# STUDY OF BELT STRETCH IN RELATION TO ROTATIONAL SPEED

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"I have read this literary work and in my opinion it is fully adequate,
in scope and quality for the award of the degree of
Bachelor of Mechanical Engineering (Structure & Material)"

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| Signature | : ............................................... |
| First Supervisor's Name | : ............................................... |
| Date | : ............................................... |

"I declared that this project report entitled "Study of Belt Stretch" is written by me and is my own effort except the ideas and citations which I have clarified their sources."

Signature : ……………………………………

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Date : ……………………………………

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# ABSTRACT

Belt stretch introduces an extra dimension to the load-sharing problem. In order for a drive drum to transfer power to a belt, it experiences tension in the belt by stretching such that a section of belt entering the drum is longer than the same section of belt as it leaves the drum. In order to stretch a belt, speed of the drum must be equal to or greater than belt speed at all points of contact. Ideally, the speed of a belt entering a drum is equal to the speed of the contact surface of the drum. The speed of the belt leaving the drum is lower by the amount of belt stretch. Besides, the project will study the effect of belt stretch in relation to various rotational speeds. Universal Testing Machine was used to study the belt stretch. All the data were taken by the experiment conducted and calculation. From the experiment, data shows that the belts stretch increase with increasing belt velocity.

# ABSTRAK

Keregangan tali sawat memperkenalkan dimensi ekstra ke atas masalah pengagihan beban. Apabila takal pemacu memindahkan kekuatan kepada tali sawat, tali sawat menjadi tegang melalui regangan sehingga bahagian tali sawat memasuki takal lebih panjang daripada bahagian tali sawat semasa meninggalkan takal. Dalam rangka untuk meregangkan tali sawat, kecepatan takal harus sama atau lebih besar daripada kecepatan tali sawat di semua titik persentuhan. Idealnya, kecepatan tali sawat memasuki takal adalah sama dengan kecepatan permukaan persentuhan takal. Kecepatan tali sawat meninggalkan takal lebih rendah dengan adanya bahagian tali sawat meregang. Selain itu, projek ini akan mempelajari kesan daripada peregangan tali sawat dalam kaitannya dengan pelbagai halaju putaran. *Universal Testing Machine* (UTM) digunakan untuk mempelajari peregangan tali sawat. Semua data diambil daripada ujikaji yang dilakukan dan pengiraan. Daripada data ujikaji, ia menunjukkan bahawa keregangan tali sawat bertambah dengan peningkatan kelajuan tali sawat.

# CONTENTS

| CHAPTER | DESCRIPTION | PAGE |
|---|---|---|

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF SYMBOLS

| | | |
|---|---|---|
| CVT | = | continuously variable transmission |
| SFC | = | specific fuel consumption |
| WOT | = | wide open throttle |
| BSFC | = | brake specific fuel consumption |
| E-CVT | = | electronically continuously variable transmission |
| CAD | = | computer aided design |
| 3D | = | three dimensions |
| DC | = | direct current |
| AC | = | alternate current |
| R | = | Resistor value |
| V | = | Voltage |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Continuous belts are commonly used for conveying various elements. One common type of belt is a continuous belt that is extruded. Frequently, such belts are extruded from flexible materials, such as thermoplastic materials. One shortcoming of such belts is that the belts have a tendency to stretch during use. As the belt stretches, it tends to slip, thereby reducing the driving force of the conveyor. Further, the weight of the item to be conveyed is related to the tension in the belt. Specifically, as the weight increases, the tension in the belt needs to be increased to minimize slippage between the belt and the drive elements. The increased tension in the belt increases the tendency of the belt to stretch, which in turn increases the likelihood of the belt slipping. Over the years a number of attempts have been made to overcome the problem of belt stretch. The primary solution has been to embed an item in the belt that has a relatively high tensile strength and resistance to stretching. For instance, polyester fibers are commonly formed in conveyor belts.

The polyester fibers are less likely to stretch, and therefore the resulting belt has less likelihood of stretching than the belt without the fibers. Although the fibers in the belt improve the stretch- resistance of the belt, the tendency of the belt to stretch has still remained a problem. Since the belt is typically formed from a length of material, the fibers are no continuous loops. In other words, along the length of the belt, the fibers are continuous.

