

		[mm ²]	[mm]	[mm ³]	[mm ⁴]	[mm ⁴]
č.	ROZMERY	A	z	A·z	I _{yi}	I _{zi}
1		84,10 ²	150	12,6·10 ⁶	630,10 ⁶	548,7·10 ⁶
2		-21,6·10 ²	80	-1,72·10 ⁶	-69,2·10 ⁶	-9,72·10 ⁶
Σ		62,4·10 ³	174,2	10,87·10 ⁶	560,88·10 ⁶	539,1·10 ⁶

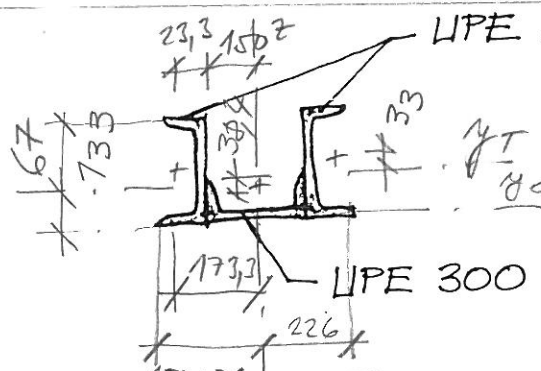
$$I_y = 560,88 \cdot 10^6 + 84,10^3 \cdot 24,2^2 - 21,6 \cdot 10^3 \cdot 94^2 = \underline{419,2 \cdot 10^6 \text{ mm}^4}$$

$$I_z = 539,1 \cdot 10^6 - 21,6 \cdot 10^3 \cdot 110^2 = \underline{247,44 \cdot 10^6 \text{ mm}^4}$$

$$W_{yH} = \frac{419,2 \cdot 10^6}{174,2} = 2406,5 \cdot 10^3 \text{ mm}^3 \quad i_y = \sqrt{\frac{419,2 \cdot 10^6}{62,4 \cdot 10^3}} = 81,9 \text{ mm}$$

$$W_{yD} = \frac{419,2 \cdot 10^6}{125,8} = 3332,2 \cdot 10^3 \text{ mm}^3$$

$$W_z = \frac{277,74 \cdot 10^6}{140} = 1983,9 \cdot 10^3 \text{ mm}^3 \quad i_z = \sqrt{\frac{277,74 \cdot 10^6}{62,4 \cdot 10^3}} = 66,7 \text{ mm}$$



	VEDROTKY	mm ²	mm	mm ³	mm ⁴	mm ⁴
č.	ROZMERY	A	z	A·z	I _{yi}	I _{zi}
1	UPE 300	4070	28,6	116,4·10 ³	4,03·10 ⁶	58,7·10 ⁶
2	2x UPE 200	2x 2350	100	470·10 ³	2x 15,4·10 ⁶	2x 1,37·10 ⁶
Σ		8770	66,9	586,402·10 ³	19,43·10 ⁶	61,44·10 ⁶

$$i_y = \sqrt{\frac{30,55 \cdot 10^6}{8770}} = 59 \text{ mm}$$

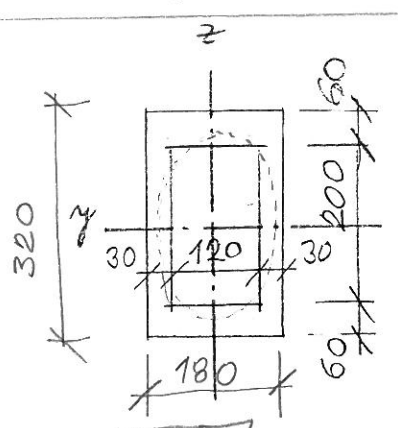
$$i_z = \sqrt{\frac{202,6 \cdot 10^6}{8770}} = 152 \text{ mm}$$

$$I_y = 19,43 \cdot 10^6 + 4070 \cdot 38,4^2 + 2 \cdot 2350 \cdot 33^2 = \underline{30,55 \cdot 10^6 \text{ mm}^4}$$

$$I_z = 61,44 \cdot 10^6 + 2 \cdot 2350 \cdot 173,3^2 = \underline{202,6 \cdot 10^6 \text{ mm}^4}$$

