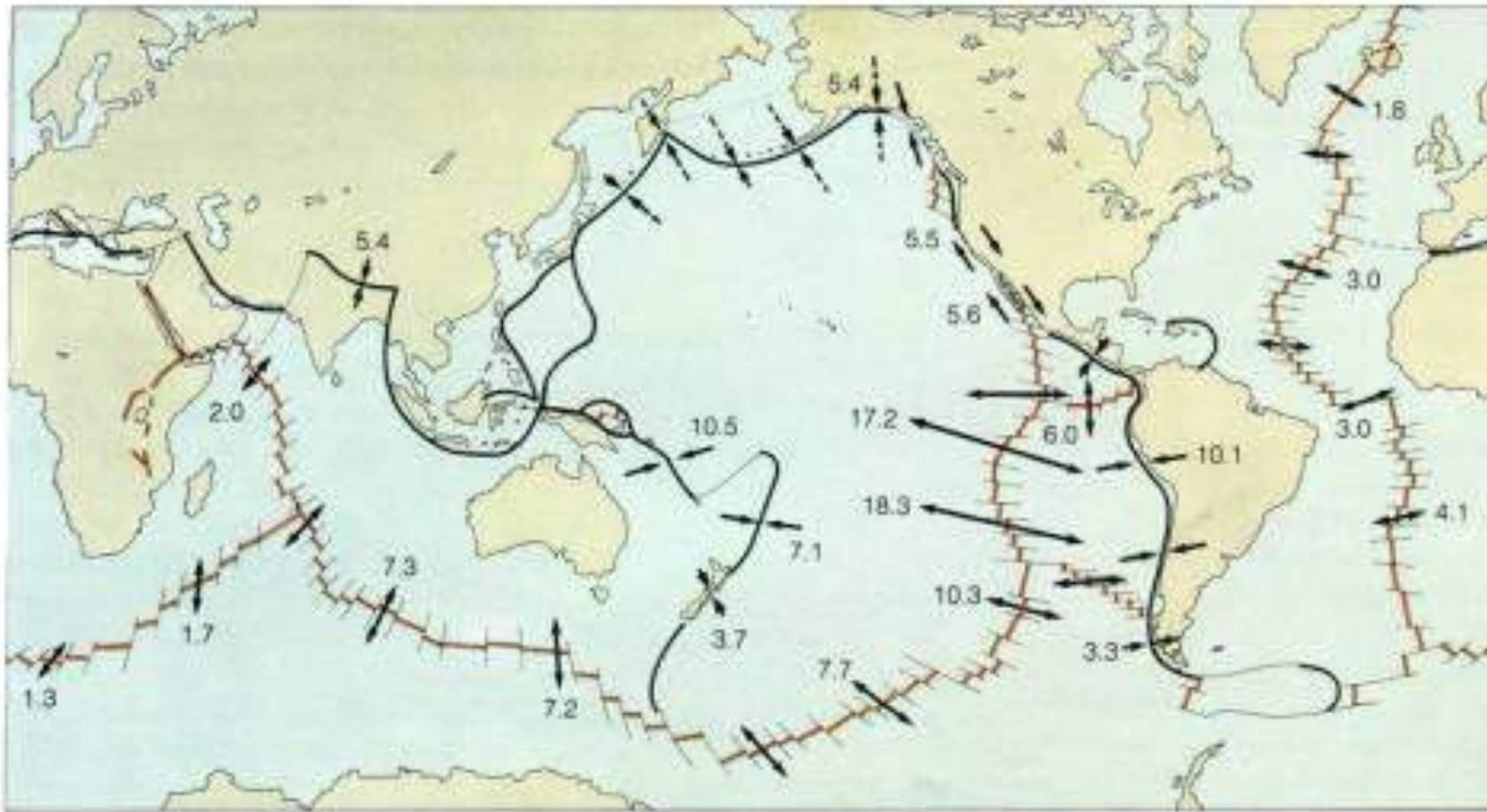
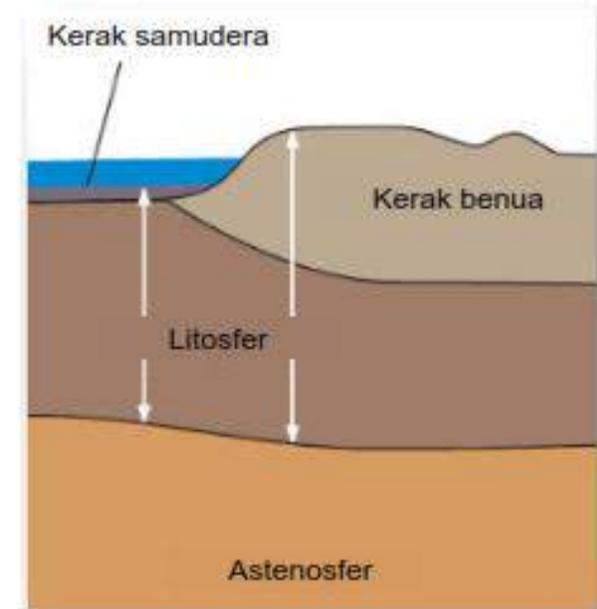


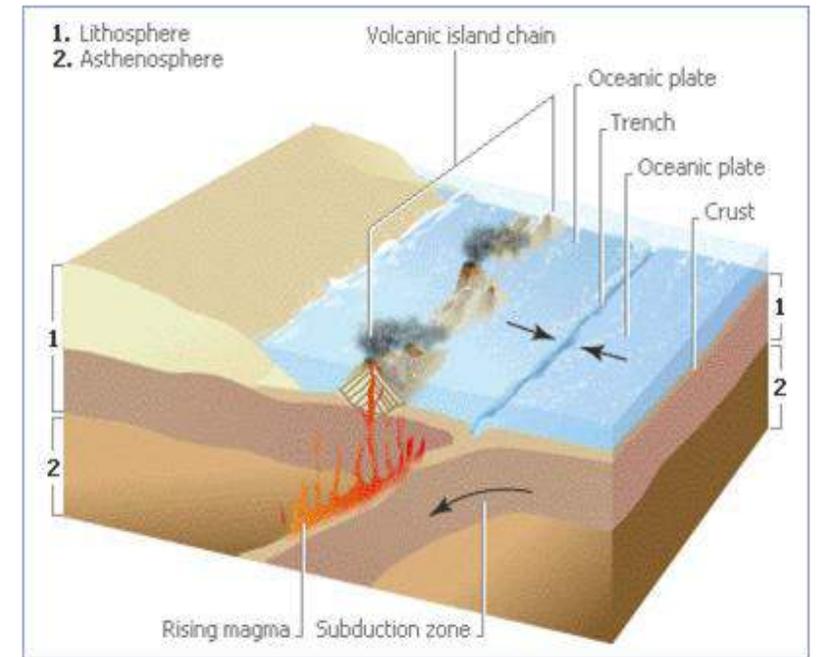
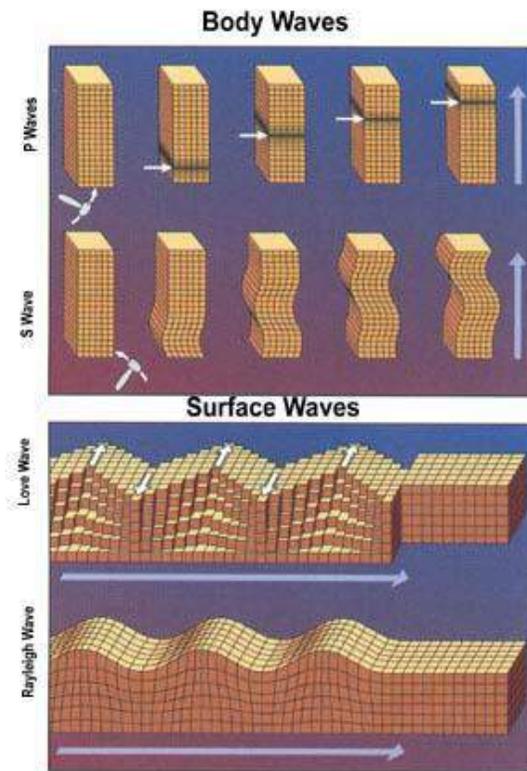
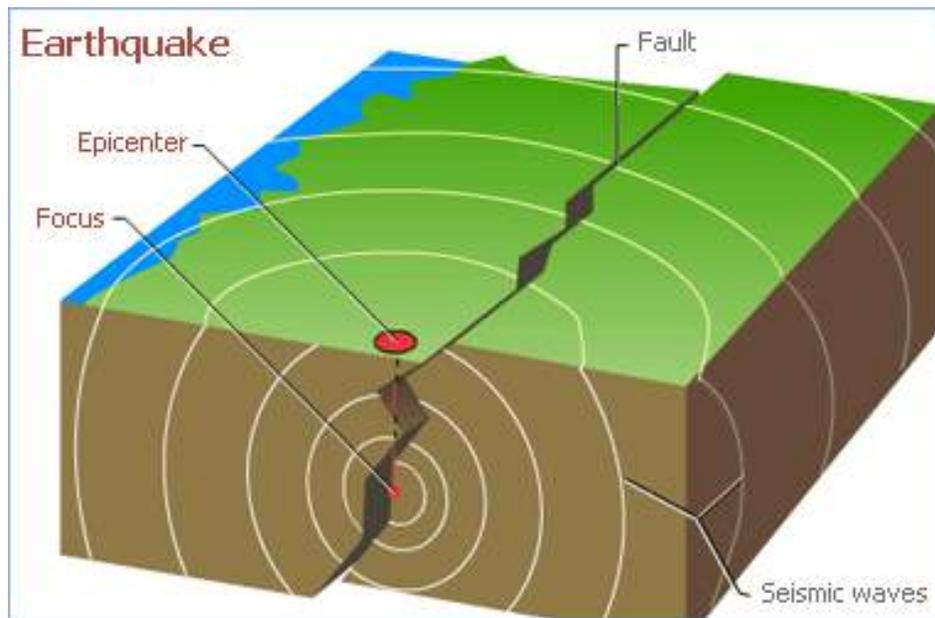
Figure 17.29

Relative velocities and directions of plate movement show how the major plates are presently interacting. The length of the arrows are proportional to the velocity of plate movement and the numbers represent velocity in centimeters per year.





GERAKAN PLAT TEKTONIK



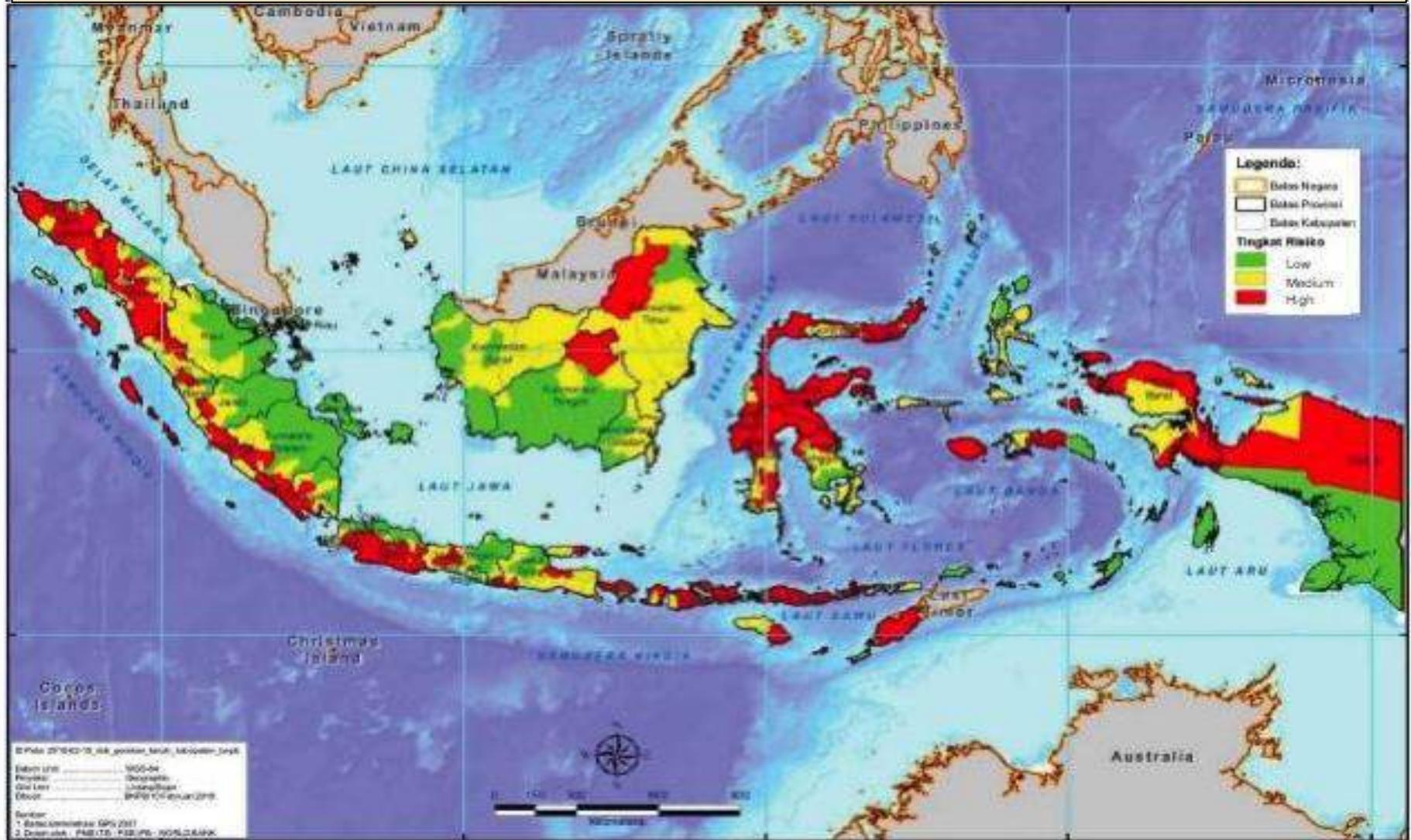


AKIBAT PERGESERAN PLAT





Indonesia's Flood Risk
Map of Indonesia's Landslide Risk



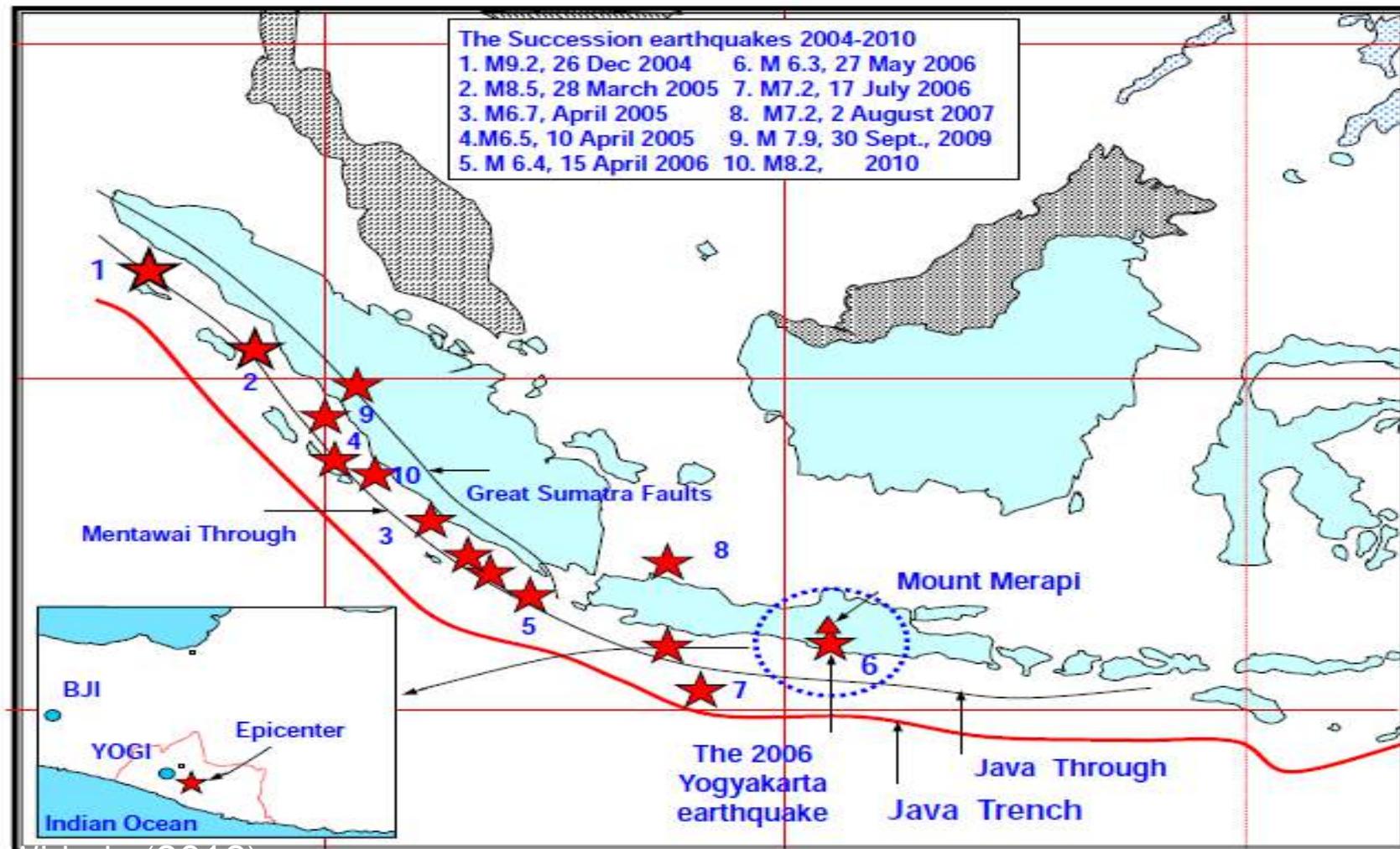
PEMETAAN KORBAN GEMPA DI INDONESIA

Sumber: Teguh (2016)

