BELT STRETCH MEASUREMENT IN RELATION TO SPEED

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"I hereby declared this thesis is my own work except the ideas and summaries Whish I have clarified their sources"

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ABSTRACT

The great majority of mechanical power transmission applications involve rotating shafts, since rotation is continuous and the shafts are cheap relative to other means of power transmission. The two most common power transmission mechanisms in industry are belts, usually V-belts and gears. The efficiencies of belts are generally less than those of gears - that is why belts are not found in the main drive train of road vehicles where fuel economy is critical. This thesis is from author's effort to analyze rubber v-belt behavior from the effect of speed. By development of methodology and experimental, it shows that rubber v-belt loss some amount of energy when it stretched. The literature review was done to understand the theory of v-belt transmission. Universal Testing Machine was used to study the belt stretch and to determine the amount of energy loss. All the data were taken by the experiment conducted and calculation. From the experiment, data shows that there was energy loss when the rubber v-belt is being stretched.

ABSTRAK

Majoriti dalam aplikasi sistem penghantaran kuasa mekanikal adalah melibatkan syaf berpusing oleh kerana pusingan berterusan dan syaf lebih murah berbanding dengan sistem penghantaran kuasa yang lain. Dua jenis mekanisma penghantaran kuasa yang biasa diketahui ialah tali sawat terutamanya tali sawat berbentuk V dan gear. Kecekepan tali sawat adalah kurang dara kecekapan gear, disebabkan itu ia tidak digunakan dalam sistem utama penghantaran kuasa bagi kenderan jalan raya. Tesis ini adalah hasil usaha penulis dalam menganalisa kelakuan tali sawat getah bentuk V dari tindakan halaju. Dengan membangunkan kaedah ujikaji ia menunjukkan yang tali sawat getah bentuk V kehilangan sejumlah tenaga apabila mengalami pemanjangan. Kajian ilmiah untuk memahami konsep dan teori tali sawat getah bentuk V ini. Mesin UTM (Universal Testing Machine) digunakan untuk mengkaji pemanjangan tali sawat dan mendapatkan nilai kehilangan tenaga. Segala data-data berkaitan dalam ujikaji diperolehi melalui pengiraan. Melalui ujikaji yang dilakukan data-data yang diperolehi menunjukkan kehilangan tenaga berlaku pada tali sawat apabila mengalami pemanjangan.

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SYMBOL	DEFINITION
A	Area
b	Width
E	Young's Modulus
L	Length
σ	Tensile Stress
e	Stretch
ε	Tensile Strain

GREEK'S ALPHABETS	DEFINITION
ω	Angular Velocity

SUBSCRIPT	DEFINITION
N_1	Driver Velocity
N_2	Driven Velocity
d_1	Drive Pulley's Diameter
d_2	Driven Pulley's Diameter
r_1	Drive Pulley's Radius
r_2	Driven Pulley's Diameter
T	Torque
W	Work
Rpm	Revolution per Minute

T_1	Tension at the Tight Side
T_2	Tension at the Slide Side
V	Velocity

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Overview

In rotating mechanical machine belts are used to link between two ore more rotating item.. They may be used as a source of motion points

Belts will stretch when tension is applied into it and rubber belt will loss some amount of energy. This thesis will focus on the relationship between speed and belt stretch and how it relates to energy loss for rubber belt. Also, the aspect should be taken into consideration are material and equipment preparation for experiment use and analysis to the data that have been taken.

1.2 Objective

The objective of this project is to study the energy loss of rubber V-belt

1.3 Scope

1) Research will be applied to rubber v-belt.
2) Tensile test as measurement method
3) Stretch due to torque and centrifugal force, ignore temperature effect
4) Analyzing the data.

1.4 Process Flow

To start any analysis we need to have a guideline as a work frame about what need to be done step by step. Flow chart in figure 1.1 show the process has to be taken in order to complete this project.

1) Literature Review is done to understand about rubber v-belt behavior. References from journals, websites and books like machine mechanism and mechanical design are need.
2) Decision to choose type of belt and it size.
3) To select the measurement method and to ensure that the equipments can be provide.
4) Material and measurement method are suggest. It will be evaluate either it can be accepted or not.
5) Experiment can be done which to know the effect of speed to belt stretch and the amount of energy loss of rubber v-belt.
6) At the same time, the theoretical calculation for belt stretch will be done.
7) Results from experiment and theoretical calculation will be compared.
8) All the results will be analyzed.
9) Final process is writing the report depends on study and analysis that have been done.