$$W_{yH} = \frac{30,55 \cdot 10^6}{133} = 229,7 \cdot 10^3 \text{ mm}^3 \quad W_z = \frac{202,6 \cdot 10^6}{226} = 896,5 \cdot 10^3 \text{ mm}^3$$

$$W_{yD} = \frac{30,55 \cdot 10^6}{67} = 456 \cdot 10^3 \text{ mm}^3$$



$$A = 33600 \text{ mm}^2$$

$$I_y = \frac{1}{12} (180 \cdot 320^3 - 120 \cdot 200^3) = \underline{411,5 \cdot 10^6 \text{ mm}^4}$$

$$I_z = \frac{1}{12} (180^3 \cdot 320 - 120^3 \cdot 200) = \underline{126,7 \cdot 10^6 \text{ mm}^4}$$

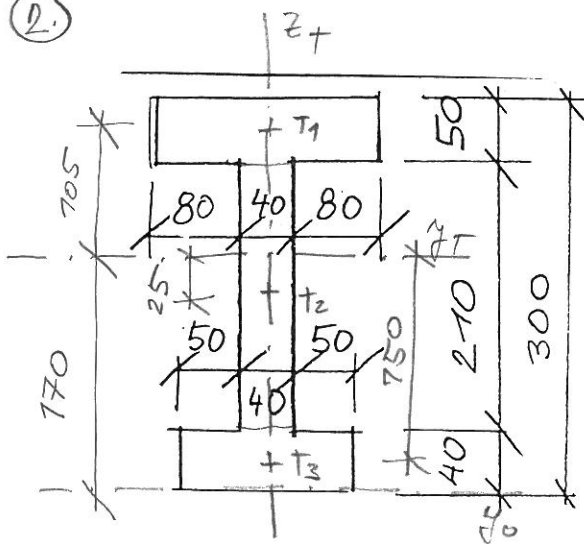
$$W_y = \frac{411,5 \cdot 10^6}{160} = 2571,8 \cdot 10^3 \text{ mm}^3$$

$$W_z = \frac{126,7 \cdot 10^6}{90} = 1407,7 \cdot 10^3 \text{ mm}^3$$

$$i_y = \sqrt{\frac{411,5 \cdot 10^6}{33600}} = 110,7 \text{ mm}$$

$$i_z = \sqrt{\frac{126,7 \cdot 10^6}{33600}} = 61,4 \text{ mm}$$

2.



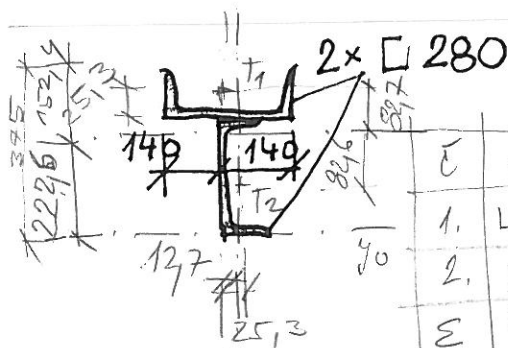
	mm	mm ²	mm	mm ³	mm ⁴	mm ⁴
i	OBJ.	A	z	A·z	I _{yi}	I _{zi}
1		10·10 ³	275	275·10 ³	$\frac{1}{12} \cdot 200 \cdot 50^3 = 20833 \cdot 10^6$	$\frac{1}{12} \cdot 200^3 \cdot 50 = 33,37 \cdot 10^6$
2		8,4·10 ³	145	1218·10 ³	$\frac{1}{12} \cdot 40 \cdot 210^3 = 30,87 \cdot 10^6$	$\frac{1}{12} \cdot 40^3 \cdot 210 = 1,12 \cdot 10^6$
3		5,6·10 ³	20	112·10 ³	$\frac{1}{12} \cdot 160 \cdot 40^3 = 0,746 \cdot 10^6$	$\frac{1}{12} \cdot 160^3 \cdot 40 = 9,146 \cdot 10^6$
Σ		24·10 ³	170	408·10 ³	33,7·10 ⁶	43,6·10 ⁶

