Preliminary structural analysis

<u>Objective:</u>

- design of the load-bearing structure (shape and supporting) + basic check
- design and verify dimensions of all load-bearing elements = the most loaded elements

Preliminary structural analysis

Cooperation with other designers and architect and provider

Outputs:

- **drawing of the layout of load-bearing structures**

Preliminary structural analysis

- Idealisation of the structure - simplifications.
- Effects of loads (M, N, V) – estimation.

Preliminary structural analysis

Procedure:

- from beard to bearing structures

Cast-in-place (in- situ, monolitic) structures – beams, slabs

1. design of dimensions – empirical formulas
2. load
3. effect of loads of the most loaded member
4. check of the load-bearing capacity in bending: Check of the depth of compressed zone x/d, reinforcement ratio ρ
5. check of the load-bearing capacity in shear :

   for beams – check of resistance $V_{Rd,max}$

   for slabs supported on columns (punching) – check of resistance $v_{Rd,max}$
6. check of SLS (deflection: l/d)

   Very thin members may require detailed calculation of deflection and crack width in prelim. design

1

GIRDERS		depth	width
simply supported and continuous beams			
	conventional	(1/15 - 1/8) *l*	(0,33-0,4) *h*
	roof	(1/17 - 1/12) *l*	(0,33-0,4) *h*
cantilever beams			
	conventional	1/5 *l*	(0,33-0,4) *h*
	roof	1/10 *l*	(0,33-0,4) *h*

- Check:
  - ULS
  - SLS

Deflection control

$$\lambda = l/d$$

<u>Important for slabs</u>

2

Loads of the slab

	characteristic kN/m^2	γ_F	design kN/m^2
Permanent			
floor	3,13		
self weight of the slab 0,16m . $25kN/m^3$	4,00		
Permanent load	g_k = 7,13	1,35	g_d = 9,63
Variable load	q_k = 4,5	1,5	q_d = 6,75
Total	$(g+q)_k$ = 11,63		$(g+q)_d$ = 16,38

Estimation is possible, if the proper values are not known yet.

