Machine Elements Report

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Chapter 1

Slip coefficient and Slip curve of Belt drive

1.1 Nomenclature

F_{ms}	friction force, N	n	rotational speed, rpm
F_0	initial tension, N	d	diameter, mm
F_t	tangential force, N	f	coefficient of friction
Q	load, $kg \cdot F$	a	center distance, mm
g	gravitational acceleration at sea level, m/s^2	α	wrap angle, $^\circ$
		β	slack angle due to load Q, $^\circ$
h_i	distance between outer sides of the belt before applying load Q, mm	ξ	slip coefficient
		ϕ	drag coefficient
h_f	distance between outer sides of the belt after applying load Q, mm	$\overline{\xi}$	average slip coefficient kW
		$_1$	subscript for driving pulley
Δh	difference between h_i and h_f, mm	$_2$	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
- $\alpha_1 = 180 - 57\dfrac{d_2 - d_1}{a} \approx 162.3°$
- $\alpha_2 = 180 + 57\dfrac{d_2 - d_1}{a} \approx 197.6°$

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 $\bar{\xi} \approx 0.0198$

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)

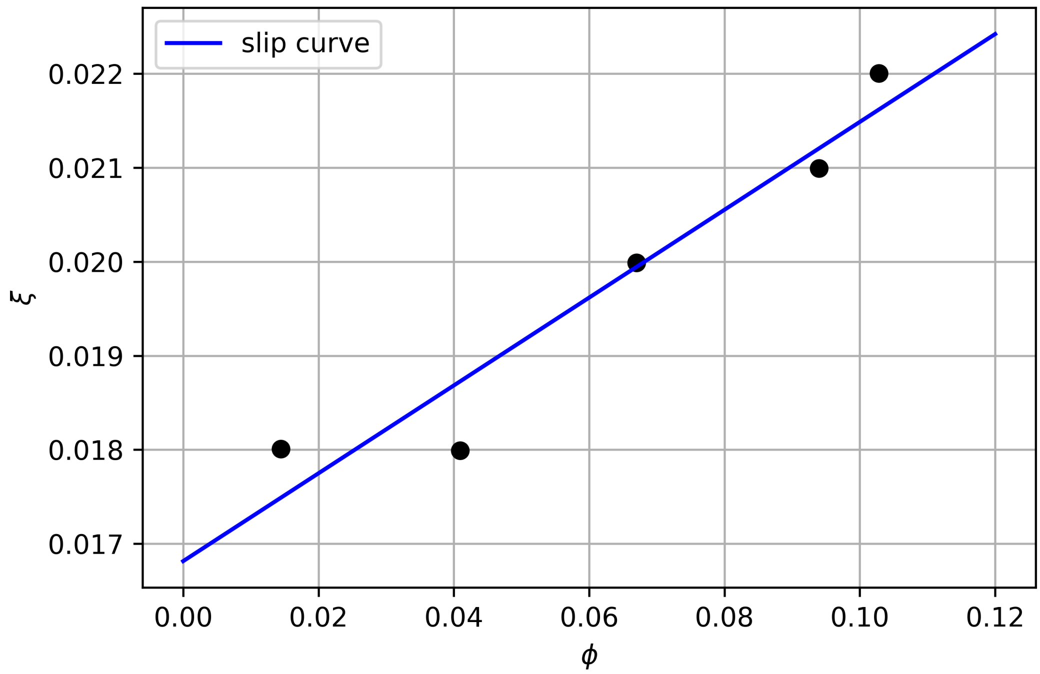

Figure 1.1: Slip curve of belt drive

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

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
$[F_{cb}]$	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