$$I_y = 33,7 \cdot 10^6 + 10 \cdot 10^3 \cdot 105^2 + 8,4 \cdot 10^3 \cdot 25^2 + 5,6 \cdot 10^3 \cdot 150^2 = \frac{2752,10^6}{\text{mm}^4}$$

$$W_{y_k} = \frac{2752,10^6}{130} = 2116,9 \cdot 10^3 \text{ mm}^3 \quad i_y = \sqrt{\frac{2752,10^6}{24 \cdot 10^3}} = 107,1 \text{ mm}$$

$$W_{y_d} = \frac{2752,10^6}{170} = 1618,8 \cdot 10^3 \text{ mm}^3$$

$$W_z = \frac{43,6 \cdot 10^6}{100} = 436 \cdot 10^3 \text{ mm}^3 \quad i_z = \sqrt{\frac{43,6 \cdot 10^6}{24 \cdot 10^3}} = 48,6 \text{ mm}$$



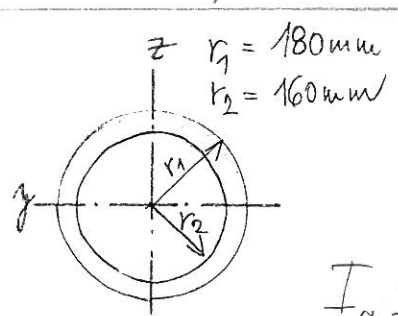
	OBJ.	mm ²	SOVĚZ. mm	mm	mm ³	mm ³	mm ⁴	mm ⁴
i	OBJ.	A	y	z	A·y	A·z	I _{yi}	I _{zi}
1.		5340	0	305,3	0	163·10 ⁴	3,98·10 ⁶	62,8·10 ⁶
2.		5340	25,3	140	13,57·10 ⁴	44,76·10 ⁴	62,8·10 ⁶	3,98·10 ⁶
Σ		10680	12,7	222,6	13,57·10 ⁴	237,76·10 ⁴	66,48·10 ⁶	66,48·10 ⁶

$$I_{z0} I_y = 66,48 \cdot 10^6 + 5340 \cdot 82,7^2 + 5340 \cdot 82,6^2 = 1397,10^6 \text{ mm}^4$$

$$I_z = 66,48 \cdot 10^6 + 5340 \cdot 12,7^2 + 5340 \cdot 12,6^2 = 68,49 \cdot 10^6 \text{ mm}^4$$

$$W_{y_k} = \frac{139,7 \cdot 10^6}{152,4} = 916,6 \cdot 10^3 \text{ mm}^3 \quad W_{z_e} = \frac{68,49 \cdot 10^6}{127,7} = 4485 \cdot 10^3 \text{ mm}^3$$

$$W_{y_d} = \frac{139,7 \cdot 10^6}{222,6} = 624,58 \cdot 10^3 \text{ mm}^3 \quad W_{z_p} = \frac{68,49 \cdot 10^6}{127,3} = 538 \cdot 10^3 \text{ mm}^3$$



$$i_y = \sqrt{\frac{139,7 \cdot 10^6}{10680}} = 114,37 \text{ mm}$$

$$i_z = \sqrt{\frac{68,49 \cdot 10^6}{10680}} = 80,1 \text{ mm}$$

$$I_{y,z} = \frac{\pi}{64} \cdot (360^4 - 320^4) = 309,6 \cdot 10^6 \text{ mm}^4$$

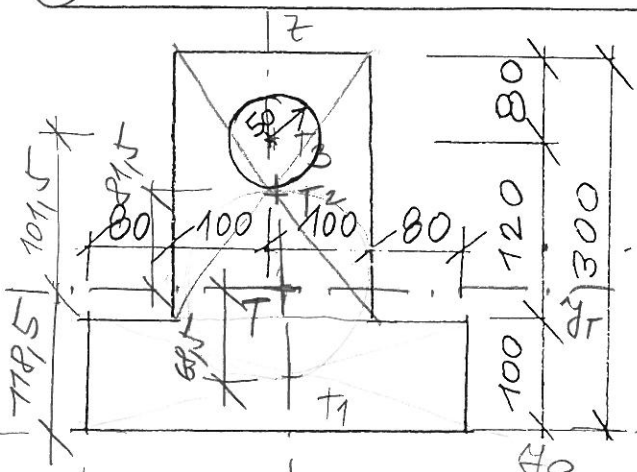
$$W_{y,z} = \frac{309,6 \cdot 10^6}{180} = 1720 \cdot 10^3 \text{ mm}^3$$

