# ANALYSIS THE I BEAM SUBJECTED TO THREE POINT LOADING OR BENDING FOR DIFFERENT MATERIAL

ADLI ZIL IKRAM BIN ABDULLAH

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**SUPERVISOR DECLARATION**

"I hereby declared that I have read through this thesis and in my opinion this report is sufficient in terms of scope and quality for awarding the Degree of Bachelor Mechanical Engineering (Design & Innovation)."

Signature : ……

Supervisor : Mr. Dr Mohd Basri bin Ali

Date : …….

# ANALYSIS THE I BEAM SUBJECTED TO THREE POINT LOADING OR BENDING FOR DIFFERENT MATERIAL

**ADLI ZIL IKRAM BIN ABDULLAH**

**"This report is prepared in fulfillment for awarding the Degree of Bachelor Mechanical Engineering (Design & Innovation)."**

**Faculty of Mechanical Engineering**

**Universiti Teknikal Malaysia Melaka**

**JUNE 2013**

**DECLARATION**

"I hereby declared that this report is a result of my own work except for the works that have been cited clearly in the references."

Signature : ……

Name : Adli Zil Ikram Bin Abdullah

Date : ……

Dedicate to

My beloved mother Che Eshah Binti Hamzah

My father Abdullah Bin Muda

My supervisor ENGR Dr Mohd Basri bin Ali

## ACKNOWLEDGEMENT

First of all, thank to my Allah The Almighty God for giving me a bless to complete my final year project. Also I would like to express my acknowledgement to my former supervisor, Mr. Basri bin Ali for guiding and encouraging me to write the best thesis. Not forgot to all member of Bachelor of Mechanical Engineering (Design and Innovation) for giving me moral support and for being my references in order to complete their task. My Allah blesses you all. Not to forget, my family who support me from the bottom to the top through this year. Thank for their concern, encouragement and understanding. Last but not list, to those who have contributed directly or indirectly to the success of this thesis and project whom I have not mentioned their name specifically. Without them, there will be no successful this thesis.

# ABSTRAK

Laporan ini membincangkan tentang reka bentuk, analisis dan hubung kait antara tegasan dan terikan rasuk I menggunakan bahan yang berbeza. Bahan yang dipilih adalah keluli (besi), loyang dan aluminium. Ia adalah bahan umum yang selalu digunakan dalam pembinaan struktur. Rasuk I akan dibuat mengikut dimensi skala sebenar dengan mengecilkan nisbah dari skala sebenar iaitu 30 mm x 30 mm x 300 mm untuk dijadikan bahan eksperimen. Selain itu, laporan ini membincangkan prosedur analitikal untuk rasuk ini. Ia merangkumi kajian sifat terikan dan pembengkokan yang disebabkan oleh beban. Kemudian, berdasarkan data yang diperolehi, anggaran untuk muatan maksima untuk rasuk I ini akan dibuat dengan mengambil kira perubahan tegasan yang berlaku pada rasuk menggunakan tolok terikan. Analisis yang dilakukan adalah berdasarkan teori dan ujikaji atau eksperimen. Persedian untuk melakukan ujikaji ini adalah dengan membuat kajian literatur berdasarkan elemen yang menjadi pemboleh ubah di dalam eksperimen. Ia merangkumi kajian tentang elemen – elemen berkaitan dengan rasuk, tegasan, terikan, pesongan dan teori serta formula yang berkaitan. Kemudian, kajian literatur juga dibuat terhadap kajian – kajian yang telah dibuat yang berkaitan dengan kajian ini. Ini bertujuan untuk mengkaji serta memahami konsep dan pendekatan metodologi yang digunakan, mengkaji kelebihan dan kekurangan di dalam kajian tersebut dan melihat hasil yang diperolehi dari kajian mereka. Untuk metodologi, laporan ini membincangkan aspek – aspek penting untuk ujikaji seperti prosedur ujikaji, penyediaan peralatan dan spesimen, dan permasangan alatan seperti tolok terikan. Dalam kajian ini, keputusan yang diperolehi dalam eksperimen dan data yang diperolehi dari teori menggunakan kaedah Castigliano dibandingkan dan

dibincangkan dengan terperinci. Ketepatan setiap teknik dapat ditentukan berdasarkan analisis yg telah dibuat serta keputusan yang telah diperolehi. Perkara yang mempengaruhi keputusan juga dapat dikenalpasti dan dibincangkan terutama perbezaan bahan yang menjadi pemboleh ubah dimanipulasi dalam uji kaji ini. Hubungkait antara tegasan dan terikan telah diperolehi daripada hasil kajian iaitu tegasan berkadar terus dengan terikan yang memenuhi hukum Hooke. Keputusan yang diperolehi dari kajian ini adalah rasuk I daripada keluli adalah lebih baik daripada aluminium dan loyang dari segi data terikan dan pembengkokan. Keputusan ini adalah tepat berdasarkan kajian literatur iaitu terikan dan pembengkokan berkadar songsang dengan modulus keanjalan. Perbezaan yang sedikit diantara data yang diperolehi dalam eksperimen dan pengiraan  melalui persamaan teori membuktikan kajian ini berjaya mencapai objektif yang dikehendaki.

