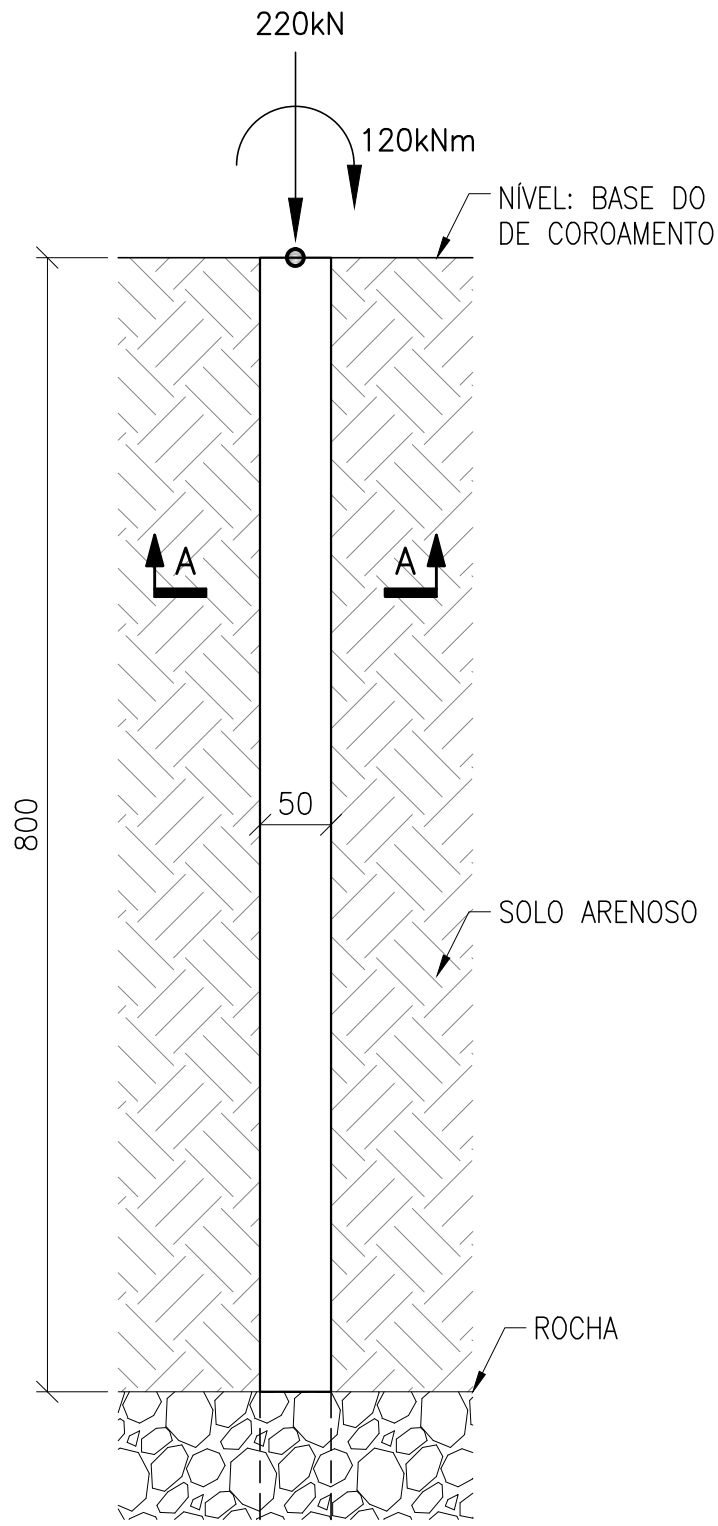
EXERCÍCIO 4.A

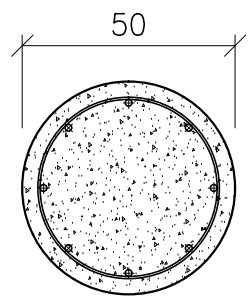
PROBLEMA:

REALIZAR A ANÁLISE ESTRUTURAL DA ESTACA DE CONCRETO ARMADO REPRESENTADA. SIMULAR A ESTACA UTILIZANDO ELEMENTOS TRIDIMENSIONAIS (**SOLID185**) E SIMULAR A AÇÃO DO SOLO UTILIZANDO ELEMENTOS DE MOLA UNIDIRECIONAIS (**LINK180**). CONSIDERAR APENAS COMPORTAMENTO NO PLANO **XZ**.



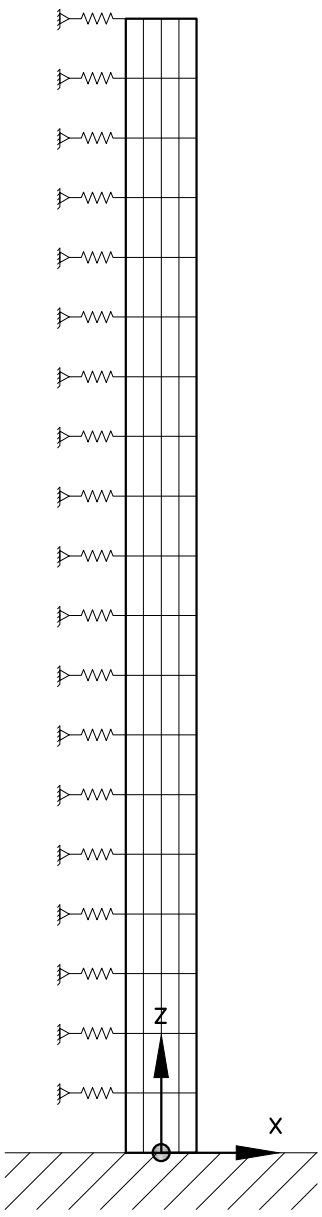
ELEVAÇÃO DA ESTACA

ESC.: 1/75



CORTE AA

ESC.: 1/25



MODELO NUMÉRICO

ESC.: 1/75

DADOS:

MATERIAL: CONCRETO ARMADO
- f_{ck} = 30MPa
- E_{cs} = 30GPa
- v = 0.2
- p = 2500kg/m^3

MATERIAL: SOLO
- E_s = 40GPa
- v = 0.2
- p = 1800kg/m^3

PARA PONDERAR:

EXERCÍCIO 4.A

Análise de uma estaca cilíndrica flexo-comprimida.

