DEVELOPMENT OF UMP RUNABOUT VEHICLE (URV) FRAME

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ABSTRACT

This project was carried out to develop a specific frame structure for UMP Runabout Vehicle (URV). In carrying out the project, the objective is to develop and analyze the UMP Runabout Vehicle (URV) frame. The URV frame structure had been involved in design and analysis. The material of URV frame had been use aluminum alloy plate. The application of URV will be widely used running in small area such as campus. The methodology of this project was design a new trend of the frame structure and modeling the concept by using CAD software. In this project, 3 generation of URV had been done. Finally, analyze the modeling by using FEA software. This thesis will discuss regarding to certain aspect such as the stress distribution, strain analysis, static displacement, deformation and design check for the model.

ABSTRAK

Projek ini dibangunkan untuk mencipta satu rangka yang khusus untuk UMP Runabout Vehicle (URV). Matlamat projek ini adalah membangunkan dan menganalisis rangka URV. Rangka URV akan melibatkan kemahiran mereka bentuk dan analisa. Rangka URV akan menggunakan kepingan aloi aluminum. Kegunaan URV adalah sesuai digunakan secara luasnya di kawasan yang kecil seperti di kampus. Perkaedahan kepada projek ini adalah reka satu rangka yang mengikuti aliran yang baru. Selain itu, projek ini menggunakan perisian komputer untuk menjalankan pemobelan bagi URV tersebut. Dalam projek ini 3 generasi rangka telah dibentukkan. Akhirnya, ketiga-tiga generasi akan dianalysiskan dengan menggunakan perisian komputer tertentu. Tesis ini akan membincangkan dalam beberapa espek seperti corak tegasan, ketegangan analisa, pengambilaalihan, pencacatan dan pemeriksaan rekaan pada rangka tersebut apabila sesuatu berat diterapkan

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CHAPTER 1

INTRODUCTION

1.1 Project Background

UMP Runabout Vehicle (URV) is a current running project. But there is no particular frame to the URV. So, this project is need to develop a particularly UMP Runabout Vehicle's frame. Basic concept of the URV's frame is made from Aluminum Alloy plate and using epoxy joint to assembly the whole URV frame. The URV is used 50cc engine and there has single strut system at rear of the URV. Final job of installing the URV component required. Lastly, the most important is having a full assessment of the URV and to have a professional testing and evaluate of URV.

1.2 Problem Statement

University Malaysia Pahang Runabout Vehicle (URV) was the final year project for diploma student last year. The project was not properly developed. They did not materialize but it has a strong base. In other words, this project has potential but requires future design and future fabrication.

1.3 Project objective

The objectives of this project are:

- To develop and analyze the UMP Runabout Vehicle (URV) frame

1.4 Scope of Project

- Design the concept of the UMP Runabout Vehicle (URV) by using CAD software
- Analyze the static load on structural of the URV frame by Finite Element Analysis software

1.5 Project Schedule

This project will take 2 semesters to complete. Part one is Final Year Project 1 which is getting project title from faculty and starting getting information about the title. Basically in Final Year Project 1 should be done until chapter 3 which is methodology of the project at end of that duration and also starting to create concept design. Second part is Final Year Project 2 which is complete the whole project at that duration included modeling, optimum the design and analysis. Final element of Final Year project is to write a thesis of the project. Figure 1 show the schedule of the overall Final Year Project

