

# Museu do Ipiranga

Restauro, Infraestrutura e Ampliação

2017-2022

## **ARQUITETURA, COORDENAÇÃO E COMPATIBILIZAÇÃO**

H+F Arquitetos: Eduardo Ferroni e Pablo Hereñú (Coord.), Camila Omiya, Camila Paim, Felipe Maia, Josephine Poirot-Delpech, Leonardo Bonfim, Lúcia Furlan, Luna Brandão, Levy Vitorino, Maria Beatriz Souza, Marina Uematsu, Mateus Loschi, Sofia Toi, Stephanie Galdino;

## **RESTAURO**

OAR Arquitetura e Restauração: Olympio Augusto Ribeiro; Griselda Klüppel, Anna Beatriz Ayroza Galvão (projeto)/; Paulicéia: Mita Ito (obra).

## **ESTRUTURAS**

Companhia de Projetos (Coord. Heloísa Maringoni)

## **FUNDAÇÕES E GEOTECNIA**

MAG Engenheiros Associados / Nouh Engenharia (Coord. Marcos Lima Verde Guimarães)

## **INSTALAÇÕES HIDRÁULICA E ELÉTRICAS**

Ramoska & Castellani Projetistas Associados Ltda.

## **AUTOMAÇÃO E SEGURANÇA**

Bettoni Automação, Segurança e Consultoria

## **INSTALAÇÕES MECÂNICAS / CLIMATIZAÇÃO**

THERMOPLAN Engenharia Térmica (Coord. Eizo Kosai)

## **PAISAGISMO**

Raul Pereira Arquitetos Associados

## **LUMINOTECNIA**

Lux Projetos (Coord. Ricardo Heder)

## **ORÇAMENTO**

TRÍADE Engenharia de Custos

## **CONSERVAÇÃO**

Claudia Carvalho

## **PREVENÇÃO E COMBATE A INCÊNDIOS**

FEUERTEC Engenharia (Coord. Nilton Miranda)

## **CONFORTO TÉRMI (projeto)/ CO E LUMÍNICO**

Greenwatt

## **CONFORTO ACÚSTICO**

Harmonia Acústica

## **CAIXILHOS**

Dinaflex / Pedro Martins

## **IMPERMEABILIZAÇÃO**

Proassp Assessoria & Projetos

## **PESQUISA HISTÓRICA**

Memórias Assessoria e Projetos

## **MANEJO ARBÓREO**

CBFT

## **CIRCULAÇÃO VERTICAL**

EMPRO Engenharia

## **TERRAPLENAGEM**

Estudio Piza Engenharia, Arquitetura e Urb.

## **APROVAÇÃO LEGAL**

Maia e Martines Arquitetura e Design

## **COMUNICAÇÃO VISUAL**

CLDT (Celso Longo e Daniel Trench)

## **EXPOGRAFIA**

Metrópole (Anna Helena Villela e Ana Paula Pontes)

## **GERENCIAMENTO GERAL**

FUSP

## **GERENCIAMENTO PROJETOS E OBRA**

SETEC

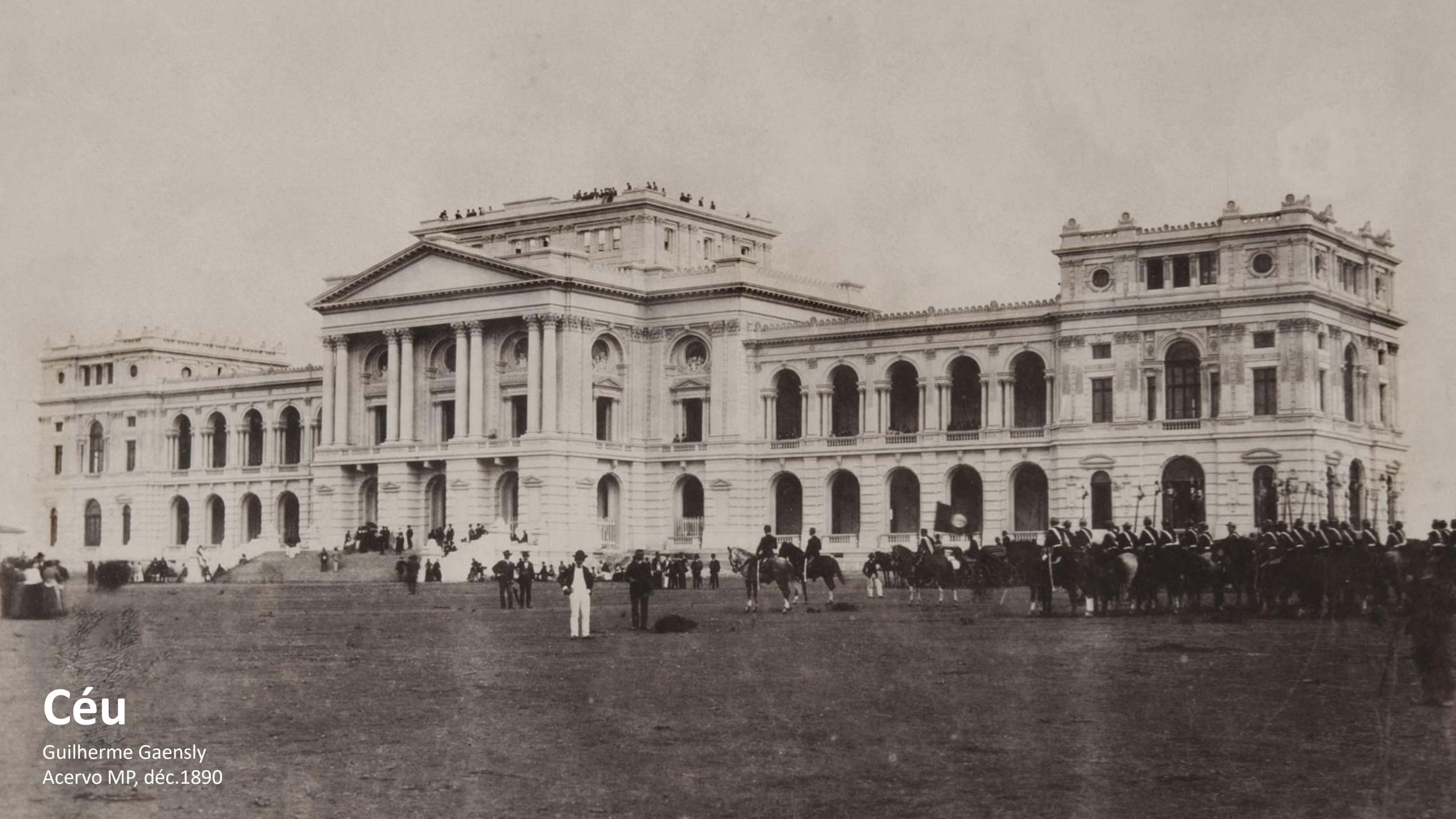
## **CONSTRUÇÃO**

CONCREJATO





Paisagem do Campo do Ipiranga  
Antônio Parreiras  
Acervo MP, 1893



# Céu

Guilherme Gaensly  
Acervo MP, déc.1890



# Chão

Augustin Salinas y Teruel.  
Museu do Ipiranga, 1912



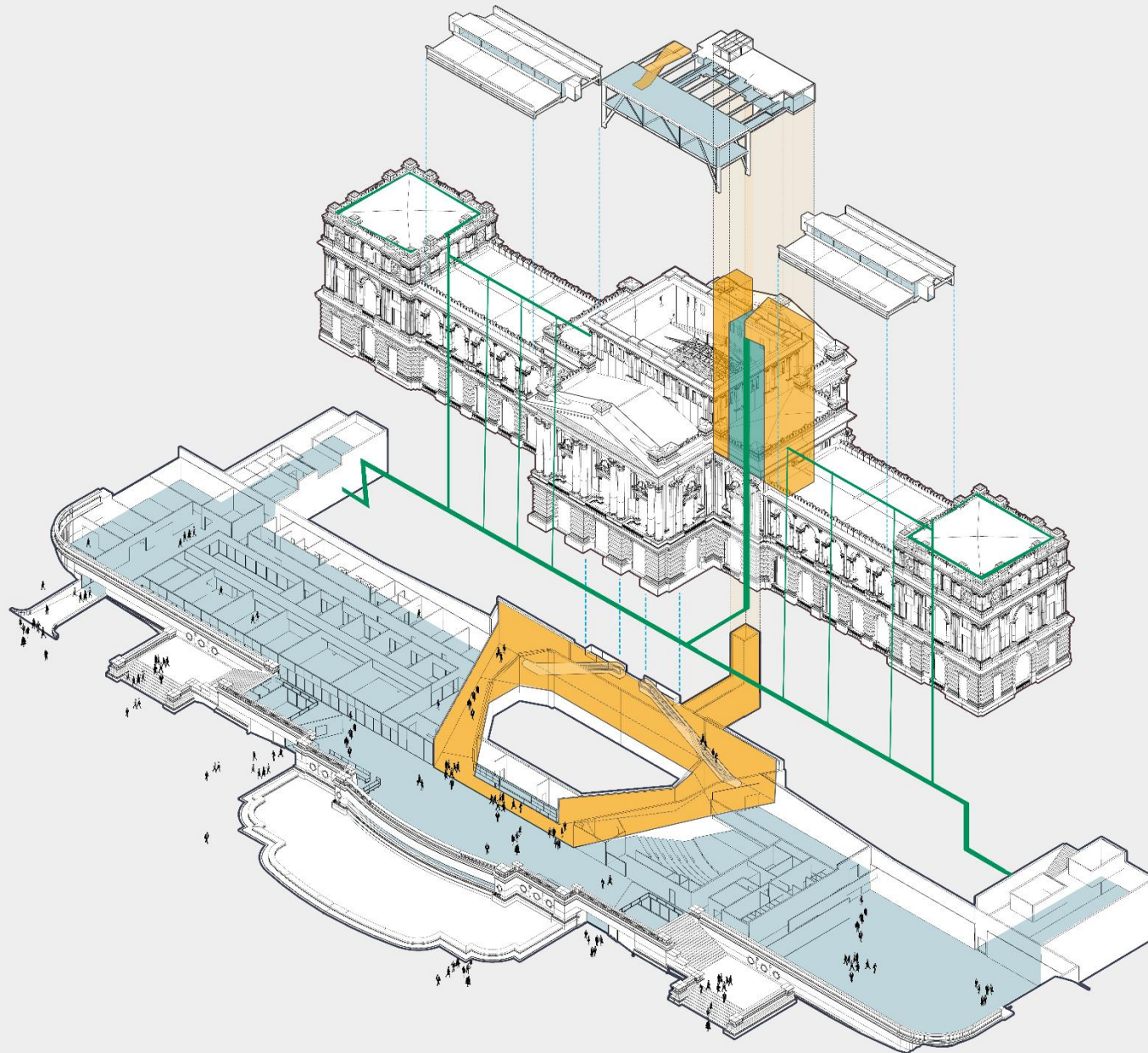








# arquitetura - desejo / concepção



MIRANTE

CONEXÃO ENTRE AS TORRES

CONFORTO AMBIENTAL

TORRE INFRAESTRUTURAL

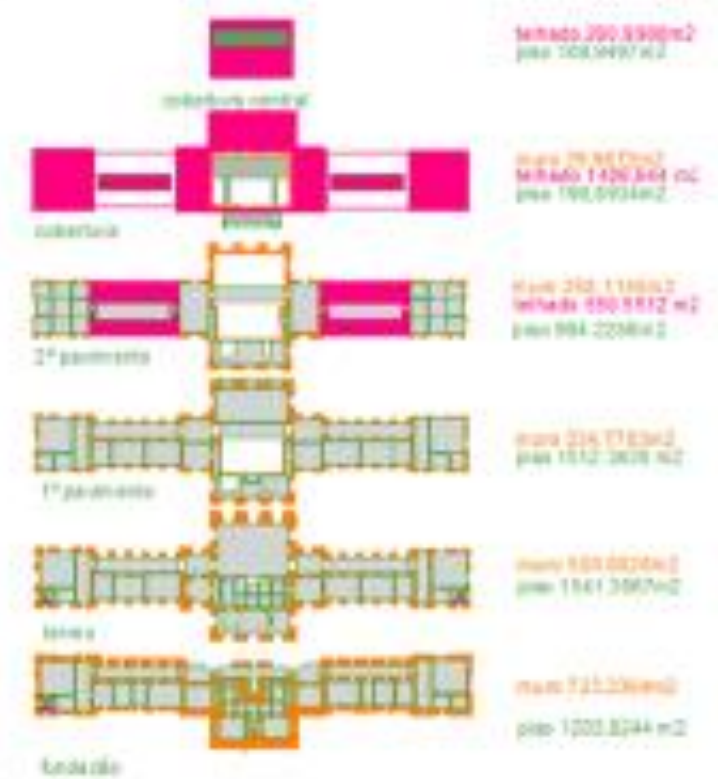
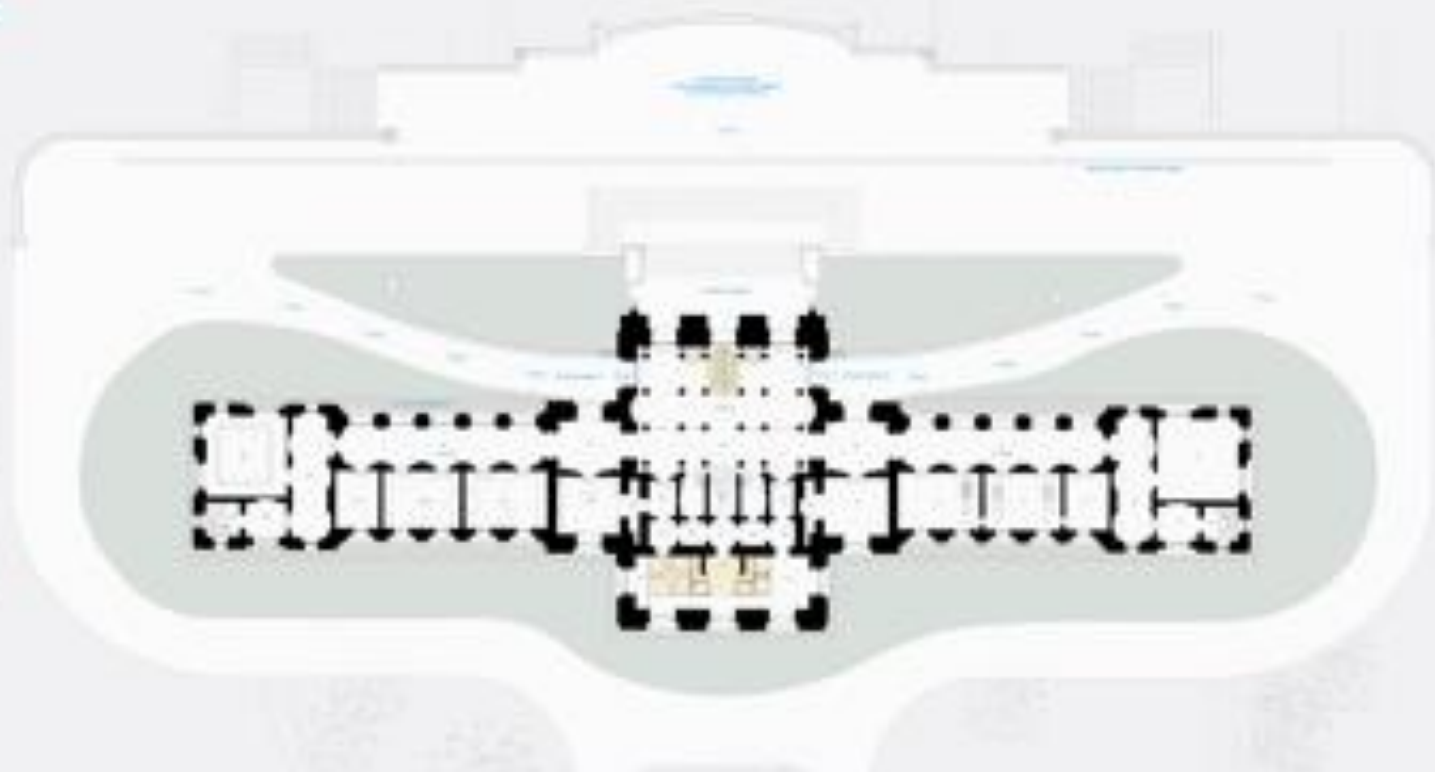
INFRAESTRUTURAS CAPILARES

