SIMULASI DAKTILITAS PILAR JEMBATAN BERDASARKAN MODEL-MODEL KEKANGAN EKSISTING

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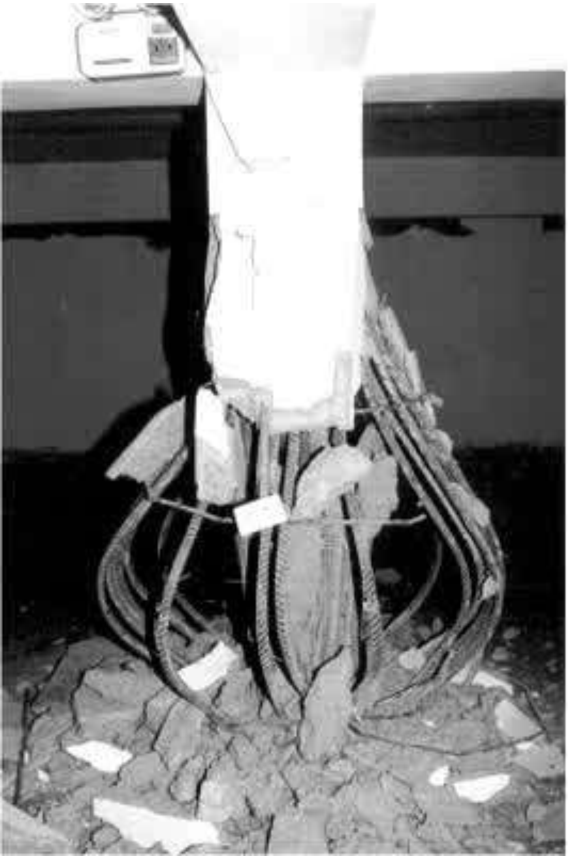
Semarang

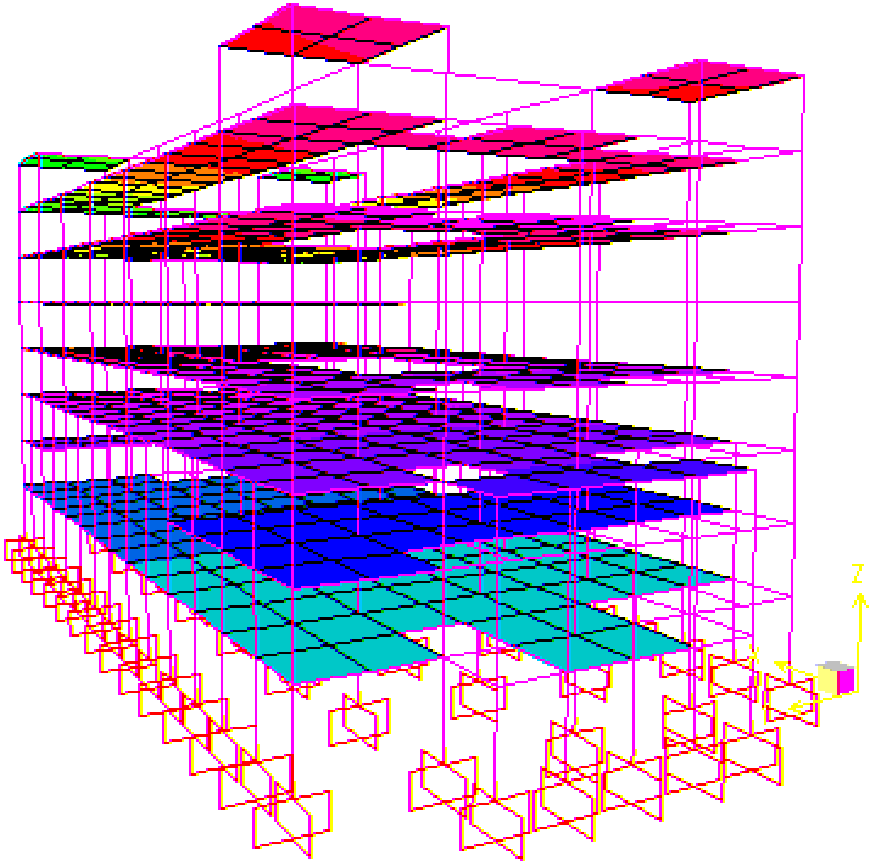
Latar belakang



Taiwan 1999

India 2001

Wenchuan 2008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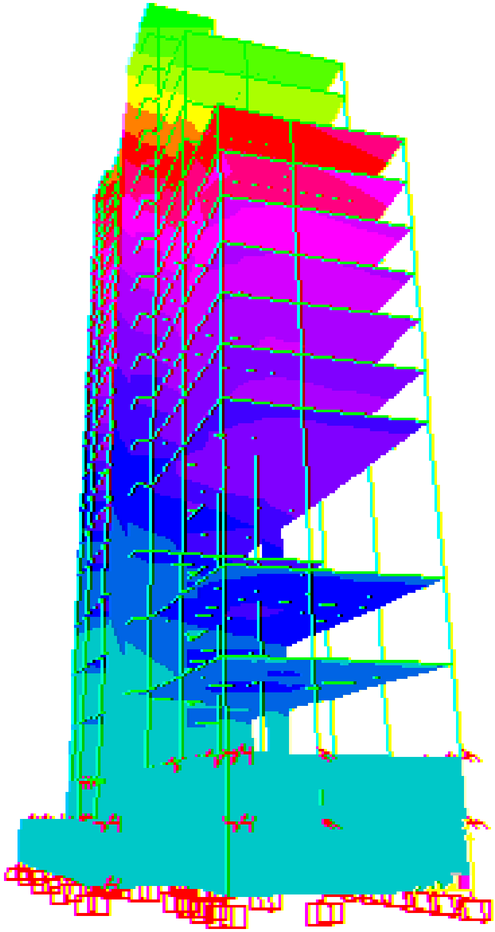
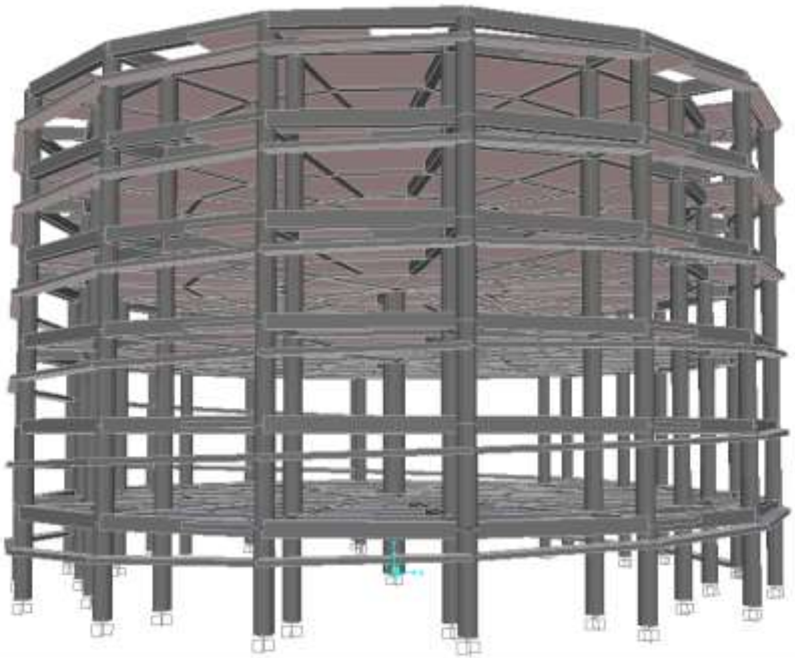
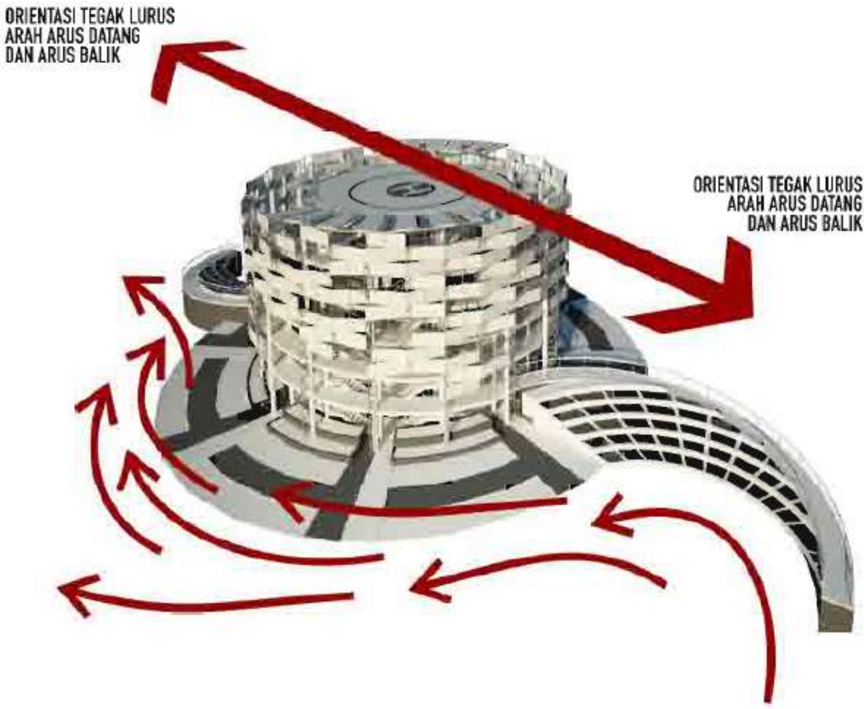
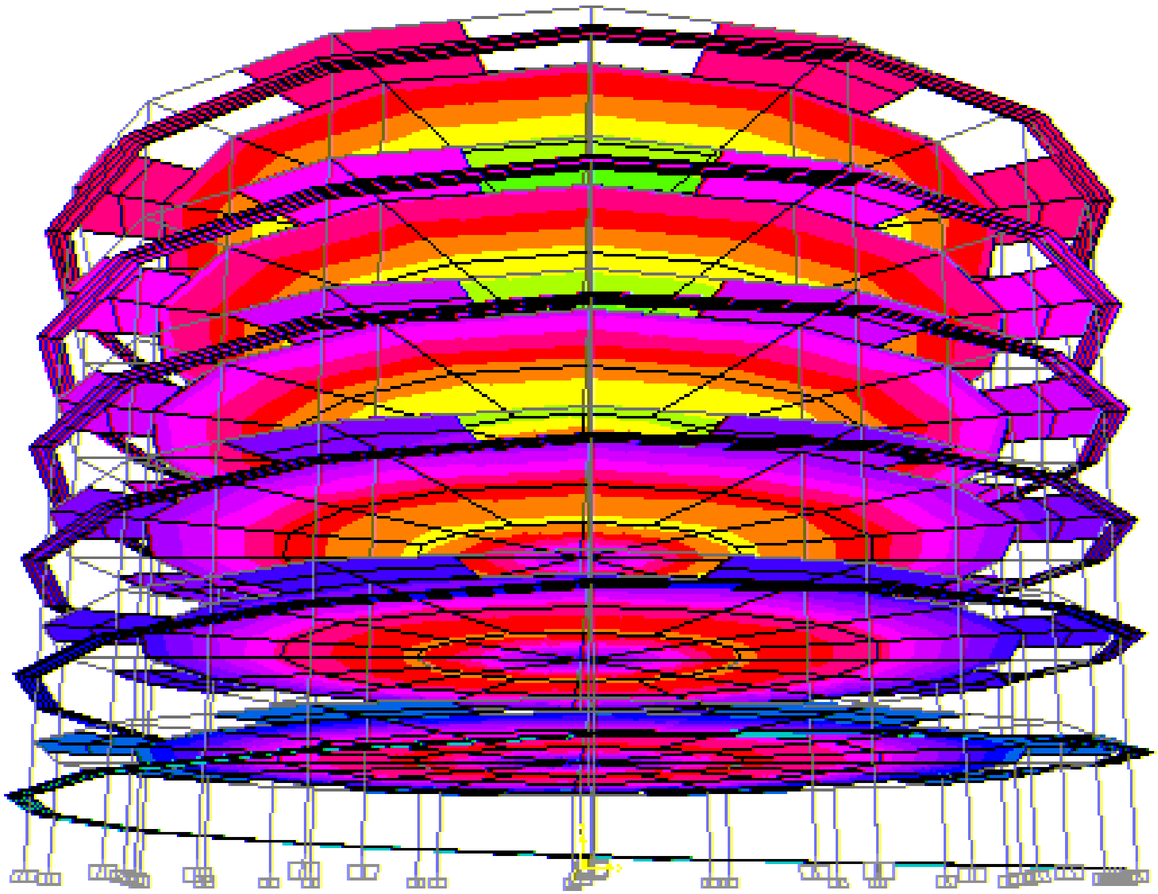


