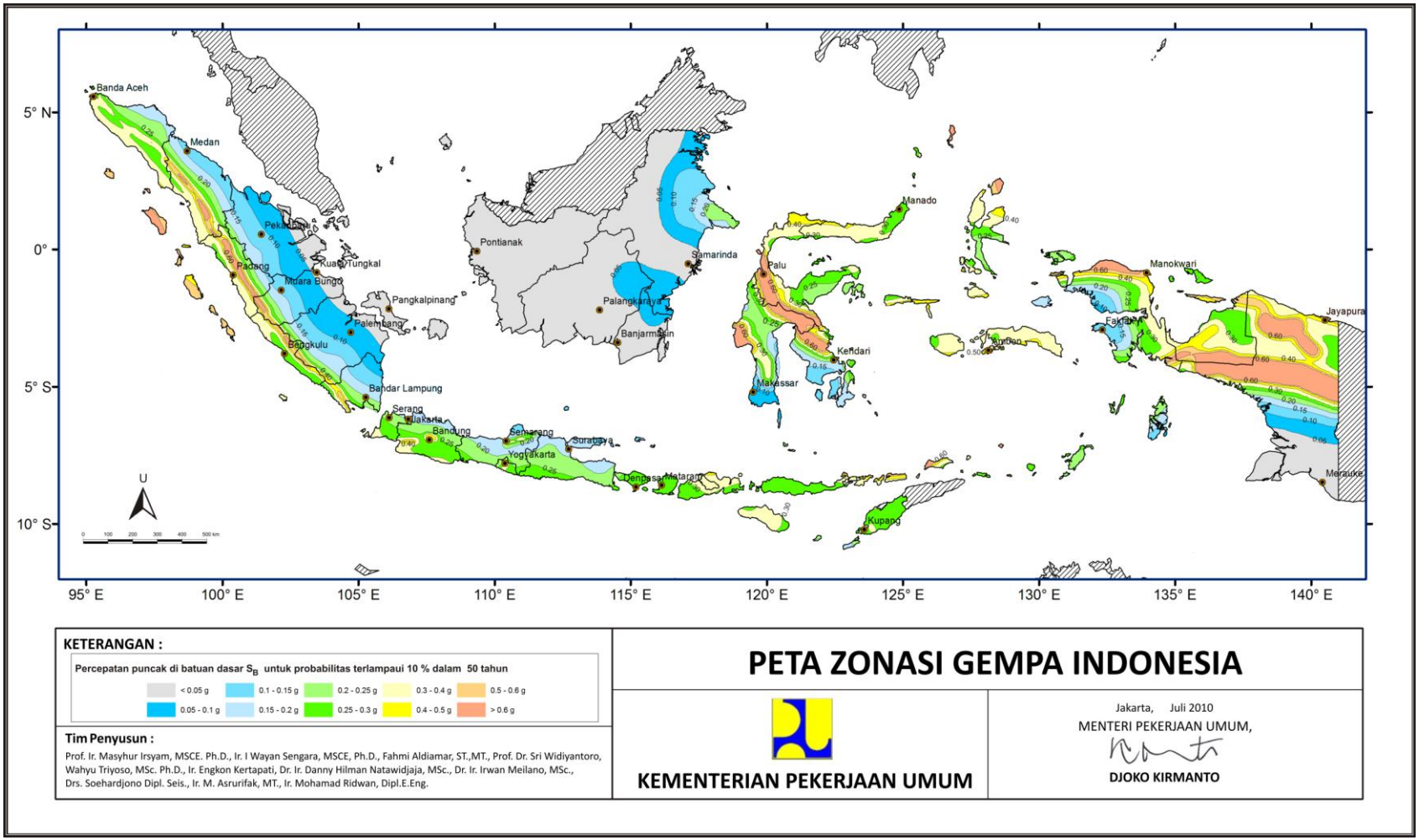
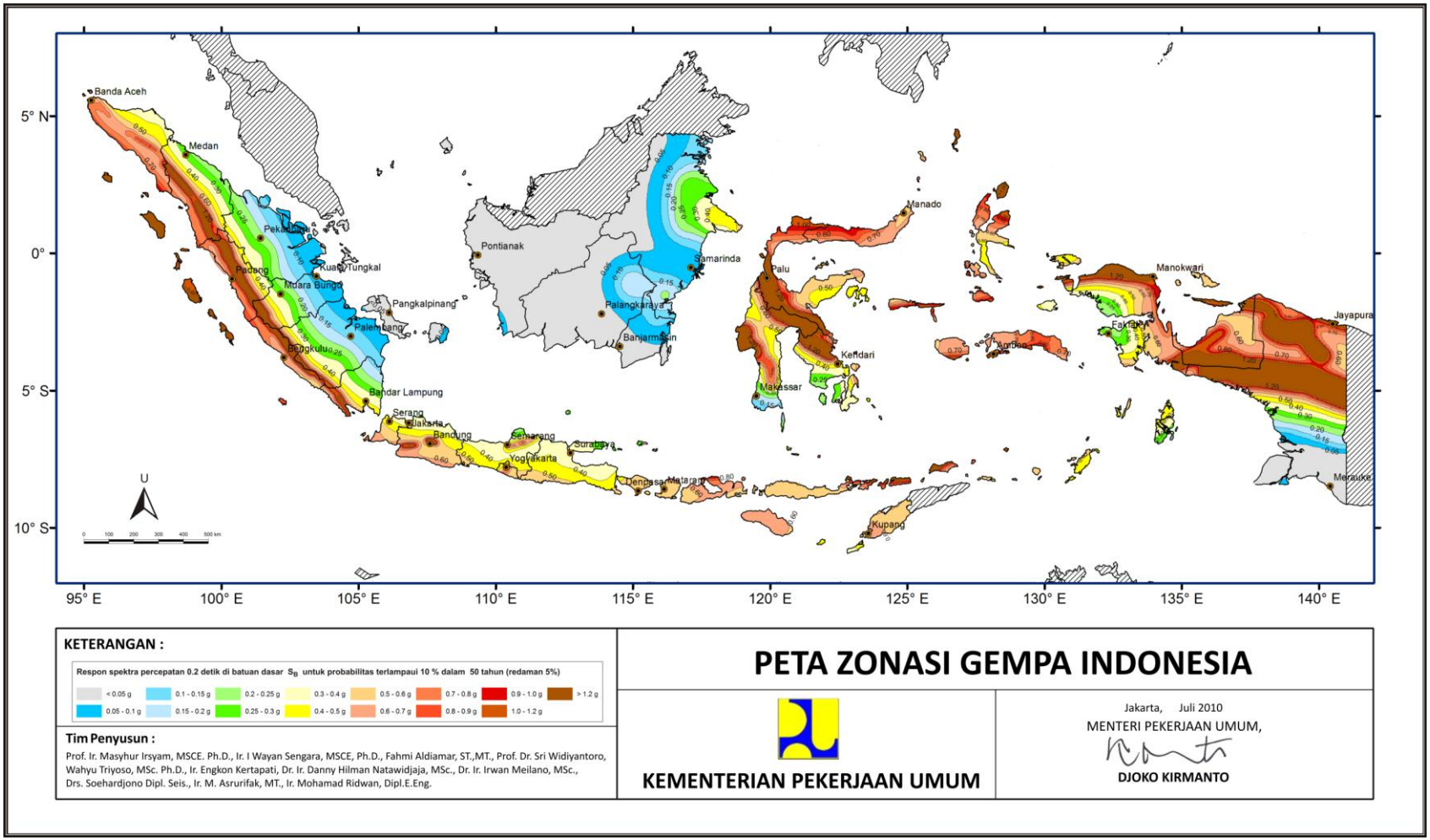
LAMPIRAN 1

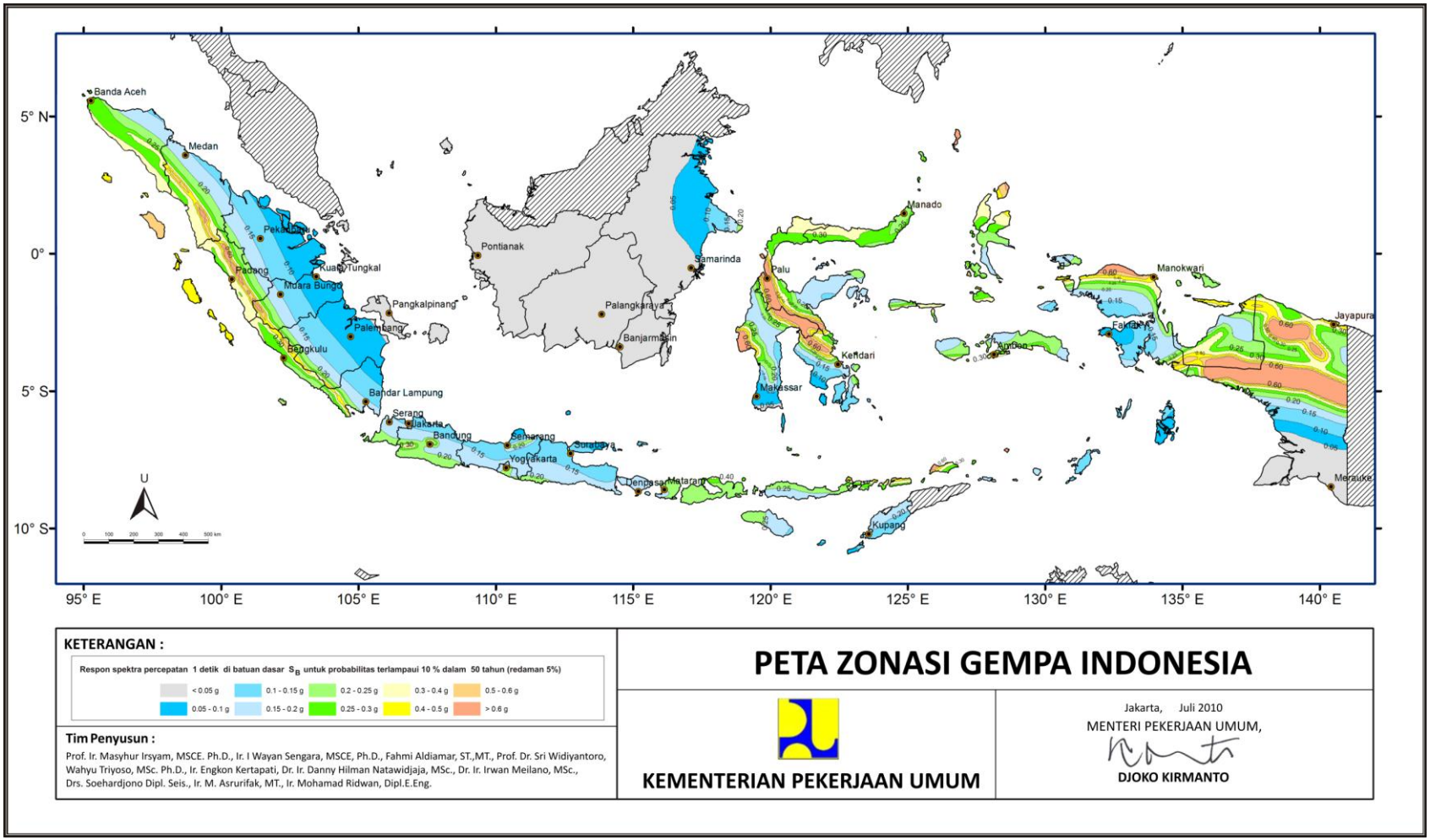
(PETA GEMPA INDONESIA 2010)



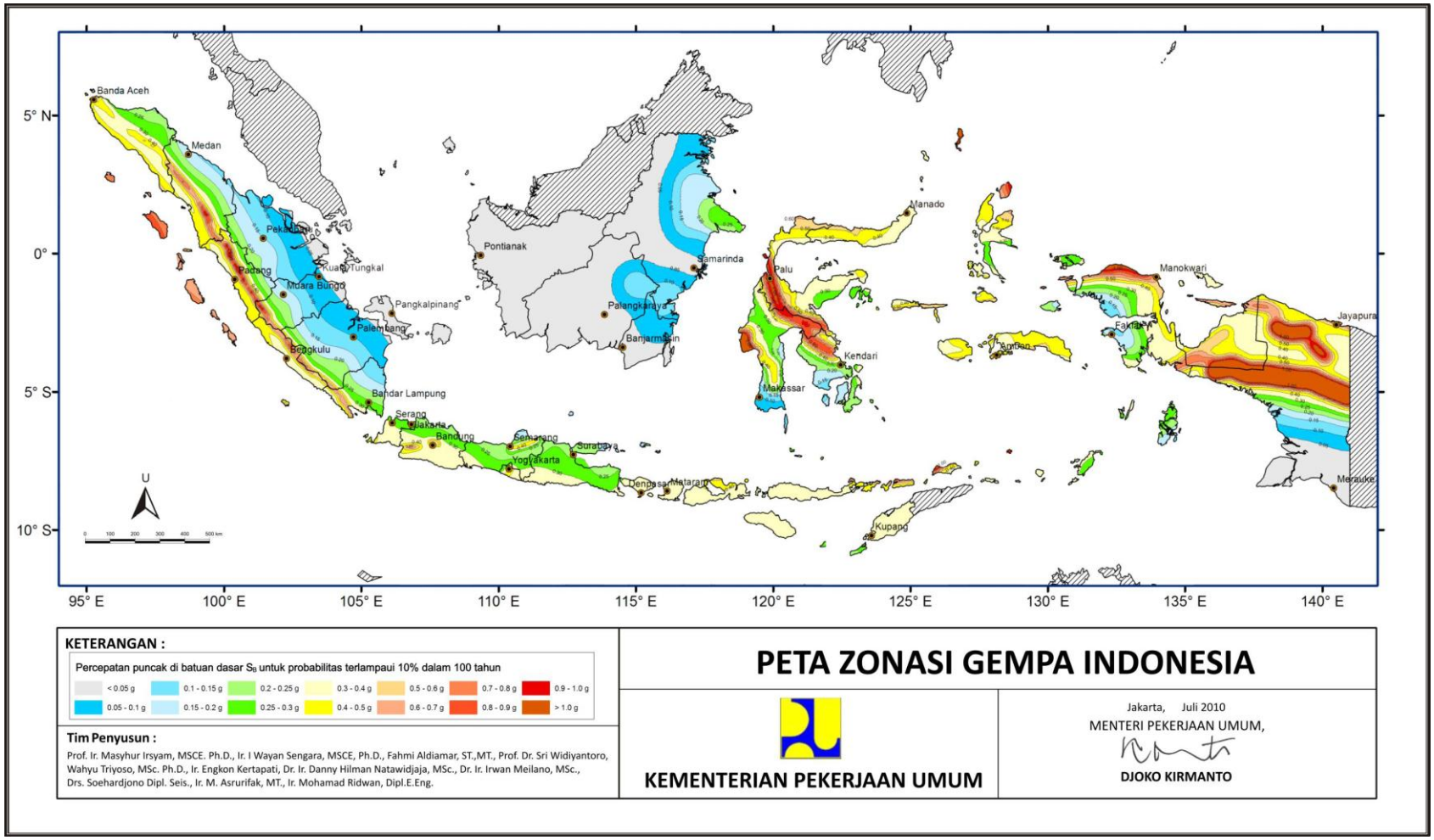
Gambar L1.1 Peta percepatan puncak (PGA) di batuan dasar (SB) untuk probabilitas terlampaui 10% dalam 50 tahun



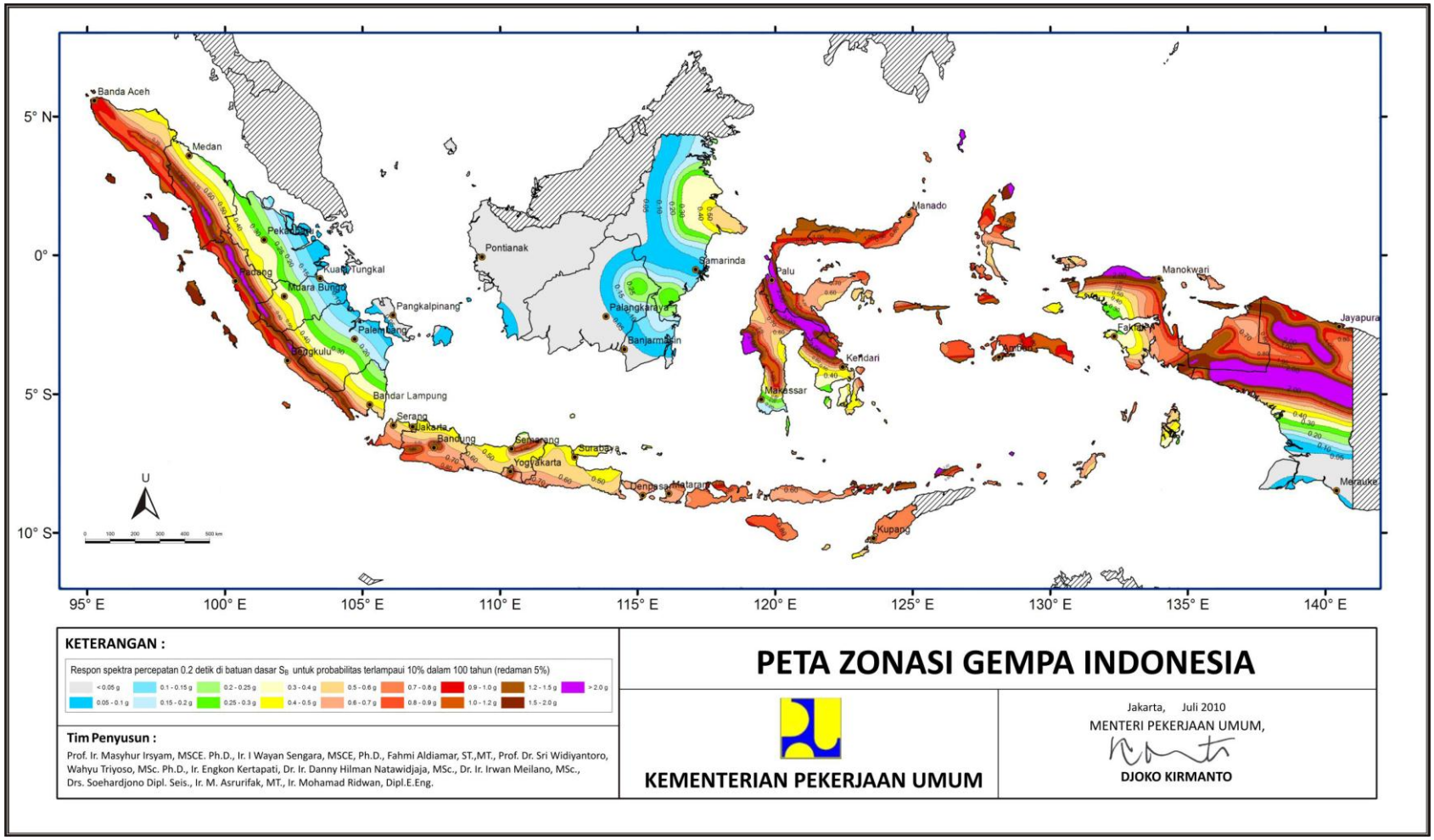
Gambar L1.2 Peta respon spektra percepatan 0.2 detik (S_S) di batuan dasar (S_B) untuk probabilitas terlampaui 10% dalam 50 tahun