GALERIA DE ACESSO

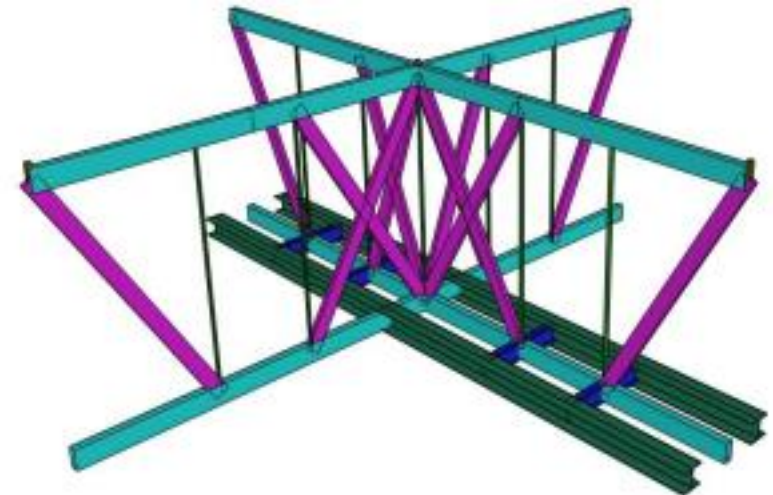
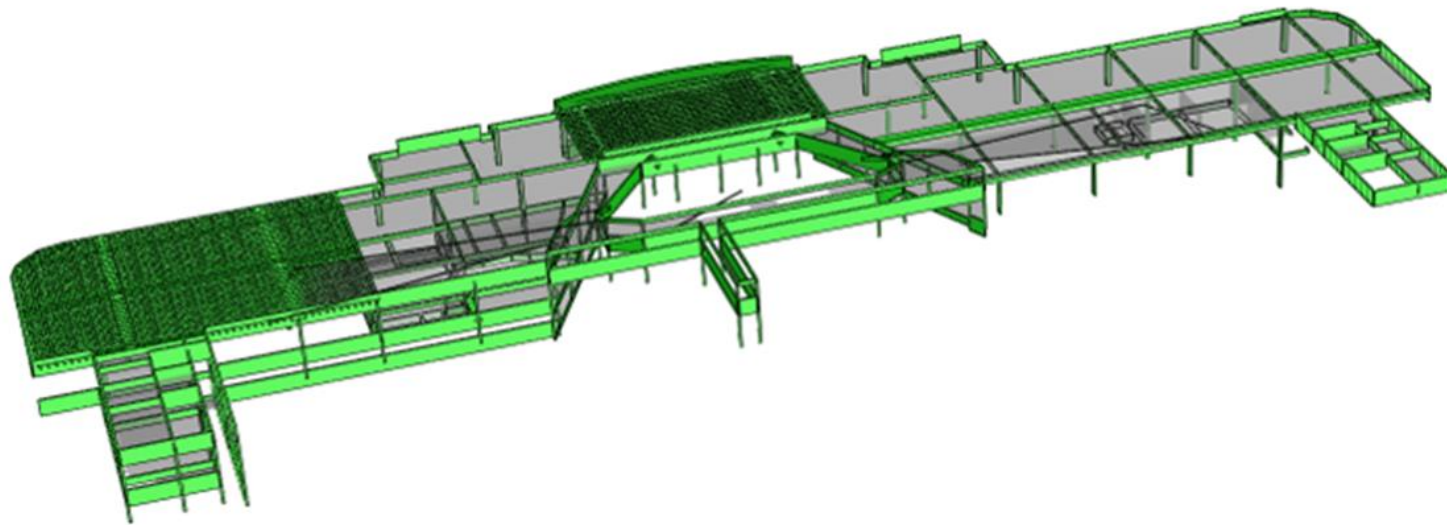
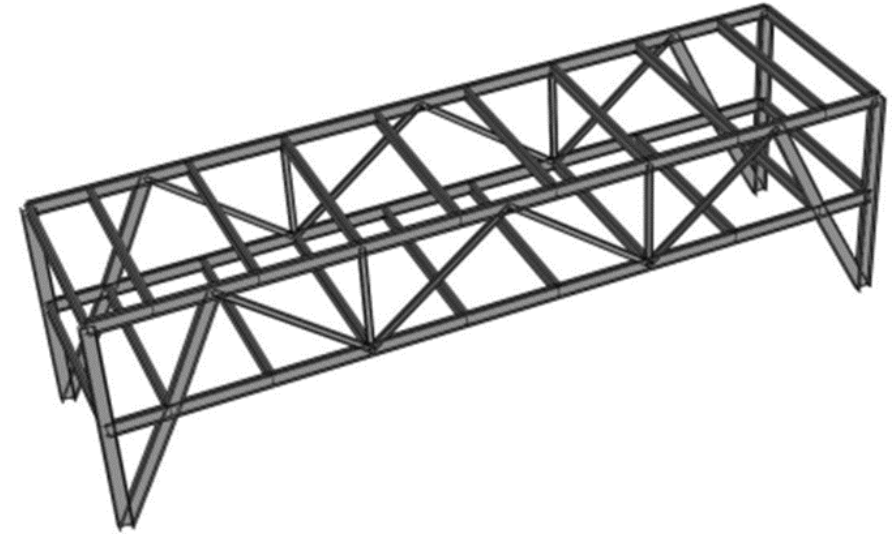
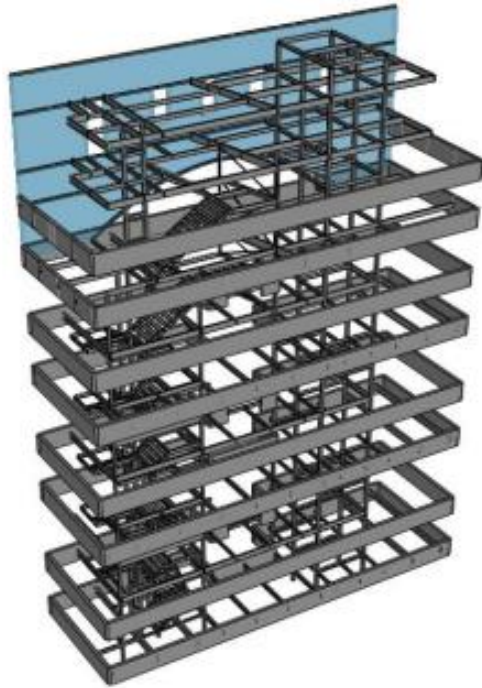
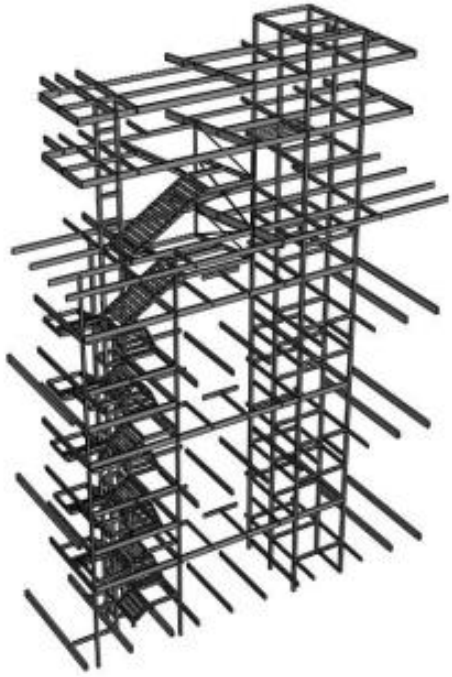
AMPLIAÇÃO

## Análise do edifício-condições existentes, intervenção e possibilidades

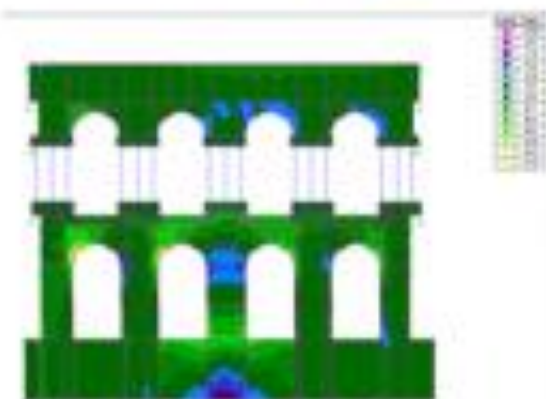
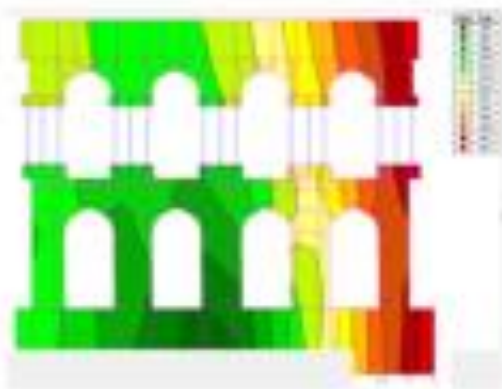
outubro/novembro: Tommaso Gaudenzio Bezzi, engenheiro italiano, residente na cidade do Rio de Janeiro, é indicado pela Comissão Central do Monumento do Ipiranga para elaborar o projeto do monumento, que é entregue em São Paulo, à Comissão Provincial do Monumento do Ipiranga, em 17 de novembro de 1882.



as modelagens para análise foram feitas em dois modeladores estruturais, TQS e STRAP



monitoramento e análise do impacto da escavação sobre o edifício monumento











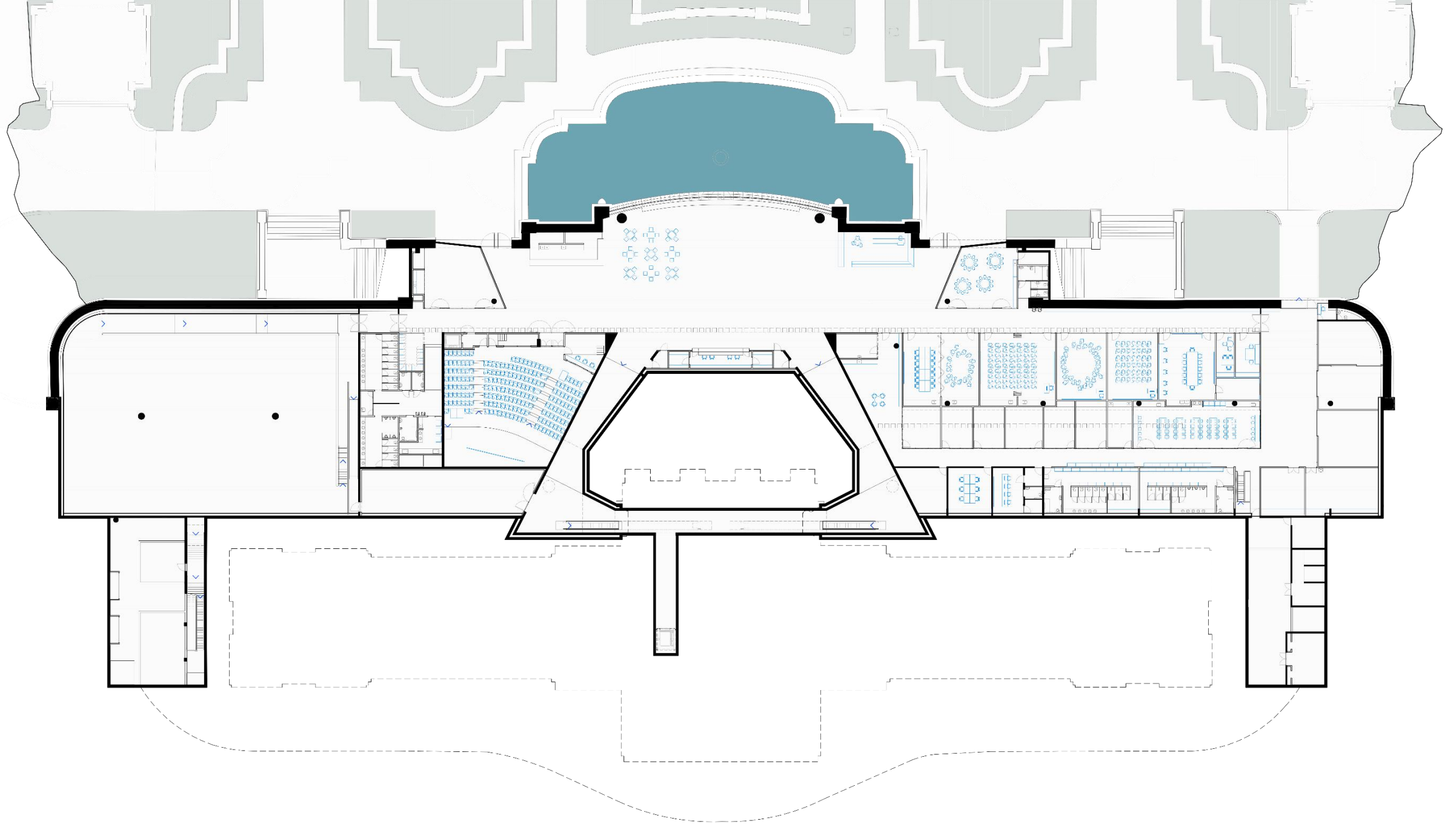






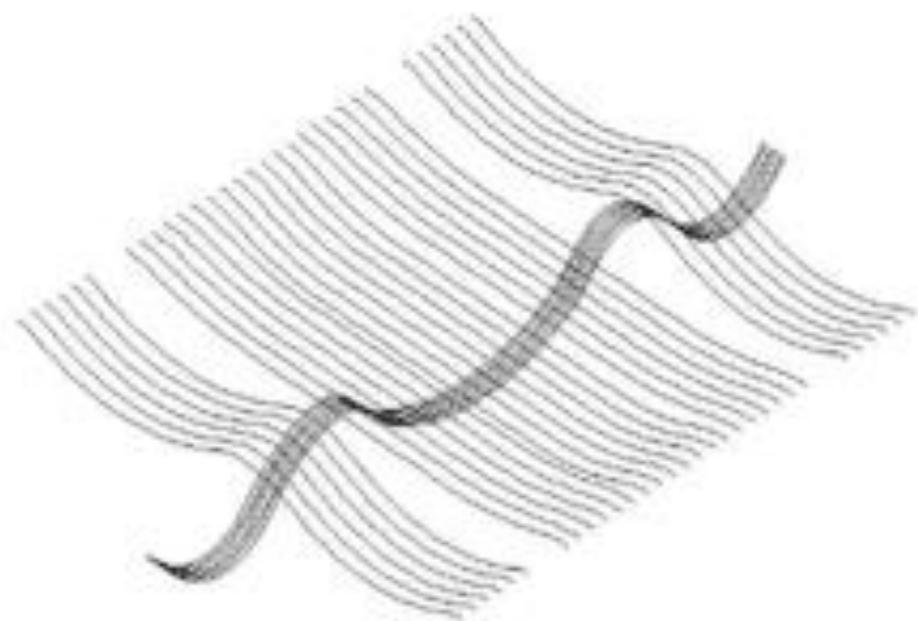
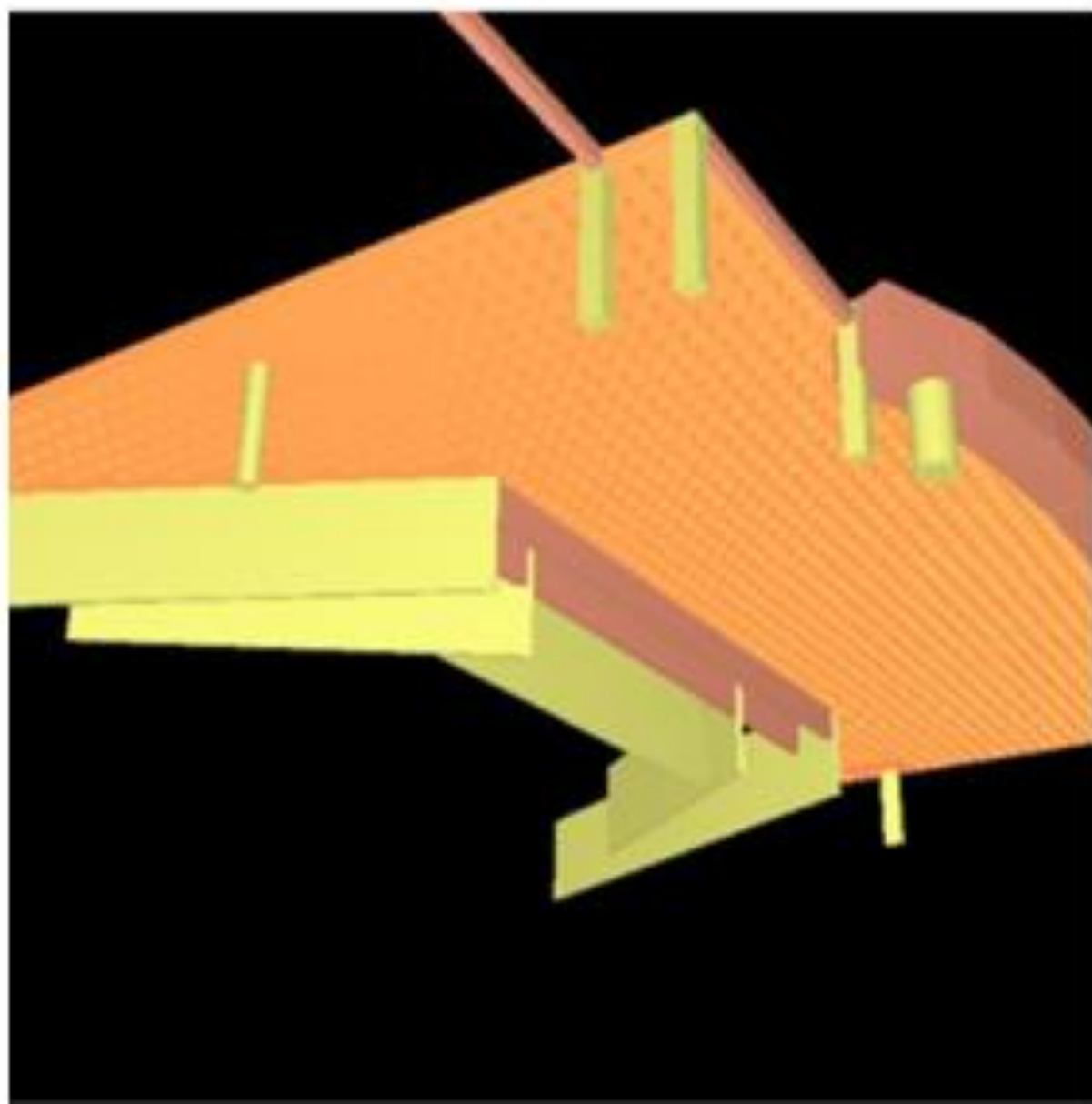