IDEALISASI SISTEM STRUKTUR

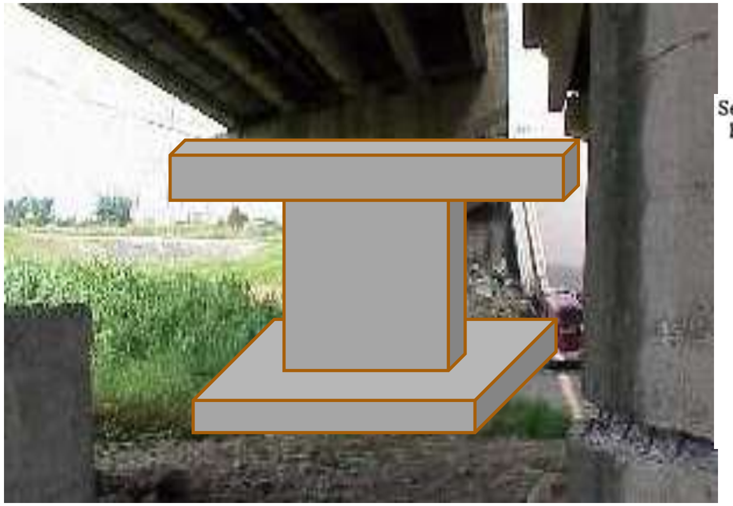


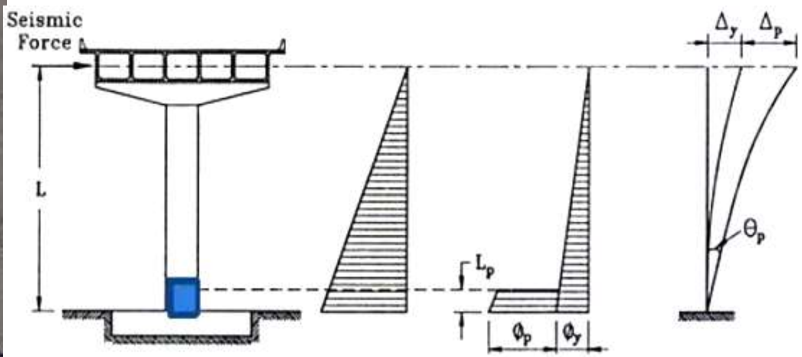




Perilaku Seismik pada Pilar Jembatan

- In the seismic design of RC columns of building and bridge piers, the potential plastic hinge regions need to be carefully detailed for ductility in order to ensure that the shaking from large earthquakes will not cause collapse [Antonius et al., 2013]

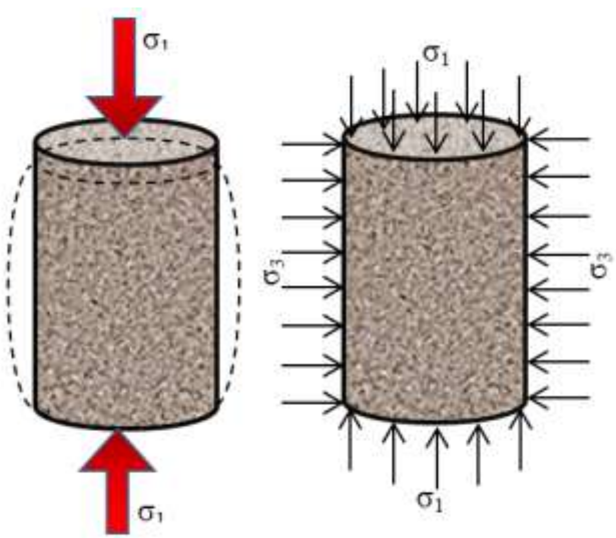




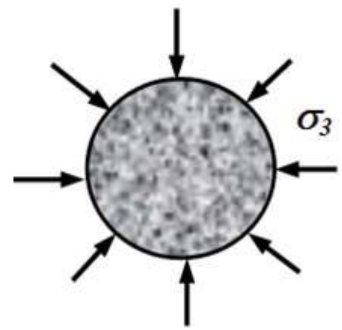
- Most important design consideration for ductility of plastic hinge regions of RC columns with provided of confinement, to prevent buckling of the longitudinal bars and to prevent of shear failure

Dasar Teori:

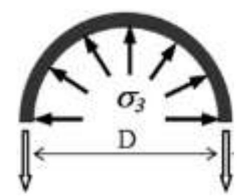
Perilaku beton terhadap beban triaksial



a) Beban uniaksial dan pengekangan pada silinder beton

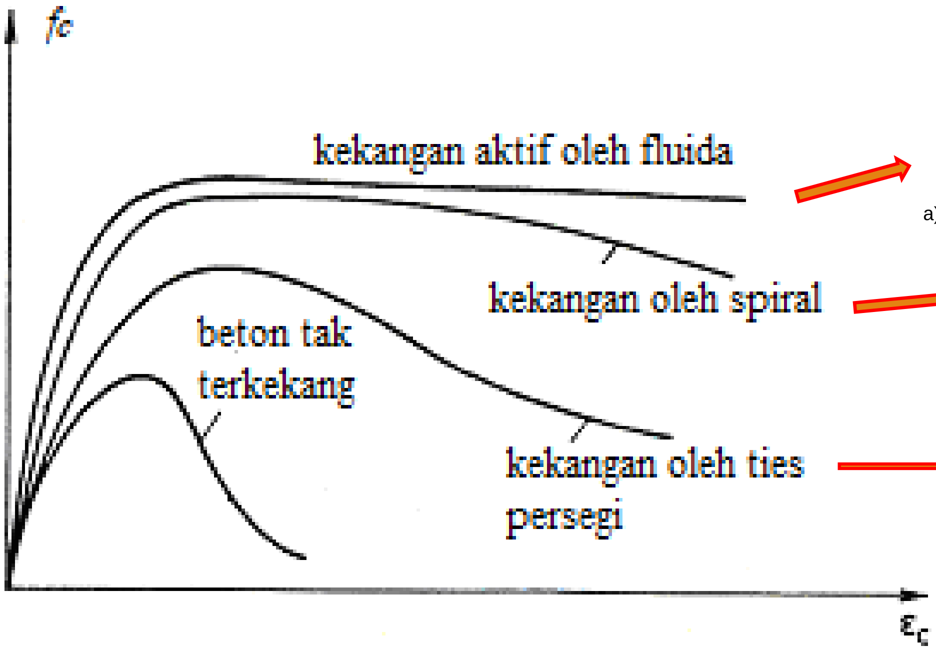


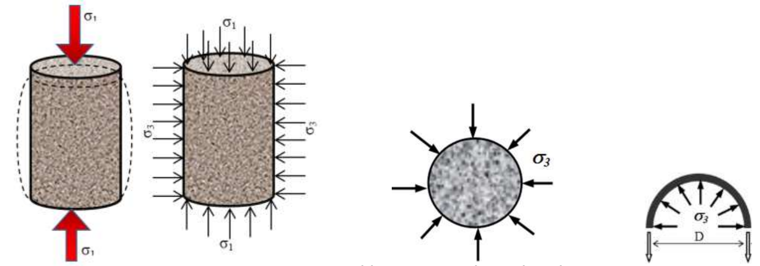
b) Tegangan lateral pada penampang inti



c) Aksi busur kekangan spiral

Hubungan Beban-defleksi kolom dengan variasi sengkang





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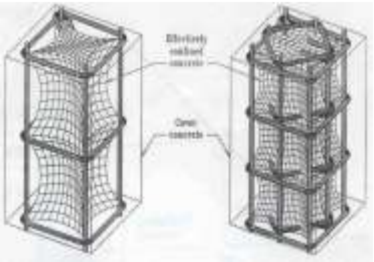
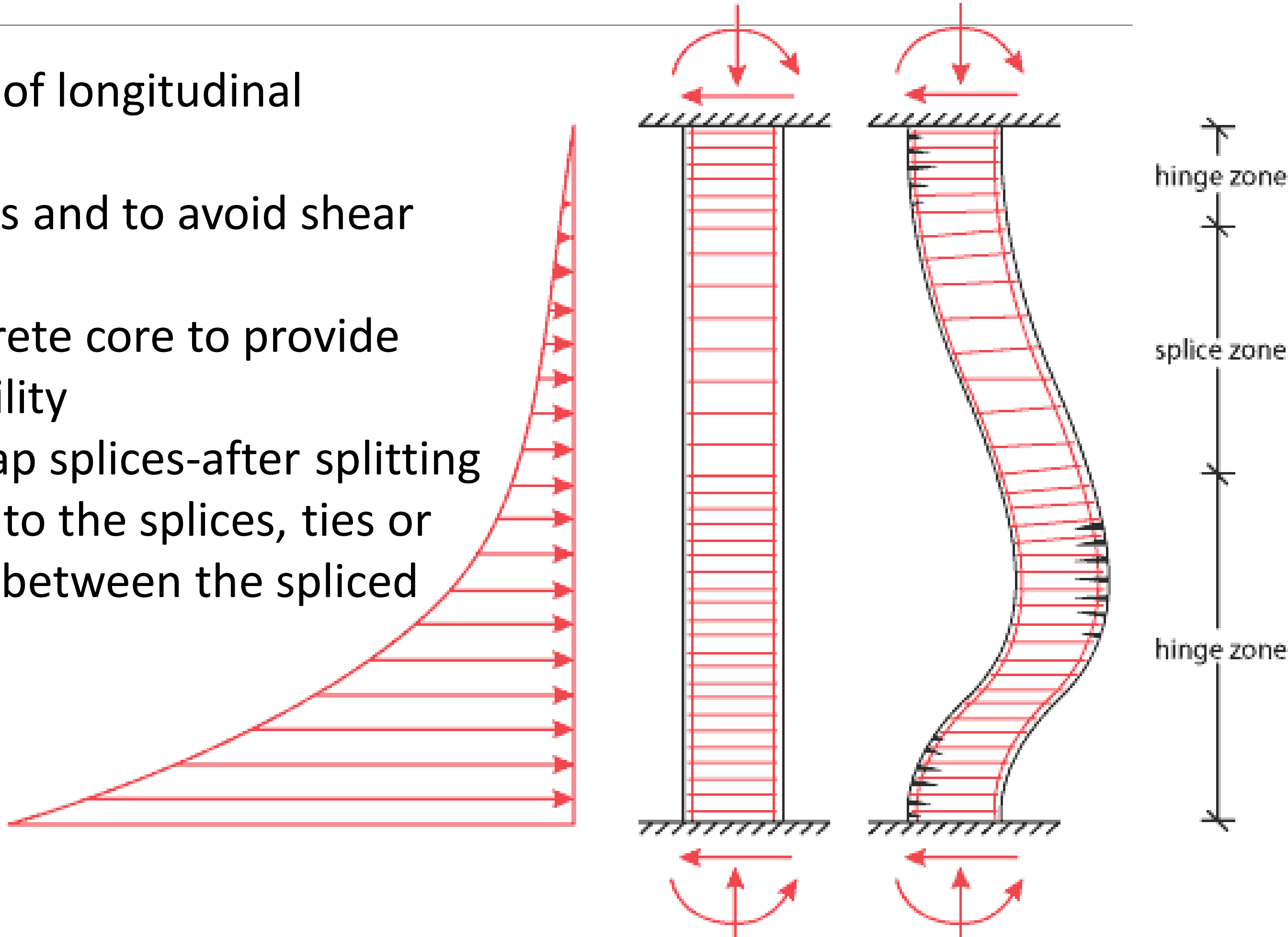


Tujuan Tulangan Pengekang

- To prevent buckling of longitudinal reinforcement bars
- To resist shear forces and to avoid shear failure
- To confine the concrete core to provide sufficient deformability
- To clamp together lap splices-after splitting cracks form parallel to the splices, ties or spirals restraint slip between the spliced bars