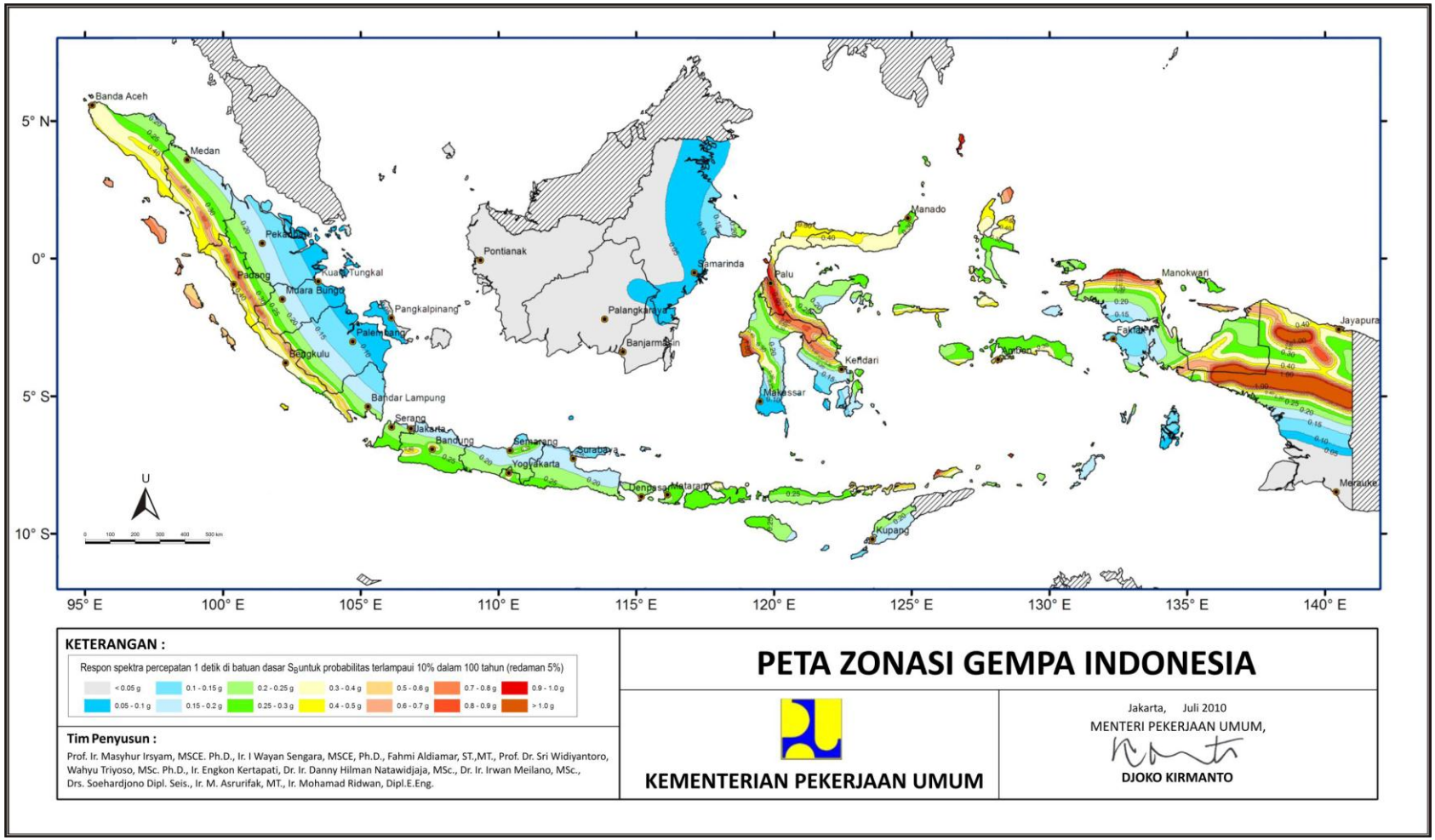
Gambar L1.3 Peta respon spektra percepatan 1.0 detik (S_1) di batuan dasar (S_B) untuk probabilitas terlampaui 10% dalam 50 tahun



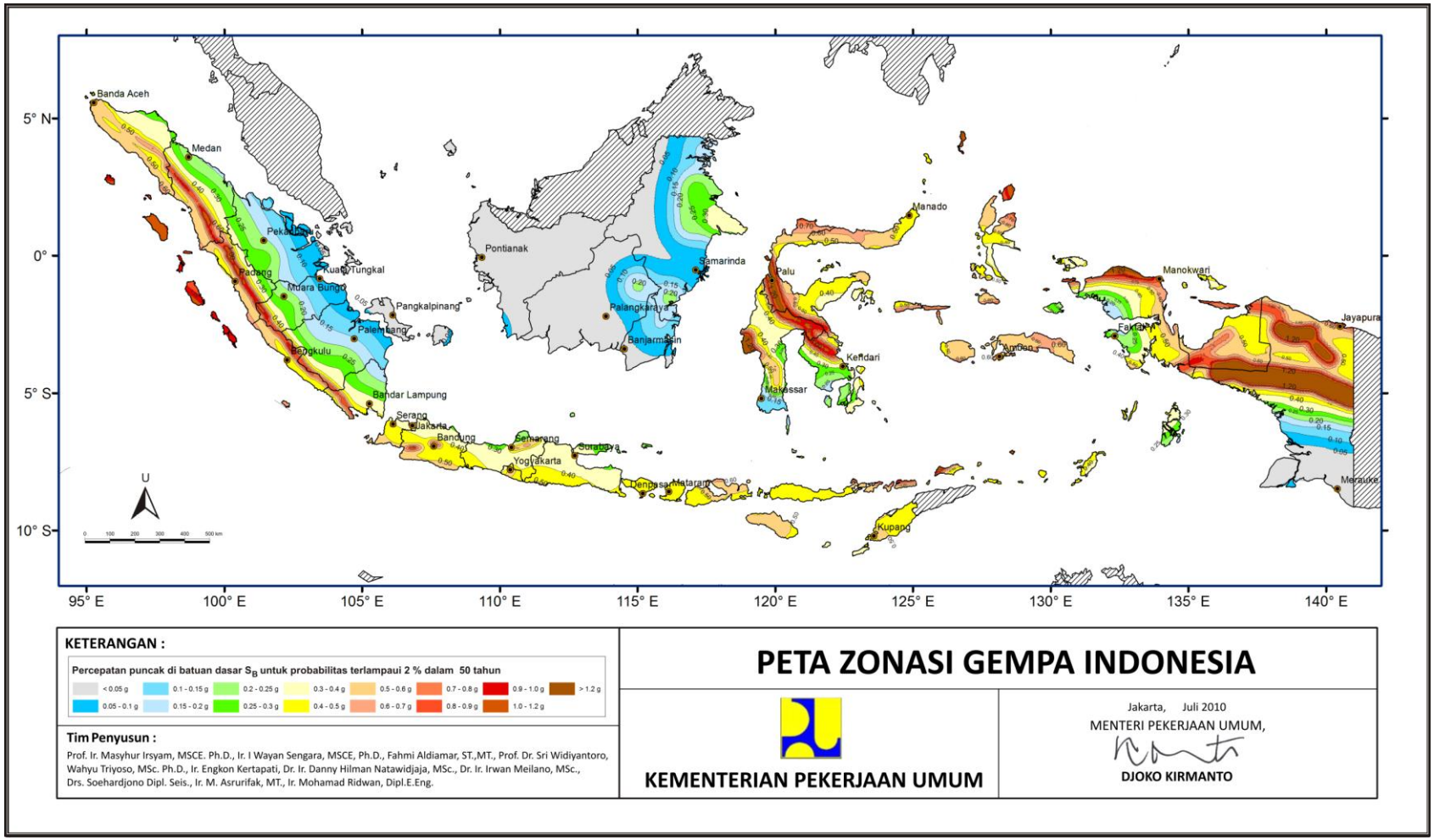
Gambar L1.4 Peta percepatan puncak (PGA) di batuan dasar (S_B) untuk probabilitas terlampaui 10% dalam 100 tahun



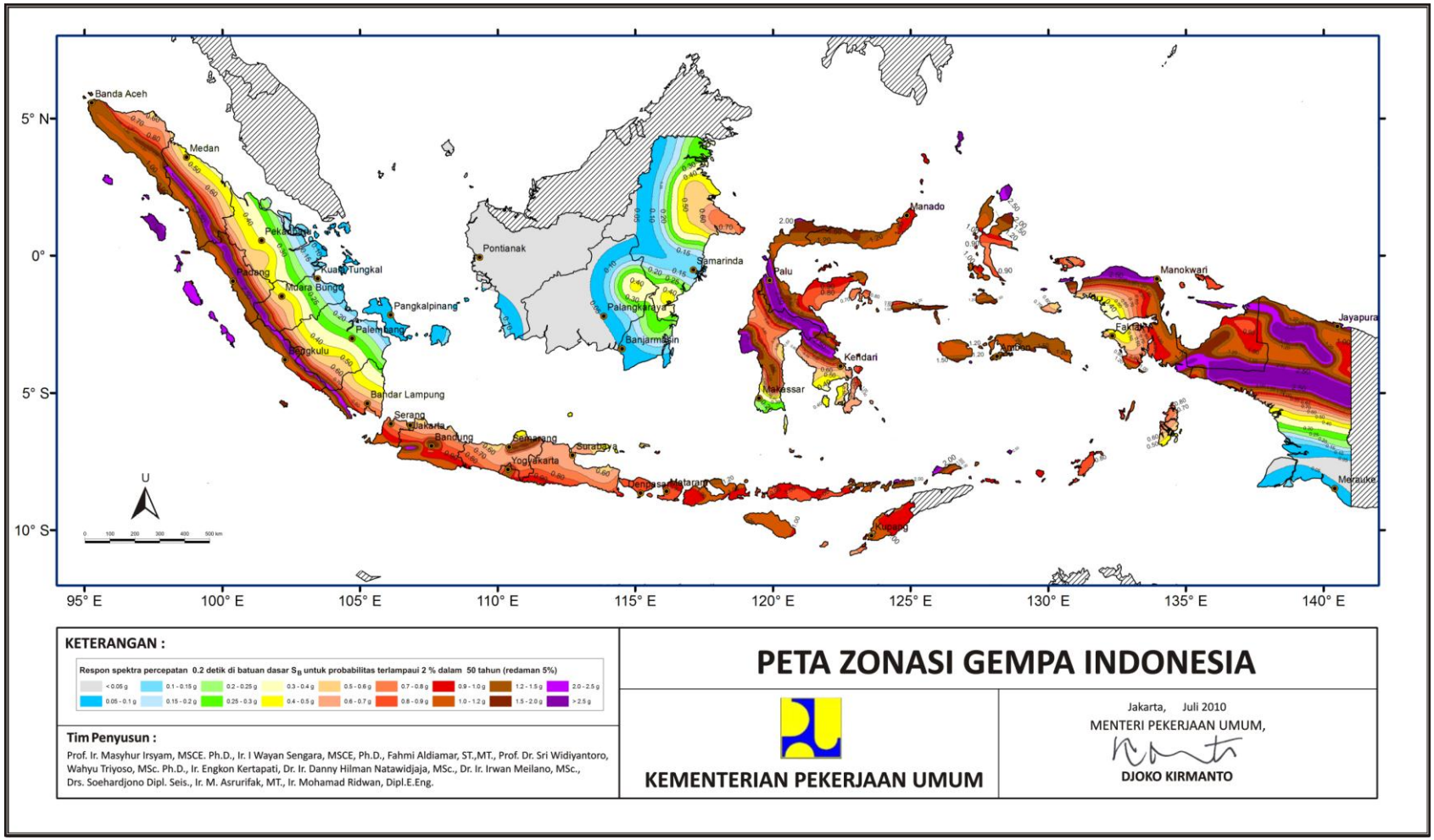
Gambar L1.5 Peta respon spektra percepatan 0.2 detik (S_S) di batuan dasar (S_B) untuk probabilitas terlampaui 10% dalam 100 tahun



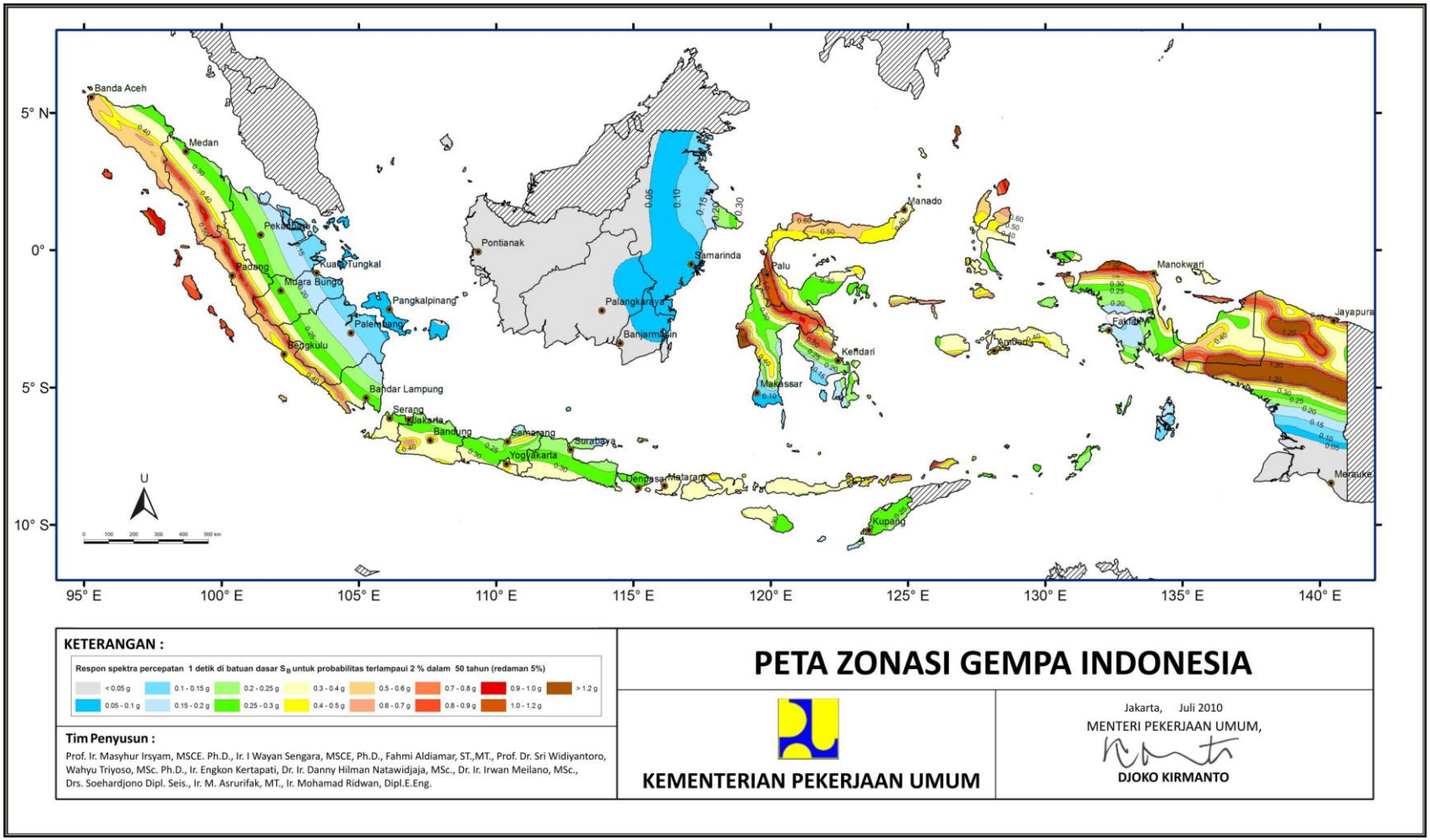
Gambar L1.6 Peta respon spektra percepatan 1.0 detik (S_1) di batuan dasar (S_B) untuk probabilitas terlampaui 10% dalam 100 tahun



Gambar L1.7 Peta percepatan puncak (PGA) di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun



Gambar L1.8 Peta respon spektra percepatan 0.2 detik (S_S) di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun



Gambar L1.9 Peta respon spektra percepatan 1.0 detik (S_1) di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun

LAMPIRAN 2

(Hasil Analisis ETABS Gedung berdasarkan Peta Gempa 2002)

Mode	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
1	0.60906	0	85.0215	0	0	85.0215	0	96.9703	0	2.2837	96.9703	0	2.2837
2	0.60331	87.2724	0	0	87.2724	85.0215	0	0	99.4932	0	96.9703	99.4932	2.2837
3	0.53181	0	2.2191	0	87.2724	87.2405	0	2.521	0	85.6424	99.4913	99.4932	87.9261
4	0.18988	0	9.3025	0	87.2724	96.5431	0	0.3049	0	0.2961	99.7961	99.4932	88.2222
5	0.18823	9.6239	0	0	96.8963	96.5431	0	0	0.3169	0	99.7961	99.8102	88.2222
6	0.16803	0	0.3155	0	96.8963	96.8586	0	0.0102	0	8.8818	99.8063	99.8102	97.104
7	0.10352	0	2.4746	0	96.8963	99.3332	0	0.1836	0	0.1174	99.9899	99.8102	97.2214
8	0.10263	2.5743	0	0	99.4706	99.3332	0	0	0.1896	0	99.9899	99.9998	97.2214
9	0.09343	0	0.1302	0	99.4706	99.4633	0	0.0099	0	2.2907	99.9998	99.9998	99.5121
10	0.07052	0	0.498	0	99.4706	99.9613	0	0.0001	0	0.0344	100	99.9998	99.5465
11	0.06998	0.5294	0	0	100	99.9613	0	0	0.0002	0	100	100	99.5465
12	0.06456	0	0.0387	0	100	100	0	0	0	0.4535	100	100	100