/prep7	Preprocessor	
ET,1,185 ET,2,180	Element Type → Add/Edit/Delete → Add… → Library of Element Types = Structural Mass ; Solid ; Brick 8 node 185 Element type reference number = 1 → Apply → Library of Element Types = Structural Mass ; Link ; 3D finit stn 180 Element type reference number = 2 → OK → Close	
MP,EX,1,30E9 MP,PRXY,1,0.2 MP,EX,2,40E6 MP,PRXY,2,0.2	Material Props → Material Models → Structural → Linear → Elastic → Isotropic → EX = 30e9 PRXY = 0.2 → Material → New Model → Define Material ID = 2 → OK → Structural → Linear → Elastic → Isotropic → EX = 40e6 PRXY = 0.2 → OK → Material → Exit	
R,1,1,0,0	Real Constants → Add/Edit/Delete → Add… → Type 2 LINK180 → OK → Real Constant Set No. = 1 Cross-sectional area = 1 Added Mass (Mass/Length) = 0 Tension and compression = BOTH → OK → Close	
/vup,,Z /view,1,0,1,0	PlotCtrls → View Settings → Viewing Direction → Window number = Window 1 Coords of view point = 0, 1, 0 Coord axis orientation = Z-axis up → OK	
CYL4,0,0,0.25,,,,8	Modeling → Create → Volumes → Cylinder → Solid Cylinder → WP X = 0 WP Y = 0 Radius = 0.25 Depth = 8 → OK	

WPSTYL,0.01,0.5,-10,10,0.001,0,1,,5	WorkPlane → WP Settings… → Cartesian Grid Only Spacing = 0.5 Minimum = -10 Maximum = 10 → OK	
WPROTA,,,90	WorkPlane → Offset WP by Increments… → Degrees XY, YZ, ZX Angles = 0,0,90 → OK	
VSBW,ALL,,DELETE	Modeling → Operate → Booleans → Divide → Volu by WrkPlane → Pick All	
WPROTA,,,-90 WPROTA,,90	WorkPlane → Offset WP by Increments… → Degrees XY, YZ, ZX Angles = 0,0,-90 → Apply → Degrees XY, YZ, ZX Angles = 0,90,0 → OK	
VSBW,ALL,,DELETE	Modeling → Operate → Booleans → Divide → Volu by WrkPlane → Pick All	
WPSTYLE,,,,,,,,0	WorkPlane → Display Working Plane	
ESIZE,0.1	Meshing → Size Cntrls → Manual Size → Global → Size → Element edge length = 0.1 → OK	
MSHAPE,1,3D VMESH,ALL	Meshing → Mesh → Volumes → Free → Pick All	
*get,MxNd,NODE,,NUM,MAXD	List → Status → Preprocessor → Nodes → *[Anotar o valor identificado como "**Maximum node number**"]*	
LSEL,S,LOC,X,0.25 NSLL,S,1	Select → Entities… → Lines By Location X coordinates Min,Max = 0.25 From Full → Apply → Nodes Attached to Lines, all From Full → OK	

NGEN,2,MxNd,ALL,,,1	Modeling → Copy → Nodes → Copy → Pick All Total number of copies = 2 X-offset in active CS = 1 Node number increment = *[Valor anotado para "**maximum node number**"]* Spacing ratio = 1 → OK	
TYPE,2 MAT,2	Meshing → Mesh Attributes → Default Attribs → Element type number = 2 LINK180 Material number = 2 Real constant set = 1 → OK	
EINTF,0.0001,,LOW,0,1	Modeling → Create → Elements → Auto Numbered → Offset Nodes → Tolerance of coincidence = 0.0001 Nodal number ordering = Low to high Coordinate system = 0 Offset in X-direction = 1 → OK	
NSEL,S,LOC,X,1.25	Select → Entities… → Nodes By Location X coordinates Min,Max = 1.25 From Full → OK	
D,ALL,ALL,0	Loads → Define Loads → Apply → Structural → Displacement → On Nodes → Pick All DOFs to be constrained = All DOF → OK	
ASEL,S,LOC,Z,0	Select → Entities… → Areas By Location Z coordinates Min,Max = 0 From Full → OK	
DA,ALL,ALL,0	Loads → Define Loads → Apply → Structural → Displacement → On Areas → Pick All DOFs to be constrained = All DOF → OK	
ALLSEL	Select → Everything	

NSEL,S,LOC,Z,8 NSEL,R,LOC,X,0 NSEL,R,LOC,Y,0	Select → Entities… → Nodes By Location Z coordinates Min,Max = 8 From Full → Apply → Nodes By Location X coordinates Min,Max = 0 Reselect → Apply → Nodes By Location Y coordinates Min,Max = 0 Reselect → OK	
F,ALL,FZ,-220E3 F,ALL,MY,120E3	Loads → Apply → Structural → Force/Moment → On Nodes → Pick All Direction of force/mom = FZ Apply as = Constant value Force/moment value = -220e3 → Apply → Direction of force/mom = MY Apply as = Constant value Force/moment value = 120e3 → OK	
ALLSEL	Select → Everything	
/solu	**Solution**	
SOLVE	Solve → Current LS → OK	
/post1	**General Postproc**	
SET,,1	Read Results → First Set	
[Inspecionar os resultados por conta própria]		

