STUDY THE FAILURE PHENOMENON ON PROTON WAJA'S DOOR HANDLE AND REDESIGN THE MODEL TO REDUCE FAILURE

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The PSM (Projek Sarjana Muda) report is considered as one of the essential for students to complete their bachelor program in Mechanical Engineering (Automotive)

Faculty of Mechanical
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"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya telah jelaskan sumbernya"

Tandatangan : ....
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Tarikh : 13-05-08

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DEDICATION

To my beloved mother, father, brother and sister, and all my friends
All member of Bachelor of Mechanical Engineering : Automotive (BMCA)
All lecturers from BMCA department
Staff of Faculty Mechanical Engineering
Staff of Universiti Teknikal Malaysia Melaka (UTEM)

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With the name of Allah, The Most Gracious and Most Merciful

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ABSTRACT

The nation's automotive industries have increased tremendously during the recent years. In Malaysia, Proton is one of the automotive industries companies which are top among the Malaysian car users. As a manufacturer of Waja car, Proton basically has improved their research and development in order to ensure that Waja car satisfies the highly standard for quality. However, customers have been facing many problems since the first model was launched. The problems include electrical system, body, power window and door handle. Door handle failure is one the major problems which frequently occur on Waja's car and this failure can impact the overall satisfaction of the users. In order to get better understanding on the failure mechanism of the door handle, failure analysis is required to determine causes so that changes can be made to minimize the failure. Finite element approach is used in the study by using CATIA Analysis. This project also investigates how to reduce failure phenomenon of Waja's door handle. It includes thickness and diameter modification, material modification and some concentration in parameters of injection molding process. It is found that, by increasing the thickness, the stress concentration at the failure area reduced. Material selection also has an important implication on the door handle performance. It is because the proper material properties reduce the possibility of failure on door handle.

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ABSTRAK

Bidang automotif negara telah berkembang secara mendadak akhir-akhir ini. Di Malaysia, Proton merupakan sebuah syarikat industri automotif yang menjadi pengeluar utama kereta bagi pengguna di Malaysia. Sebagai pengeluar kereta Waja, Proton secara umumnya telah meningkatkan kajian dan pembangunan untuk memastikan Waja menepati citaras kereta berkualiti tinggi. Walau bagaimanpun, pelanggan menghadapi banyak masalah sejak model pertama di lancarkan. Masalah yang dihadapi termasuklah sistem elektrik, power window, body, dan pembuka pintu. Kerosakan pembuka pintu begitu kerap terjadi pada kereta Waja dan kerosakan ini boleh merosakan keseluruhan kepercayaan pengguna. Bagi memastikan lebih kefahaman terhadap mekanisme kerosakan pembuka pintu tersebut, analisis kerosakan diperlukan untuk memastikan punca kerosakan dan perubahan yang boleh dilakukan bagi mengurangkan kerosakan. Unsur terbatas (Finite element) digunakan didalam kajian dengan mengunakan CATIA Analysis. Ujian ketumpatan juga dilakukan untuk menentukan fenomena kerosakan pada pembuka pintu kereta Waja. Kajian ini juga menyiasat bagaimana cara untuk mengurangkan fenomena kerosaakan pembuka pintu kereta Waja. Ianya termasuk pengubahsuaian ketebalan dan ukurlilit, pengubahsuain bahan yang di gunakan, dan tumpuan pada proses suntikan penbentukan. Di dapati bahawa dengan meningkatkan ketebalan, penumpuan tegasan di tempat kerosakan dapat dikurangkan. Pemilihan bahan yang digunakan juga penting membabitkan prestasi pembuka pintu. Ini kerana pengunaan bahan yang betul mengurangkan kemungkinan kerosakan pada pembuka pintu.

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LIST OF ABBREVIATIONS

SYMBOL		DEFINITION
σ_c	-	Critical stress
Kc	-	Critical Stress Intensity Factor
K_{IC}	-	Fracture Toughness of material
E	-	Young Modulus
ν	-	Poison ratio
a	-	Length of crack
h	-	Length of plate
b	-	Width of plate
S_f	-	Fatigue strength
N	-	Number of cycle
S_e	-	Endurance limit
S_{ut}	-	Ultimate tensile strength
F	-	Force
σ_{Ym}	-	Yield stress of the material
σ_{VM}	-	Von Misses stress

