UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL INVESTIGATION OF FRONT SPROCKET FAILURE OF FIXED BICYCLE USING ACOUSTIC EMISSION AND VIBRATION ANALYSIS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Bachelor of Mechanical Engineering Technology Maintenance Technology) (Honours)

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

……

(Mr. Muhamad Azwar Bin Azhari)

ABSTRAK

Getaran adalah gerakan ayunan yang berkenaan pada titik keseimbangan. Kebanyakan getaran yang tidak diingini dalam mesin dan struktur kerana mereka menyebabkan kehilangan tenaga ,menyebabkan kehakisan, meningkatkan beban galas, mewujudkan ketidakselesaan penumpang dalam menunggang basikal dan menyerap tenaga daripada sistem. Basikal gegancu hadapan adalah salah satu bahagian yang penting dalam basikal. Pergerakan gegancu hadapan akan membawa kepada sentuhan mengejut dengan rantai dan menyebabkan kehakisan. Jadi, untuk mengatasi kegagalan ini kami menggunakan kaedah baru melalui pancaran akustik dan bukannya analisis getaran. Pelepasan akustik adalah fenomena radiasi gelombang akustik dalam pepejal yang berlaku apabila bahannya yang mengalami perubahan tidak dapat dipulihkan dalam struktur dalamannya , contohnya akibat pembentukan retak. Perbezaan daripada analisis getaran ialah pelepasan akustik memberikan ukuran yang tepat pada kegagalan gegancu hadapan sewaktu dalam pergerakannya.Terdapat tiga sampel yang digunakan dalam ujian ini, dengan sampel A, B dan C. Saiz untuk setiap sampel adalah nombor 22, 32 dan 42 gigi masing-masing. Selain itu, dua keadaan yang berbeza telah diuji untuk memberi lebih banyak hasil afektif untuk mengesan kegagalan gegancu depan. Pada asasnya, saiz yang berbeza daripada gegancu sama sekali tidak menjejaskan hasilnya. Pada akhirnya, kedua-dua ujian itu menunjukkan kenaikan data dalam keadaan rosak berbanding dengan keadaan normal. Perlaksanaan AE pada kelajuan kadar perlahan memberikan hasil lebih baik berbanding dengan penggunaan analisis getaran.

ABSTRACT

Vibration is a rapid oscillatory motion of an equilibrium point. Most vibrations are undesirable in machines and structures because they produce energy losses, cause added wear, increase bearing loads, create passenger discomfort in riding bicycles and absorb energy from the system. Front sprocket bicycle is one of the important part in bicycle. The moving of the front sprocket will lead to the contact shock with the chain and cause wear. So, in order to overcome this failure we are using new method via acoustic emission instead of vibration analysis. The acoustic emission (AE) is the phenomenon of radiation of acoustic waves in solids that occurs when a material undergoes irreversible changes in its internal structure, for example as a result of crack formation. Difference from vibration analysis, the acoustic emissions provide a direct measure of failure of the front sprocket in action. There are three samples that been used in this test, with sample A, sample B and sample C. The sizes for each sample are 22, 32 and 42 number of teeth respectively. Besides, the two different condition been tested to give more affective result for detecting failure of front sprocket. Basically, the different sizes of the sprockets totally didn‟t affect the result of the sprocket. At the end, both of the test showed an increment of data in defect condition compare to normal condition. The AE application on slow rate speed give more acceptable result rather than vibration analysis.

DEDICATION

I dedicate this project to my parents and family who have given me the opportunity of an education from the best institutions and support throughout my life. I also dedicate this work to my supervisor, En. Muhamad Azwar Bin Azhari who has encouraged me all the way and whose encouragement has made sure that I give it all it takes to finish that which I have started. To all my friends who have been affected in every way possible by this journey. I‟m glad that I can finish up my project and also for experiencing this new knowledge in studying purpose or real life education. Thank you so much for participating till the end.

