Belt friction test objective engineering essay

This experiment is done to determine the coefficient of friction between belt and pulley. The factors to be discussed is the use of belt and the angle of contact between belt and pulley. Two types of belt used in this experiment is a flat belt and V-shaped belt. This experiment was initiated by placing a fixed weight of 1. 48 kg mass at one end of a flat belt. The value is recorded as tension T1. The other end of the stad S was placed at angles of 60 ° to 210 °. A nylon rope was attached on the rim of the pulley clockwise and end freely suspended with a weight of value which is W. The weight of the lead pulley is taken when the pulley starts to rotate at constant velocity. Then the tension T2 is obtained by subtracting the total value W from T1. The ratio of T1/T2 is taken and the value of ln (T1/T2) is calculated. A graph of ln (T1/T2) against contact angle, Î± was plotted to find the coefficient of sliding friction, Î between belt and pulley. Similar method was used to calculate the value of the coefficient of friction for the V shape belt. However, the dimension of V belt should be recorded prior to obtain the required angle Î¢ in the formula. From the results we can conclude that the coefficient of friction for the flat belt is 0. 400 while for the V shape belt is 0. 185.

INTRODUCTION & THEORY:

The friction that exists between the belt and pulley is influenced by several factors such as the following:

Materials used for making belt

Belt shape

The angle of contact between the belt and pulley

Factors studied in this experiment is the angle of contact between the belt and pulley.

This experiment is divided into two parts, namely:

experiments for flat belt

Experiments for V shape belt

Touching the flat belt with a pulley is as shown below:

🚹 ±

T2 T1

Diagram 1

Derivation for the formula 1

âˆ‘ Fx = 0 âˆ‘ Fy = 0

µdN + T cos(d🚹±/2) – (T + dT) cos(d🚹±/2) = 0

dN – T sin(d🚹±/2) – (T + dT) sin(d🚹±/2) = 0

d🚹±/2 á´🗎 0 ƒ sin(d🚹±/2) = d🚹±/2

dT á´🗎 0 ƒ cos(d🚹±/2) = 1

µdN + T – T – dT = 0 ƒ µdN = dT…1

dN – T (d🚹±/2) – (T + dT)(d🚹±/2) = 0

dN – 2(T(d🚹±/2)) = 0

dN = T(d🚹±)…2

Sub 2 into 1

μ(T(d 🚺 ±)) = dT

μ = dT/T

Integrate both sides

μ 🚺 ± = ln (T1/T2)

T1 = T2 eμ 🚺 ± (shown)

For the V shape belt, the diagram for the calculation is as shown below:

D

h

L

🚺 ¢

d

Diagram 2

Derivation for the formula 2

R = 2 x (dN/2) sin (Î²/2)

= dN sin (Î²/2)

âˆ‘ Fx = 0 âˆ‘ Fy = 0

μdN + T cos(d 🚺 ±/2) – (T + dT) cos(d 🚺 ±/2) = 0 dN sin (Î²/2) – T sin(d ±/2) – (T + dT) sin(d ±/2) = 0

d ±/2 á´ 0 ƒ sin(d ±/2) = d ±/2

dT á´ 0 ƒ cos(d ±/2) = 1

µdN + T – T – dT = 0 ƒ µdN = dT…1

dN sin (Î²/2) – T (d ±/2) – (T + dT)(d ±/2) = 0

dN sin (Î²/2) – 2(T(d ±/2)) = 0

dN = T(d ±) / sin (Î²/2)…2

Sub 2 into 1

µ(T(d ±) / sin (Î²/2)) = dT

dT / T = µ((d ±) / sin (Î²/2))

Integrate both sides

ln (T1 / T2) = µ ± / sin (Î²/2)

T1 = T2e µ ± / sin (Î²/2) (shown)

