Machine Elements Report

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Chapter 1

Slip coefficient and Slip curve of Belt drive

1.1 Nomenclature

a	center distance, mm	n	rotational speed, rpm
f	coefficient of friction	Q	load, $kg \cdot F$
d	diameter, mm	α	wrap angle, $^\circ$
F_0	initial tension, N	β	slack angle due to load Q, $^\circ$
F_{ms}	friction force, N	Δh	difference between h_i and h_f, mm
F_t	tangential force, N	ϕ	drag coefficient
g	gravitational acceleration at sea level, m/s^2	$\overline{\xi}$	average slip coefficient kW
h_f	distance between outer sides of the belt after applying load Q, mm	ξ	slip coefficient
h_i	distance between outer sides of the belt before applying load Q, mm	$_1$	subscript for driving pulley
		$_2$	subscript for driven pulley

1.2 Purpose

1. Investigate slip in belt drives
2. Find relative slip coefficient and conduct experiment to find ξ
3. Find F_0
4. Draw slip curve with respect to Q

1.3 Safety Procedures

Students must follow safety rules in the lab.

1.4 Conduct Experiment

1.4.1 Find parameters of the experiment kit

- $d_1 = 67.8$ (mm), $d_2 = 165$ (mm), $a = 315$ (mm)
- Belt type: flat belt
- $\alpha_1 = 180 - 57 \times \dfrac{d_2 - d_1}{a} \approx 162.3°$
- $\alpha_2 = 180 + 57 \times \dfrac{d_2 - d_1}{a} \approx 197.6°$

1.4.2 Find F_0

- $h_i = 124$ (mm), $h_f = 94$ (mm), $Q = 4.1$ (kg $\cdot$ F)
- $\Delta_h = |h_f - f_i| = 30$ (mm), $\beta = \arctan \dfrac{2\Delta_h}{a} \approx 10.78°$
- $F_0 = \dfrac{Qg}{2 \sin \beta} \approx 107.48$ (N)

1.4.3 Measurements

Using the formulas $\xi = 1 - \frac{d_2 n_2}{d_1 n_1}$ and $\phi = \frac{F_t}{2F_0}$, we obtain the following table: Averaging the values of ξ yields $\overline{\xi} \approx 0.0198$

No.	F_0 (N)	n_1 (rpm)	n_2 (rpm)	ξ	F_t (N)	ϕ
1	107.48	283.62	114.04	0.018	3.1	0.014
2	107.48	330.47	133.35	0.018	8.8	0.041
3	107.48	273.83	110.27	0.02	14.4	0.067
4	107.48	307.52	123.71	0.021	20.2	0.094
5	107.48	354.42	142.43	0.022	22.1	0.103

Table 1.1: Observed data

1.4.4 Draw the slip curve graph

From the data above, we can approximate the best fitted line through the data points (assuming linearity since ϕ does not reach critical value)

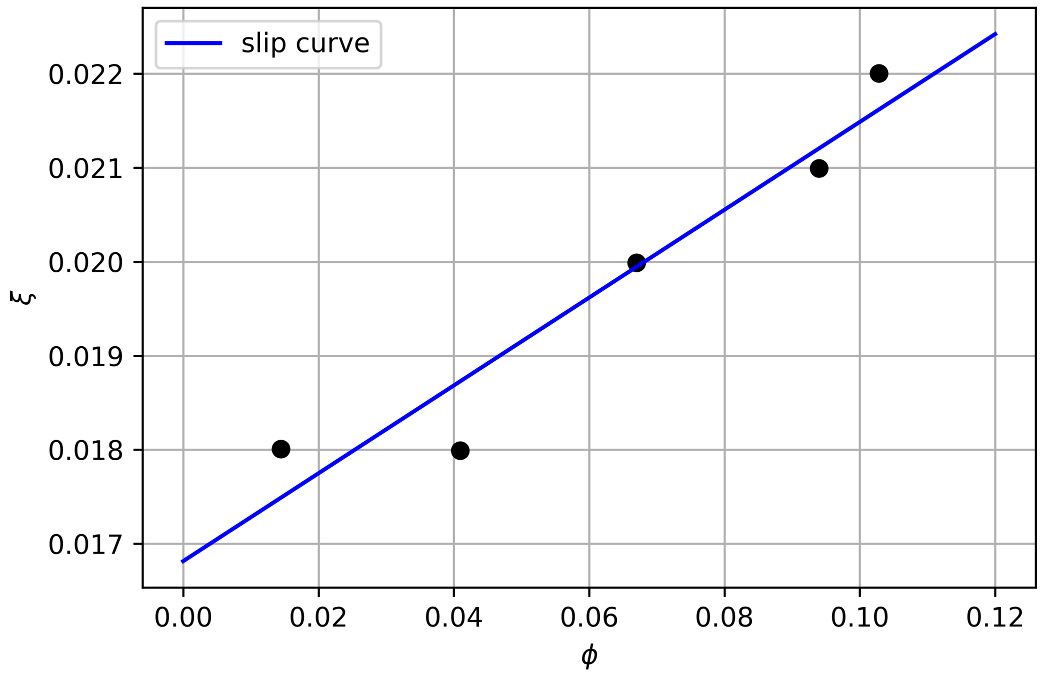

Figure 1.1: Slip curve of belt drive

1.5 Conclusions

In summary:

- Slip coefficient from experiment is in allowable range ($0.01 \div 0.02$).
- The slip curve is in agreement with theory (error is smaller than 5%). Since ϕ does not exceed critical value (the motor is frequency-controlled), we can safely assume linearity for the curve.
- Possible errors:
  - manually measure dimensions in the kit.
  - rounding.
  - incorrect reading of rotational speeds.
- The slip coefficient and slip curve is considerably accurate due to reliable instrument