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My deepest gratitude goes to Allah the Almighty who has provided all that was needed to complete this project and the study for which it was undertaken for. There was never lack or want. Throughout this entire study, He took care of everything that would have stopped me in my tracks and strengthened me even through my most difficult times. Most importantly, none of this could have happened without my family. Thank you for their wise counsel and sympathetic ear. You are always there for me, supported me greatly and were always willing to help me till the end. Thank you for their unflagging love and unconditional support through my life and my studies. You made me live the most unique, magic and carefree childhood that has made me who I am now. I sincere appreciation also goes to my supervisor En. Muhamad Azwar Bin Azhari whose contribution and constructive criticism has pushed me to expend the kind of efforts I have exerted to make this work as original as it can be. In addition, thank you for your excellent cooperation and for all of the opportunities I was given to conduct my research .Thanks to him I have experienced true research and my knowledge on the subject matter has been widened. I will never forget you sir. Finally, there are my friends. We were not only able to support each other by deliberating over our problems and findings, but also happily by talking about things other than just our papers. They were fundamental in supporting me during these stressful and difficult moments.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCULTURE

AC	-	Alternating Current
AE	-	Acoustic Emission
ASTM	-	American Standard Testing Method
CO_2	-	Carbon Dioxide
CPM	_	Cycles Per Minutes
DB	-	Decibel
dB	-	Decibel
F	-	Frequency
FEA	-	Infinite Element Analysis
Hz	-	Hertz
m/s^2	-	millimeter per second square
mm	-	Millimeter
NDT	_	Non-Destructing Method
PC	-	Personal Computer
RPM	-	Rotation Per Minutes
SO	-	Signal Operator
SPL	-	Sound Pressure Level
SPM	-	Stroke Per Minutes
SWM	-	Solid Waste Management
T	-	Time

CHAPTER 1

INTRODUCTION

1.1 Vibration

Vibration is a motion of rapid oscillatory within an equilibrium point. This movement is due to oscillates of force in about some specific or random movement. Vibration can be described in two different concept which are desirable and undesirable. For desirable vibration, the sound propagation is desirable and necessary follow the correct oscillates of various selected devices. The example for desirable motion are the tuning fork, the uses of musical instrument or in harmonica, and the audio signal source such as the loudspeaker that contain lightweight metal cone. Next, the undesirable are often being done. It‟s also called noise, which are creating unwanted sound and wasting of energy. In example, the vibrations of any mechanical devices or engines in operation. Other vibrations that caused by unbalanced of rotating parts of gear that may cause frictions or wear as shown in Figure 1.1 (William , 2012).

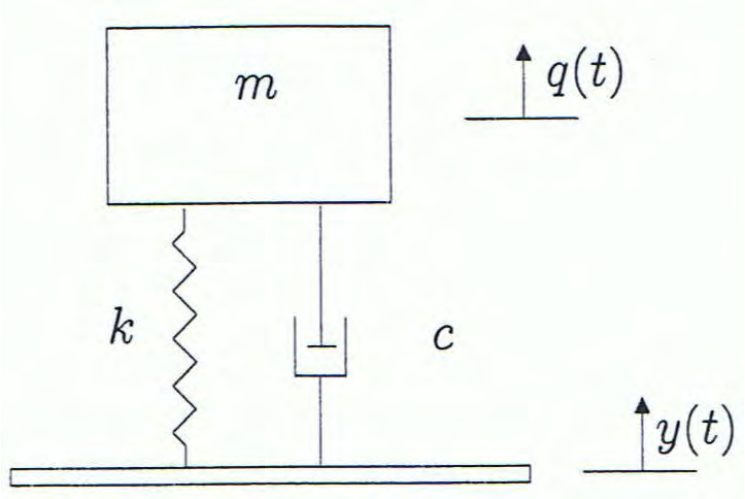

Figure 1.1: A schematic of mass spring damper on the ground. (Joachim, 2010).