Antonius



PUSAT GEMPA DI INDONESIA TAHUN 2004-2010



Sumber: Teguh (2016)



CATATAN KORBAN BENCANA ALAM DI INDONESIA

DISASTER	LOCATION	VICTIMS
Earthquake and Tsunami	Aceh, December 26th 2004	186.983 died, 42.883 lost (United Nations)
Earthquake	Yogyakarta , May 27th 2006	> 6000 died
Earthquake	West Sumatera , September 30th 2009	6.234 died (SATKORLAK PB)
Earthquake and Landslide	Cianjur (West Java), September 2nd 2009	33 died
Flood	Wasior , October 4th 2010	158 died
Tsunami	Mentawai, October 25th 2010	286 died, 252 lost
Volcano eruption	Yogyakarta, November 5th 2010	275 died (BNPB)
Tornado	South Sulawesi, March 19th 2012	1 died
Earthquake	Aceh and Sumatra, April 11st 2012	4 died

Sumber: Teguh (2016)



KORBAN GEMPA YOGYAKARTA 2006 (6.3 RS)

COLLAPSED MULTI-STORY BUILDINGS



- DEAD : 5.048 people
- INJURED : 19.401 people
- HANDICAPPED :
permanently handicapped >
1500 people,
(296 people paralyzed)

6.3 RICHTER SCALE EARTHQUAKE

Sumber: Teguh
(2016)



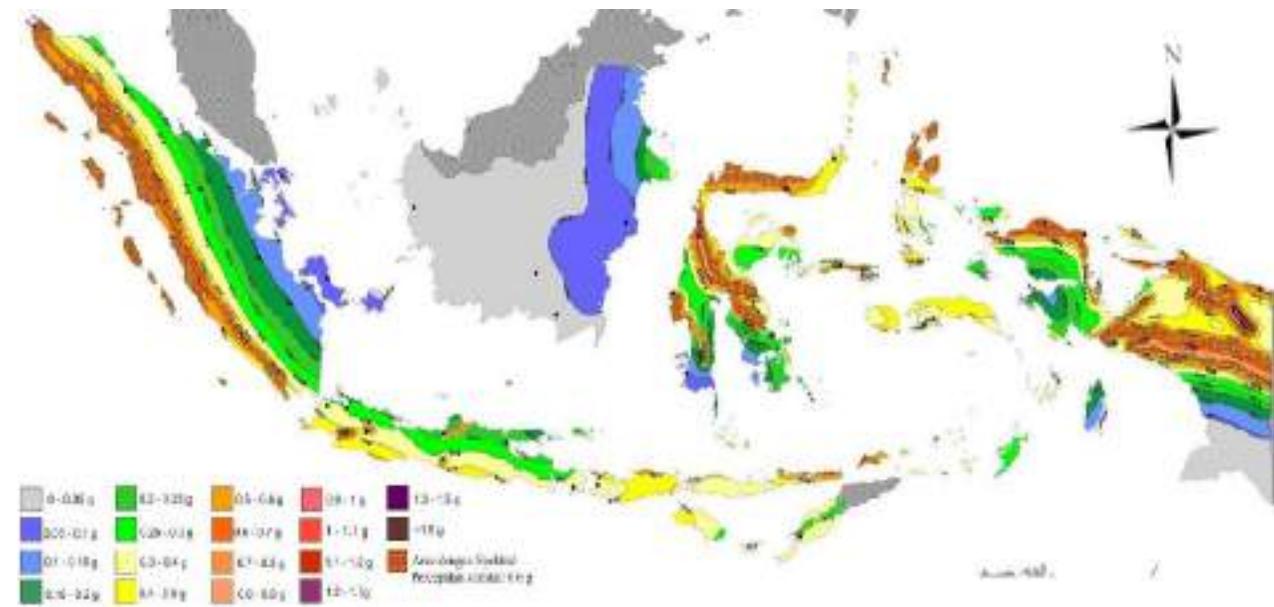
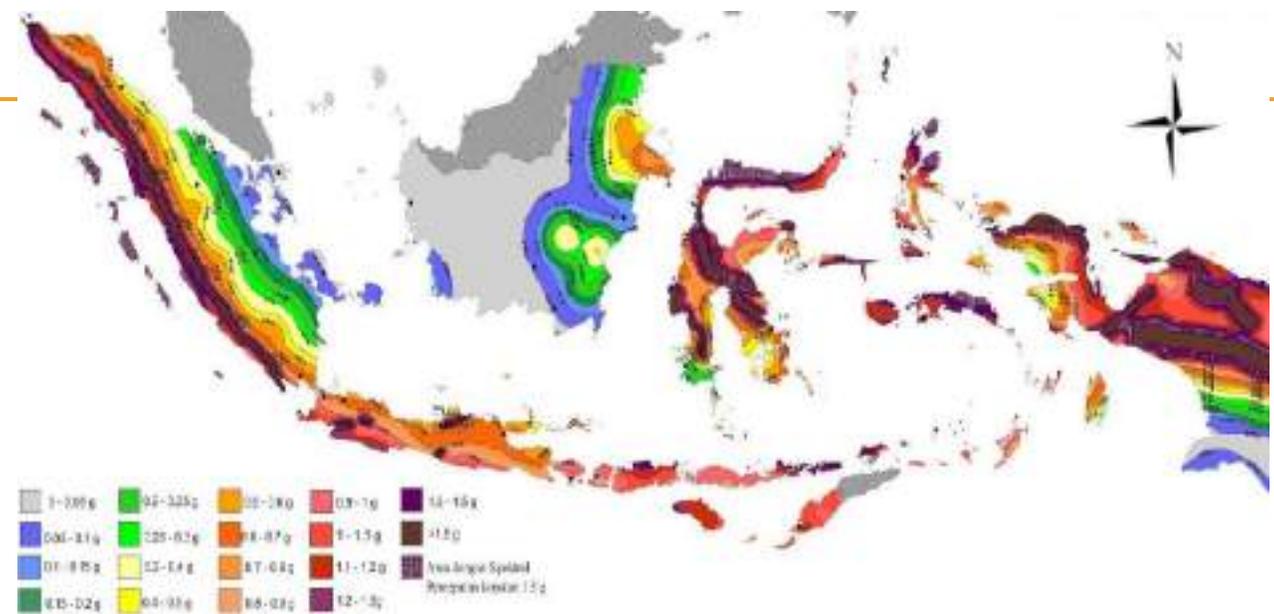
KORBAN YOGYAKARTA 2006



Sumber: Teguh
(2016)

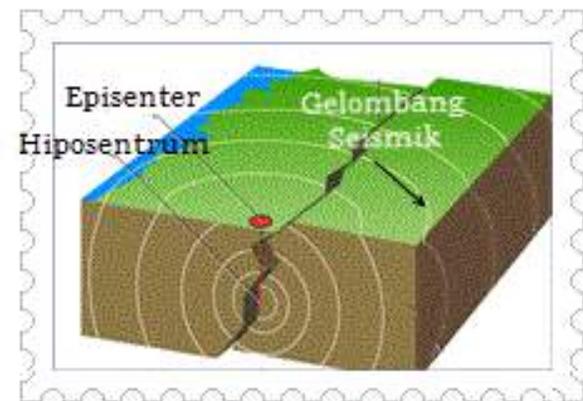
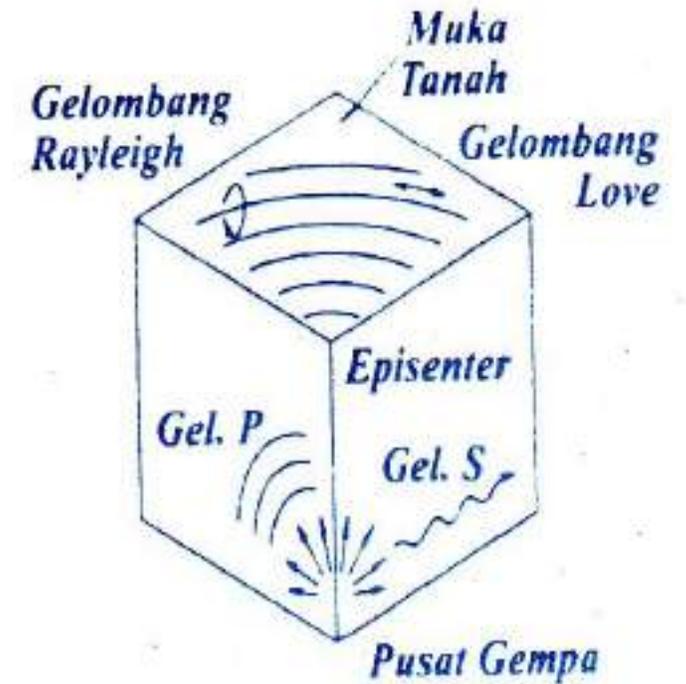