However, at the point where the ends of the belt are connected to one another, the fibers may be next to one another, but they are not continuous. Therefore, the weak point in a belt seems to be the point at which the ends are connected. For this reason, the focus of many attempts to reduce the problem of belt stretch have focused on manipulating the fibers at the point of connection, resulting in the development of complicated techniques for connecting the ends of the belts. Although many of these techniques have improved the problem of belt stretching, there still exists a need for providing a belt having a reduced tendency to stretch. In particular there is a need for a belt that resists stretch and is economical to produce.

## 1.2 Objective of study

The objective of this project is to study belt stretch. Before starting this project, several targets and goals have been set to achieve a good the relationship between the belt stretch and the speed of motor. The following are the goals for this project:

a) To setup an experiment of studying belt stretch.
b) To conduct an experiment to study the effect of belt stretch in relation to various rotational speed.
c) To analyse and compare the theoretical and experiment results of the study.

## 1.3 Problem Statement

Belt stretch introduces an extra dimension to the load-sharing problem. In order for a drive drum to transfer power to a belt, it must increase tension in the belt by stretching the belt so that a section of belt entering the drum is longer than the same section of belt as it leaves the drum. In order to stretch a belt, speed of the drum must be equal to or greater than belt speed at all points of contact. Ideally, the speed of a belt entering a drum is equal to the speed of the contact surface of the drum, and the speed of the belt leaving the drum is lower by the amount of belt stretch. Figure 1 applies to a drive drum with 1782-rpm motors (1% slip) and a belt that stretches by 1% at rated power—a stretch-to-slip ratio of 1.0 for the drum. For illustration, speed is referenced to the motor shaft.

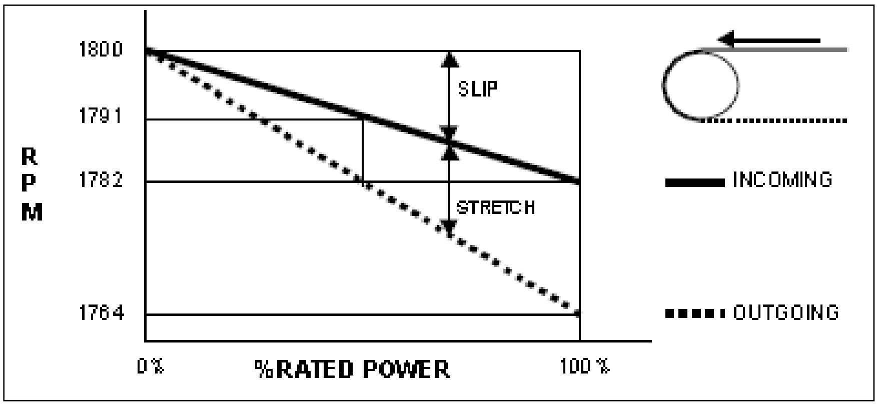


Figure 1.1: An example of incoming and outgoing belt speed as a function of rated power.

(Shigley and Mischke, 2001)

## 1.4 Scopes of project

Based on the objective of this project, several scopes have been decided to achieve all these objectives:

a) To use only commercially available belt.
b) To conduct a study to at least 3 different rotational speed.
c) To conduct the experiment in the limitations of available laboratory equipment and environment.

## 1.5 Benefit of study

This Project Sarjana Muda (PSM) has not been done in this university or in other university. There is no journal that can be used as a reference to accompany the path to do this project. This means that, after the author complete this project successfully, this thesis can be used as a reference to all people.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

A belt is a looped strip of flexible material, used to mechanically link two or more rotating shafts. They may be used as a source of motion, to efficiently transmit power, or to track relative movement. Belts are looped over pulleys. In a two pulley system, the belt can either drive the pulleys in the same direction, or the belt may be crossed, so that the direction of the shafts is opposite. As a source of motion, a conveyor belt is one application where the belt is adapted to continually carry a load between two points.

Belts are the cheapest utility for power transmission between shafts that may not be axially aligned. Power transmission is achieved by specially designed belts and pulleys. The demands on a belt drive transmission system are large and this has led to many variations on the theme. They run smoothly and with little noise, and cushion motor and bearings against load changes, albeit with less strength than gears or chains. Improvements in belt engineering allow use of belts in systems that only formerly allowed chains or gears.