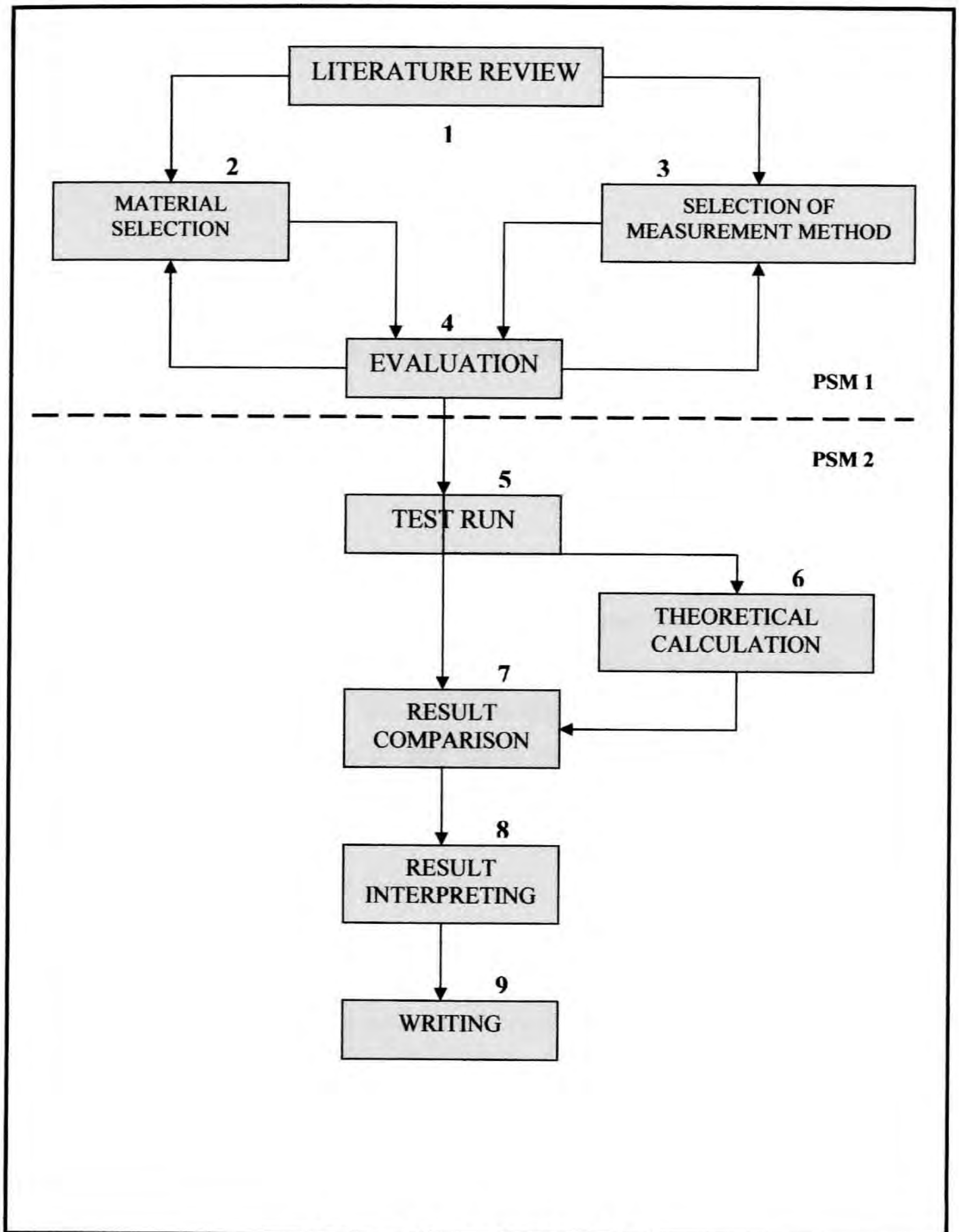

Figure 1.1: Project Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 Type Of Belt Drive

Power transmission belting has been used for more than 200 years. The first belts were flat and ran on flat pulleys. Later, cotton or hemp rope was used with V-groove pulleys to reduce belt tension. This led to the development of the vulcanized rubber V-belt in 1917. The need to eliminate speed variations led to the development of synchronous or toothed belts about 1950 and the later development of fabric-reinforced elastomer materials.

