UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2004/2005

Mac 2005

REG 262 – Rekabentuk Struktur

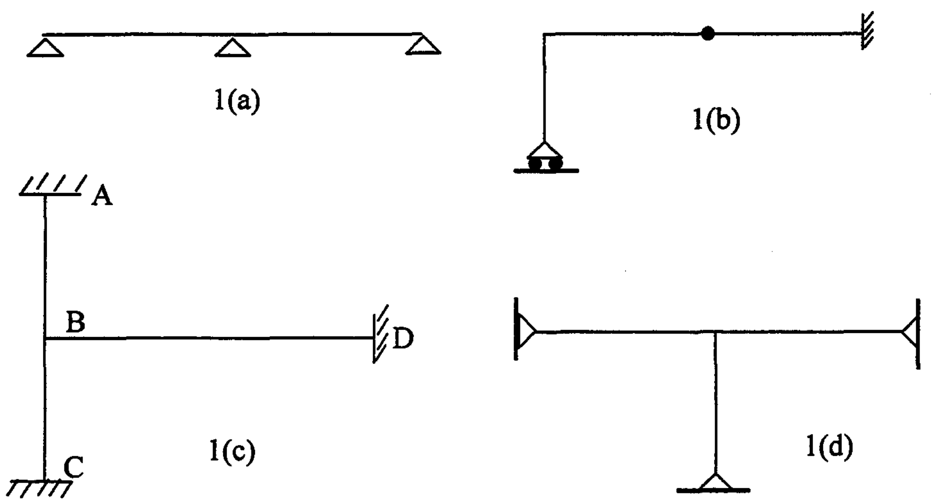
Masa: 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH** muka surat yang tercetak sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** soalan sahaja.

1. **Gambarajah 1** menunjukkan beberapa buah rasuk dan kerangka struktur. Bagi setiap satu, tentukan sama ada rasuk atau kerangka tersebut *Tentu Statik* atau *Tak Tentu Statik* dengan memberikan penjelasan sewajarnya.

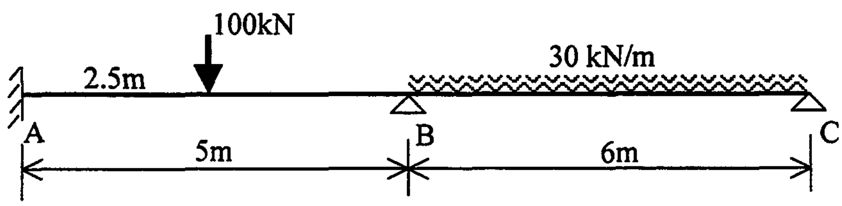
   Jika kerangka 1(c) membawa beban teragih seragam sebesar 25kN/m di sepanjang rentang BD, dengan menggunakan kaedah cerun-pesongan, kira momen lentur di sendi sendi A, B, C dan D. Panjang rentang BD ialah 6m, manakala tinggi tiang AB dan BC ialah 4m. Lakarkan gambarajah taburan momen lentur ini. Andaikan nilai EI untuk semua anggota adalah sama.



Gambarajah 1

(20 markah)

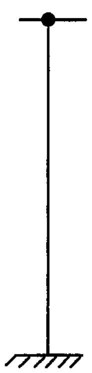
2. Dengan menggunakan kaedah agihan momen, kira momen lentur dan daya ricih bagi rasuk yang ditunjukkan dalam **Gambarajah 2**. Seterusnya, lakarkan gambarajah momen lentur dan gambarajah daya ricih bagi rasuk tersebut.



Gambarajah 2

(20 markah)

3. Satu tiang keluli dengan ketinggian 4m, menggunakan keratan UC (Jadual 12.4), dikehendaki menanggung beban rekabentuk sebesar 2000 kN. Jika keadaan di kedua-dua hujung tiang tersebut seperti yang ditunjukkan dalam **Gambarajah 3**, pilih saiz UC yang sesuai bagi tiang ini.