PETA GEMPA INDONESIA
2012



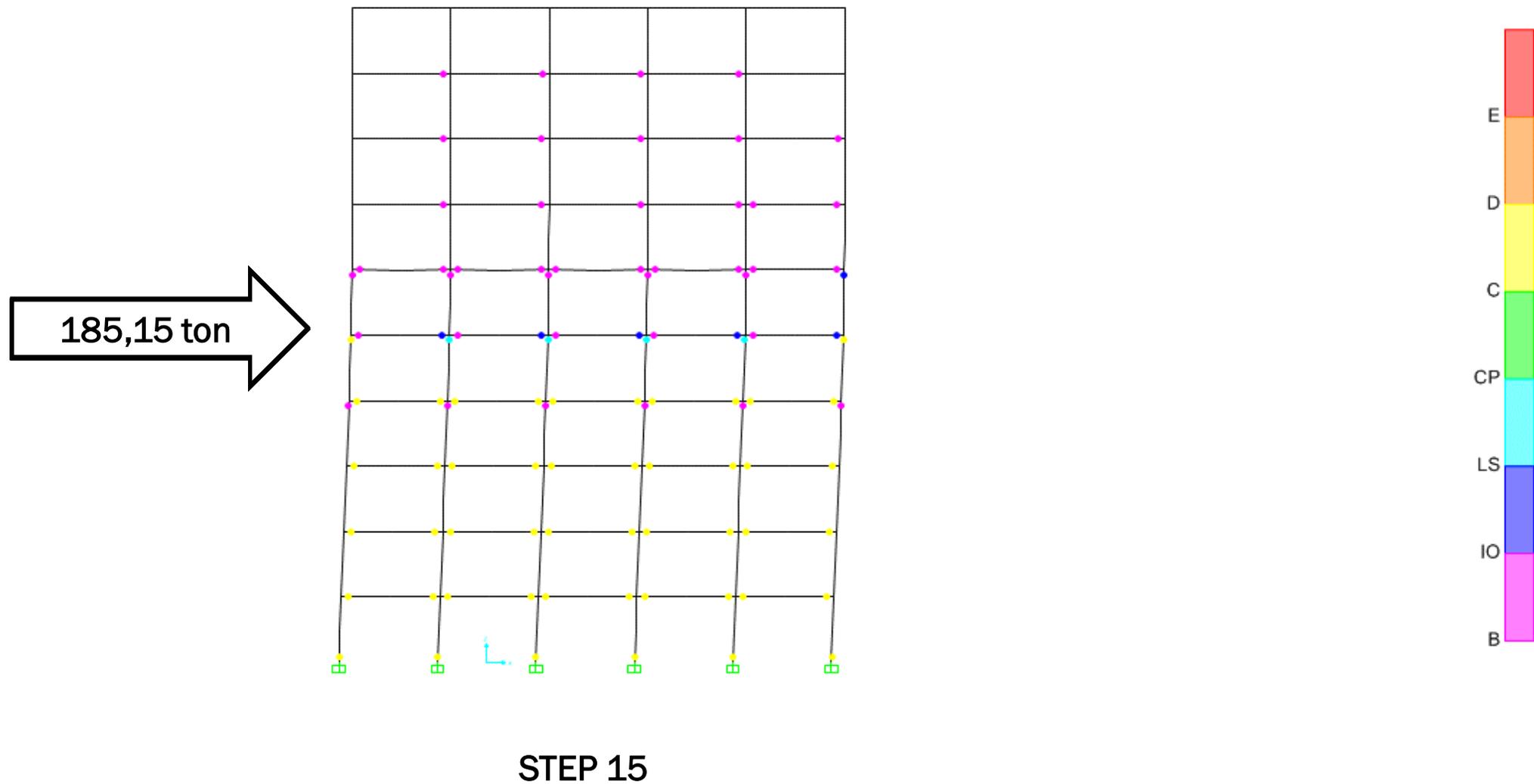


Pemencaran Gelombang Gempa



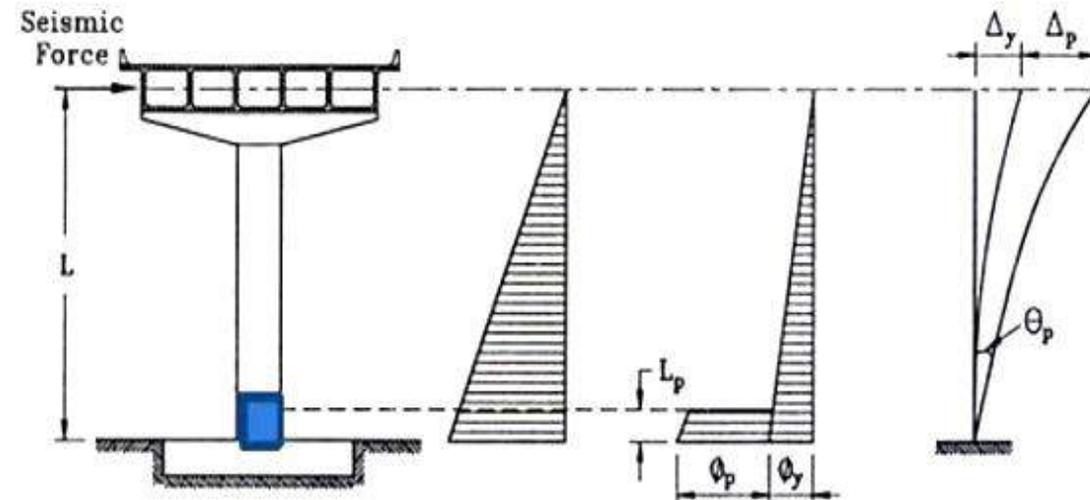


PENGARUH GEMPA PADA GEDUNG





PENGARUH GEMPA PADA PILAR JEMBATAN





TUJUAN PERENCANAAN STRUKTUR

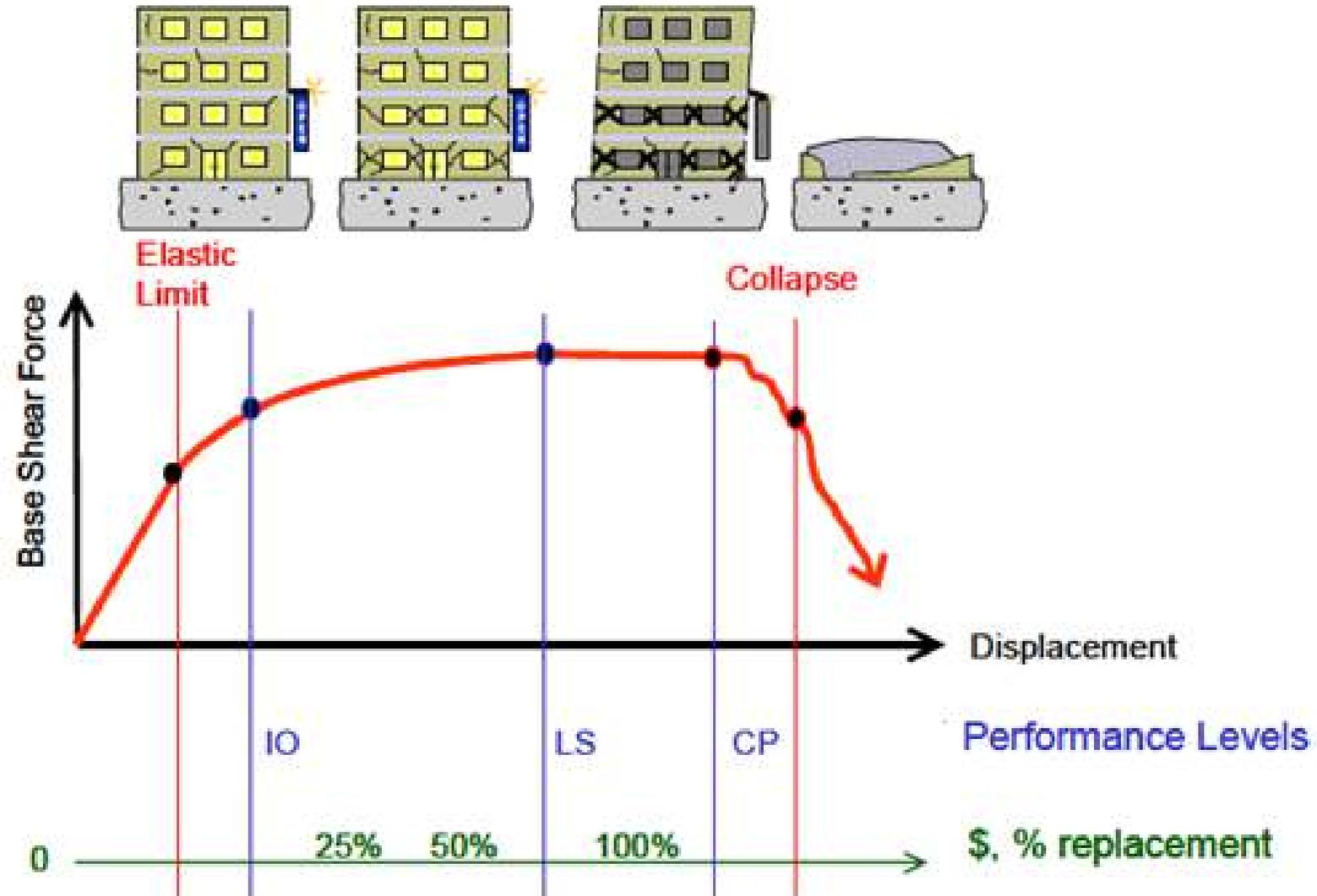
- a) Kuat  strength  Ultimit capacity
- b) Kaku  serviceability  Deflection, kekangan, beban dll
- c) Daktail  survival  Tahan gempa, deformability
- d) Stabil  geometri  Secondary effect

Sistem LRFD:

$$\phi M_n \geq M_u$$
$$\phi P_n \geq P_u$$
$$\phi V_n \geq V_u$$



LEVEL KINERJA GEDUNG





DINAMIKA STRUKTUR

Modus getar 1



Modus getar 2



Modus getar 3

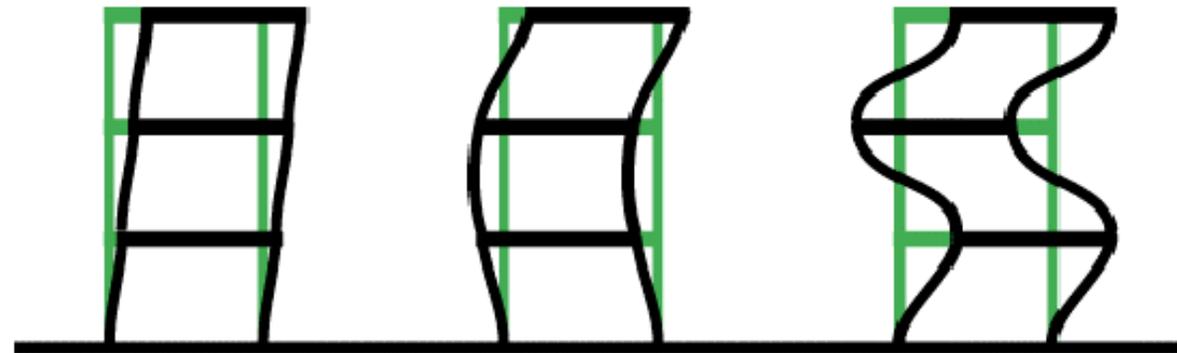




MODE GETAR

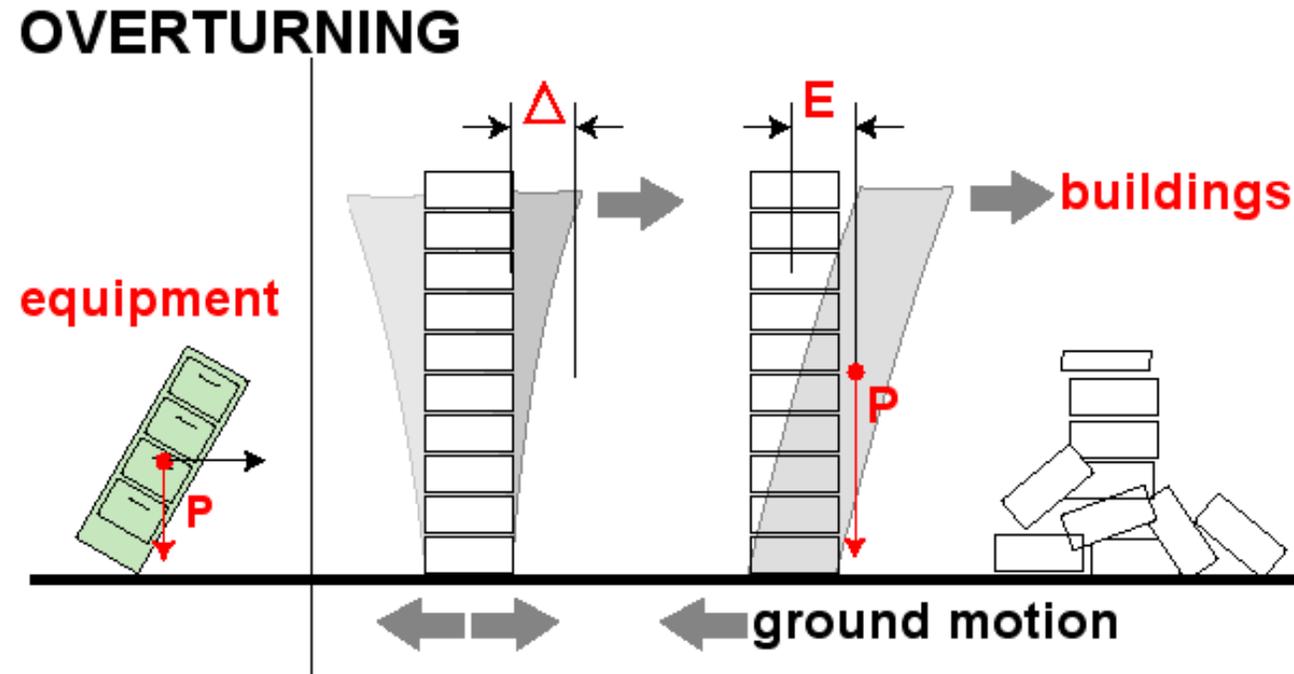
MODES OF VIBRATION

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



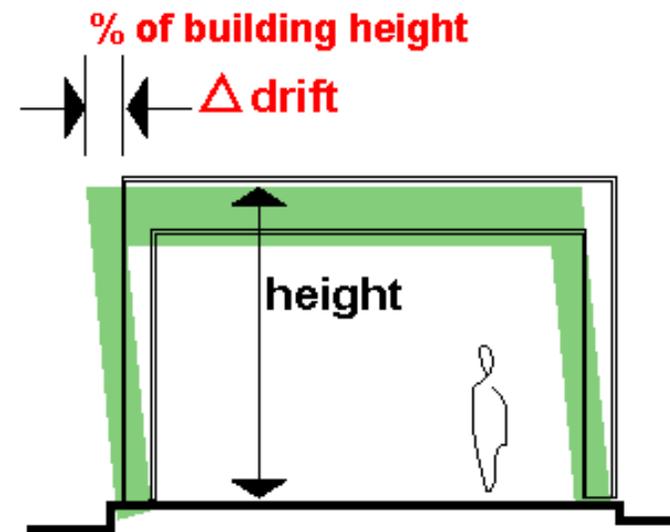
Bangunan jarang mengalami overturning, tapi mengalami keruntuhan total atau sebagian seperti pancake



DRIFT DAN DEFORMASI

DRIFT and DEFORMATION

story drift ratio



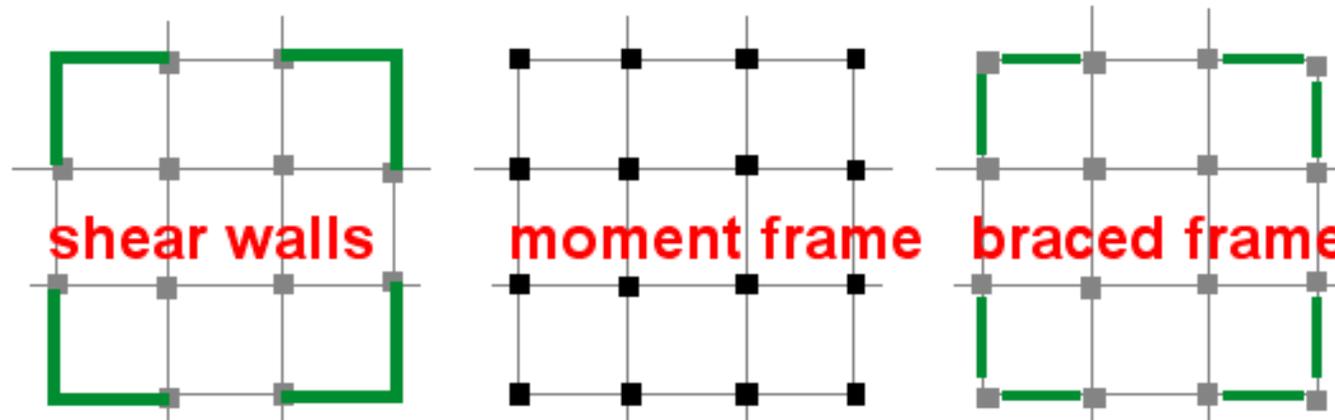


SISTEM STRUKTUR TAHAN GEMPA



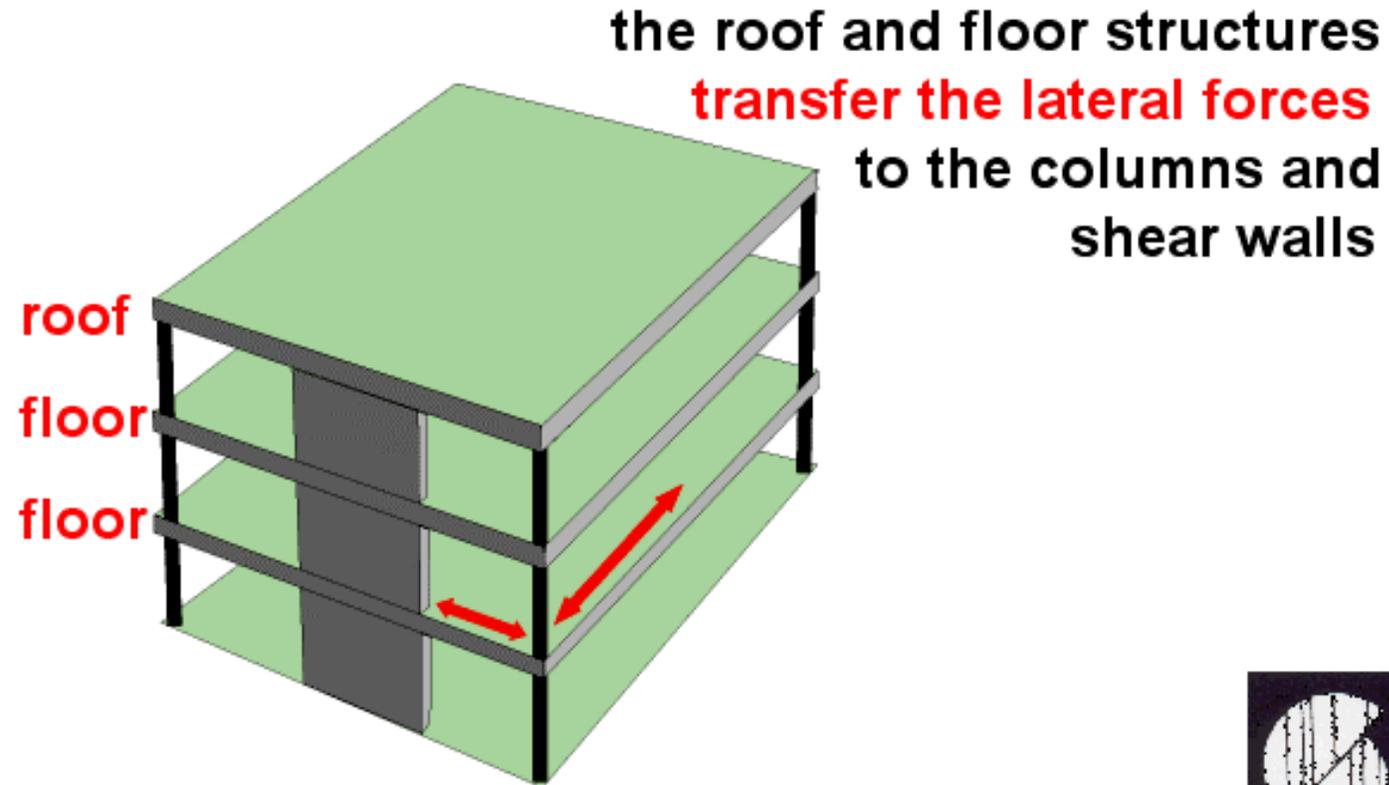
SISTEM STRUKTUR DASAR

LATERAL FORCE RESISTING SYSTEMS basic types





DIAFRAGMA





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.

