

I. PERHITUNGAN KOLOM

A. KOLOM LANTAI DUA

1. Reaksi Dan Moment Pada Balok Atap

- a. Tinjau balok AS A (3 – 4)
- q total balok AS A (3 – 4) = 6,6 kN/m
 - L = 4 m
 - Reaksi
 - Di A3 = $\frac{q \cdot l}{2} = \frac{6,6 \cdot 4}{2} = 13,2 \text{ kN}$
 - Di A4 = $\frac{q \cdot l}{2} = \frac{6,6 \cdot 4}{2} = 13,2 \text{ kN}$
 - Moment
 - Di A3 = $\frac{q \cdot L^2}{12} = \frac{6,6 \cdot 4^2}{12} = 8,8 \text{ kN m}$
 - Di A4 = $\frac{q \cdot L^2}{12} = \frac{6,6 \cdot 4^2}{12} = 8,8 \text{ kN m}$

Table hasil perhitungan reaksi dan moment balok atap

REAKSI DAN MOMENT PADA BALOK ATAP									
No.	balok AS	q total (kN/m)	L (m)	titik	R (kN)	M (kN/m)	titik	R (kN)	M (kN/m)
1	A 3 – 4	6.60	4.00	A3	13.21	8.80	A4	13.21	8.80
2	4 A – B	4.98	3.00	4A	7.47	3.74	4B	7.47	3.74
3	3 A – B	4.98	3.00	3A	7.47	3.74	3B	7.47	3.74
4	B 3 – 4	10.50	4.00	B3	21.01	14.00	B4	21.01	14.00
5	4 B – C	3.46	2.00	4B	3.46	1.15	4C	3.46	1.15
6	3 B – C	6.06	2.00	3B	6.06	2.02	3C	6.06	2.02
7	C 3 – 4	10.50	4.00	C3	21.01	14.00	C4	21.01	14.00
8	4 C – E	4.98	3.00	4C	7.47	3.74	4E	7.47	3.74
9	E 3 – 4	6.60	4.00	E3	13.21	8.80	E4	13.21	8.80
10	3 C – E	8.45	3.00	3C	12.67	6.34	3E	12.67	6.34
11	2 B – C	6.06	2.00	2B	6.06	2.02	2C	6.06	2.02
12	C 2 – 3	6.06	2.00	C2	6.06	2.02	C3	6.06	2.02
13	B 2 – 3	3.46	2.00	B2	3.46	1.15	B3	3.46	1.15
14	E 2 – 3	3.46	2.00	E2	3.46	1.15	E3	3.46	1.15
15	2 C – E	8.45	3.00	2C	12.67	6.34	2E	12.67	6.34
16	E 1 – 2	6.60	4.00	E1	13.21	8.80	E2	13.21	8.80
17	1 C – E	4.98	3.00	1C	7.47	3.74	1E	7.47	3.74
18	C 1 – 2	10.50	4.00	C1	21.01	14.00	C2	21.01	14.00
19	1 B – C	3.46	2.00	1B	3.46	1.15	1C	3.46	1.15
20	B 1 – 2	5.63	4.00	B1	11.26	7.50	B2	11.26	7.50

2. Perhitungan Kolom Lantai Dua

Direncanakan

- $H = 3,5 \text{ m}$
- $F_c' = 30 \text{ Mpa}$
- $F_y' = 240 \text{ Mpa}$
- $\emptyset = 0,65$
- $\beta = 1,2$
- $d' = 5 \text{ cm}$