Referring to both diagram 1 and diagram 2, when the constant slide happens,

T1 = T2e ± (flat belt) ………Œ

T1 = T2e [± / sin (¢/2)] (V shape belt) ………

Where,

 = Coefficient of friction

T1, T2 = Belt tension (T1 > T2)

± = Contact angle between belt and pulley

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€ € € € € € € ¢€ € € € € € € € € € = angle of V shape belt

Apparatus & Instruments:

Nylon rope

Weight hanger

Pulley

Constant load (1. 48 kg)

Flat belt

V shape belt

SUSUNAN RADAS:

Pulley

Stad S

Belt Nylon rope

Constant load, T1

Weight hanger

Diagram 3

PROCEDURE:

The stad S was put at the position of 60°.

The flat belt was chosen. The end of A was hooked at stad S and the end of ï¢€ was passed on the pulley in anticlockwise direction.

A known load, 1. 48kg (T1) was put at ï¢€®

The nylon rope (which is attached on the rim of the pulley) was winded on to the pulley in clockwise direction. Then the weight hanger (P) was attached at the free end of the nylon rope.

The weight at (P) was added until the pulley rotates slowly with a constant velocity. The total weight was determined and recorded.

Procedure 1 to 5 were repeated with different angles ranging from 90° to 210°, that are 90°, 120°, 150°, 180° and 210°. The constant load T1 was remained unchanged.

Then the results were arranged in a table.

A graph of ln (T1 / T2) against ï±€ was plotted to validate equation 1 and to calculate the value of ï€¬€ coefficient of friction.

Procedure 1 to 8 were repeated using V shape belt.

RESULTS:

Flat Belt:

Contact angle,

🚹 ± / rad

Constant load,

T1 / N

Weight hanger,

W / N

Tension,

T2 = T1 – W / N

Ratio

T1 / T2

ln(T1 / T2)

1. 047

14. 519

4. 905

9. 614

1. 510

0. 412

1. 571

14. 519

6. 082

8. 437

1. 721

0. 543

2. 094

14. 519

7. 063

7. 456

1. 947

0. 666

2. 618

14. 519

8. 829

5. 690

2. 552

0. 937

3. 142

14. 519

10. 202

4. 317

3. 363

1. 213

3. 665

14. 519

11. 772

2. 747

5. 285

1. 665

Graph of ln (T1 / T2) against Î¸

From the graph,

Y = mX + c where m = gradient of graph

c = y-intercept

ln(T1 / T2) = m Î¸ + 0

T1 / T2 = emÎ¸

T1 = T2em🚹±

Replace m = 🚹,

T1 = T2e🚹 🚹±

With this, equation 1 is verified.

= e🚹 🚹±

🚹 🚹± = ln ()

🚹 =

🚹œcoefficient of friction, 🚹 = gradient of graph ln (T1/T2) against 🚹±

= 0. 400

V shape belt:

Contact angle,

🚹± / rad

Constant load,

T1 / N

Weight hanger,

W / N

Tension,

T2 = T1 – W / N

Ratio

T1 / T2

ln(T1 / T2)

1. 047

14. 519

7. 456

7. 063

2. 056

0. 721

1. 571

14. 519

8. 437

6. 082

2. 387

0. 870

2. 094

14. 519

9. 614

4. 905

2. 960

1. 085

2. 618

14. 519

10. 987

3. 532

4. 111

1. 414

3. 142

14. 519

12. 164

2. 355

6. 165

1. 819

3. 665

14. 519

12. 949

1. 570

9. 248

2. 224

Dimension for V shape belt:

Dimension (cm)

1

2

3

Average

Top length, D

1. 20

1. 20

1. 20

1. 20

Bottom length, d

0. 70

0. 70

0. 70

0. 70

Side, h

0. 80

0. 80

0. 80

0. 80

From the whole triangle, sin (🚺 ¢ / 2) = (1. 20 / 2) / L (1)

From the unshaded triangle sin (🚺 ¢ / 2) = (0. 70 / 2) / (L – 0. 80) (2)

(1) = (2) ; 0. 60 / L = 0. 35 / (L – 0. 80)

0. 35L = 0. 60L – 0. 48

0. 25L = 0. 48

L = 1. 92 cm

From (1) sin (🚺 ¢ / 2) = 0. 60 / 1. 92

= 0. 3125

ï¢ / 2 = 18. 21°

ï¢ = 36. 42°

= 0. 6356 rad.