FINISH	**Finish**	
/EOF	*!! INTERROMPER MODELAGEM AQUI*	
/prep7	**Preprocessor**	
ET,3,MASS21	Element Type → Add/Edit/Delete → Add… → Library of Element Types = Structural Mass ; 3D mass 21 Element type reference number = 3 → OK → Close	
R,2,0	Real Constants → Add/Edit/Delete → Add… → Type 3 MASS21 → OK → Real Constant Set No. = 2 Mass in X direction = 0 Mass in Y direction = 0 Mass in Z direction = 0 Rotary inertia about IXX = 0 Rotary inertia about IYY = 0 Rotary inertia about IZZ = 0 → OK → Close	
NSEL,S,LOC,Z,8 NSEL,R,LOC,X,0 NSEL,R,LOC,Y,0	Select → Entities… → Nodes By Location Z coordinates Min,Max = 8 From Full → Apply → Nodes By Location X coordinates Min,Max = 0 Reselect → Apply → Nodes By Location Y coordinates Min,Max = 0 Reselect → OK	
*get,MasterNd,NODE,,NUM,MIN	List → Status → Preprocessor → Nodes → *[Anotar o valor identificado como "**Maximum node number**"]*	

TYPE,3 REAL,2	Meshing → Mesh Attributes → Default Attribs → Element type number = 3 MASS21 Real constant set = 2 → OK	
E,MasterNd	Modeling → Create → Elements → Auto Numbered → Thru Nodes → *[Digitar o número do nó identificado como "**maximum node number**"]* → OK	
NSEL,S,LOC,Z,8 ESLV,S NSLE,R	Select → Entities… → Nodes By Location Z coordinates Min,Max = 8 From Full → Apply → Elements Attached to Volumes From Full → Apply → Nodes Attached to Elements Reselect → OK	
CERIG,MasterNd,ALL,UXYZ	Coupling / Ceqn → Rigid Region → *[Digitar o número do nó identificado como "**maximum node number**"]* → OK → Pick All DOF used with equation = All applicable → OK	
F, MasterNd,FZ,-220E3 F, MasterNd,MY,120E3	Loads → Apply → Structural → Force/Moment → On Nodes → *[Digitar o número do nó identificado como "**maximum node number**"]* → OK → Direction of force/mom = FZ Force/moment value = -220e3 → Apply → Direction of force/mom = MY Force/moment value = 120e3 → OK	

ALLSEL	Select → Everything	
/solu	**Solution**	
SOLVE	Solve → Current LS → OK	
/post1	**General Postproc**	
SET,,1	Read Results → First Set	
[Inspecionar os resultados por conta própria]		
FINISH	**Finish**	

EXERCÍCIO 4.B (1/7)

PROBLEMA:

OBTER PARA A ESTRUTURA DESENHADA:

1. DIAGRAMAS DE MOMENTO FLETOR (AMBAS AS DIREÇÕES), MOMENTO TORÇOR, FORÇA CORTANTE E FORÇA NORMAL DOS ELEMENTOS RETICULADOS;

2. DIAGRAMAS DE MOMENTO FLETOR (EM AMBAS AS DIREÇÕES), TORÇOR, FORÇA CORTANTE E FORÇA NORMAL DOS ELEMENTOS PLANOS;

3. REAÇÕES DE APOIO NA BASE DE CADA PILAR;

4. FLECHA MÁXIMA DAS LAJES;

5. FLECHA MÁXIMA DAS VIGAS;

DADOS:

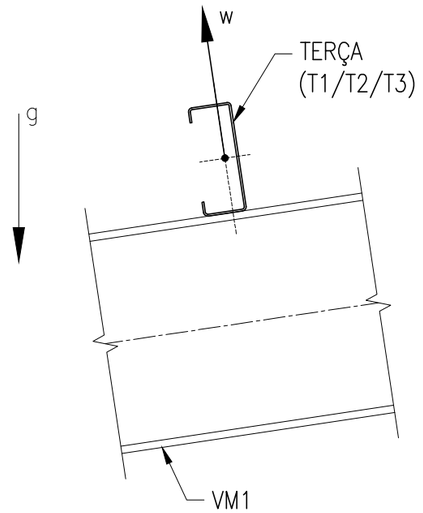
MATERIAL: CONCRETO ARMADO
- f_{ck} = 25MPa
- E_{cs} = 23.8GPa
- v = 0.2
- p = 2500kg/m³

MATERIAL: AÇO A572–Gr50
- f_y = 345MPa
- E_s = 200GPa
- v = 0.3
- p = 7850kg/m³

CARREGAMENTO TOTAL:
- q = 4kN/m² (SOBRE TODAS AS LAJES)
- p = 8kN/m (SOBRE VIGAS PERIMETRAIS)
- F = 28kN (FORÇA LATERAL)
- w = 1kN/m (SOBRE TODAS AS TERÇAS, **VER DETALHE**)
- g = 9.81m/s² (GRAVIDADE GLOBAL)

OBSERVAÇÕES:

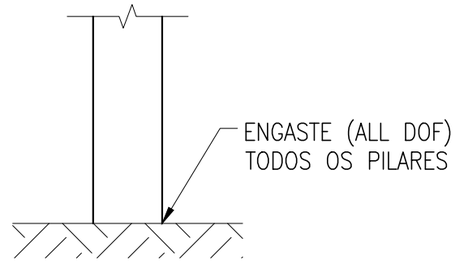
1. MODELAR CONCRETO E AÇO COMO MATERIAIS LINEARES, ELÁSTICOS E ISOTRÓPICOS.
2. AS CARGAS LINEARES SOBRE AS TERÇAS DA COBERTURA SIMULAM AÇÕES DE SUCÇÃO DEVIDO AO VENTO E DEVEM, PORTANTO, SER APLICADAS COMO INDICA O DETALHE ABAIXO.



