



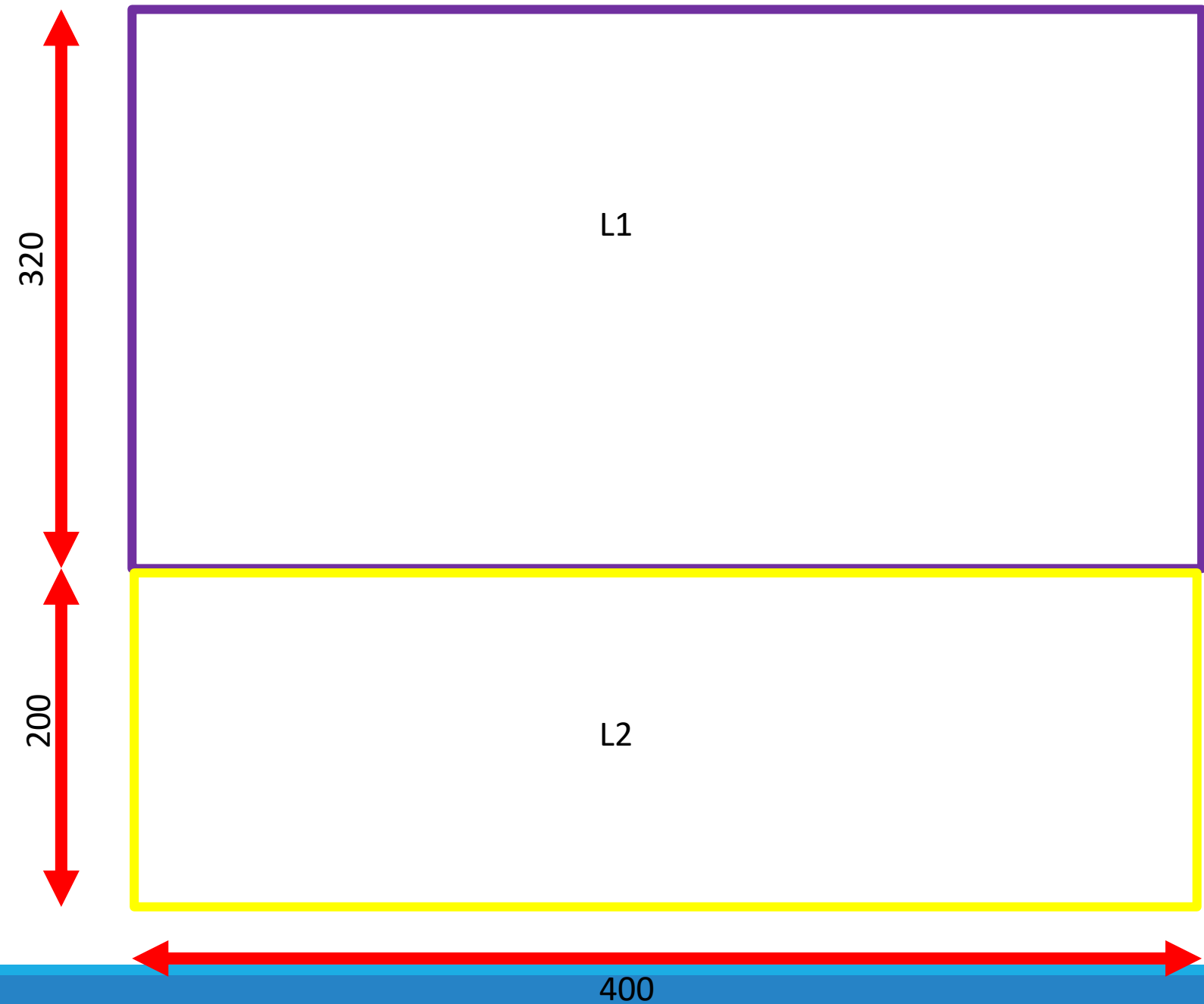
FACULDADE DE TECNOLOGIA E CIÊNCIAS DA BAHIA

Dimensionamento de lajes maciças – momentos fletores

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Da aula anterior...

Foi definido o vão teórico das lajes, ou seja, o vão das lajes usado para o dimensionamento...



... As características geométricas das lajes bem como as cargas atuantes nas mesmas...

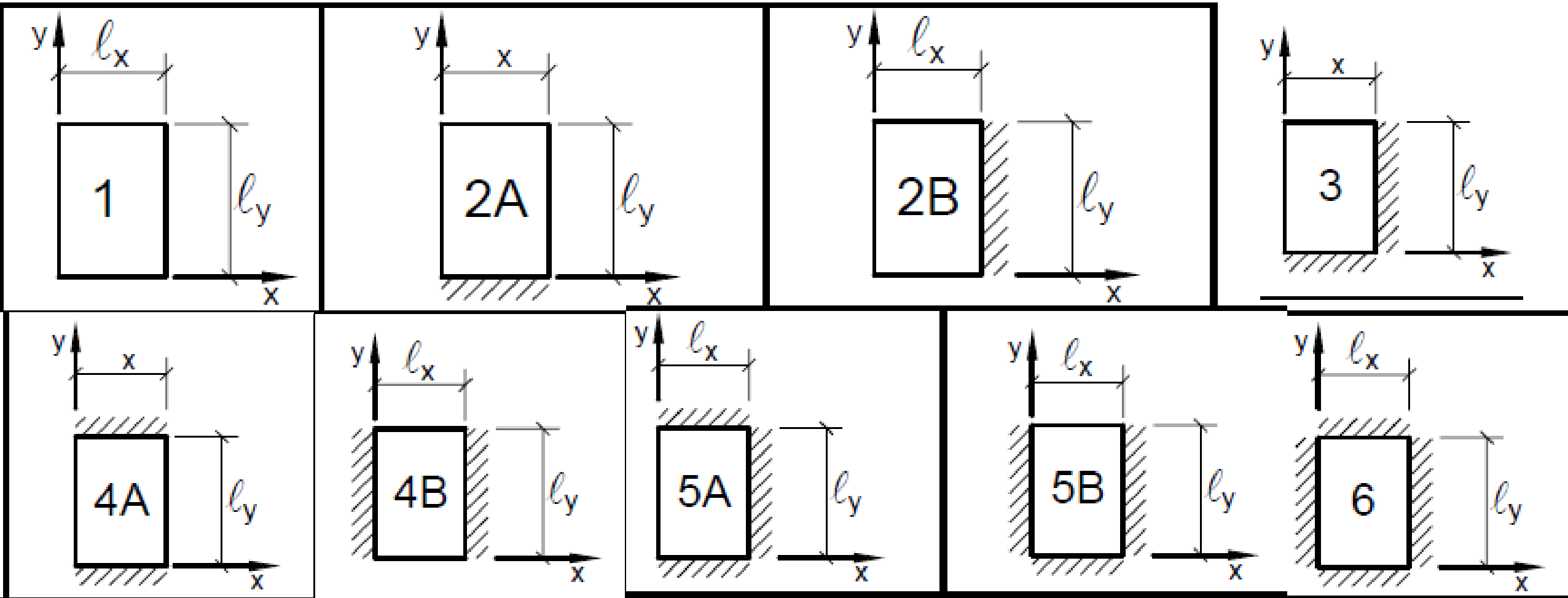
TABELA 1. Características geométricas das lajes

LAJE	CASO	lx (CM)	ly (cm)	λ (ly/lx)	d (cm)	H (cm)	OBSERVAÇÃO
1	2B	320	400	$400/320=1,25 < 2$	$H-c \frac{\phi_{arm.long.}}{2} = 10 - 3 - 1/2 = 6,5 \text{ cm}$	10	Armada em duas direções
2	2B	200	400	$400/200=2$	6,5 cm	10	Armada em duas direções

TABELA 2. Cargas atuantes nas lajes

LAJE	H (cm)	Peso próprio (kN/m ²)	Revestimento (kN/m ²)	Forro (kN/m ²)	Alvenaria	Acidental (kN/m ²)	P Total ou Fsd
1	10	2,5	1,0	-	-	1,5	7
2	10	2,5	1,4	-	-	1,5	7,56