$$A = \frac{\pi \cdot 360^2}{4} - \frac{\pi \cdot 320^2}{4}$$

$$A = 21352 \text{ mm}^2$$

$$i_{y,z} = \sqrt{\frac{309,6 \cdot 10^6}{21352}} = 120,4 \text{ mm}$$

3)



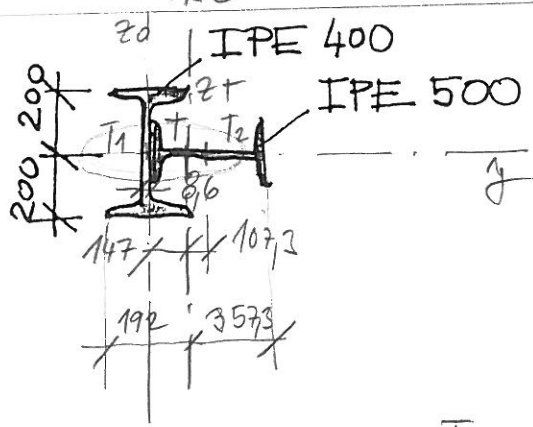
	mm	mm ²	mm	mm ²	mm ⁴	mm ⁴
z	OBR ₁	A	z	A·z	I _{yi}	I _{zi}
1,		36·10 ³	50	1800·10 ³	$\frac{1}{12} 360 \cdot 100^3$	$\frac{1}{12} 360 \cdot 100$
2,		40·10 ³	200	8000·10 ³	$\frac{1}{12} 200^4$	$\frac{1}{12} 200^4$
③		-7,8 ^{10³}	220	-1727,6 ⁵	$-\frac{\pi \cdot 100^4}{64}$	$-\frac{\pi \cdot 100^4}{4}$
Σ		68,15 ^{10³}	118,5	8043,10 ³	15843,10 ⁶	517,2,10 ⁶

$I_y = 15843,10^6 + 36 \cdot 10^3 \cdot 68,15^2 + 40 \cdot 10^3 \cdot 81,5^2 - 4850 \cdot 101,5^2$
 $I_y = 5121,10^6 \text{ mm}^4$

$W_{yk} = \frac{5121,10^6}{181,5} = 2821,5 \cdot 10^3 \text{ mm}^3$
 $W_{yd} = \frac{5121,10^6}{118,5} = 4321,5 \cdot 10^3 \text{ mm}^3$
 $W_z = \frac{517,2,10^6}{180} = 2873,10^3 \text{ mm}^3$

$i_y = \sqrt{\frac{5121,10^6}{68,15,10^3}} = 86,4 \text{ mm}$

$i_z = \sqrt{\frac{517,2,10^6}{68,15,10^3}} = 87,1 \text{ mm}$



	mm ²	mm	mm ³	mm ⁴	mm ⁴	
z	OBR ₁	A	y	A·y	I _{yi}	I _{zi}
1	IPE 400	8450	0	0	231,10 ⁶	13,2,10 ⁶
2	IPE 500	11600	254,3	294,9910 ⁴	21,4,10 ⁶	482,10 ⁶
Σ	I+I	20050	147	-	252,4,10 ⁶	495,2,10 ⁶

$I_z = 495,2,10^6 + 8450 \cdot 147^2 + 11600 \cdot 107,3^2 = 811,3,10^6 \text{ mm}^4$