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CHAPTER I

INTRODUCTION

1.1 Introduction

Perusahaan Otomobil Nasional Berhad (PROTON) incorporated on May 7, 1983 to assemble, manufacture, and sell motor vehicles and related products, including accessories, spare parts and other components. PROTON produced Malaysia's first car, the Proton SAGA, commercially launched on July 9, 1985 by Malaysian Prime Minister at that time, Tun Dr. Mahathir Mohamad, who had firstly conceived the idea of producing a Malaysian car. PROTON model line up includes the Waja, Satria, GTi, Wira, Iswara, Arena, Perdana V6, Juara , Gen-2 and the latest is Persona. The range of 1.3, 1.5, 1.6, 1.8, and 2.0 liter engines satisfies a wide spectrum of customers both locally and abroad. PROTON made a major step in upgrading its engineering capabilities with the acquisition of Lotus Group International Limited, a British automotive engineering company and manufacturer of luxury sports cars in October 1996. Together, PROTON and Lotus offer large-scale manufacturing capabilities with excellent engineering expertise.

PROTON cars are making their mark internationally as competitive and innovative automobiles. They are being exported to 50 countries including the highly competitive United Kingdom and continental European markets. The latest strategy, they try to enter the West Asian countries such as Kuwait, Oman, Syria, Qatar, Iran and Asian countries like Brunei and Singapore.

One of the top models manufactured by PROTON is Proton Waja. The first Proton Waja was produced on September 2000 at Medium Volume Factory (MVF), which is next to the main plant at Shah Alam. There are four types of Proton Waja which is 1.6 A, 1.6 M, 1.8 A and 1.8 M. Petrol blue, artic blue, silver and indium color of Proton Waja makes Proton Waja more stylish compare to the other car.

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Proton Waja using 4G18 with emission standard of EC 94/12 engine. The maximum power is 76 KW / 6000 rpm and maximum torque is 140 Nm / 2750 rpm.

Since it was produced on September 2000, Proton Waja has faced many problems in terms of engine performance, body, electrical and electronic system and certain parts malfunction. Door handle failure is one of the major problems which frequently occur on Waja and most of the Waja's users have ever facing a problem of the door handle while using it.

There are two company supply the door handle to the Proton. There are EP Polymer and Delloyd Industries Sdn. Bhd.. EP Polymer is the first company that supplied door handle to the Proton but now Delloyd Industries Sdn. Bhd. has taken the place due to the problems that the previous company couldn't overcome.

Failure of door handle is normally un-expected and often occurs abruptly. Failure is refer to any malfunction or deviation from the normal that significantly detracts from performance. Failure of door handle is a very complex matter that may be fully within the normal expectation or maybe unexpected depending on material, design, processing and service conditions. Figure 1.1 shows the component of the door handle that believe gives problem to almost all Waja's users.

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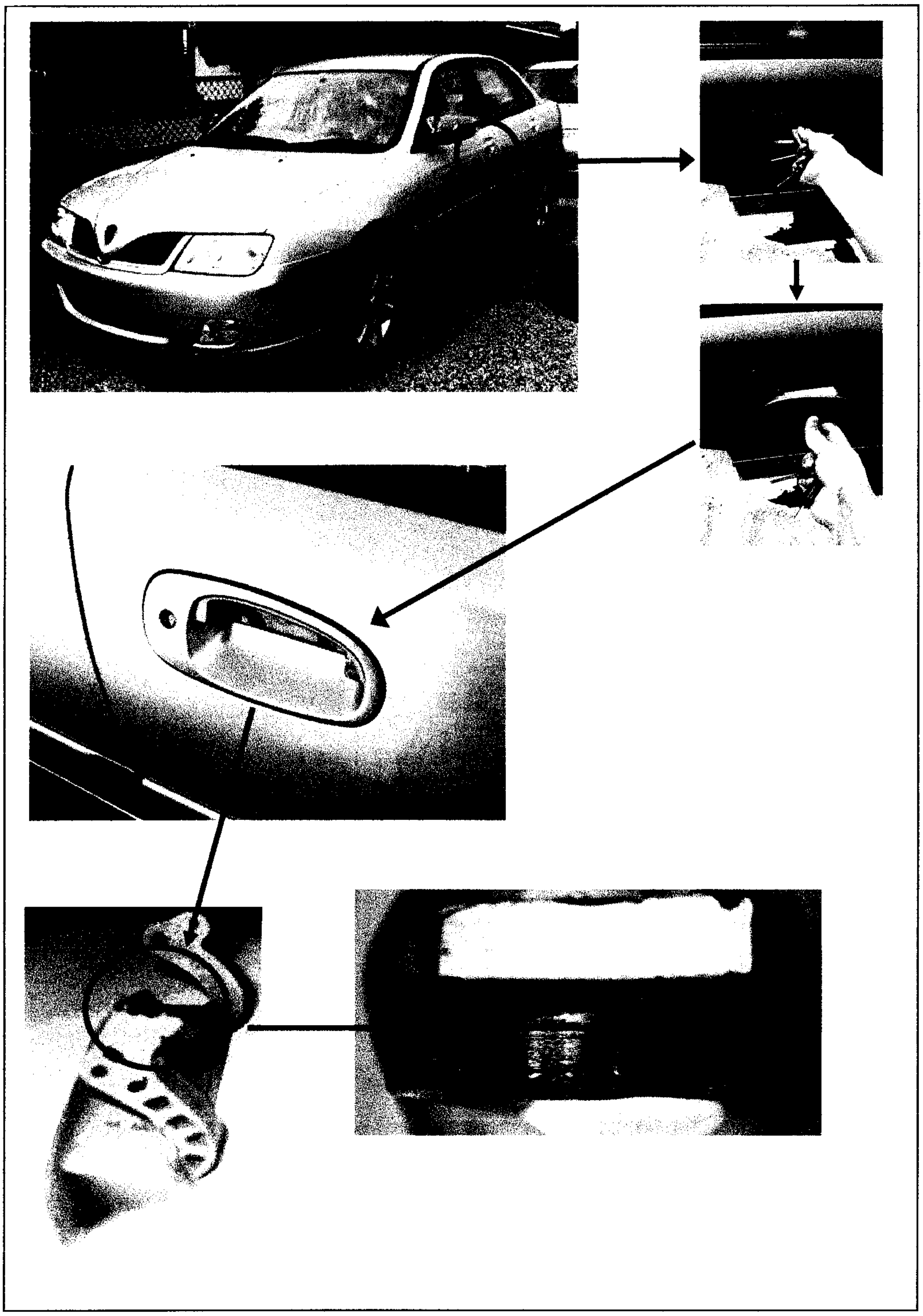