Vibration generally expressed in terms of frequency such as Hertz (Hz) or cycles per second, rotation per minute (rpm) or (cpm) or and strokes per minute (spm). This is the wave of oscillations which occurs in that time period. The amplitude is the magnitude of force in distance of travel. Vibrating source emits sound waves in front and behind source. Sound wave is a wave of energy created by the disturbance of air around a vibrating source. The waves of sound energy move out in all directions coming from the source. As the wave of pressure expends so it turns into almost spherical and this spherical expansion causes a rapid increases of energy distance or decrease in sound intensity. (Osama ,2009).

In rotating machine parts needs to be careful in order to prevent damage from excessive vibrations. It‟s also occurs when a system is displaced from a position of equilibrium. (Rao and Srinivas ,2012).

In other hand, vibration in machinery measurements and analysis. There are two general situations that related to the vibration situations. First of all, the situation is to analysis the problem faced on machinery and how to fix the problem. Secondly, the vibrations measurements on checking the routine of the machine to make sure it follow the standard routine basics. Therefore an appropriate fix have been done to make sure that all the machine in good condition. (Victor, 1991)

There‟re two types of vibration under vibration analysis. There‟re free vibration and forced vibration. The free vibration happens due to natural frequency. Example, vibration of a building during an earthquake. There are divided into two, free vibration without damping and free vibration with damping. Secondly, the forced vibration caused by the add of harmonic force. For example, generated by a rotating imbalance. In addition, this force divided into two types forced vibration with damping and forced vibration without damping. (William , 2012)

1.2 Bicycle Vibration

About three or four centuries ago, Jacques Ozanam the French mathematician invented a new benefits of carriage by human powered in which one can drive oneself wherever one pleases, without horses. The French‟s inventor stated that the owner of the bicycle as shown in Figure 1.2 below could even enjoy a healthy exercise without having to take care for an animal by moving freely along the road. (David , 2004).

Figure 1.2: Parts of a bicycle (Joachim, 2010)

It‟s was originally manufactured in France and Germany. Hans-Erhard Lessing, one of the inventor found the circumstantial evidence that Drais' interest in finding an alternative way to overcome starvation and death of the horses, caused by crop failure in early 18‟s. Besides that, during that moment the development of the bicycle was the most successful inventor in the history. It also bring an impact to their own use and also public awareness from being a dangerous toy for sporting young men to being an everyday transportation for women and men for all of ages.

To increase the awareness for an environment can cost gradually higher for gasoline that makes bicycles more attractive the before for short-distance traffic. It‟s important setup of cycling trails to gets more significant not only for safety causes but also for the part of cycling discomfort. Besides, due to higher cost of gasoline. It‟s shows that less people are using the car as their main transportation. Besides, it will cause less traffic through the entire cities and also attract more people about an awareness of the protection of an environment in cycling. Therefore, this will increase the development of bicycle because more people are using bicycles as shown in Figure 1.2. (Christin et al., 2012).