MUSEU  
DO PIRANGA  
- USP



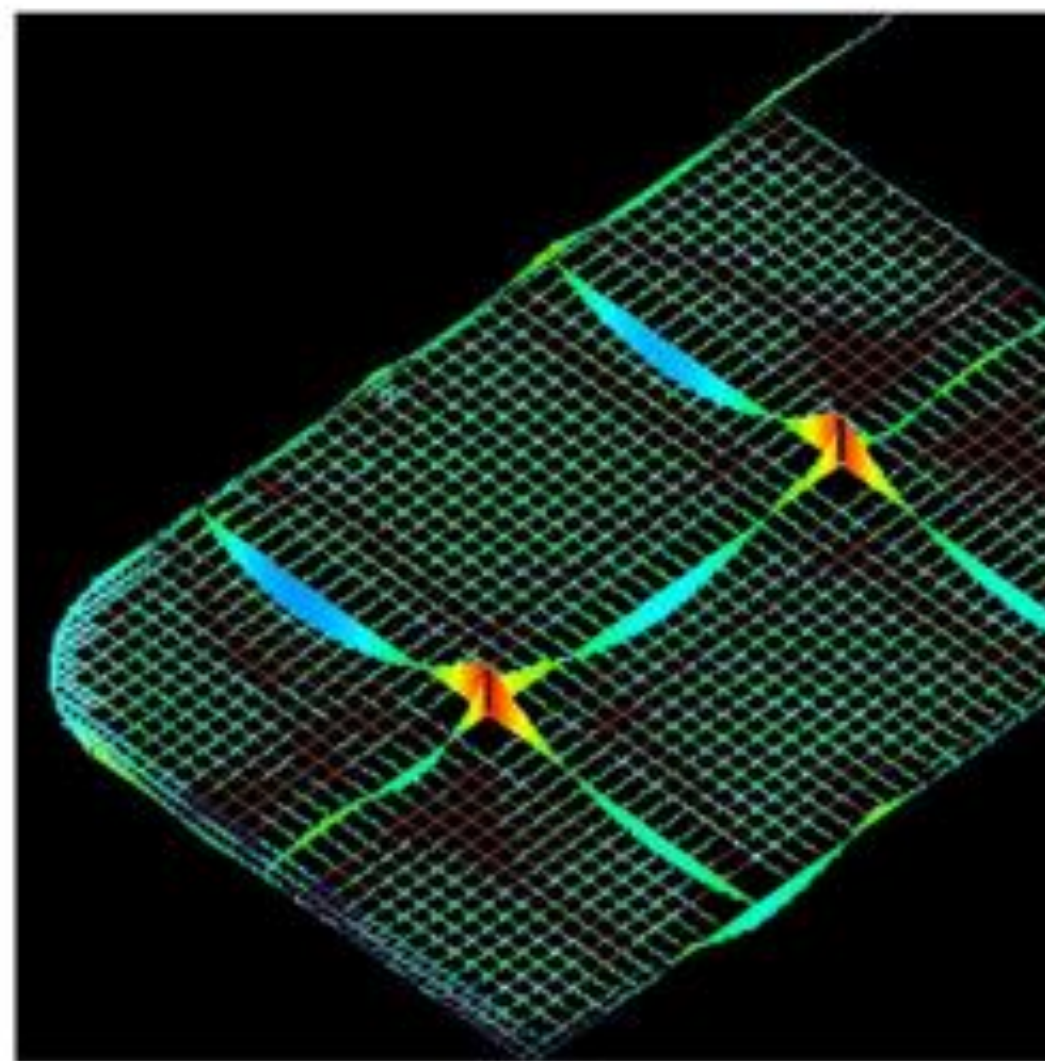
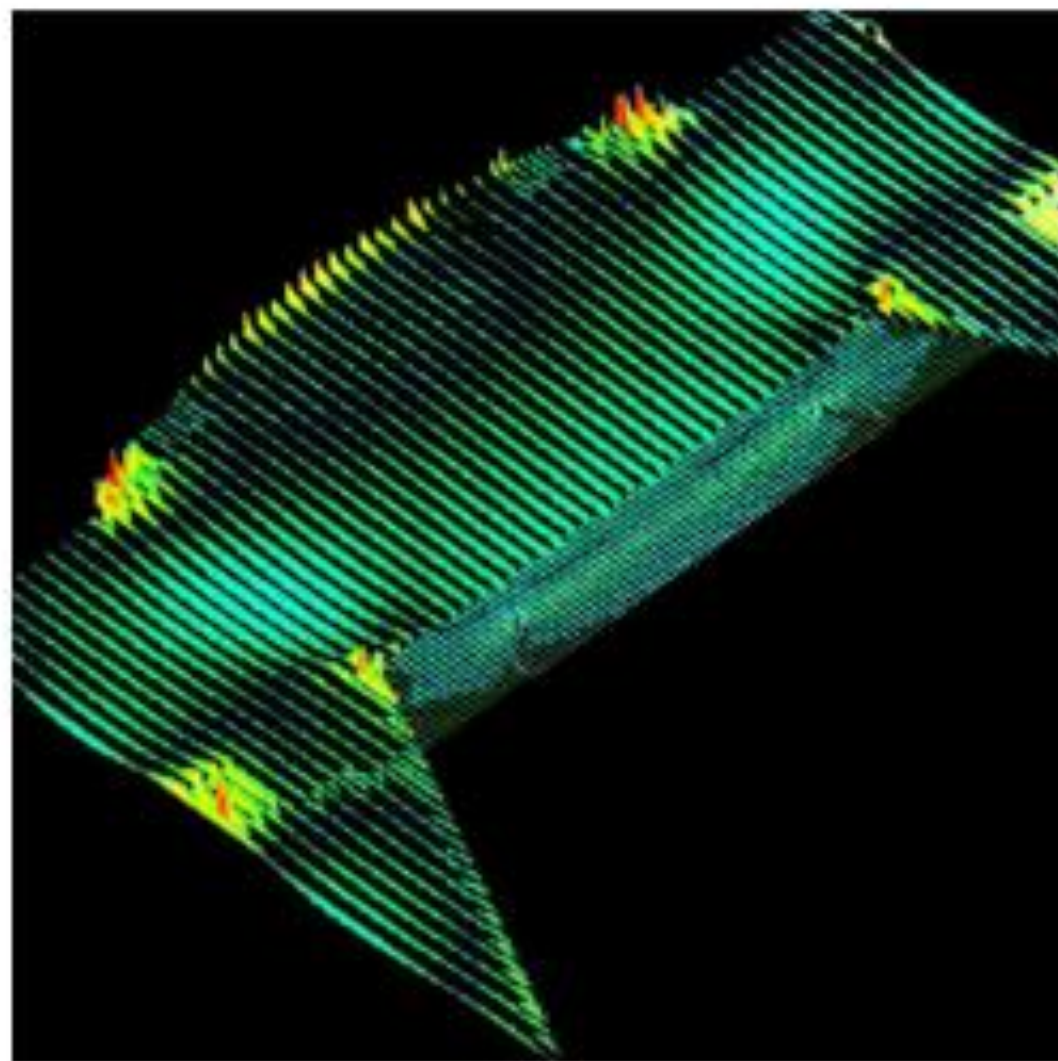
AMPLIAÇÃO

# modelagem estrutural



EV - E 1:200  
EV - V 1:50

## análise dos modelos





verificações e dimensionamentos de detalhes foram feitas em planilhas e cálculos detalhados caso a caso.

### CÁLCULO DA FORÇA DE PROTENSÃO "P"

Viga bi-apoiada  
perdas imediatas e progressivas

Trama: n/a **10,30 m**

**DADOS DE ENTRADA**

Granulato	el	10 cm	area	1428,0 cm <sup>2</sup>
	el	10,0 cm	prop. pl	24,1 cm
	total	20,0 cm	l	201140,2 cm <sup>2</sup>
	ba	40,0 cm	ar	15,0 cm
	ba	10,0 cm	sa	4028,0 cm <sup>2</sup>
			sb	1428,0 cm <sup>2</sup>
tipo	caso 1			

Carga	q <sub>0</sub> (q <sub>sd</sub> )	3,00 kN/m
	q <sub>0</sub>	5,44 kN/m
	q <sub>0</sub>	5,20 kN/m

Age	f <sub>yk</sub>	180 kN/cm <sup>2</sup>
	E <sub>p</sub>	200 GPa
		20000 kN/cm <sup>2</sup>

Concreto	para exp	15 kN/cm <sup>2</sup>
	f <sub>ck</sub>	40 MPa
		4,0 kN/cm <sup>2</sup>
	alfa	1,2
	f <sub>ctm</sub>	3,21 MPa
	f <sub>ctk,inf</sub>	2,46 MPa
	f <sub>ctk,inf,1</sub>	0,24 kN/cm <sup>2</sup>
	E	28000 MPa
		2842 kN/cm <sup>2</sup>

Trocado de eixo	4-eixo	10 cm
	4-pede	24,1 cm
	varia	25,1 cm
	prop. pl	20,0 cm

Manuseio mínimo		
comp. adm		
n/a	62,74 kN/m	
n/a	62,74 kN/m	

Combinação	Fator I	0,25
	Fator II	0,25
Vão	Hor	229,14 kN/m
	Hof	229,12 kN/m
	Hogg	149,15 kN/m

<b>Protensão completa</b>	E <sub>p</sub> cm	0,24 kN/cm <sup>2</sup>	p <sub>0Hof</sub>	<b>792,3 kN</b>
	E <sub>p</sub> cm	0 kN/cm <sup>2</sup>	p <sub>0Hof</sub>	
Vão	Hof	229,14 kN/m	P <sub>0</sub>	712,5 kN
	Hof	229,12 kN/m	P <sub>0</sub>	712,3 kN

<b>Protensão limitada</b>	E <sub>p</sub> cm	0,24 kN/cm <sup>2</sup>	p <sub>0Hof</sub>	<b>699,7 kN</b>
	E <sub>p</sub> cm	0 kN/cm <sup>2</sup>	p <sub>0Hogg</sub>	
Vão	Hof	229,12 kN/m	P <sub>0</sub>	619,7 kN
	Hogg	149,15 kN/m	P <sub>0</sub>	619,8 kN

### ESPAÇAMENTO DAS ARMAS

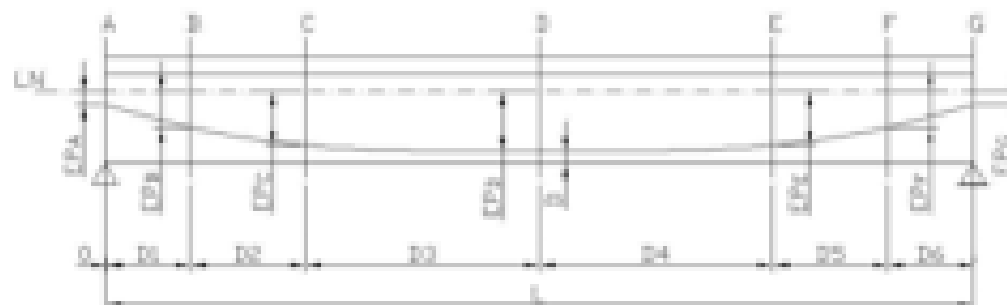
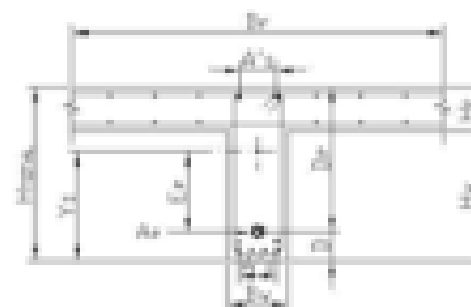
a: **6,00 m**

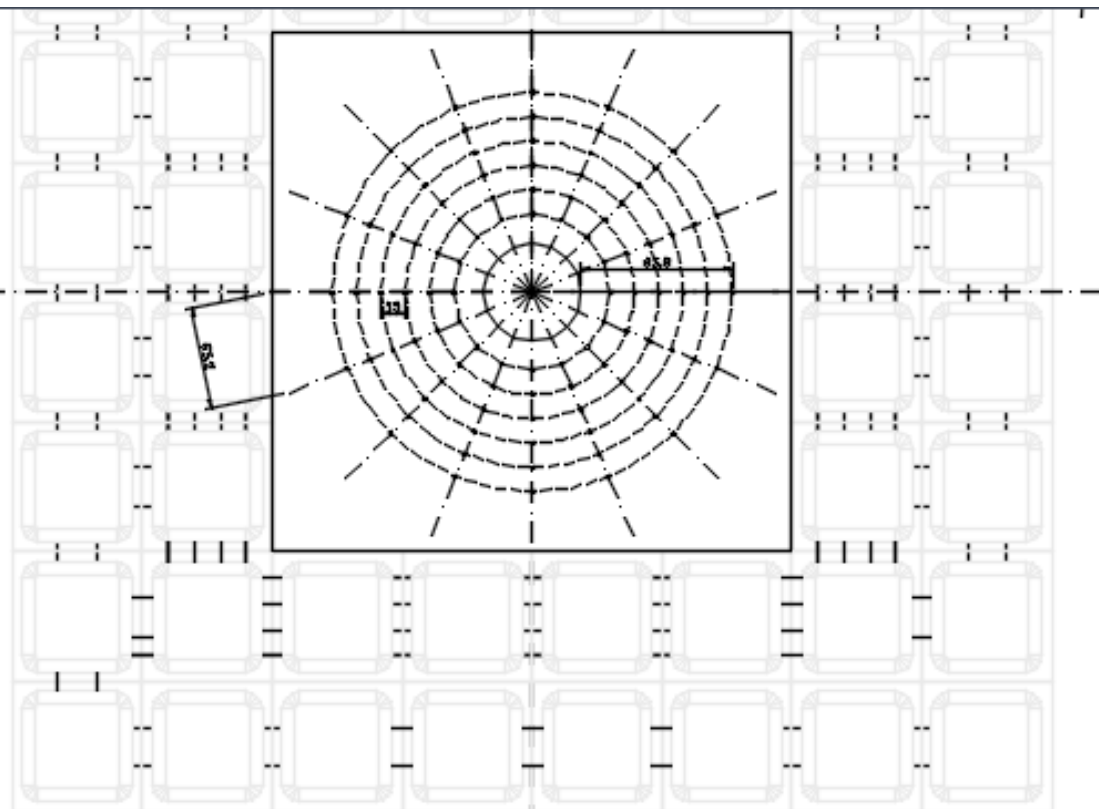
### CARGAS DISTRIBUÍDAS NA ÁREA

q <sub>0</sub>	600 kg/m <sup>2</sup>	Carga direção	0,37
q <sub>0</sub>	600 kg/m <sup>2</sup>	Carga direção	0,43
q <sub>0</sub>	500 kg/m <sup>2</sup>		

### PISO DA MESA

**3,73 m**



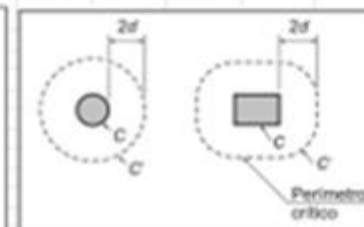
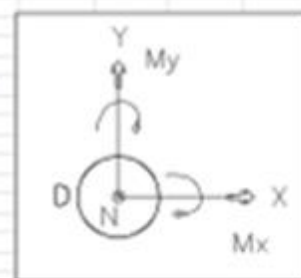


### DIMENSIONAMENTO DE LAJE À PUNÇÃO - PILAR CIRCULAR INTERNO

NBR 6118-03 - Item 19.5

F26

Pilar		Estrichos		Concreto		Aço	
Ø	60	Nx	289	fck	40	fyk	500
ocorr	3	Nkx	3,5	fcd	28,57	fyd, máx	43,5
		Nky	0	fctm	3,51	fyd, mín	25,0
Laje	50	Nd	404,65	fctk,ef	2,46	fyd	4,36
h	70	Md	495	fcd	1,75		
Aa, flexão	52	Mdy	0	av	0,84		
d	66	Mtotal	490,00				
ba	100						
p	0,74%						
		Coef. segurança					
		γf	1,4	Solitação			
		γc	1,4	Resist. concreto			
		γs	1,15	Resist. aço			



$$r = \sqrt{x^2 + y^2}$$

$$d = (d_x + d_y) / 2$$

Verificação indireta da tensão de compressão diagonal - Contorno C (face do pilar)	
u	188,50
Wp	3000,00
K	0,6
vsd	33,76
vrd2	64,80

Verificação da capacidade de ligação à punção (tração diagonal) - Contorno C' (distante 2d da face do pilar)

Verificação da capacidade de ligação à punção (tração diagonal) - Contorno C' (distante 2d da face do pilar)	
u	1017,88
Wp	104276,00
K	0,6
vsd	6,07
vrd1	6,24

Cálculo da armadura de punção, se necessária

2d	132	
sr, máx	48,5	
sr	15	Espaçamento radial entre linhas de armadura de punção
n, calc	9	
n, adotado	13	Linhas de armadura
Aa, calc	2,96	cm²
a, adotado	8	mm
n, calc	6	
n, adotado	24	Número de barras no contorno
Aa	12,06	cm²
vrd3	9,96	kgf/cm² OK

Verificação da capacidade de ligação à punção (tração diagonal) - Contorno C'' (distante 2d de contorno C')

u	187,5	
Wp	383161	
K	0,75076	
vsd	3,51	
vrd1	6,24	OK

Colapso progressivo - Armadura de flexão inferior

γf	1,3	Solitação - adicional
Aa	120,08	cm²

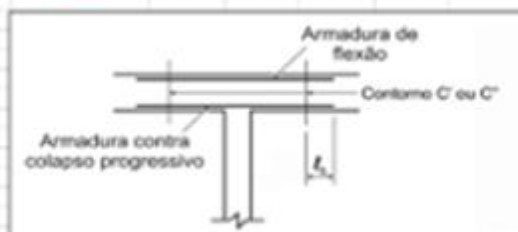


Figura 19.10 - Armadura contra colapso progressivo

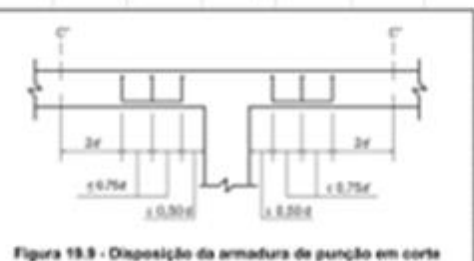
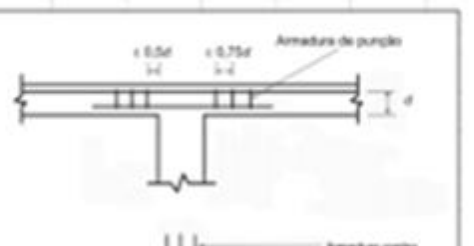
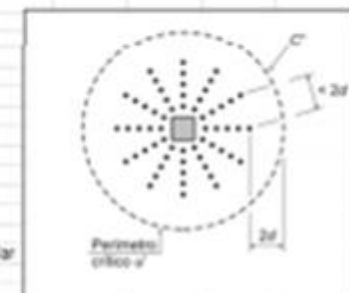
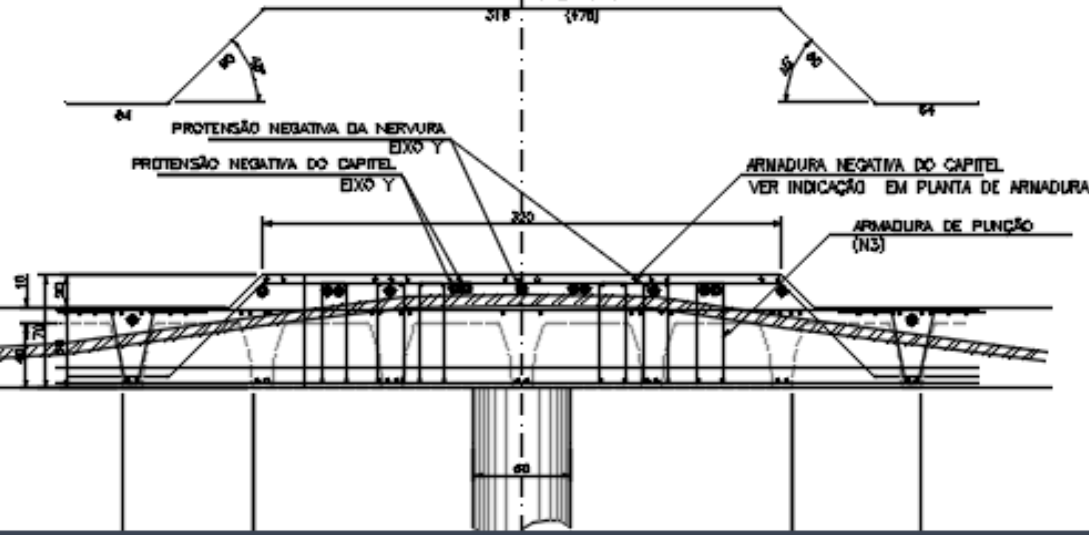