Figure 1.1 Failure phenomena of Proton Waja door handle

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1.2 Objective

The main aim of the project is to study the failure phenomenon on Proton Waja door handle by emphasizes on the properties of the material, failure characteristics in terms of fatigue failure and fracture mechanics. The other objective is to investigate the stress concentration using finite element method. This study emphasizes on the stress distribution at Proton Waja door handle. It is hoped that by performing this project, few justifications could make on the door handles failure phenomenon, which occurs at Waja car. Lastly, this project also hopes to investigate any approach that can be carried out to minimize the problem of this door handle.

1.3 Scope of The Project

This project involves experimental and analytical investigation of Proton Waja's door handle. Specimens of failure door handle are collected for the purpose of identification of failure behaviors by referring to the fracture surface and the different factor of failure. The fracture surface of the failure door handle is investigated using microscope. The experimental result will be analyzed to identify the possible factor of failure.

Since the failures are believed due to fatigue behaviors, an approach of fatigue failure is used. This criterion can determine the performance of the component at certain cyclic loading. The analytical or mathematical approach is used to obtain the fatigue failure and fracture mechanics criteria.

The calculated data is then entered in the computer for finite element analysis. For the first step , Proton Waja door handle model will be redrawn using CATIA and the next step is analysis the model using CATIA.

Before the part of failure door handle are analysed, several basic understanding in terms of methods of fabrication, materials used and design gained as the reference in performing the analysis of failure door handle.

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CHAPTER II

LITERATURE REVIEW

2.1 Theory of Failure

When a component is subject to increasing loads it eventually fails. It is comparatively easy to determine the point of failure of a component subject to a single tensile force. The strength data on the material identifies this strength. However when the material is subject to a number of loads in different directions some of which are tensile and some of which are shear, then the determination of the point of failure is more complicated

Failure is a malfunction or deviation from the norm that significantly detracts from performance. Excessive plastic deformation or shrinkage, wear or loss of attractive appearance may constitute failure just as much as fracture does. At a times several different modes may combine to produce the resultant failure.

Figure 2.1 shows a plastic washer or seal for a water faucet valve. It had been in service 15 years for hot and cold water. It illustrates the type of fracture that occurs starting at screw holes under pressure of tightened screws and extending into the rest of the part. Figure 2.2 shows a part of a typical polystyrene fatigue fracture surface and it shows two main features, a series of concentric rings and a smooth region. The smooth region surrounding the source is indication of crack propagation through a surface craze.