When compared to other forms of power transmission, belts provide a good combination of flexibility, low cost, simple installation and maintenance, and minimal space requirements. Belt-driven equipment uses readily available components. Replacement parts can be easily obtained from local distributors. This availability reduces downtime and inventory. Sheaves and pulleys are usually less expensive than chain drive sprockets and have little wear over long periods of operation.

Some of the many forms of belt are introduced below. Historically, flat belts made from joined hides were first on the scene; however modern flat belts are of composite construction with cord reinforcement. They are particularly suitable for high speeds.

Classical banded V-belts comprise cord tensile members located at the pitch line, embedded in a relatively soft matrix which is encased in a wear resistant cover. The wedging action of a V-belt in a pulley groove results in a drive which is more compact than a flat belt drive, but short centre V-belt drives are not conducive to shock absorption.

Synchronous or timing belt drives are positive rather than friction drives as they rely on gear- like teeth on pulley and belt enabled by modern materials and manufacturing methods. They are mentioned here only for completeness - we shall not examine them further.

2.2 V-belt drive

V-belts are available in a number of standard cross-sectional sizes, designated in order of increasing size A, B, etc, while wedge belts are designated variously as SPA, SPB, etc (or α, β etc in the US). Each size is suitable for a particular power range as suggested by the carpet diagrams in figure 2.1.

V-belts are commonly used in industrial applications because of their relative low cost, ease of installation, and wide range of sizes (Fig. 2.2). The V-shape makes it easier to keep fast-moving belts in sheave grooves than it is to keep a flat belt on a pulley. The biggest operational advantage of a V-belt is the wedging action into the sheave groove. This geometry multiplies the low tensioning force to increase friction force on the pulley sidewalls (Fig. 2.3).