## ABSTRACT

This report discussed about the shape, analysis and relationship between stress and strain of I beam by using different types materials. Materials selected are mild steel, brass and aluminum. It is the common materials that is used in structural. The i beam will be made to follow the actual dimension scale by using a ratio of the actual dimension. In addition, this report discussed an analytical procedures for the I beam. It consist of study of stress and strain characteristics, and deflection caused by the loads. Then, based on the data obtained, the estimation of maximum load carrying capacity for the I beam will be made by taking into consideration the change of stress that occurs along the beam by using the application of strain gauges. The analysis carried out based on the theory and experiment. Preparation of the experiment is made by doing the literature study on the related elements in this study and experiment. It consists of elements of beams, stress, strain, deflection and related formula and theory. Then, the literaure study is also made on the related previous research for studying and understanding the the concept and methodology used assess strengths and weaknesses in these studies and study the results of their thesis. For methodolgy, this thesis discussed the important aspects for experiment such as the procedures, materials preparation and apparatus installation. In this research, the results of all analyze techniques and methods are compared and briefly discussed. In this study, the results obtained in the experimental and theoretical data obtained from Castigliano methods are compared and discussed in detail. The accuracy of each technique can be determined based result obtained. The factor that affected the results has been identified and discussed especially types of materials as it is the main manipluation variables in this study. Lastly, the relationship of stress and strain

can be determined from the finding of this thesis which is stress is directly proportional to strain which obey the Hooke's Law. The results obtained from this study is the I-beam of steel is better than aluminum and brass in terms of strain and bending. The results are accurate based on the literature review as strain and deflection is inversely proportional to the modulus of elasticity. The slightly differences between the data obtained in the experiment and calculation by the theoretical equation prove this study achieved the desired objectives.

# TABLE OF CONTENT

# LIST OF TABLE

## LIST OF FIGURE

## ANNOTATION AND ABBREVIATION

| | | |
|---|---|---|
| UTS | = | Ultimate Tensile Strength |
| TS | = | Tensile Strength |
| Pa | = | Pascal |
| Mpa | = | Megapascals |
| SMYS | = | Specified Minimum Yield Strength |
| UteM | = | Universiti Teknikal Malaysia Melaka |
| mm | = | Milimeter |
| m | = | Meter |
| kg | = | Kilogram |
| g | = | Gram |
| N | = | Newton |
| kN | = | Kilo Newton |
| kNm | = | Kilo Newtom Meter |

## LIST OF APPENDIX

# CHAPTER 1

# INTRODUCTION

## 1.1 BACKGROUND

A bridge is a structure that connects a gap for example river, roadway, and valley for giving access to people and moving vehicles to places which beforehand were not available to access in the first place. For example to cross a river and get to the other side (Blagovest, 2004). The traffic that uses a bridge consist of people or vehicles. There are many type of bridge depend on it purpose and use. The common type of bridges are beam bridge, cantilever bridge, truss bridges and arch bridges. The design are accounted depending on the the action of the bridge, the attributes of the area area the bridge is constructed, the actual acclimated to accomplish it and the funds accessible to body it. The failure of bridges is one of main concern for structural engineers and contractor in trying to improve bridge design, construction and maintenance (Blagovest, 2004). The important things is the bridge should be designed such that it is safe, aesthetically pleasing, and conservative as it involve the lives of people that use it when something happen to the bridge.In the construction of pre-tensioned or post-tensioned beam bridges, a very common problem that most contractors faced was to actuate and estimate the actual upward deflection of beams due to prestressing (Loo, 2010). In other word, we need to able to estimate the deflection of beam in the sturucture due to bending. From the statements above, the objectives were stated as to design the ideal shape of I beam, to determine the strain stress behavior using strain gauge for different materials and To investigate the deflection of beam between experiment and theory with by using Castigliano's Theorem method.

Stress-strain analysis of a material is restricted to confirm a large number of its physical properties. With the information progressed through much investigation, one can foresee how a material structure will respond when a loads are placed on it. This can be proved when the results obained from this experiment give the desired result which same with the theorem statement. As the Castigliano's Theorem state that the deflection and strain is inversely proportional to Young Modulus, the results are also give the same flow as the I Beam from mild steel give the better result inn strain and deflection compared to brass and aluminium.