Tabel L2.1 ***Modal Participating Mass Ratio***

meter (M)

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORY4	1	E	-0.0018	0.0075	0	-0.0002	-0.00004	0.00036
STORY3	1	E	-0.0016	0.0063	0	-0.0004	-0.00008	0.00031
STORY2	1	E	-0.0011	0.0045	0	-0.0005	-0.00012	0.00022
STORY1	1	E	-0.0006	0.0022	0	-0.0006	-0.00014	0.00011

Tabel L2.2 ***Point Displacements***

meter(M)

Story	Diaphragm	Load	UX	UY	Z	X	Y	RZ	Point	X	Y	Z
STORY4	D4	E	-0.0002	0.0092	0	0	0	0.00036	959	4.914	5.000	12.5
STORY3	D3	E	-0.0002	0.008	0	0	0	0.00031	960	5.249	5.367	9.5
STORY2	D2	E	-0.0001	0.0056	0	0	0	0.00022	961	4.89	5.000	6.5
STORY1	D1	E	0	0.0028	0	0	0	0.00011	962	4.886	5.000	3.5

Tabel L2.3 ***Diagraph CM Displacements***

Meter(M)

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY4	Max Drift X	E	8	0	0	12.5	0.000076	
STORY4	Max Drift Y	E	10	10	0	12.5		0.000524
STORY3	Max Drift X	E	10	10	0	9.5	0.000146	
STORY3	Max Drift Y	E	10	10	0	9.5		0.000895
STORY2	Max Drift X	E	4	10	10	6.5	0.000186	
STORY2	Max Drift Y	E	10	10	0	6.5		0.001141
STORY1	Max Drift X	E	10	1	0	3.5	0.000159	
STORY1	Max Drift Y	E	10	10	0	3.5		0.000954

Tabel L2.4 ***Story Drifts***

meter (M)

Story	Point	Load	FX	FY	FZ	MX	MY	MZ
BASE	1	COMB1	449.34	-1387.86	19622.4	2986.094	887.261	-105.816
BASE	2	COMB1	610.43	-1771.75	32180.9	3706.195	1072.328	-105.816
BASE	3	COMB1	-54.51	-2015.01	23887.27	4404.276	308.421	-105.816
BASE	4	COMB1	172.26	-1513.64	25299.91	3130.591	220.097	-105.816
BASE	5	COMB1	394.27	-2524.89	49739.14	5564.931	486.648	-169.496
BASE	6	COMB1	-541.12	-2297.9	32395.02	4729.266	-599.458	-105.816
BASE	7	COMB1	-205.32	-962.8	12006.34	2497.767	-562.52	-105.816
BASE	8	COMB1	-176.93	-1129.71	25798.67	2968.593	-529.909	-105.816
BASE	9	COMB1	-648.43	-1576.57	16505.35	3900.577	-1071.59	-105.816

Tabel L2.5 ***Support Reactions***

LAMPIRAN 3

(Hasil Analisis ETABS Gedung berdasarkan Peta Gempa 2010)

Mode	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
1	0.60906	0	85.0215	0	0	85.0215	0	96.9703	0	2.2837	96.9703	0	2.2837
2	0.60331	87.2724	0	0	87.2724	85.0215	0	0	99.4932	0	96.9703	99.4932	2.2837
3	0.53181	0	2.2191	0	87.2724	87.2405	0	2.521	0	85.6424	99.4913	99.4932	87.9261
4	0.18988	0	9.3025	0	87.2724	96.5431	0	0.3049	0	0.2961	99.7961	99.4932	88.2222
5	0.18823	9.6239	0	0	96.8963	96.5431	0	0	0.3169	0	99.7961	99.8102	88.2222
6	0.16803	0	0.3155	0	96.8963	96.8586	0	0.0102	0	8.8818	99.8063	99.8102	97.104
7	0.10352	0	2.4746	0	96.8963	99.3332	0	0.1836	0	0.1174	99.9899	99.8102	97.2214
8	0.10263	2.5743	0	0	99.4706	99.3332	0	0	0.1896	0	99.9899	99.9998	97.2214
9	0.09343	0	0.1302	0	99.4706	99.4633	0	0.0099	0	2.2907	99.9998	99.9998	99.5121
10	0.07052	0	0.498	0	99.4706	99.9613	0	0.0001	0	0.0344	100	99.9998	99.5465
11	0.06998	0.5294	0	0	100	99.9613	0	0	0.0002	0	100	100	99.5465
12	0.06456	0	0.0387	0	100	100	0	0	0	0.4535	100	100	100

Tabel L3.1 ***Modal Participating Mass Ratio***

meter(M)

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORY 4	1	E	-0.0010	0.0042	0	-0.0001	-0.00002	0.00020
STORY 3	1	E	-0.0009	0.0036	0	-0.0002	-0.00005	0.00018
STORY 2	1	E	-0.0006	0.0026	0	-0.0003	-0.00007	0.00013
STORY 1	1	E	-0.0003	0.0013	0	-0.0004	-0.00008	0.00006

Tabel L3.2 ***Point Displacements***

meter(M)

Story	Diaphragm	Load	UX	UY	Z	X	Y	RZ	Point	X	Y	Z
STORY4	D4	E	-0.0002	0.0052	0	0	0	0.0002	647	4.914	5.000	12.500
STORY3	D3	E	-0.0002	0.0045	0	0	0	0.00018	648	5.249	5.367	9.500
STORY2	D2	E	-0.0001	0.0032	0	0	0	0.00013	649	4.89	5.000	6.500
STORY1	D1	E	0.0000	0.0016	0	0	0	0.00006	650	4.886	5.000	3.500

Tabel L3.3 ***Diagram CM Displacements***

meter (M)

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY4	Max Drift X	COMB1	4	10	10	12.5	0.00006	
STORY4	Max Drift Y	COMB1	10	10	0	12.5		0.000296
STORY3	Max Drift X	COMB1	4	10	10	9.5	0.00009	
STORY3	Max Drift Y	COMB1	10	10	0	9.5		0.000506
STORY2	Max Drift X	COMB1	4	10	10	6.5	0.00012	
STORY2	Max Drift Y	COMB1	10	10	0	6.5		0.000644
STORY1	Max Drift X	COMB1	4	10	10	3.5	0.0001	
STORY1	Max Drift Y	COMB1	10	10	0	3.5		0.000539

Tabel 3.4 ***Story Drifts***

meter (M)

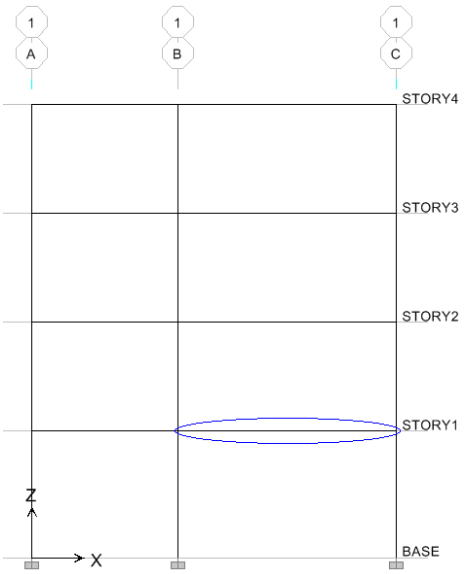
Story	Point	Load	FX	FY	FZ	MX	MY	MZ
BASE	1	COMB1	306.93	-876.52	17965.82	1793.215	571.896	-59.782
BASE	2	COMB1	439.17	-1140.63	30792.62	2254.304	723.812	-59.782
BASE	3	COMB1	-183.7	-1233.78	22281.56	2597.816	8.241	-59.782
BASE	4	COMB1	172.26	-855.16	25299.84	1768.676	220.098	-59.782
BASE	5	COMB1	394.28	-1426.47	49739.13	3143.983	486.65	-95.759
BASE	6	COMB1	-541.12	-1298.23	32395.02	2671.858	-599.457	-59.782
BASE	7	COMB1	-62.91	-451.5	13662.99	1304.934	-247.162	-59.782
BASE	8	COMB1	-5.66	-498.59	27186.94	1516.706	-181.391	-59.782
BASE	9	COMB1	-519.24	-795.34	18111.07	2094.117	-771.408	-59.782

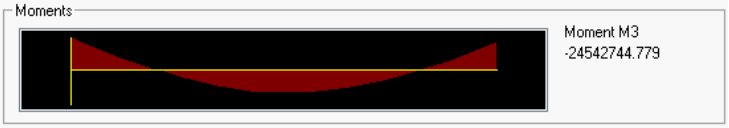
Tabel L3.5 ***Support Reactions***

LAMPIRAN 4

(Perhitungan Jumlah Tulangan Balok)

Tumpuan Tump Kiri 2002





Penampang persegi beton bertulang dengan h = 450 mm, b = 300 mm, menerima momen M_u = 24542744,779 Nmm Desain penampang tulangan ganda.

Solusi:

Asumsikan : $d = dt = h - 38 = 450 - 38 = 412$ mm, $\rightarrow$ $d' = 38$ mm

$$f_c^{'} = 25 \text{ MPa} \rightarrow \beta_1 = 0{,}85$$

$$\overline{\rho}_b = \beta_1 \frac{0{,}85.f_c^{'}}{f_y}.\frac{600}{600+f_y}$$

$$\overline{\rho}_b = 0{,}85\frac{0{,}85.25}{400}.\frac{600}{600+400}$$

$$\overline{\rho}_b = 0{,}0271$$

$$A_{s1} = 0{,}1.\overline{\rho}_b.b.d$$

$$A_{s1} = 0{,}1.0{,}0271.300.412$$

$$A_{s1} = 334{,}956 \text{ mm}^2$$

$$a = \frac{A_{s1}.f_y}{0{,}85.f_c^{'}.b} = \frac{334{,}956.400}{0{,}85.25.300} = 21{,}017 \text{ mm}$$

$$M_{n1} = A_{s1}.f_y.(d - \frac{1}{2}a)$$

$$M_{n1} = 334,956.400.(412 - \frac{1}{2}21,017)$$

$$M_{n1} = 53789177,22 \text{ Nmm}$$

$$M_n = \frac{M_u}{\phi_{lentur}} = \frac{24542744,779}{0,9} = 27269716,41 \text{ Nmm}$$

$$M_{n2} = M_n - M_{n1} = 27269716,41 - 53792794,75 = 26523078,34 \text{ Nmm}$$

$$A_{s2} = A_s' = \frac{M_{n2}}{f_y.(d-d')} = \frac{26523078,34}{400.(412-38)} = 177,293 \text{ mm}^2$$

$$A_s = A_{s1} + A_{s2} = 334,956 + 177,293 = 512,249 \text{ mm}^2$$

$$A_{s,\min} = \frac{\sqrt{f_c'}}{4.f_y}.b_w.d = \frac{\sqrt{25}}{4.400}.300.412 = 386,25 \text{ mm}^2 < \frac{1,4}{f_y}.b_w.d = \frac{1,4}{400}.300.412 =$$

$$432,6 \text{ mm}^2$$

$A_s = 512,249 \text{ mm}^2 > A_{s,min} = 432,6 \text{ mm}^2$,,,,,,, Ok → Pakai 3D16 (603mm)

$$\rho = \frac{A_s}{b.d} = \frac{512,249}{300.412} = 0,00414 \qquad \rho' = \frac{A_s'}{b.d} = \frac{177,293}{300.412} = 0,00143$$

$$\rho - \rho' \geq \frac{\beta 1.0,85.f_c'.d'}{f_y.d} \cdot \frac{600}{600 - f_y}$$

$$0,00414 - 0,00143 \geq \frac{0,85.0,85.25.38}{400.412} \cdot \frac{600}{600-400}$$

$$0,00271 \leq 0,0125$$

$$f_s' = 600\{1 - \frac{0,85.f_c'.\beta 1.d'}{(\rho - \rho')f_y.d}\} \leq f_y$$

$$f_s' = 600\{1 - \frac{0,85.25.0,85.38}{(0,00271).400.412}\} \leq f_y$$

$f_s' = 322{,}117 \leq f_y = 400$ MPa

$f_{sb}' = 600 - \frac{d'}{d}(600 + f_y) \leq f_y$

$f_{sb}' = 600 - \frac{38}{412}(600 + 400) \leq f_y$

$f_{sb}' = 507{,}767$ MPa ≥ 400 MPa

$f_{sb}' = f_y = 400$ MPa

$\rho \leq 0{,}75 \,.\, \overline{\rho}_b + \frac{\rho'.f_{sb}'}{f_y}$

$0{,}00414 \leq 0{,}75 \,.\, 0{,}0271 + \frac{0{,}00143.400}{400}$

$0{,}00414 \leq 0{,}0217$

$$a = \frac{A_s f_y - A_s' f_s'}{0{,}85.f_c'.b} = \frac{512{,}249.400 - 177{,}293.400}{0{,}85.25.300} = 21{,}017 \text{ mm}$$

$M_n = \{(A_s f_y - A_s' f_s')(d - a/2) + A_s' f_s' (d - d')\}$

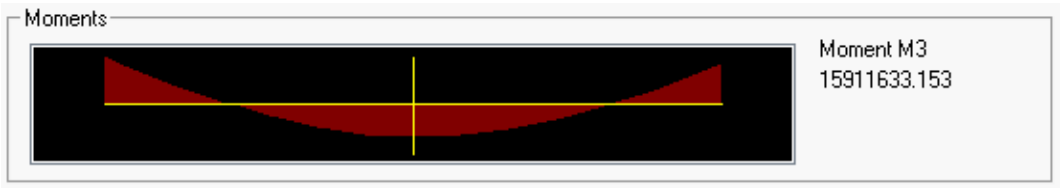
$M_n = \{(512{,}249.400 - 177{,}293.400)(412 - \frac{1}{2}21{,}017) + 177{,}293.400.(412 - 38)\}$

$M_n = 80315827{,}55$ Nmm

$M_u \leq \phi M_n$

$24542744{,}779$ Nmm $\leq 0{,}9 \,.\, 80315827{,}55 = 72284244{,}79$ Nmm $\rightarrow$ Ok

Lapangan 2002



Penampang persegi beton bertulang dengan h = 450 mm, b = 300 mm, mnerima momen M_u = 15911633,153 Nmm Desain penampang tulangan ganda.

Solusi:

Asumsikan : $d = dt = h - 38 = 450 - 38 = 412$ mm, $\rightarrow$ $d' = 38$ mm

$f_c^{'} = 25$ MPa $\rightarrow$ $\beta_1 = 0,85$

$$\overline{\rho}_b = \beta_1 \frac{0,85.f_c^{'}}{f_y}.\frac{600}{600+f_y}$$

$$\overline{\rho}_b = 0,85\frac{0,85.25}{400}.\frac{600}{600+400}$$

$$\overline{\rho}_b = 0,0271$$

$A_{s1} = 0,1.\ \overline{\rho}_b .b.d$

$A_{s1} = 0,1.0,0271.300.412$

$A_{s1} = 334,956$ mm^2

$$a = \frac{A_{s1}.f_y}{0,85.f_c^{'}.b}$$

$$a = \frac{334,956.400}{0,85.25.300}$$

a = 21,017 mm

$$M_{n1} = A_{s1}.\ f_c^{'}.(\ d - \frac{1}{2}a\ )$$

$$M_{n1} = 334,956.400.(\ 412 - \frac{1}{2}21,017\ )$$

$M_{n1} = 53792794,75$ Nmm

$$M_n = \frac{M_u}{\phi_{lentur}} = \frac{15911633,153}{0,9} = 17679592,39 \text{ Nmm}$$

$$M_{n2} = M_n - M_{n1} = 17679592,39 - 53792794,75 = 36113202,36 \text{ Nmm}$$

$$A_{S2} = A_S' = \frac{M_{n2}}{f_y.(d-d')} = \frac{36113202,36}{400.(412-38)} = 241,398 \text{ mm}^2$$

$$A_S = A_{S1} + A_{S2} = 334,956 + 241,398 = 576,354 \text{ mm}^2$$

$$A_{s,\min} = \frac{\sqrt{f_C'}}{4.fy}.b_w.d = \frac{\sqrt{25}}{4.400}.300.412 = 386,25 \text{ mm}^2 < \frac{1,4}{f_y}.b_w.d = \frac{1,4}{400}.300.412 =$$

$$432,6 \text{ mm}^2$$

$A_s = 576,354 \text{ mm}^2 > A_{s,\min} = 432,6 \text{ mm}^2$ ……Ok → Pakai 3D16 (603mm)

$$\rho = \frac{A_s}{b.d} = \frac{576,354}{300.412} = 0,00466 \qquad \rho' = \frac{A_s'}{b.d} = \frac{241,398}{300.412} = 0,00195$$

$$\rho - \rho' \geq \frac{\beta 1.0,85.f_C'.d'}{fy.d} . \frac{600}{600 - fy}$$

$$0,00466 - 0,00195 \geq \frac{0,85.0,85.25.38}{400.412} . \frac{600}{600 - 400}$$

$$0,00271 \leq 0,0125$$

$$f_c' = 600\{1 - \frac{0,85.f_C'.\beta 1.d'}{(\rho - \rho')fy.d}\} \leq f_y$$

$$f_c' = 600\{1 - \frac{0,85.25.0,85.38}{(0,00271)400.412}\} \leq f_y$$

$$f_c' = 322,117 \leq f_y = 400 \text{ MPa}$$

$$f_c' = f_y = 400 \text{ MPa}$$

$$f_{sb}' = 600 - \frac{d'}{d}(600 + f_y) \leq f_y$$

$f_{sb}' = 600 - \frac{38}{412}(600 + 400) \leq f_y$

$f_{sb}' = 507{,}767 \text{ MPa} \geq 400 \text{ MPa}$

$f_{sb}' = f_y = 400 \text{ MPa}$

$$\rho \leq 0{,}75 \,.\, \overline{\rho}_b + \frac{\rho'.f_{sb}'}{f_y}$$

$$0{,}00466 \leq 0{,}75 \,.\, 0{,}0271 + \frac{0{,}00195 \,.400}{400}$$

$0{,}00466 \leq 0{,}029$

$$a = \frac{A_S f_y - A_S' f_S'}{0{,}85.f_c'.b} = \frac{576{,}354.400 - 241{,}398 \,.400}{0{,}85.25.300} = 21{,}205 \text{ mm}$$

$M_n = \{(A_S f_y - A_S' f_S')(d - a/2) + A_S' f_S' (d - d')\}$

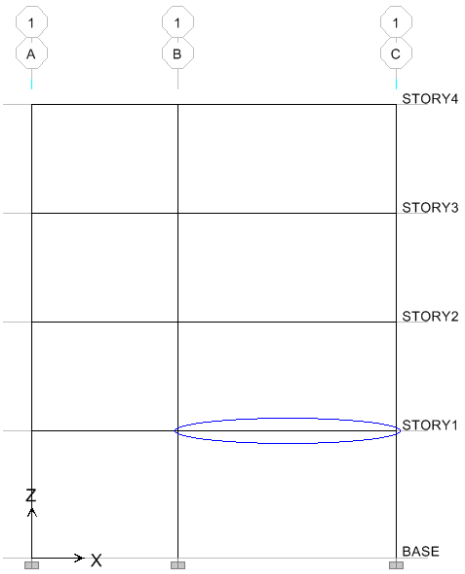
$M_n = \{(576{,}354.400 - 241{,}398.400)(412 - \frac{1}{2}21{,}205) + 241{,}398.400.(412 - 38)\}$

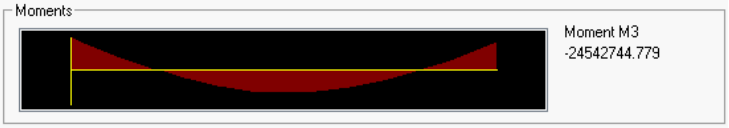
$M_n = 89893341{,}2 \text{ Nmm}$

$M_u \leq \phi M_n$

$16563527{,}810 \text{ Nmm} \leq 0{,}9 \,.\, 89893341{,}2 = 80904007{,}08 \text{ Nmm} \rightarrow \text{Ok}$

Tumpuan Tump Kiri 2010





Penampang persegi beton bertulang dengan h = 450 mm, b = 300 mm, menerima momen M_u = 24542744,779 Nmm Desain penampang tulangan ganda.