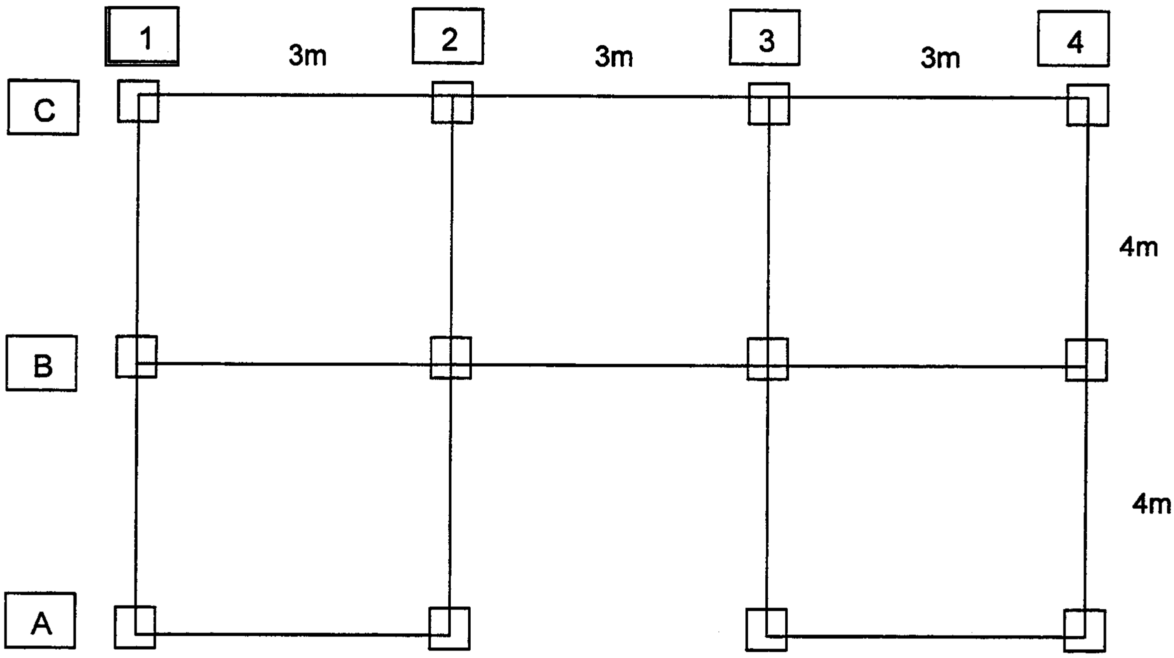
Gambarajah 3

Jadual 3: Tinggi Efektif Tiang

Jenis Topang	Panjang efektif
1. Kedua dua hujung nya dipegang pada kedudukan dan terikat pada arah	0.7L
2. Kedua dua hujungnya dipegang pada kedudukan dan satu daripada hujung nya terikat pada arah	0.85L
3. Kedua dua hujung nya dipegang pada kedudukan tetapi tidak terikat pada arah	L
4. Satu hujungnya dipegang pada kedudukan dan terikat pada arah	2L

(20 markah)

4. Sebuah sistem lantai ditunjukan dalam **Gambarajah 4** diperbuat daripada konkrit bertulang. Ianya dibebankan dengan beban hidup sebanyak 2.5 kN/m^2 dan beban lepaan sebanyak 1 kN/m^2. Ketabalan lantai tersebut adalah 125 mm. Tentukan momen lentur dalam setiap lantai (arah x dan y) berdasarkan Jadual 3.15 dari BS 8110 : Part 1 : 1985.



Gambarajah 4

(20 markah)

5. Berdasarkan beban tersebut di dalam 4.0, kirakan beban yang akan dikenakan pada kesemua sistem rasuk dalam **Gambarajah 4**.

(20 markah)

6. Berdasarkan beban yang dikirakan dalam 5.0 lukisan **Gambarajah 4** daya ricih dan momen lentur pada sistem rasuk B – 1 - 2 - 3 - 4 .