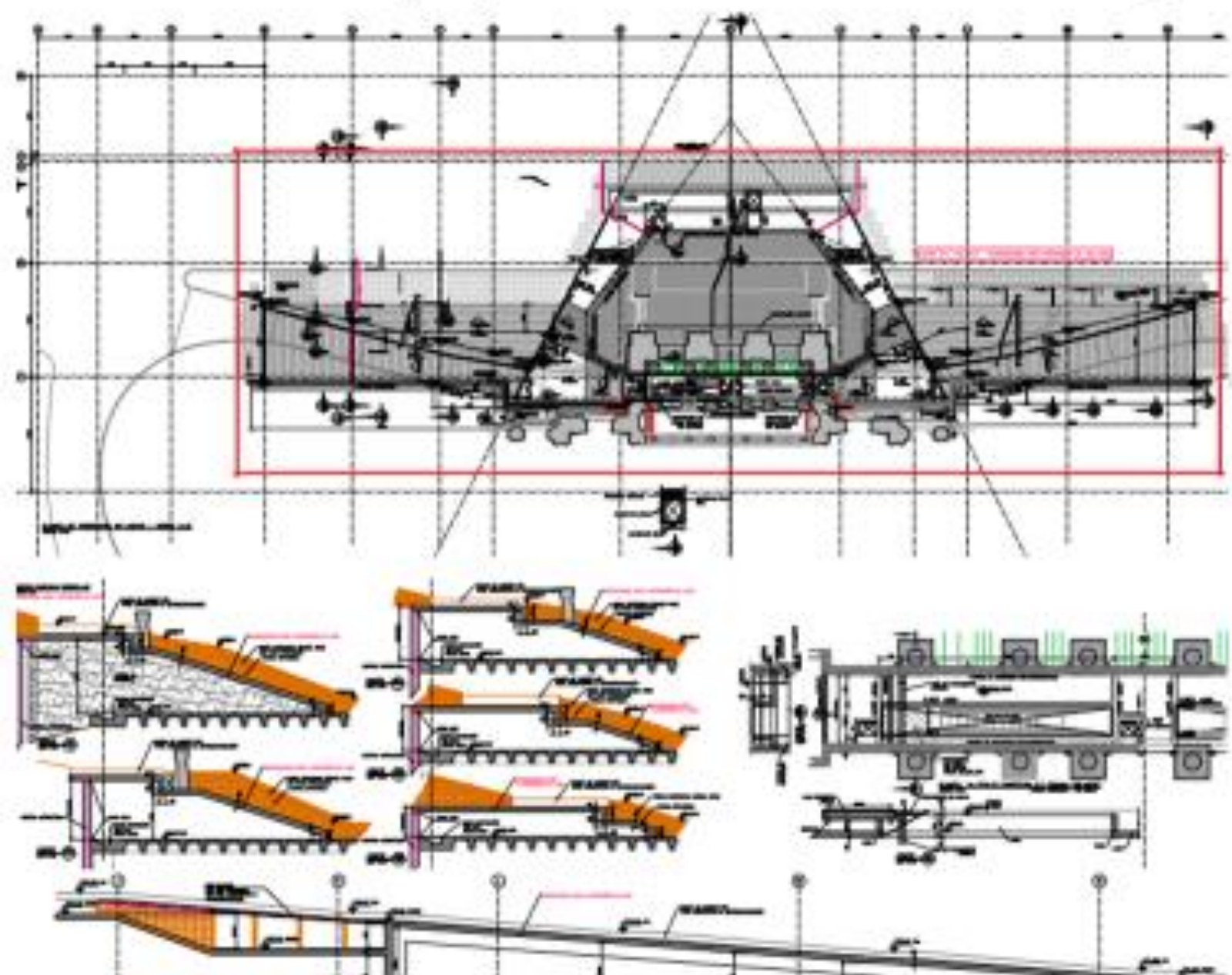
Figura 19.9 - Disposição da armadura de punção em corte



(N3 Ø 20 C=784)  
NT Ø 20 C=804



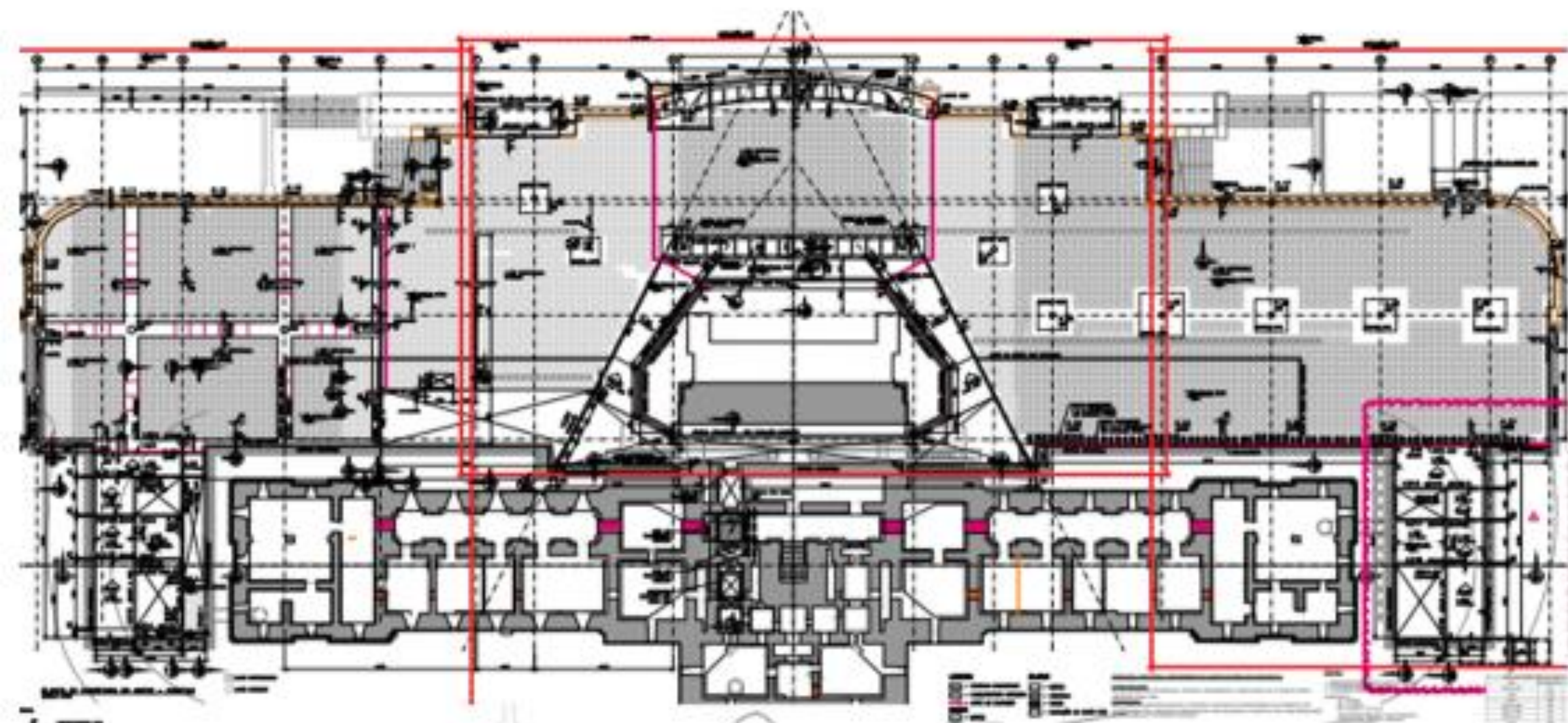
o projeto foi desenvolvido ao longo de 2018 e 2019



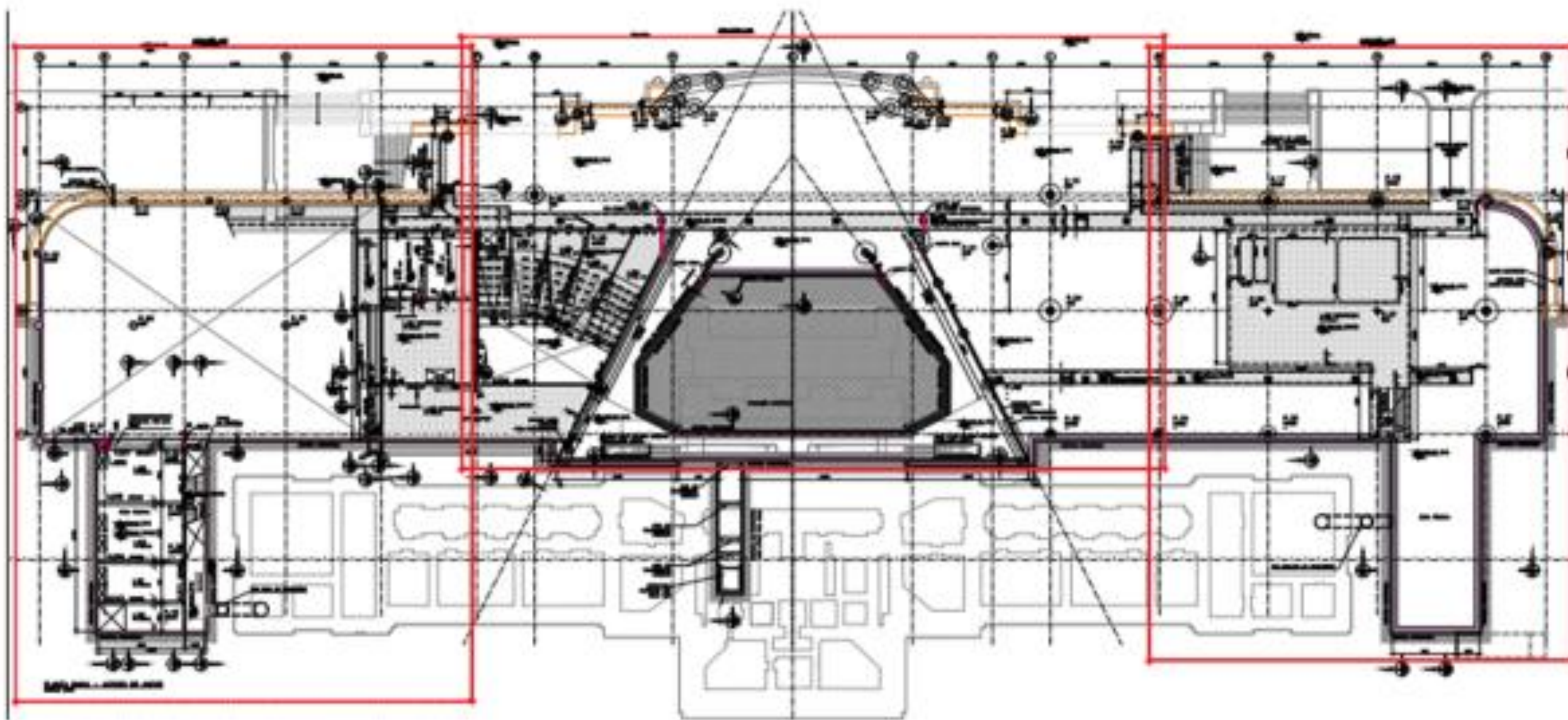
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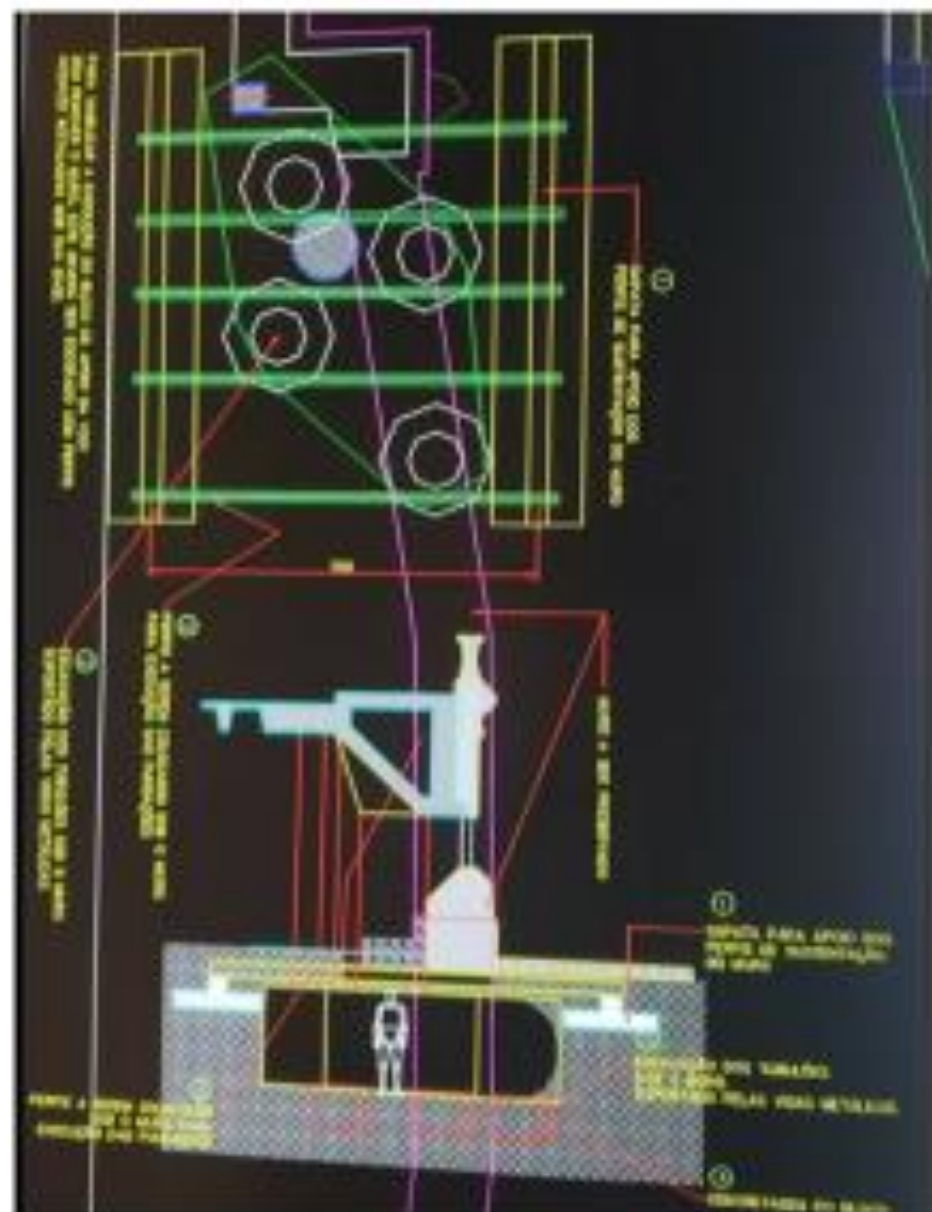
belvedere