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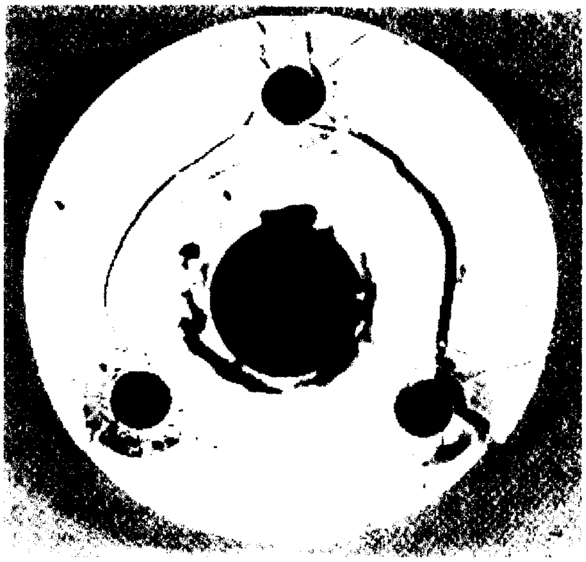

Figure 2.1 Fracture of water faucet seal around screw holes. It had been in service with hot and cold water for about 15 years.

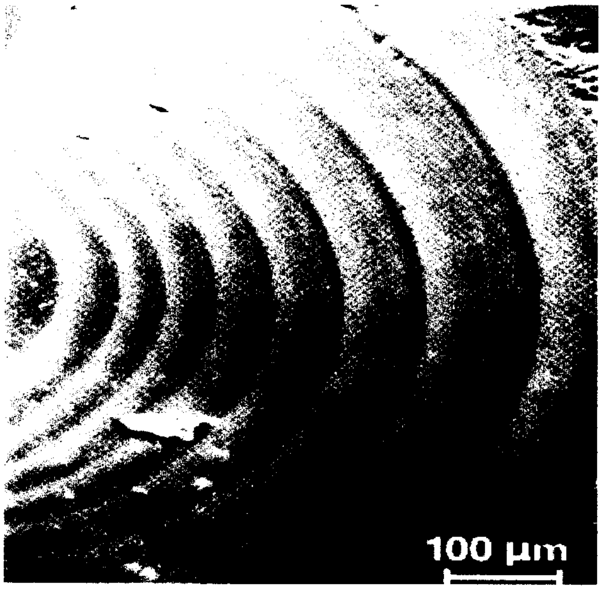

Figure 2.2 Fatigue fracture surface of polystyrene

Failure is the one case may be the intended result in another. High orientation or frozen in stress is usually undesirable in most products, causing shrinkage, distortion and cracking to relieve the stress . While high orientation is required for some application such as fibers or living hinges many plastic are designed for one time, disposable service. If they break when someone make multiple or improper use of them, that should

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not be consider failure in the usual sense. At the other end of the service life spectrum are applications requiring life of many years. Failure is to be judged in the light of the product design and expected service life.

In the case of my study, the failure of Waja's door handle occurs when the part cannot give a service after fracture. The part must be replaced by a new part to give back its function. Figure 2.3 shows a fracture of the Proton Waja's door handle. The fracture occurs at the end of the part that is connected to the connecting rod. Higher stress at that area is believed to be the main factor contributing to the fracture. The severity of service plays a role but it appears that this product is operating near its limit of strength.

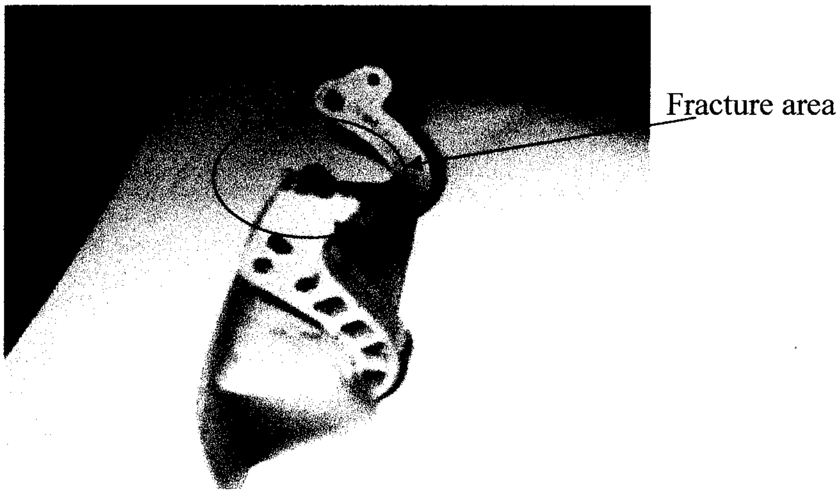

Figure 2.3 Fracture of the Proton Waja's door handle

2.1.1 Common Features and Differences in Performance or Failure of All Material

Basically, the failure of the plastic material must be considered by the manufacturer to ensure a good product can be produced. There are four major areas that need to be considered as follows:

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1. Material – the polymer or polymers plus all additives and contamination
2. Design – dimensions, reinforcements, stress sites,etc
3. Processing- thermal and orientation effect, degradation during processing, uniform dispersion of material, etc
4. Service condition – heat, humidity, outdoor exposure, chemical resistance, fatigue, etc

The first three are chosen to satisfy the service requirement. Failure is the result of inadequacy in material, design, processing, or end use. There often is considerable interaction of the four factors. One design may tolerate greater variation in material characteristic, such as molecular weight than another design. If sufficient design reinforcements are used, and areas of stress concentration are minimized, the part performance may not depend so much on material properties .