Solusi:

Asumsikan : $d = dt = h - 38 = 450 - 38 = 412$ mm, $\rightarrow$ $d' = 38$ mm

$$f_c^{'} = 25 \text{ MPa} \rightarrow \beta_1 = 0{,}85$$

$$\overline{\rho}_b = \beta_1 \frac{0{,}85.f_c^{'}}{f_y}.\frac{600}{600+f_y}$$

$$\overline{\rho}_b = 0{,}85\frac{0{,}85.25}{400}.\frac{600}{600+400}$$

$$\overline{\rho}_b = 0{,}0271$$

$$A_{s1} = 0{,}1.\overline{\rho}_b.b.d$$

$$A_{s1} = 0{,}1.0{,}0271.300.412$$

$$A_{s1} = 334{,}956 \text{ mm}^2$$

$$a = \frac{A_{s1}.f_y}{0{,}85.f_c^{'}.b}$$

$$a = \frac{334{,}956.400}{0{,}85.25.300} = 21{,}017 \text{ mm}$$

$$M_{n1} = A_{s1}.f_y.(d - \frac{1}{2}a)$$

$$M_{n1} = 334{,}956.400.(412 - \frac{1}{2}21{,}017)$$

$$M_{n1} = 53789177{,}22 \text{ Nmm}$$

$$M_n = \frac{M_u}{\phi_{lentur}} = \frac{24542744{,}779}{0{,}9} = 27269716{,}41 \text{ Nmm}$$

$$M_{n2} = M_n - M_{n1} = 27269716{,}41 - 53792794{,}75 = 26523078{,}34 \text{ Nmm}$$

$$A_{s2} = A_s' = \frac{M_{n2}}{f_y.(d - d')} = \frac{26523078{,}34}{400.(412 - 38)} = 177{,}293 \text{ mm}^2$$

$$A_s = A_{s1} + A_{s2} = 334{,}956 + 177{,}293 = 512{,}249 \text{ mm}^2$$

$$A_{s,\min} = \frac{\sqrt{f_c'}}{4.f_y}.b_w.d = \frac{\sqrt{25}}{4.400}.300.412 = 386{,}25 \text{ mm}^2 < \frac{1{,}4}{f_y}.b_w.d = \frac{1{,}4}{400}.300.412 =$$

$$432{,}6 \text{ mm}^2$$

$A_s = 512{,}249 \text{ mm}^2 > A_{s,min} = 432{,}6 \text{ mm}^2$,,,,,,, Ok → Pakai 3D16 (603mm)

$$\rho = \frac{A_s}{b.d} = \frac{512{,}249}{300.412} = 0{,}00414 \qquad \rho' = \frac{A_s'}{b.d} = \frac{177{,}293}{300.412} = 0{,}00143$$

$$\rho - \rho' \geq \frac{\beta 1.0{,}85.f_c'.d'}{f_y.d} \cdot \frac{600}{600 - f_y}$$

$$0{,}00414 - 0{,}00143 \geq \frac{0{,}85.0{,}85.25.38}{400.412} \cdot \frac{600}{600 - 400}$$

$$0{,}00271 \leq 0{,}0125$$

$$f_s' = 600\{1 - \frac{0{,}85.f_c'.\beta 1.d'}{(\rho - \rho')f_y.d}\} \leq f_y$$

$f_s' = 600\{1- \frac{0{,}85.25.0{,}85.38}{(0{,}00271).400.412}\} \leq f_y$

$f_s' = 322{,}117 \leq f_y = 400$ MPa

$f_{sb}' = 600 - \frac{d'}{d}(600 + f_y) \leq f_y$

$f_{sb}' = 600 - \frac{38}{412}(600 + 400) \leq f_y$

$f_{sb}' = 507{,}767$ MPa ≥ 400 MPa

$f_{sb}' = f_y = 400$ MPa

$\rho \leq 0{,}75 \,.\, \bar{\rho}_b + \frac{\rho'.f_{sb}'}{f_y}$

$0{,}00414 \leq 0{,}75 \,.\, 0{,}0271 + \frac{0{,}00143.400}{400}$

$0{,}00414 \leq 0{,}0217$

$a = \frac{A_s f_y - A_s' f_s'}{0{,}85.f_c'.b} = \frac{512{,}249.400 - 177{,}293.400}{0{,}85.25.300} = 21{,}017$ mm

$M_n = \{(A_s f_y - A_s' f_s')(d - a/2) + A_s' f_s' (d - d')\}$

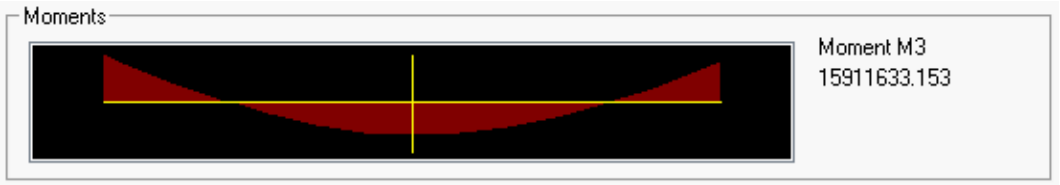
$M_n = \{(512{,}249.400 - 177{,}293.400)(412 - \frac{1}{2}21{,}017) + 177{,}293.400.(412 - 38)\}$

$M_n = 80315827{,}55$ Nmm

$M_u \leq \phi M_n$

$24542744{,}779$ Nmm $\leq 0{,}9 \,.\, 80315827{,}55 = 72284244{,}79$ Nmm $\rightarrow$ Ok

Lapangan 2010



Penampang persegi beton bertulang dengan h = 450 mm, b = 300 mm, mnerima momen M_u = 15911633,153 Nmm Desain penampang tulangan ganda.

Solusi:

Asumsikan : $d = dt = h - 38 = 450 - 38 = 412$ mm, $\rightarrow$ $d' = 38$ mm

$f_c^{'} = 25$ MPa $\rightarrow$ $\beta_1 = 0,85$

$$\overline{\rho}_b = \beta_1 \frac{0,85.f_c^{'}}{f_y}.\frac{600}{600+f_y}$$

$$\overline{\rho}_b = 0,85\frac{0,85.25}{400}.\frac{600}{600+400}$$

$$\overline{\rho}_b = 0,0271$$

$A_{s1} = 0,1.\ \overline{\rho}_b .b.d$

$A_{s1} = 0,1.0,0271.300.412$

$A_{s1} = 334,956$ mm^2

$$a = \frac{A_{s1}.f_y}{0,85.f_c^{'}.b}$$

$$a = \frac{334,956.400}{0,85.25.300}$$

a = 21,017 mm

$$M_{n1} = A_{s1}.\ f_c^{'}.(\ d - \frac{1}{2}a\ )$$

$$M_{n1} = 334,956.400.(\ 412 - \frac{1}{2}21,017\ )$$

$M_{n1} = 53792794,75$ Nmm

$$M_n = \frac{M_u}{\phi_{lentur}} = \frac{15911633,153}{0,9} = 17679592,39 \text{ Nmm}$$

$$M_{n2} = M_n - M_{n1} = 17679592,39 - 53792794,75 = 36113202,36 \text{ Nmm}$$

$$A_{S2} = A_S' = \frac{M_{n2}}{f_y.(d-d')} = \frac{36113202,36}{400.(412-38)} = 241,398 \text{ mm}^2$$

$$A_S = A_{S1} + A_{S2} = 334,956 + 241,398 = 576,354 \text{ mm}^2$$

$$A_{s,\min} = \frac{\sqrt{f_C'}}{4.fy}.b_w.d = \frac{\sqrt{25}}{4.400}.300.412 = 386,25 \text{ mm}^2 < \frac{1,4}{f_y}.b_w.d = \frac{1,4}{400}.300.412 =$$

$$432,6 \text{ mm}^2$$

$A_s = 576,354 \text{ mm}^2 > A_{s,\min} = 432,6 \text{ mm}^2$ ……Ok → Pakai 3D16 (603mm)

$$\rho = \frac{A_s}{b.d} = \frac{576,354}{300.412} = 0,00466 \qquad \rho' = \frac{A_s'}{b.d} = \frac{241,398}{300.412} = 0,00195$$

$$\rho - \rho' \geq \frac{\beta 1.0,85.f_C'.d'}{fy.d} \cdot \frac{600}{600 - fy}$$

$$0,00466 - 0,00195 \geq \frac{0,85.0,85.25.38}{400.412} \cdot \frac{600}{600-400}$$

$$0,00271 \leq 0,0125$$

$$f_c' = 600\{1 - \frac{0,85.f_C'.\beta 1.d'}{(\rho - \rho')fy.d}\} \leq f_y$$

$$f_c' = 600\{1 - \frac{0,85.25.0,85.38}{(0,00271)400.412}\} \leq f_y$$

$$f_c' = 322,117 \leq f_y = 400 \text{ MPa}$$

$$f_c' = f_y = 400 \text{ MPa}$$

$$f_{sb}' = 600 - \frac{d'}{d}(600 + f_y) \leq f_y$$

$f_{sb}' = 600 - \frac{38}{412}(600 + 400) \leq f_y$

$f_{sb}' = 507{,}767 \text{ MPa} \geq 400 \text{ MPa}$

$f_{sb}' = f_y = 400 \text{ MPa}$

$$\rho \leq 0{,}75 \,.\, \overline{\rho}_b + \frac{\rho' \cdot f_{sb}'}{f_y}$$

$$0{,}00466 \leq 0{,}75 \,.\, 0{,}0271 + \frac{0{,}00195 \,.400}{400}$$

$0{,}00466 \leq 0{,}029$

$$a = \frac{A_S f_y - A_S' f_S'}{0{,}85 . f_c' . b} = \frac{576{,}354 .400 - 241{,}398 \,.400}{0{,}85.25.300} = 21{,}205 \text{ mm}$$

$M_n = \{(A_S f_y - A_S' f_S')(d - a/2) + A_S' f_S' (d - d')\}$

$M_n = \{(576{,}354.400 - 241{,}398.400)(412 - \frac{1}{2} 21{,}205) + 241{,}398.400. (412 - 38)\}$

$M_n = 89893341{,}2 \text{ Nmm}$

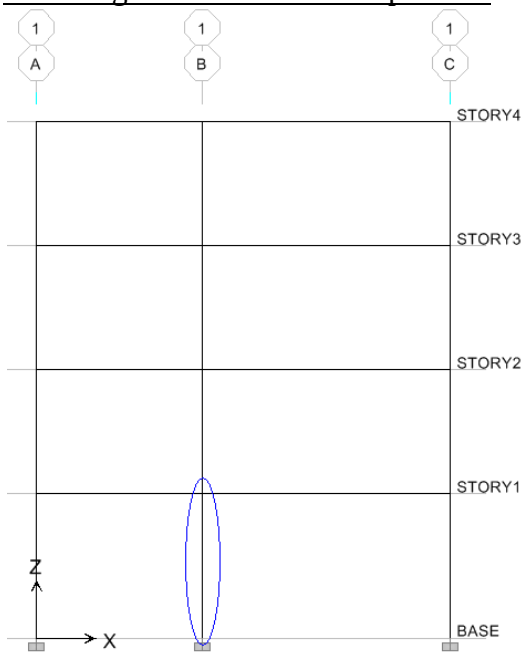
$M_u \leq \phi M_n$

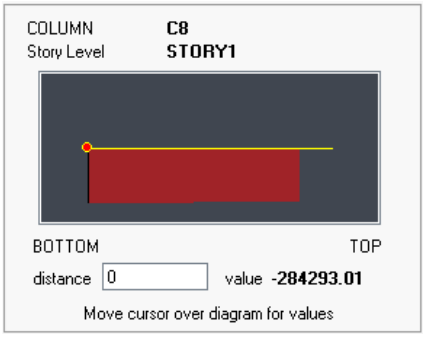
$16563527{,}810 \text{ Nmm} \leq 0{,}9 \,.\, 89893341{,}2 = 80904007{,}08 \text{ Nmm} \rightarrow \text{Ok}$

LAMPIRAN 5

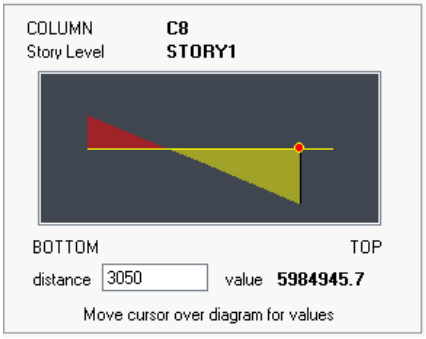
(Perhitungan Jumlah Tulangan Kolom)

Perhitungan Kolom Peta Gempa 2002





Gambar Nilai Pu



Gambar Nilai Mu

Kolom 400 x 400 mm

P_u = 284293,01 N

M_u = 5984945,7 Nmm

gh = h – 2 (cover + d_{bs}) - d_b = 400 – 2(20 + 10) – 16 = 324 mm

$$g = \frac{gh}{h} = \frac{324}{400} = 0{,}81$$

$$m = \frac{f_y}{0{,}85.f_c'} = \frac{400}{0{,}85.25} = 18{,}82$$

$$\frac{P_u}{f_c'.b.h} = \frac{284293{,}01}{25.400.400} = 0{,}071 \qquad \frac{M_u}{f_c'.b.h} = \frac{5984945{,}7}{25.400.400^2} = 0{,}00374$$

Kedua nilai tersebut diplotkan ke dalam grafik NZS, sehingga didapatkan nilai ρ_{tm}. dari Chart C5.3 380/0,8 dan C5.3 380/0,9

Untuk g = 0,8 → ρ_{tm} = 0,080

Untuk g = 0,9 → ρ_{tm} = 0,080

Untuk g = 0,81 → ρ_{tm} = 0,18 → $\rho_t = \frac{\rho_{tm}}{m} = \frac{0{,}18}{18{,}82} = 0{,}0095$

$A_{st,\text{perlu}} = \rho_t.b.h$ = 0,0095 . 400 . 400 = 1520 mm^2 → 8 D 16 = 1608 mm^2

$\phi P_{n,\max} = \phi[0{,}8\{0{,}85.f_c'(A_g - A_{st}) + A_{st}.f_y\}]$

= 0,65[0,8{0,85.25.(400^2 -1608) +1608.400}]

= 2084695,6 N > Pu = 284293,01 N..OK

$\rho_{t,\text{pakai}} = \frac{1608}{400^2} = 0{,}01005 \rightarrow \rho_{tm} = 0{,}01005 \,.\, 18{,}82 = 0{,}189$

$P_n = \frac{P_u}{\phi} = \frac{284293.01}{0{,}65} = 437373{,}86 \text{ N} \rightarrow \frac{P_n}{f_c'.b.h} = \frac{437373{,}86}{25.400.400} = 0{,}11$

Lihat Chart C6.4 380/0.8 untuk $\rho_{tm} = 0{,}189$

$\frac{P_n}{f_c'.b.h} = 0{,}11$

$\frac{M_u}{f_c'.b.h^2} = 0{,}102$

$M_n = 0{,}102 \text{ x } f_c' \text{ x } b \text{ x } h^2$

$= 0{,}102 \text{ x } 25 \text{ x } 400 \text{ x } 400^2$

$= 163200000 \text{ Nmm}$

$\phi M_n = 0{,}65 \text{ x } 163200000$

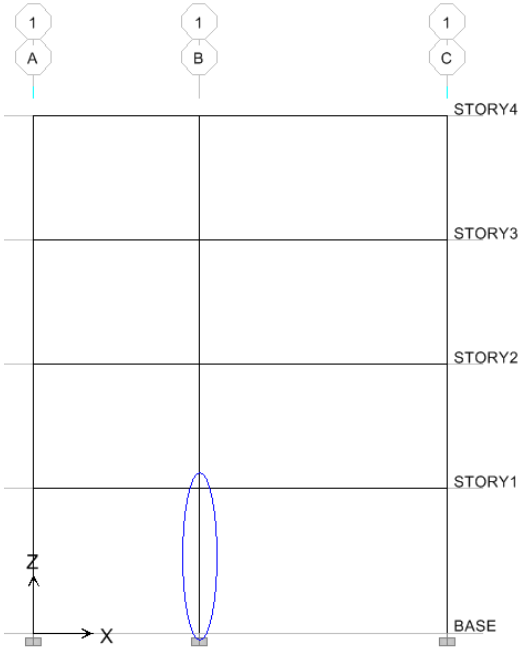
$\phi M_n = 106080000 \text{ Nmm}$

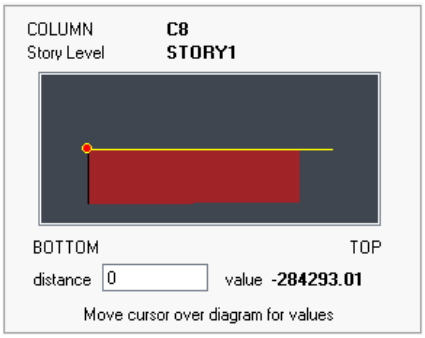
$\phi M_n > M_u$

$106080000 \text{ Nmm} > 5984945{,}7 \text{ Nmm} \rightarrow$ Kolom kuat

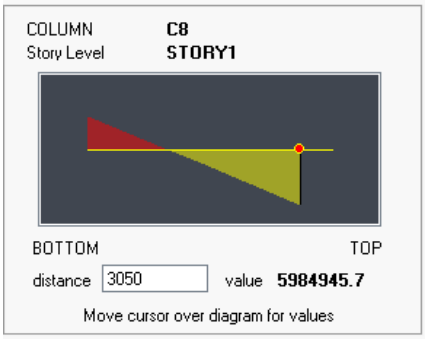
Hasil jumlah tulangan yang diperoleh baik dengan menggunakan ETABS dan cara manual diperoleh jumlah tulangan 8Ø16 dan kekuatan kolom sangat kuat.