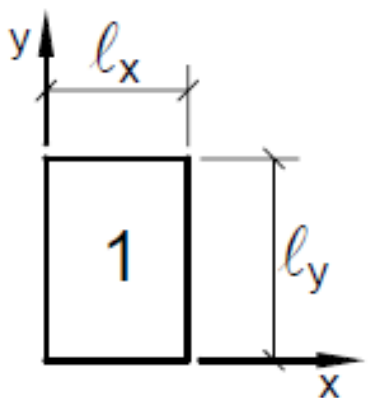
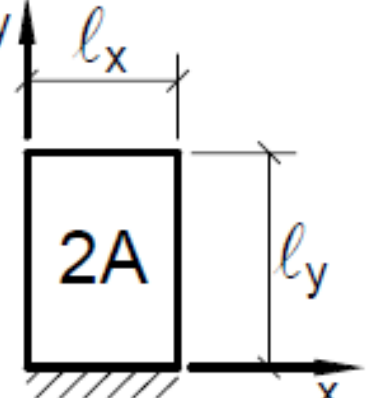
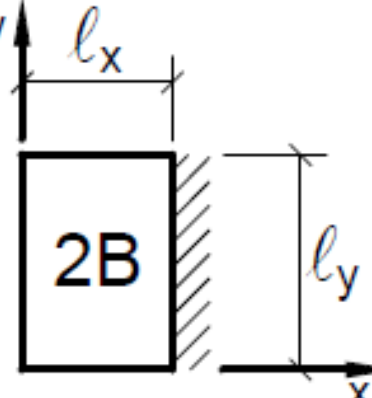
Vinculações em lajes



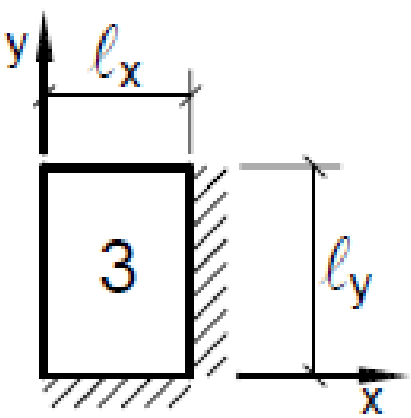
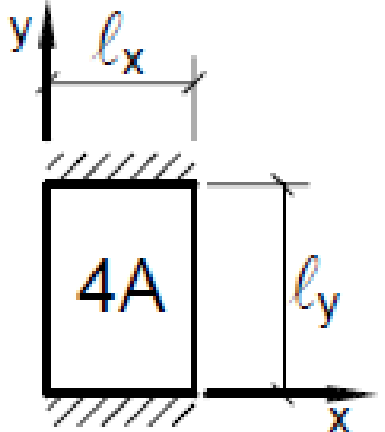
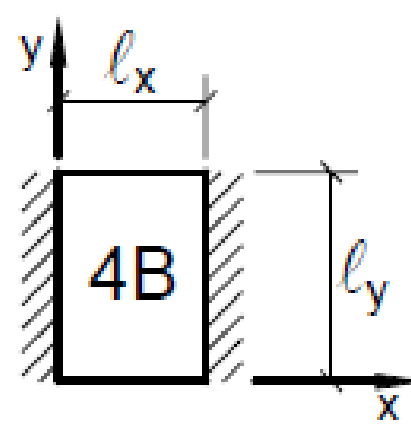
...foram apresentadas as vinculações que as lajes podem ter assim como as tabelas de lajes que serão utilizadas...

Tabela 2.3a

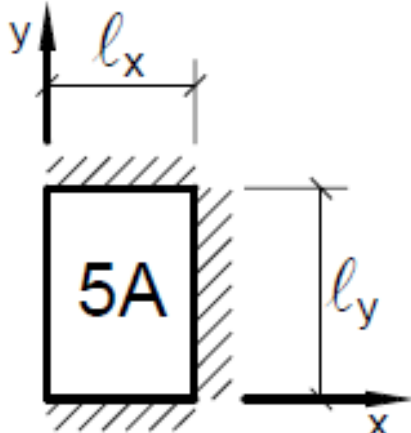
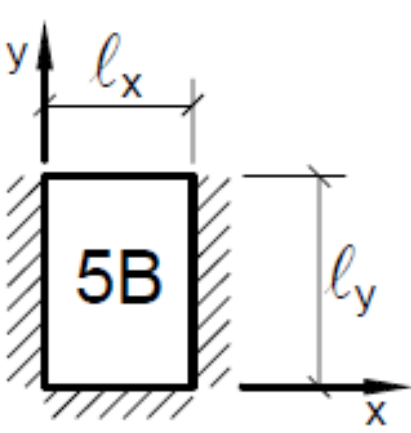
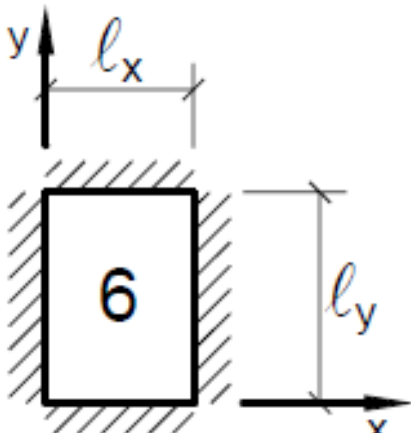
MOMENTOS FLETORES EM LAJES COM CARGA UNIFORME

Tipo									Tipo
$\lambda = \frac{l_y}{l_x}$	μ_x	μ_y	μ_x	μ_y	μ'_y	μ_x	μ'_x	μ_y	$\lambda = \frac{l_y}{l_x}$
1,00	4,23	4,23	2,91	3,54	8,40	3,54	8,40	2,91	1,00
1,05	4,62	4,25	3,26	3,64	8,79	3,77	8,79	2,84	1,05
1,10	5,00	4,27	3,61	3,74	9,18	3,99	9,17	2,76	1,10

MOMENTOS FLETORES EM LAJES COM CARGA UNIFORME

Tipo											Tipo
$\lambda = \frac{l_y}{l_x}$	μ_x	μ'_x	μ_y	μ'_y	μ_x	μ_y	μ'_y	μ_x	μ'_x	μ_y	$\lambda = \frac{l_y}{l_x}$
1,00	2,69	6,99	2,69	6,99	2,01	3,09	6,99	3,09	6,99	2,01	1,00
1,05	2,94	7,43	2,68	7,18	2,32	3,23	7,43	3,22	7,20	1,92	1,05
1,10	3,19	7,87	2,67	7,36	2,63	3,36	7,87	3,35	7,41	1,83	1,10
1,15	3,42	8,28	2,65	7,50	2,93	3,46	8,26	3,46	7,56	1,73	1,15
1,20	3,65	8,69	2,62	7,63	3,22	3,56	8,65	3,57	7,70	1,63	1,20

MOMENTOS FLETORES EM LAJES COM CARGA UNIFORME

Tipo													Tipo
$\lambda = \frac{l_y}{l_x}$	μ_x	μ'_x	μ_y	μ'_y	μ_x	μ'_x	μ_y	μ'_y	μ_x	μ'_x	μ_y	μ'_y	$\lambda = \frac{l_y}{l_x}$
1,00	2,02	5,46	2,52	6,17	2,52	6,17	2,02	5,46	2,02	5,15	2,02	5,15	1,00
1,05	2,27	5,98	2,56	6,46	2,70	6,47	1,97	5,56	2,22	5,50	2,00	5,29	1,05
1,10	2,52	6,50	2,60	6,75	2,87	6,76	1,91	5,65	2,42	5,85	1,98	5,43	1,10
1,15	2,76	7,11	2,63	6,97	3,02	6,99	1,84	5,70	2,65	6,14	1,94	5,51	1,15
1,20	3,00	7,72	2,65	7,19	3,16	7,22	1,77	5,75	2,87	6,43	1,89	5,59	1,20