1.6 Review questions

1. There are

Chapter 2

Tension on Bolts

2.1 Nomenclature

$[F_{cb}]$	tension force at failure of common bolt, N
$[F_{sb}]$	tension force at failure of steel bolt, N
$[\sigma_{cb}]$	tension at failure of common bolt, MPa
$[\sigma_{sb}]$	tension at failure of steel bolt, MPa
d	nominal diameter of M8 bolt, mm
F_c	tension force of hydraulic cylinder
F_{cb}	tension force at failure of common bolt, N
F_{sb}	tension force at failure of steel bolt, N

2.2 Purpose

Provide basic knowledge on conducting experiment regarding ultimate strength of materials

2.3 Safety Procedures

Close the machine door before every operation.

2.4 Conduct Experiment

No.	Experiment with d = 8 (mm)	
	F_{sb}	F_{cb}
1	33898	37377
2	33574	37053
3	34211	36426
4	33727	37053
5	34211	36426
Average	33323.4	36867

Table 2.1: Tension force at failure of common and steel bolts

2.5 Data graphs

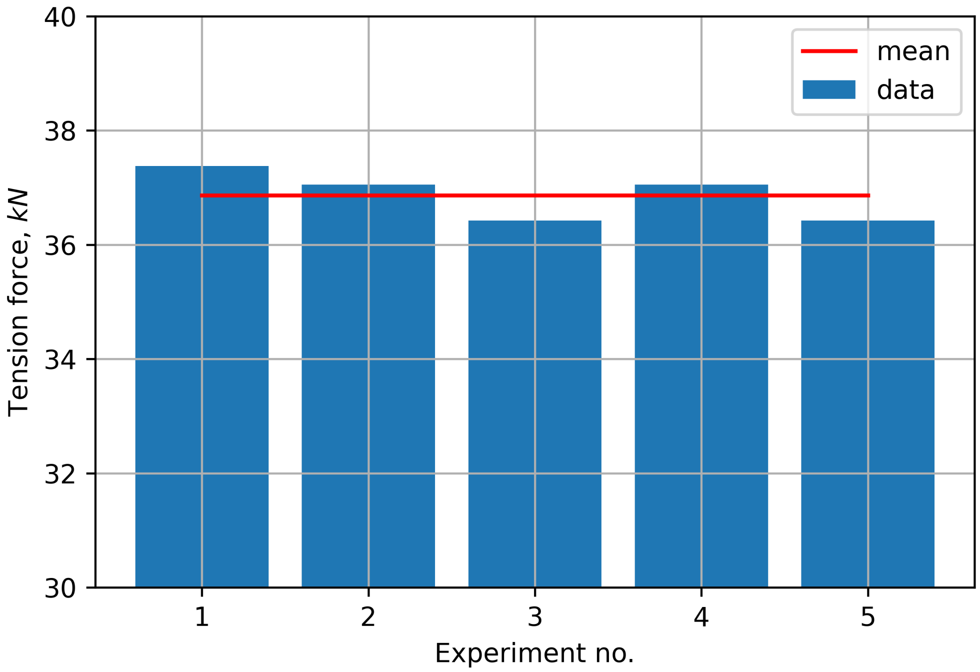

Figure 2.1: Tension force at failure of common bolt

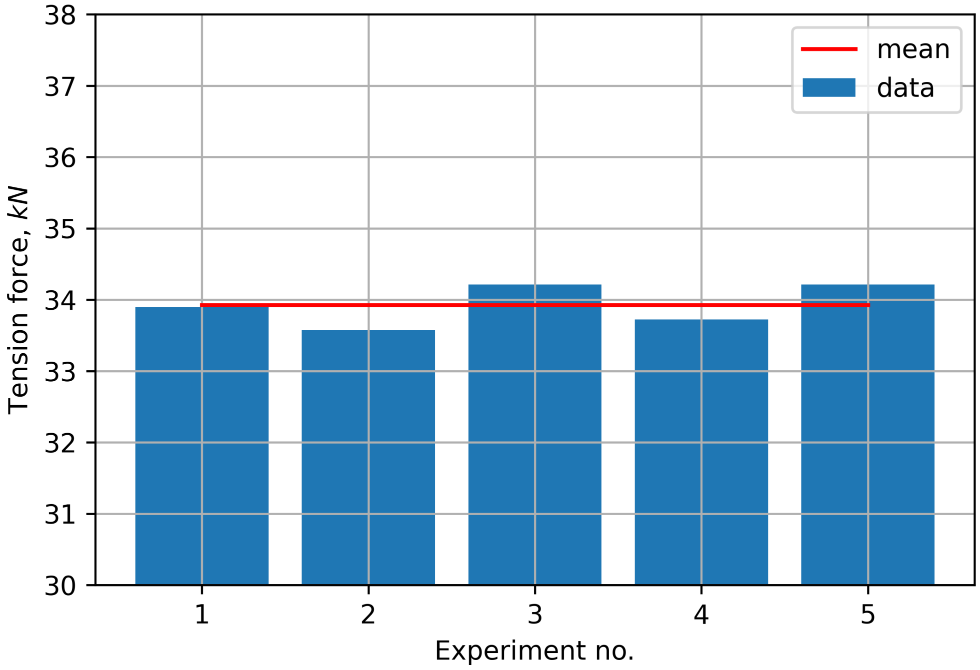

Figure 2.2: Tension force at failure of steel bolt