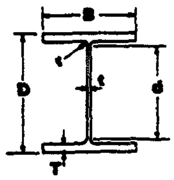
(20 markah)

Table 12.2 Compressive strength, p_c (in N/mm^2), for struts (from Tables 27(a) and (b) BS5950: Part 1: 1985)

	Axis of buckling x–x				*Axis of buckling y–y*			
λ \ Py	265	275	340	355	265	275	340	355
15	265	275	340	355	265	275	340	355
25	261	270	333	347	258	267	328	342
35	254	264	324	338	247	256	313	327
45	247	256	313	326	235	243	296	308
50	242	251	306	318	229	237	286	298
55	237	245	267	309	221	228	275	285
60	232	239	288	298	214	221	263	272
65	224	232	275	285	205	211	249	257
70	217	224	262	270	196	202	235	242
75	208	214	246	252	187	192	221	226
80	198	203	230	235	177	181	206	211
85	188	192	214	217	167	171	192	196
90	177	180	198	201	157	161	178	181
95	166	168	183	185	148	150	165	168
100	155	157	169	171	138	141	153	155
105	145	147	155	157	129	131	142	144
110	135	137	144	145	121	123	132	134
115	126	127	133	134	113	115	123	124
120	118	119	124	125	107	108	114	116
125	109	110	115	116	100	101	106	107
130	103	103	107	108	94	95	100	101
135	96	97	100	101	88	89	93	94
140	90	91	94	94	83	84	88	88
145	85	85	88	88	78	79	82	83
150	80	80	82	83	74	74	77	78
155	75	75	77	78	70	70	73	73
160	71	71	73	73	66	66	69	69
165	67	67	69	69	63	63	65	66
170	63	64	65	65	59	60	62	62
175	60	60	61	62	56	57	58	59
180	57	57	58	58	54	54	55	56
250	30	30	31	31	29	29	30	30
350	16	16	16	16	15	15	16	16

$$\lambda = \frac{\text{effective length of strut}}{\text{radius of gyration about relevant axis}}$$

Table 12.4 Universal columns: dimensions and properties (from Table 6 of BS4: Part 1: 1980)



Designation		Depth of section	Width of section	Thickness		Root radius	Depth between fillets	Area of section
Serial size	Mass per unit length	D	B	Web t	Flange T	r	d	
mm	kg/m	mm	mm	mm	mm	mm	mm	cm^2
356×406	634	474.7	424.1	47.6	77.0	15.2	290.1	808.1
	551	455.7	418.5	42.0	67.5	15.2	290.1	701.8
	467	436.6	412.4	35.9	58.0	15.2	290.1	595.5
	393	419.1	407.0	30.6	49.2	15.2	290.1	500.9
	340	406.4	403.0	26.5	42.9	15.2	290.1	432.7
	287	393.7	399.0	22.6	36.5	15.2	290.1	366.0
	235	381.0	395.0	18.5	30.2	15.2	290.1	299.8
Column core	477	427.0	424.4	48.0	53.2	15.2	290.1	607.2
356×368	202	374.7	374.4	16.8	27.0	15.2	290.1	257.9
	177	368.3	372.1	14.5	23.8	15.2	290.1	225.7
	153	362.0	370.2	12.6	20.7	15.2	290.1	195.2
	129	355.6	368.3	10.7	17.5	15.2	290.1	164.9
305×305	283	365.3	321.8	26.9	44.1	15.2	246.5	360.4
	240	352.6	317.9	23.0	37.7	15.2	246.5	305.6
	198	339.9	314.1	19.2	31.4	15.2	246.5	252.3
	158	327.2	310.6	15.7	25.0	15.2	246.5	201.2
	137	320.5	308.7	13.8	21.7	15.2	246.5	174.6
	118	314.5	306.8	11.9	18.7	15.2	246.5	149.8
	97	307.8	304.8	9.9	15.4	15.2	246.5	123.3
254×254	167	289.1	264.5	19.2	31.7	12.7	200.2	212.4
	132	276.4	261.0	15.6	25.3	12.7	200.2	168.9
	107	266.7	258.3	13.0	20.5	12.7	200.2	136.6
	89	260.4	255.9	10.5	17.3	12.7	200.2	114.0
	73	254.0	254.0	8.6	14.2	12.7	200.2	92.9
203×203	86	222.3	208.8	13.0	20.5	10.2	160.8	110.1
	71	215.9	206.2	10.3	17.3	10.2	160.8	91.1
	60	209.6	205.2	9.3	14.2	10.2	160.8	75.8
	52	206.2	203.9	8.0	12.5	10.2	160.8	66.4
	46	203.2	203.2	7.3	11.0	10.2	160.8	58.8
152×152	37	161.8	154.4	8.1	11.5	7.6	123.4	47.4
	30	157.5	152.9	6.6	9.4	7.6	123.4	38.2
	23	152.4	152.4	6.1	6.8	7.6	123.4	29.8