acolhimento – exposição temporária e auditório







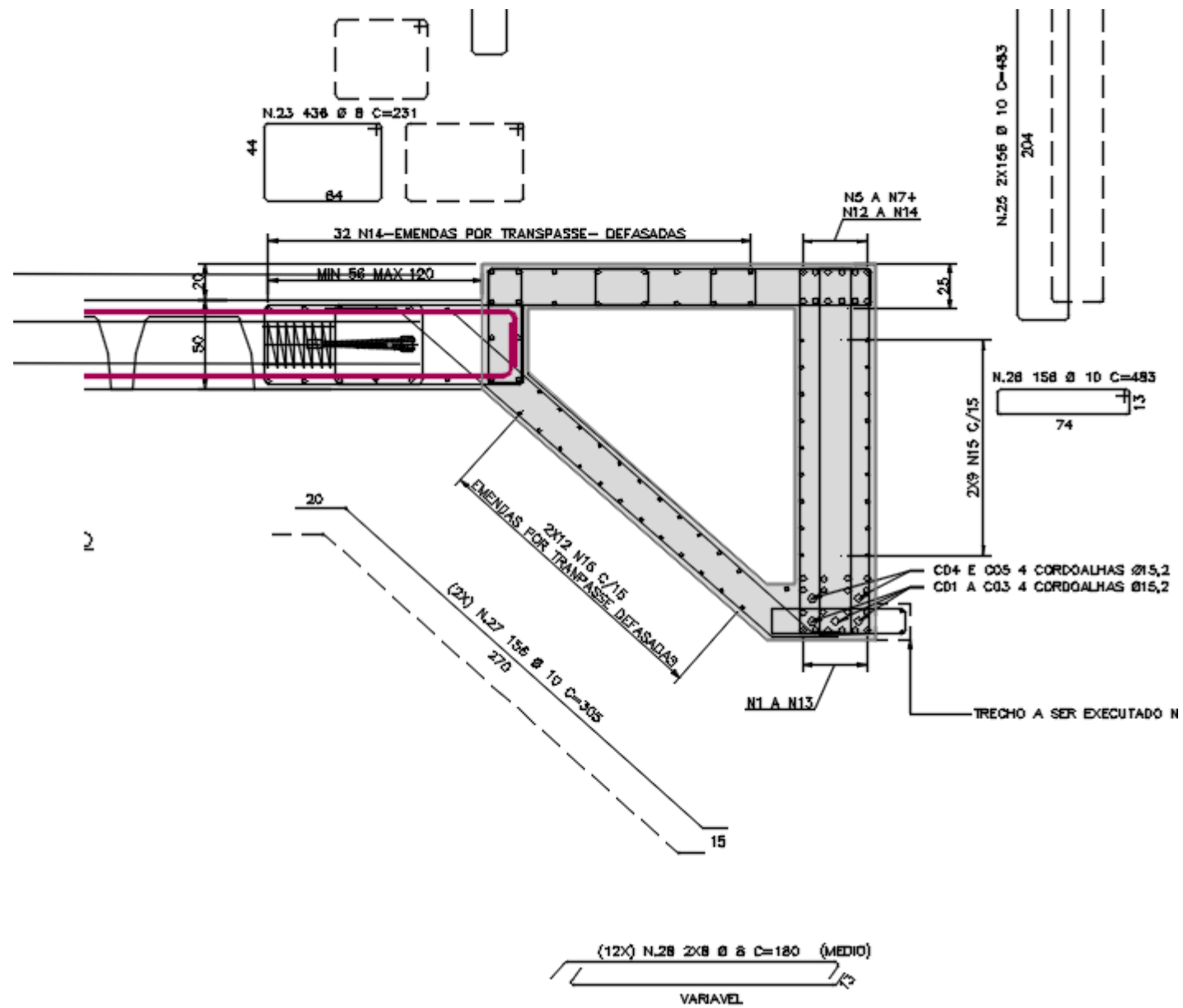












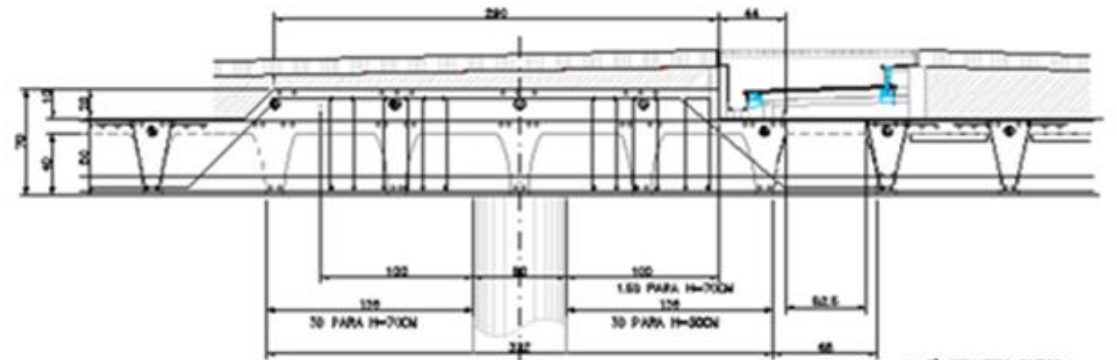






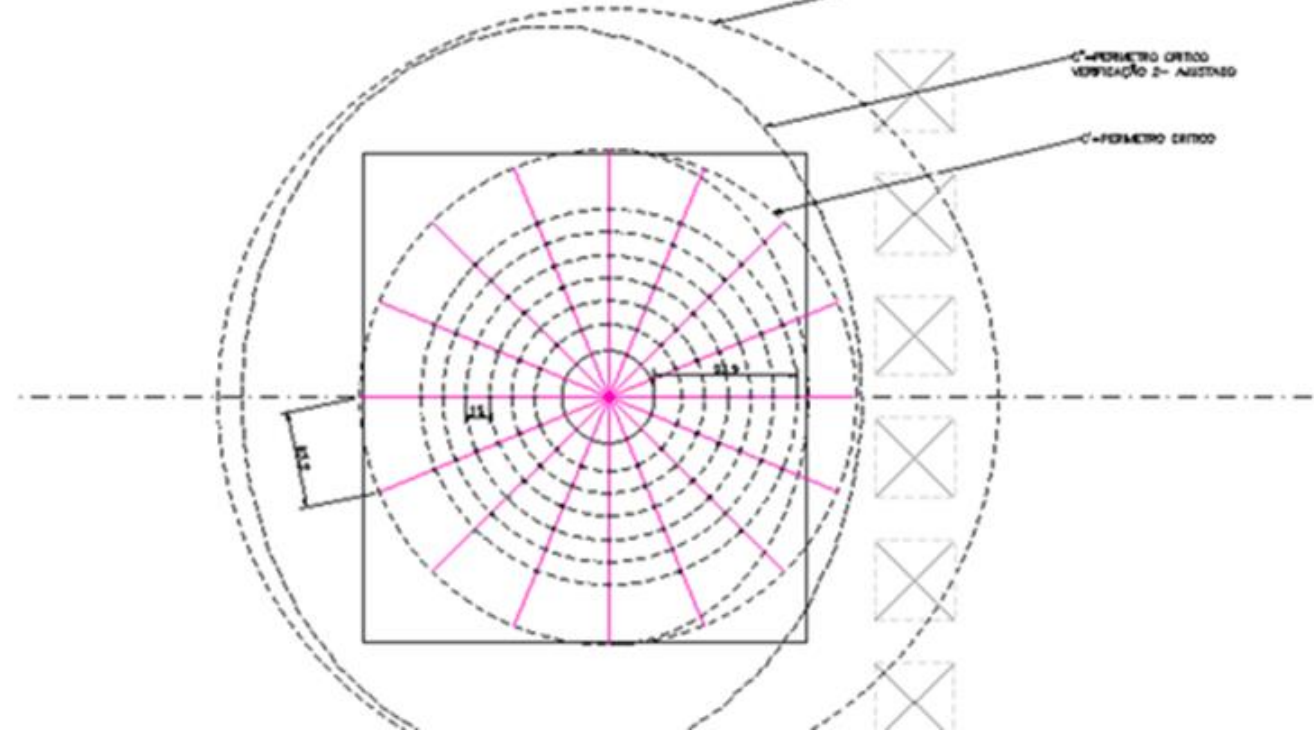


### verificações específicas



DETALHE DOS CAPITEIS JUNTO A ABERTURAS  
ESCALA 1:25

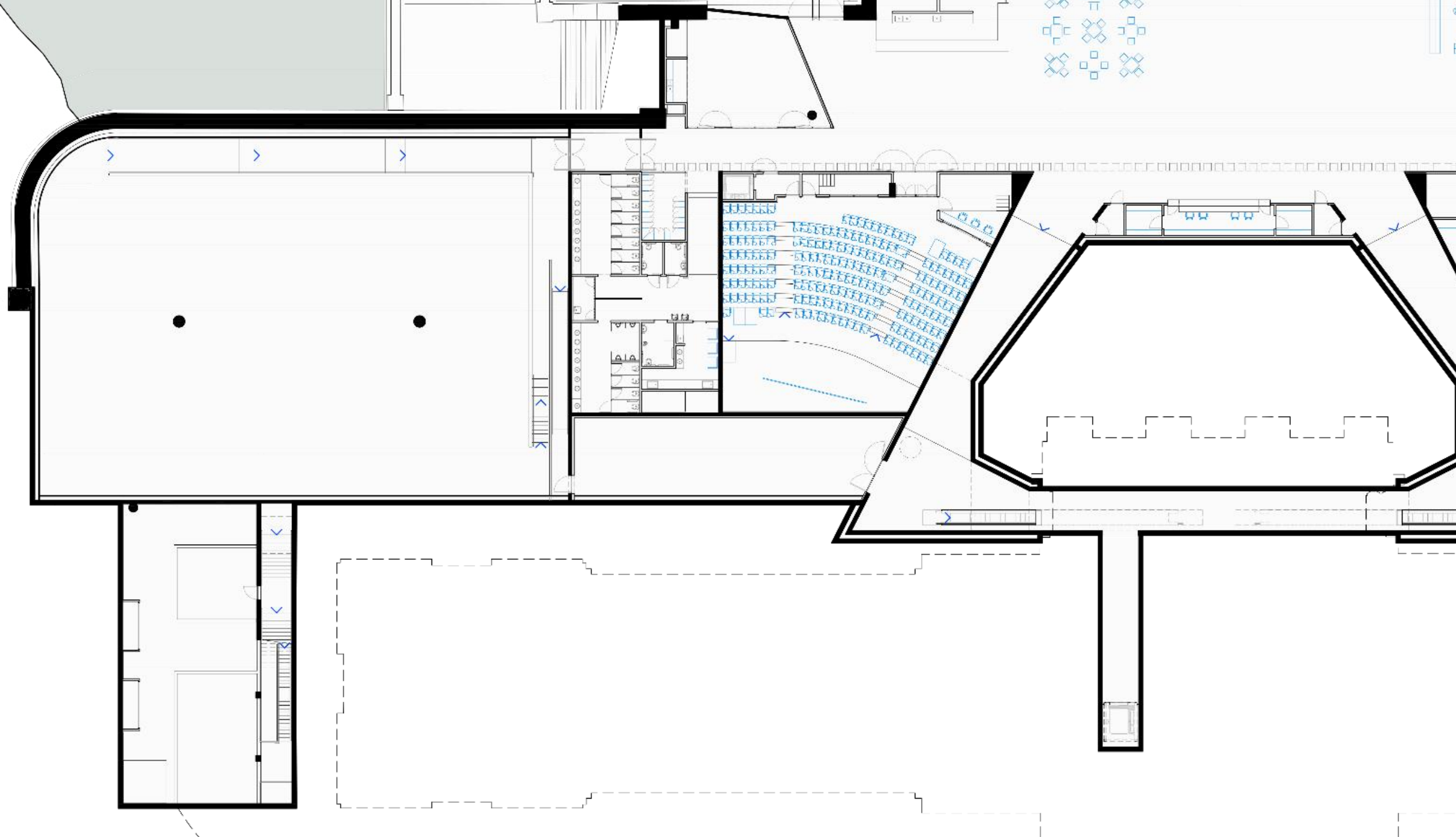
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VERIFICAÇÃO 2-NORMA



C=PERIMETRO CRÍTICO  
VERIFICAÇÃO 2- NBR14830

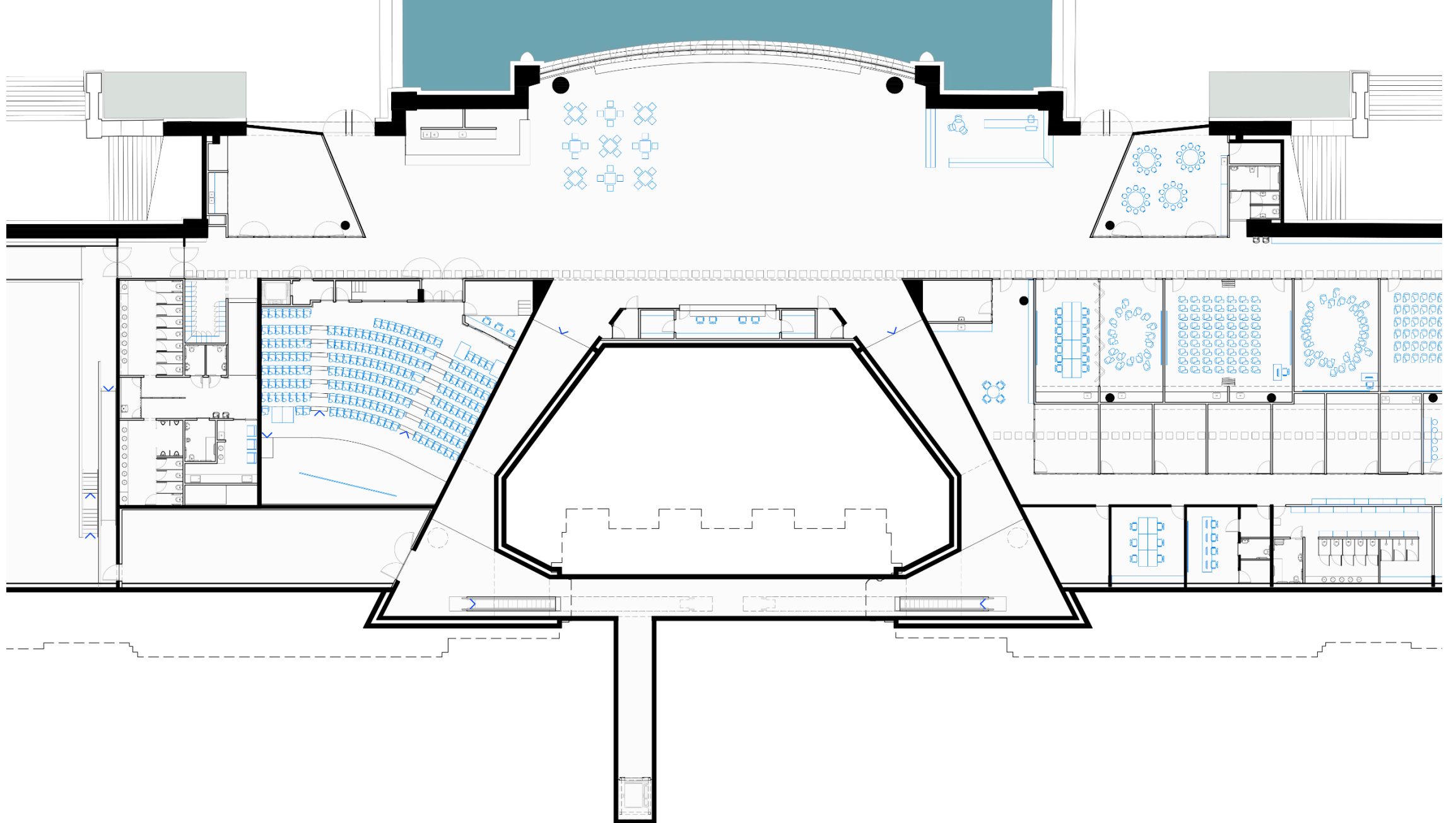
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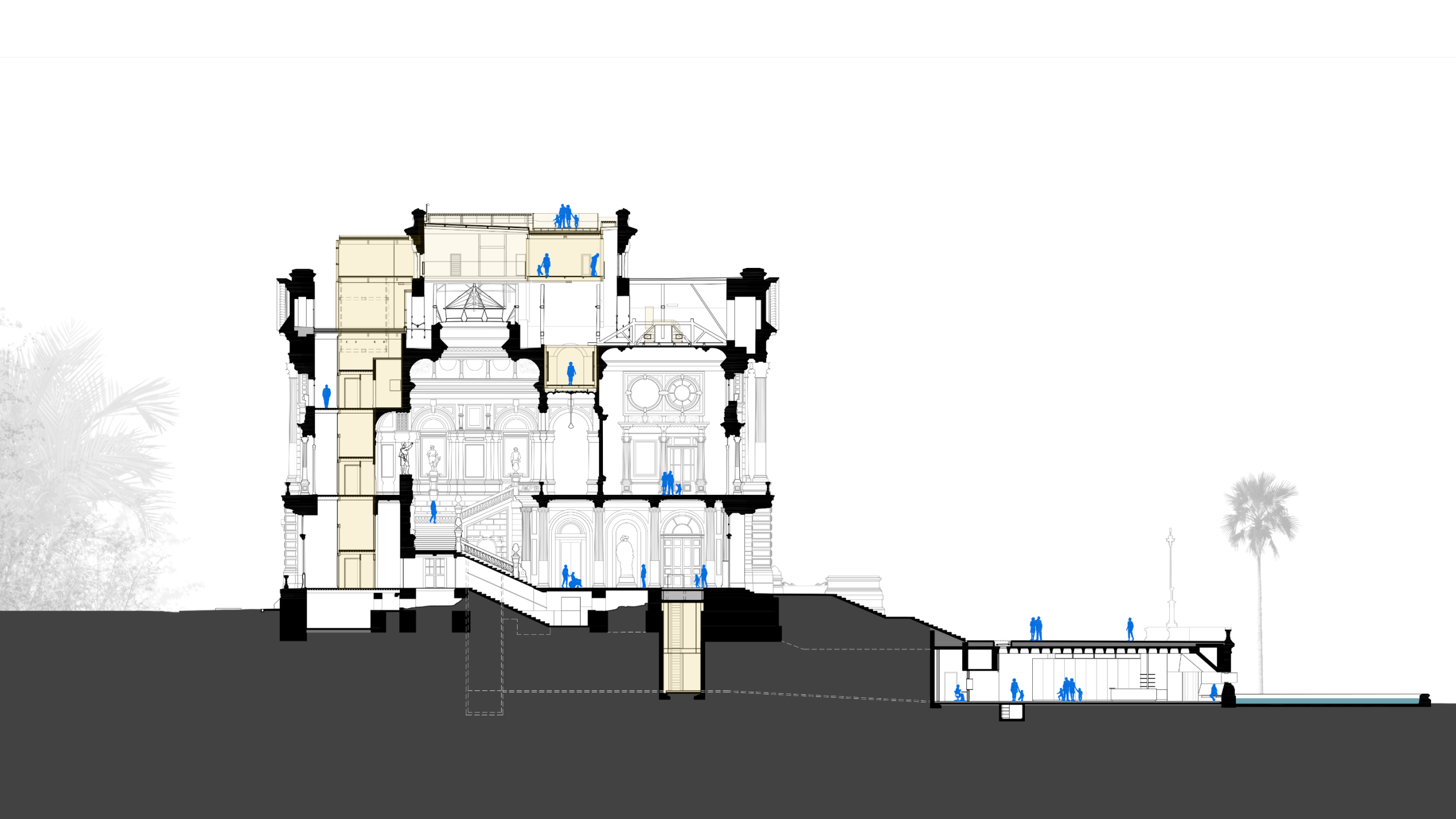