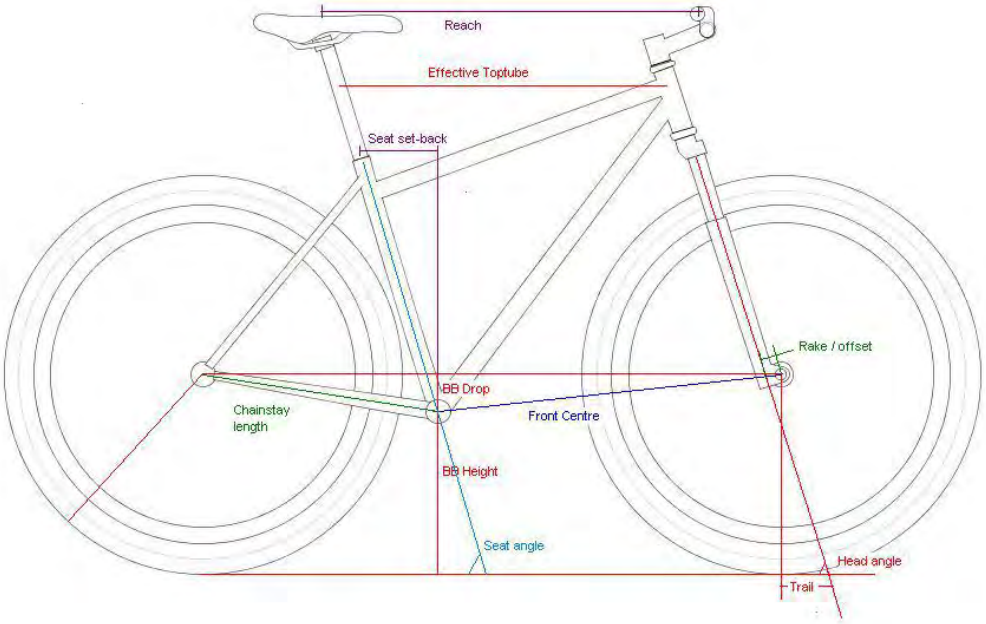

Figure 1.3: Mountain Bike Geometry Diagram (David , 2006)

In a bicycle structure contains many fragments and parts. Some of the main parts are wheels, handle bars, frame, saddle, wheels, and gear components. Besides, also could consider that the helmet as one of the safety equipment in order to prevent any injuries. First of all, wheels give the ultimate purpose to the bicycle itself. A bicycle wheel contains a hub, spokes, rim, tire, and tube. Different material properties may require for each part of the wheel. Next, the frame is the core and main components to the bicycle as a key complete of functional unit. On the other hand, deciding material play an important role by understanding it strength and weight (i.e. strength/density materials and processing). But a part of them all, a major consideration is the design of the tube frame. In addition, the gear components together with mechanical parts: consider everything but with the wheel, frame, seat and handle bars. Same goes that, the ,material give an importance role on selecting the components. After that, the focus is parts function, wear, cost and weight. Beside all of the above, examples of the bicycle parts are brake/shifting levers, crank, rear derailleur, front derailleur, cassette, and chain system. Lastly, the helmet materials will be considered individually from the other bicycle components. But generally, crushable foams are the standard helmet materials. Helmet design factors are cost, weight and safety. (Andrew , 2003).

1.3 Gear And Sprocket Vibration Analysis

Bicycle gearing is the part of a bicycle drive train. It will control the required speed that needed by the cyclist. Besides that, it will determines the relation between the rate at which the drive wheel turns and rate at which the cyclist pedals. Some of the bicycles, there is only one gear and it‟s fixed. Many existing bicycles contains multiple gear ratios and have multiple gears. A shifting mechanism allows selection of the suitable gear ratio for effectiveness or relaxation under the normal circumstances. For example, it may be comfortable by using low gear when cycling uphill, high gear when cycling downhill and a medium gear when cycling on flat road. Different gear ranges and gear ratios are appropriate for different people, styles of cycling and circumference.

Derailleur gears are one of the gear system in variable ratio transmission system. This system generally used on bicycles, a chain system, front and rear sprockets of different sizes, and also the tendency to move the chain of the sprocket from one to another. Even been referred to as gears in the bike world, these bicycle gears are technically sprockets. Since they contain drive or are driven by a chain and not by itself.