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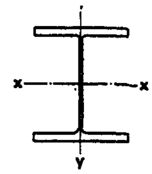


Designation	Second moment of area		Radius of gyration		Elastic modulus		Plastic modulus		Ratio $\frac{D}{T}$
Serial size	X–X axis	Y–Y axis	X–X axis	Y–Y axis	X–X axis	Y–Y axis	X–X axis	Y–Y axis	
mm	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	
356×406	275 140	98 211	18.5	11.0	11 592	4 632	14 247	7 114	6.2
	227 023	82 665	18.0	10.9	9 964	3 951	12 078	6 058	6.7
	183 118	67 905	17.5	10.7	8 388	3 292	10 009	5 038	7.5
	146 765	55 410	17.1	10.5	7 004	2 723	8 229	4 157	8.5
	122 474	46 816	16.8	10.4	6 027	2 324	6 994	3 541	9.5
	99 994	38 714	16.5	10.3	5 080	1 940	5 818	2 952	10.8
	79 110	31 008	16.2	10.2	4 153	1 570	4 689	2 384	12.6
Column core	172 391	68 056	16.8	10.6	8 075	3 207	9 700	4 979	8.0
356×368	66 307	23 632	16.0	9.57	3 540	1 262	3 977	1 917	13.9
	57 153	20 470	15.9	9.52	3 104	1 100	3 457	1 668	15.5
	48 525	17 469	15.8	9.46	2 681	943.8	2 964	1 430	17.5
	40 246	14 555	15.6	9.39	2 264	790.4	2 482	1 196	20.3
305×305	78 777	24 545	14.8	8.25	4 314	1 525	5 101	2 337	8.3
	64 177	20 239	14.5	8.14	3 641	1 273	4 245	1 947	9.3
	50 832	16 230	14.2	8.02	2 991	1 034	3 436	1 576	10.8
	38 740	12 524	13.9	7.89	2 368	806.3	2 680	1 228	13.1
	32 838	10 672	13.7	7.82	2 049	691.4	2 298	1 052	14.7
	27 601	9 006	13.6	7.75	1 755	587.0	1 953	891.7	16.8
	22 202	7 268	13.4	7.68	1 442	476.9	1 589	723.5	20.0
254×254	29 914	9 796	11.9	6.79	2 070	740.6	2 417	1 132	9.1
	22 575	7 519	11.6	6.68	1 634	576.2	1 875	878.6	10.9
	17 510	5 901	11.3	6.57	1 313	456.9	1 485	695.5	13.0
	14 307	4 849	11.2	6.52	1 099	378.9	1 228	575.4	15.0
	11 360	3 873	11.1	6.46	894.5	305.0	988.6	462.4	17.9
203×203	9 462	3 119	9.27	5.32	851.5	298.7	978.8	455.9	10.8
	7 647	2 536	9.16	5.28	708.4	246.0	802.4	374.2	12.4
	6 088	2 041	8.96	5.19	581.1	199.0	652.0	302.8	14.8
	5 263	1 770	8.90	5.16	510.4	173.6	568.1	263.7	16.5
	4 564	1 539	8.81	5.11	449.2	151.5	497.4	230.0	18.5
152×152	2 218	709	6.84	3.87	274.2	91.78	310.1	140.1	14.0
	1 742	558	6.75	3.82	221.2	73.06	247.1	111.2	16.8
	1 263	403	6.51	3.68	165.7	52.95	184.3	80.87	22.3