a. Tinjau Kolom A4

- $b = 20 \text{ cm}$
- $h = 25 \text{ cm}$
- $A_{qr} = b * h = 20 * 25 = 500 \text{ cm}^2$
- $d'/h = 5 / 25 = 0,2$
- beban P dari reaksi balok ($P_{rb.}$)
$$= R_{A4} + R_{4A}$$
$$= 13,21 + 7,47 = 20,68 \text{ Kn}$$
- beban P berat sendiri ($P_{bs.}$)
$$= 1,2 * (b/100) * (h/100) * H * 24 \text{ kN/m}^3$$
$$= 1,2 * (20/100) * (25/100) * 3,5 * 24$$
$$= 5,04 \text{ Kn}$$
- $P_u = P_{rb.} + P_{bs.}$
$$= 20,68 + 5,04 = 25,72 \text{ kN}$$
- $M_u = M_{A4} + M_{4A}$
$$= 8,8 + 3,74 = 12,54 \text{ Kn m}$$
- $e_i = M_u / P_u$
$$= 12,54 / 25,72 = 0,49 \text{ m}$$
- $e_i / h = 0,49 / (25/100) = 1,95$
- $$\frac{P_u}{\emptyset * A_{qr} * 0,85 * f_c'} = \frac{25,72 * 1000 \text{ N}}{0,65 * (500 * 100 \text{ mm}) * 0,85 * 30} = 0,0310$$
- $$\frac{P_u}{\emptyset * A_{qr} * 0,85 * f_c'} * \left(\frac{e_i}{h} \right) = 0,0310 * 1,95 = 0,0605$$
- r (bacaan grafik penulangan) = 0,010
- $\rho = r * \beta = 0,010 * 1,2 = 0,0120$
- $A_s = \rho * A_{qr}$
$$= 0,0120 * 500 = 6 \text{ cm}^2$$
- Tulangan dipakai = 4 ϕ 14 (6,16 cm^2)

Table hasil penulangan kolom lantai dua

Penulangan Kolom Lanantai Dua																		
No.	kolom	b (cm)	h (cm)	Aqr (cm ²)	d'/h (d'=5cm)	P rb. (Kn)	P bs. (Kn)	Pu (Kn)	Mu (Kn.m)	ei (m)	ei/h	Pu/(ϕ Aqr. 0.85.fc)	(Pu/ ϕ Aqr.0.85.fc) *(ei/h)	r	ρ	As (cm ²)	Tulangan Dipakai	As tulangan
1	A4	20.00	25.00	500.00	0.20	20.68	5.04	25.72	12.54	0.49	1.95	0.0310	0.0605	0.010	0.0120	6.00	6 ϕ 12	6.78
2	A3	20.00	25.00	500.00	0.20	20.68	5.04	25.72	12.54	0.49	1.95	0.0310	0.0605	0.010	0.0120	6.00	6 ϕ 12	6.78
3	B4	20.00	35.00	700.00	0.14	31.94	7.06	39.00	16.58	0.43	1.22	0.0336	0.0408	0.006	0.0072	5.04	6 ϕ 12	6.78
4	B3	20.00	35.00	700.00	0.14	38.00	7.06	45.06	14.56	0.32	0.92	0.0388	0.0359	0.004	0.0048	3.36	4 ϕ 12	4.52
5	B2	20.00	25.00	500.00	0.20	20.78	5.04	25.82	8.37	0.32	1.30	0.0312	0.0404	0.006	0.0072	3.60	4 ϕ 12	4.52
6	B1	20.00	25.00	500.00	0.20	14.72	5.04	19.76	8.66	0.44	1.75	0.0238	0.0418	0.008	0.0096	4.80	6 ϕ 12	6.78
7	C4	20.00	35.00	700.00	0.14	31.94	7.06	39.00	16.58	0.43	1.22	0.0336	0.0408	0.006	0.0072	5.04	6 ϕ 12	6.78
8	C3	20.00	35.00	700.00	0.14	45.80	7.06	52.86	16.30	0.31	0.88	0.0456	0.0401	0.004	0.0048	3.36	4 ϕ 12	4.52
9	C2	20.00	35.00	700.00	0.14	45.80	7.06	52.86	16.30	0.31	0.88	0.0456	0.0401	0.004	0.0048	3.36	4 ϕ 12	4.52
10	C1	20.00	35.00	700.00	0.14	31.94	7.06	39.00	16.58	0.43	1.22	0.0336	0.0408	0.006	0.0072	5.04	6 ϕ 12	6.78
11	E4	20.00	25.00	500.00	0.20	20.68	5.04	25.72	12.54	0.49	1.95	0.0310	0.0605	0.010	0.0120	6.00	6 ϕ 12	6.78
12	E3	20.00	25.00	500.00	0.20	29.34	5.04	34.38	13.98	0.41	1.63	0.0415	0.0675	0.012	0.0144	7.20	8 ϕ 12	9.05
13	E2	20.00	25.00	500.00	0.20	29.34	5.04	34.38	13.98	0.41	1.63	0.0415	0.0675	0.012	0.0144	7.20	8 ϕ 12	9.05
14	E1	20.00	25.00	500.00	0.20	20.68	5.04	25.72	12.54	0.49	1.95	0.0310	0.0605	0.010	0.0120	6.00	6 ϕ 12	6.78

B. KOLOM LANTAI SATU

1. Reaksi Dan Moment Pada Balok Lantai Dua

a. Tinjau balok AS F (3 – 4)