DETALHE – CARGA SOBRE TERÇAS

ESC.: 1/10

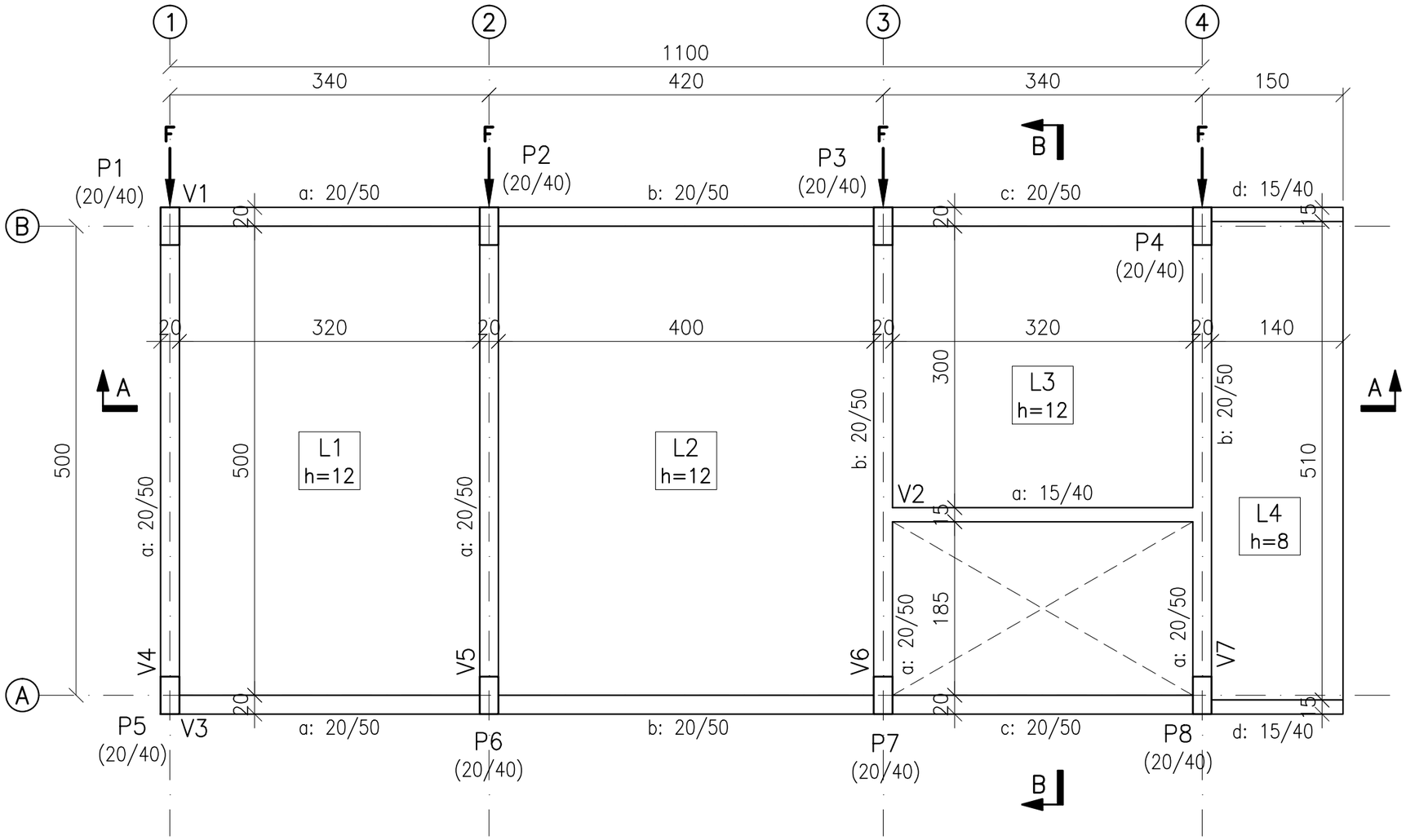
3. DECLARAR APOIOS COMO ENGASTES NA BASE DOS PILARES.



BASE DOS PILARES

ESC.: 1/25

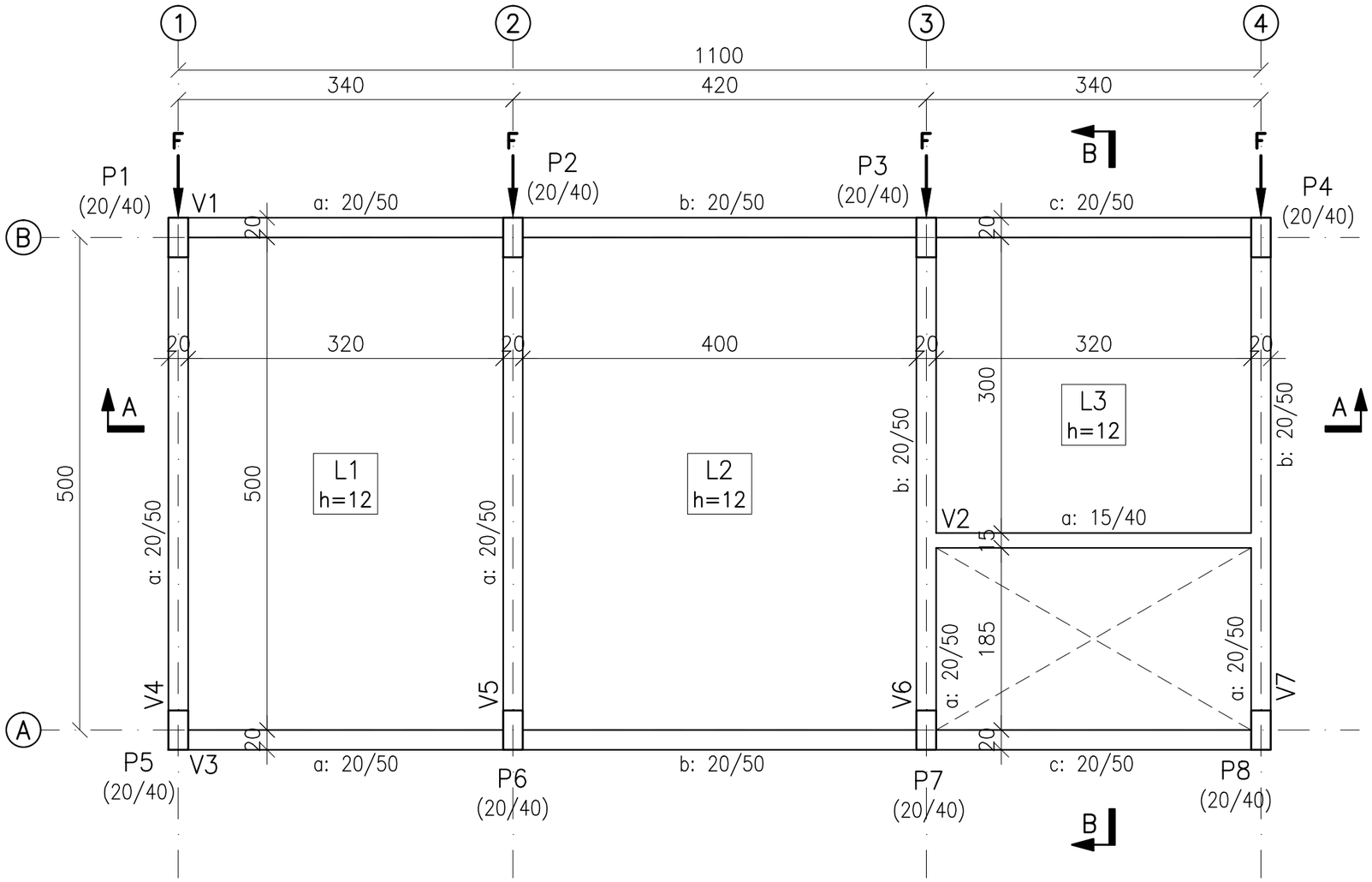
EXERCÍCIO 4.B (2/7)