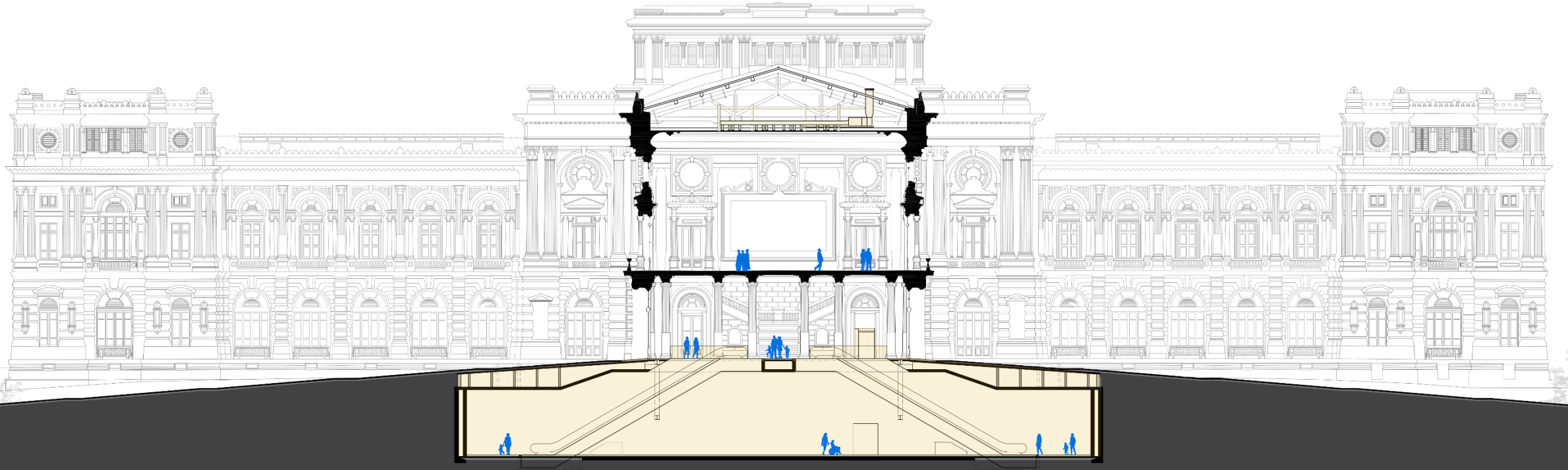






**RITUAL DE ACESSO**













SALA DE  
BIEN-ESTAR  
→





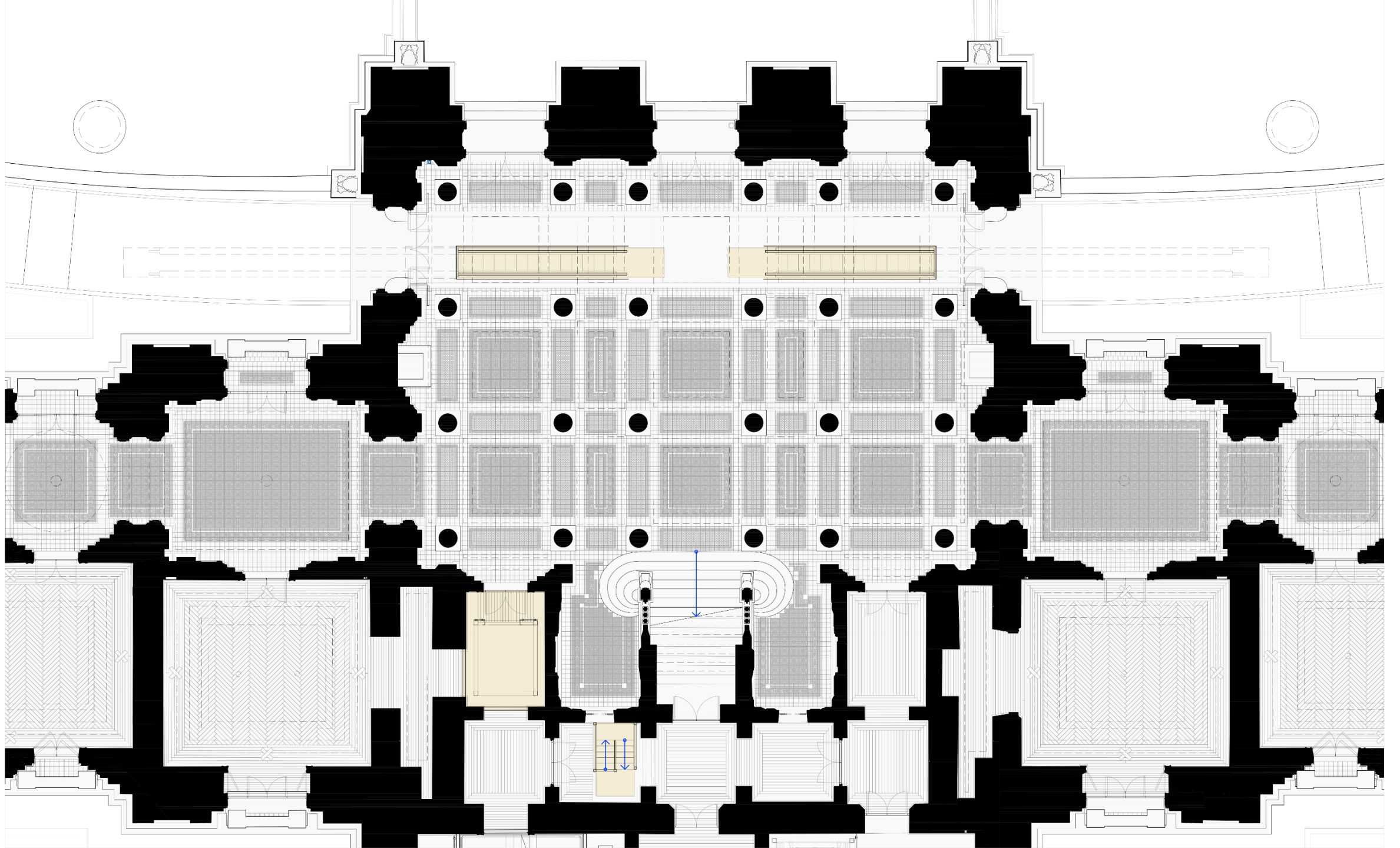




→  
BARDA  
EXIT

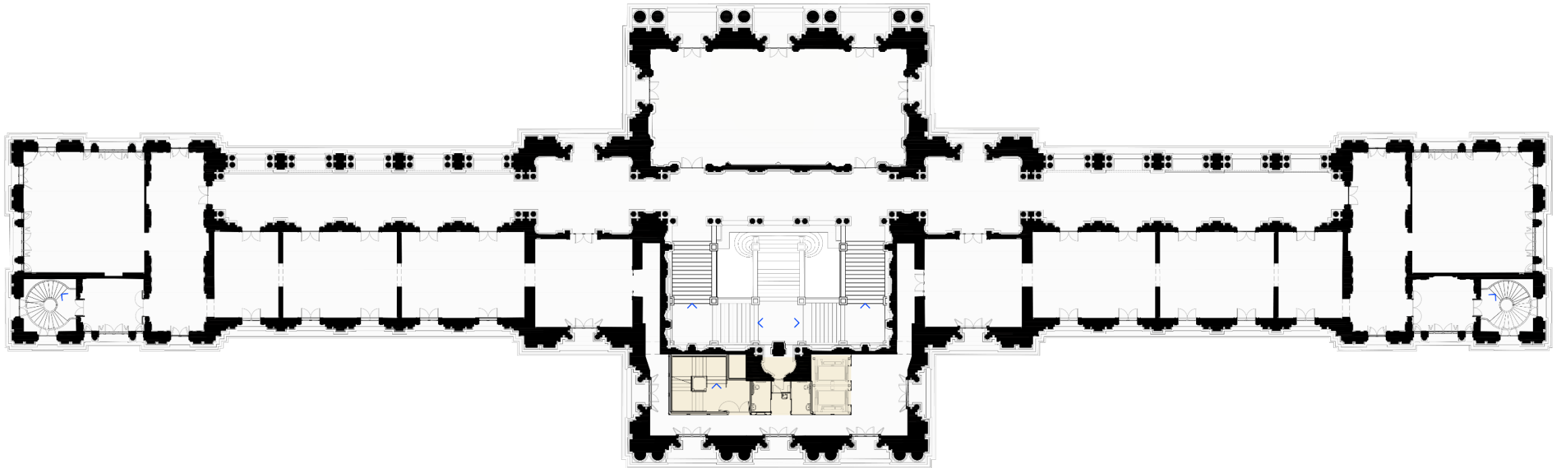
EXPOSIÇÕES  
LONGA  
DURAÇÃO  
LONG-TERM  
EXHIBITIONS





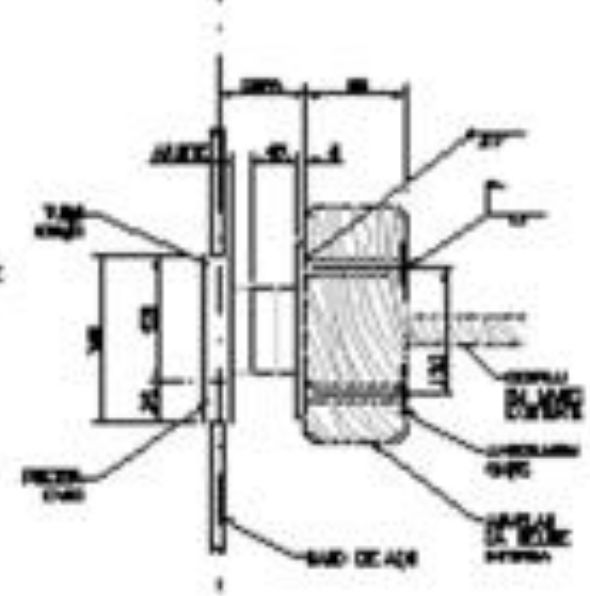
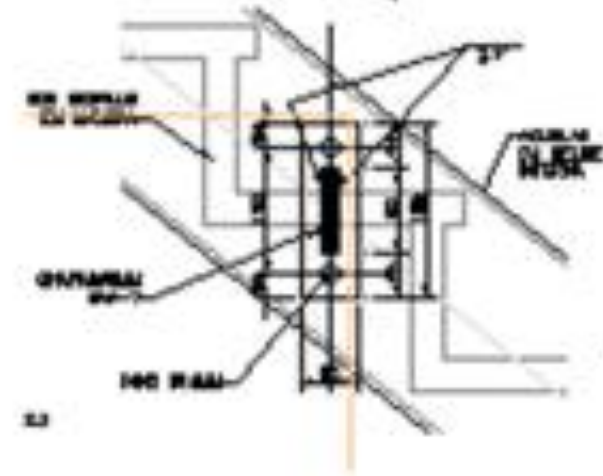
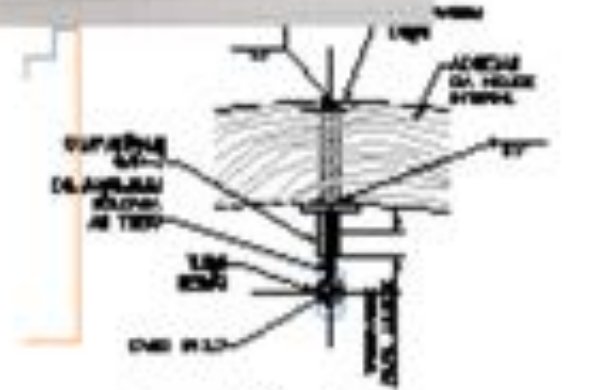
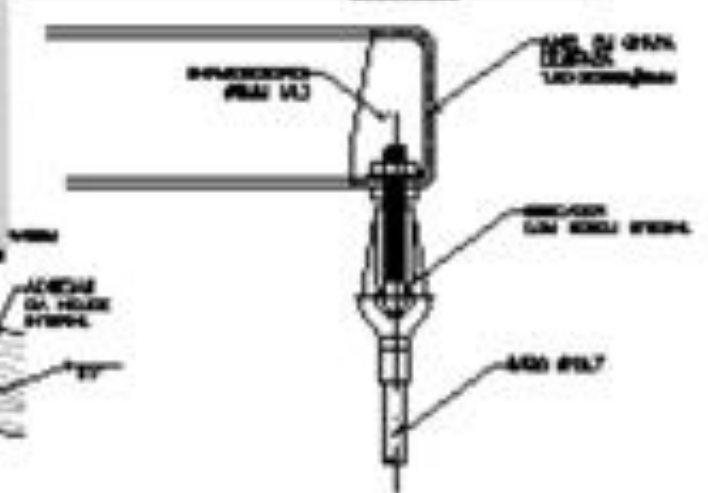
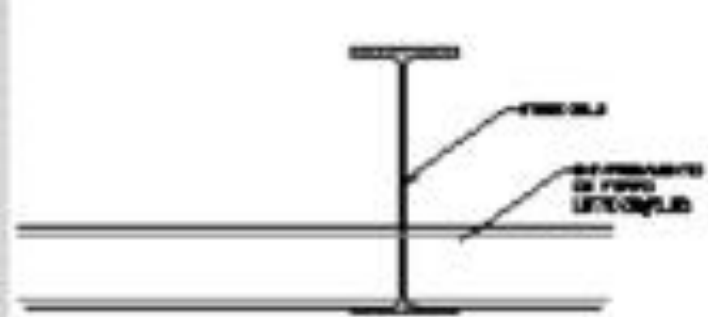
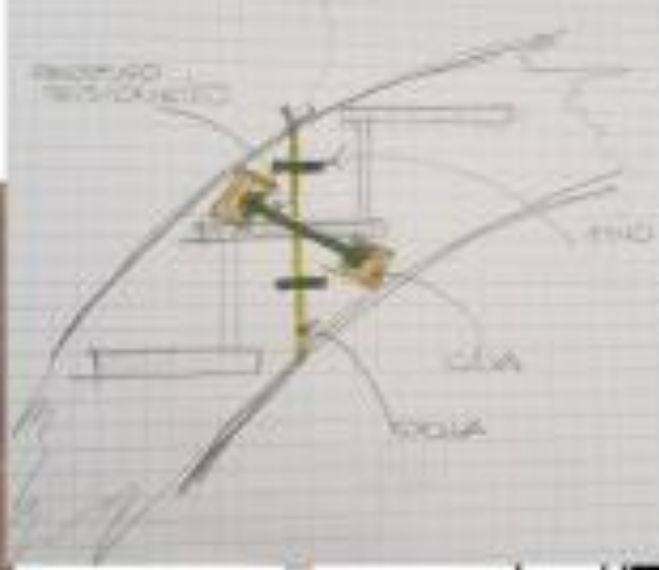


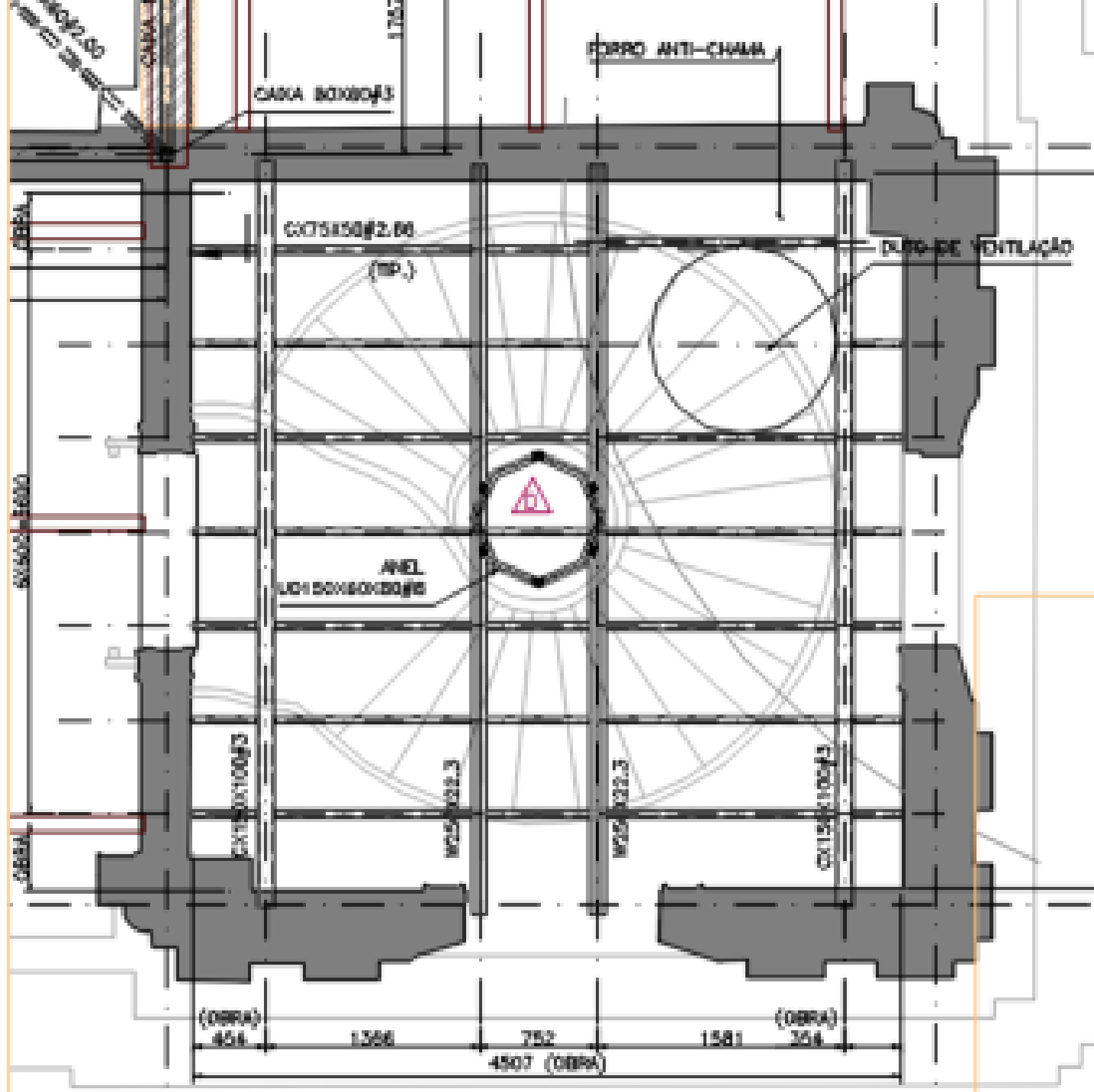
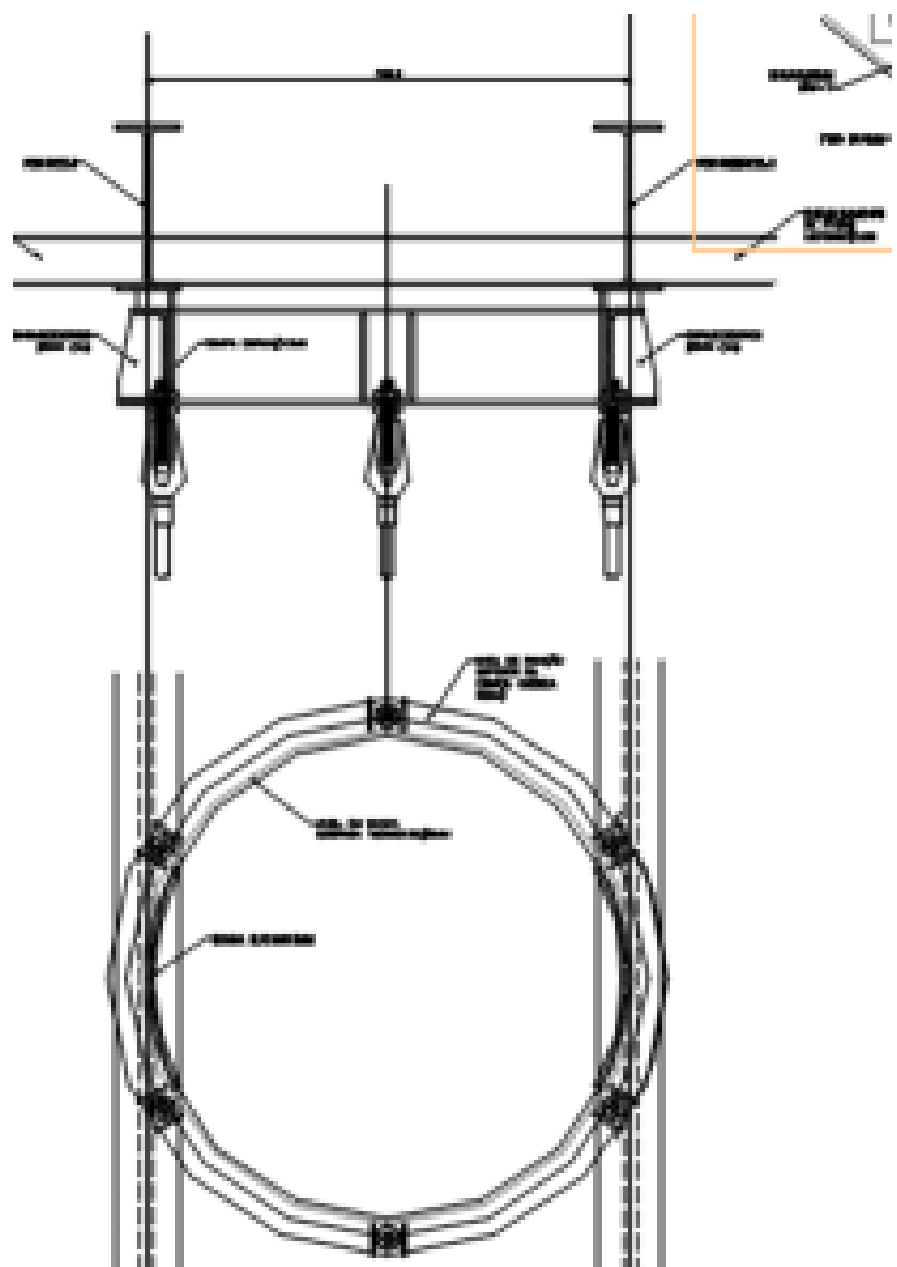