- q total balok AS F (3 – 4) = 9,44 kN/m

- L = 4 m

- Reaksi

$$\bullet \text{ Di F3} = \frac{q \cdot l}{2} = \frac{9,44 \cdot 4}{2} = 18,89 \text{ kN}$$

$$\bullet \text{ Di F4} = \frac{q \cdot l}{2} = \frac{9,44 \cdot 4}{2} = 18,89 \text{ kN}$$

- Moment

$$\bullet \text{ Di A3} = \frac{q \cdot L^2}{12} = \frac{9,44 \cdot 4^2}{12} = 12,59 \text{ kN m}$$

$$\bullet \text{ Di A4} = \frac{q \cdot L^2}{12} = \frac{9,44 \cdot 4^2}{12} = 12,59 \text{ kN m}$$

Table hasil perhitungan reaksi dan moment balok atap

REAKSI DAN MOMENT PADA BALOK LANTAI DUA									
No.	balok	q total	L	titik	R	M	Titik	R	M
	AS	(kN/m)	(m)		(kN)	(kN/m)		(kN)	(kN/m)
1	A 3 - 4	20.44	4.00	A3	40.89	27.26	A4	40.89	27.26
2	4 A - B	17.73	3.00	4A	26.60	13.30	4B	26.60	13.30
3	3 A - B	17.73	3.00	3A	26.60	13.30	3B	26.60	13.30
4	B 3 - 4	26.39	4.00	B3	52.77	35.18	B4	52.77	35.18
5	4 B - C	15.54	2.00	4B	15.54	5.18	4C	15.54	5.18
6	C 3 - 4	15.39	4.00	C3	30.78	20.52	C4	30.78	20.52
7	4 C - E	17.73	3.00	4C	26.60	13.30	4E	26.60	13.30
8	E 3 - 4	27.87	4.00	E3	55.74	37.16	E4	55.74	37.16
9	4 E - F	7.02	3.00	4E	10.53	5.27	4F	10.53	5.27
10	F 3 - 4	9.44	4.00	F3	18.89	12.59	F4	18.89	12.59
11	3 E - F	7.02	3.00	3E	10.53	5.27	3F	10.53	5.27
12	B 2 - 3	15.54	2.00	B2	15.54	5.18	B3	15.54	5.18
13	3 B - C	19.50	2.00	3B	19.50	6.50	3C	19.50	6.50
14	C 2 - 3	18.51	2.00	C2	18.51	6.17	C3	18.51	6.17
15	3 C - E	9.00	3.00	3C	15.16	7.57	3E	11.71	6.32
16	D 2 - 3	3.84	2.00	D2	3.84	1.28	D3	3.84	1.28
17	2 C - E	9.00	3.00	2C	15.16	7.57	2E	11.71	6.32
18	B 1 - 2	18.96	4.00	B1	37.91	25.28	B2	37.91	25.28
19	2 B - C	8.79	2.00	2B	8.79	2.93	2C	8.79	2.93
20	C 1 - 2	26.39	4.00	C1	52.77	35.18	C2	52.77	35.18
21	1 B - C	15.54	2.00	1B	15.54	5.18	1C	15.54	5.18
22	E 1 - 2	20.44	4.00	E1	40.89	27.26	E2	40.89	27.26
23	1 C - E	17.73	3.00	1C	26.60	13.30	1E	26.60	13.30
24	E 2 - 3	11.57	2.00	E2	11.57	3.86	E3	11.57	3.86

2. Perhitungan Kolom Lantai Satu

Direncanakan

- H = 3,5 m
- F_c' = 30 Mpa
- F_y' = 240 Mpa
- \emptyset = 0,65
- β = 1,2
- d' = 5 cm