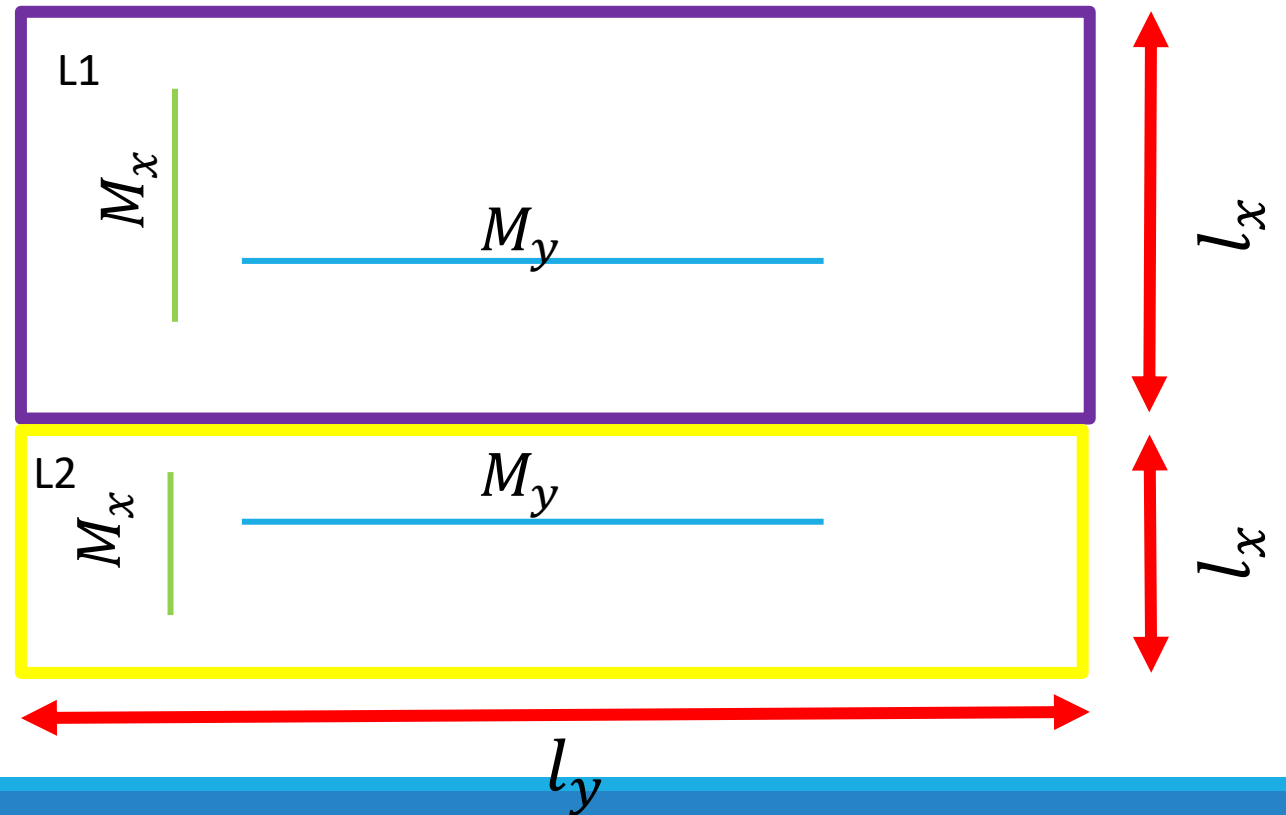
3. Determinação dos momentos fletores

$$\lambda = \frac{l_y}{l_x}$$

$$M_x = \mu_x * p * \frac{l_x^2}{100}$$

$$M_y = \mu_y * p * \frac{l_x^2}{100}$$

Meio do vão da laje



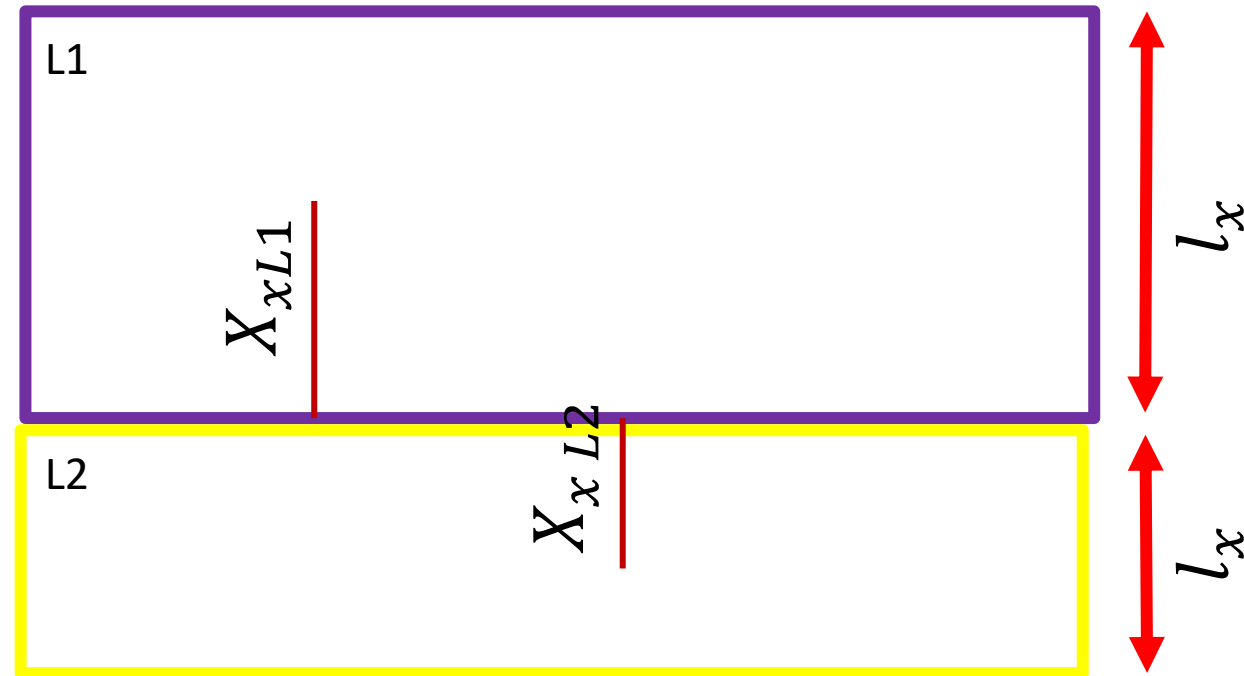
3. Determinação dos momentos fletores

$$\lambda = \frac{l_y}{l_x}$$

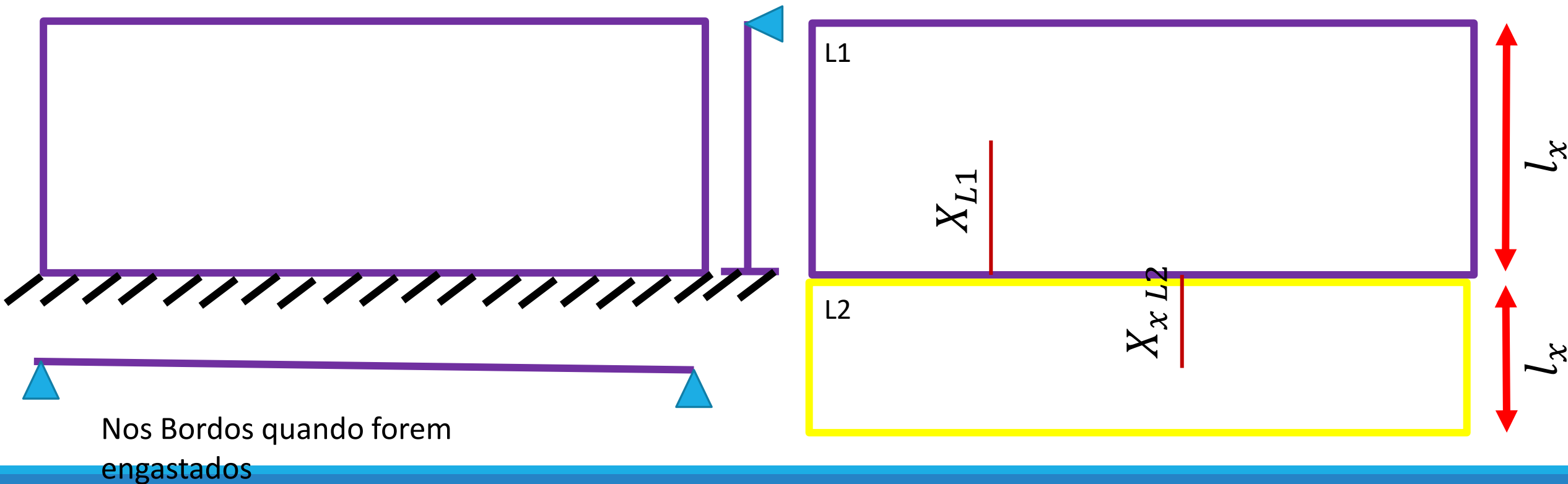
$$X_x = \mu'_x * p * \frac{l_x^2}{100}$$

$$X_y = \mu'_y * p * \frac{l_x^2}{100}$$

Nos Bordos quando forem engastados



3. Determinação dos momentos fletores



L1

L2

L3

L4

L5

L6

Voltando pro Exemplo...