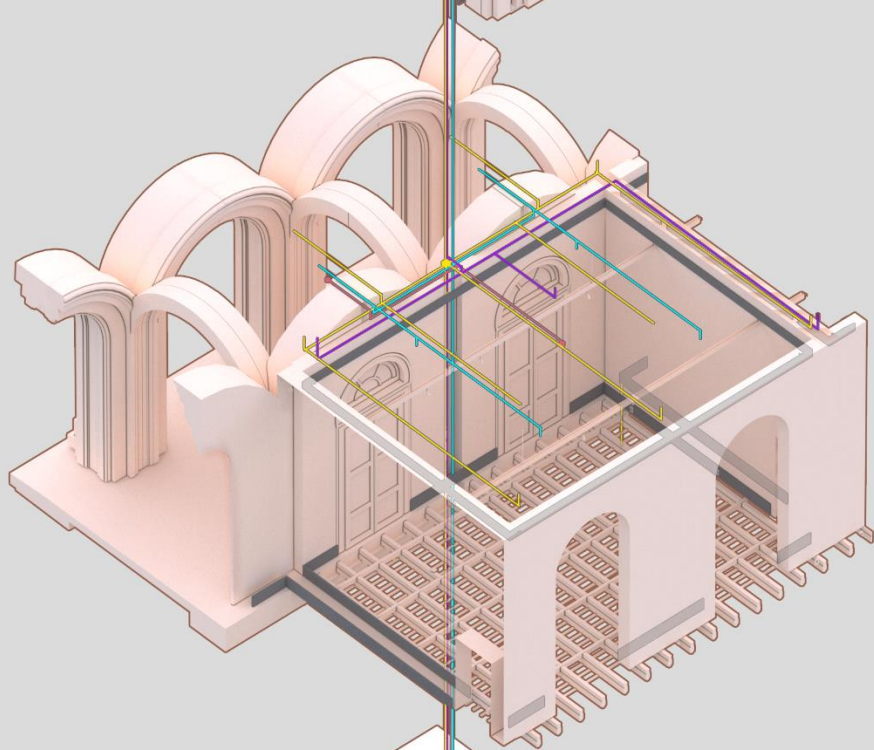
**PRIMEIRO PAVIMENTO**



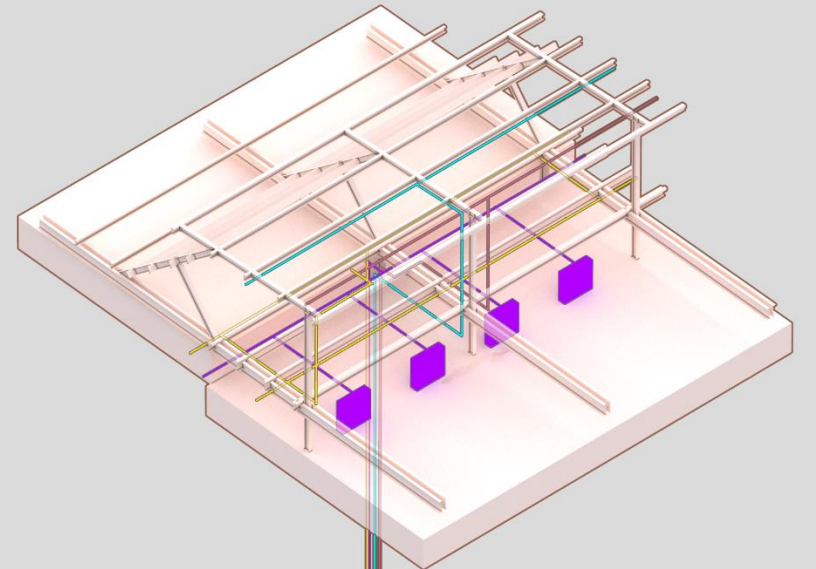




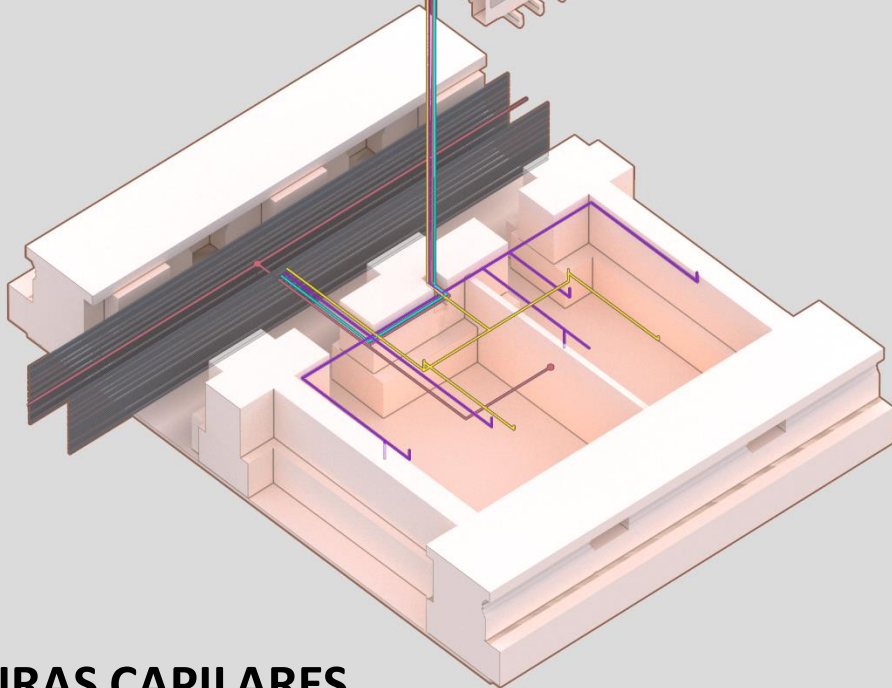
**TÉRREO**



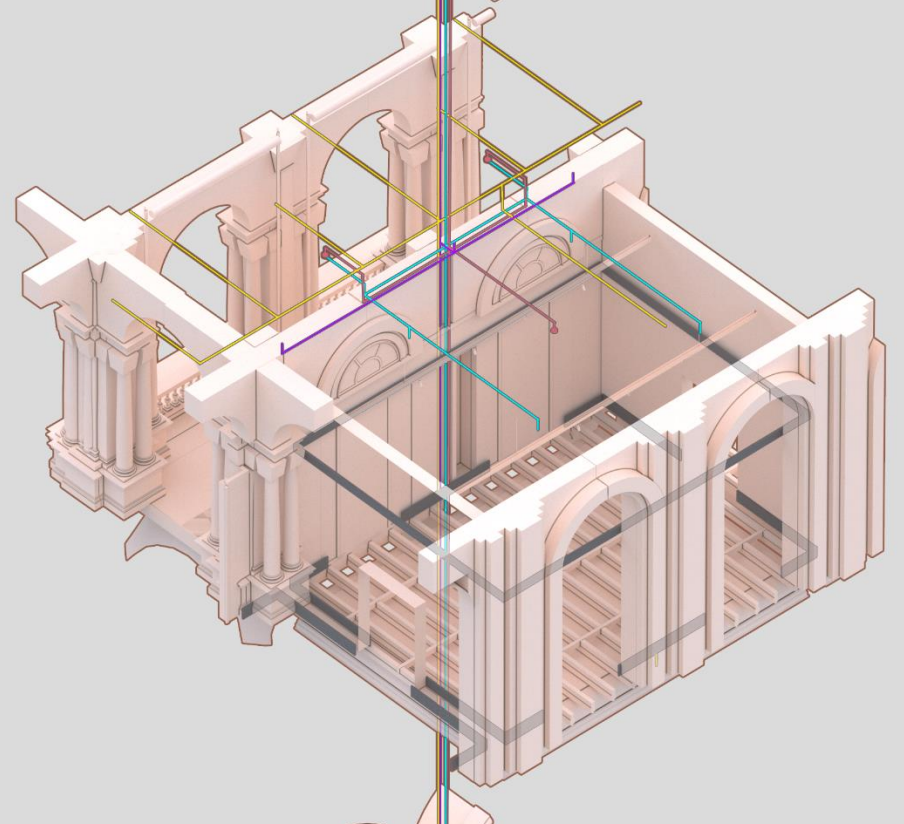
**2º PAV.**



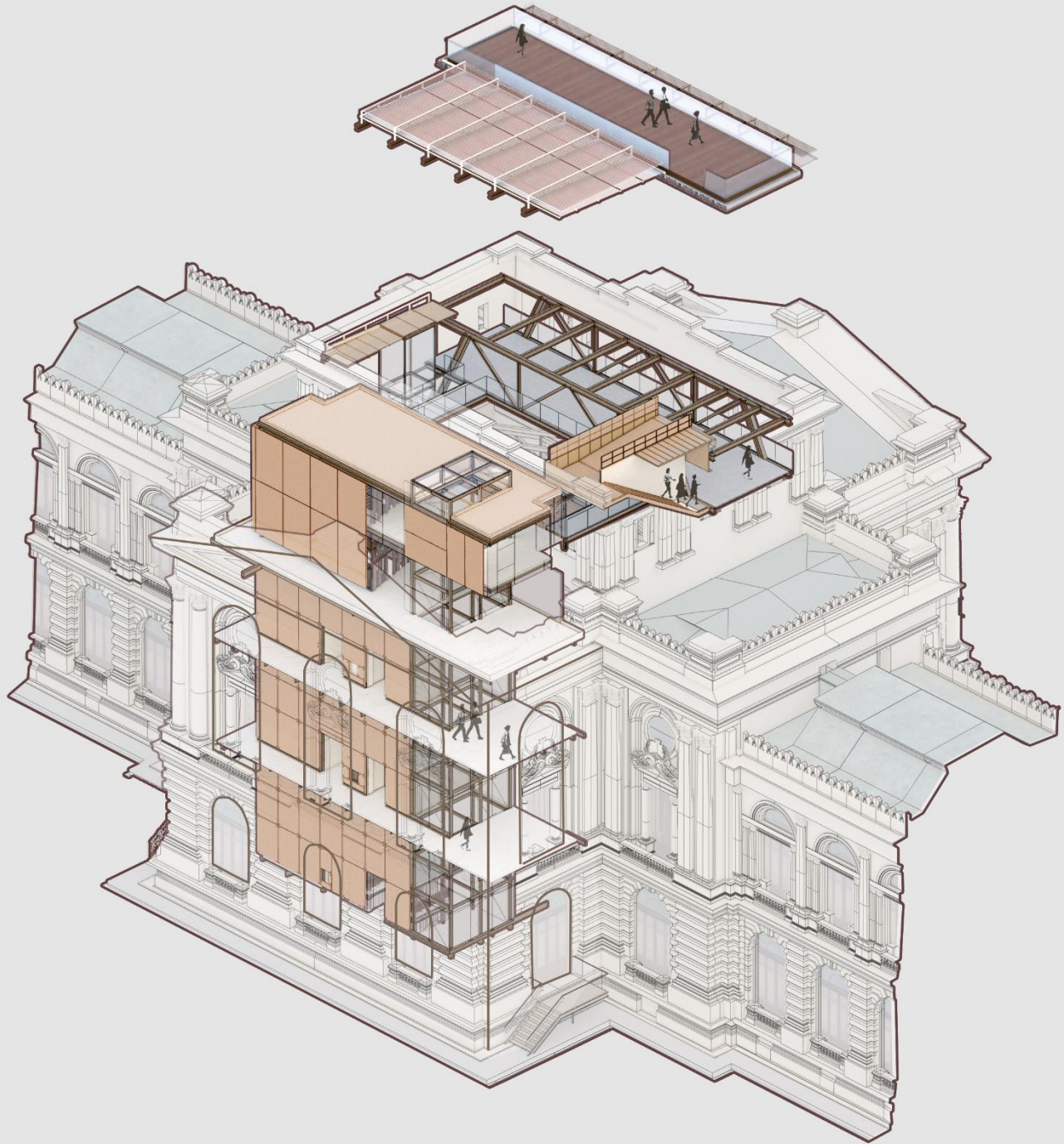
**PORÃO**

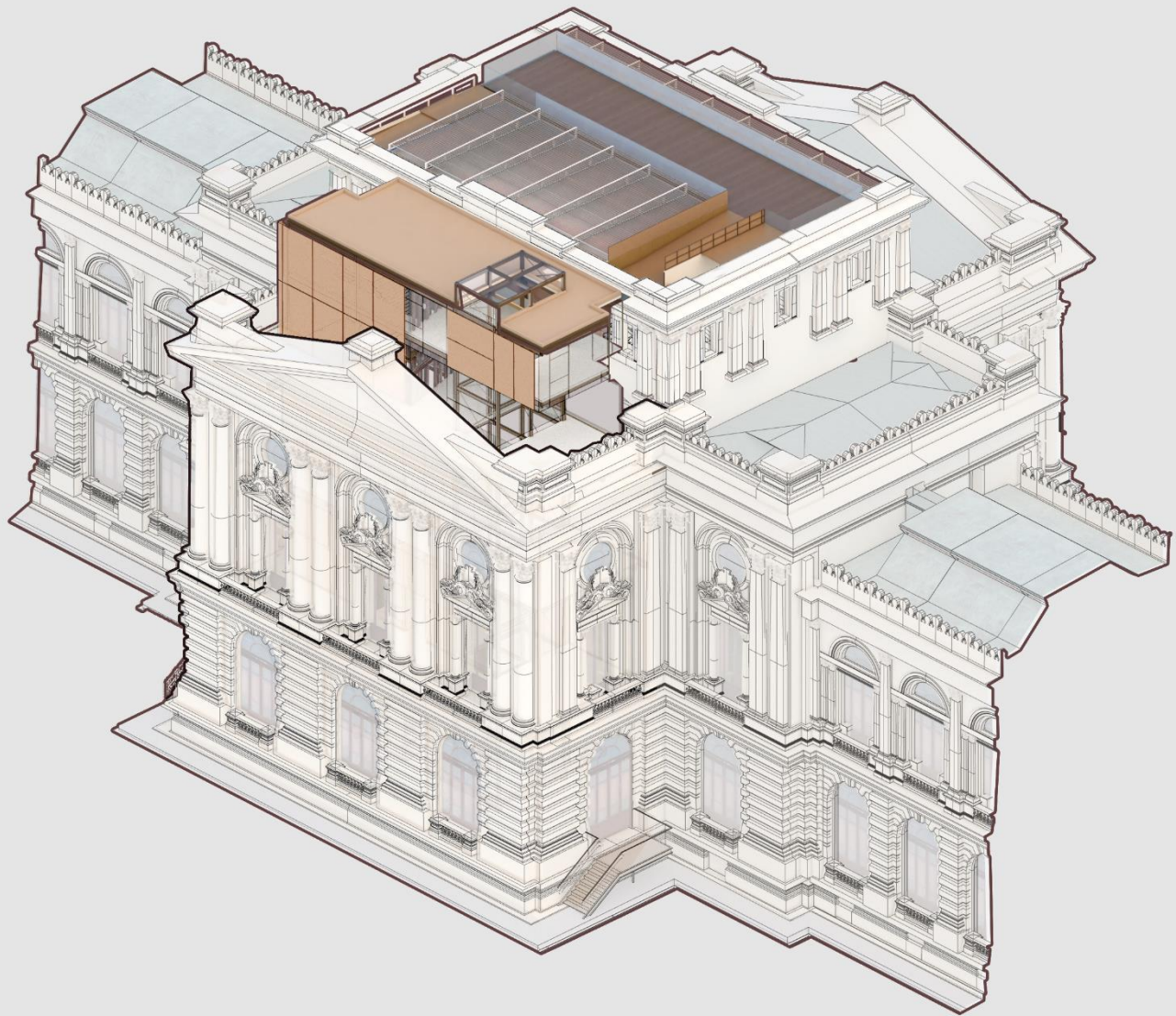


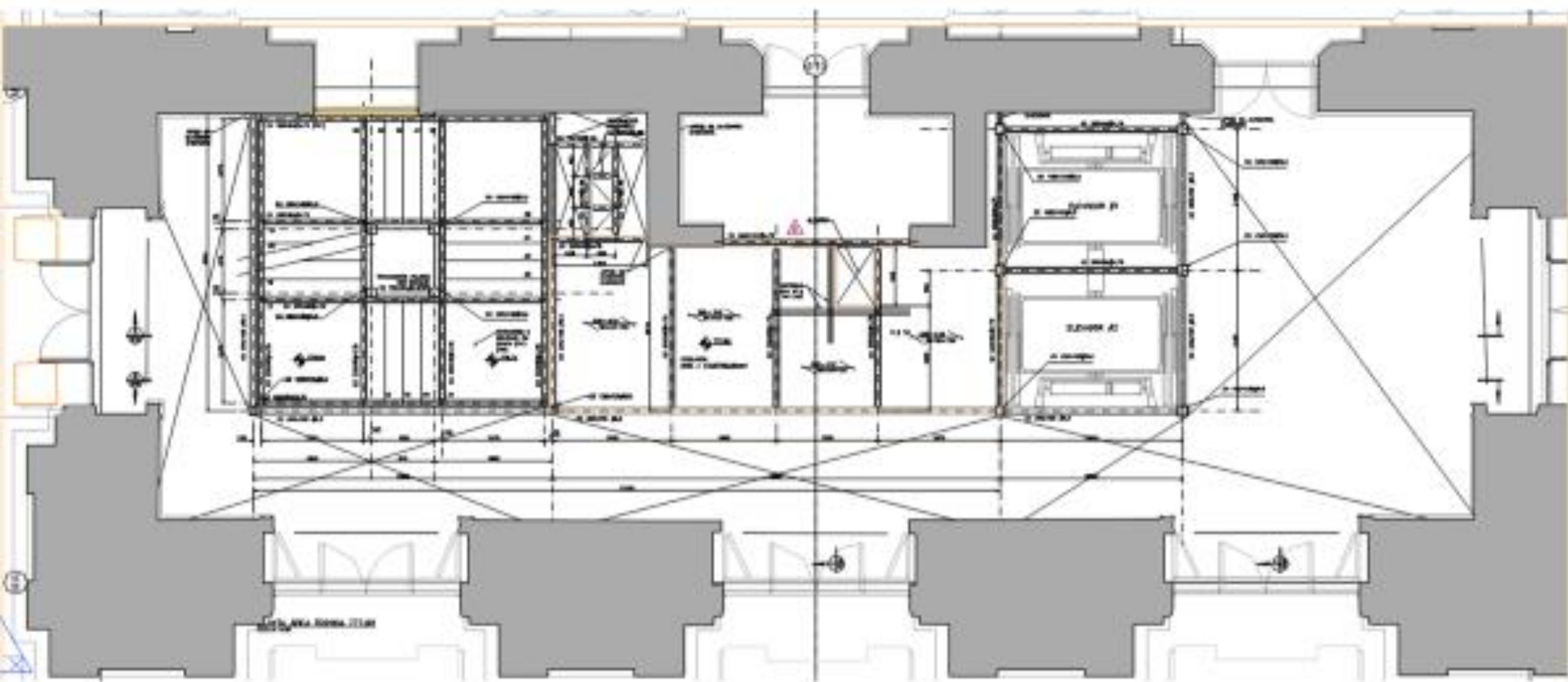
**1º PAV.**



**INFRAESTRUTURAS CAPILARES**



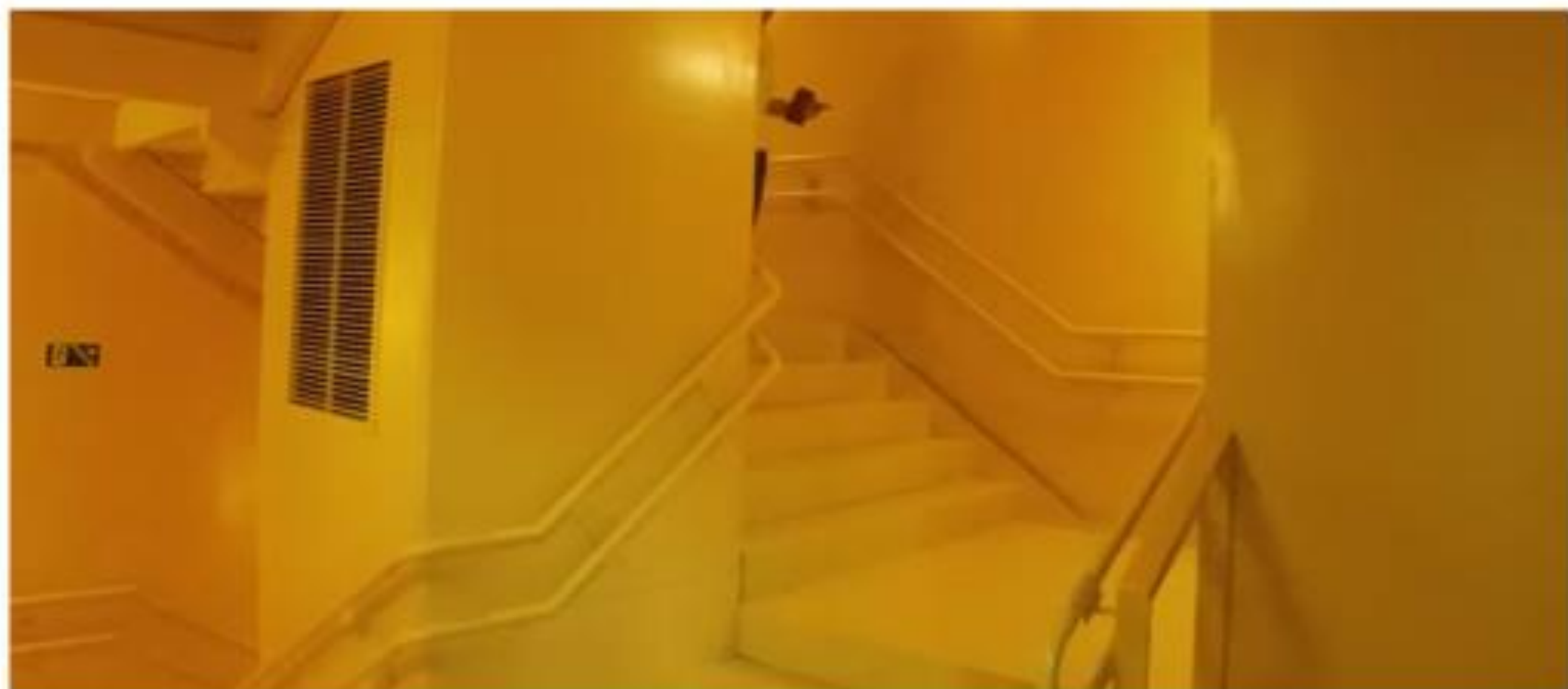