Fixed-end moments for uniform beams

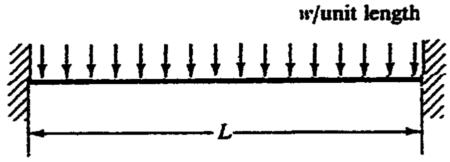
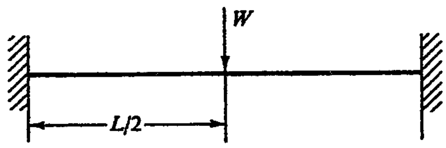
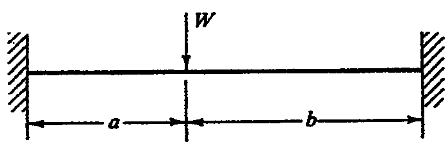
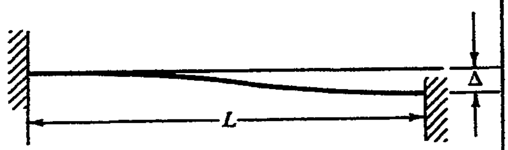
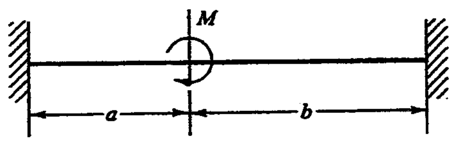
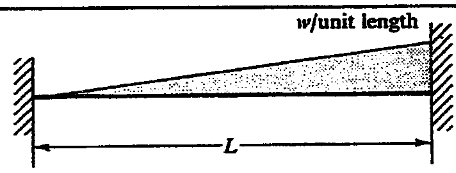
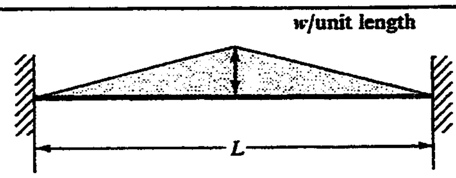
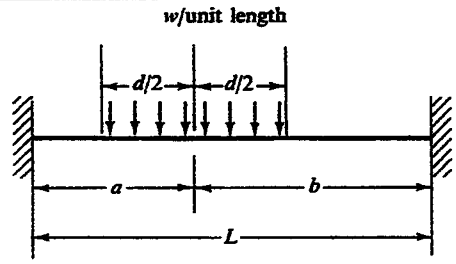
$\frac{wL^2}{12}$		$\frac{wL^2}{12}$
$\frac{WL}{8}$		$\frac{WL}{8}$
$\frac{Wab^2}{L^2}$		$\frac{Wba^2}{L^2}$
$\frac{6EI}{L^2}\Delta$		$\frac{6EI}{L^2}\Delta$
$\frac{Mb}{L^2}(2a-b)$		$\frac{Ma}{L^2}(2b-a)$
$\frac{wL^2}{30}$		$\frac{wL^2}{20}$
$\frac{5wL^2}{96}$		$\frac{5wL^2}{96}$
$\frac{wd}{L^2}\left(ab^2+\frac{(a-2b)d^2}{12}\right)$		$\frac{wd}{L^2}\left(a^2b+(b-2a)\frac{d^2}{12}\right)$

Fig. 6·3–1

Table 3.15 Bending moment coefficients for rectangular panels supported on four sides with provision for torsion at corners

Type of panel and moments considered	Short span coefficients, β_{sx}								Long span coefficients, β_{sy}, for all values of l_y/l_x
	Values of l_y/l_x								
	1.0	1.1	1.2	1.3	1.4	1.5	1.75	2.0	
Interior panels									
Negative moment at continuous edge	0.031	0.037	0.042	0.046	0.050	0.053	0.059	0.063	0.032
Positive moment at mid-span	0.024	0.028	0.032	0.035	0.037	0.040	0.044	0.048	0.024
One short edge discontinuous									
Negative moment at continuous edge	0.039	0.044	0.048	0.052	0.055	0.058	0.063	0.067	0.037
Positive moment at mid-span	0.029	0.033	0.036	0.039	0.041	0.043	0.047	0.050	0.028
One long edge discontinuous									
Negative moment at continuous edge	0.039	0.049	0.056	0.062	0.068	0.073	0.082	0.089	0.037
Positive moment at mid-span	0.030	0.036	0.042	0.047	0.051	0.055	0.062	0.067	0.028
Two adjacent edges discontinuous									
Negative moment at continuous edge	0.047	0.056	0.063	0.069	0.074	0.078	0.087	0.093	0.045
Positive moment at mid-span	0.036	0.042	0.047	0.051	0.055	0.059	0.065	0.070	0.034
Two short edges discontinuous									
Negative moment at continuous edge	0.046	0.050	0.054	0.057	0.060	0.062	0.067	0.070	–
Positive moment at mid-span	0.034	0.038	0.040	0.043	0.045	0.047	0.050	0.053	0.034
Two long edges discontinuous									
Negative moment at continuous edge	–	–	–	–	–	–	–	–	0.045
Positive moment at mid-span	0.034	0.046	0.056	0.065	0.072	0.078	0.091	0.100	0.034
Three edges discontinuous (one long edge continuous)									
Negative moment at continuous edge	0.057	0.065	0.071	0.076	0.081	0.084	0.092	0.098	–
Positive moment at mid-span	0.043	0.048	0.053	0.057	0.060	0.063	0.069	0.074	0.044
Three edges discontinuous (one short edge continuous)									
Negative moment at continuous edge	–	–	–	–	–	–	–	–	0.058
Positive moment at mid-span	0.042	0.054	0.063	0.071	0.078	0.084	0.096	0.105	0.044