Determine a armadura das lajes a seguir, sabendo que:

$f_{ck}=30$ MPa

Classe de agressividade 3

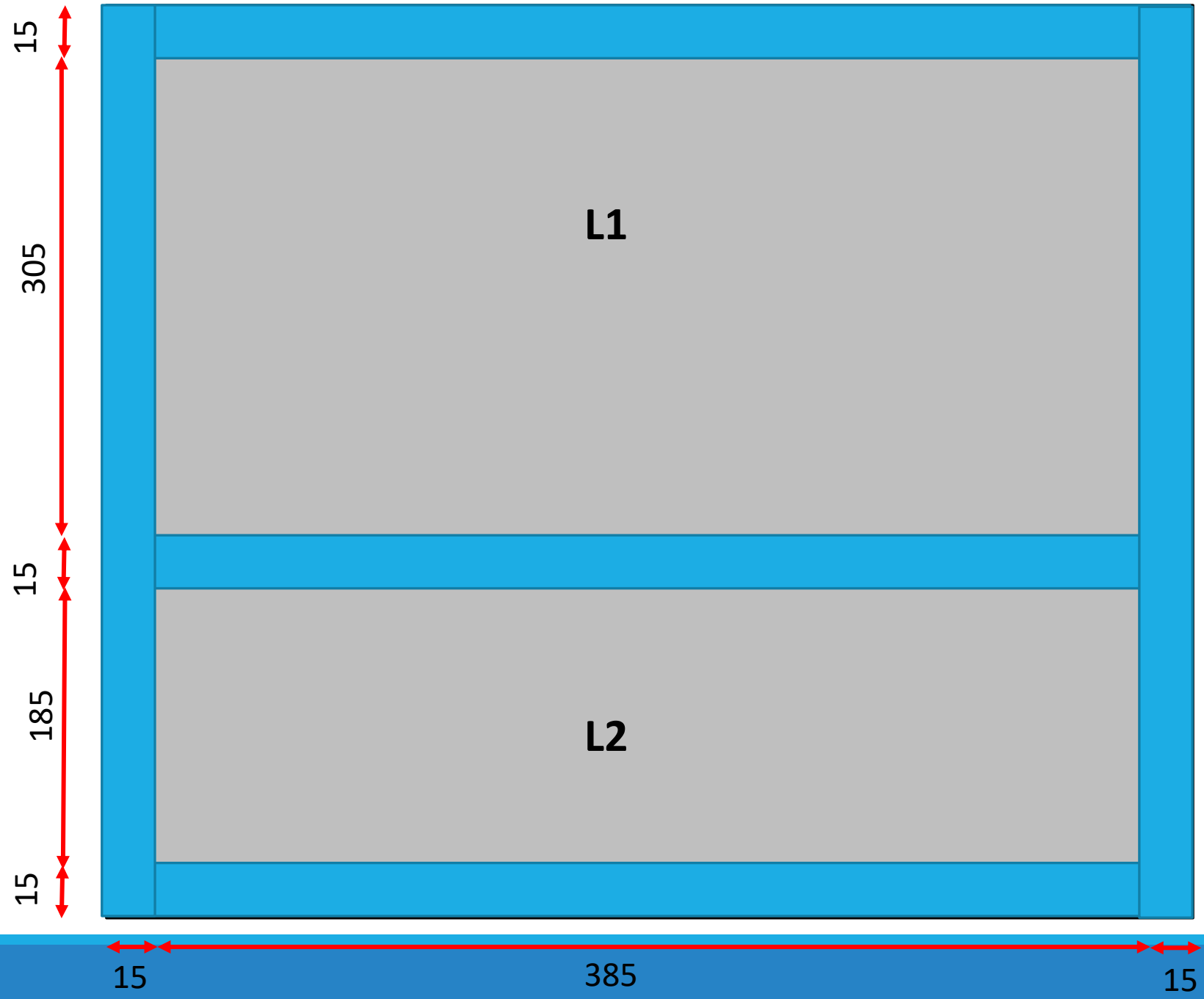
As lajes serão utilizadas para uma edificação residencial (quarto, sala)

na laje 1: Revestimento cerâmico de espessura de 5 cm

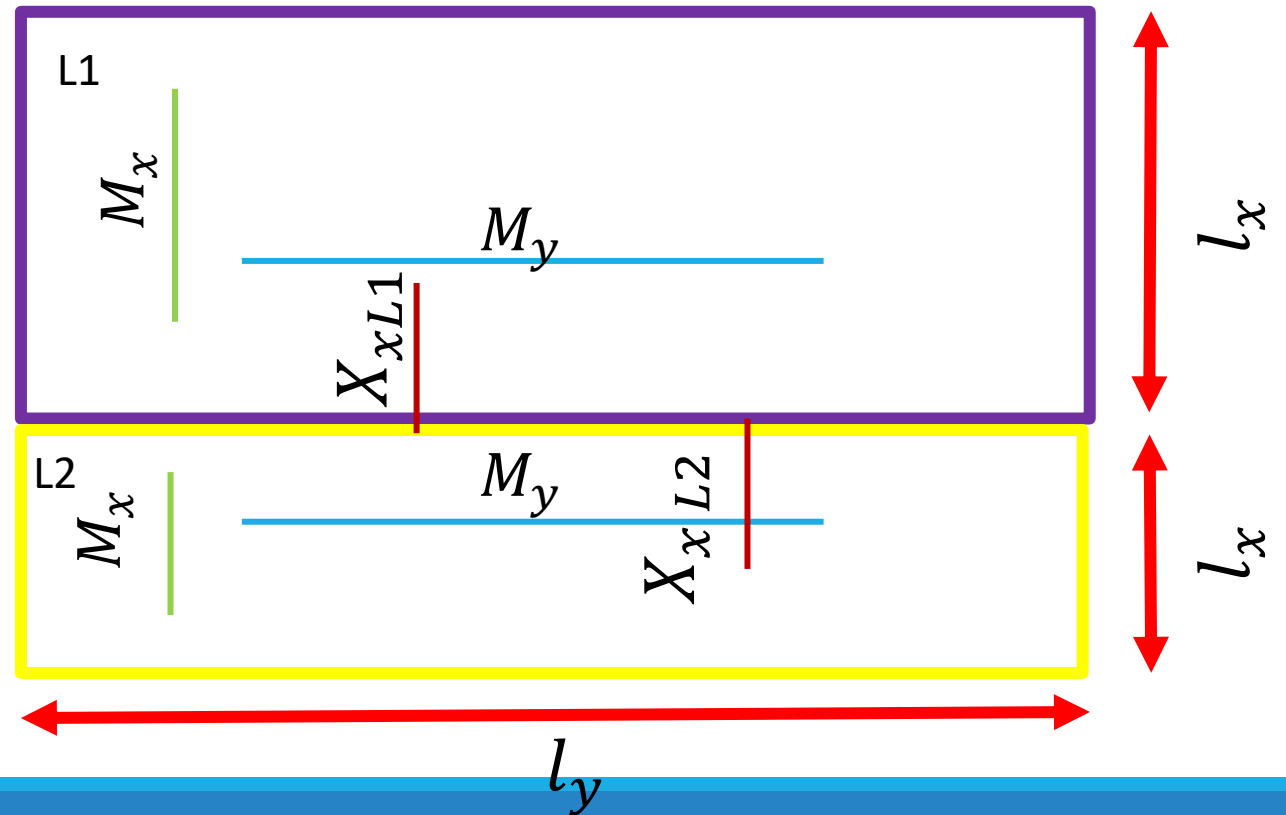
na laje 2: Revestimento cerâmico de espessura de 7 cm

