Machine Elements Report

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F_t tangential force, N
v conveyor belt speed, m/s
D pulley diameter, mm
L service life, $year$
T working torque, $N \cdot mm$
t working time, s
δ_u error of speed ratio, %

Chapter 1

Shaft Design

1.1 Nomenclature

1.2 Choose material

We choose material based on the following formula:

$$v_s = 4.5 \times 10^{-5} n \sqrt[3]{T} \tag{1.1}$$

With $n_{sh1} = 2930\,(\text{rpm})$, $T_{sh1} \approx 37570.93\,(\text{N} \cdot \text{mm}) \Rightarrow v_{s1} \approx 4.42\,(\text{m/s})$

With $n_{sh2} = 586\,(\text{rpm})$, $T_{sh2} \approx 178537.08\,(\text{N} \cdot \text{mm}) \Rightarrow v_{s2} \approx 1.48\,(\text{m/s})$

Therefore, for shaft 1, we choose worm wheel material бра жн 10-4-4, which yields $\sigma_{b1} = 600\,(\text{MPa})$, $\sigma_{ch1} = 200\,(\text{MPa})$ according to table 7.1. Using interpolation and table 7.2, the choice of shaft material is quenched and tempered 45 steel (specifications in table 6.1), which yields $[\sigma_{H1}] \approx 191.3259\,(\text{MPa})$.

For shaft 2, we choose worm wheel material сч 15-32, which yields $\sigma_{b2} = 150\,(\text{MPa})$, $\sigma_{ch2} = 320\,(\text{MPa})$ according to table 7.1. Also using interpolation and table 7.2, the choice of shaft material is 20X steel (specifications in table 6.1), which yields $[\sigma_{H2}] \approx 141.7534\,(\text{MPa})$.

1.3 Determine permissible stress

1.3.1 Find $[\sigma_H]$

Since $v_{s1} \approx 4.42\,(\mathrm{m/s}) < 5\,(\mathrm{m/s})$ and $v_{s2} \approx 1.48\,(\mathrm{m/s}) < 2\,(\mathrm{m/s})$, table 7.2 is used to find $[\sigma_H]$. From the results above, we choose:

$[\sigma_{H1}] \approx 191.3259\,(\mathrm{MPa})$

$[\sigma_{H2}] \approx 141.7534\,(\mathrm{MPa})$

1.3.2 Find $[\sigma_F]$

For shaft 1, we use the formula:

$$[\sigma_{F1}] = [\sigma_{FO1}]K_{FL1} \tag{1.2}$$

Since the steel is quenched, we can increase $[\sigma_{FO1}]$ by 25%:

$[\sigma_{FO1}] = (0.25\sigma_{b1} + 0.08\sigma_{ch1}) \times 125\% = 207.5\,(\mathrm{MPa})$

$K_{FL1} = \sqrt[9]{10}$