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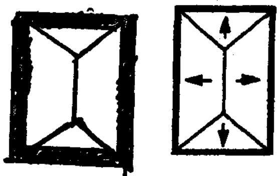
Loads From Slabs To Supporting Beams

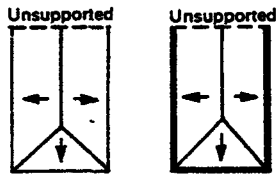


$k > 1$: $R_1 = R_3 = \frac{1}{4} w l_x^2$

$R_2 = R_4 = \frac{1}{2}(k - \frac{1}{2}) w l_x^2$

$\alpha = \beta = 1/2k$

$k = 1$: $R_1 = R_2 = R_3 = R_4 = \frac{1}{4} w l_x^2$

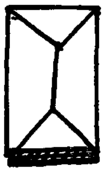


$R_1 = 0$

$R_2 = R_4 = \frac{1}{2}(k - \frac{1}{4}) w l_x^2$

$R_3 = \frac{1}{4} w l_x^2$

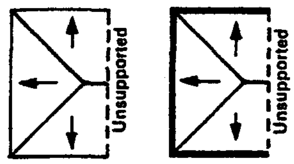
$\beta = 1/2k$



$k \not< 1\frac{1}{3}$: $R_1 = \frac{1}{4} w l_x^2$ (min.) $\alpha = 1/2k$ (min.)

$R_2 = R_4 = \frac{1}{2}(k - \frac{2}{3}) w l_x^2$

$R_3 = \frac{5}{12} w l_x^2$ (max.) $\beta = 5/6k$ (max.)

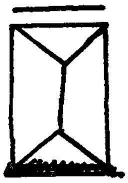


$k \not> 2$: $R_1 = R_3 = \frac{1}{2}k(1 - \frac{1}{4}k) w l_x^2$

$R_2 = 0$

$R_4 = \frac{1}{4}k^2 w l_x^2$

$\psi = k/2$

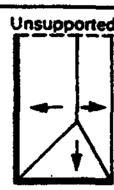


$k \leqslant 1\frac{1}{3}$: $R_1 = \frac{3}{5} R_3$ approx. (min.) $\alpha = 3k/8$

$\beta = 5k/8$

$R_2 = R_4 = \frac{3}{16} k^2 w l_x^2$ $\psi = \xi = 3k/8$

$R_3 = \frac{5}{8}k(1 - \frac{3}{8}k) w l_x^2$ approx. (max.)

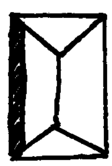


$R_1 = 0$ $\beta = 5/8k$

$R_2 = \frac{3}{5} R_4$ (min.) $\psi = \frac{5}{8}$

$R_3 = \frac{5}{16} w l_x^2$

$R_4 = \frac{5}{8}(k - \frac{5}{16}) w l_x^2$ (max.)

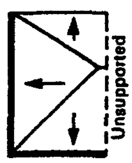


$R_1 = R_3 = \frac{3}{16} w l_x^2$

$R_2 = \frac{3}{5} R_4$ (min.)

$R_4 = \frac{5}{8}(k - \frac{3}{8}) w l_x^2$ (max.)