From the graph,

Y = mX + c where m = gradient of graph

c = y-intercept

ln(T1 / T2) = m ï± + 0

T1 / T2 = em ï±

T1 = T2em ï±

T1 = T2e ï ï± / sin(ï¢/2)

Replace m = ï / sin(ï¢ / 2)

ï = m [sin(ï¢ / 2)]

m = 0. 581

ïœ€ ï = (0. 581)(0. 6356 / 2)

= 0. 185

Graph of ln (T1 / T2) against Î±

DISCUSSION:

Experimental results obtained from both the graph line graph is a straight line and through the origin although flat belt graph deviates a little bit from the origin. This shows that the experimental results correspond to the equation shown in the theory.

The mounting weight of P, which is a cylindrical tin with a relatively narrow nozzle resulting in difficulty putting weight to the weight P without any jerk.

Listen

Read phonetically

It was found that the coefficient of friction of the belt is even higher than the coefficient of friction of the V shape belt. Although the coefficient of friction of the V-shaped belt is smaller than that of the flat belt, the amount of force required to move the V belt pulley is larger. This is because the more force is needed to overcome the forces of reaction where there are additional on V shape belt due to contact with the side of the rim.

The value of coefficient of friction of V-shaped belt depends on the value of Î¢. The higher the value of Î¢, the smaller the coefficient of friction. However, the coefficient of friction is not affected by the area of contact.

Referring to the data obtained from the experiment and found that both of the graphs are straight line graphs. This shows that ln (T1/T2) is directly proportional to Î±. So, the equation of coefficient of friction is correct for both of the belt. There are several factors that influence the results of this experiment. Among them are:

sufficient to overcome the friction between the belt and pulley. Recoil forces of different magnitude will be produced even the screws and nuts are placed with care. The bigger the mass of the weight, the greater force is created. Measurement error arising from the differences in the magnitude of the recoil force.

Listen

Read phonetically

The path for the mounting W falls right is one of the factors. Chance of W falls with acceleration cannot be denied because the current path is short. Also, the acceleration is very difficult to be detected.

The total weight required to overcome friction is greater because of the effects of friction between nylon rope with a pulley on the axis of rotation and the rope. It is difficult to determine the mass of the weight when pulley started to rotate with a constant speed due to different weights of nuts and screws of various size and mass. The presence of recoil force during the weight placed in the mounting cannot be ignored. This force causes the mounting W fall before the total weight should be in the W-nylon strap that overlap.

Listen

Read phonetically

The uniform velocity for the mounting of P is an estimated value only. This depends on the observer because no accurate tools are used for measuring the velocity of P.

The value obtained for the coefficient of friction is likely not accurate. This is caused by the use of low precision weight measurer (only read up to 10g). In addition, there is an error, the common error (parallax error) when observing the weight for the W.

The following steps should be taken to repair the results of the experiment:

Weights are added slowly into the weight container to avoid a surge in weight.

The nylon rope used must be wrapped properly and do not overlap each other or else more force is required to overcome the coefficient of friction between the nylon rope itself.

The V shape belt must be placed exactly in the middle of the rim to minimize the friction that is on both of the sides of belt surface.

More time should be allocated to obtain a uniform speed pulley to get better results. However, the acquisition speed is only an estimated value.

CONCLUSION:

From this experiment,

Coefficient of friction for flat belt = 0. 400

ii) Coefficient of friction for V shape belt = 0. 185

This experiment showed that the coefficient of friction is influenced by the angle of contact between the belt with the pulley.