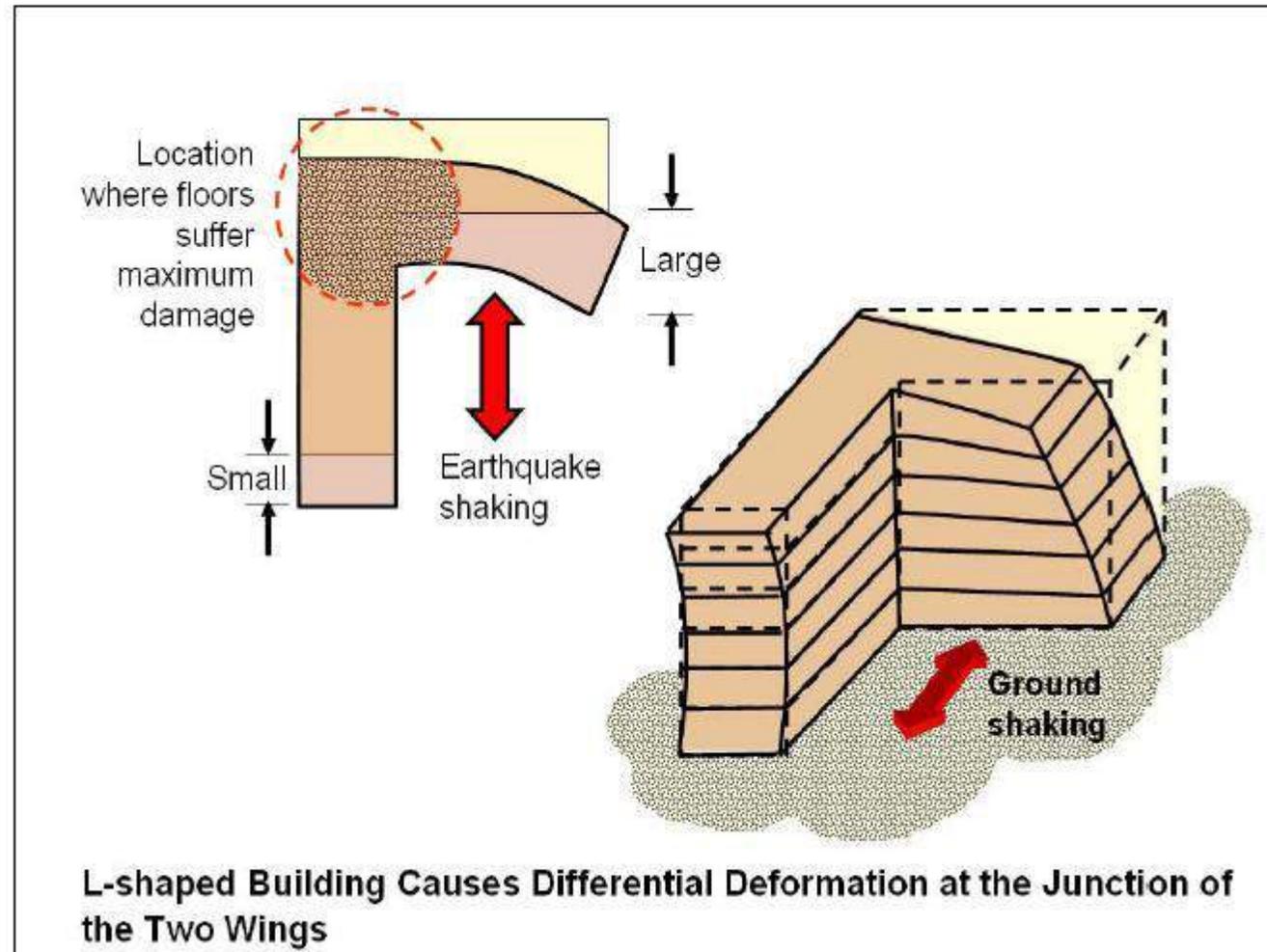


KARAKTERISTIK STRUKTUR YANG MENGHASILKAN PERILAKU YANG KURANG BAIK

- ✘ 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



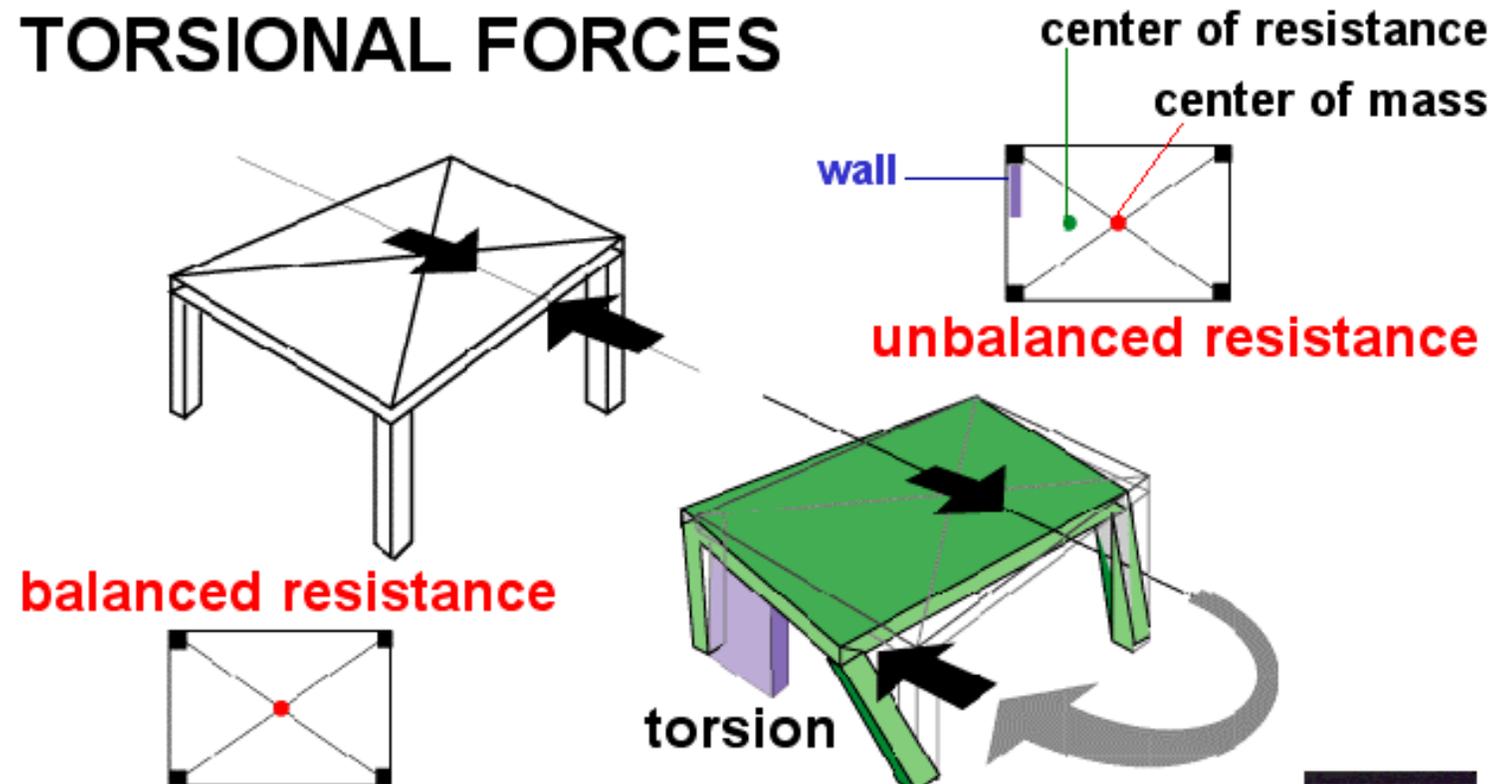
TORSI DAN KONSENTRASI TEGANGAN





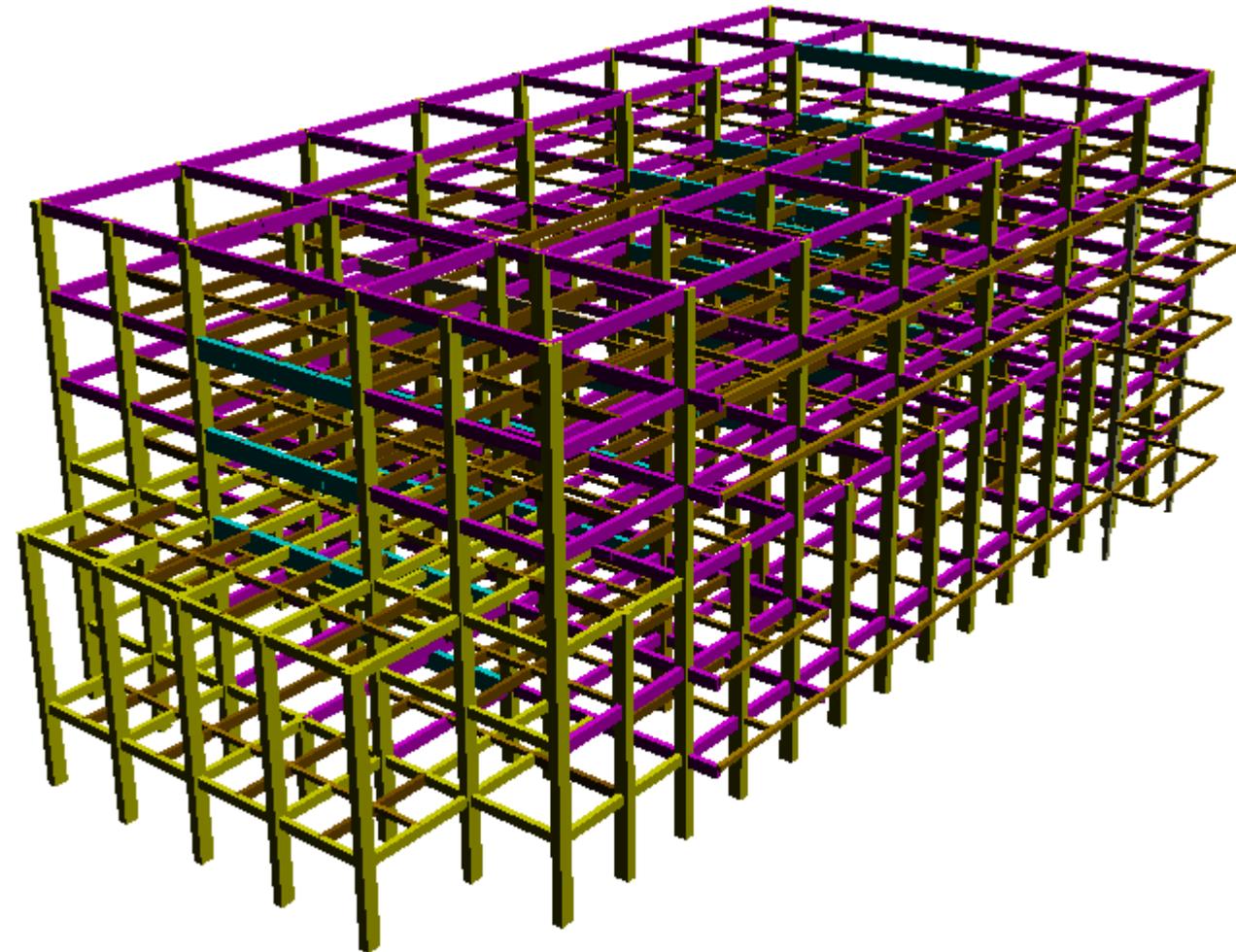
EKSENTRISITAS

TORSIONAL FORCES



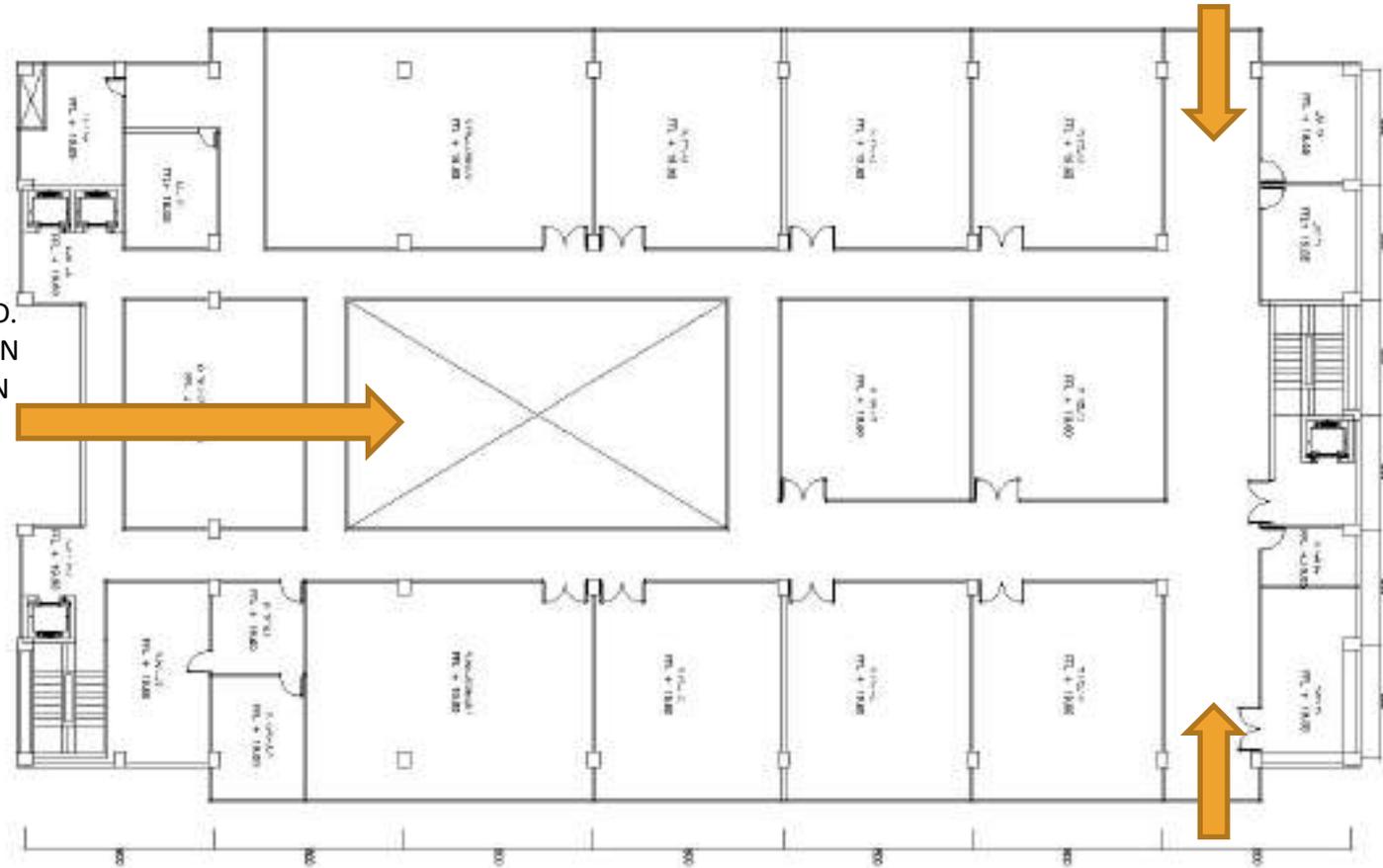


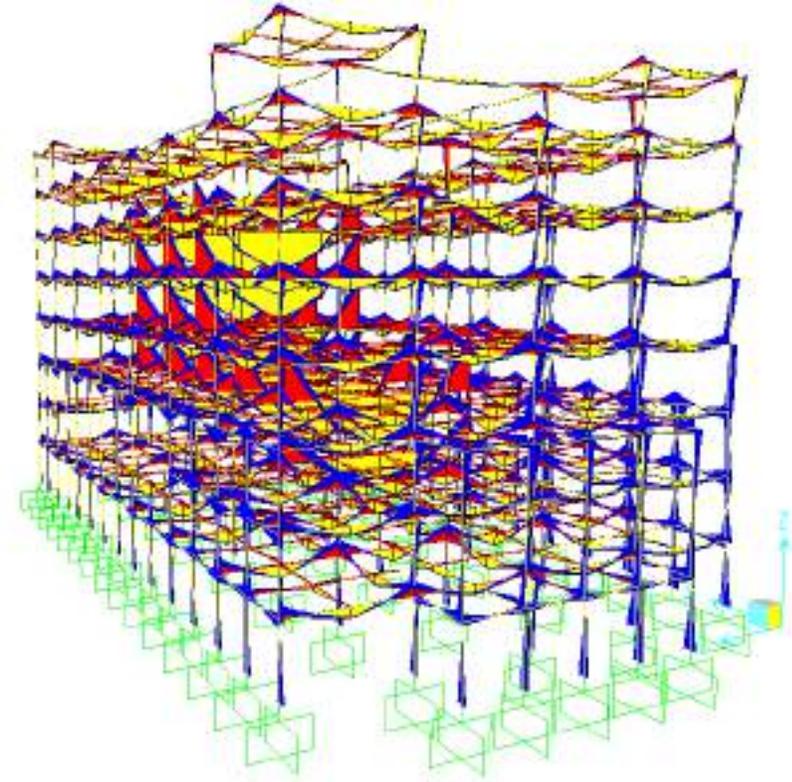
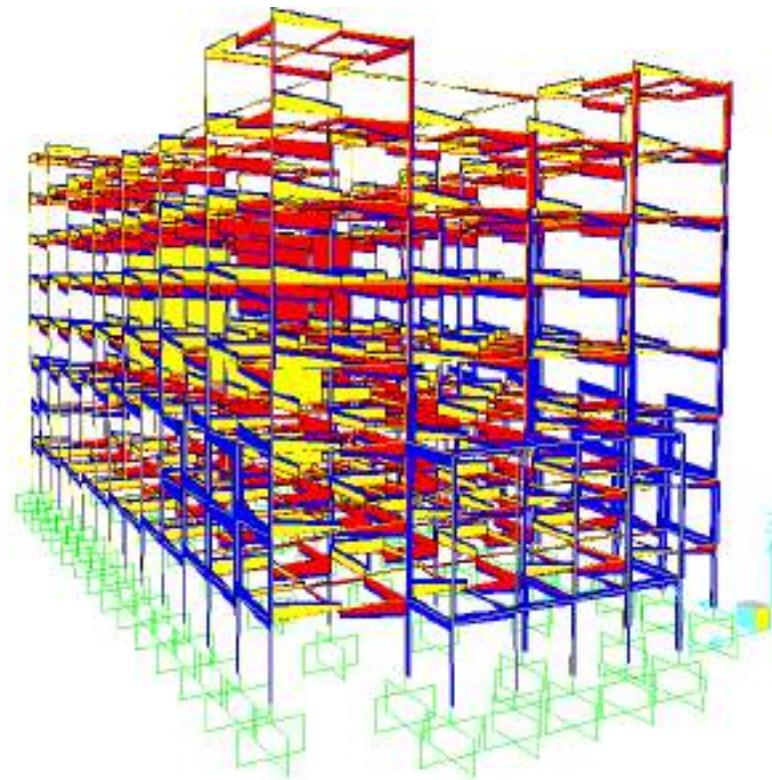
CONTOH SISTEM STRUKTUR BETON TAHAN GEMPA **SISTEM RANGKA PEMIKUL MOMEN**