Perhitungan Kolom Peta Gempa 2010





Gambar Nilai Pu



Gambar Nilai Mu

Kolom 400 x 400 mm

P_u = 284293,01 N

M_u = 5984945,7 Nmm

$gh = h - 2(\text{cover} + d_{bs}) - d_b = 400 - 2(20 + 10) - 16 = 324$ mm

$$g = \frac{gh}{h} = \frac{324}{400} = 0{,}81$$

$$m = \frac{f_y}{0{,}85.f_c'} = \frac{400}{0{,}85.25} = 18{,}82$$

$$\frac{P_u}{f_c'.b.h} = \frac{284293{,}01}{25.400.400} = 0{,}071 \qquad \frac{M_u}{f_c'.b.h^2} = \frac{5984945{,}7}{25.400.400^2} = 0{,}00374$$

Kedua nilai tersebut diplotkan ke dalam grafik NZS, sehingga didapatkan nilai ρ_{tm}. dari Chart C5.3 380/0,8 dan C5.3 380/0,9

Untuk $g = 0{,}8 \rightarrow \rho_{tm} = 0{,}080$

Untuk $g = 0{,}9 \rightarrow \rho_{tm} = 0{,}080$

Untuk $g = 0{,}81 \rightarrow \rho_{tm} = 0{,}18 \rightarrow \rho_t = \frac{\rho_{tm}}{m} = \frac{0{,}18}{18{,}82} = 0{,}0095$

$A_{st,\text{perlu}} = \rho_t.b.h = 0{,}0095 \,.\, 400 \,.\, 400 = 1520 \text{ mm}^2 \rightarrow$ 8 D 16 = 1608 mm^2

$\phi P_{n,\max} = \phi[0{,}8\{0{,}85.f_c'(A_g - A_{st}) + A_{st}.f_y\}]$

$= 0{,}65[0{,}8\{0{,}85.25.(400^2 - 1608) + 1608.400\}]$

= 2084695,6 N > Pu = 284293,01 N..OK

$\rho_{t,\text{pakai}} = \frac{1608}{400^2} = 0{,}01005 \rightarrow \rho_{tm} = 0{,}01005 \,.\, 18{,}82 = 0{,}189$

$P_n = \frac{P_u}{\phi} = \frac{284293.01}{0{,}65} = 437373{,}86 \text{ N} \rightarrow \frac{P_n}{f_c^{'}.b.h} = \frac{437373{,}86}{25.400.400} = 0{,}11$

Lihat Chart C6.4 380/0.8 untuk $\rho_{tm} = 0{,}189$

$\frac{P_n}{f_c^{'}.b.h} = 0{,}11$:

$\frac{M_u}{f_c^{'}.b.h^2} = 0{,}102$

$M_n = 0{,}102 \text{ x } f_c\text{' x } b \text{ x } h^2$

$= 0{,}102 \text{ x } 25 \text{ x } 400 \text{ x } 400^2$

$= 163200000$ Nmm

$\phi M_n = 0{,}65 \text{ x } 163200000$

$\phi M_n = 106080000$ Nmm

$\phi M_n > M_u$

106080000 Nmm > 5984945,7 Nmm → Kolom kuat

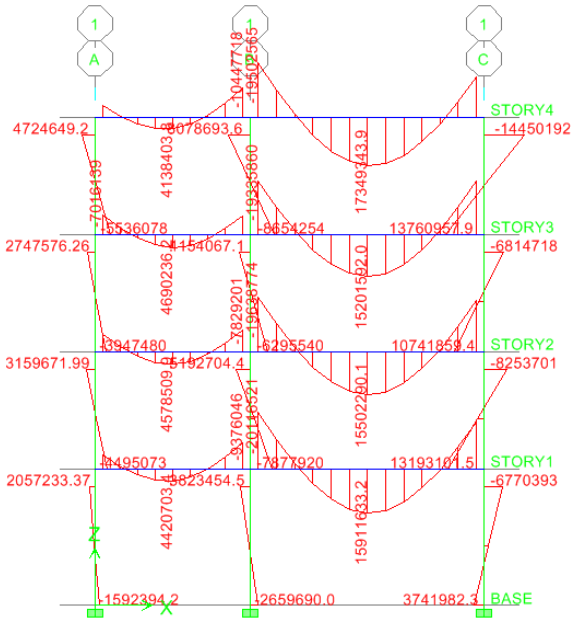
Hasil jumlah tulangan yang diperoleh baik dengan menggunakan ETABS dan cara manual diperoleh jumlah tulangan 8Ø16 dan kekuatan kolom sangat kuat.

LAMPIRAN 6

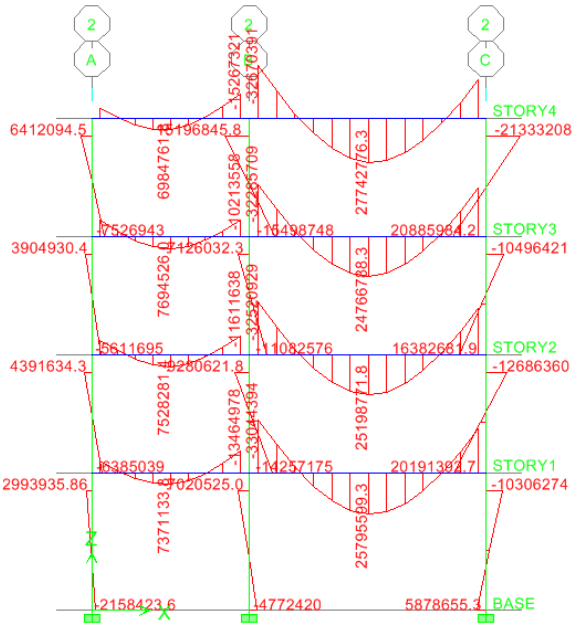
(Diagram *Moment* dan *Axial Force*)