2

Load of a beam

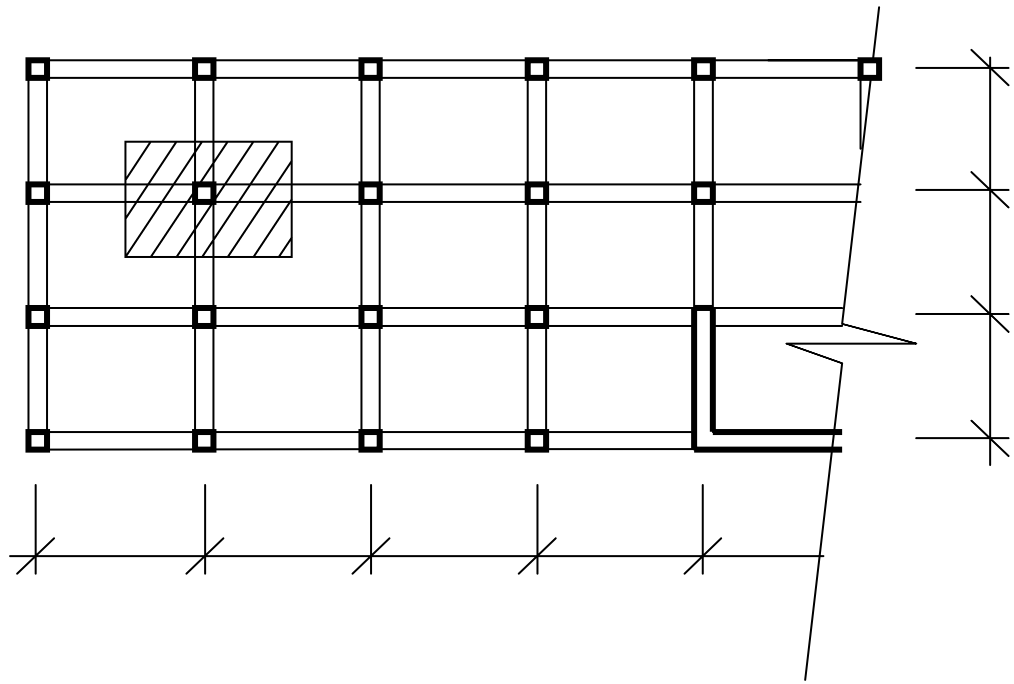
tributing sripe 4m

UDL

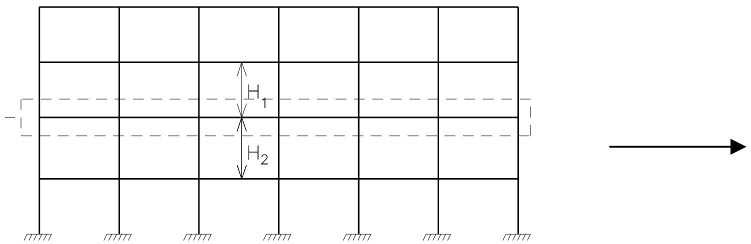
		characteristic kN/m	γ_F	design kN/m
Permanent				
load from the slab	4m . 7,13 kN/m^2	46,52		
self weight of the beam	0,25m . 0,5m . 25kN/m^3	3,13		
Permanent load		g_k = 49,65	1,35	g_d = 67,03
Variable load				
Variable from the slab	4m . 4,5 kN/m^2	q_k = 18	1,5	q_d = 27
Total		$(g+q)_k$ = 46,47		$(g+q)_d$ = 94,03

2

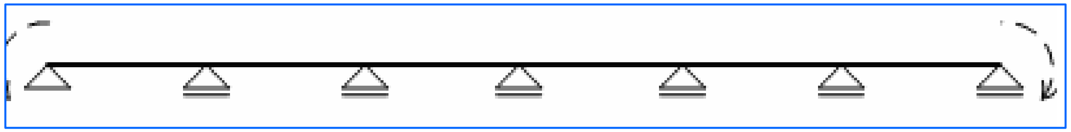
Load for column



3



$$M = (1/10 \text{ resp. } 1/12)\, fl^2$$



- **Load from slabs supported on 4 sides – re-calculate: UDL.**
- **Usually only 1 load case**

4 check of the load-bearing capacity in bending

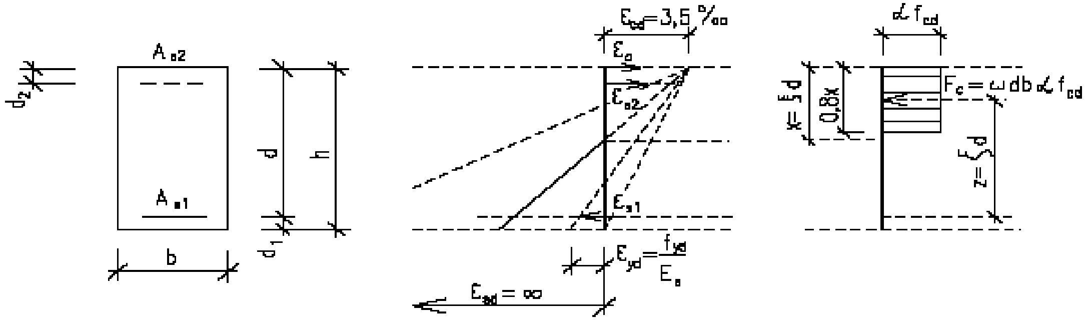
= verifying that the dimensions of the member are sufficient and the reinforcement could be later designed.