Konfigurasi Tulangan

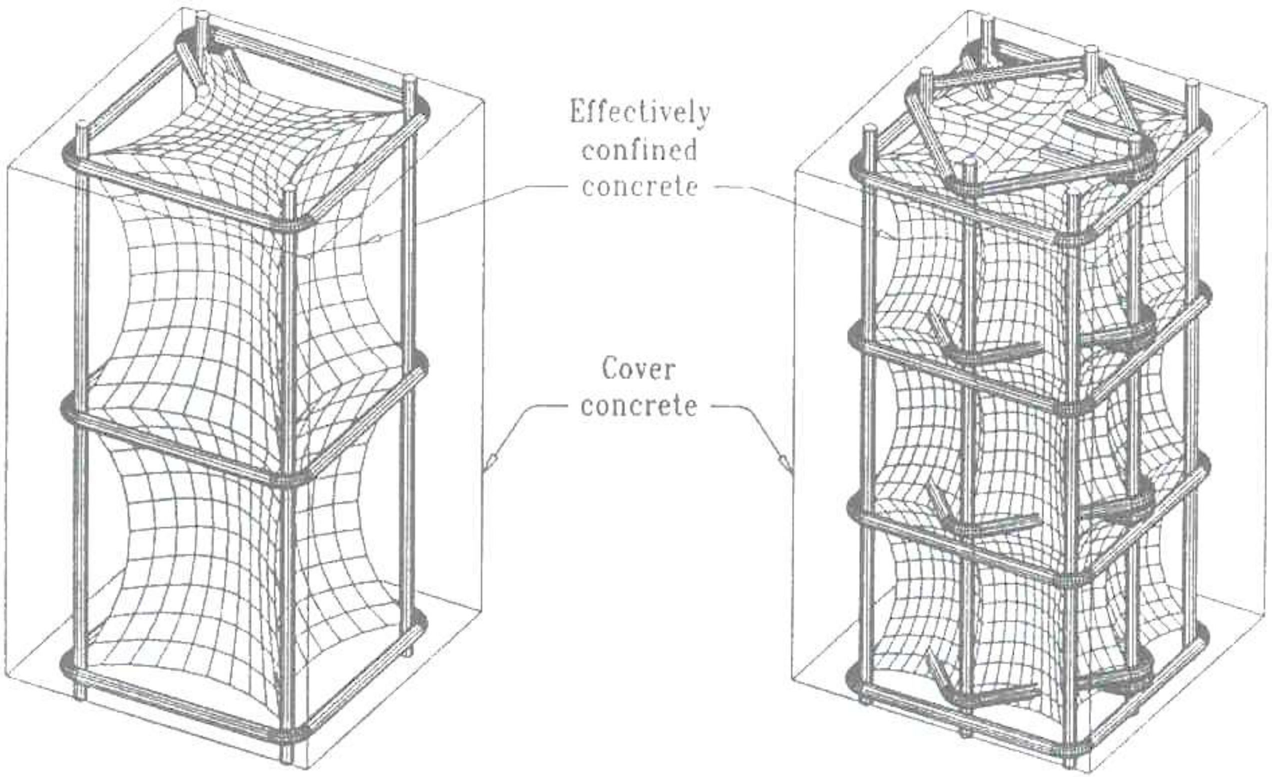
(a) Sengkang bulat/hoop

(b) Sengkang konfigurasi sederhana/bulat

(c) Sengkang gabungan konfigurasi biasa dan silang

(d) Sengkang gabungan konfigurasi biasa dan diamon

EFEKTIFITAS KEKANGAN PENAMPANG PERSEGI



SNI 2833:2008 → Untuk Jembatan

- Beban Statik

Circular section: $$\rho_s = 0.45\left(\frac{A_g}{A_c} - 1\right)\frac{f'_c}{f_y}$$

Rectangular section: $$A_{sh} = 0.3sh_c \frac{f'_c}{f_{yh}}\left(\frac{A_g}{A_c} - 1\right)$$

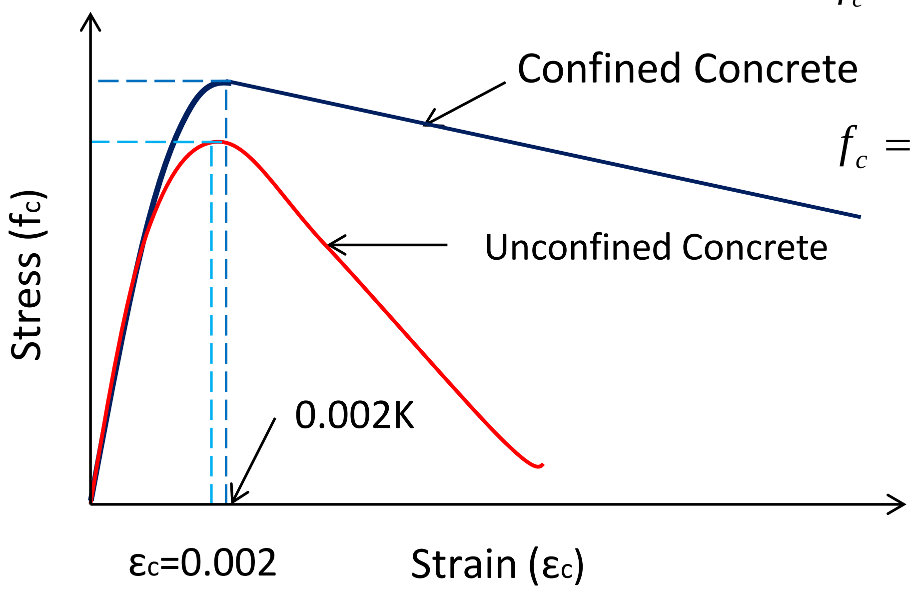
- Beban Seismik

Circular section: Ag/Ac≤1,27 → $$\rho_s = 0,12\frac{f_c{}'}{f_y}$$

Rectangular section: Ag/Ac≤1,3 → $$A_{sh} = 0,09.s.d_c\frac{f_c{}'}{f_y}$$

Model-model Kekangan

Model Scott et al. 1982



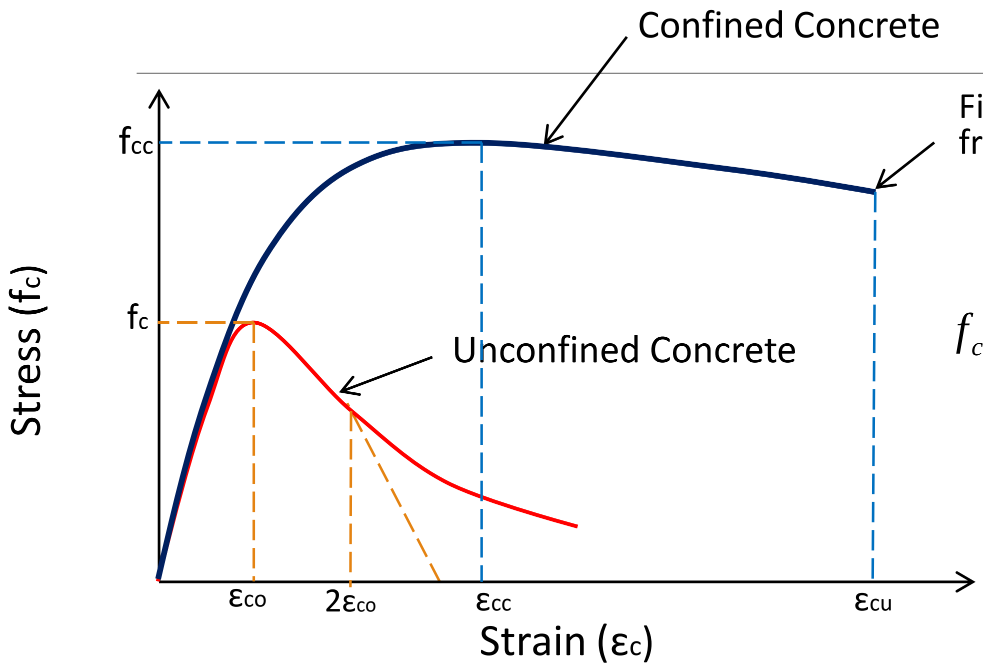
$$f_c = Kf'_c\left[\frac{2\varepsilon_c}{0.002K} - \left(\frac{\varepsilon_c}{0.002K}\right)^2\right] \; ; \; \varepsilon_c \leq 0.002K$$

$$f_c = Kf'_c\left[1 - Z_m\left(\varepsilon_c - 0.002K\right)\right]; \; \varepsilon_c > 0.002K$$

$$K = 1 + \frac{\rho_s f_{yh}}{f'_c}$$

$$Z_m = \frac{0.5}{\frac{3 + 0.29 f'_c}{145 f'_c - 1000} + \frac{3}{4}\rho_s\sqrt{\frac{h''}{s_h}} - 0.002K}$$

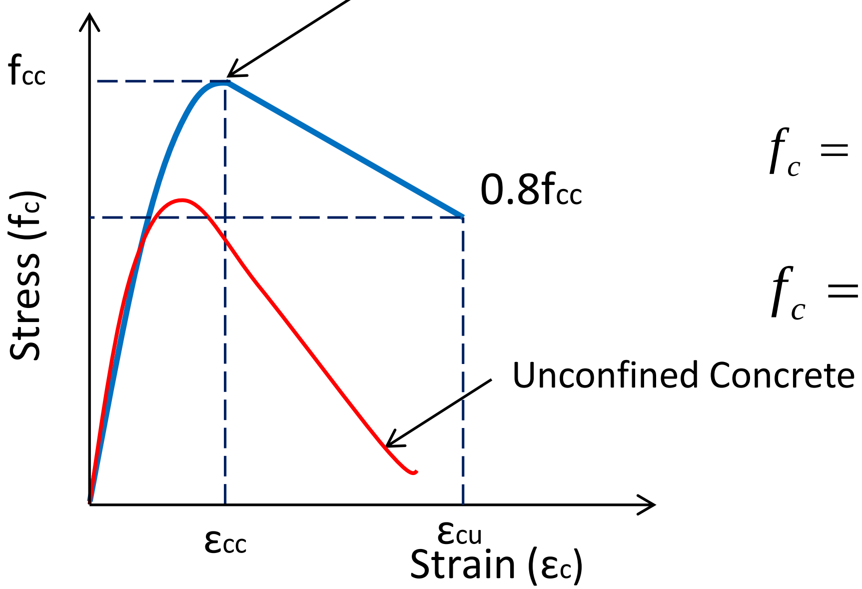
Model Mander et al. (1988)



$$f_c = \frac{f'_{cc}\, x r}{r - 1 + x^r} \quad ; \varepsilon_{cc} = \varepsilon_{co}\left[1 + 5\left(\frac{f'_{cc}}{f'_{co}} - 1\right)\right]$$

$$f'_{cc} = f'_{co}\left(-1.254 + 2.254\sqrt{1 + \frac{7.94 f'_l}{f'_{co}}} - 2\frac{f'_l}{f'_{co}}\right)$$