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

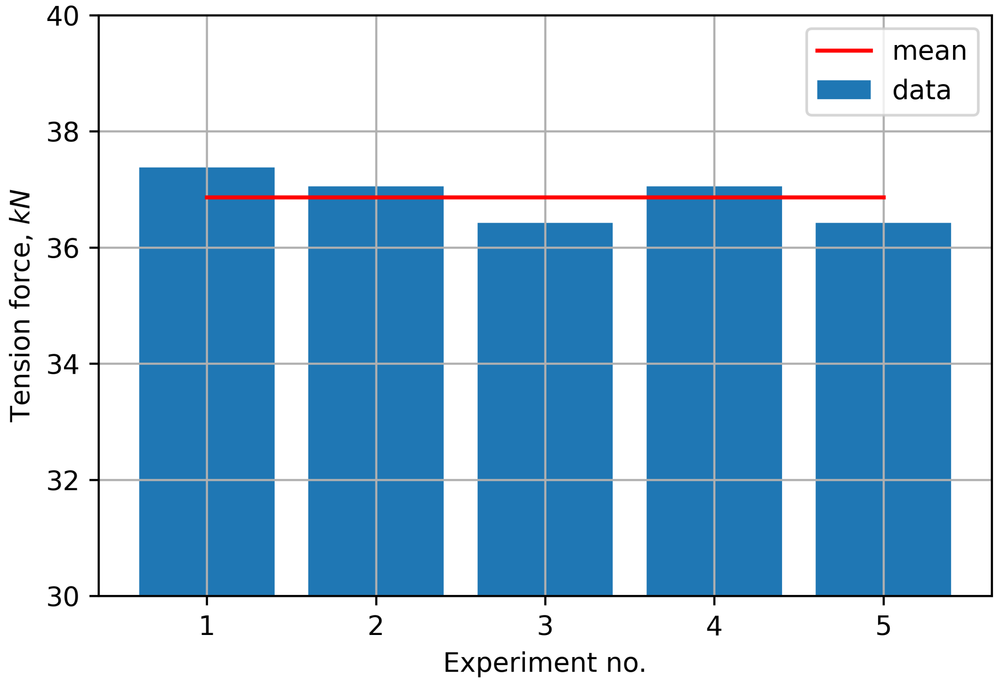

Figure 2.1: Tension force at failure of common bolt

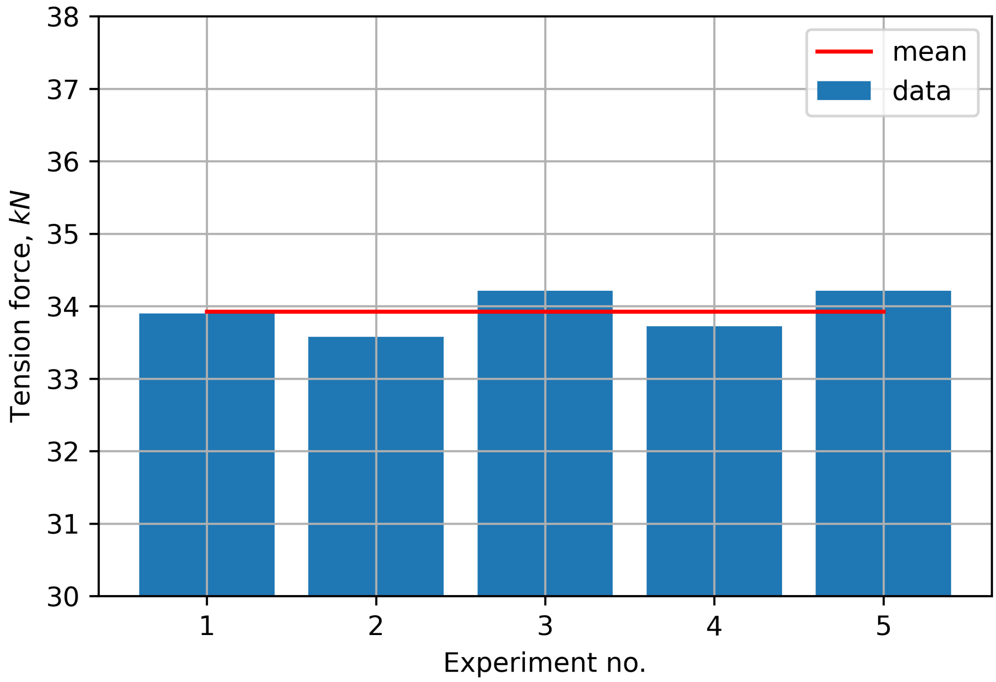

Figure 2.2: Tension force at failure of steel bolt