It is not necessary to design number and diameter of bars; check may be performed with help of tables of required area of reinforcement $A_{s,req}$

$\xi \leq \xi_{max}$

event. calculate ρ

With tables: max $M_{Ed} \rightarrow \mu \rightarrow \xi \leq \xi_{max}$



$$\mu = \frac{M}{b\,d^2\,\alpha\,f_{cd}}$$

$$\omega = \frac{F_c}{b\,d\,\alpha\,f_{cd}}$$

$$\zeta = \frac{z}{d} \qquad \xi = \frac{x}{d}$$

μ	ω	ξ	ζ	εs1	εc	εs2 pro d2/d 0,05	0,1	0,15	0,2
0.010	0.0101	0.013	0.995	275.093	-3.500	10.430	24.359	38.289	52.219
0,020	0,0202	0,025	0,990	135,086	-3,500	3,429	10,359	17,288	24,217
0,030	0,0305	0,038	0,985	88,412	-3,500	1,096	5,691	10,287	14,882
0,040	0,0408	0,051	0,980	65,071	-3,500	-0,071	3,357	6,786	10,214
0,050	0,0513	0,064	0,974	51,063	[illegible]	[illegible]	[illegible]	[illegible]	7,413
0,060	0,0619	0,077	0,969	41,722	[illegible]	[illegible]	[illegible]	[illegible]	5,544
0,070	0,0726	0,091	0,964	35,047	[illegible]	[illegible]	[illegible]	[illegible]	4,209
0,080	0,0835	0,104	0,958	30,039	[illegible]	[illegible]	[illegible]	[illegible]	3,208
0,090	0,0945	0,118	0,953	26,142	[illegible]	[illegible]	[illegible]	[illegible]	2,428
0,100	0,1056	0,132	0,947	23,022	[illegible]	[illegible]	[illegible]	[illegible]	1,804
0,110	0,117	0,146	0,942	20,468	-3,500	-2,302	-1,103	0,095	1,294
0,120	0,128	0,160	0,936	18,337	-3,500	-2,408	-1,316	-0,224	0,867
0,130	0,140	0,175	0,930	16,533	-3,500	-2,498	-1,497	-0,495	0,507
0,140	0,151	0,189	0,924	14,985	-3,500	-2,576	-1,651	-0,727	0,197
0,150	0,163	0,204	0,918	13,642	-3,500	-2,643	-1,786	-0,929	-0,072

$\xi \leq$ …….

Without table:

max $M_{Ed} \rightarrow$ design of reinforcement (estimate $z \rightarrow A_{s,req} \rightarrow x \rightarrow \xi \leq \xi_{max}$, event check of ρ)

Alternatively:

ξ_{opt} = 0,25-0,3 (for beam) → from the table: *μ* →

d = √..... → *h*

$$\mu = \frac{M}{b\, d^2\, \alpha\, f_{cd}}$$

4 check of the load-bearing capacity in shear

= check of „compressed diagonals“

$$\max V_{Ed} \leq V_{Rd,max}$$

6 Check of SLS

deflection – important especially for slabs

$$l / d \leq \lambda_{\mathrm{lim}}$$

Cast-in-place (in- situ, monolithic) structures – columns

Moments are usually neglected and the member is designed just with respect to compressive force.

Assumption: ρ = 1,5 ~ 2%

Very slender columns or combination of N and high M – calculation with respect to N+M