Peta Gempa 2002

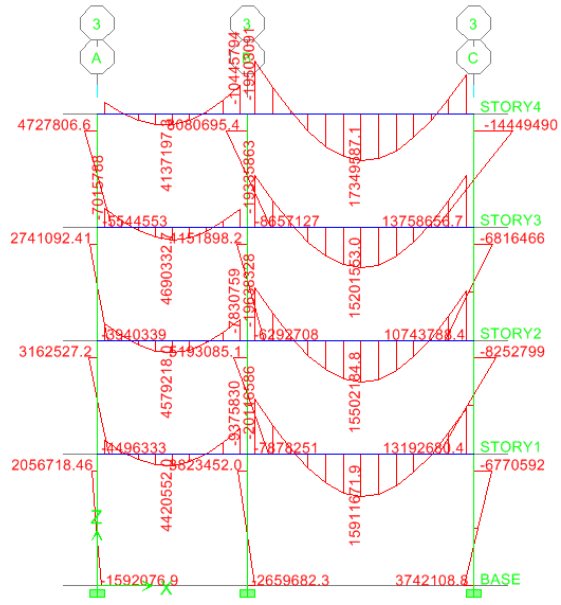
Moment 3-3 (Nmm) Pada Balok



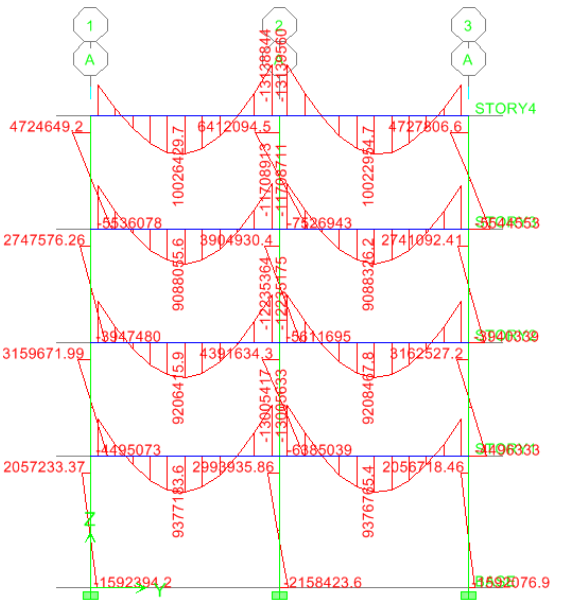
Potongan 1-1



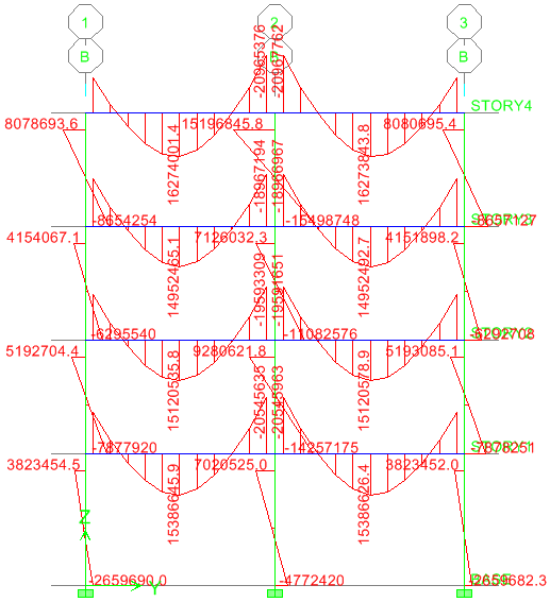
Potongan 2-2



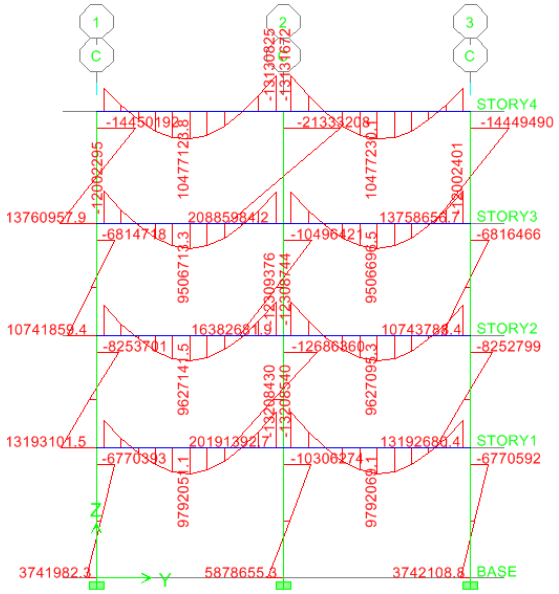
Potongan 3-3



Potongan A-A

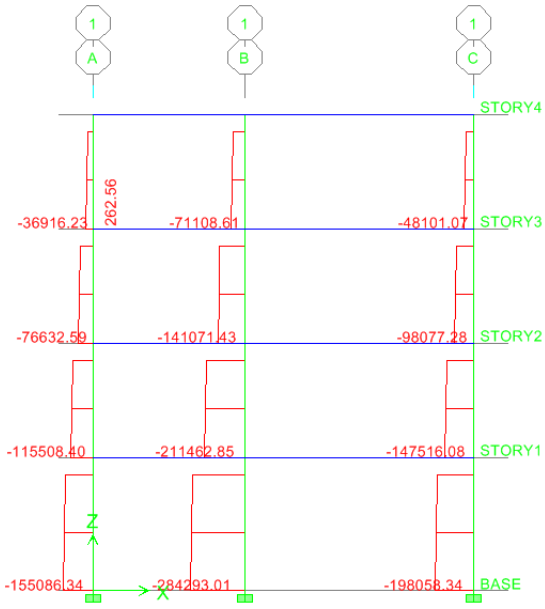


Potongan B-B

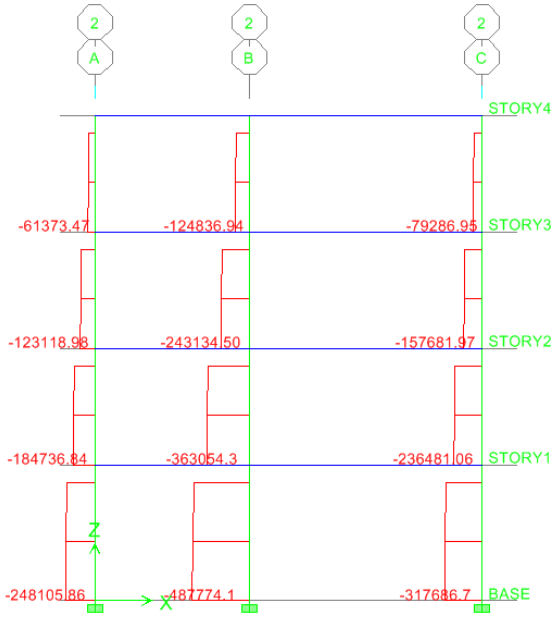


Potongan C-C

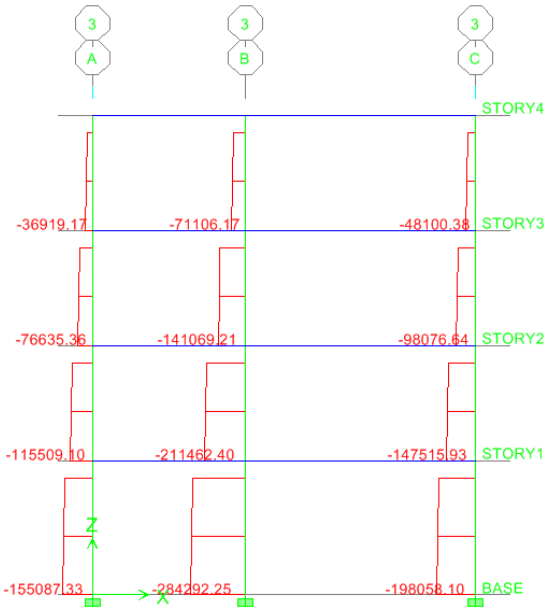
AXIAL FORCE **pada Kolom**



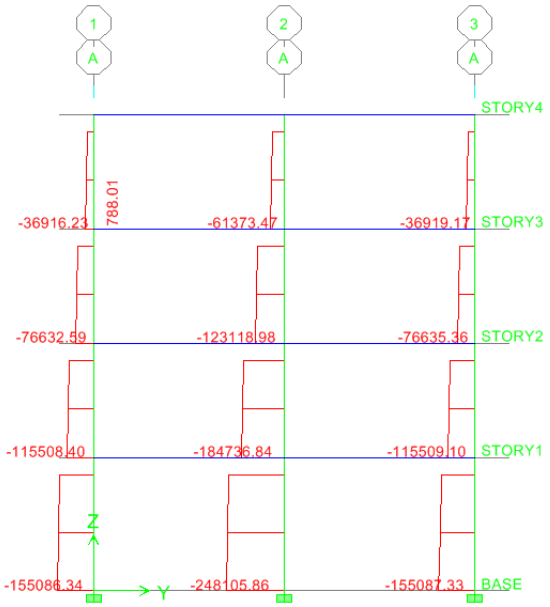
Potongan 1-1



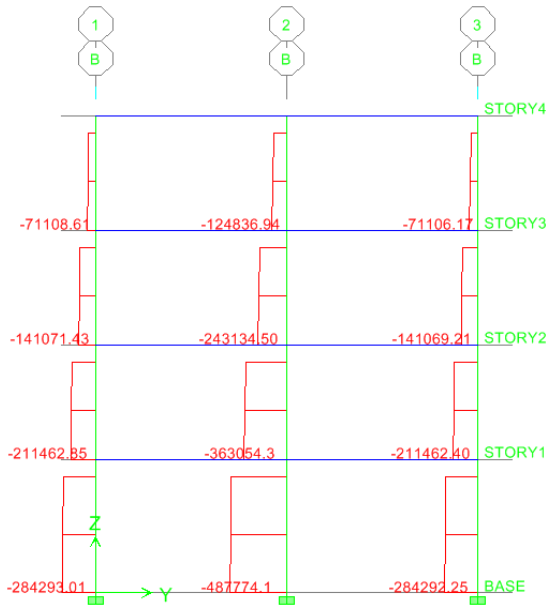
Potongan 2-2



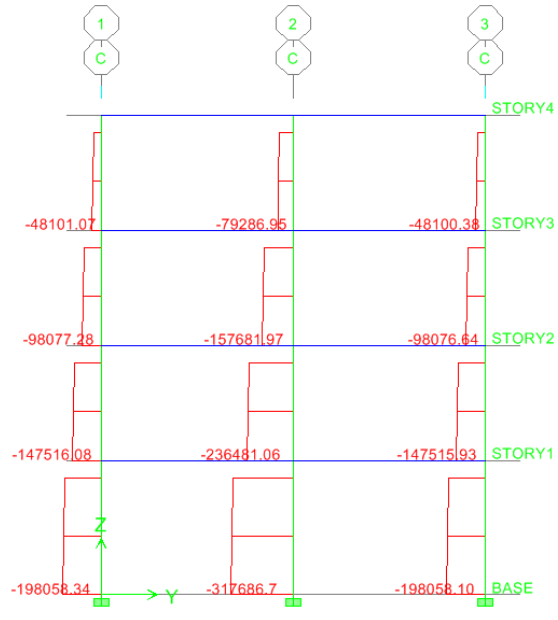
Potongan 3-3



Potongan A-A

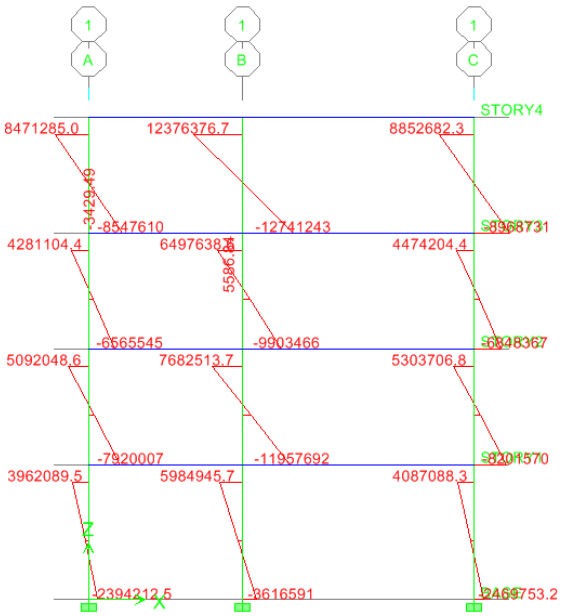


Potongan B-B

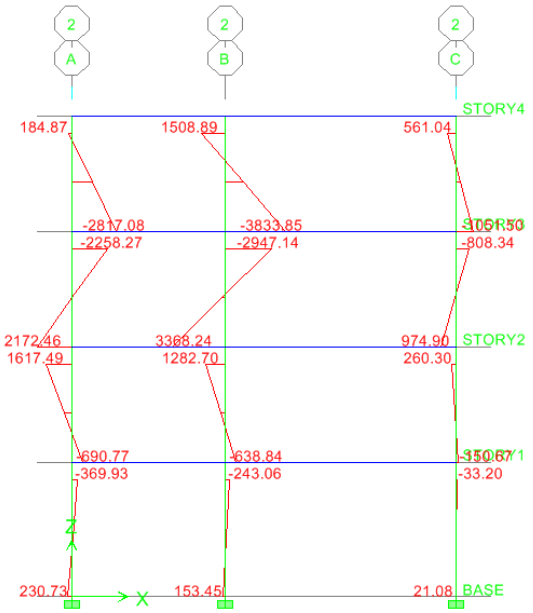


Potongan C-C

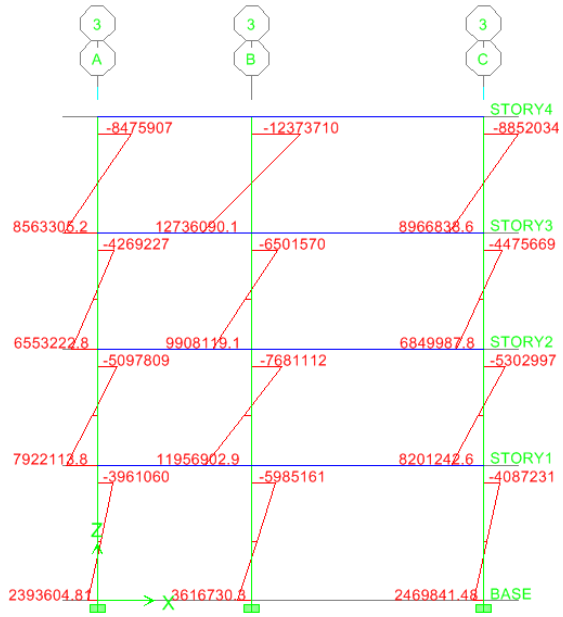
***MOMENT* 2-2 (Nmm) pada Kolom**



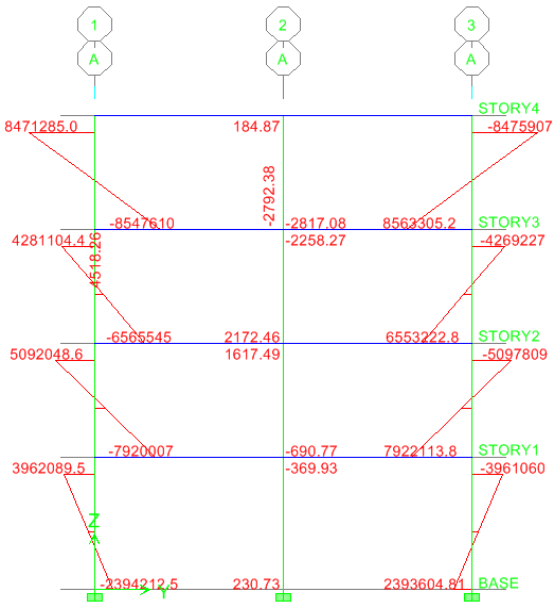
Potongan 1-1



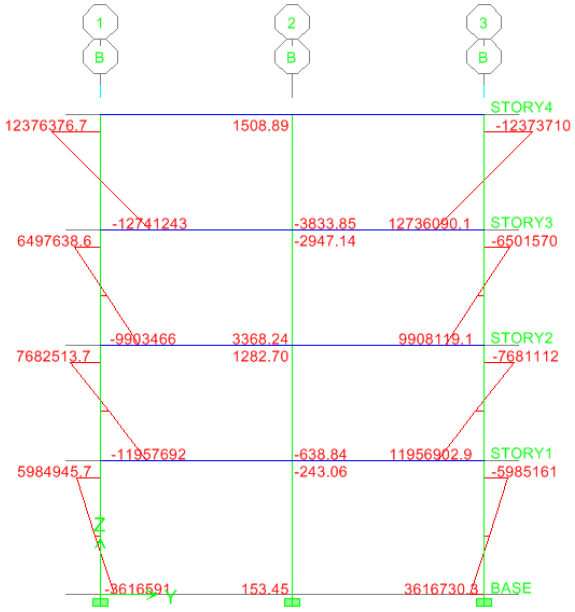
Potongan 2-2



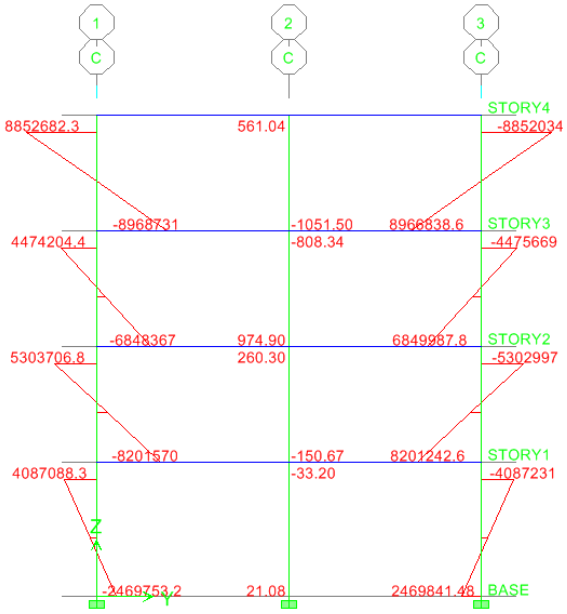
Potongan 3-3



Potongan A-A



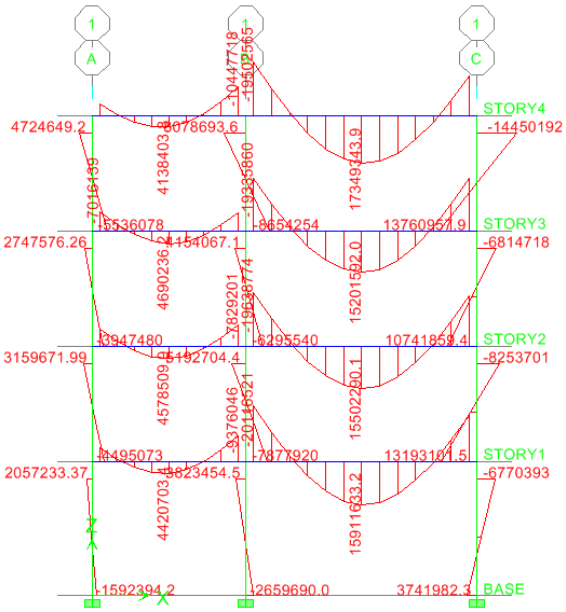
Potongan B-B



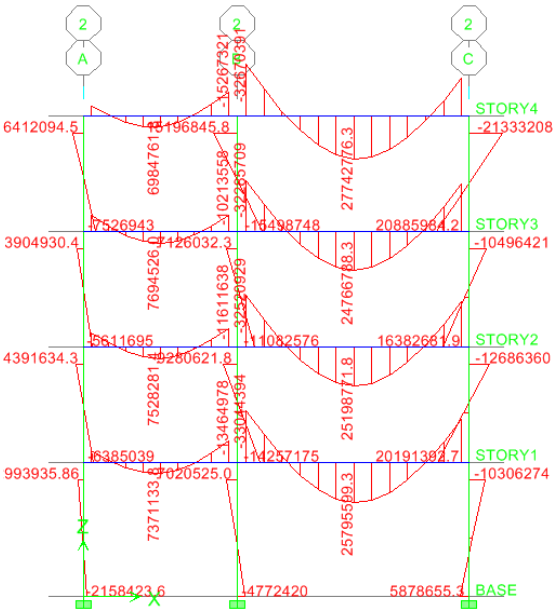
Potongan C-C

Peta Gempa 2010

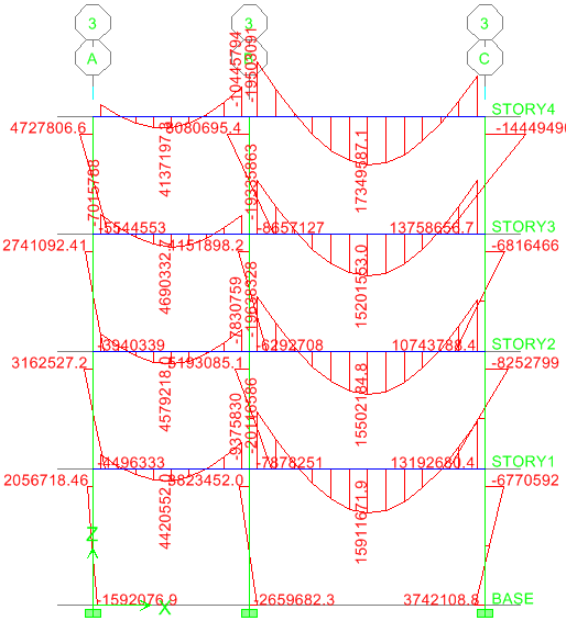
Moment 3-3 (Nmm) Pada Balok



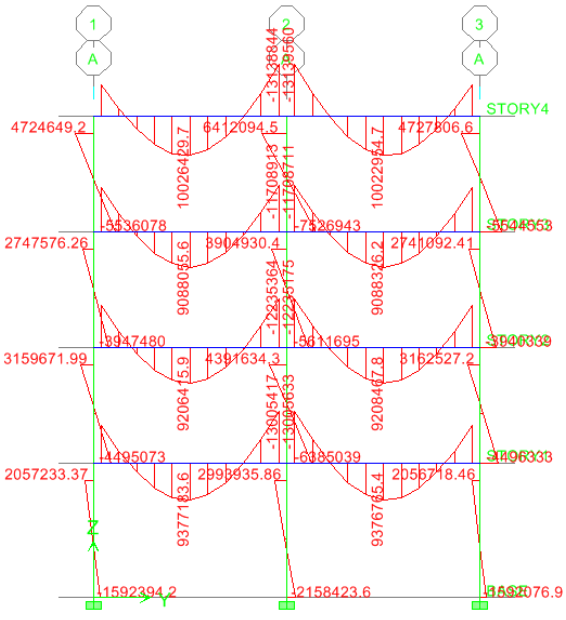
Potongan 1-1



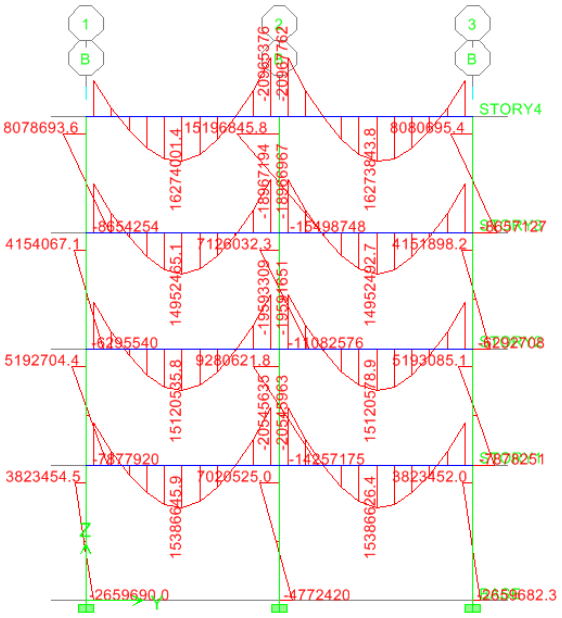
Potongan 2-2



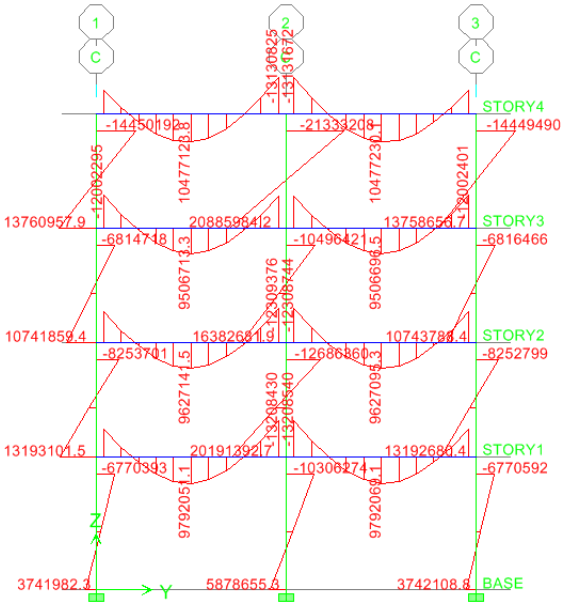
Potongan 3-3



Potongan A-A

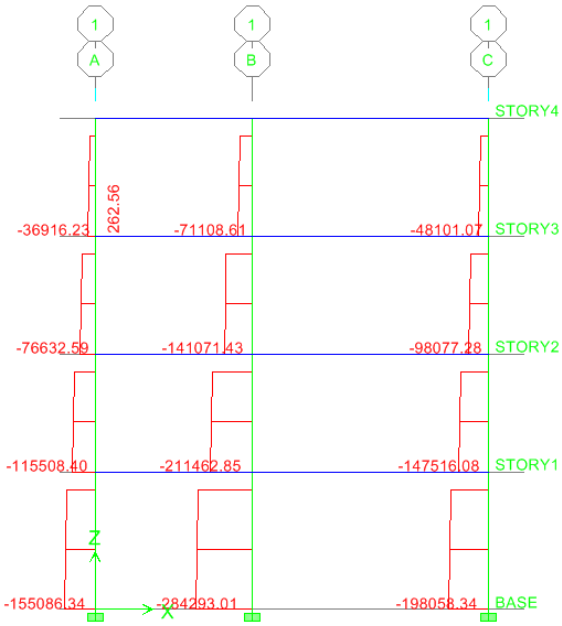


Potongan B-B

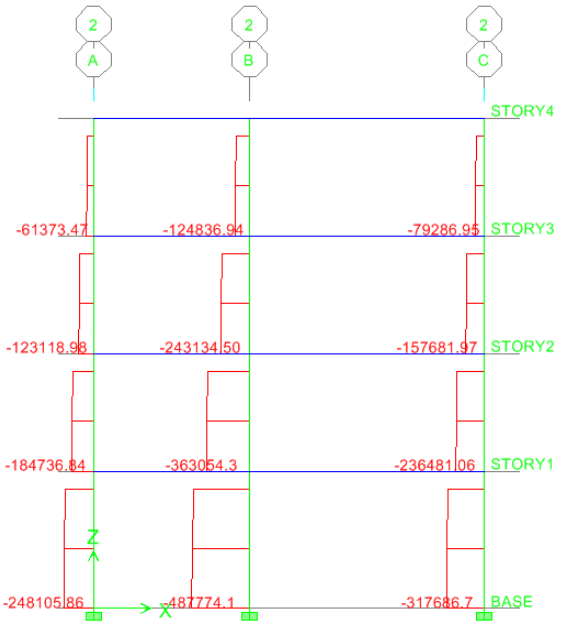


Potongan C-C

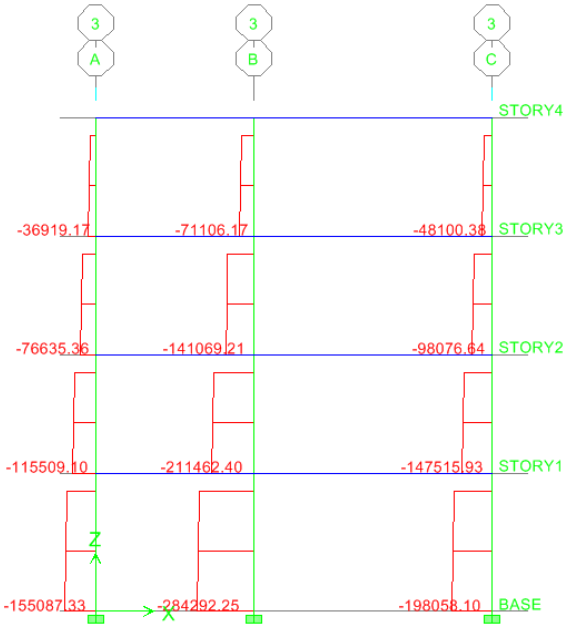
AXIAL FORCE **pada Kolom**



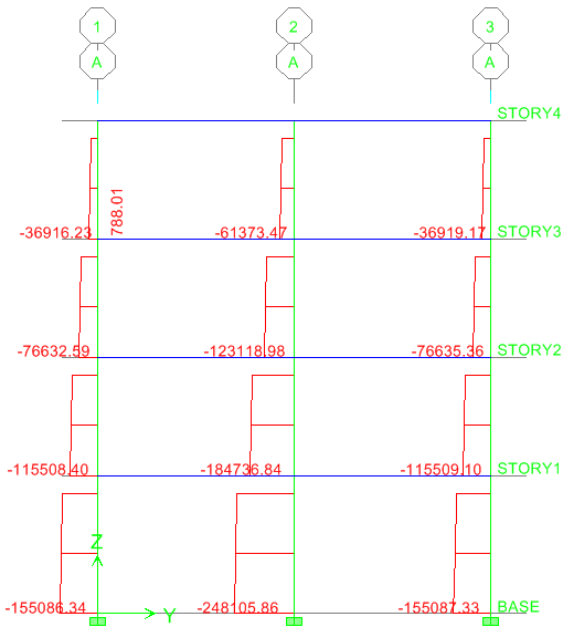
Potongan 1-1