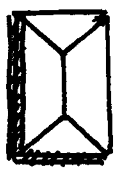
$\alpha = \beta = \frac{3}{8}k$ $\psi = \frac{5}{8}$ (max.)



$k \not> 1\frac{2}{3}$: $R_1 = \frac{3}{5} R_3$ (min.) $R_2 = 0$

$R_3 = \frac{5}{8}k(1 - \frac{5}{16}k) w l_x^2$ (max.)

$R_4 = \frac{5}{16} k^2 w l_x^2$ $\alpha = \frac{5}{8}$ $\psi = 5k/8$

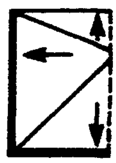


$R_1 = \frac{3}{16} w l_x^2$ (min.) $\alpha = \beta = 3/8k$

$R_2 = \frac{3}{5} R_4$ (min.) $\beta = 5/8k$ (max.)

$R_3 = \frac{5}{16} w l_x^2$ (max.) $\psi = \frac{5}{8}$ (max.)

$R_4 = \frac{5}{8}(k - \frac{1}{2}) w l_x^2$ (max.)

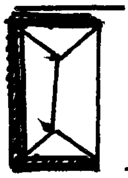


$k \geqslant 1\frac{2}{3}$: $R_1 = \frac{3}{10} w l_x^2$ (min.) $R_2 = 0$

$R_3 = \frac{1}{2} w l_x^2$

$R_4 = (k - \frac{4}{5}) w l_x^2$ (max.)

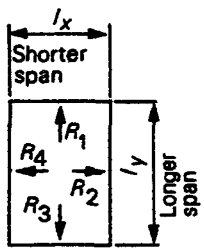
$\alpha = 3/5k$ $\beta = 1/k$



$k \not< 1\frac{1}{4}$: $R_1 = R_3 = \frac{5}{16} w l_x^2$ $\alpha = \beta = \frac{5}{8}k$

$R_2 = \frac{3}{5} R_4$ (min.) $\psi = \frac{5}{8}$ (max.)

$R_4 = \frac{5}{8}(k - \frac{5}{8}) w l_x^2$ (max.)

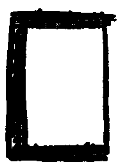


$$k = \frac{l_y}{l_x} = \frac{\text{Longer span}}{\text{Shorter span}}$$

w = Intensity of uniformly-distributed service load per unit area.

If analysis due to ultimate loads is undertaken, substitute n for w in appropriate formulæ.

R_1, R_2, R_3, R_4 = total load carried by each support of panel.



$k \leqslant 1\frac{1}{4}$: $R_1 = R_3 = \frac{1}{2}k(1 - \frac{2}{5}k) w l_x^2$ $\alpha = \beta = k/2$

$R_2 = \frac{3}{20} k^2 w l_x^2$ (min.)

$R_4 = \frac{1}{4} k^2 w l_x^2$ (max.) $\psi = k/2$ $\xi = 3k/10$

$R_1 = \frac{3}{20} w l_x^2$ (min.) $\alpha = 3/10k$ (min.)

$R_2 = R_4 = \frac{1}{2}(k - \frac{2}{5}) w l_x^2$

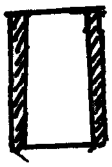
$R_3 = \frac{1}{4} w l_x^2$ (max.) $\beta = 1/2k$ (max.)

Condition of supports

- - - - - - - - = No support

———— = Freely supported

———— = Continuity or fixity

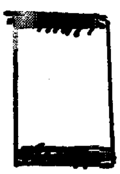


$R_1 = R_3 = \frac{3}{20} w l_x^2$ (min.)

$R_2 = R_4 = \frac{1}{2}(k - \frac{3}{10}) w l_x^2$ (max.)

$\alpha = \beta = 3/10k$ (min.)

Loads marked (min.) apply if panel is entirely freely supported along edge indicated: if partially restrained, load will be slightly greater than given and load marked (max.) on opposite edge will be correspondingly reduced.



$k \not< 1\frac{2}{3}$: $R_1 = R_3 = \frac{5}{12} w l_x^2$ (min.)

$R_2 = R_4 = \frac{1}{2}(k - \frac{5}{6}) w l_x^2$ (max.)

$\alpha = \beta = 5/6k$ (min.)