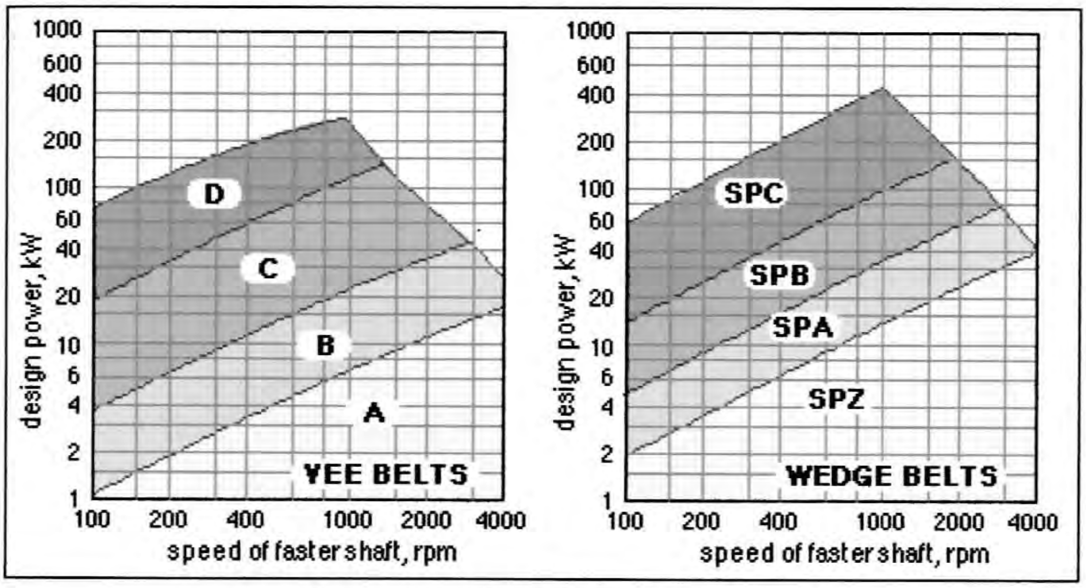

Figure 2.1: Size and power range of v-belt

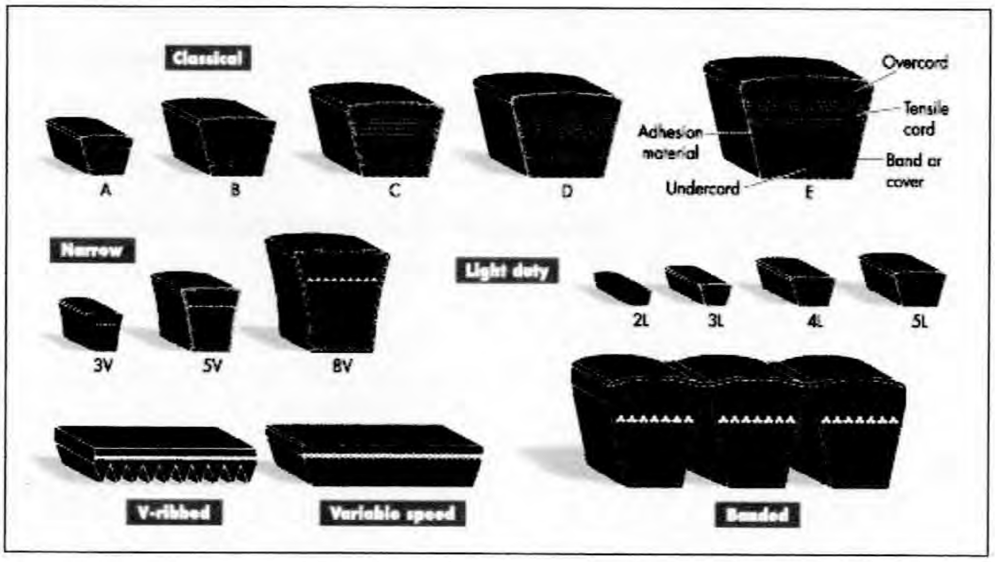

Figure 2.2: Size of v-belt

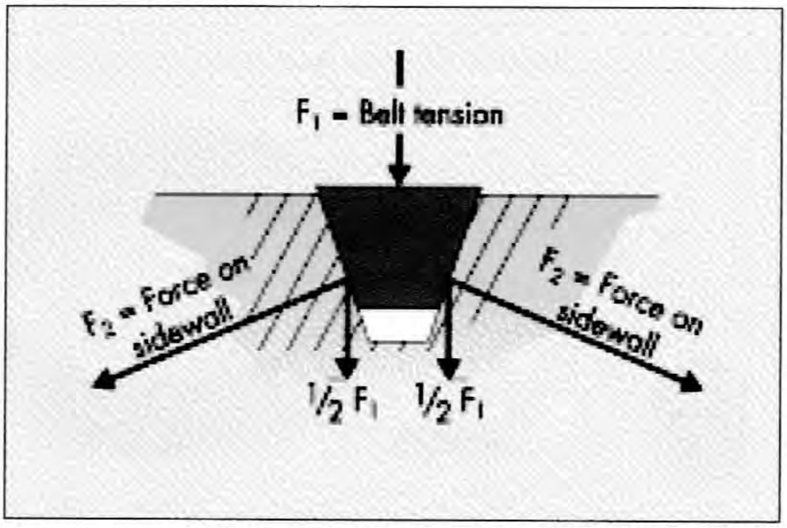

Figure 2.3: Geometry of v-belt

2.3 Stretch of rubber v-belt

Any belt will stretch when a load is applied to it, although the amount of stretch is usually very small. When torque is applied to the driving pulley of a belt drive, one span of the belt gets tighter and stretches slightly in response to the additional load applied by the driving torque. At the same time, the load in the loose span reduces by the same amount, and the loose span shortens by the same amount the tight side stretched. This behavior is illustrated in figure 2.4. Stretch of belt can be measured while it operates. From that we can know the behavior of belt.