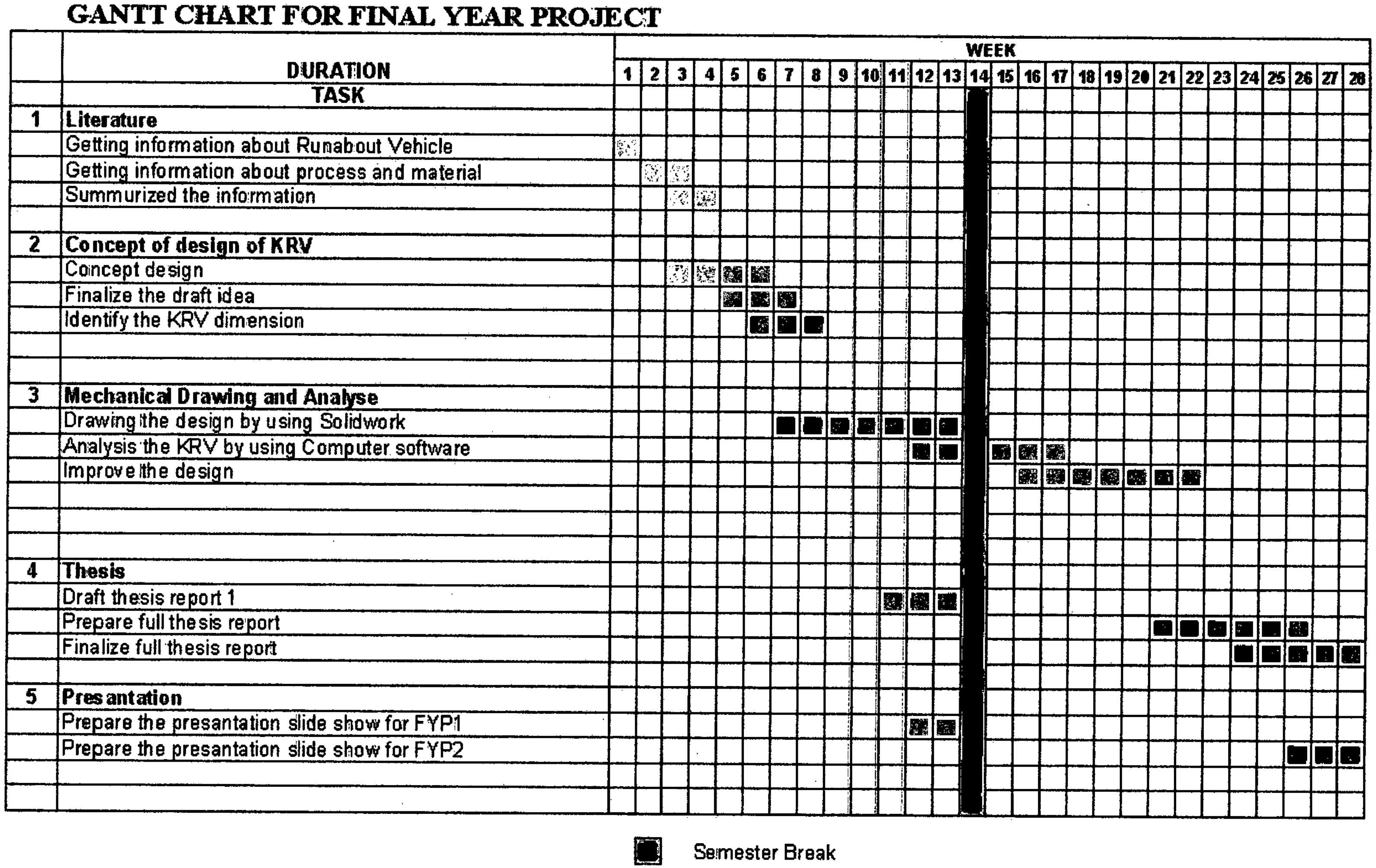

Figure 1.1: Gantt chart for Final Year Project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is study about information regarding to this project.

2.2 Fundamental of motorcycle

A motorcycle is a single-track, two-wheeled motor-vehicle powered by an engine. The chassis (or frame) of a motorcycle is typically made from welded aluminum or steel (or alloy) struts, with the rear suspension in the design.

A motorcycle fork is the portion of a motorcycle that holds the front wheel and allows one to steer. For handling, the front fork is the most critical part of a motorcycle. The combination of rake and trail determines how stable the motorcycle.