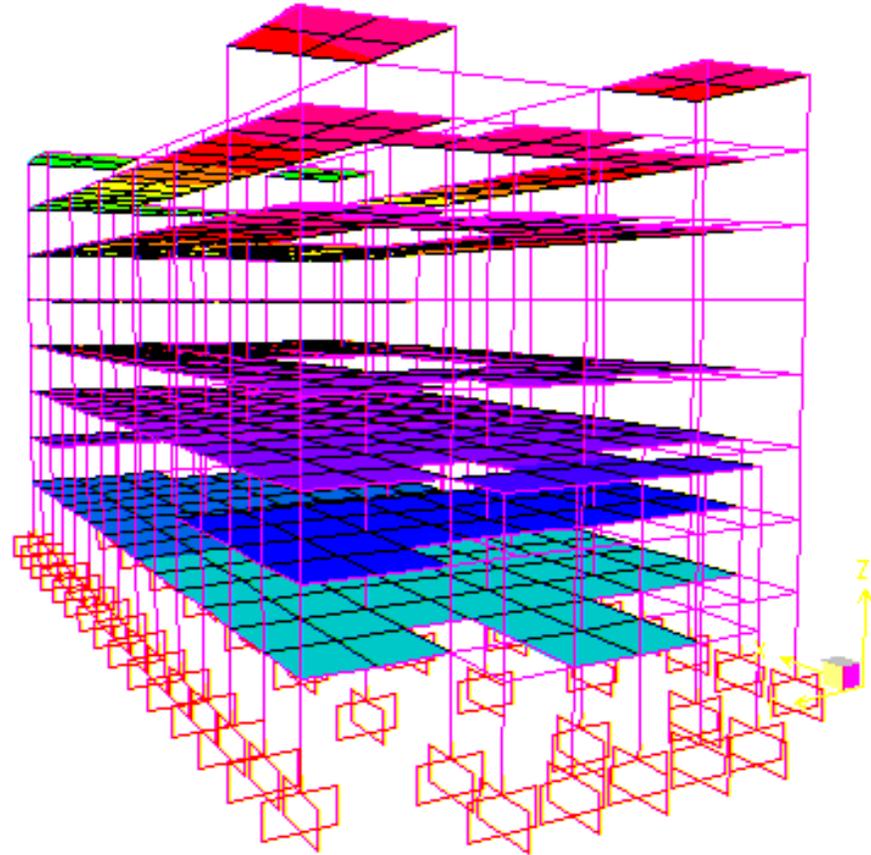




ADA VOID DAN BID.
BUKAAN DI BAGIAN
MUKA BANGUNAN
SBG CROSS
VENTILATION,
PENYEBAR
PENCAHAYAAN
ALAMI









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Dinas Pekerjaan Umum Bina Marga dan Cipta Karya, Provinsi Jawa Tengah, 18 Mei 2017*





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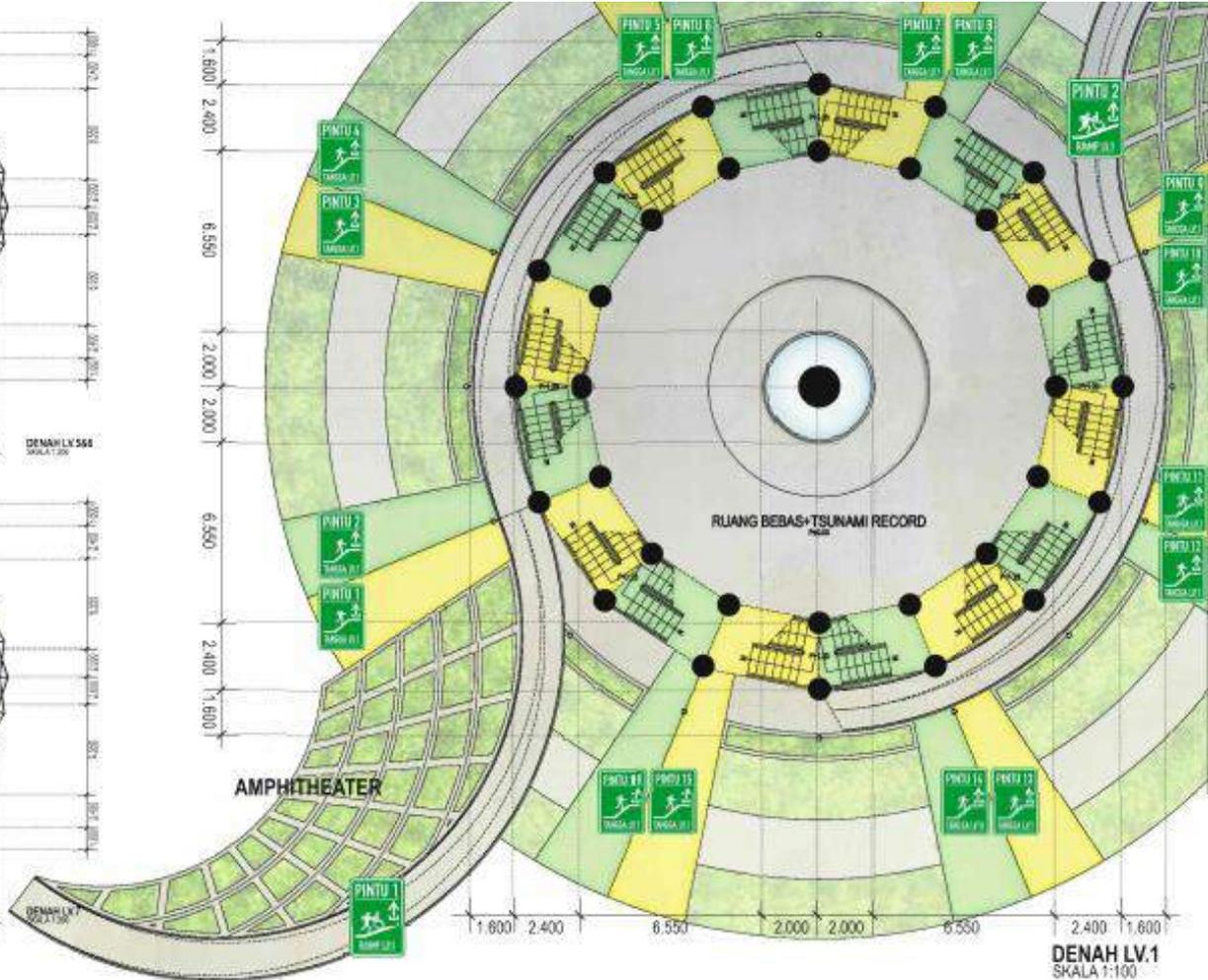
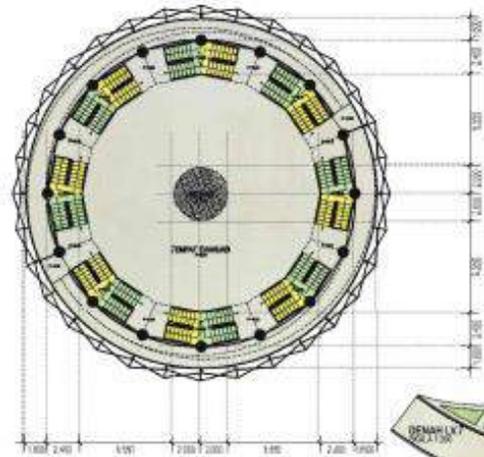
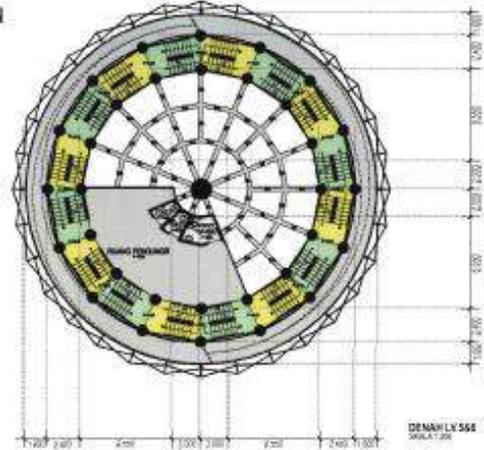




Sosialisasi Bangunan Tahan Gempa dan Greenbuilding

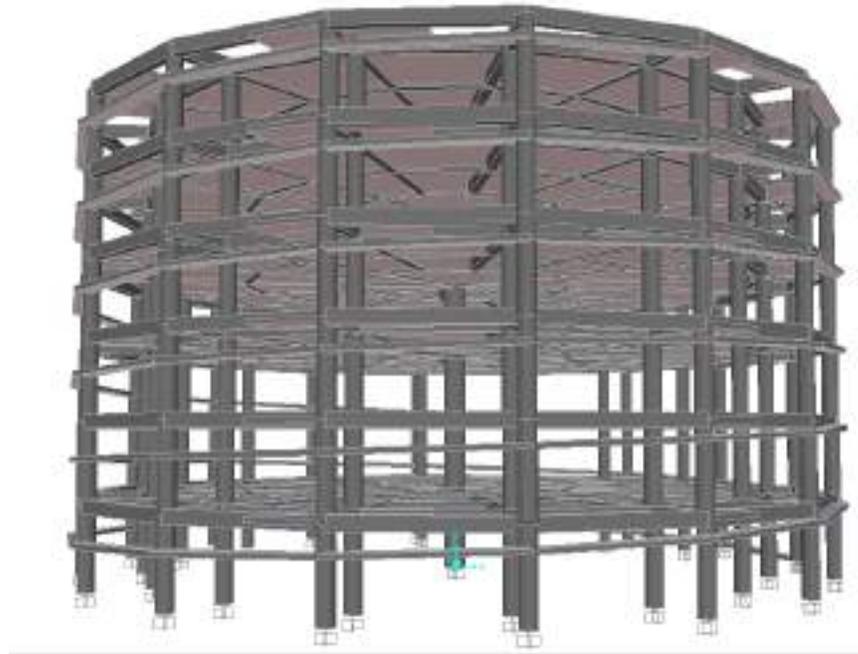
Dinas Pekerjaan Umum Bina Marga dan Cipta Karya, Provinsi Jawa Tengah, 18 Mei 2017

DENAH
LAYOUT PLAN

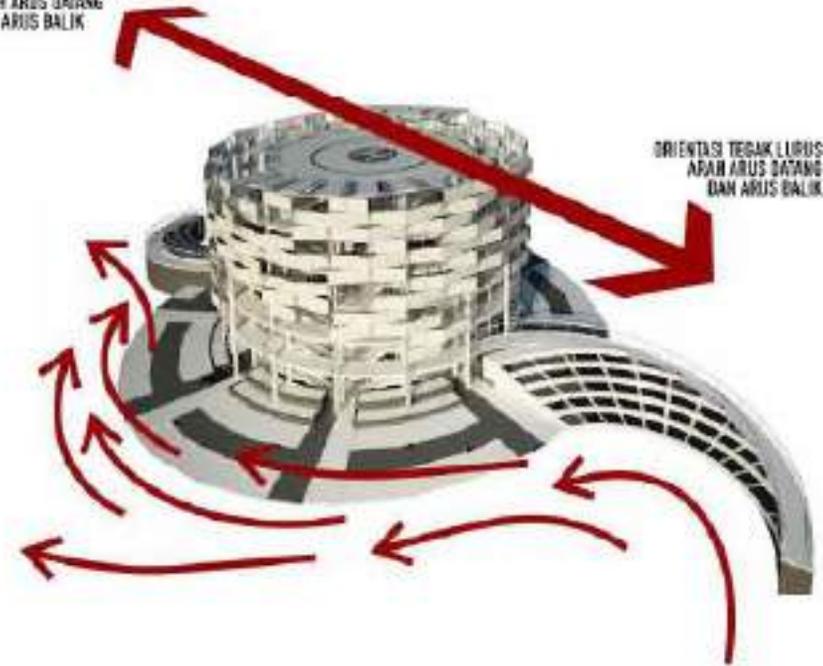




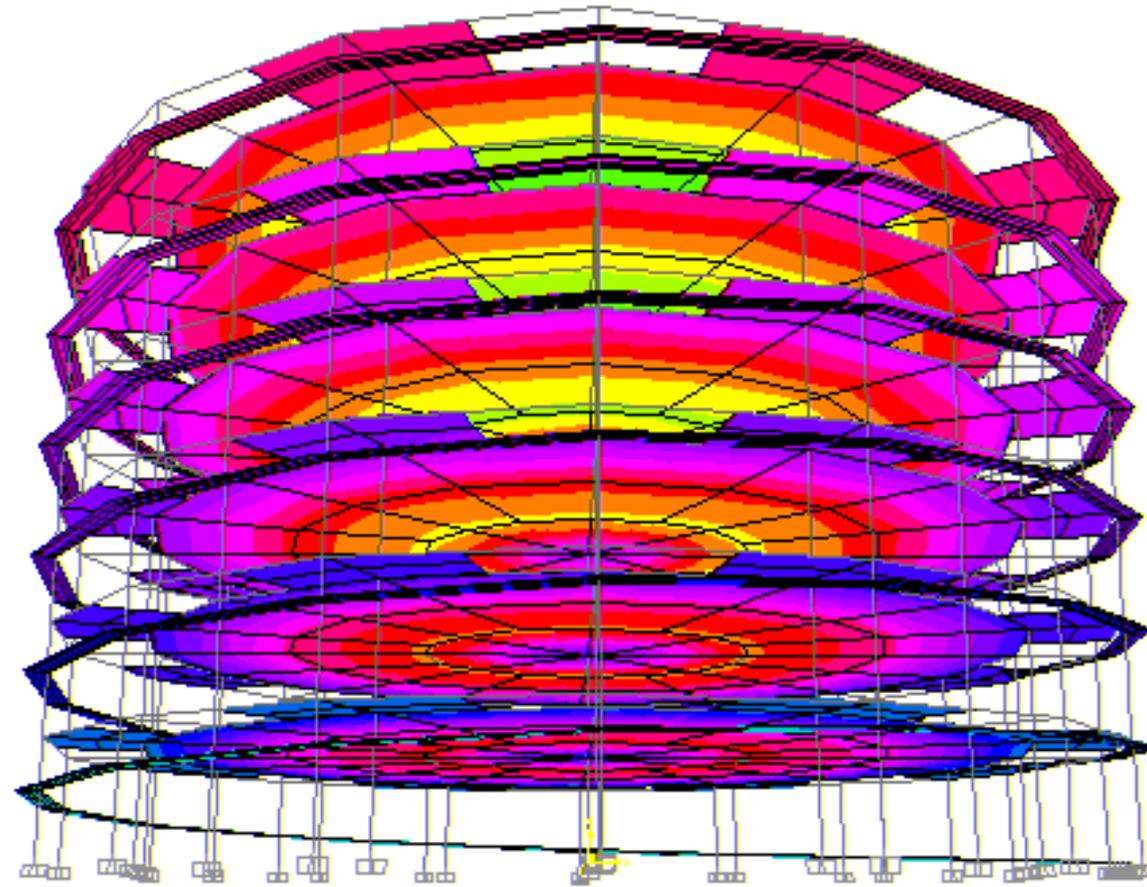
IDEALISASI SISTEM STRUKTUR



ORIENTASI TEGAK LURUS
ARAH ARUS DATANG
DAN ARUS BALIK



ORIENTASI TEGAK LURUS
ARAH ARUS DATANG
DAN ARUS BALIK





CONTOH SISTEM STRUKTUR BAJA TAHAN GEMPA

The advertisement features a large photograph of a steel structure under construction. The structure consists of a grid of vertical columns and horizontal beams, with a complex roof system. A small airplane is visible in the sky above the structure. The background is a clear blue sky.

Logo: Foshan City Nanhai District Guanhui Mechanical & Electric Equipment Industry Co., Ltd.