Model Hoshikuma, J., Kawashima, K. (1997)



$$f_c = E_c \varepsilon_c \left\{ 1 - \frac{1}{n} \left(\frac{\varepsilon_c}{\varepsilon_{cc}} \right)^{n-1} \right\}$$ Ascending branch

$$f_c = f'_{cc} - E_{des} \left(\varepsilon_c - \varepsilon_{cc} \right)$$ Descending branch

$$f'_{cc} = f'_c + 3.8 \alpha \rho_s f_{yh}$$

$$E_{des} = 11.2 \frac{f'^{2}_{c}}{\rho_s f_{yh}}$$

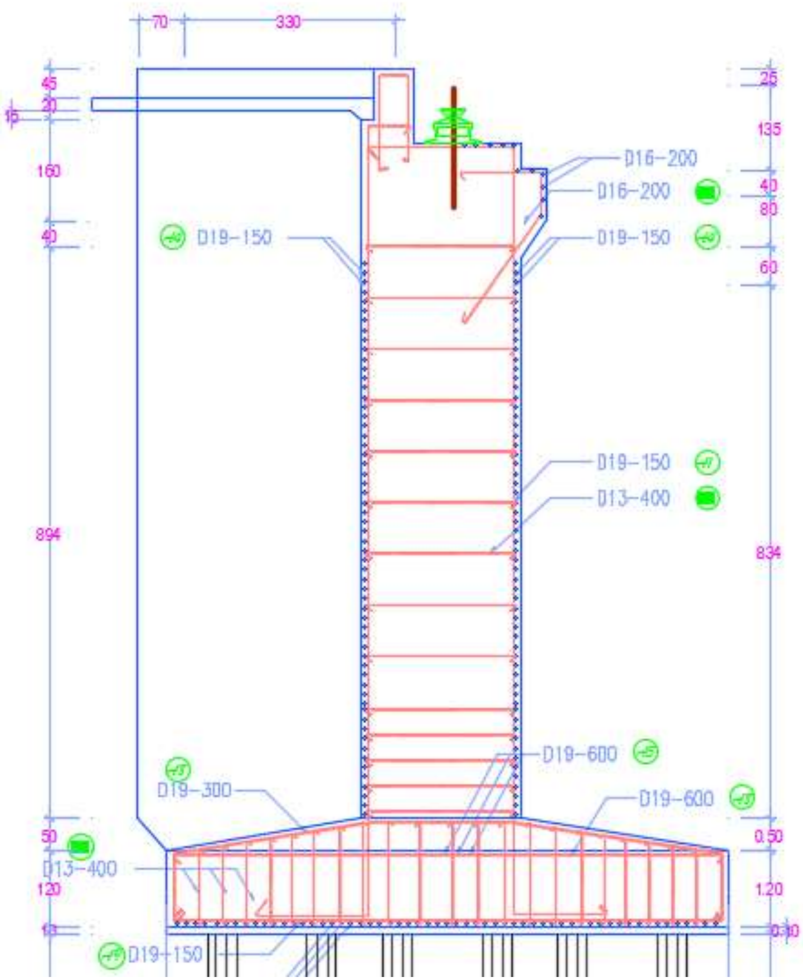
$$\varepsilon_{cc} = 0.002 + 0.033 \beta \frac{\rho_s f_{yh}}{f'_c}$$