The wheel rims are usually steel or aluminum (generally with steel spokes and an aluminum hub). At one time, motorcycles all used spoke wheels built up from separate components. But one-piece wheels are more common now.

Motorcycles mainly use pneumatic tires. However, in some cases where punctures are common, the tires are filled with a "mousse" which is unpunctureable. The most important characteristic of any tire is the contact patch. That is the small area that is in contact with the road surface while riding

There are generally two independent brakes on a motorcycle, one set on the front wheel and one on the rear. Front brakes are generally much more effective than rear brakes: roughly two thirds of stopping power comes from the front brake-mainly as a result of weight transfer being much more pronounced compared to longer or lower vehicles, due to the motorcycle's relatively short wheelbase. Brakes can either be drum or disc based, with disc brakes

Motorcycles are driven by conventional gasoline internal combustion engines. Motorcycle engines range from less than 50 cc (cubic centimeters), commonly found in many small scooters. A minibike is a miniaturized version of a motorcycle (Motorcycle - Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Motorcycle).

Finally, the construction of UMP Runabout Vehicle (URV) can be category as a motorcycle. This is because the URV having a frame or chassis; it have two wheels; it also have front fork; it driven a two stroke engine; it also having brake system; it also have single suspension system. The only different with motorcycles is the size and the structure of the chassis design.

2.3 Structural analysis

Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behavior of structures. This analysis is to test structural ability to withstand loads. It incorporates the fields of mechanics, dynamics, and the many failure theories. From a theoretical perspective the primary goal of structural analysis is the computation of deformations, internal forces, and stresses. To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure.

There are two approaches to the analysis: the mechanics of materials approach (also know as strength of materials), and the finite element approach. Normally, the FEM approach is much more accurate and faster.

2.3.1 Finite element approach

Finite element method models a structure as an assembly of elements or components with various forms of connection between them. Thus, a continuous system such as a plate or shell is modeled as a discrete system with a finite number of elements interconnected at finite number of nodes. The behavior of individual elements is characterized by the element's stiffness or flexibility relation, which altogether leads to the system's stiffness or flexibility relation. The finite element analysis divides into three phases which is Pre-processing, Analysis solver, and Post-processing of results.

2.3.1.1 Pre-processing

Pre-processing is constructing a finite element model of the structure to be analyzed. The model can be in either 1D, 2D, or 3D form, modeled by line, shape, or surface representation, respectively, although nowadays 3D models are predominantly used. The primary objective of the model is to realistically replicate the important parameters and features of the real model. The simplest mechanism to achieve modeling similarity in structural analysis is to utilize pre-existing digital blueprints, design files, CAD models, and/or data by importing that into an FEA environment. Once the finite element geometric model has been created, a meshing procedure is used to define and break up the model into small elements. In general, a finite element model is defined by a mesh network, which is made up of the geometric arrangement of elements and nodes. Nodes represent points at which features such as displacements are calculated. FEA packages use node numbers to serve as an identification tool in viewing solutions in structures such as deflections. Elements are bounded by sets of nodes, and define localized mass and stiffness properties of the model. Elements are also defined by mesh numbers, which allow references to be made to corresponding deflections or stresses at specific model locations

2.3.1.2 Analysis solver

The next stage of the FEA process is analysis. The FEM conducts a series of computational procedures involving applied forces, and the properties of the elements which produce a model solution. Such a structural analysis allows the determination of effects such as deformations, strains, and stresses which are caused by applied structural loads such as force, pressure and gravity.

2.3.1.3 Post-processing of results

These results can then be studied using visualization tools within the FEA environment to view and to fully identify implications of the analysis. Numerical and graphical tools allow the precise location of data such as stresses and deflections to be identified.