ISO 9001:2008 BUREAU VERITAS

on-site install guidance available ■ ■ ■ ■ ■



SOFT STOREY

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

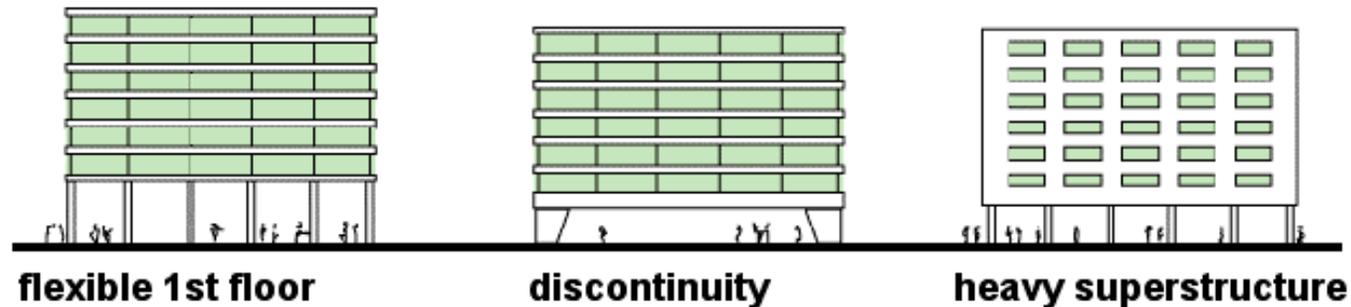
Definisi struktur gedung tak beraturan adalah terdapat sistem struktur tingkatan lunak (*soft storey*) dalam arah vertikal. Dalam arah tersebut, sistem struktur menurut kedua standar tersebut di atas, *soft storey* didefinisikan sebagai suatu tingkat dimana kekakuan lateralnya kurang dari 70 persen kekakuan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



SOFT STORY

STRESS CONCENTRATIONS

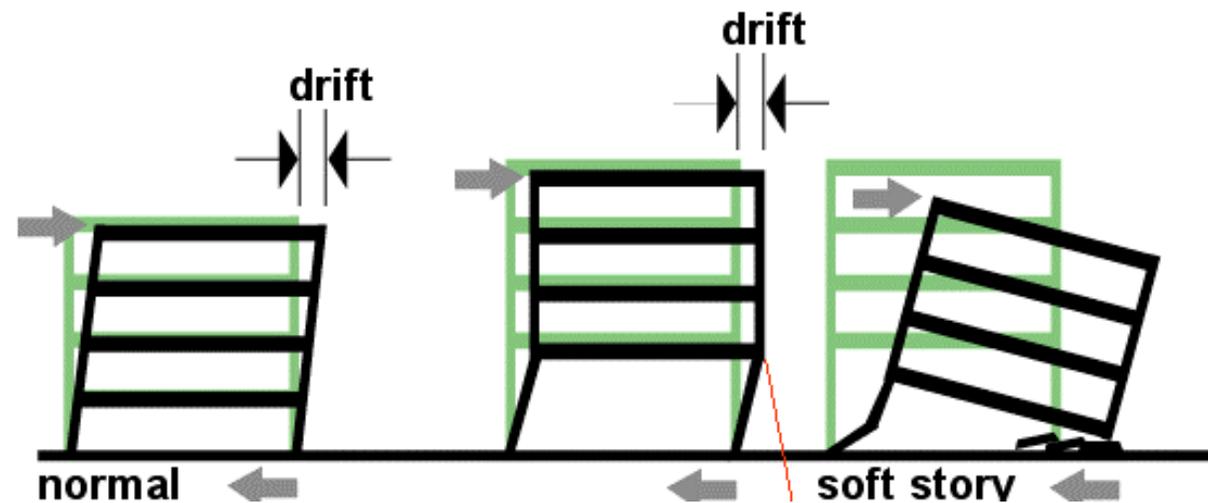
The most serious condition of vertical irregularity is the **soft or weak story**, in which one story, usually the first with **taller, fewer columns**, is significantly weaker or more flexible than the stories above.





KERUNTUHAN SOFT STORY

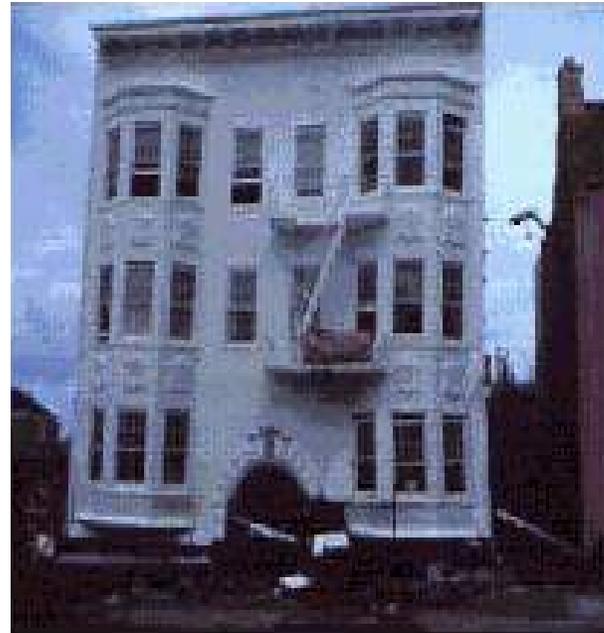
STRESS CONCENTRATIONS the soft story collapse mechanism





CONTOH KERUNTUHAN SOFT STORY

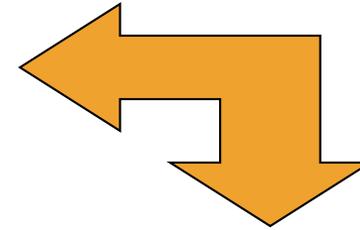
soft stories





KEGAGALAN STRUKTUR AKIBAT EFEK SOFT-STOREY

Gempa Padang 2009

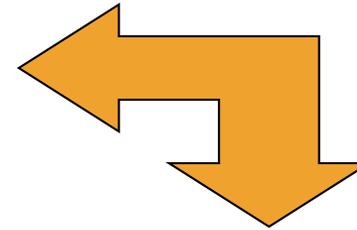




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Gempa Padang 2009

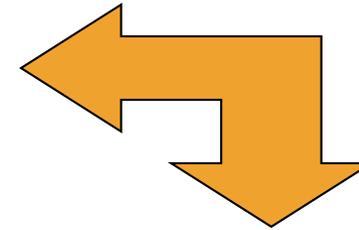




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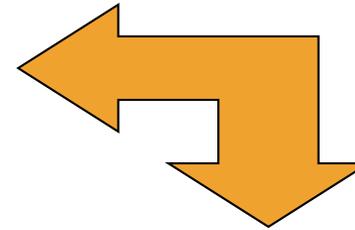


Gempa Aceh 2004





Gempa Nias 2009

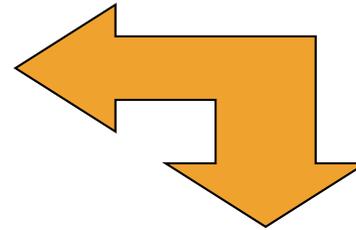




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Gempa Jogja 2006





Gempa Chili





Gempa di Cina (1999)



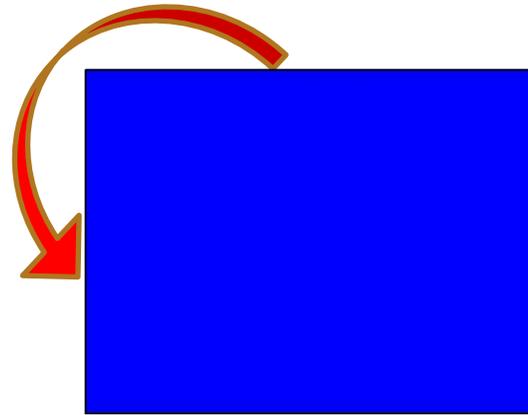


Gempa di India

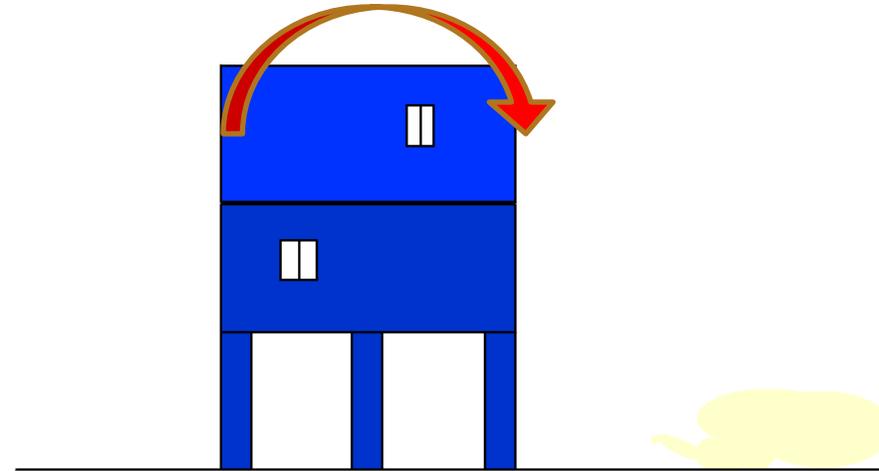




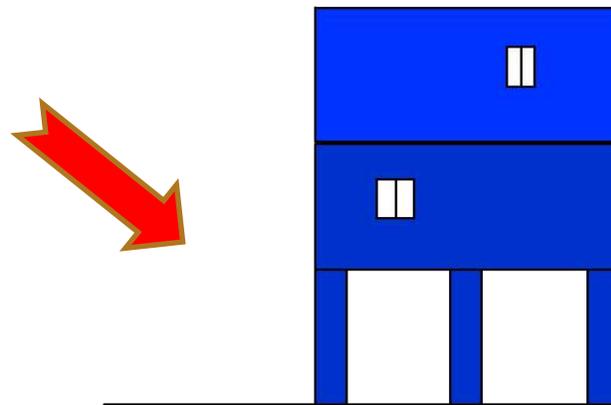
Mekanisme keruntuhan gedung dengan soft-storey



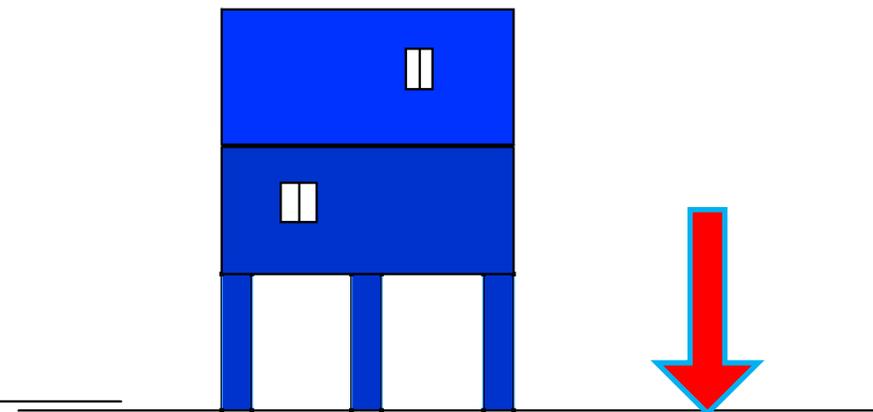
Memutar (Rotation)



Guling (Overtuning)



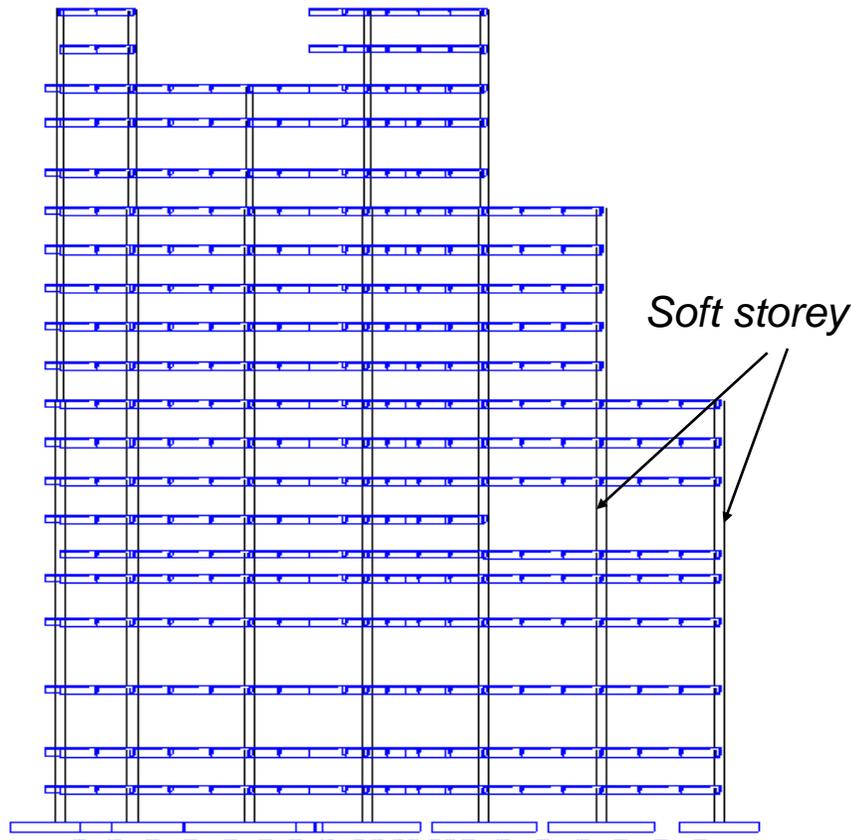
Collapse
(Softstory effect)



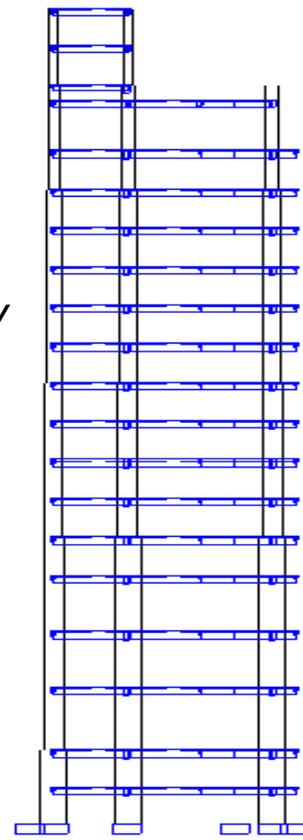
Amblas
(Liquifaction)