Where,

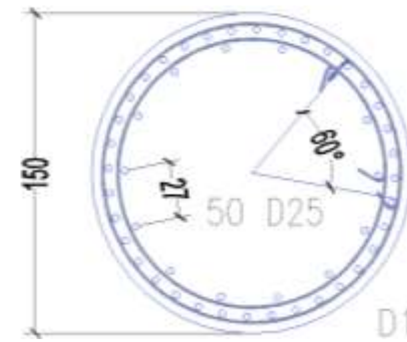
α=1.0 and β=1.0 : circular sections,

α=0.2 and β=0.4: rectangular sections

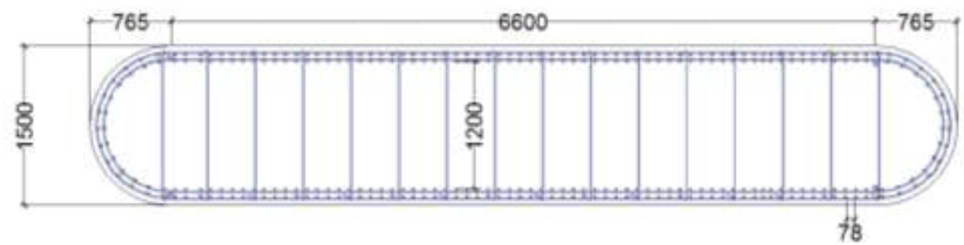
Studi kasus



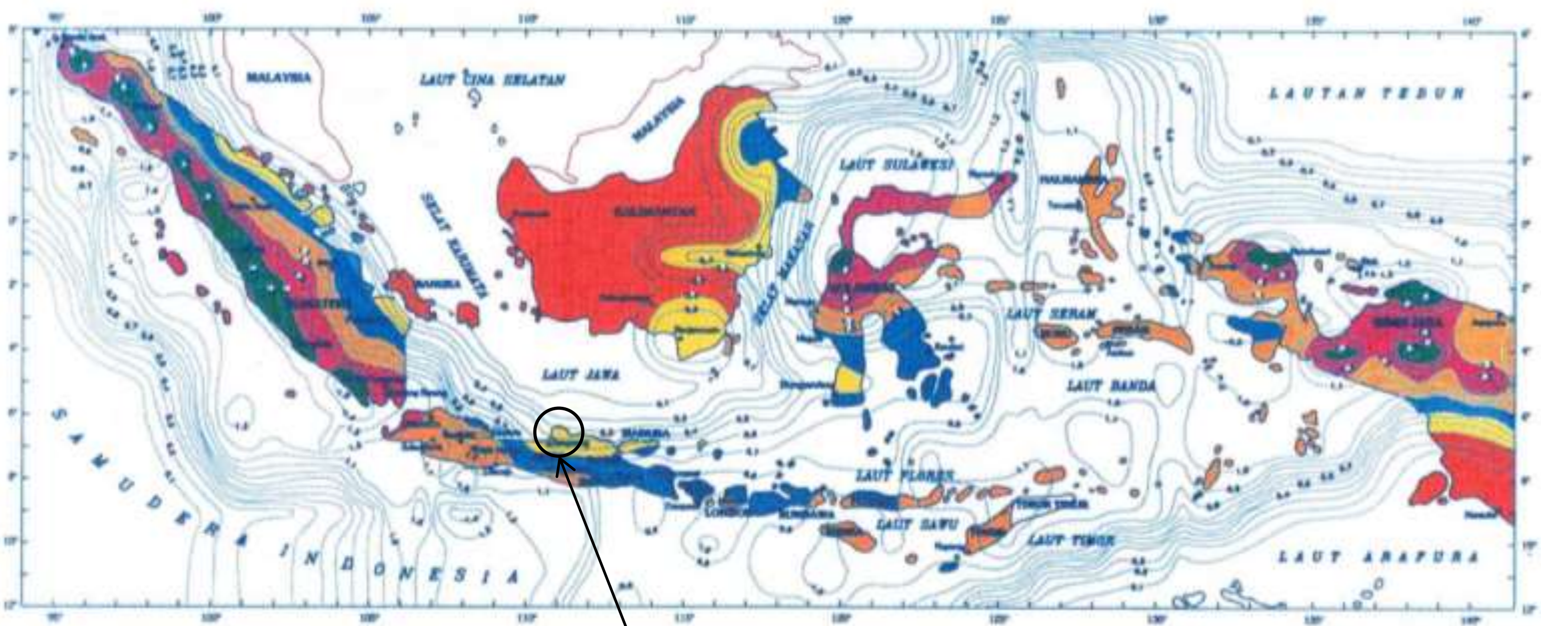
Penampang pilar jembatan Greenwood



Penampang pilar jembatan Srowol



Peta Gempa untuk jembatan SNI 2833:2008

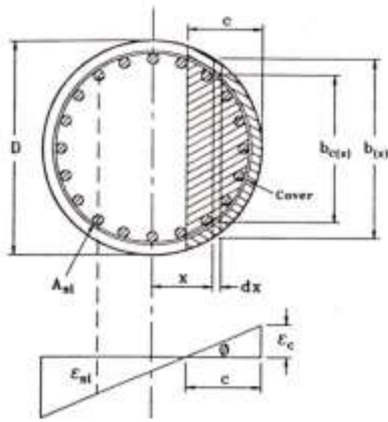


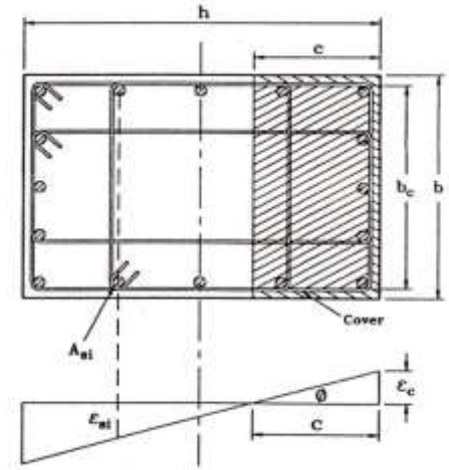
Greewood, Semarang and Srowol, magelang

Moment-Curvature Analysis

Moment equilibrium,

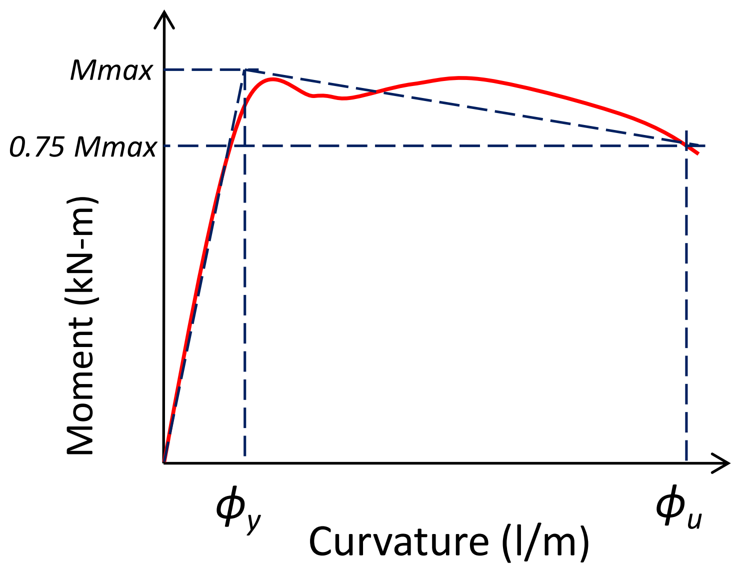
$$M = \int_{x=(D/2)-c}^{D/2} \left[b_{c(x)} f_c(\varepsilon_x) + \left(b_{(x)} - b_{c(x)} \right) f_{cu}(\varepsilon_x) \right] x\,dx + \sum_{i=1}^{n} A_{si} f_s(\varepsilon_{xi}) x_i$$





And the curvature is

$$\phi = \frac{\varepsilon_c}{c}$$



And the Ductility curvature is

$$\mu = \frac{\phi_u}{\phi_y}$$

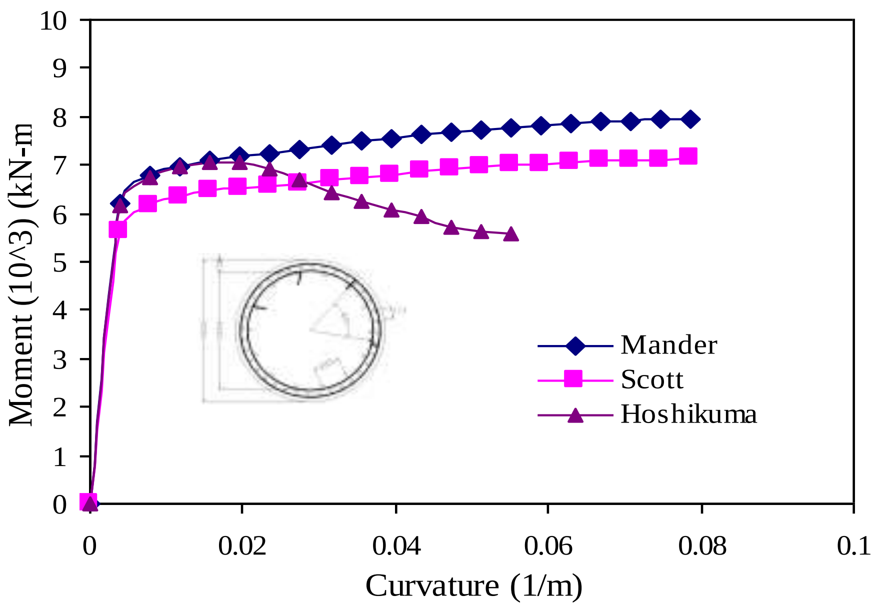
Definisi:

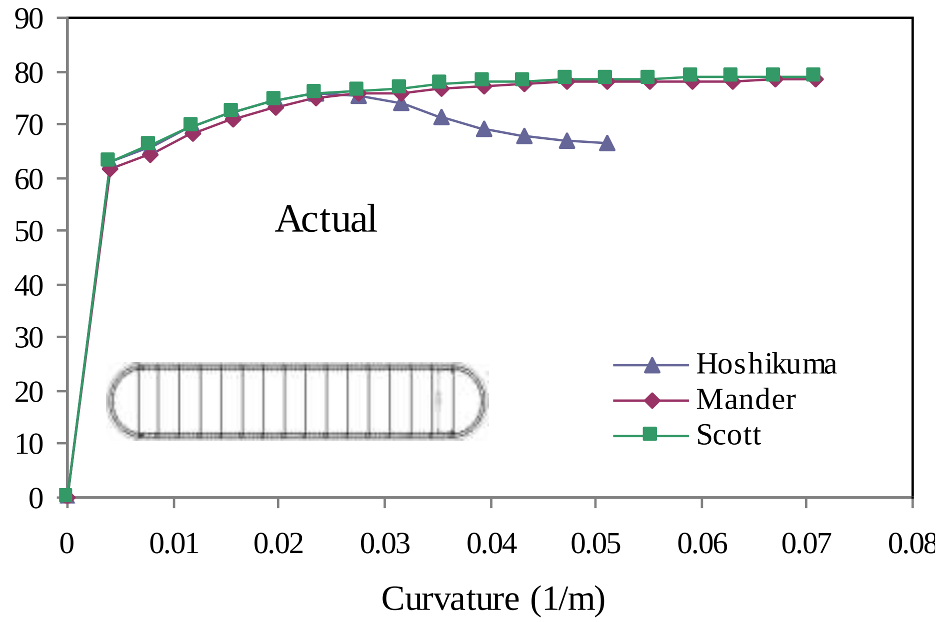
Sharma et al (2005) : daktilitas kurvatur struktur pilar jembatan tahan gempa setidaknya bernilai 16

Hasil

Piers bridge	Confining steel			Long. steel	Curvature ductility (μ)		
	D -s	f_y (MPa)	Volumetric ratio (ρ)		Scott	Mander	Hoshikuma
Greenwood (Bulat)	13-150	320	0.5	50D25	17.6	17.6	11.9
Srowol (Dinding)	16-150	320	0.5	240D22	16.8	15.4	10.9