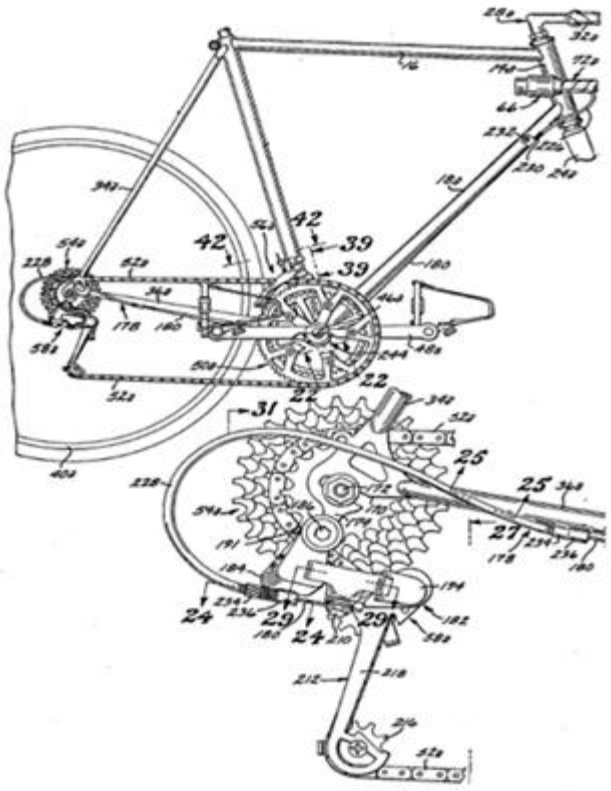

Figure 1.4 : An enlarged fragmentary side elevational view of another bicycle embodying front and rear gear (Sam, 1989).

A bicycle derailleur gear shifting system as shown in Figure 4 above having a derailleur shifting mechanism that is coupled with a rotatable handgrip actuator cam through a control cable system. They are two different actuator cam associated with the rear and front derailleurs. (Sam, 1989).

While a sprocket or sprocket gear is known as wheel with teeth, cogs, or even sprockets that mesh with a chain, track or any indented material. The name 'sprocket' applies commonly to any wheel upon which engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed directly and differs from a pulley in that sprocket in Figure 1.5 that contains teeth and pulleys that are smooth.

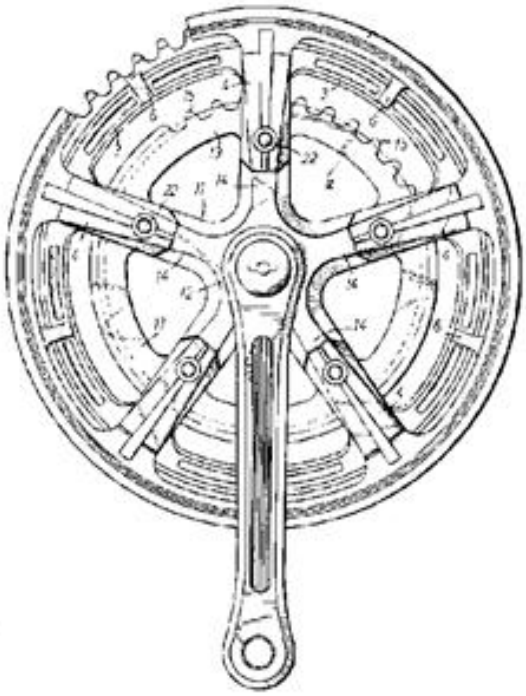

Figure 1.5: Shows the front sprocket wheel for bicycle (Yasushi, 1982)

A front sprocket wheel for bicycles which comprises an annual member in the form of integral molding made of plastic or including chain guard. Besides the front sprocket wheels having a chain guard are use in bicycles that contains inner gear and outer gear. The outer gear diametrically larger than inner gear. (Yasushi, 1982).

Sprockets are utilized in bicycles, cars, motorcycles, tracked conveyances and other machinery either to transmit rotary kinetics between two shafts where gears are unsuitable. Perhaps the most mundane form of sprocket may be found in the bicycle, in which the pedal shaft carries an immensely huge sprocket-wheel, which drives a chain, which in turn, drives a little sprocket on the axle of the rear wheel. Early automobiles were additionally largely driven by sprocket and chain mechanism, a practice largely replicated from bicycles.

Same time a sprocket may be kenned known as concerning illustration wheel for teeth, cogs, or indeed sprockets that network for a chain or different indented material. The division 'sprocket' applies by to whatever wheel whereupon remains of spiral projections captivate a chain over it again. It will be separated from a gear in that sprockets that never coincided together directly. Other than that, more varies starting with a pulley in that sprockets need teeth and pulleys that are smooth.