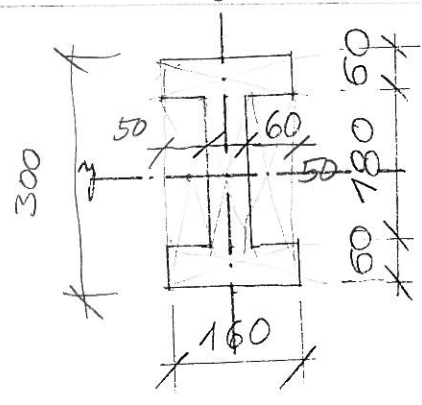
$i_y = \sqrt{\frac{252,4,10^6}{2005,10^3}} = 112 \text{ mm}$

$W_y = \frac{252,4,10^6}{200} = 1262,10^3 \text{ mm}^3$

$W_{ze} = \frac{811,3,10^6}{192} = 4225,5,10^3 \text{ mm}^3$

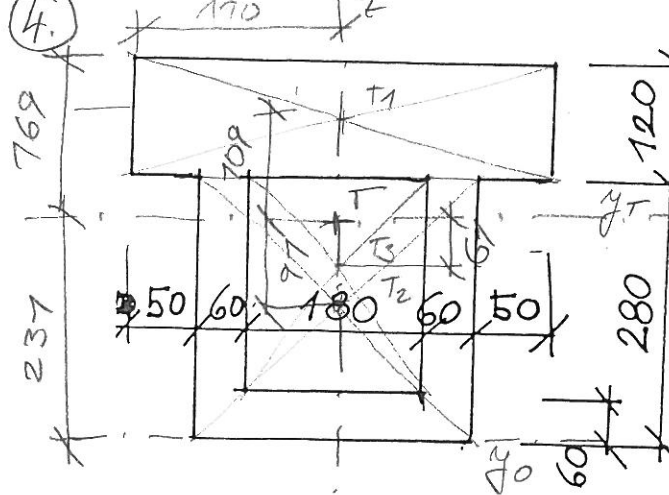
$W_{zp} = \frac{811,3,10^6}{357,3} = 2270,6,10^3 \text{ mm}^3$

$i_z = \sqrt{\frac{811,3,10^6}{2005,10^3}} = 201 \text{ mm}$



$A = 19800 \text{ mm}^2$
 $I_y = \frac{1}{12} (160 \cdot 300^3 - 2 \cdot 50 \cdot 180^3) = 311,4,10^6 \text{ mm}^4$
 $I_z = \frac{1}{12} (2 \cdot 160^3 \cdot 60 + 60^3 \cdot 180) = 44,2,10^6 \text{ mm}^4$
 $W_y = \frac{311,4,10^6}{150} = 2076,10^3 \text{ mm}^3$
 $W_z = \frac{44,2,10^6}{80} = 552,5,10^3 \text{ mm}^3$
 $i_y = \sqrt{\frac{311,4,10^6}{19800}} = 125,3 \text{ mm}$
 $i_z = \sqrt{\frac{44,2,10^6}{19800}} = 47,2 \text{ mm}$

4.



	mm ²	mm	mm ²	mm ⁴	mm ⁴
OBJ.	A	z	A · z	I _{y_i}	I _{z_i}
1	48 · 10 ³	340	1632 · 10 ³	$\frac{1}{12} \cdot 400 \cdot 120^3$	$\frac{1}{12} \cdot 400^3 \cdot 120$
2	84 · 10 ³	140	1176 · 10 ³	$\frac{1}{12} \cdot 300 \cdot 280^3$	$\frac{1}{12} \cdot 300^3 \cdot 280$
3	-39,6	170	-6732	$\frac{1}{12} \cdot 180 \cdot 220^3$	$\frac{1}{12} \cdot 180^3 \cdot 220$
Σ	924 · 10 ³	231	2134,8 · 10 ³	446,7 · 10 ⁶	1163 · 10 ⁶

$$I_y = 446,7 \cdot 10^6 + 48 \cdot 10^3 \cdot 109^2 + 84 \cdot 10^3 \cdot 91^2 - 39,6 \cdot 10^3 \cdot 61^2$$