FORMAS DO PISO 1

ESC.: 1/75 EL.: +3.200 T.L. COTAS EM CENTÍMETROS

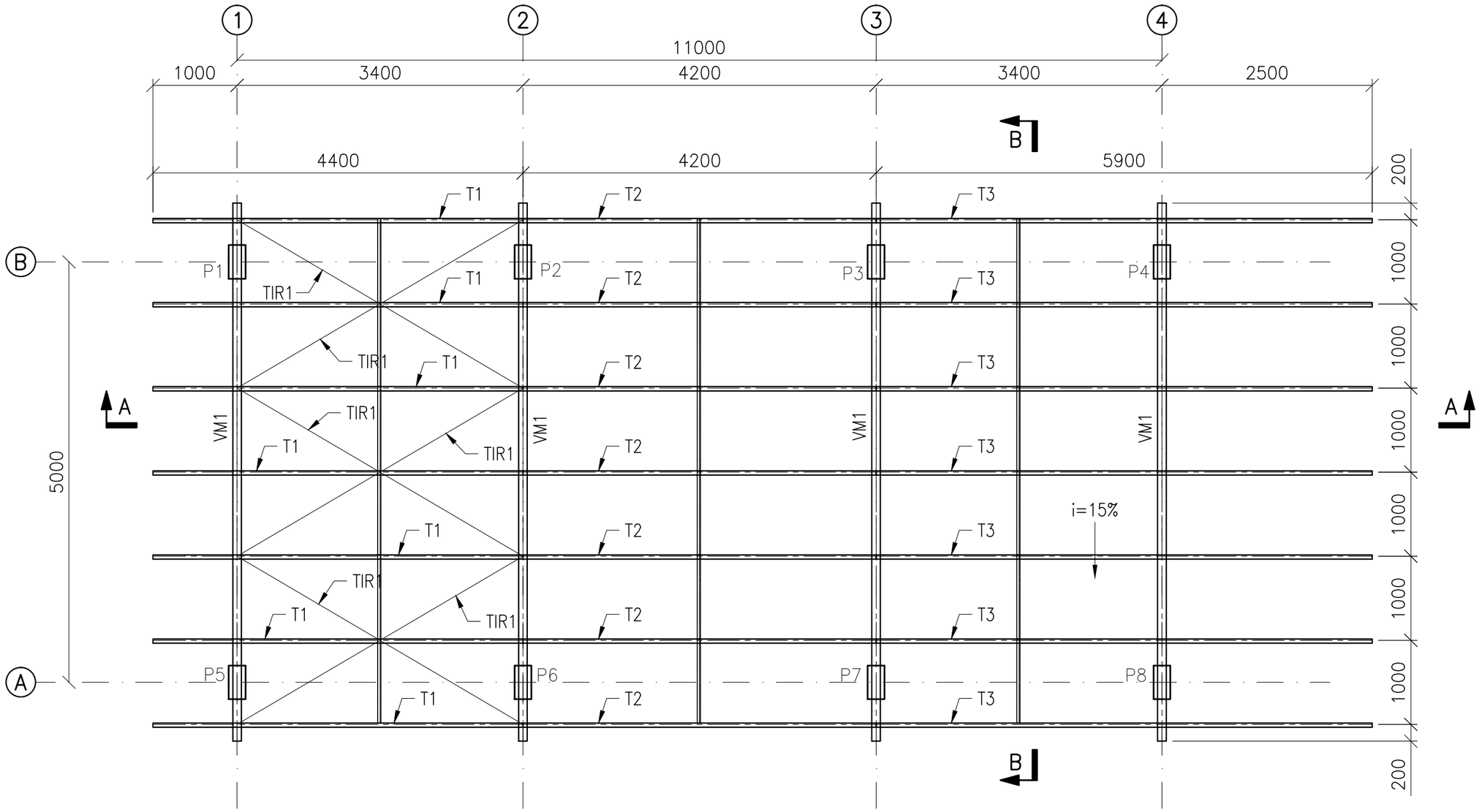
EXERCÍCIO 4.B (3/7)