Lajes maciças

Considere pilares embutidos nas paredes



3. Determinação dos momentos fletores



3. Determinação dos Momentos nas lajes

Laje 1 - vertical

$$M_x = \mu_x * p * \frac{l_x^2}{100}$$

$$M_x = 4,55 * 7 * \frac{3,20^2}{100}$$

$$M_x = 3,26 \text{ kN.m}$$

Laje 1 - horizontal

$$M_y = \mu_y * p * \frac{l_x^2}{100}$$

$$M_y = 2,51 * 7 * \frac{3,20^2}{100}$$

$$M_y = 1,80 \text{ kN.m}$$

Laje 1 - engaste

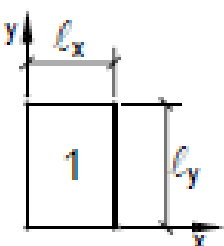
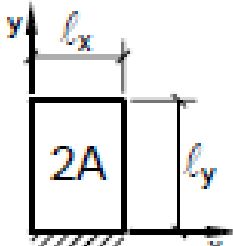
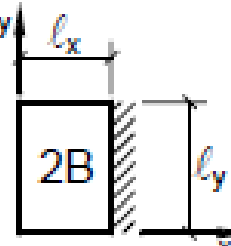
$$X_{L1} = \mu'_x * p * \frac{l_x^2}{100}$$

$$X_{xL1} = 10,06 * 7 * \frac{3,20^2}{100}$$

$$X_{xL1} = 7,21 \text{ kN.m}$$

Tabela 2.3a

MOMENTOS FLETORES EM LAJES COM CARGA UNIFORME

Tipo									Tipo
	$\lambda = \frac{l_y}{l_x}$	μ_x	μ_y	μ_x	μ_y	μ'_y	μ_x	μ'_x	
1,00	4,23	4,23	2,91	3,54	8,40	3,54	8,40	2,91	1,00
1,05	4,62	4,25	3,26	3,64	8,79	3,77	8,79	2,84	1,05
1,10	5,00	4,27	3,61	3,74	9,18	3,99	9,17	2,76	1,10
1,15	5,38	4,25	3,98	3,80	9,53	4,19	9,49	2,68	1,15
1,20	5,75	4,22	4,35	3,86	9,88	4,38	9,80	2,59	1,20
1,25	6,10	4,17	4,72	3,89	10,16	4,55	10,06	2,51	1,25
1,30	6,44	4,12	5,09	3,92	10,41	4,71	10,32	2,42	1,30
1,35	6,77	4,06	5,44	3,93	10,64	4,86	10,54	2,34	1,35
1,40	7,10	4,00	5,79	3,94	10,86	5,00	10,75	2,25	1,40
1,45	7,41	3,95	6,12	3,91	11,05	5,12	10,92	2,19	1,45
1,50	7,72	3,89	6,45	3,88	11,23	5,24	11,09	2,12	1,50
1,55	8,00	3,83	6,76	3,85	11,39	5,34	11,23	2,04	1,55

3. Determinação dos Momentos nas lajes

Laje 2 - vertical

$$M_x = \mu_x * p * \frac{l_x^2}{100}$$

$$M_x = 5,94 * 7,56 * \frac{2^2}{100}$$

$$M_x = 1,80 \text{ kN.m}$$

Laje 2 - horizontal

$$M_y = \mu_y * p * \frac{l_x^2}{100}$$

$$M_y = 1,48 * 7,56 * \frac{2^2}{100}$$

$$M_y = 0,45 \text{ kN.m}$$

Laje 2 - engaste

$$X_{L1} = \mu'_x * p * \frac{l_x^2}{100}$$

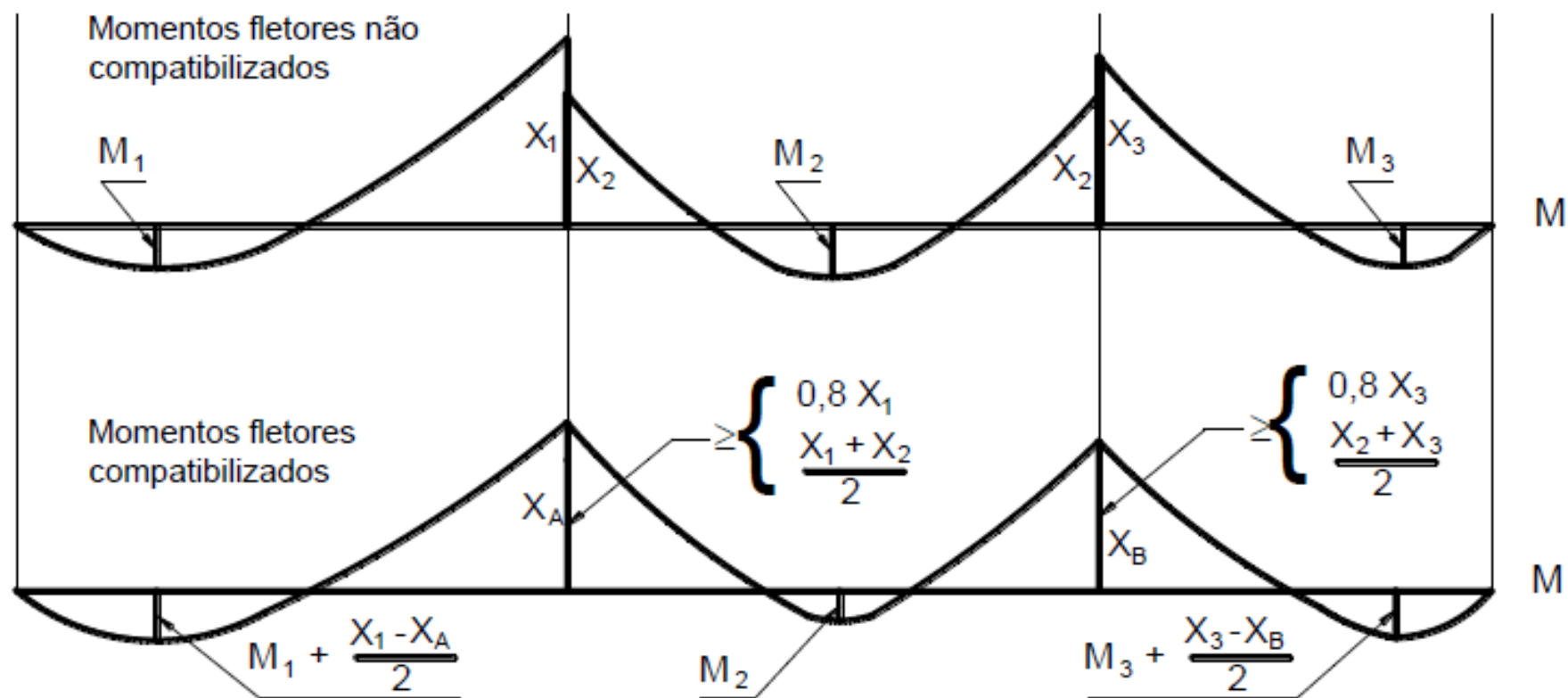
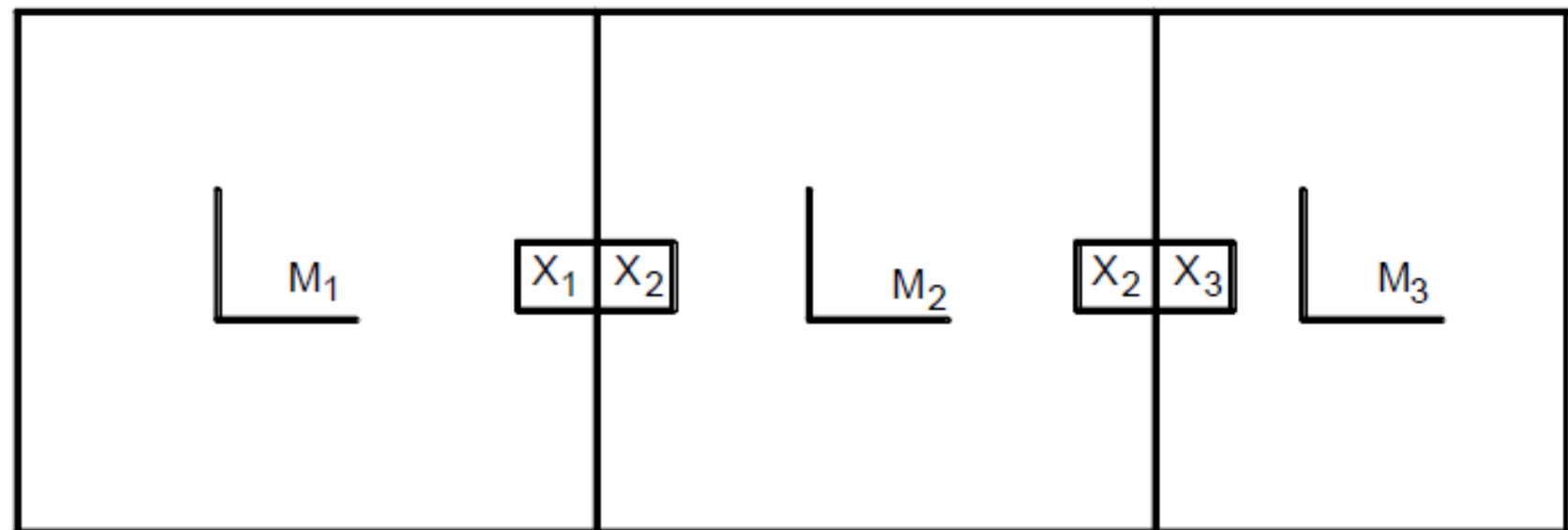
$$X_{L1} = 12,13 * 7,56 * \frac{2^2}{100}$$