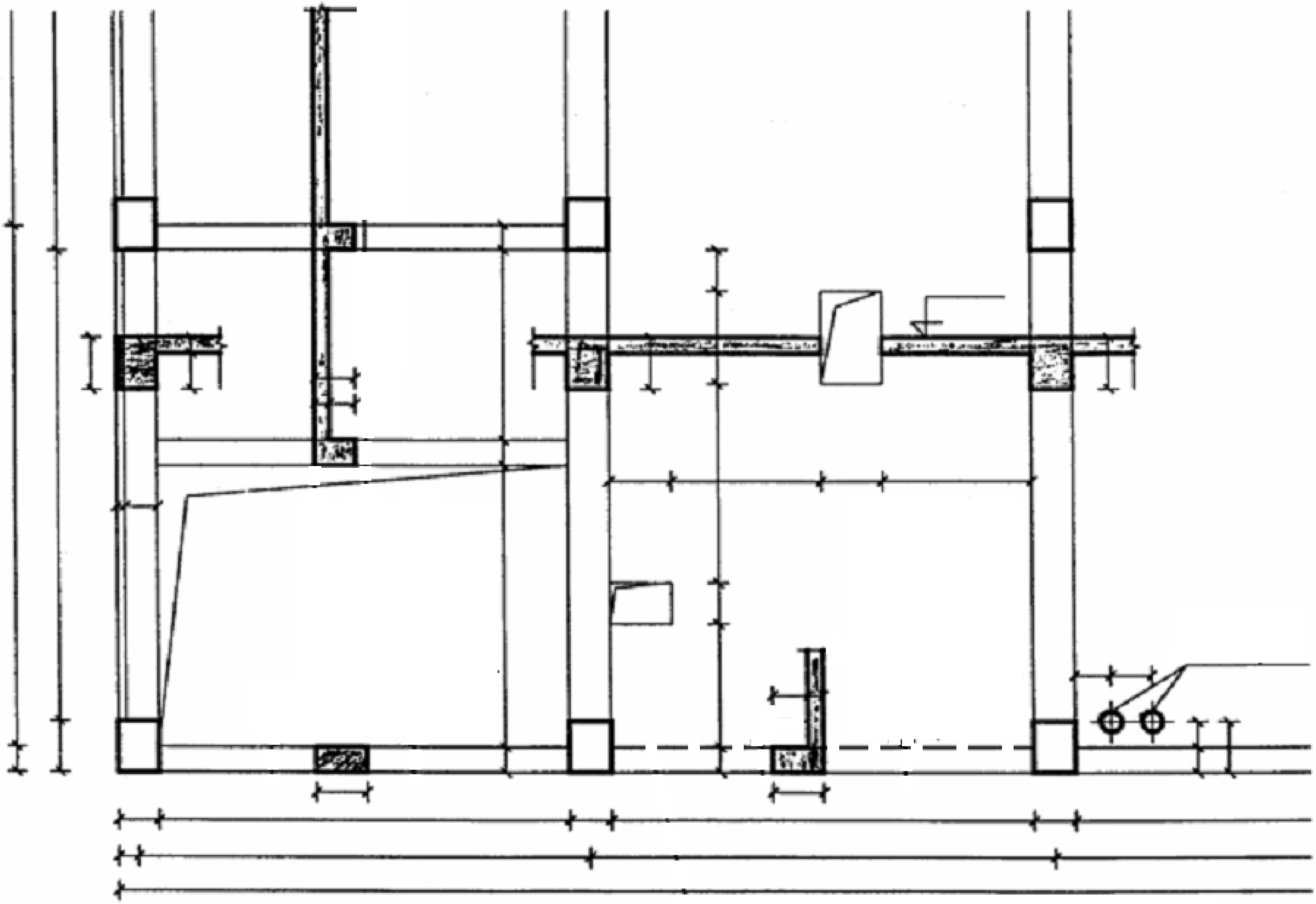
Structural analysis form

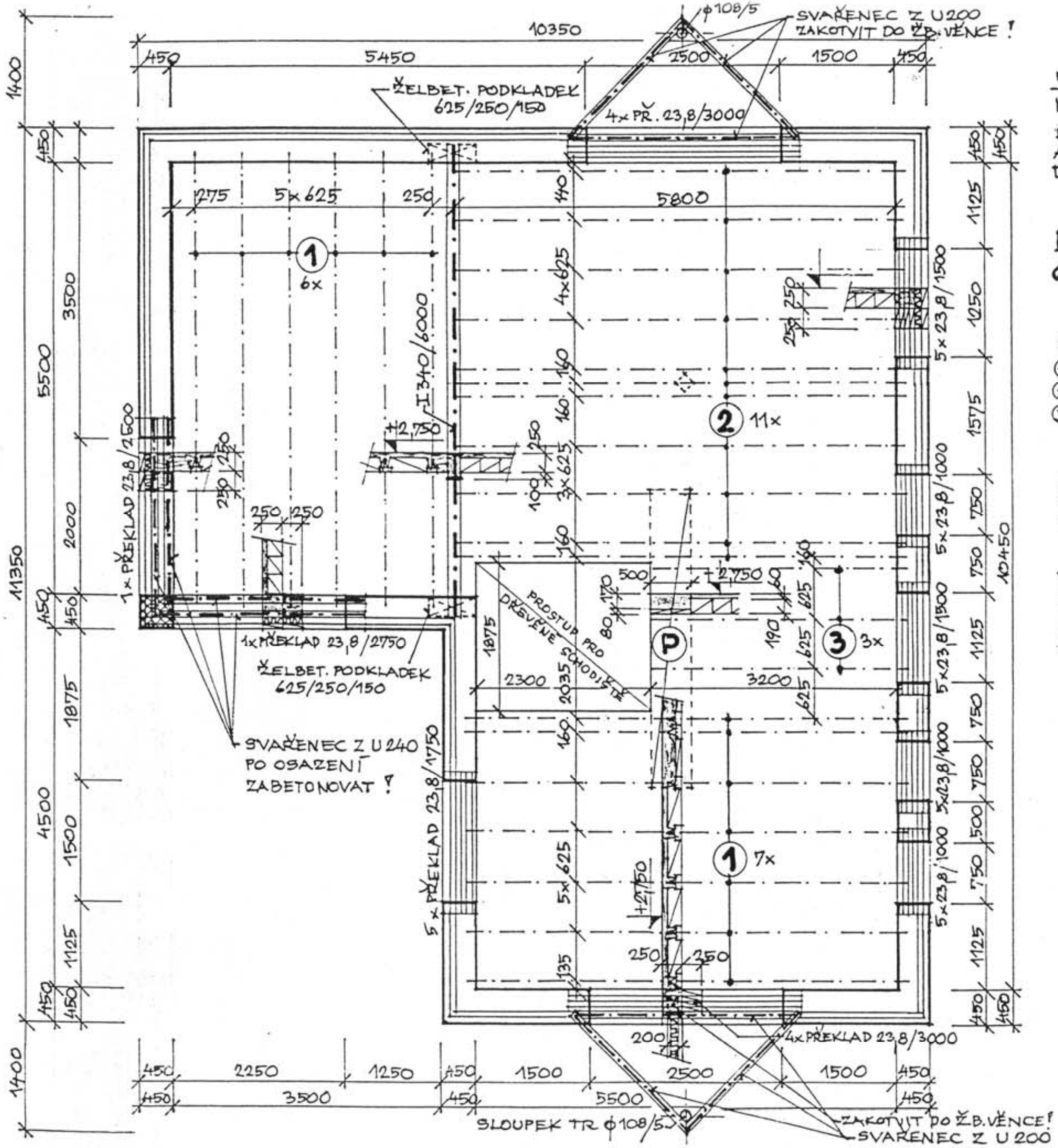
well-arranged, logical, legible

- use one side of the sheet of paper only
- number of pages –
- all calculations in the analysis, notes, explanations
- formula – introduction – result
- units
- sketches, figures
- state Code used for analysis

Drawing of the layout of load-bearing structure

- drawings of general arrangement
- assembly drawings





UPOZORNĚNÍ:

NEDÍLNOU SOUČÁSTÍ VÝKRESU JE „PODKLAD PRO NAVRHOVÁNÍ POROTHERM“ A STATICKÝ VÝPOČET S KONSTRUKČNÍMI DETAILY A SCHÉMATY !