Belt drive, moreover, is simple, inexpensive, and does not require axially aligned shafts. It helps protect the machinery from overload and jam, and damps and isolates noise and vibration. Load fluctuations are shock-absorbed (cushioned). They need no lubrication and minimal maintenance. They have high efficiency (90-98%, usually 95%), high tolerance for misalignment, and are inexpensive if the shafts are far apart. Clutch action is activated by releasing belt tension. Different speeds can be obtained by step or tapered pulleys.

However, the angular-velocity ratio may not be constant or equal to that of the pulley diameters, due to slip and stretch. However this problem has been largely solved by the use of toothed belts. Temperatures range from −35 °C (−31 °F) to 85 °C (185 °F). Adjustment of center distance or addition of an idler pulley is crucial to compensate for wear and stretch.

## 2.2 Belt drive

A belt drive is a method of transferring rotary motion between two shafts. A belt drive includes one pulley on each shaft and one or more continuous belts over the two pulleys. The motion of the driving pulley is, generally, transferred to the driven pulley via the friction between the belt and the pulley. Synchronous/timing belts have teeth and therefore do not depend on friction. Gear transmissions have a much greater life expectancy than belt drives. Belt drives also have relatively high inspection and maintenance demands. On the other hand, belt drive has the following advantages:

a) Easy, flexible equipment design, as tolerances are not important.

b) Isolation from shock and vibration between driver and driven system.

c) Driven shaft speed conveniently changed by changing pulley sizes.

d) Belt drives require no lubrication.

e) Maintenance is relatively convenient

f) Very quiet compared to chain drives, and direct spur gear drives.

For belt drives, other than synchronous drives, the belts will slip in a high overload event providing a certain measure of safety. The belts transferring torque by surface friction need to be in tension. This results in the need for adjustable shaft centres or using tensioning pulleys.

Table 2.1: Types of belt drivers

| Belt Type | Description |
|---|---|
| Flat | Belt transfers torque by friction of the belt over a pulley. Needs tensioner. Traction related to angle of contact of belt on pulley. Is susceptible to slip. Belt made from leather, woven cotton and rubber. |
| Vee | Better torque transfer possible compared to flat belt. Generally arranged with a number of matched vee belts to transmit power. Smooth and reliable. Made from hi-tech woven textiles, polyurethane, etc. |
| Poly-Vee | Belt is flat on outside and Vee Grooved along the inside. Combines advantages of high traction of the Vee belt. |
| Timing/ Synchronous | Belt toothed on the inside driving via grooved pulleys. This enables positive drive. Limited power capacity compared to chain and Vee belt derivatives. Does not require lubrication. Extensively used in low power applications |
| Vee Link Belts | Linked belts that can be used in place of vee belts. Advantage that the length can be adjusted and the belt can be easily installed with removing pulleys. Expensive and limited load capacity. |

### 2.2.1 Flat belts

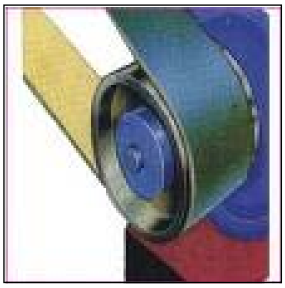

Figure 2.1: Flat belts

Flat belts as shown in Figure 2.1 were used early in line shafting to transmit power in factories. It is a simple system of power transmission that was well suited to its day. It delivered high power for high speeds (372.85 kW for 50.8 m/s), in cases of wide belts and large pulleys. These drives are bulky, requiring high tension leading to high loads, so vee belts have mainly replaced the flat-belts except when high speed is needed over power. The Industrial Revolution soon demanded more from the system, and flat belt pulleys need to be carefully aligned to prevent the belt from slipping off. Because flat belts tend to slip towards the higher side of the pulley, pulleys were made with a slightly convex or "crowned" surface (rather than flat) to keep the belts centered. The flat belt also tends to slip on the pulley face when heavy loads are applied. Many proprietary dressings were available that could be applied to the belts to increase friction, and so power transmission. Grip was better if the belt was assembled with the hair (i.e. outer) side of the leather against the pulley although belts were also often given a half-twist before joining the ends, so that wear was evenly distributed on both sides of the belt. Belts were joined by lacing the ends together with leather thronging or later by patent steel comb fasteners. A good modern use for a flat belt is with smaller pulleys and large central distances. They can connect inside and outside pulleys, and can come in both endless and jointed construction.

(Alam N.Gent, 2000)