Struktur Bangunan Tinggi dengan Soft-Storey



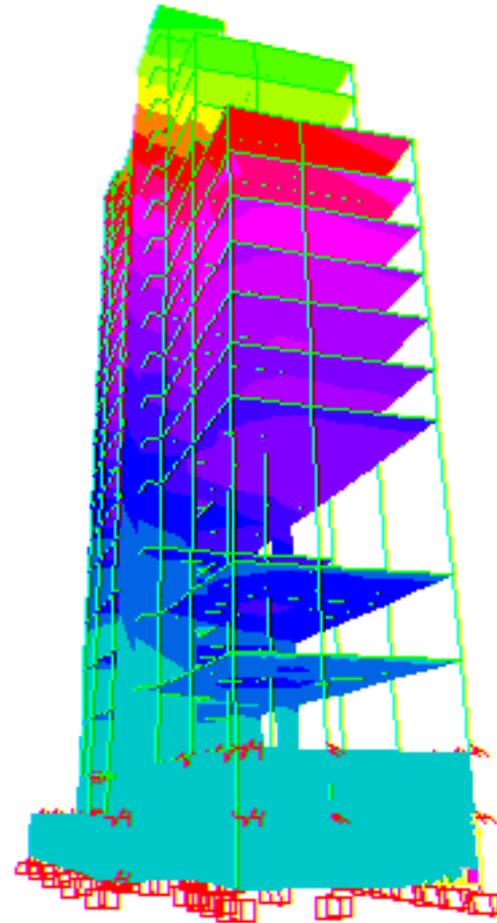
Arah z



Arah y



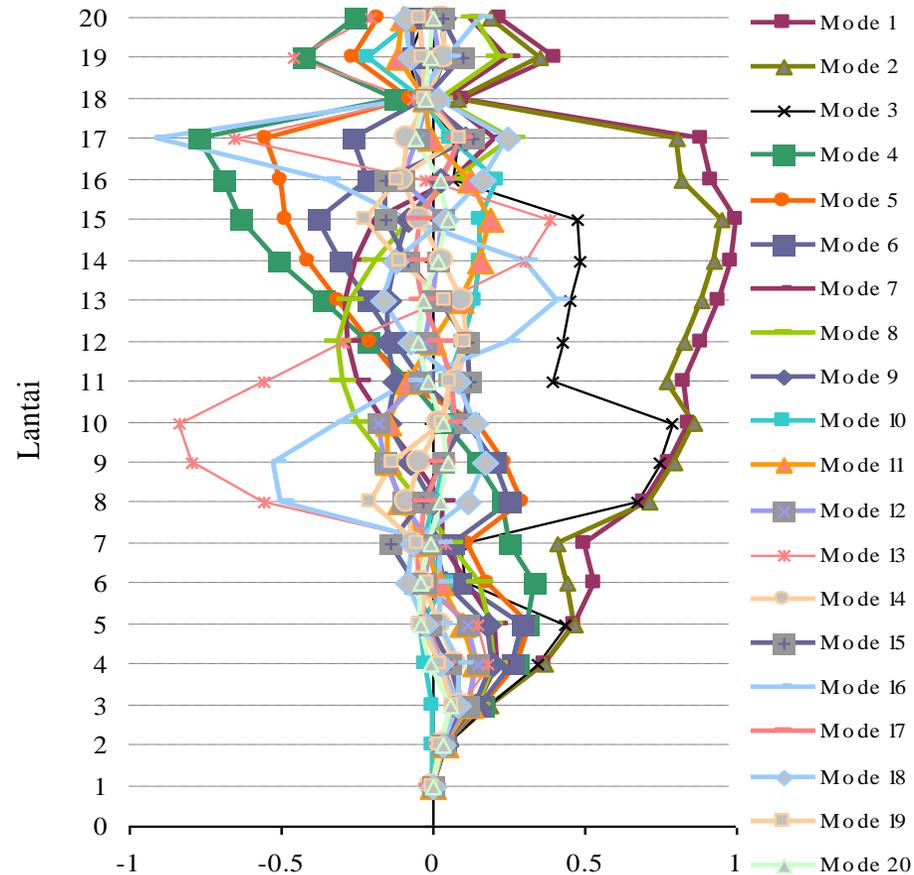
Isometri



MODUS GETAR STRUKTUR DENGAN SOFT STOREY



MODUS GETAR

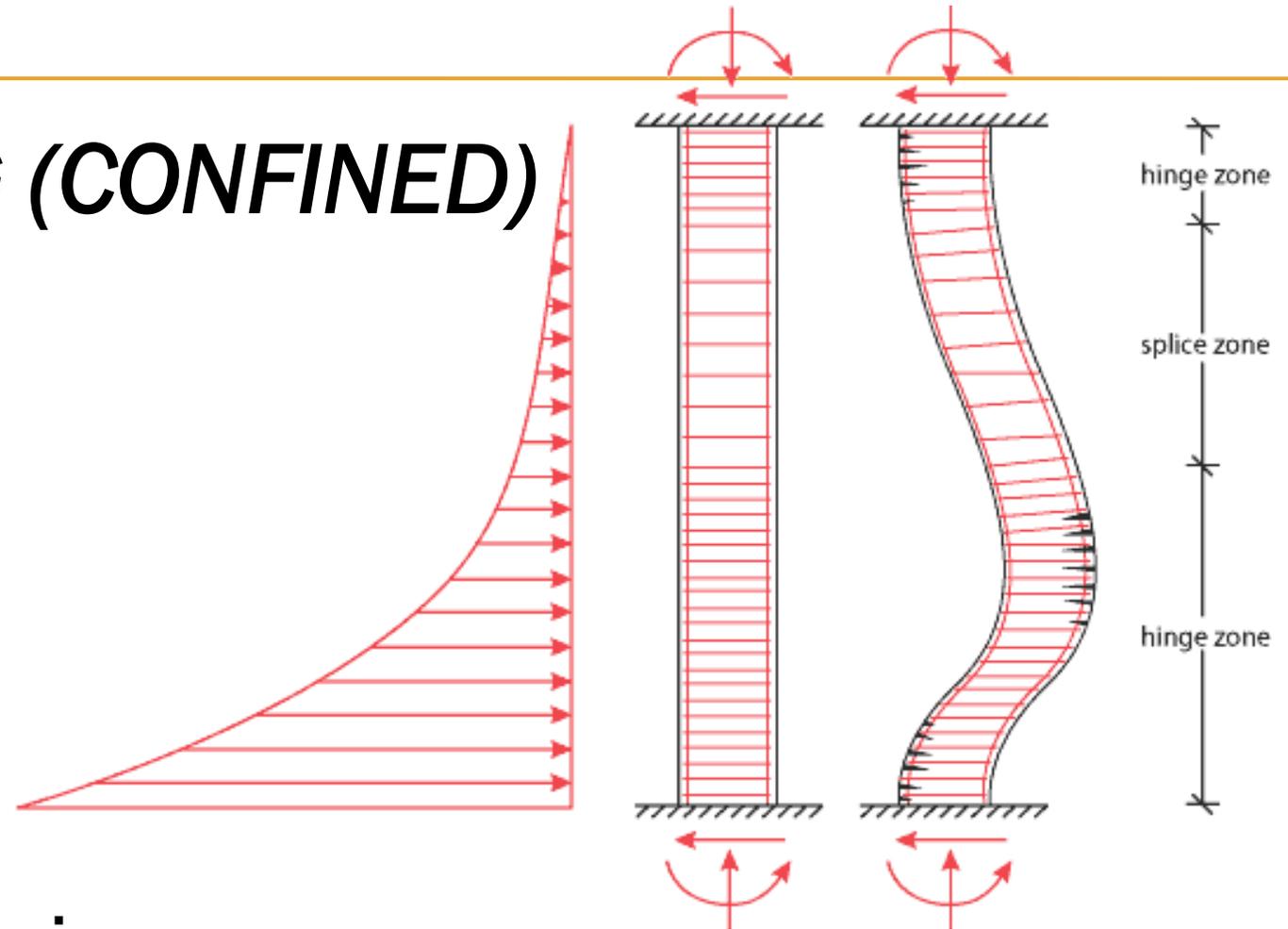


Struktur gedung dengan *soft storey*



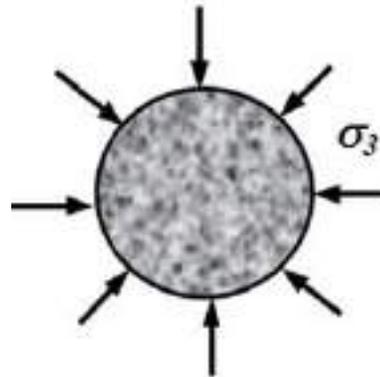
TULANGAN PENGEKANG (CONFINED)

- Mencegah buckling tulangan longitudinal
- Mencegah keruntuhan geser
- Mengekang inti beton hingga beton mengalami deformasi yang signifikan

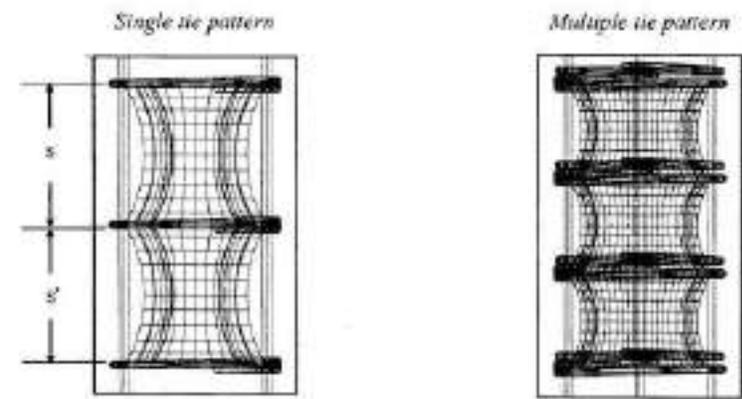
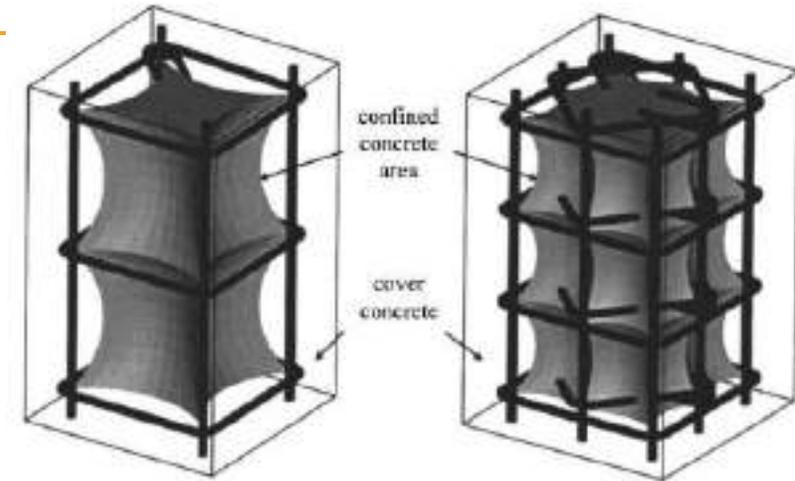




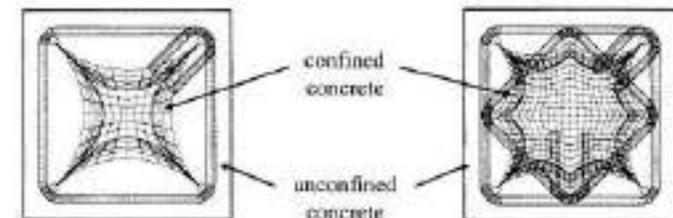
Penampang Bulat



Penampang Persegi



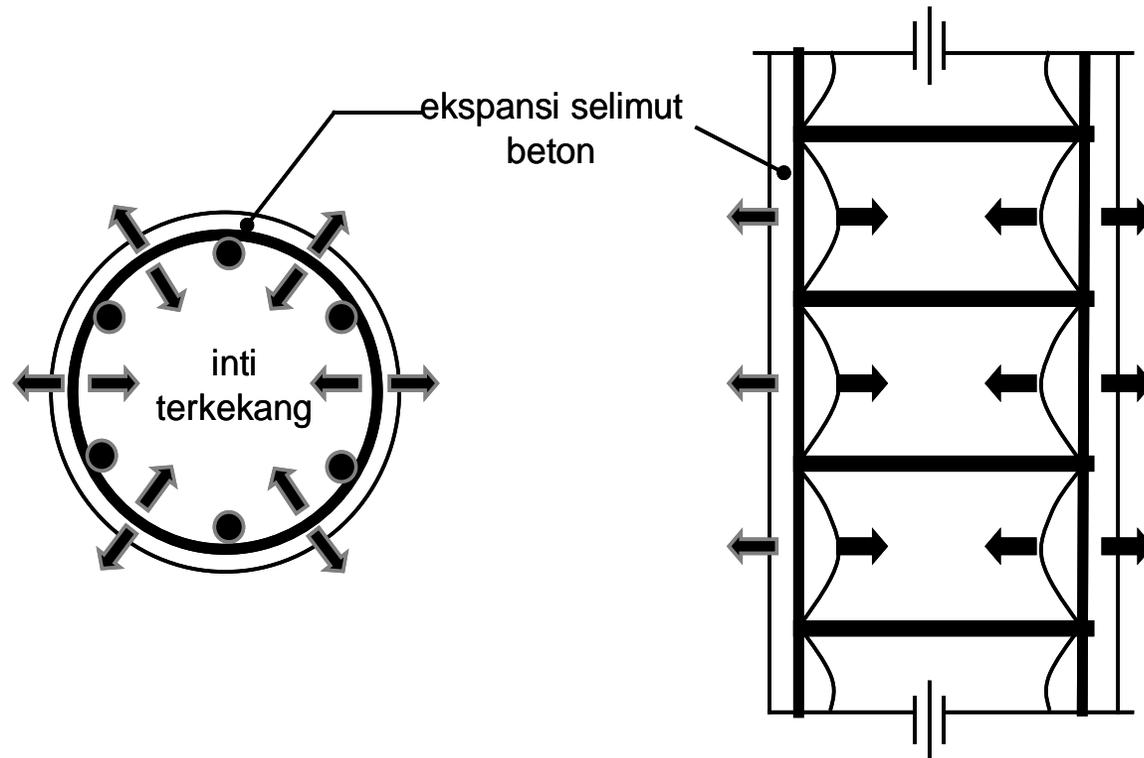
Arching action along the height in confined concrete