$$I_y = 1565,24 \cdot 10^6 \text{ mm}^4$$

$$W_{y,sk} = \frac{1565,24 \cdot 10^6}{169} = 9261,8 \cdot 10^3 \text{ mm}^3$$

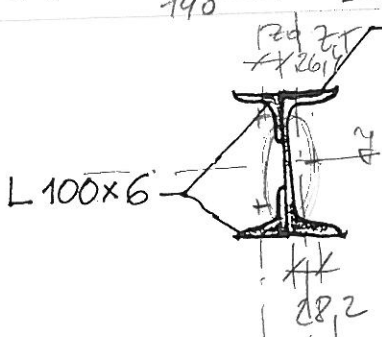
$$i_y = \sqrt{\frac{1565,24 \cdot 10^6}{924 \cdot 10^3}} = 130,1 \text{ mm}$$

$$W_{y,d} = \frac{1565,24 \cdot 10^6}{231} = 6746 \cdot 10^3 \text{ mm}^3$$

$$i_z = \sqrt{\frac{1163 \cdot 10^6}{924 \cdot 10^3}} = 112,2 \text{ mm}$$

$$W_z = \frac{1163 \cdot 10^6}{190} = 6121 \cdot 10^3 \text{ mm}^3$$

LPE 270

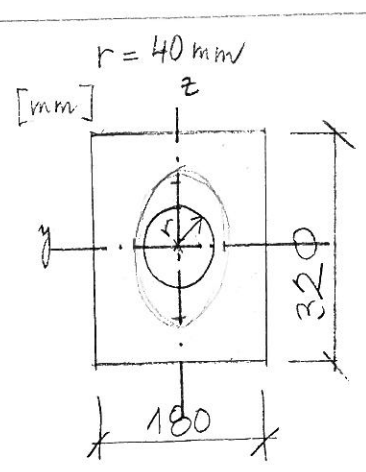


	mm	mm	mm ²	mm ⁴	mm ⁴	
z	A	y	A · y	I _y	I _z	
1	UPE 270	3540	54,6	19,35 · 10 ⁴	421 · 10 ⁶	3,22 · 10 ⁶
2	2x 100/6	2x 1180	0	-	2x 1,11 · 10 ⁶	1,11 · 10 ⁶ · 2
Σ	I	5900	32,8	19,33 · 10 ⁴	44,32 · 10 ⁶	5,44 · 10 ⁶

$$I_z = 5,44 \cdot 10^6 + 3540 \cdot 21,8^2 + 2 \cdot 1180 \cdot 32,8^2 = 9,66 \cdot 10^6 \text{ mm}^4$$

$$W_y = \frac{44,32 \cdot 10^6}{135} = 328,3 \cdot 10^3 \text{ mm}^3 \quad i_y = \sqrt{\frac{44,32 \cdot 10^6}{5900}} = 86,7 \text{ mm}$$

$$W_{zL} = \frac{9,66 \cdot 10^6}{106,4} = 90,8 \cdot 10^3 \text{ mm}^3 \quad W_{zP} = \frac{9,66 \cdot 10^6}{88,6} = 109 \cdot 10^3 \text{ mm}^3 \quad i_z = \sqrt{\frac{9,66 \cdot 10^6}{5900}} = 40,5 \text{ mm}$$



$$A = 180 \cdot 180 - \frac{\pi \cdot 80^2}{4} = 52576 \text{ mm}^2$$

$$I_y = \frac{1}{12} \cdot 180 \cdot 180^3 - \frac{\pi \cdot 80^4}{64} = 489,51 \cdot 10^6 \text{ mm}^4$$

$$I_z = \frac{1}{12} \cdot 180^3 \cdot 180 - \frac{\pi \cdot 80^4}{64} = 153,51 \cdot 10^6 \text{ mm}^4$$

$$W_y = \frac{489,51 \cdot 10^6}{160} = 3059,4 \cdot 10^3 \text{ mm}^3$$

$$W_z = \frac{153,51 \cdot 10^6}{90} = 1705,6 \cdot 10^3 \text{ mm}^3$$

$$i_y = \sqrt{\frac{489,51 \cdot 10^6}{52576}} = 96,5 \text{ mm} \quad i_z = \sqrt{\frac{153,51 \cdot 10^6}{52576}} = 54 \text{ mm}$$