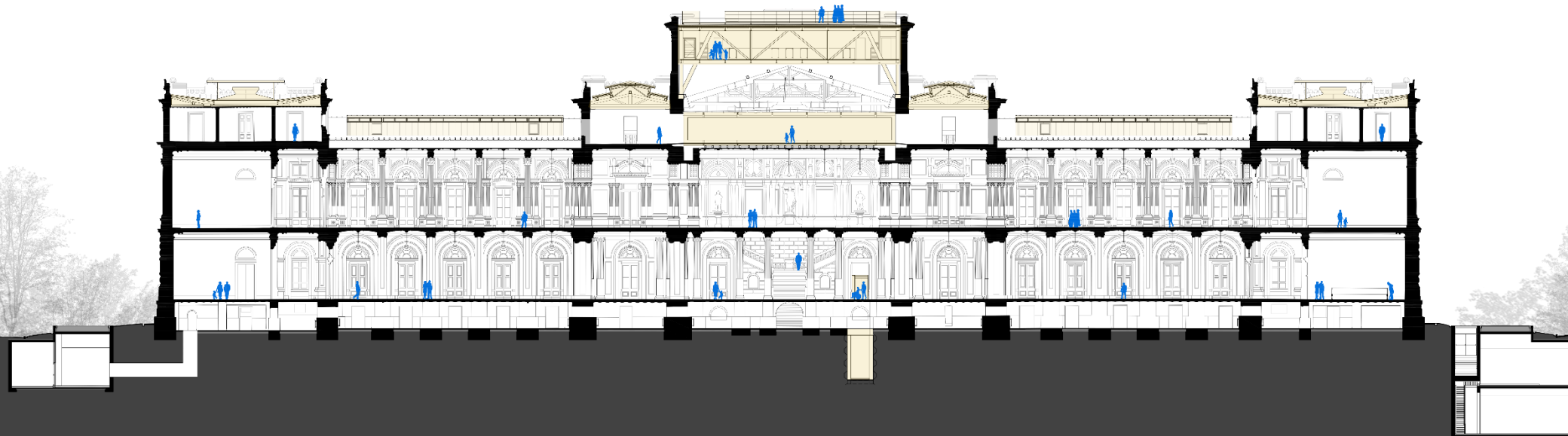
TORRE  
LESTE

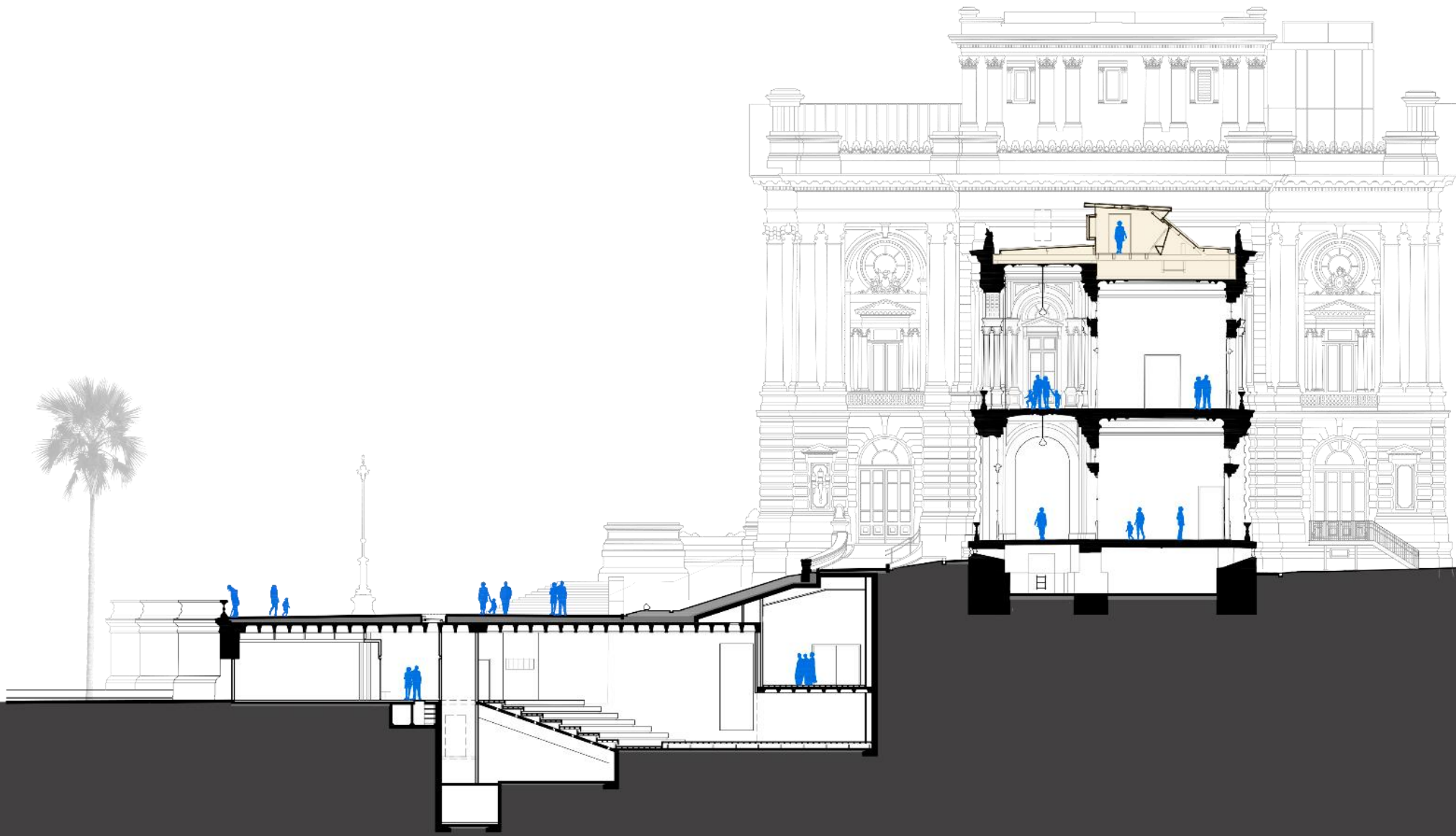
CONEXÃO  
LESTE

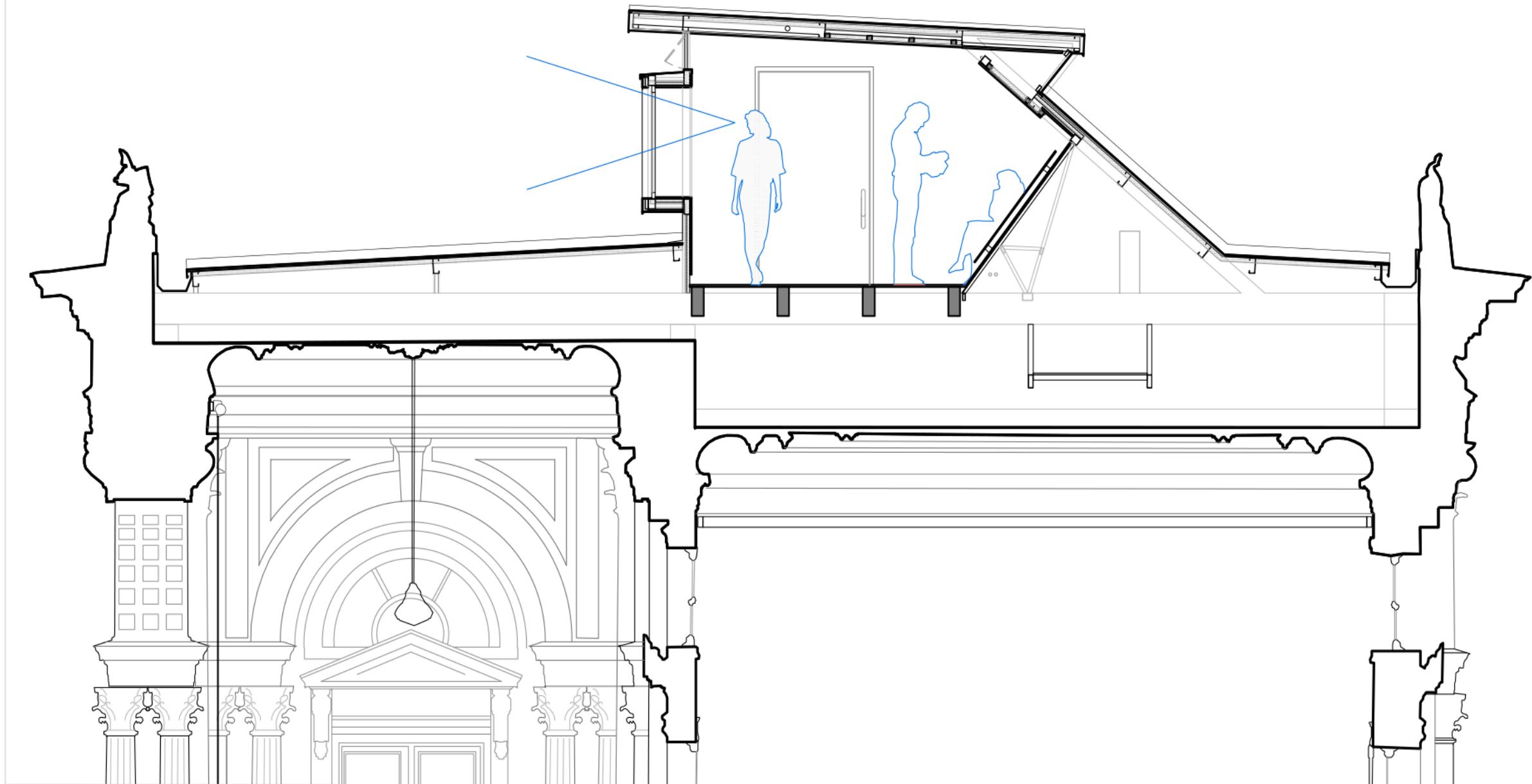
CONEXÃO  
CENTRAL E  
MIRANTE

CONEXÃO  
OESTE

TORRE  
OESTE







**CONEXÕES LATERAIS**

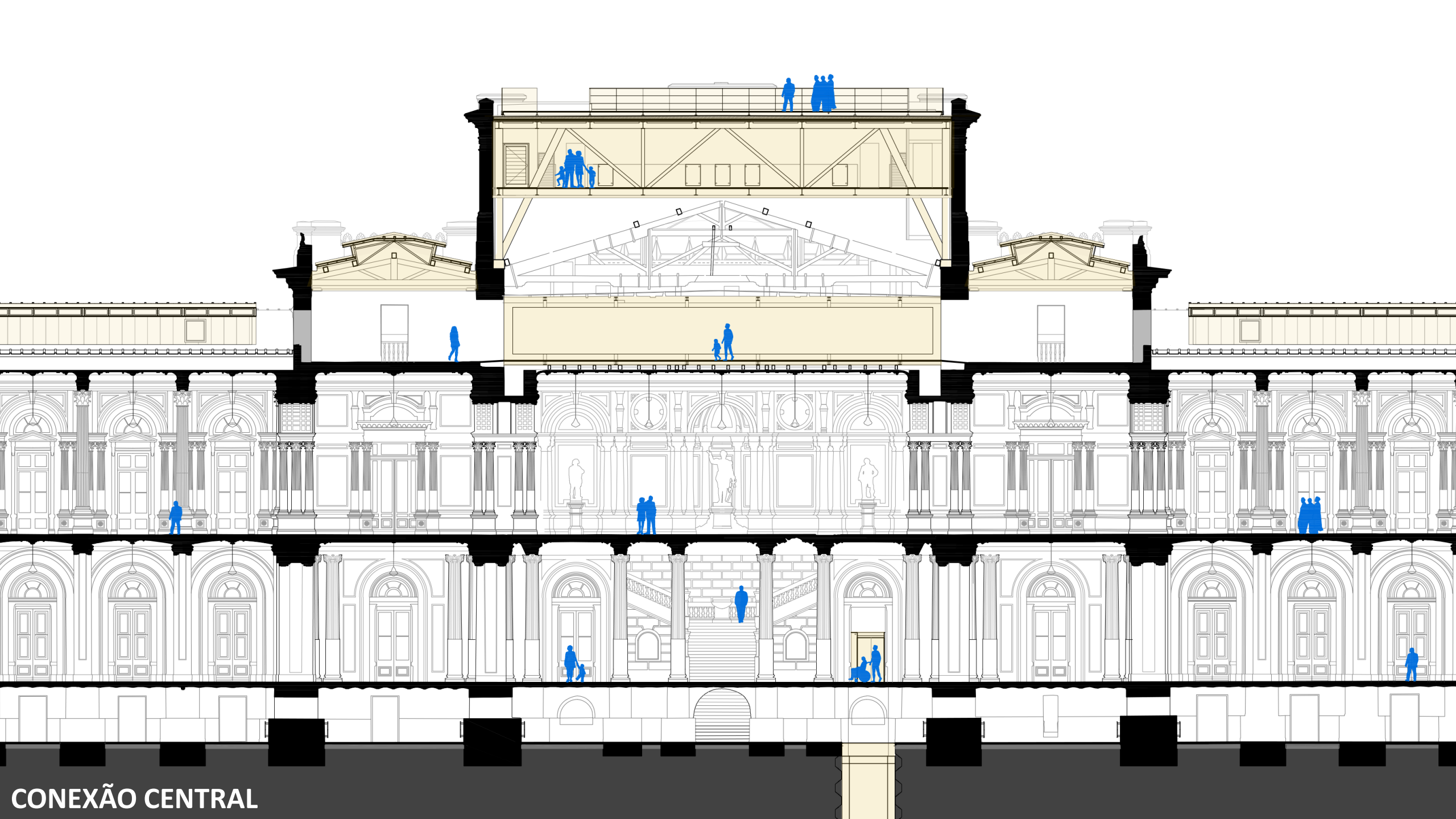












CONEXÃO CENTRAL



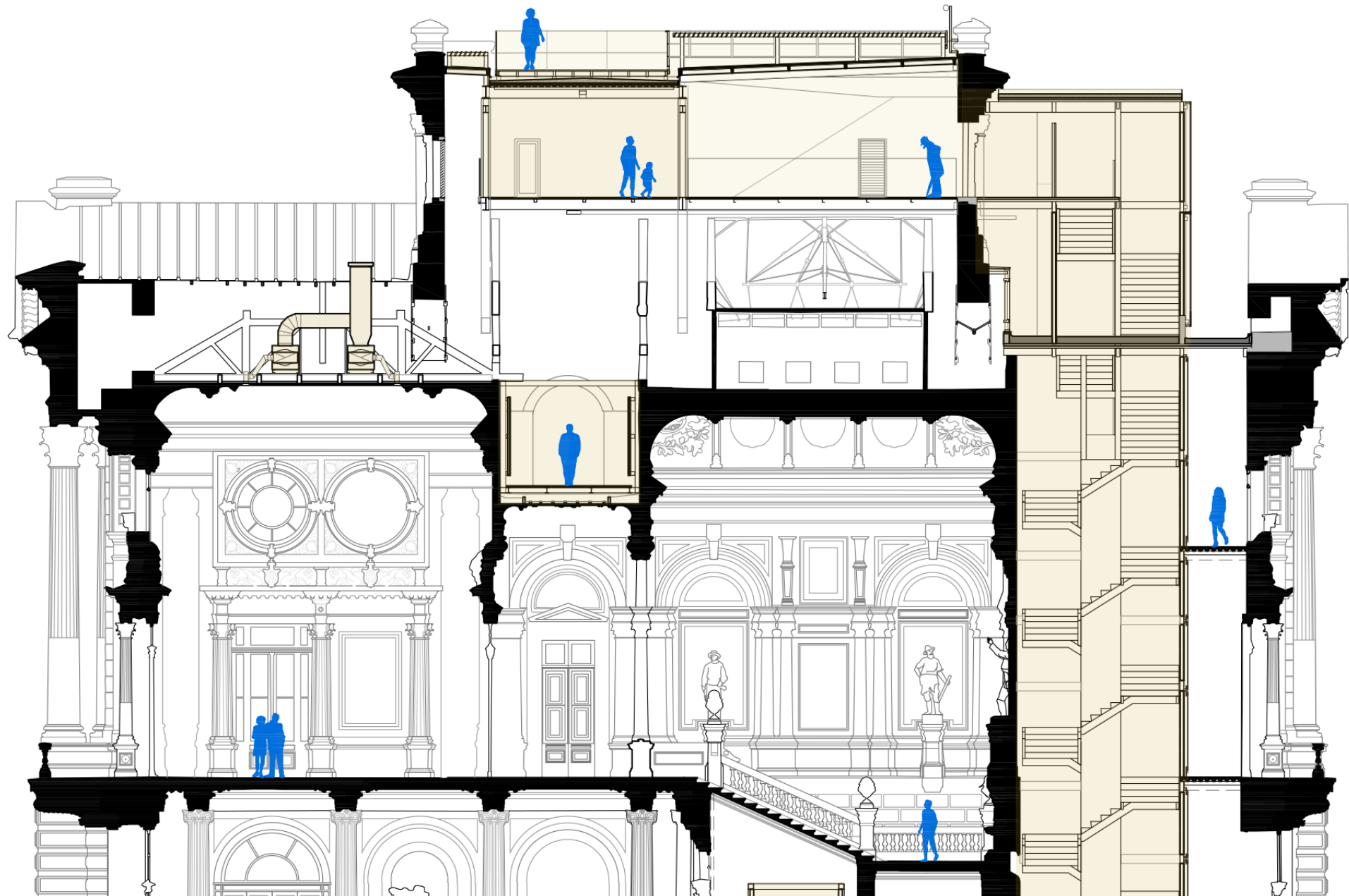












MIRANTE