Arching action in plan in confined concrete

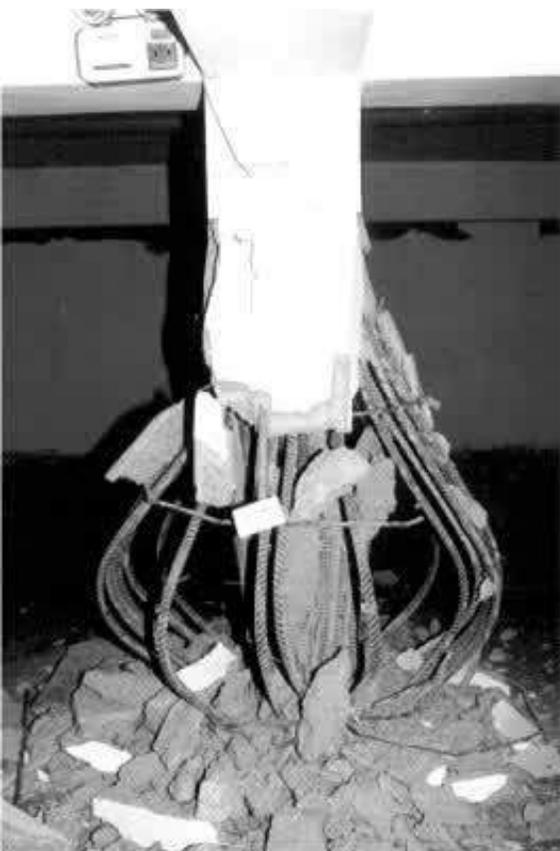


Cover spalls





Contoh Poor Confined pada Kolom yang Terkena Gempa



Taiwan 1999



India 2001



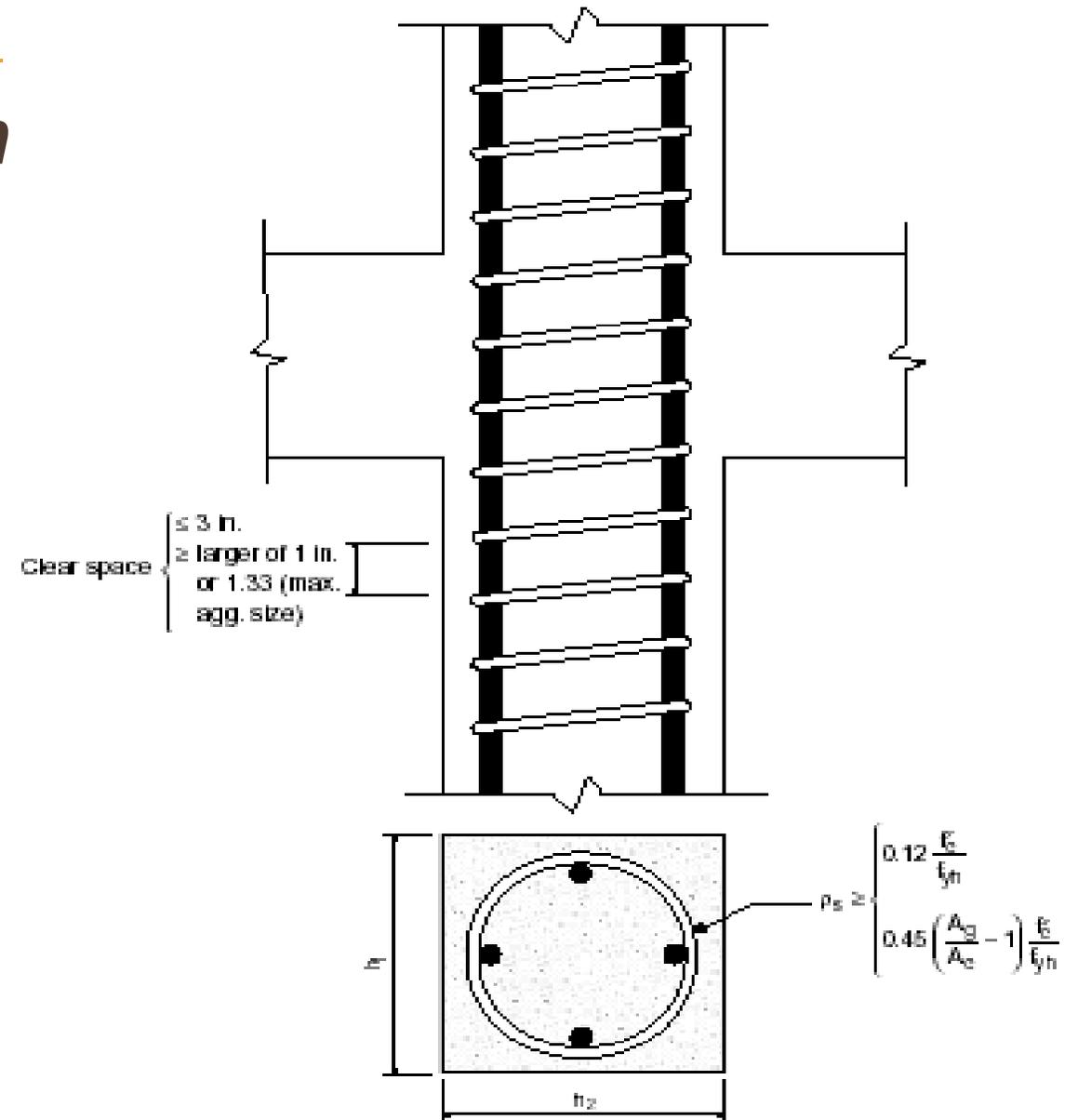
Aceh 2004



Wenchuan 2008

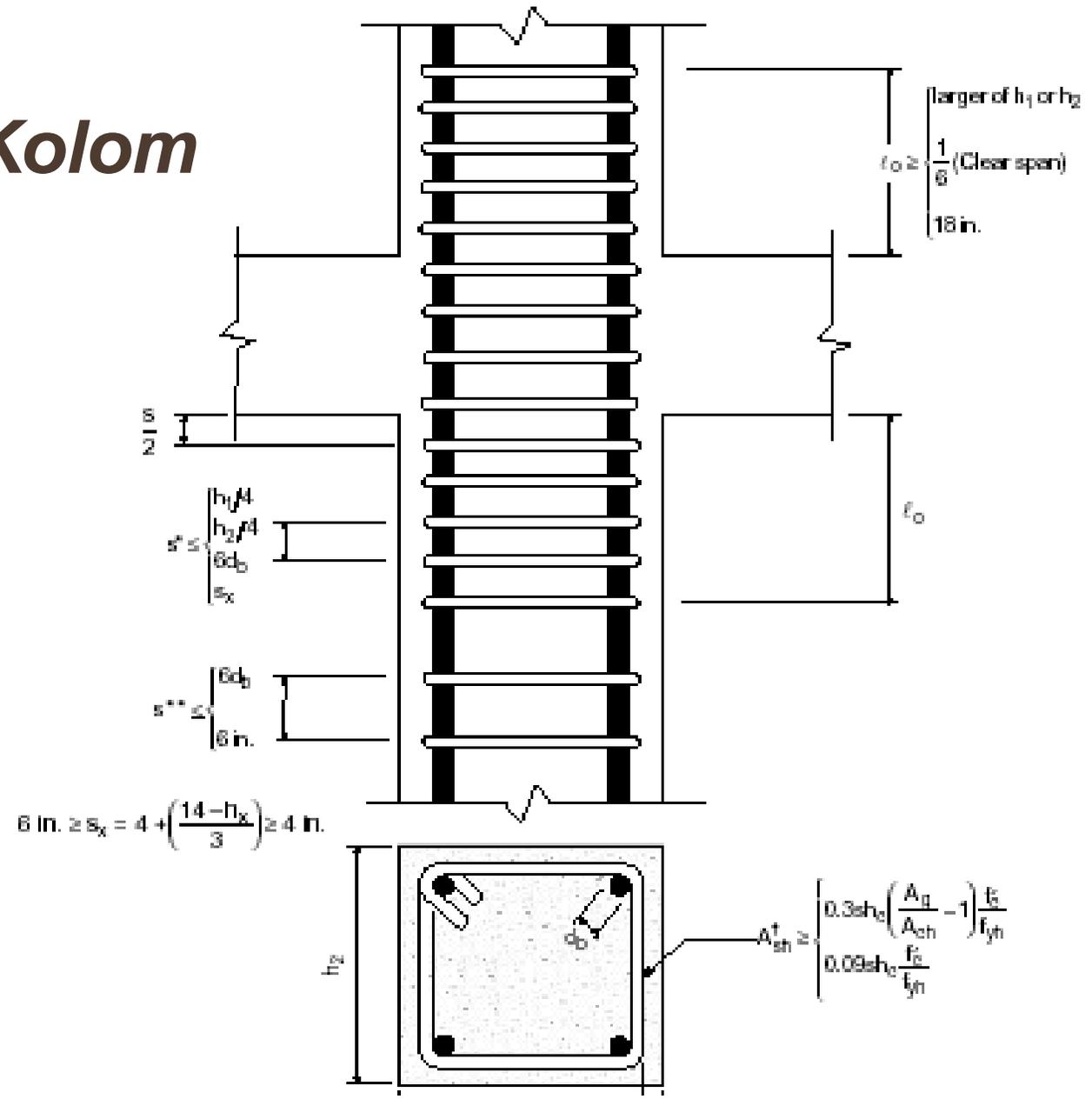


Persyaratan Kekangan Kolom



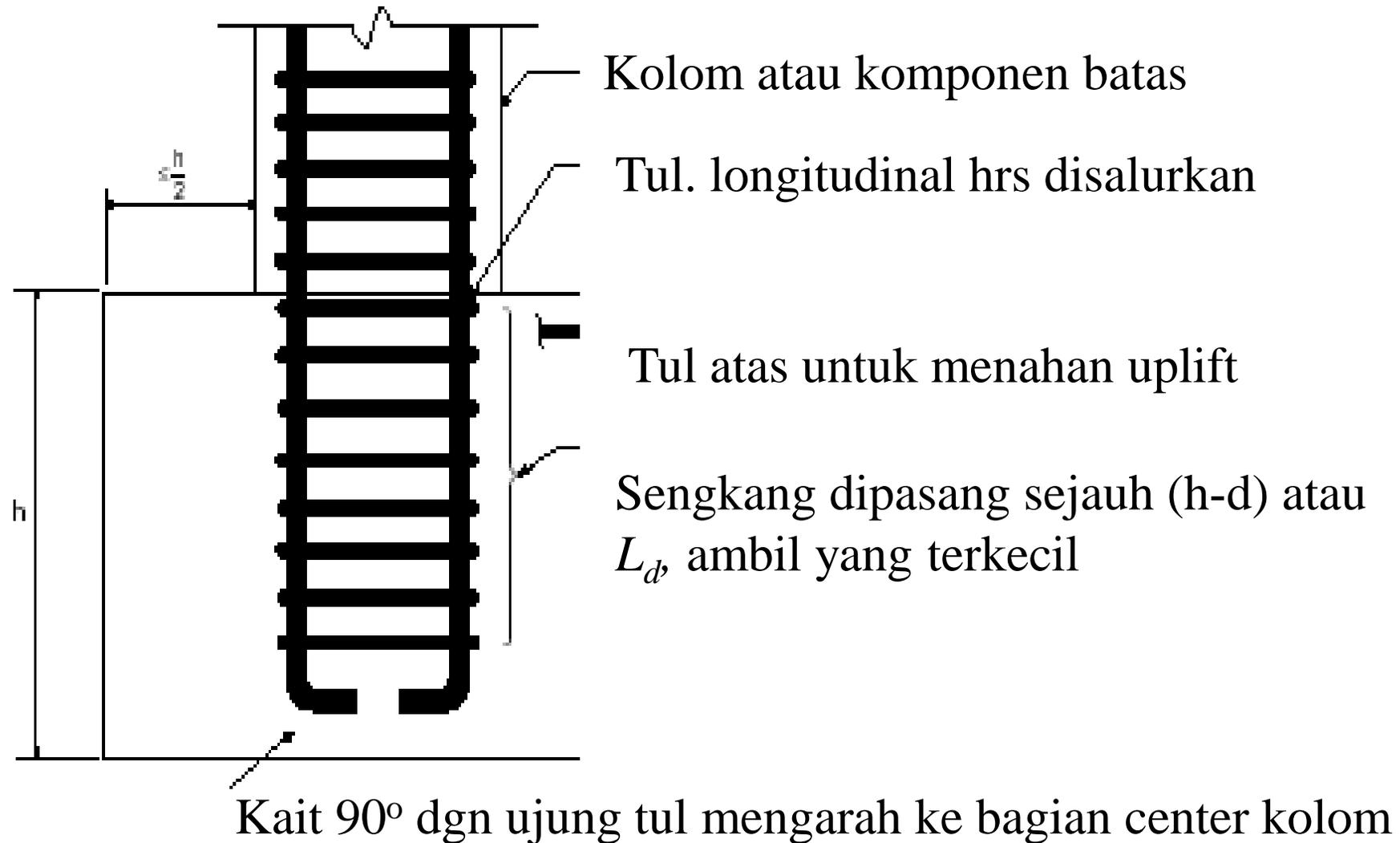


Persyaratan Kekangan Kolom Penampang Persegi





Detail Penjangkaran Tulangan Kolom/Dinding pada Fondasi

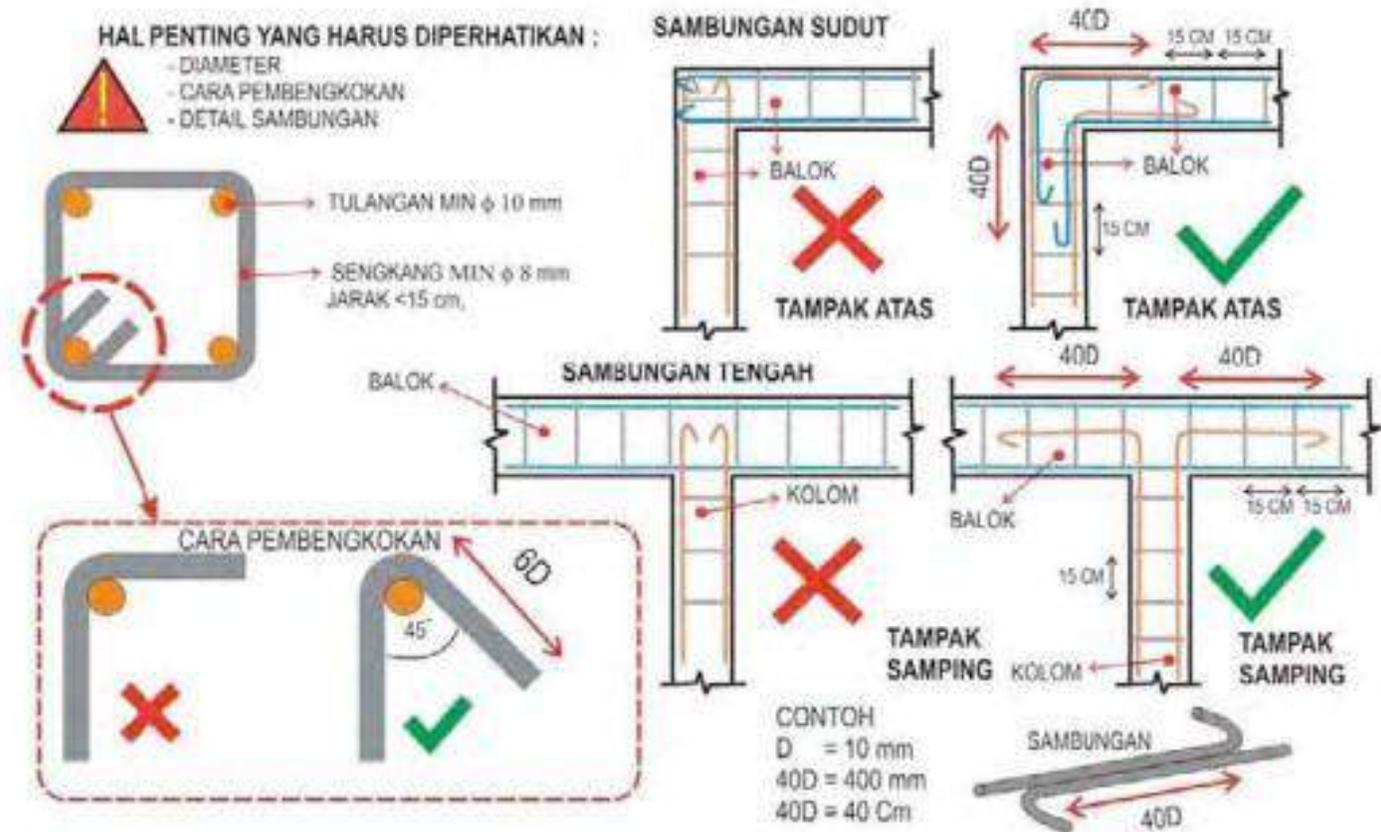




PENDETAILAN TULANGAN STRUKTUR TAHAN GEMPA

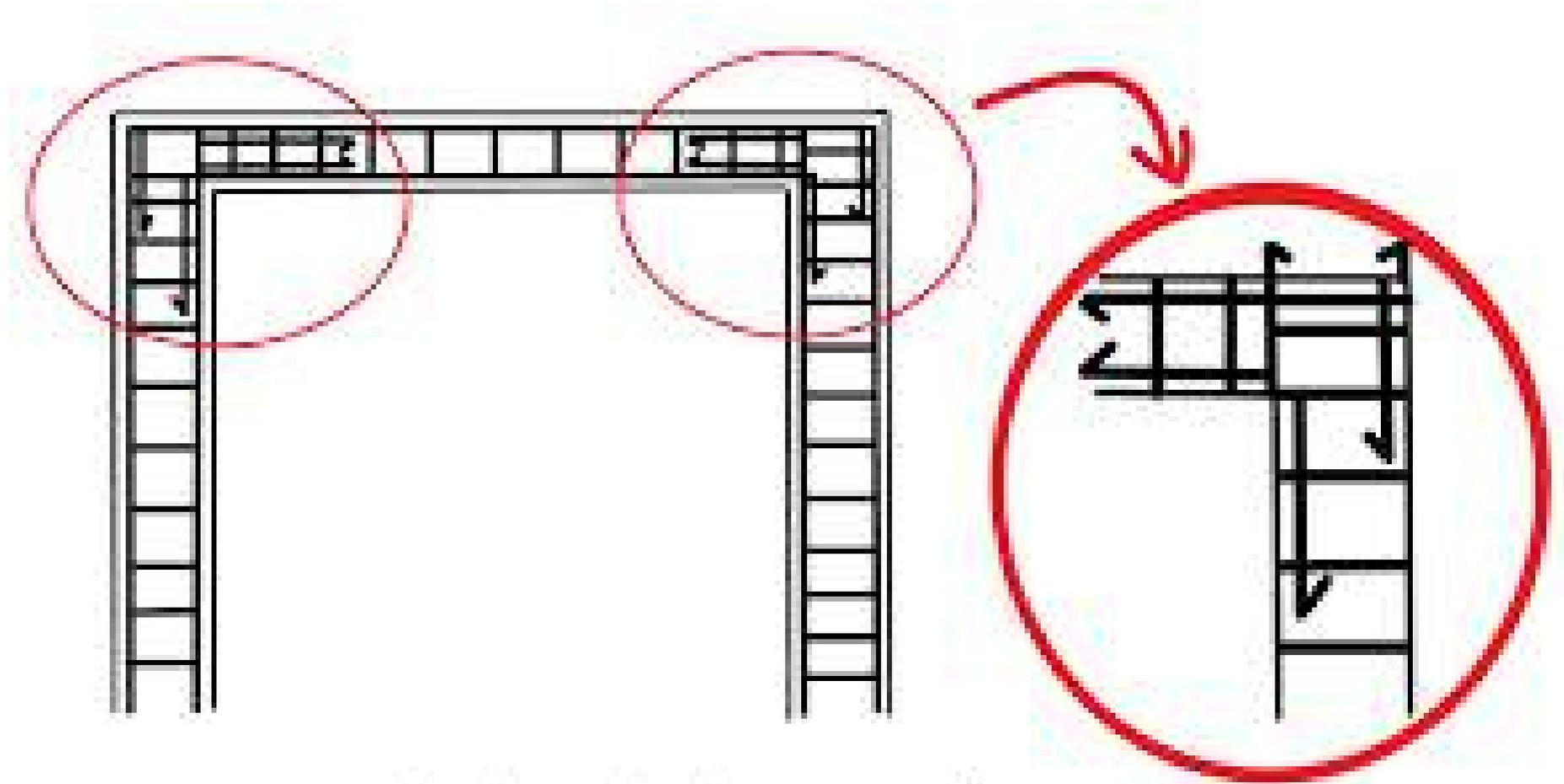


9. DETAIL SAMBUNGAN TAHAN GEMPA





DETAIL JOINT



Contoh struktur bangunan yang benar



TERIMA KASIH