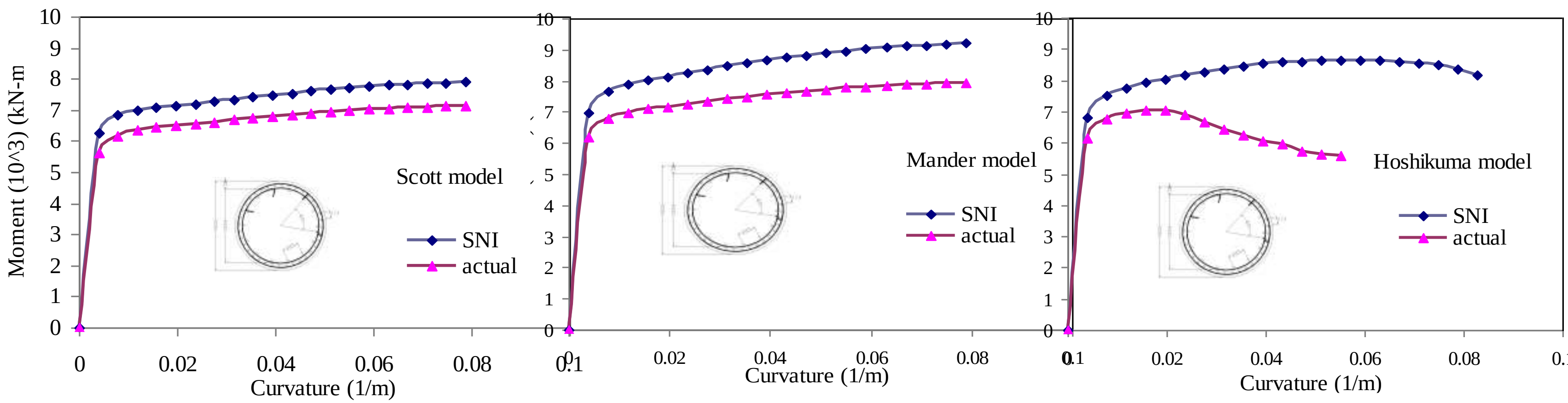
Hasil moment vs kurvatur



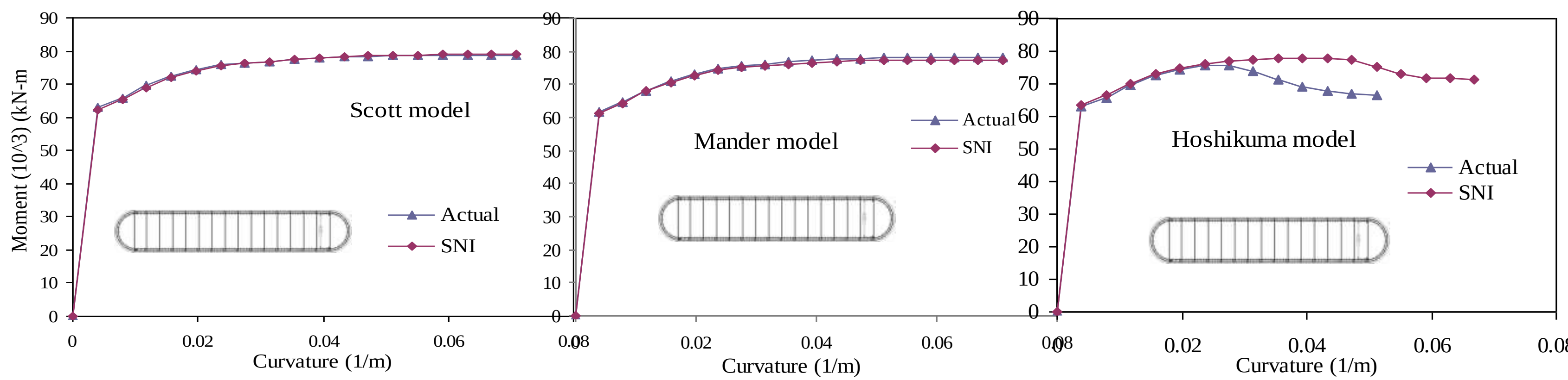


Perbandingan perilaku Moment-curvature model-model kekangan Scott, Mander, dan Hoshikuma