FORMAS DO PISO 2

ESC.: 1/75 EL.: +6.400 T.L. COTAS EM CENTÍMETROS

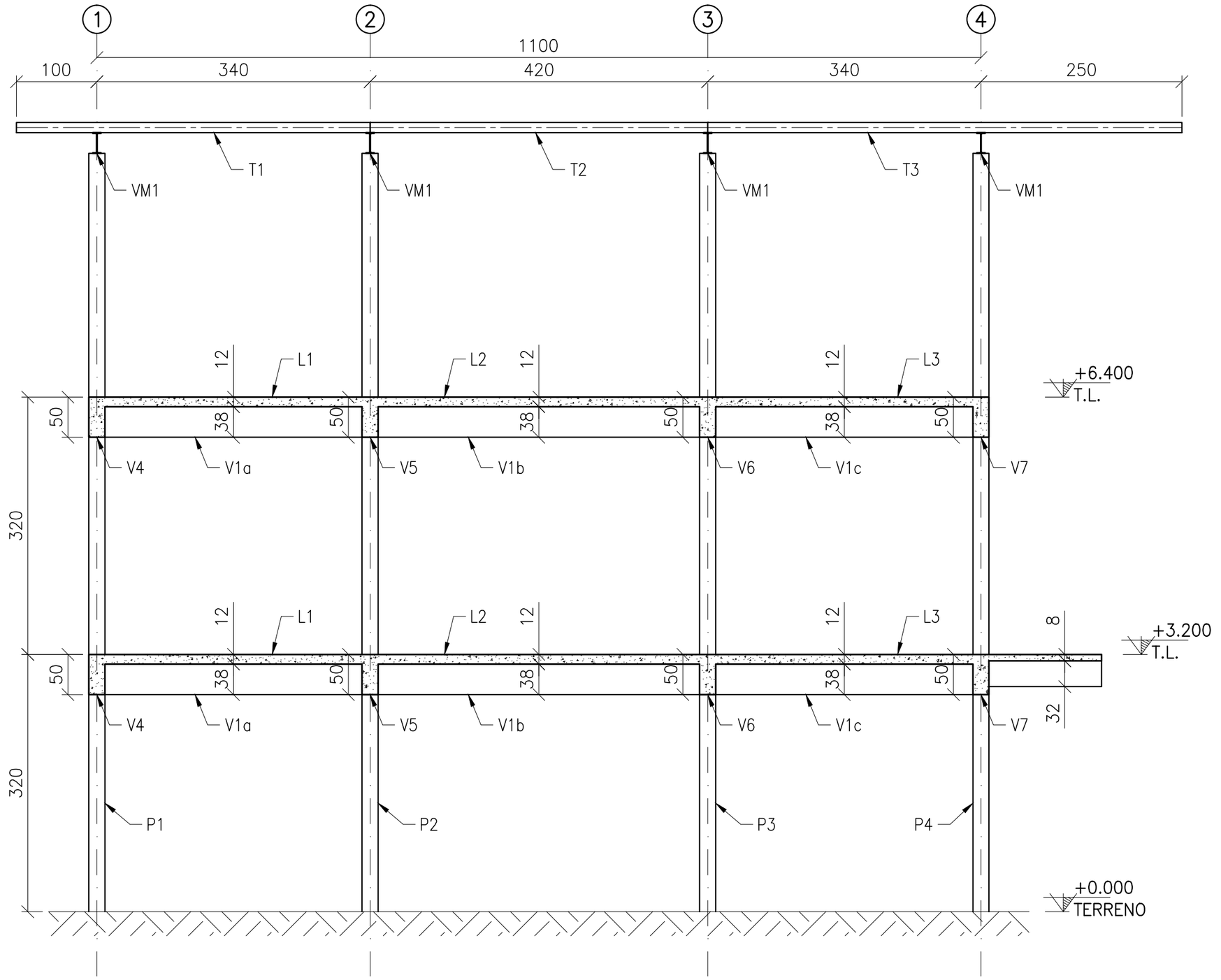
EXERCÍCIO 4.B (4/7)



PLANO DA COBERTURA

ESC.: 1/75 EL.: +9.850 E.V. COTAS EM MILÍMETROS

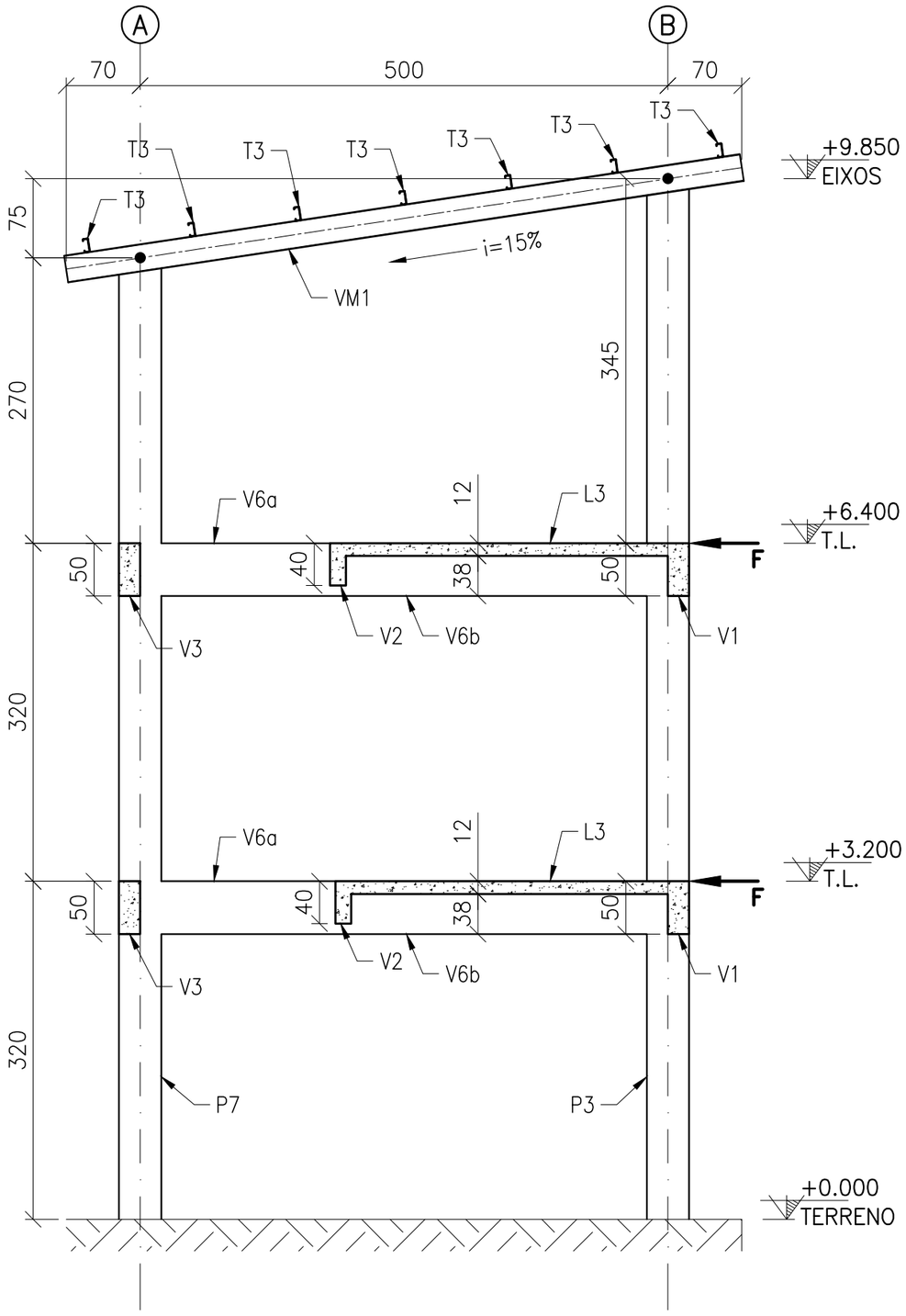
EXERCÍCIO 4.B (5/7)