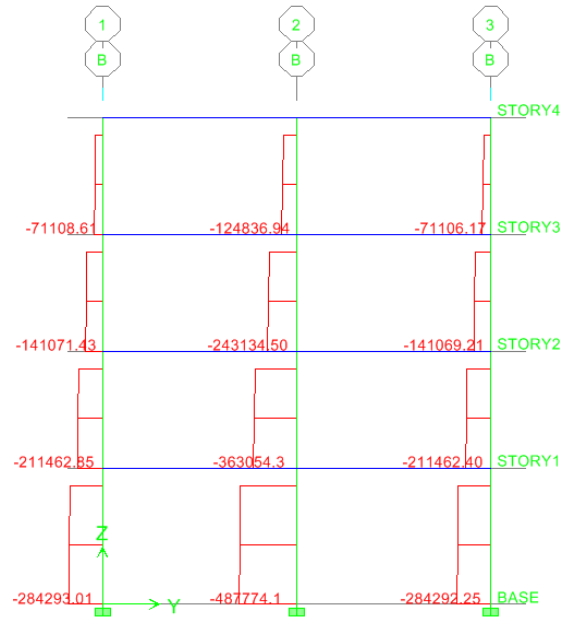
Potongan 2-2



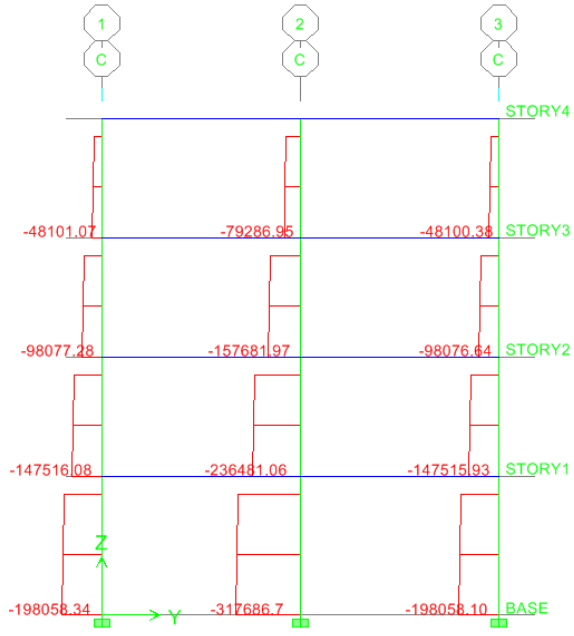
Potongan 3-3



Potongan A-A

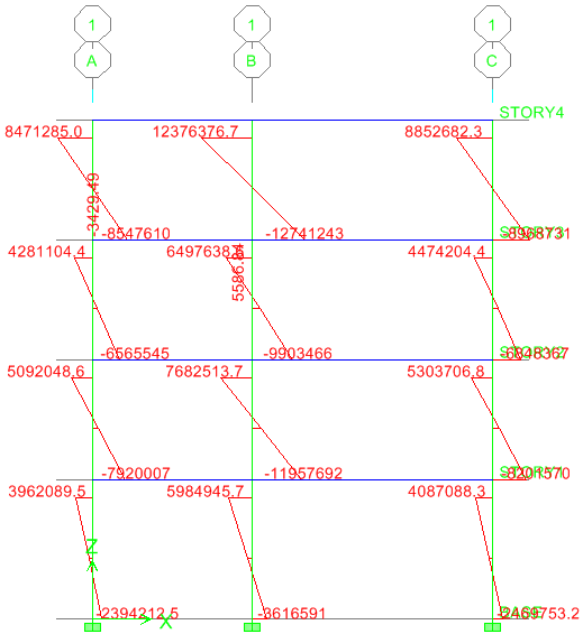


Potongan B-B

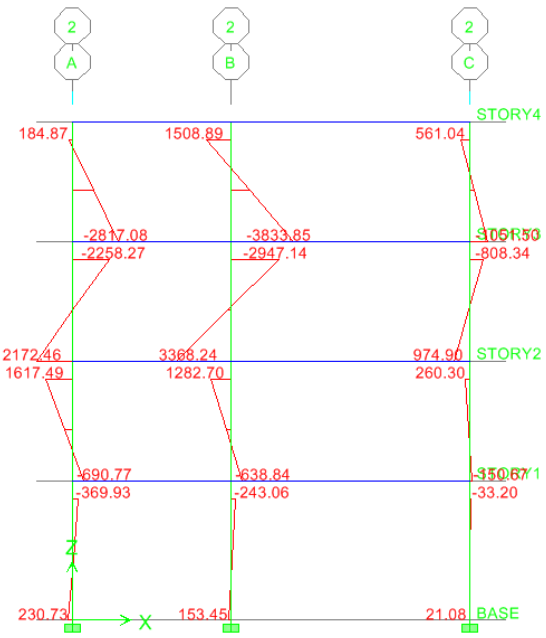


Potongan C-C

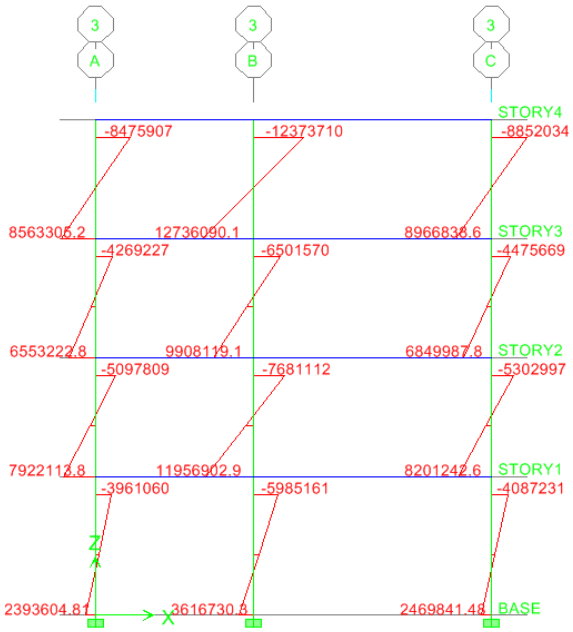
***MOMENT* 2-2 (Nmm) pada Balok**



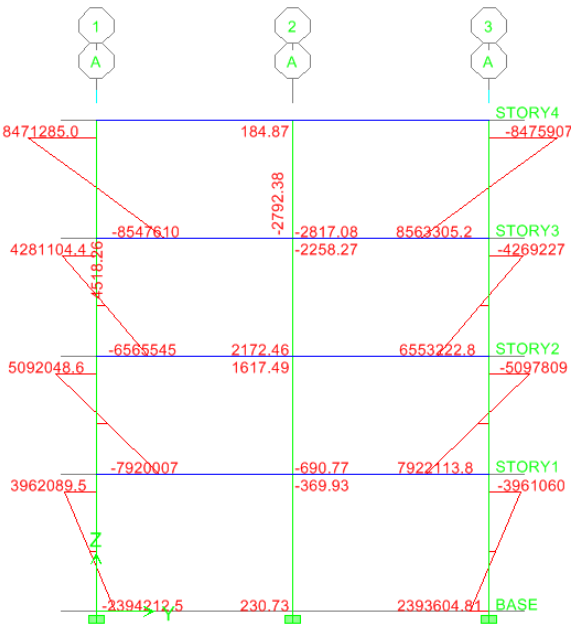
Potongan 1-1



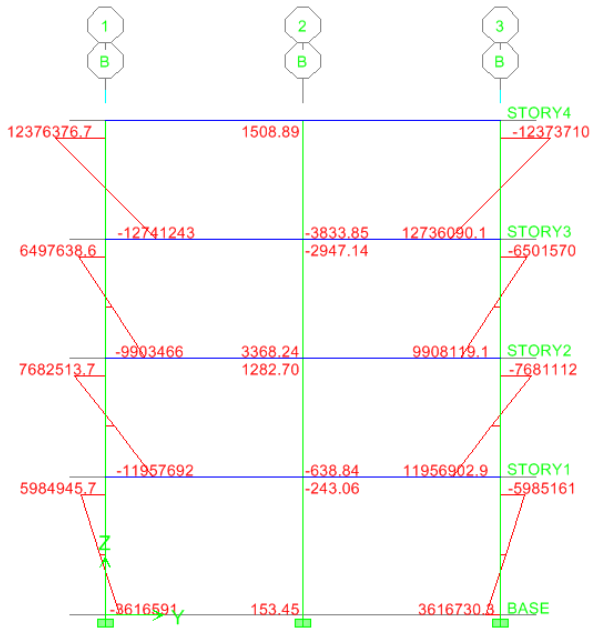
Potongan 2-2



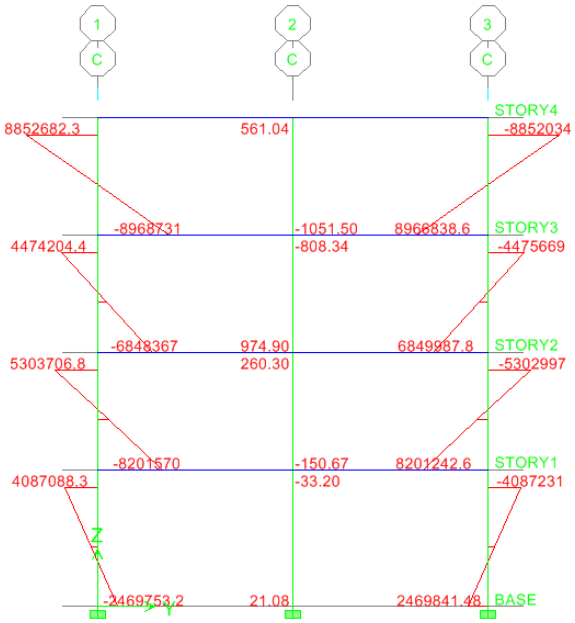
Potongan 3-3



Potongan A-A



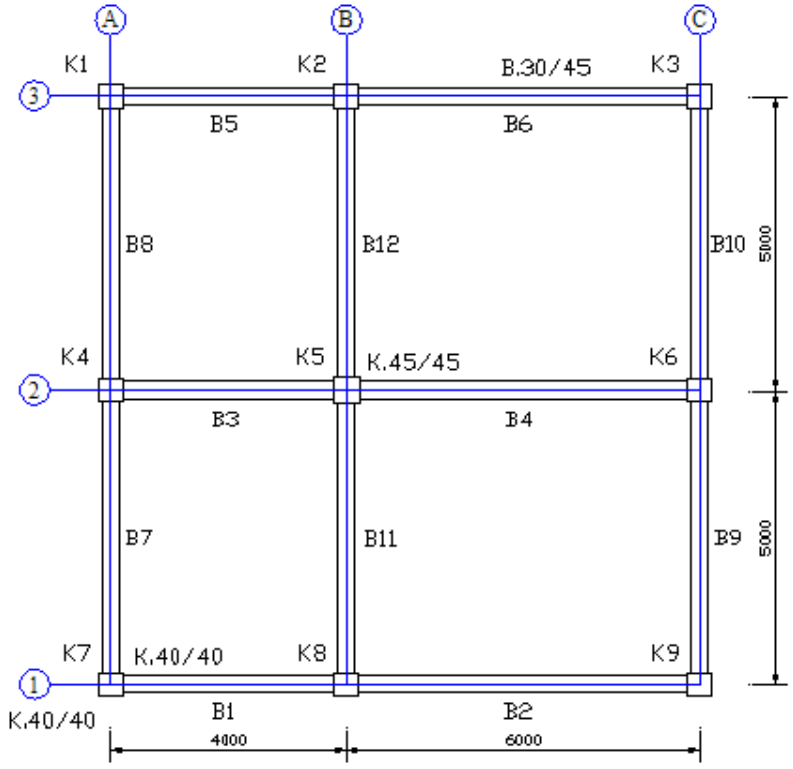
Potongan B-B



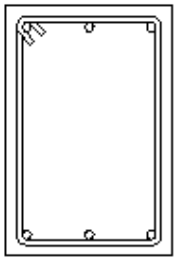
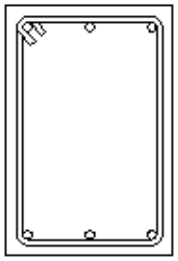
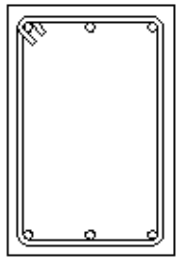
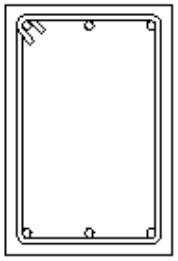
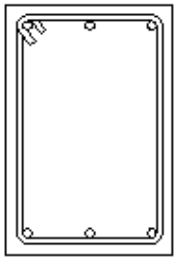
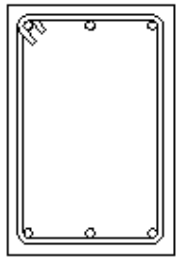
Potongan C-C

LAMPIRAN 7

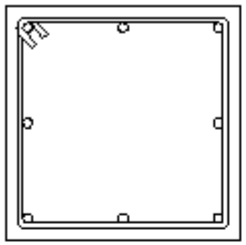
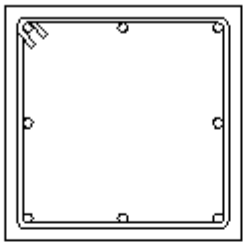
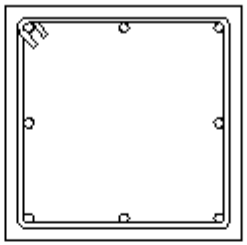
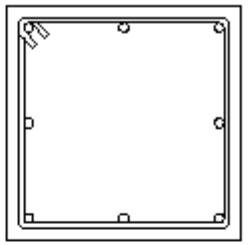
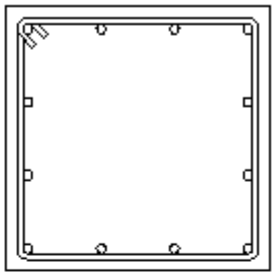
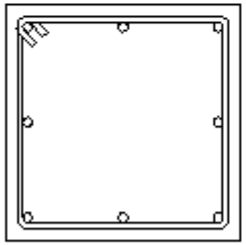
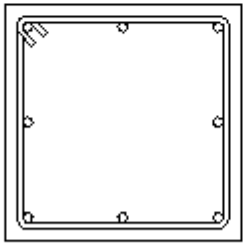
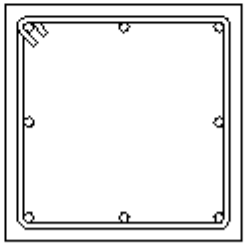
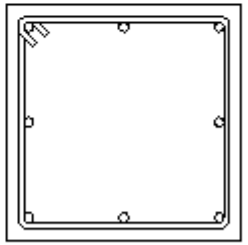
(Gambar Detail Penulangan)



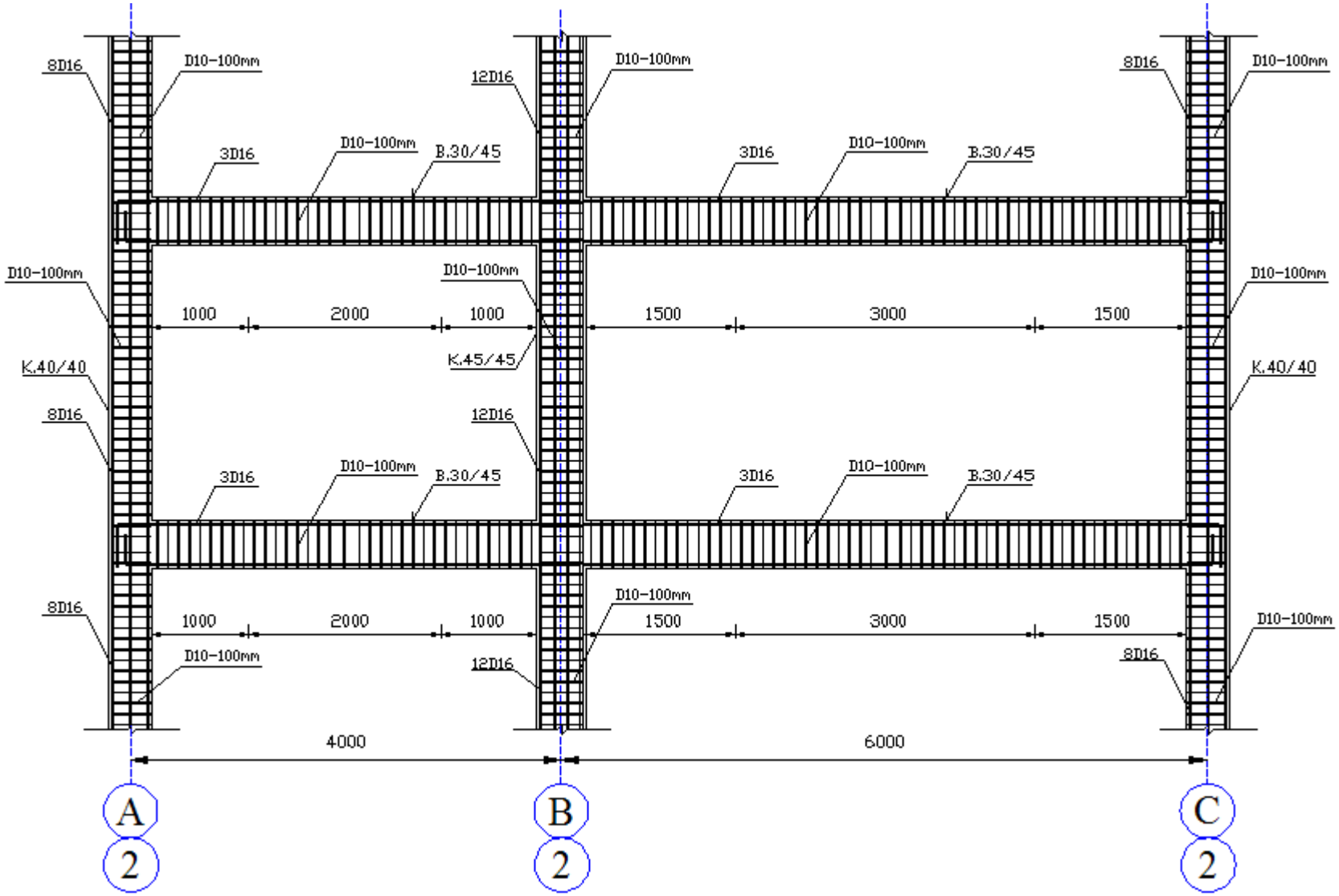
Gambar L7.1 : Denah Bangunan

TIPE / LANTAI	Balok 300 x 450		
	Tump Kiri	Lapangan	Tump Kanan
Lantai 4 Lantai 3			
TULANGAN ATAS	3Ø16	3Ø16	3Ø16
TULANGAN BAWAH	3Ø16	3Ø16	3Ø16
SENGKANG	D10−100	D10−100	D10−100
TIPE / LANTAI	Balok 300 x 450		
	Tump Kiri	Lapangan	Tump Kanan
Lantai 2 Lantai 1			
TULANGAN ATAS	3Ø16	3Ø16	3Ø16
TULANGAN BAWAH	3Ø16	3Ø16	3Ø16
SENGKANG	D10−100	D10−100	D10−100