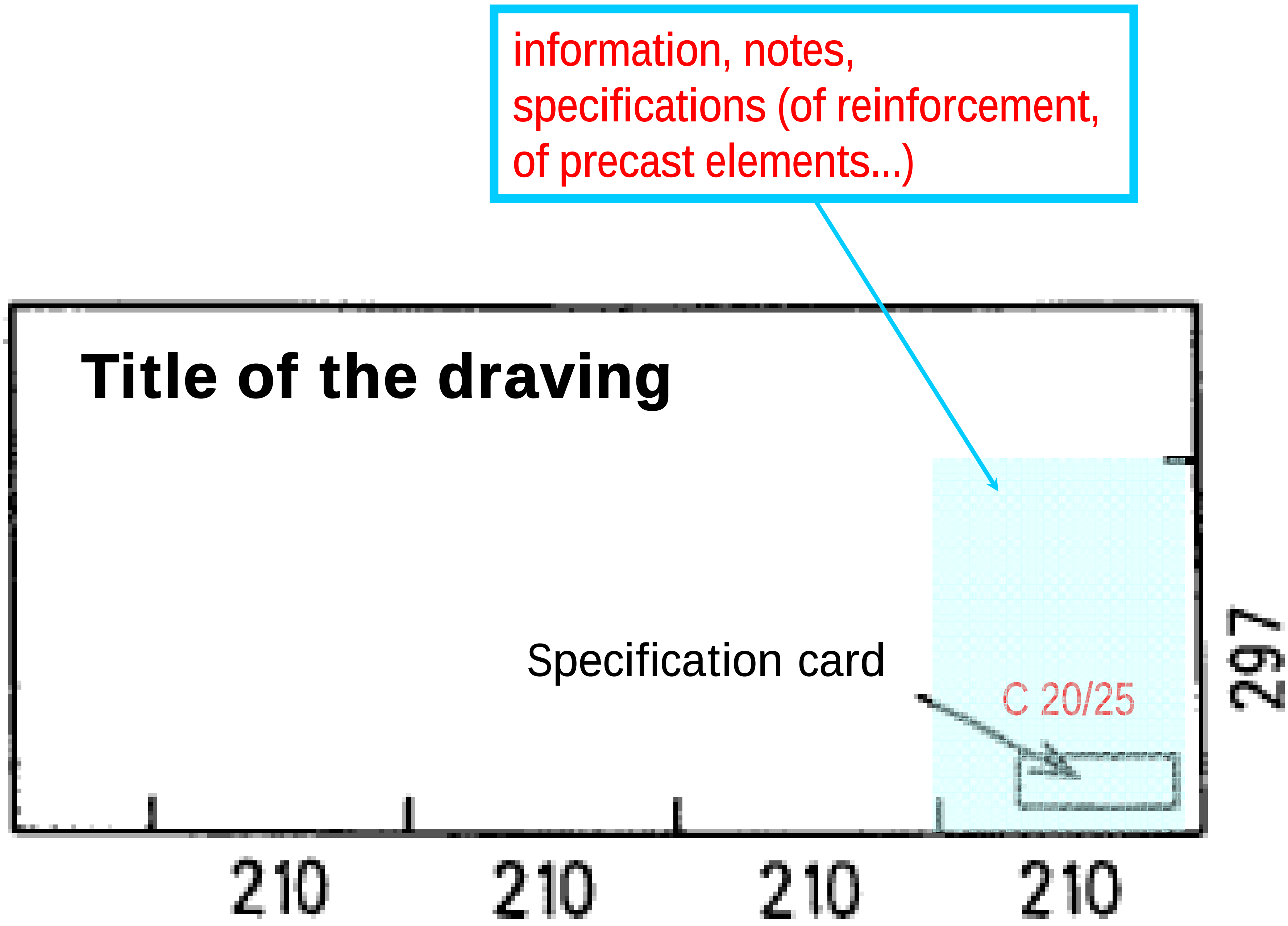
BETON C16/20
OCEL 10505 (ϕR)

STROPNÍ NOSNÍKY :
① POT 575/902 , KS 13
② POT 625/902 , KS 11
③ POT 350/902 , KS 3

STROPNÍ VLOŽKY :
MIAKO 19/62,5 PTH , KS 410
MIAKO 8/62,5 PTH , KS 10

ZDIVO POROTHERM 44 P+D, P10 + MVC 5

ZDIVO CP (290/140/65), P15 + MC10


information, notes,
specifications (of reinforcement,
of precast elements...)
Title of the draving
Specification card
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