Service conditions are unpredictable and may be underestimated. Furthermore, the simultaneous application of two conditions may cause failure in a way and in a time frame that would not likely occur under the influence of each alone. A common example is environmental stress cracking, to which polyethylene is particularly prone. A chemical alone, not under stress, or stress in the absence of chemical agent, are much less likely to cause failure than when the two conditions are applied together. One of the subtle of failure analysis is that stress sufficient to interact with environmental stress-cracking agents to cause failure may be present within the part as a result of processing.

Figure 2.4 shows a clothes pin that broke under the stress of the spring. The severity of service plays a role, but it appears that this product is operating near its limit of strength. Variables within their normal statistical distribution, such as composition, molding stresses, the spring force, etc can contribute to fracture.

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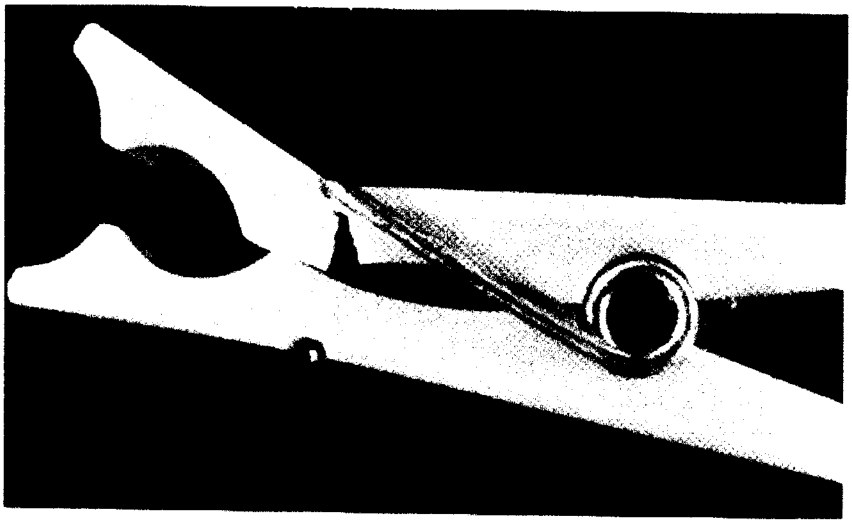

Figure 2.4 Fractured impact polystyrene clothespin cracked at the pin arm

The trick is to introduce into a satisfactory, economical part as little frozen in stress as possible such that it will not fail within its expected service life. Improper processing will make the degree of orientation is lower than needed to achieved the required shrinkage, that product failed for a reason that most other plastics processors work very hard to have in their product ,i.e., a low level of frozen in stress

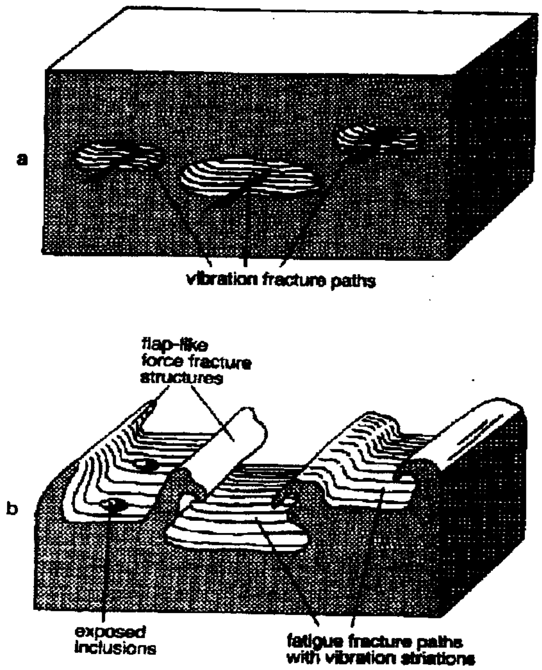

Figure 2.5 Propagation of fatigue fracture within staggered fatigue striation in ductile polymers.

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