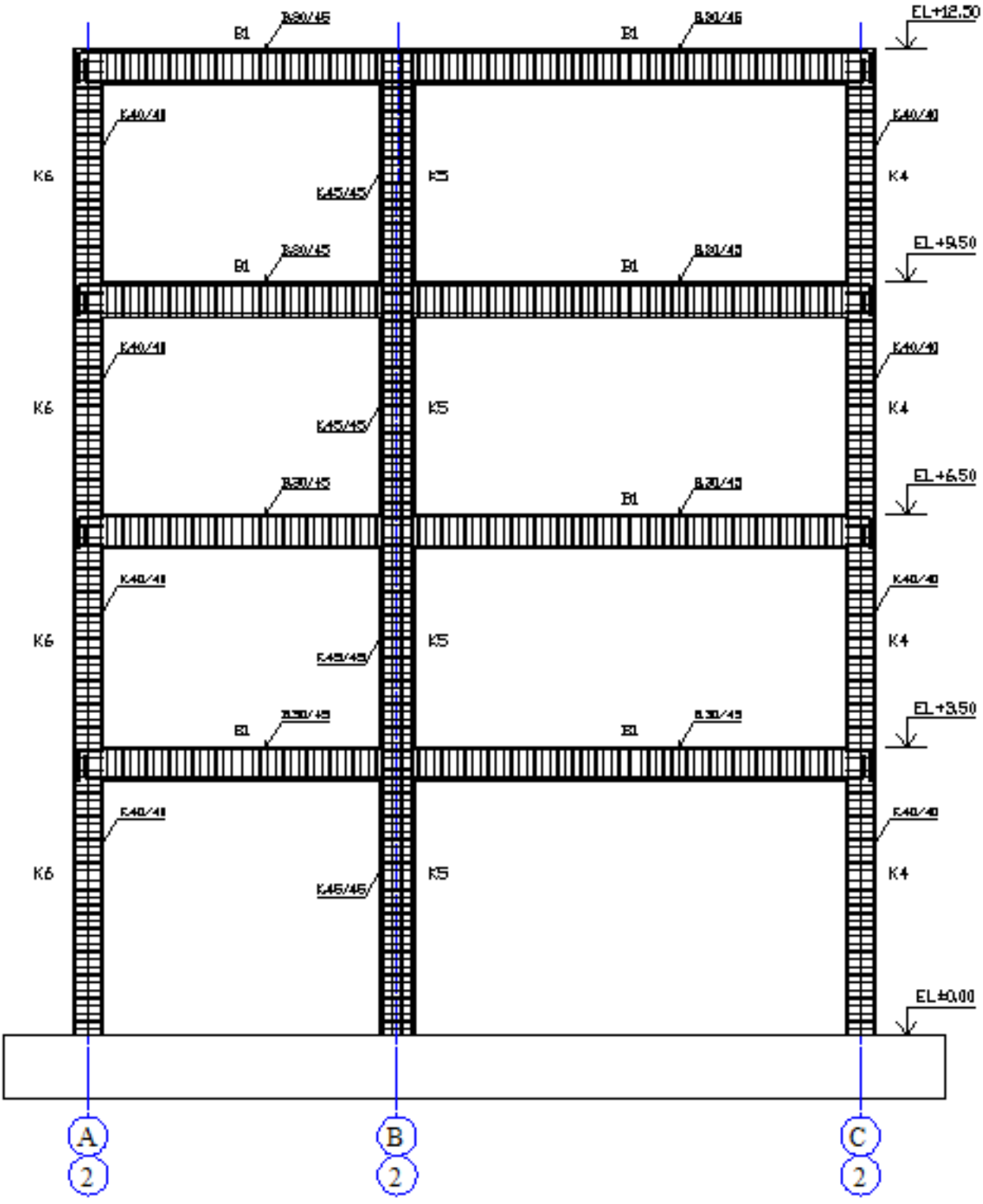
Gambar L7.2 : Tabel Penulangan pada Balok

KOLOM	K-1	K-2	K-3	K-4	K-5
					
DIMENSI	400X400	400X400	400X400	400X400	450X450
TUL. UTAMA	8ø16	8ø16	8ø16	8ø16	12ø16
SENGKANG	D10-100	D10-100	D10-100	D10-100	D10-100
KOLOM	K-6	K-7	K-8	K-9	
					
DIMENSI	400X400	400X400	400X400	400X400	
TUL. UTAMA	8ø16	8ø16	8ø16	8ø16	
SENGKANG	D10-100	D10-100	D10-100	D10-100	

Gambar L7.3 : Tabel Penulangan pada Kolom



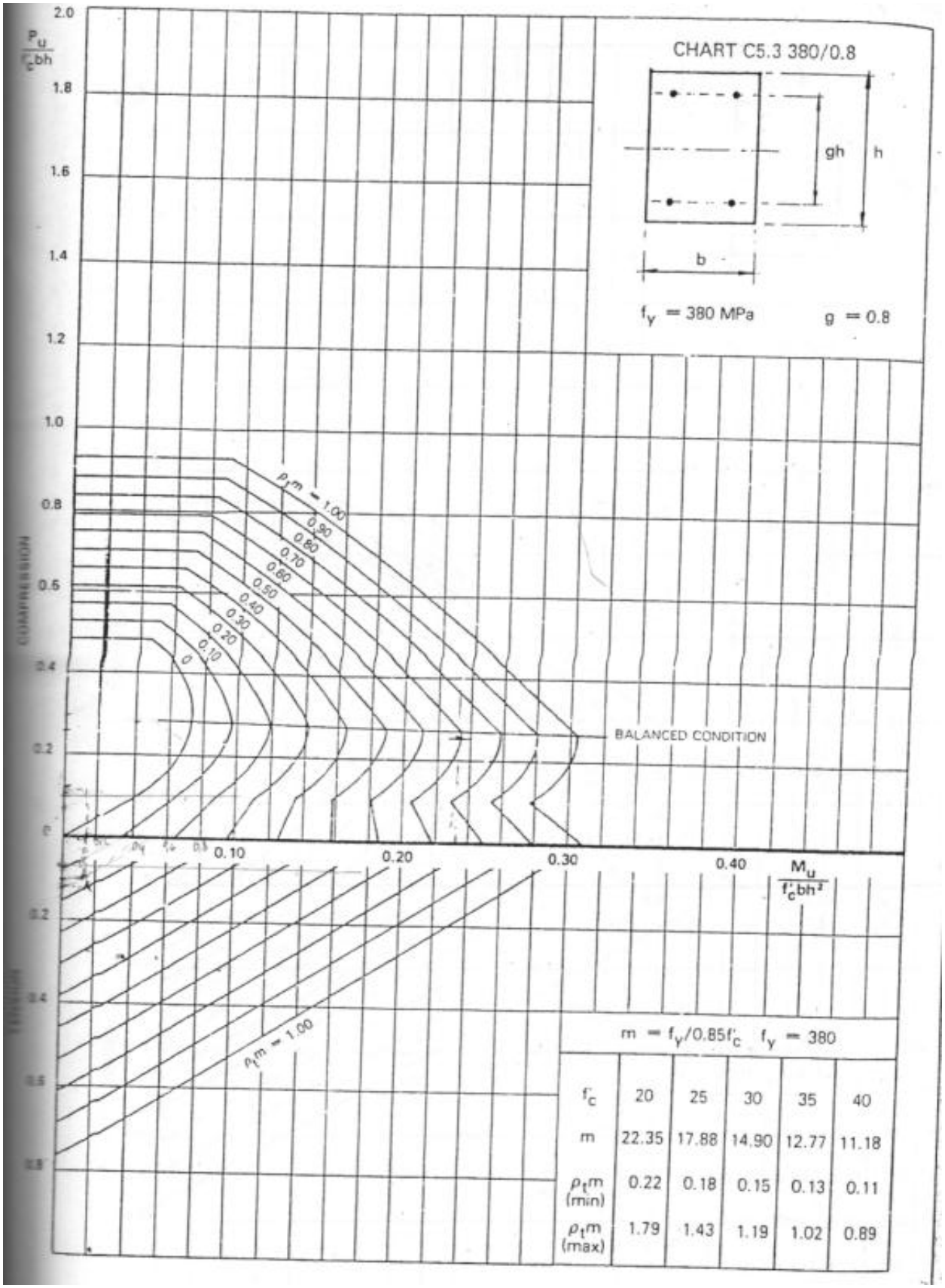
Gambar L7.4 : Detail Penulangan pada Balok dan Kolom



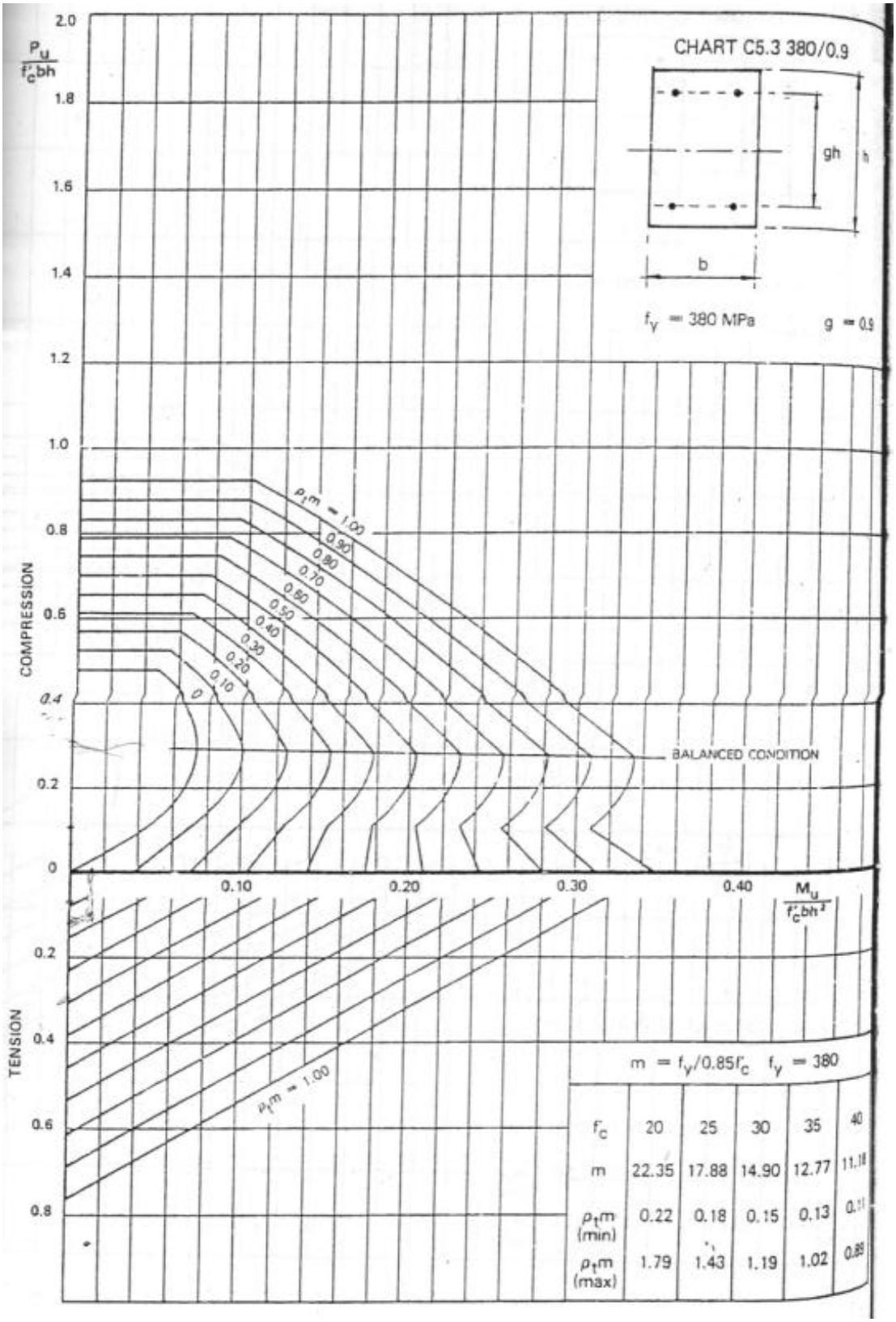
Gambar L7.5 : Detail Penulangan Struktur

LAMPIRAN 8

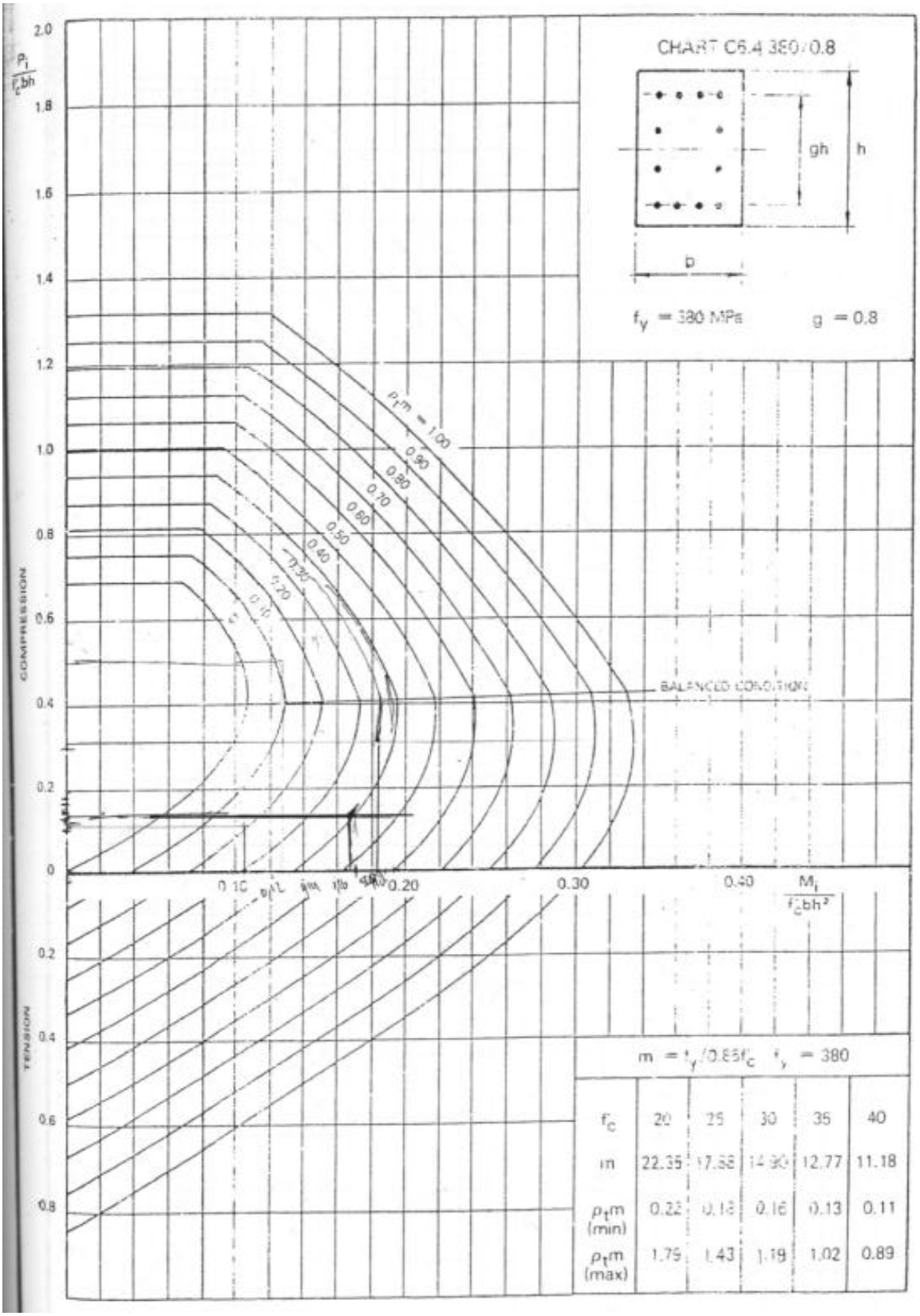
(Grafik NZS)



Gambar L8.1 C5.3 380/0.8



Gambar L8.2 C5.3 380/0.9



Gambar L8.3 C6.4 380/0.9