Parts and Assemblies Engineering Lab 2

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Varient №: 5
Unit System: Si unit (mm)

1. Task variant and Maximum Tensile Load

Type of stringers: **420069**
P, N: **2700**

$P_{max\_str} = 35100\,\text{N}$

Dimensions:

Type	Dimensions, $[mm]$					Cross-section area, $[mm^2]$
420069	H	B	S	S1	R	82
	20	30	1.5	2.0	2.0	

2. Materials of stringers, pad and skin

Material	Ultimate tensile strength σ_B, MPa	Proof strength σ_{02}, MPa	Shear strength* τ_B, τ_{02} (% of tensile strength)	Modulus of elasticity E, GPa	Shear modulus G, GPa	Density, ρ g/cm^3
30ХГСА	1100	850	63	210	78	7,85
Д16Т	450	300	50	72	28	2,8
ВТ20	1000	910	50	110	44	4,5

* - ultimate shear strength and proof strength are approximated by taking the denoted percentage of tensile ultimate and proof strength respectively

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In this task I choose the **BT20** as the materials of stringers, pad and skin.

3. Diameter of rivet

$d_{rivet} = 2\sqrt{t_{str} + t_{skin} + t_{pad}} = 2\sqrt{1.5 + 1.5 + 1.5} = 4.243 \rightarrow 5$ mm

4. Tensile Stress

$\sigma = P_{max\_str}/A_{str\_without\_rivet} = 35100/(82 - 5 \cdot 1.5) = 471.14$ MPa.
$[\sigma] = 0.8 \cdot \sigma_{B,str} = 0.8 \cdot 1000 = 800$ MPa.

$\sigma \leq [\sigma]$ is **True**.

5. Coefficient of safety

$\eta = [\sigma]/\sigma = 1.7$

6. Requirable Number of Rivets

According to OST 1 34104-80, the rivet shear force for double-sided riveting made of steel 12X18H9T with a diameter of 5 mm is 9810 N.

$n_{rivet} = P_{max\_str}/P_{max\_riv} = 35100/9810 = 3.58$

To increase the margin of safety, we choose the number of rivets n = 5.

7. Bearing Stringer

$\sigma = P_{max\_riv}/(d_{rivet} \cdot t_{str}) = 9810/(5 \cdot 1.5) = 1308$ MPa $\leq 1.5\sigma_{B,str} = 1500$ MPa.

8. Coefficient of safety

$\eta = [\sigma]/\sigma_{bearing} = 1500/1308 = 1.15$

9. Edge Distance

$2 \cdot d_{rivet} = 10$ mm
$2 \cdot d_{rivet} + 2 = 12$ mm

Set the edge distance $a = 12$ mm.

10. Actual shear stress

$\tau_{act} = \frac{P_{max\_riv}}{2at_{str}} = \frac{9810}{2 \cdot 12 \cdot 1.5} = 272.5$ MPa $< \tau_B = 500$ MPa.

11. Analysis of Pad

$\sigma_{bearing,pad} = \frac{P_{max\_riv}}{d_{rivet} \cdot t_{str}} = 9810/(5 \cdot 1.5) = 1308$ MPa $\leq 1.5\sigma_{B,pad} = 1500$ MPa.

12. Tension Failure of A-A

$b_{min,A-A} = \frac{k \cdot P_{max\_riv}}{t_{pad} \cdot \sigma_{B\_pad}} + n_{rivet,A-A} \cdot d_{rivet} = \frac{1.2 \cdot 9810}{1.5 \cdot 1000} + 1 \cdot 5 = 12.85$ mm.

$\sigma_{A-A} = P_{str}/[t_{pad} \cdot (b_{min} - n_{rivet,A-A} \cdot d_{rivet})] = 596.18$ MPa $\leq [\sigma]_{bear} = 1500$ MPa.

However, due to that the overlay should not be narrower than the stringer, which is 30 mm in width, the value is rounded to $b_{A-A} = 32$ mm.

13. Tension Failure of B-B

$b_{min,B-B} = \frac{k \cdot P_{max\_riv}}{t_{pad} \cdot \sigma_{B\_pad}} + n_{rivet,B-B} \cdot d_{rivet} = \frac{1.2 \cdot 9810}{1.5 \cdot 1000} + 1 \cdot 5 = 12.85$ mm.

$\sigma_{B-B} = P_{str}/[t_{pad} \cdot (b_{min} - n_{rivet,B-B} \cdot d_{rivet})] = 2675.16$ MPa $> [\sigma]_{bear} = 1500$ MPa.

The value is rounded to $b_{B-B} = 35$ mm so that $\sigma_{B-B} = 700$ MPa is less than $[\sigma]_{bear}$.

14. Length of the rivet

$t_{stringer\_skin} = t_{str} + t_{skin} = 1.5 + 1.5 = 3$ mm.
$t_{total} = t_{str} + t_{skin} + t_{pad} = 1.5 + 1.5 + 1.5 = 4.5$ mm.

Типо-размер	d	S	h	D	L	L1
1	3.5	От 2,0 до 3,5	1,2	6,7	6,5	11,4
2		3,5-5,0			8,0	14,4
3		5,0-6,5			9,5	17,4
4	4,0	2,0-3,5	1,3	7,5	7,0	12,3
5		3,5-5,0			8,5	15,3
6		5,0-6,5			10,0	18,3
7	5,0	2,5-3,5	1,5	9,3	7,5	13,4
8		3,5-5,0			9,0	16,4
9		5,0-6,5			10,5	19,4
10		6,5-8,0			12,0	22,4
11		8,0-9,5			13,5	25,4

Пример обозначения заклёпки типоразмера 7
Заклёпка 7-ОСТ1 10642-72

According to the table, for the first case, the 10-OCT1 10642-72 rivet with the length of 6.5-8.0 mm. For the second case, the 11-OCT1 10642-72 rivet with the length of 8.0-9.5 mm.

15. The Sketch