$$X_{L1} = 3,7 \text{ kN.m}$$

TABELA 3. Momentos fletores nas lajes

LAJ E	cas o	λ	d	μ_x	M_x	μ_y	M_y	μ'_x	X_x	μ'_y	X_y
1	2B	1,25	6,5		3,26		1,8		7,21	-	-
2	2B	2	6,5		1,8		0,45		3,67	-	-

$$X \geq \begin{cases} 0,8 X_1 \\ \frac{X_1 + X_2}{2} \end{cases}, \text{ com } X_1 \geq X_2$$



L1

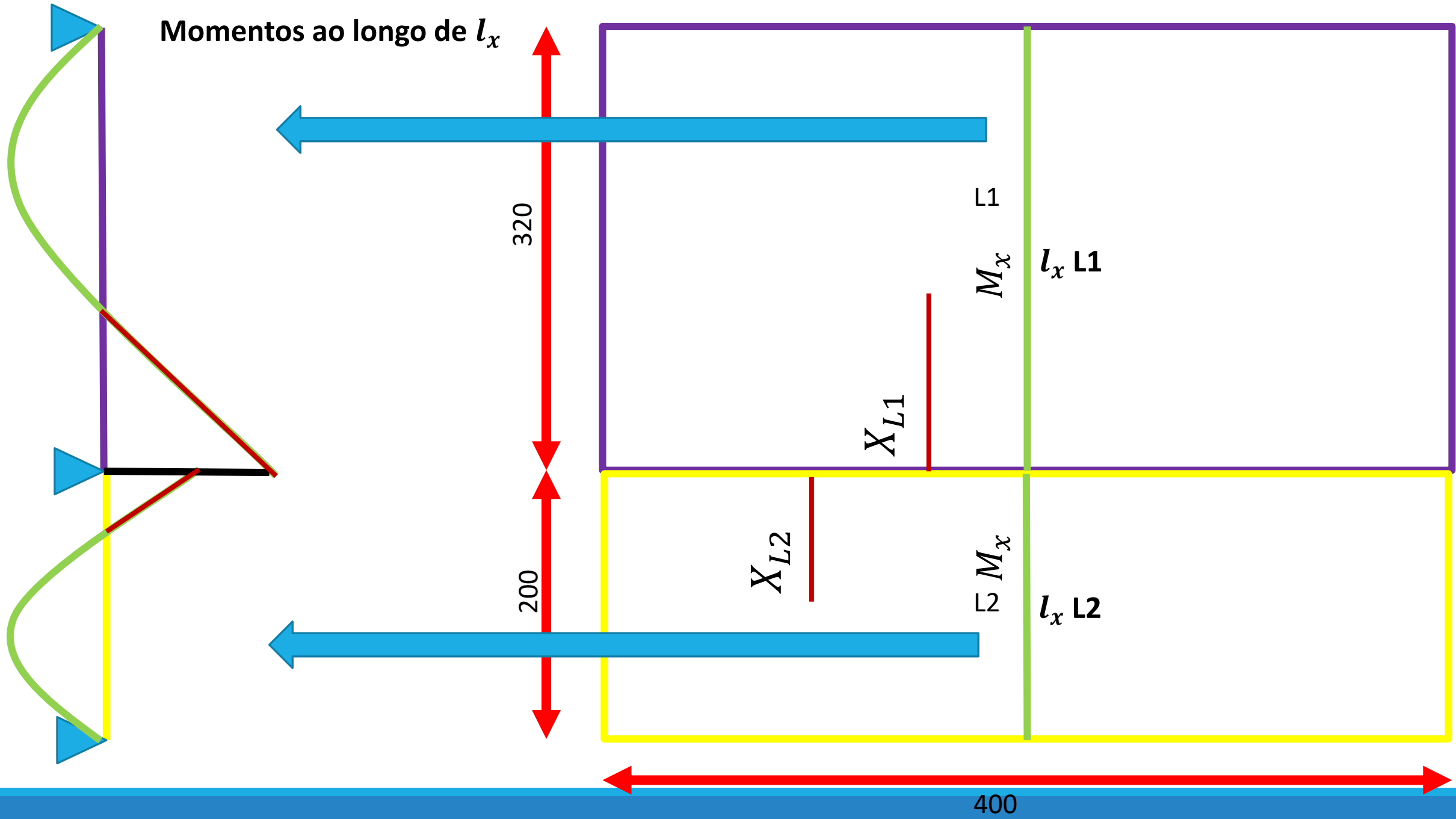
L2

L3

L4

L5

L6



Momentos ao longo de l_x

320

200

L1

L2

M_x

M_x

l_x L1

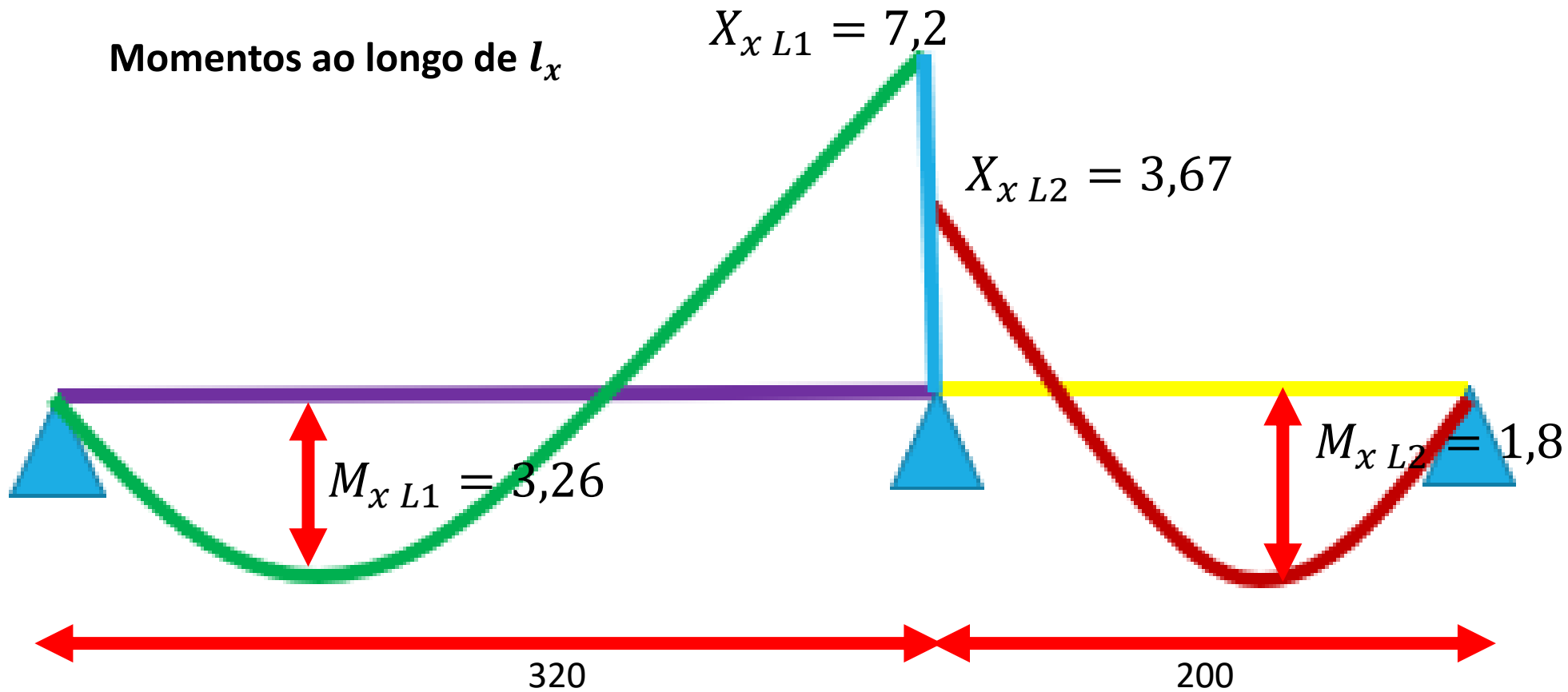
l_x L2

X_{L1}

X_{L2}

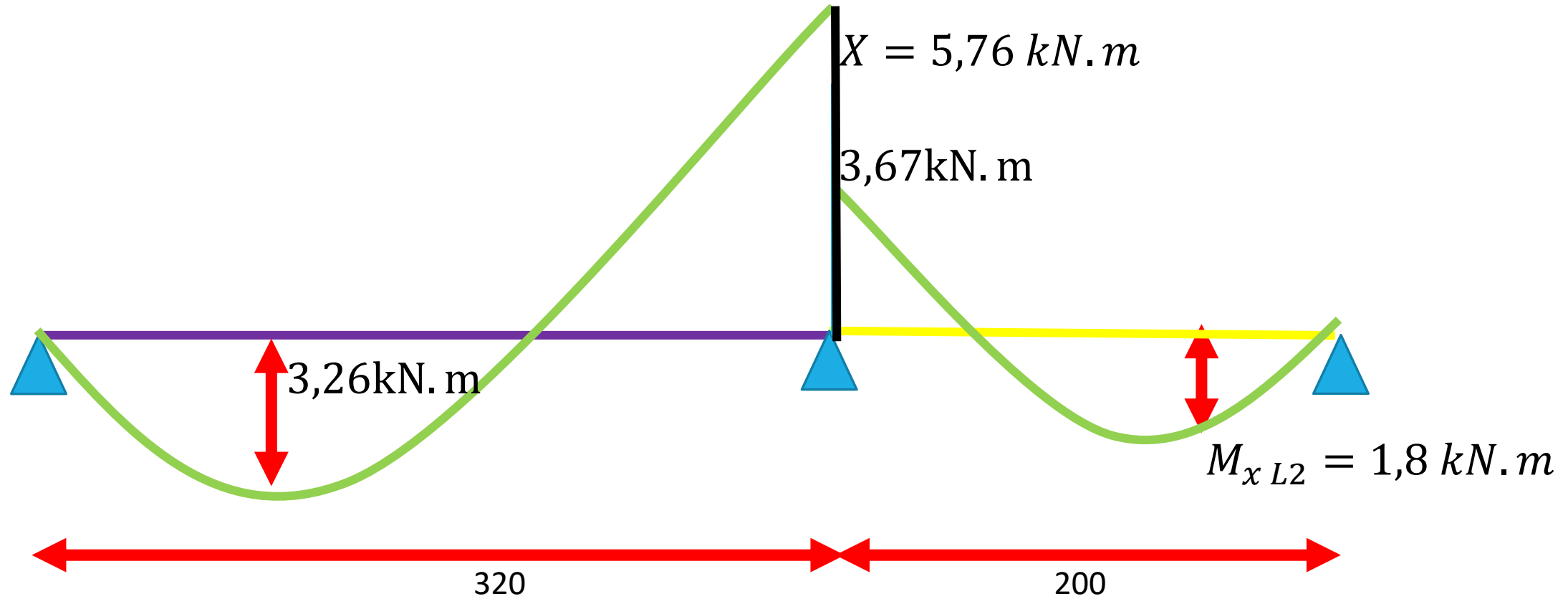
400

Momentos ao longo de l_x



$$X \begin{cases} 0,8 * X, \text{ sendo } X \text{ o maior momento: } 0,8 * 7,2 = 5,76 \text{ kN.m} \\ \frac{X_{L1} + X_{L2}}{2} = \frac{7,2 + 3,67}{2} = 5,44 \text{ kN.m} \end{cases} \rightarrow X = 5,76 \text{ kN.m}$$