b. Tinjau Kolom A4

- b = 20 cm
- h = 35 cm
- $A_{qr} = b * h = 20 * 35 = 700 \text{ cm}^2$
- $d'/h = 5 / 35 = 0,1$
- beban P dari rekasi balok ($P_{rb.}$) = $R_{A4} + R_{4A}$
 $= 40,89 + 26,6 = 67,49 \text{ Kn}$
- beban P berat sendiri ($P_{bs.}$) = $1,2 * (b/100) * (h/100) * H * 24 \text{ kN/m}^3$
 $= 1,2 * (20/100) * (35/100) * 3,5 * 24$
 $= 7,06 \text{ Kn}$
- beban akibat kolom lantai dua ($P_u \text{ Kl.dua}$) = $P_u \text{ kolom A4} = 25,72 \text{ kN}$
- $P_u = P_{rb.} + P_{bs.} + P_u \text{ Kl.dua}$
 $= 67,49 + 7,06 + 25,72 = 100,26 \text{ kN}$
- $M_u = M_{A4} + M_{4A}$
 $= 27,26 + 13,3 = 40,56 \text{ Kn m}$
- $e_i = M_u / P_u$
 $= 40,56 / 100,26 = 0,4 \text{ m}$
- $e_i / h = 0,4 / (35/100) = 1,16$
- $\frac{P_u}{\emptyset * A_{qr} * 0,85 * f_c'} = \frac{100,26 * 1000 \text{ N}}{0,65 * (700 * 100 \text{ mm}) * 0,85 * 30} = 0,0864$
- $\frac{P_u}{\emptyset * A_{qr} * 0,85 * f_c'} * \left(\frac{e_i}{h} \right) = 0,0864 * 1,16 = 0,0999$
- r (bacaan grafik penulangan) = 0,012
- $\rho = r * \beta = 0,012 * 1,2 = 0,0144$
- $A_s = \rho * A_{qr} = 0,0144 * 700 = 10,08 \text{ cm}^2$
- Tulangan dipakai = $8 \phi 14 (12,32 \text{ cm}^2)$

Table hasil perhitungan kolom lantai satu

penulangan kolom lantai satu																		
No.	Kolom	b (cm)	h (cm)	Aqr (cm ²)	d'/h (d'=5cm)	P rb. (Kn)	Pu Kl.dua (Kn)	P bs. (Kn)	Pu (Kn)	Mu (Kn.m)	ei (m)	ei/h	Pu/(φAqr. 0.85.fc)	(Pu/ φAqr.0.85 .fc) *(ei/h)	r	ρ	As (cm ²)	tulangan tulangan
1	A4	20.00	35.00	700.00	0.14	67.49	25.72	7.06	100.26	40.56	0.40	1.16	0.0864	0.0999	0.014	0.0168	11.76	8 φ 14
2	A3	20.00	35.00	700.00	0.14	67.49	25.72	7.06	100.26	40.56	0.40	1.16	0.0864	0.0999	0.014	0.0168	11.76	8 φ 14
3	B4	25.00	35.00	875.00	0.14	94.91	39.00	8.82	142.72	43.30	0.30	0.87	0.0984	0.0853	0.010	0.0120	10.50	8 φ 14
4	B3	20.00	35.00	700.00	0.14	114.41	45.06	7.06	166.52	36.80	0.22	0.63	0.1435	0.0906	0.008	0.0096	6.72	6 φ 12
5	B2	20.00	35.00	700.00	0.14	62.24	25.82	7.06	95.12	23.03	0.24	0.69	0.0820	0.0567	0.008	0.0096	6.72	6 φ 12
6	B1	20.00	35.00	700.00	0.14	53.45	19.76	7.06	80.27	30.45	0.38	1.08	0.0692	0.0750	0.010	0.0120	8.40	8 φ 12
7	C4	20.00	35.00	700.00	0.14	72.91	39.00	7.06	118.96	28.64	0.24	0.69	0.1025	0.0705	0.006	0.0072	5.04	6 φ 12
8	C3	20.00	35.00	700.00	0.14	83.94	52.86	7.06	143.86	15.42	0.11	0.31	0.1240	0.0380	0.004	0.0048	3.36	4 φ 12
9	C2	20.00	35.00	700.00	0.14	95.23	52.86	7.06	155.14	33.65	0.22	0.62	0.1337	0.0829	0.008	0.0096	6.72	6 φ 12
10	C1	20.00	35.00	700.00	0.14	94.91	39.00	7.06	140.96	43.30	0.31	0.88	0.1215	0.1066	0.012	0.0144	10.08	8 φ 14
11	E4	25.00	35.00	875.00	0.14	92.88	25.72	8.82	127.41	45.19	0.35	1.01	0.0879	0.0890	0.010	0.0120	10.50	8 φ 14
12	E3	20.00	35.00	700.00	0.14	89.56	34.38	7.06	131.00	34.35	0.26	0.75	0.1129	0.0846	0.008	0.0096	6.72	6 φ 12
13	E2	20.00	35.00	700.00	0.14	64.17	34.38	7.06	105.61	29.72	0.28	0.80	0.0910	0.0732	0.008	0.0096	6.72	6 φ 12
14	E1	20.00	35.00	700.00	0.14	67.49	25.72	7.06	100.26	40.56	0.40	1.16	0.0864	0.0999	0.014	0.0168	11.76	8 φ 14
15	F4	20.00	35.00	700.00	0.14	29.42	0.00	7.06	36.48	17.86	0.49	1.40	0.0314	0.0440	0.006	0.0072	5.04	6 φ 12
16	F3	20.00	35.00	700.00	0.14	29.42	0.00	7.06	36.48	17.86	0.49	1.40	0.0314	0.0440	0.006	0.0072	5.04	6 φ 12