A diagnostic fix in few push elastic - plastic speculation is exhibited for the immaculate bowing shaft under minor twisting. This fix recognizes the impacts of both versatile distortion and plastic deformation,and gives the connection between the instant M and the arch κ verifiably (Jin and Chen, 2010). There are countless different types of beam designs and materials in the market at the point that composing a structure. Engineer and contractor can choose different shapes, sizes, development materials, and development methods depend on suitability of construction.. Settling on the best materials and shape for a specific structure could be a muddled process. Structural designers and manufacturers have countless different types of beam designs and materials when endeavoring to make an structural configuration. Measuring bending stress is a main part of structural designing. Measuring bending stress confirms what amount of burden a structure can loads before it failed. Assembling structurally sound ventures is the main objective of succesfull structural designing (Loo, 2010).

## 1.2 PROBLEM STATEMENT

Research show that many applications have limitation on the amount of deflection that can be tolerated especially in a sturcture (Roylance, 2000). The structure will face a collapse or failure when the the amount of deflection exceeded. Unfortunately, this accident will endager many lives if many lives use the structure

in daily life or during the accident occurs. The development of extensions is the consequence of a blend of infrastructures in development materials, structural shapes, what is more configuration and dissection strategies. Composite structures were acquainted with serve as a greatly aggressive sort of connect equivalent to regular sorts of extensions for example cement and prestressed solid scaffolds because of their lessened weight and snappy and practical erection (Hayward et al. 1988). Therefore the prediction of deflection is important and must be studied. The prediction of deflection is one of part of structure analysis. When deciding to analyze the structure, engineer must know the basic part and concept of structure. In engineering, a structre is defined as a body or assemblage of bodies that capable to support loads. The structure elements or part are column,beam and trusses. There are a few method of structural analysis which are elasticity method, numerical approximation method and material strength method (Felipa, 2000). The most popular or close with deflection tolerate are bending. There are many researchers have been done related to subjected bending for analyzing the strain stress behavior of the specimen. They usually use the size, design and materials as their variables. The researches commonly focused on the bar shape because it is the basic shape. Therefore, this report will change the shape to the I Beam shape as realize the shape is extensively used in construction such as rail train, bridge and buildings. This report will focused on materials as variable by use mild steel, brass and aluminum as the main material of specimens. The choice of these three types of materials is that because this material is often used in the construction industry.

## 1.3 OBJECTIVE

The aim of this study is to analysis the I beam subjected to three point bending for different materials in term od strain stress and deflection.

The objective of this project is as follow:

1. To design the ideal shape of I beam.

2. To determine the strain stress behavior using strain gauge for different materials.

3. To investigate the deflection of beam between experiment and theory with by using Castigliano's Theorem method and Strain Energy Method.

## 1.4 SCOPE

The scope of the study will implement a few of confinements and specifications. Firstly is to design the ideal shape of i beam in real application. I beam shape was selected to analyze as i beam used extensively as reinforcement to a structure especially bridge. Then, analyze I beam based on three different materials which are mild steel, brass and aluminium. This experiment also will use strain gauge to measure strain for each material. The study based on experiment will conducted at Structure and Materials Laboratory in Universiti Teknikal Malaysia Melaka (UTeM). Lastly, the dimension of I Beam is limited to 300 mm x 30 mm x 30 mm as equipment limitation.

## 1.5 SUMMARY OF THE PROJECT

This project are divided into two parts which are Projek Sarjana Muda (PSM) 1 and PSM 2. PSM 1 consists of three chapters which are introduction, literature review and methodology. Introduction discusses on the definition, objectives, scope and problems statement related to the project. Literature review will explain in term of fundamental, method and measurement used to gain the result. Methodology make up of the technique used in obtaining the data of experiment. Result and discussion will be explained in PSM 2. Result and discussion mainly explain about the result and how the data is being analyzed after the implementation of work study. The final chapter is conclusion and the objectives that had been determined before will be concluded in this chapter.

## 1.6 BENEFIT OF PROJECT

There are many benefit of this project. The report can help the engineer to estimate the suitable material for the construction. This is because the dimension of I beam specimen is made according the ratio of the real I beam in the structural field. Then, this report will guide the engineer in investigating the two major of beam characteristics which are strength and stiffness. Strength describes how much load the beam can carry where stiffness describes how much beam deflects when loaded. So, by this researched, engineer can know how much force any structural member can take before it will deform or break.

## 1.7 PLANNING AND EXECUTION

Table 1.1 : Gantt Chart of PSM 1 Research

| RESEARCH ACTIVITES /TIME | SEPTEMBER | | | OKTOBER | | | | NOVEMBER | | | | DISEMBER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W 1 | W 2 | W 3 | W 4 | W 5 | W 6 | W 7 | W 8 | W 9 | W 10 | W 11 | W 12 | W 13 | W 14 |
| Title Selection | | | | | | | | | | | | | | |
| Problem Statement | | | | | | | | | | | | | | |
| Literature Study | | | | | | | | | | | | | | |
| Design Ideal Beam shape (for shaping process) | | | | | | | | | | | | | | |
| Specimen Preparation (order specimen) | | | | | | | | | | | | | | |
| Presentation PSM 1 | | | | | | | | | | | | | | |
| Submision of report and logbook | | | | | | | | | | | | | | |