CORTE AA

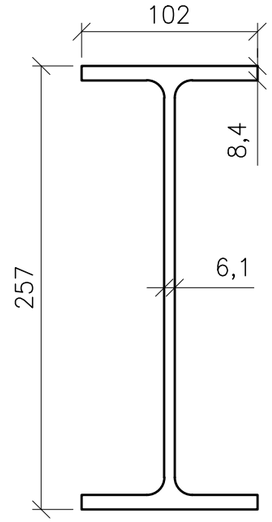
ESC.: 1/75

EXERCÍCIO 4.B (6/7)



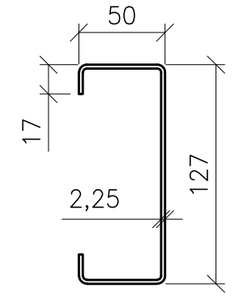
CORTE BB

ESC.: 1/75



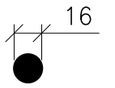
VIGAS DE AÇO (VM1)

W250x25.3



TERÇAS (T1)

Ue127x50x17x2.25

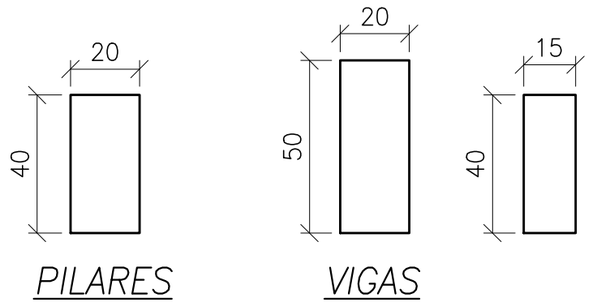


TIRANTE (TIR1)

BARRA ø16

AÇO – SEÇÕES TRANSVERSAIS

ESC.: 1/5 COTAS EM MILÍMETROS



PILARES

VIGAS

CONCRETO – SEÇÕES TRANSVERSAIS

ESC.: 1/25 COTAS EM CENTÍMETROS

EXERCÍCIO 4.B (7/7)

REAÇÕES DE APOIO

	N [kN]	V_x [kN]	V_y [kN]	M_x [kNm]	M_y [kNm]	T [kNm]
P1						
P2						
P3						
P4						
P5						
P6						
P7						
P8						

ESFORÇOS E FLECHA EM LAJES

		$M_{x,máx}$ [kNm]	$M_{y,máx}$ [kNm]	$M_{xy,máx}$ [kNm]	$V_{máx}$ [kN]	$N_{máx}$ [kN]	$\Delta_{máx}$ [mm]
PISO 1	L1						
	L2						
	L3						
	L4						
PISO 2	L1						
	L2						
	L3						

ESFORÇOS E FLECHA EM VIGAS
1° PISO

		$M_{máx}$ [kNm]	$T_{máx}$ [kNm]	$V_{máx}$ [kN]	$N_{máx}$ [kN]	$\Delta_{máx}$ [mm]
V1	a					
	b					
	d					
V2	a					
V5	a					

ESFORÇOS E FLECHA EM VIGAS
2° PISO

		$M_{máx}$ [kNm]	$T_{máx}$ [kNm]	$V_{máx}$ [kN]	$N_{máx}$ [kN]	$\Delta_{máx}$ [mm]
V1	a					
	b					
	c					
V2	a					
V5	a					

ESFORÇOS E FLECHA EM VIGAS
COBERTURA

	$M_{y,máx}$ [kNm]	$M_{z,máx}$ [kNm]	$T_{máx}$ [kNm]	$V_{z,máx}$ [kN]	$V_{y,máx}$ [kN]	$N_{máx}$ [kN]	$\Delta_{máx}$ [mm]
VM1							
T1							
T2							
T3							
TIR1							

EXERCÍCIO 4.B

Análise estrutural de edifício de concreto com cobertura de aço: criação de seção transversal customizada

/prep7

Preprocessor

K,1,0,0,0
K,2,0.00225,0,0
K,3,0.04775,0,0
K,4,0.05,0,0
K,5,0.05,0.00225,0
K,6,0.05,0.017,0
K,7,0.04775,0.017,0
K,8,0.04775,0.00225,0
K,9,0.00225,0.00225,0
K,10,0.00225,0.12475,0
K,11,0.04775,0.12475,0
K,12,0.04775,0.11,0
K,13,0.05,0.11,0
K,14,0.05,0.12475,0
K,15,0.05,0.127,0
K,16,0.04775,0.127,0
K,17,0.00225,0.127,0
K,18,0,0.127,0
K,19,0,0.12475,0
K,20,0,0.00225,0