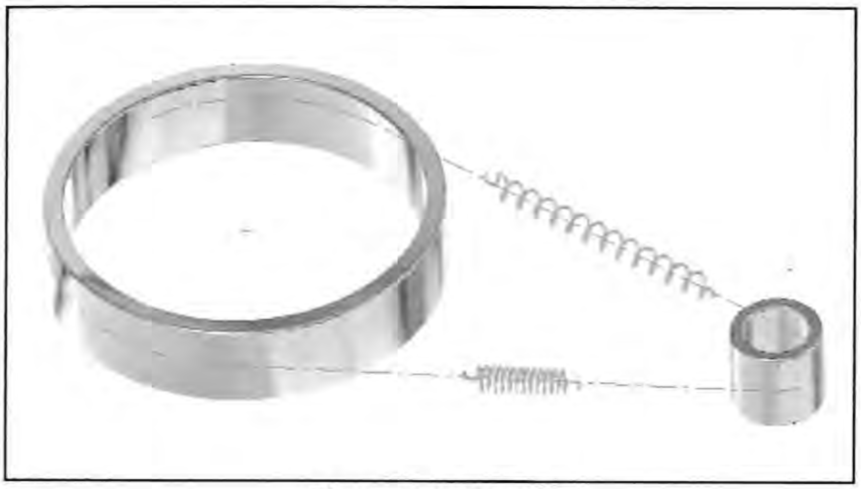

Figure 2.4: Stretch

Christian Berger (2002), conducted an experiment to measure the strain of belt. For this purpose, new noncontact measurement method using optical sensors are being developed. The sensors detect periodic patterns on the moving object. The strain is determined from a frequency analysis of the sensor signal. The measured average strain values are almost dependent on the belt force. Due to the large Young's Modulus of approximately 3000 N/mm, which was measured in a tension test of a common V-belt, only a small strain of at most one or more two percent occurs even at high axial v-belt load.

Unfortunately, there are no such technologies or equipment that can be providing for this project. So, the other way that has been chosen is to use tensile test as a measurement method. This will be discussed further at chapter 3. In this method, the stretch is dependently to mechanical properties of the v-belt like stress, strain and Young's Modulus.

2.3.1 Stress

Stress is the internal resistance, or counterforce, of a material to the distorting effects of an external force or load. This counterforce tends to return the atoms to their normal positions. The total resistance developed is equal to the external load. This resistance is known as *stress*. Although it is impossible to measure the intensity of this stress, the external load and the area to which it is applied can be measured. Stress can be equated to the load per unit area or the force (F) applied per cross-sectional area (A) perpendicular to the force as shown in the Equation below. [Engineering Edge, 2000]

$$\text{Stress, } \sigma = \frac{F}{A}$$

Where:
s = stress (N/m^2 or Newton per m.^{2})
F = applied force (N)
A = cross-sectional area (m.^{2})

Mathematically, there are only two types of internal load because tensile and compressive stress may be regarded as the positive and negative versions of the same type of normal loading. As illustrated in Figure 2.5, the plane of a tensile or compressive stress lies perpendicular to the axis of operation of the force from which it originates. *Tensile stress* is that type of stress in which the two sections of material on either side of a stress plane tend to pull apart or elongate as illustrated in Figure 2.5 (A).

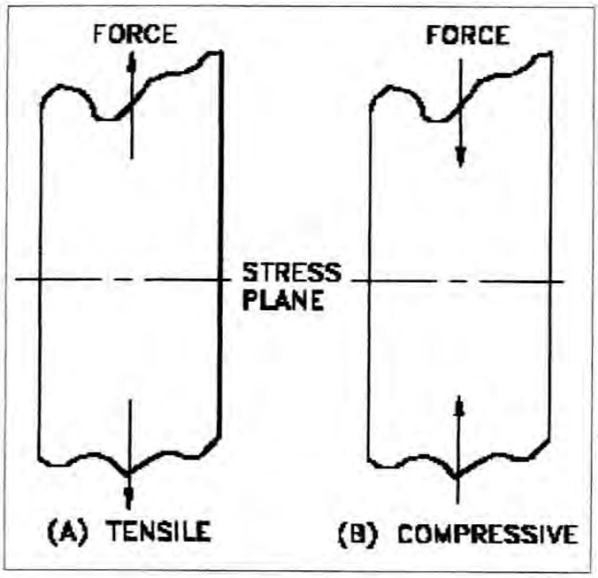

Figure 2.5: Tensile and compression stress

2.3.2 Strain

A proportional dimensional change (intensity or degree of the distortion) is called *strain* and is measured as the total elongation per unit length of material due to some applied stress. Equation below illustrates this proportion or distortion. [Engineering Edge, 2000]

$$\textbf{Strain, } \varepsilon = \frac{\delta}{L}$$

Where:

ε = strain (m/m)

δ = elongation (m)

L = initial length (m)

2.3.3 Young's Modulus

Young's Modulus also known as the *Young Modulus*, modulus of elasticity, elastic modulus or tensile modulus is a measure of the stiffness of a given material. It is defined as the ratio, for small strains, of the rate of change of stress with strain. This can be experimentally determined from the slope of a stress-strain curve created during tensile tests conducted on a sample of the material. For many materials, Young's modulus is a constant over a range of strains. Such materials are called linear, and are said to obey Hooke's law. Examples of linear materials include steel, carbon fiber, and glass. **Rubber** and soil are non-linear materials. [Engineering Edge,2000]