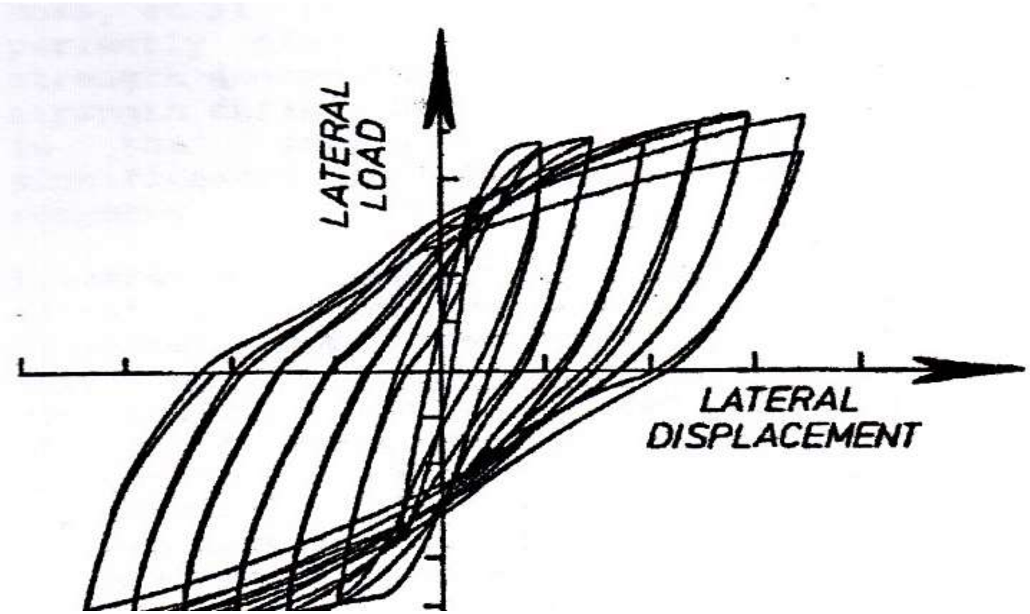
Greenwood bridge



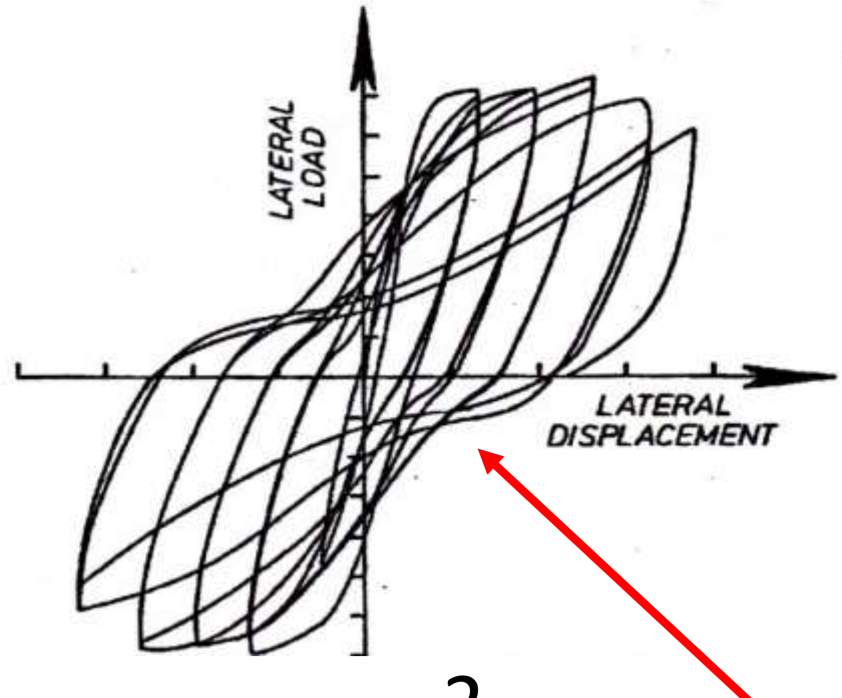
Srowol bridge



Perilaku seismik



1

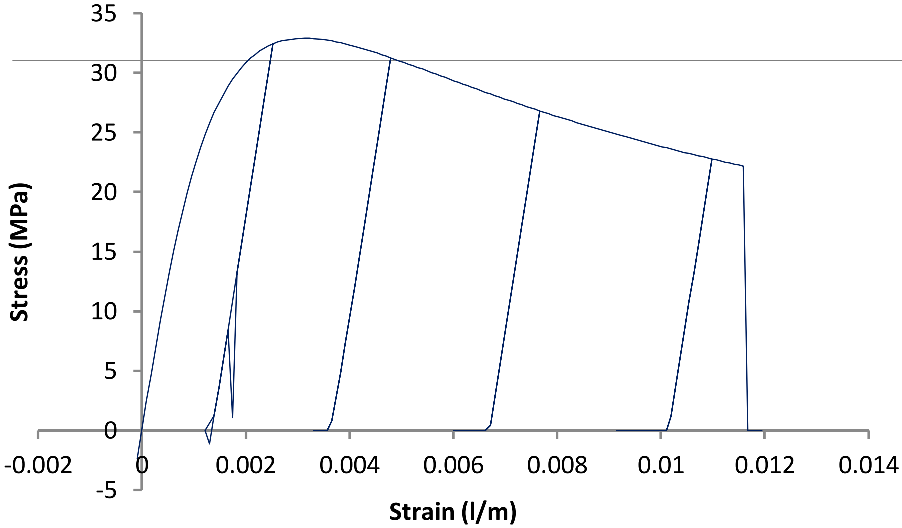


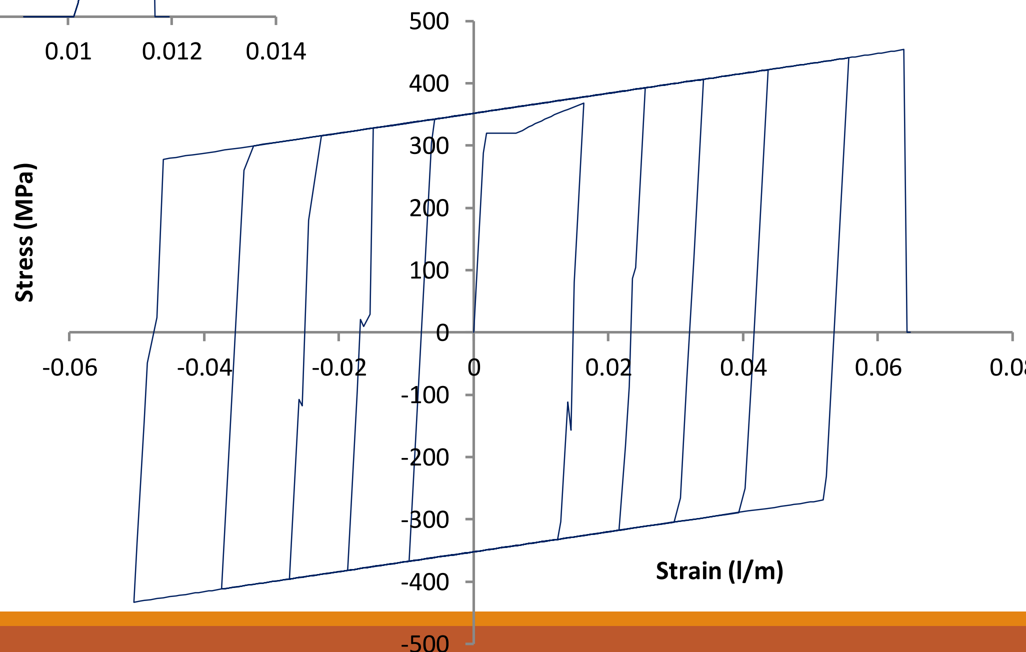
2

slip

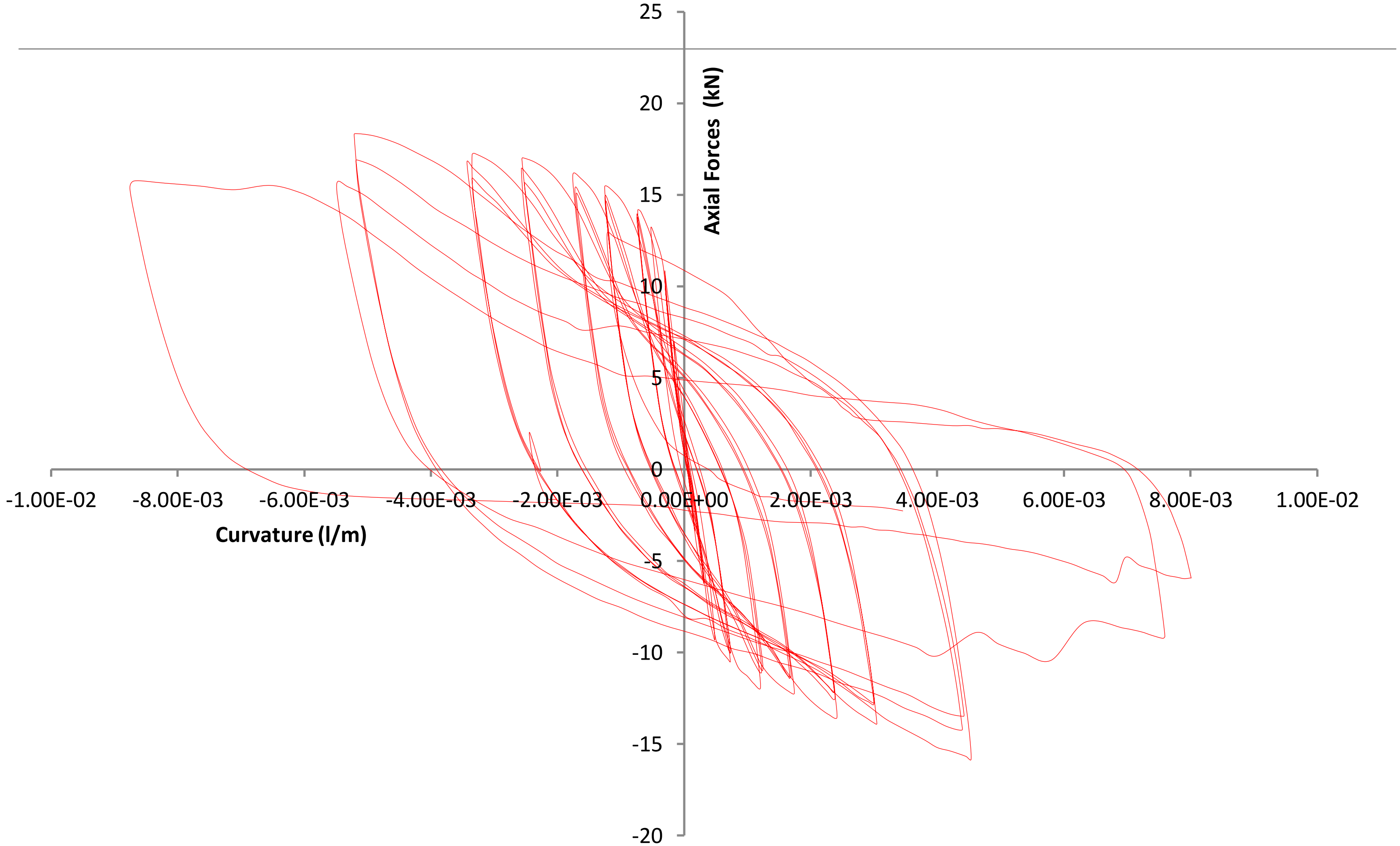
Daktilitas $\mu_1 > \mu_2$

Simulasi beban seismik i.e. model Mander

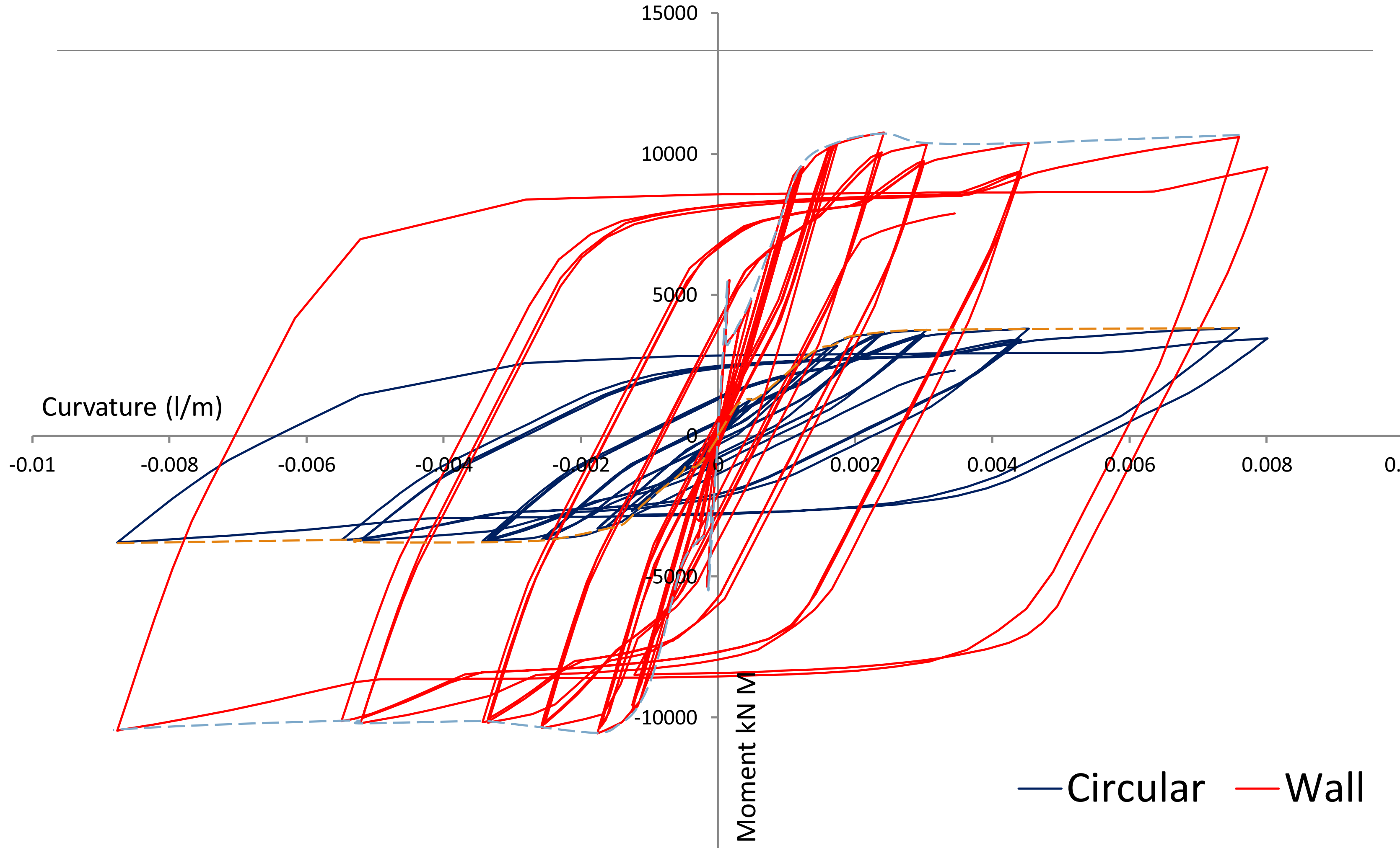




Beban siklik: model Mander



Perilaku momen-kurvatur pada beban siklik



KESIMPULAN

1. Tulangan pengekang memegang peranan signifikan dalam mempertahankan kapasitas kolom, dan mempertahankan daktilitas kolom
2. Perilaku daktilitas kurvatur pilar jembatan berdasarkan model Mander dan Scott berimpit dan sama.
3. Prediksi daktilitas kurvatur berdasarkan model Hoshikuma cenderung underestimate.
4. Simulasi beban sismik yang diterapkan pada Pilar jembatan (by Mandel model) menunjukkan bahwa pilar yang ditinjau mempunyai daktilitas yang memadai.

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Terima kasih