Modeling → Create → Keypoints → In Active CS →

Keypoint number = 1

Location in active CS = 0, 0, 0 → Apply →

#	X	Y	Z
2	0.00225	0	0
3	0.04775	0	0
4	0.05	0	0
5	0.05	0.00225	0
6	0.05	0.017	0
7	0.04775	0.017	0
8	0.04775	0.00225	0
9	0.00225	0.00225	0
10	0.00225	0.12475	0
11	0.04775	0.12475	0
12	0.04775	0.11	0
13	0.05	0.11	0
14	0.05	0.12475	0
15	0.05	0.127	0
16	0.04775	0.127	0
17	0.00225	0.127	0
18	0	0.127	0
19	0	0.12475	0

Keypoint number = 20

Location in active CS = 0, 0.00225, 0

→ OK

L,1,2
L,2,3
L,3,4
L,4,5
L,5,6
L,6,7
L,7,8
L,8,9

Modeling → Create → Lines → Lines → Straight Line →

Clicar nos keypoints 1 e 2 → Apply →

Clicar nos keypoints 2 e 3 → Apply →

Clicar nos keypoints 3 e 4 → Apply →

Clicar nos keypoints 4 e 5 → Apply →

Clicar nos keypoints 5 e 6 → Apply →

Clicar nos keypoints 6 e 7 → Apply →

Clicar nos keypoints 7 e 8 → Apply →

L,9,10 L,10,11 L,11,12 L,12,13 L,13,14 L,14,15 L,15,16 L,16,17 L,17,18 L,18,19 L,19,20 L,20,1 L,2,9 L,9,20 L,3,8 L,5,8 L,10,17 L,10,19 L,11,14 L,11,16	***Clicar nos keypoints 8 e 9*** → Apply → ***Clicar nos keypoints 9 e 10*** → Apply → ***Clicar nos keypoints 10 e 11*** → Apply → ***Clicar nos keypoints 11 e 12*** → Apply → ***Clicar nos keypoints 12 e 13*** → Apply → ***Clicar nos keypoints 13 e 14*** → Apply → ***Clicar nos keypoints 14 e 15*** → Apply → ***Clicar nos keypoints 15 e 16*** → Apply → ***Clicar nos keypoints 16 e 17*** → Apply → ***Clicar nos keypoints 17 e 18*** → Apply → ***Clicar nos keypoints 18 e 19*** → Apply → ***Clicar nos keypoints 19 e 20*** → Apply → ***Clicar nos keypoints 20 e 1*** → Apply → ***Clicar nos keypoints 2 e 9*** → Apply → ***Clicar nos keypoints 9 e 20*** → Apply → ***Clicar nos keypoints 3 e 8*** → Apply → ***Clicar nos keypoints 5 e 8*** → Apply → ***Clicar nos keypoints 10 e 17*** → Apply → ***Clicar nos keypoints 10 e 19*** → Apply → ***Clicar nos keypoints 11 e 14*** → Apply → ***Clicar nos keypoints 11 e 16*** → OK	
AL,1,21,22,20 AL,2,23,8,21 AL,3,4,24,23 AL,24,5,6,7 AL,22,9,26,19 AL,26,25,17,18 AL,10,28,16,25 AL,27,14,15,28 AL,11,12,13,27	Modeling → Create → Areas → Arbitrary → By Lines → ***Clicar nas lines 1, 21, 22 e 20*** → Apply → ***Clicar nas lines 2, 23, 8 e 21*** → Apply → ***Clicar nas lines 3, 4, 24 e 23*** → Apply → ***Clicar nas lines 24, 5, 6 e 7*** → Apply → ***Clicar nas lines 22, 9, 26 e 19*** → Apply → ***Clicar nas lines 26, 25, 17 e 18*** → Apply → ***Clicar nas lines 10, 28, 16 e 25*** → Apply → ***Clicar nas lines 27, 14, 15 e 28*** → Apply → ***Clicar nas lines 11, 12, 13 e 27*** → OK	
ET,1,82 AATT,,,1 AMESH,ALL SECWRITE,'Ue127x50x17x2.25',SECT,,1	Sections → Beam → Custom Sections → Write From Areas → Pick All → Section library file = Ue127x50x17x2.25.SECT → OK	
FINISH	Utility Menu → File → Clear & Start New… →	

/CLEAR	Read start.ans after clear? = Read file → OK → Yes	
/prep7	**Preprocessor**	
ET,1,188	Element Type → Add/Edit/Delete → Add… → Library of Element Types = Structural Mass ; Beam ; 2 node 188 → OK → Close	
MP,EX,,2E11	Material Props → Material Models → Structural → Linear → Elastic → Isotropic → EX = 2E11 → OK	
K,1,0,0,0 K,2,1,0,0	Modeling → Create → Keypoints → In Active CS → Keypoint number = 1 Location in active CS = 0, 0, 0 → Apply → Keypoint number = 2 Location in active CS = 1, 0, 0 → OK	
L,1,2	Modeling → Create → Lines → Lines → Straight Line → ***Clicar nos keypoints 1 e 2*** → OK	
SECTYPE,1,BEAM,MESH,UE SECREAD,'Ue127x50x17x2.25',SECT,,MESH	Sections → Beam → Custom Sections → Read Sect Mesh → Section ID number = 1 Section Name = UE Section library file = Ue127x50x17x2.25 → OK	
LATT,1,,1,,,,1	Meshing → Mesh Attributes → All Lines → Material number = 1 Element type number = 1 BEAM188 Element section = 1 UE → OK	
LESIZE,ALL,,,50	Meshing → Size Cntrls → ManualSize → Lines → All Lines → No. of element divisions = 50 → OK	
LMESH,ALL	Meshing → Mesh → Lines → Pick All	
/ESHAPE,1	PlotCtrls → Style → Size and Shape → Display of Element = ON → OK	
FINISH	**Finish**