Momentos ao longo de l_x 7,2kN.m

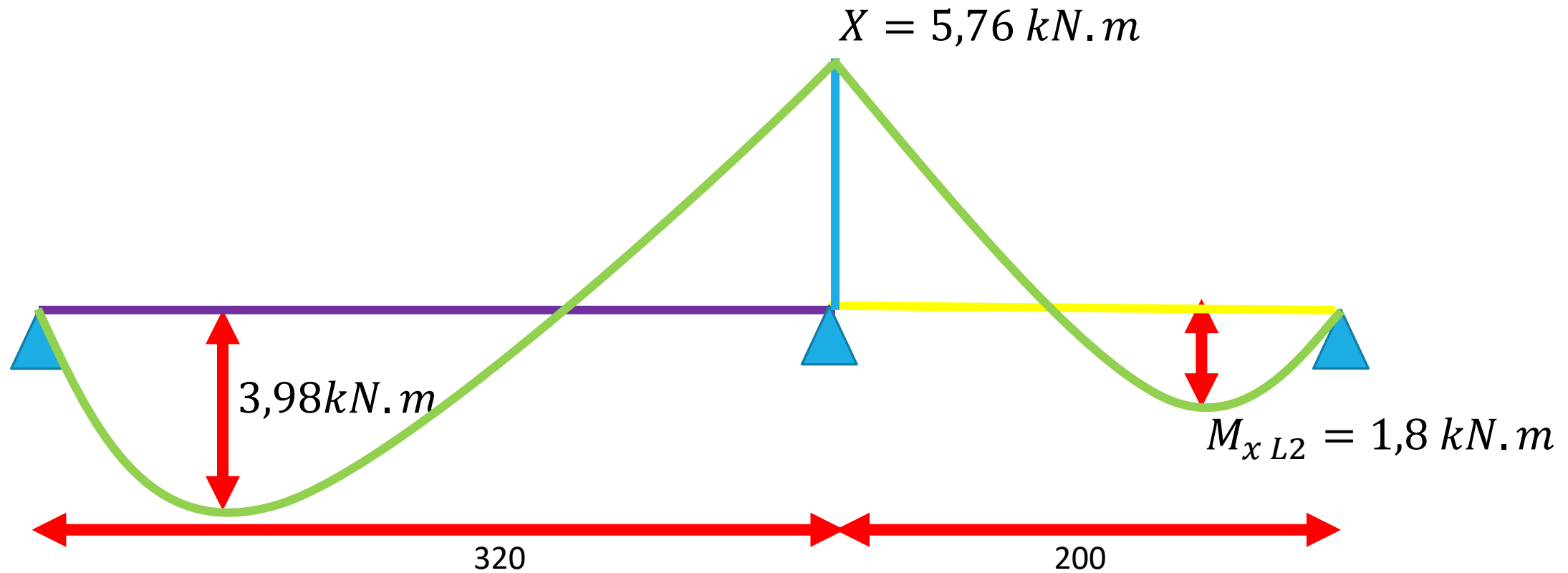


$$M_{x L1} = M_{x L1} + \frac{X_{L1} - X}{2}$$

$$M_{x L1} = 3,26 + \frac{7,2 - 5,76}{2}$$

$$M_{x L1} = 3,98 \text{ kN.m}$$

Momentos ao longo de l_x

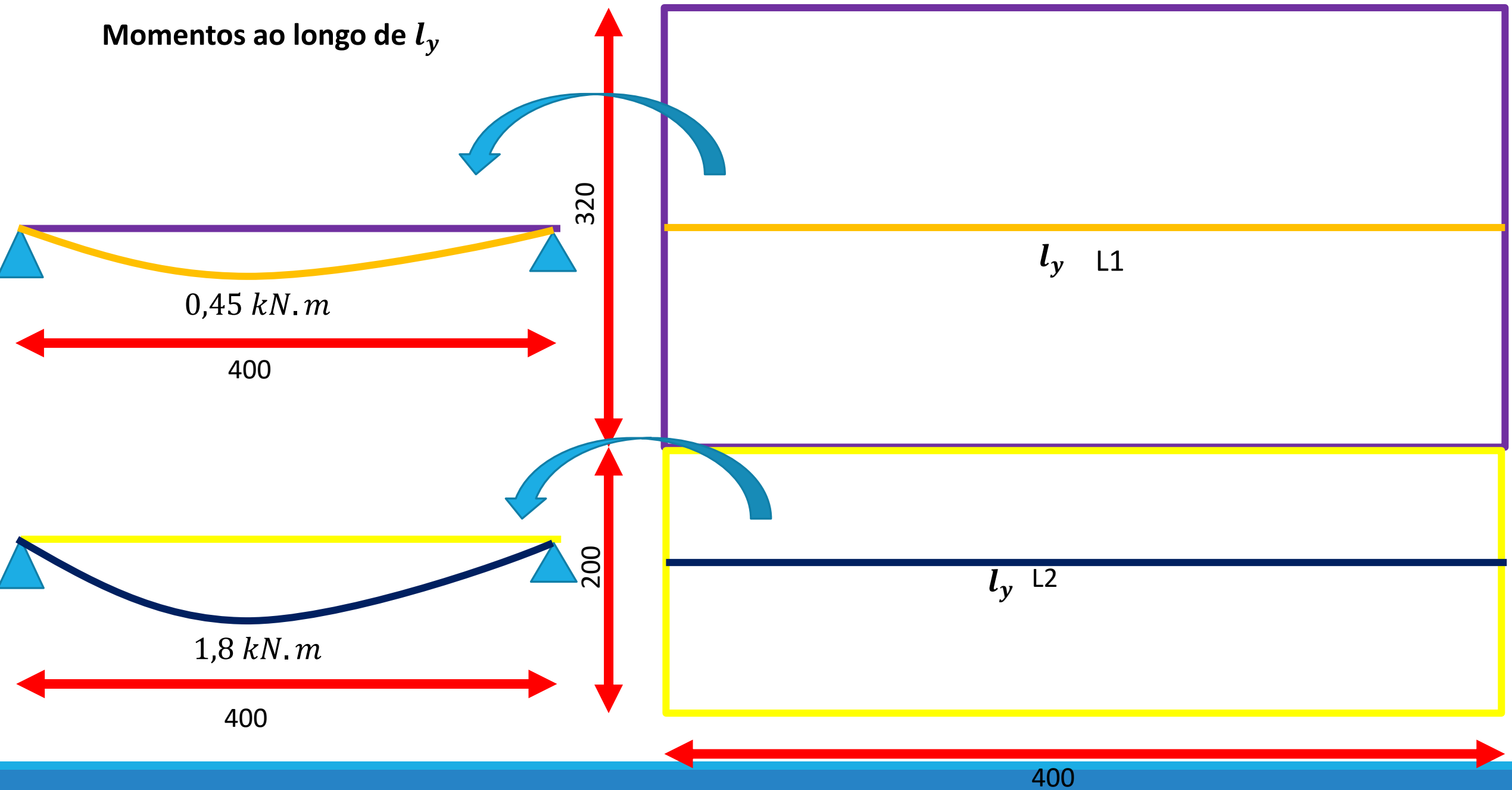


$$M_{x L1} = M_{x L1} + \frac{X_{L1} - X}{2}$$

$$M_{x L1} = 3,26 + \frac{7,2 - 5,76}{2}$$

$$M_{x L1} = 3,98 \text{ kN.m}$$

Momentos ao longo de l_y



Resumo de todos os momentos nas lajes 1 e 2