LAMPIRAN

Table Luas Tulangan Dengan Perbandingan Antara Diameter Dan Jarak Antar AS Tulangan

jarak pusat ke pusat dalam mm	Diameter dalam mm							
	6	8	10	12	14	16	19	20
50	365	1005	1571	2262	3079	4028	5671	6289
75	377	670	1047	1508	2053	2681	3780	4189
100	283	503	785	1131	1539	2011	2835	3142
125	226	402	628	905	1232	1608	2268	2513
150	188	335	524	754	1026	1340	1890	2094
175	162	287	449	646	880	1149	1620	1795
200	141	251	393	565	770	1005	1418	1571
225	126	223	349	503	684	894	1260	1396
250	113	201	314	452	616	804	1134	1257

Table Penyaluran Beban Berdasarkan Metode Amplop

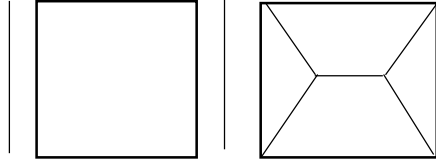
skema	Penyaluran beban berdasarkan metode amplop	Momen Per Meter Lebar	LY/LX												
			1	1.2	1.4	1.6	1.8	2	2.5	3	1.5	1.75	1.167	1.3	2.857
		$M_{lx} = 0.001 W_u l x^2 x$	25	34	42	49	53	58	62	65	45.5	52	32.515	38	64.142
		$M_{ly} = 0.001 W_u l x^2 x$	25	22	18	15	15	15	14	14	16.5	15	22.495	20	14
		$M_{tx} = -0.001 W_u l x^2 x$	51	63	72	81	81	82	83	83	76.5	81	61.02	67.5	83
		$M_{ty} = -0.001 W_u l x^2 x$	51	54	55	54	54	53	51	49	54.5	54	53.505	54.5	49.572

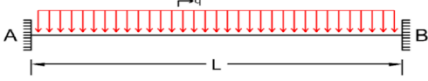

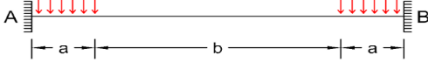
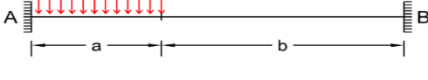
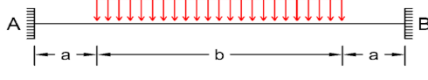
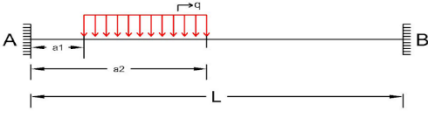
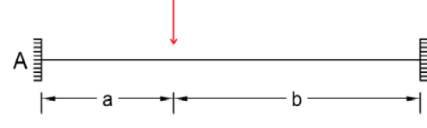
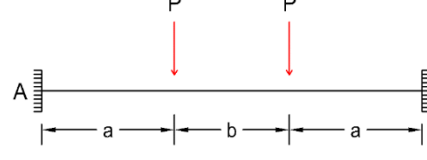
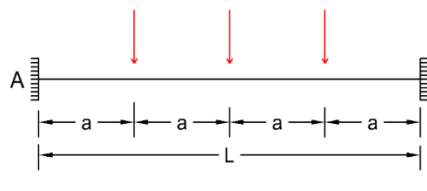
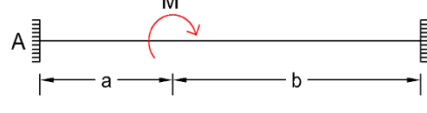
Table Konstanta Perencanaan