Momentos positivos

$$M_{x L1} = 3,98 \text{ kN.m}$$

$$M_{y L1} = 0,45 \text{ kN.m}$$

$$M_{x L2} = 1,8 \text{ kN.m}$$

$$M_{y L2} = 1,8 \text{ kN.m}$$

Momentos negativos

$$X_x = 5,76 \text{ kN.m}$$

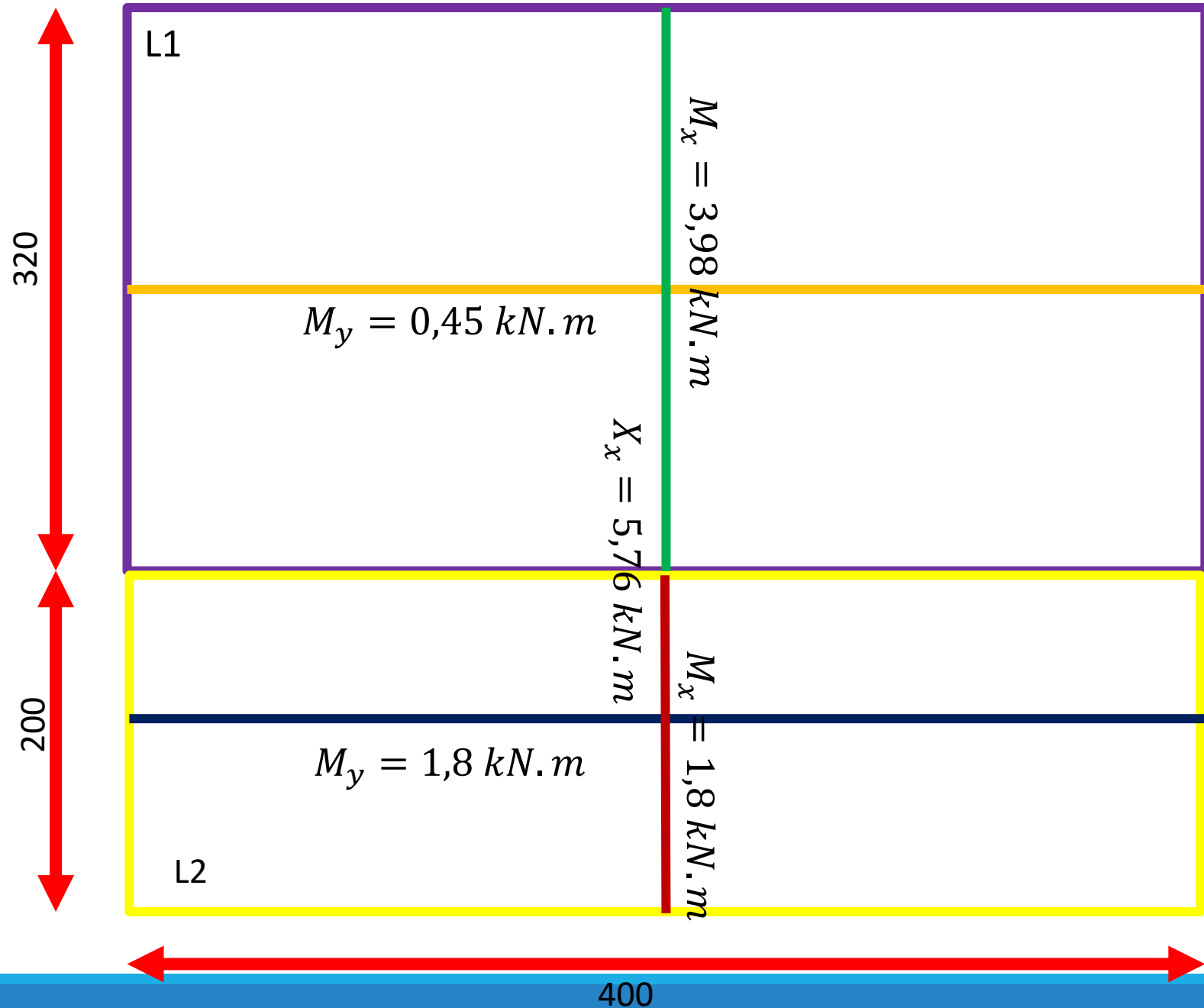


TABELA 3. Momentos fletores nas lajes compatibilizados

LAJE	caso	λ	d	μ_x	M_x (kN.m)	μ_y	M_y (kN.m)	μ'_x	X_x (kN.m)	μ'_y	X_y (kN.m)
1	2B	1,25	6,5	4,55	3,98	2,51	1,8	10,06	5,76	-	-
2	2B	2	6,5	5,94	1,8	1,48	0,45	12,13	5,76	-	-