Tulangan Baja			Mutu Beton											
Mutu Baja BJTP BJTD	fy	r _{min}	fc' = 17		fc' = 20		fc' = 25		fc' = 30		fc' = 35		fc' = 40	
			b ₁ = 0,85		b ₁ = 0,85		b ₁ = 0,85		b ₁ = 0,85		b ₁ = 0,85		b ₁ = 0,77	
			r _{max}	r _{sm}	r _{max}	r _{sm}	r _{max}	r _{sm}	r _{max}	r _{sm}	r _{max}	r _{sm}	r _{max}	r _{sm}
24	240	0,0058	0,0274	0,0132	0,0323	0,0156	0,0403	0,0198	0,0484	0,0239	0,0564	0,0269	0,0584	0,0313
30	300	0,0047	0,0205	0,0107	0,0241	0,0127	0,0301	0,0159	0,0361	0,0195	0,0421	0,0221	0,0436	0,0251
35	350	0,0040	0,0166	0,0093	0,0196	0,0107	0,0244	0,0132	0,0293	0,0163	0,0342	0,0183	0,0354	0,0214
40	400	0,0035	0,0138	0,0083	0,0163	0,0092	0,0203	0,0117	0,0244	0,0142	0,0284	0,0160	0,0295	0,0185
50	500	0,0028	0,0100	0,0070	0,0118	0,0074	0,0148	0,0098	0,0177	0,0113	0,0207	0,0126	0,0214	0,0143

Table Tulangan Baja

Diameter Tulangan (mm)	Luas Penampang (mm²)									
	Jumlah tulangan (n) batang									
	1	2	3	4	5	6	7	8	9	10
6	28,29	56,57	84,86	113,14	141,43	169,71	198,00	226,29	254,57	282,86
8	50,29	100,57	150,86	201,14	251,43	301,71	352,00	402,29	452,57	502,86
10	78,57	157,14	235,71	314,29	392,86	471,43	550,00	628,57	707,14	785,71
12	113,14	226,29	339,43	452,57	565,71	678,86	792,00	905,14	1018,29	1131,43
14	154,00	308,00	462,00	616,00	770,00	924,00	1078,00	1232,00	1386,00	1540,00
16	201,14	402,29	603,43	804,57	1005,71	1206,86	1408,00	1609,14	1810,29	2011,43
19	283,64	567,29	850,93	1134,57	1418,21	1701,86	1985,50	2269,14	2552,79	2836,43
22	380,29	760,57	1140,86	1521,14	1901,43	2281,71	2662,00	3042,29	3422,57	3802,86
25	491,07	982,14	1473,21	1964,29	2455,36	2946,43	3437,50	3928,57	4419,64	4910,71
28	616,00	1232,00	1848,00	2464,00	3080,00	3696,00	4312,00	4928,00	5544,00	6160,00
32	804,57	1609,14	2413,71	3218,29	4022,86	4827,43	5632,00	6436,57	7241,14	8045,71

Table Momen Primer

No	Pembebanan	Momen Primer
1		$M_{BA} = \frac{qL^2}{12}$ $M_{AB} = M_{BA}$
2		$M_{BA} = \frac{5qL^2}{192}$ $M_{AB} = \frac{11qL^2}{192}$
3		$M_{BA} = \frac{qa^2(3L-2a)}{6L}$ $M_{AB} = M_{BA}$
4		$M_{BA} = \frac{qaL\alpha^2(4-\alpha)}{12}$ $M_{AB} = \frac{qaL\alpha(3\alpha^2-8\alpha+6)}{12}$ $\alpha = a/L$
5		$M_{BA} = \frac{qb(3L^2-b^2)}{24L}$ $M_{AB} = -M_{BA}$
6		$M_{BA} = (q/L^2) [1/3 L(a_2^3 - a_1^3) - 1/4(a_2^4 - a_1^4)]$ $M_{AB} = (q/L^2) [1/2 L^2(a_2^2 - a_1^2) - 2/3 L(a_2^3 - a_1^3) + 1/4(a_2^4 - a_1^4)]$
21		$M_{BA} = \frac{Pba^2}{L^2}$ $M_{AB} = \frac{Pab^2}{L^2}$
22		$M_{BA} = \frac{Pa(L-a)}{L}$ $M_{AB} = M_{BA}$
23		$M_{BA} = \frac{PL(n^2 + 0,5)}{12n}$ $M_{AB} = M_{BA}$ $n = \frac{L}{a}$
24		$M_{BA} = \frac{Ma(3\alpha - 2)}{L}$ $M_{AB} = \frac{Mb(3\beta - 2)}{L}$ $\alpha = a/L ; \beta = b/L$