2.4 Material

There are varieties of material in the world. Each material has its own characteristics, applications, advantages, and limitations. (Kalpakjian et al., 2001)

- Ferrous metal: carbon, alloy, stainless, and tool-and-die steels
- Nonferrous metal: aluminum, magnesium, copper, nickel, titanium, etc
- Plastics: thermoplastic, thermoset, and elastomers.
- Ceramics, glass ceramics, glasses, graphite, diamond, and diamond-like material.
- Composite material: reinforced plastics, metal-matrix and ceramic-matrix composites.
- Nonmaterial, shape-memory alloy, amorphous alloys, superconductors.

2.4.1 Aluminum

Aluminum is found primarily in bauxite ore and is remarkable for its resistance to corrosion and its light weight. This metal is used in many industries to manufacture a large variety of products and is very important to the world economy. Structural components made from aluminum and its alloys are vital to the aerospace industry and very important in other areas of transportation and building.

2.4.1.1 Properties of Aluminum

Aluminum is a soft, lightweight metal with normally a dull silvery appearance caused by a thin layer of oxidation that forms quickly when the metal is exposed to air. Aluminum oxide has a higher melting point than pure aluminum. Aluminum is nontoxic (as the metal), nonmagnetic, and non-sparking. It has a tensile strength of about 49 MPa in a pure state and 400 MPa as an alloy. Aluminum it is malleable, ductile, and easily machined and cast. It has excellent corrosion resistance and durability because of the protective oxide layer.

Aluminum has a density around one third that of steel and is used advantageously in applications where high strength and low weight are required. This includes vehicles where low mass results in greater load capacity and reduced fuel consumption.

When the surface of aluminum metal is exposed to air, it will produce a protective oxide coating forms almost instantaneously. This oxide layer is corrosion resistant and can be further enhanced with surface treatments such as anodizing.

Aluminum is not only non-toxic but also does not release any odors or taint products with which it is in contact. This makes aluminum suitable for use in packaging for sensitive products such as food or pharmaceuticals where aluminum foil is used. (Aluminum- Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Aluminum)

Table 2.1: Physical Properties of Aluminum

Physical properties	
Phase	solid
Density	2.70 g/cm^3
Liquid density	2.375 g/cm^3
Melting point	933.47 K (660.32 °C, 1220.58 °F)
Boiling point	2792 K (2519 °C, 4566 °F)
Heat of fusion	10.71 kJ/mol
Heat of vaporization	294.0 kJ/mol
Heat capacity	(25 °C) 24.200 J/mol·K

Table 2.2: Mechanical Properties of Aluminum

Miscellaneous	
Magnetic ordering	paramagnetic
Electrical resistivity	(20 °C) 26.50 nΩ·m
Thermal conductivity	(300 K) 237 W/m·K
Thermal expansion	(25 °C) 23.1 µm/m·K
Young's modulus	70 GPa
Shear modulus	26 GPa
Bulk modulus	76 GPa
Poisson ratio	0.35
Mohs hardness	2.75
Vickers hardness	167 MPa
Brinell hardness	245 MPa

2.4.2 Aluminum Alloy

Aluminum alloys are alloys of aluminum, often with copper, zinc, manganese, silicon, or magnesium. They are much lighter and more corrosion resistant than plain carbon steel, but not quite as corrosion resistant as pure aluminum. There are many type of aluminum alloy. Such as:

- 1000 series are commercially pure aluminum with a minimum 99% aluminum- excellent corrosion resistance; high electrical and thermal conductivity; good workability; low strength; not heat treatable.
- 2000 series are alloyed with copper, can be precipitation hardened to strengths comparable to steel. Formerly referred to as duralumin, they were once the most common aerospace alloys, but were susceptible to stress corrosion cracking and are increasingly replaced by 7000 series in new designs.
- 3000 series are alloyed with manganese. Good workability; moderate strength; not generally heat-treatable.
- 4000 series are alloyed with silicon. They are also known as silumin. Lower melting point; forms an oxide film of a dark-gary to charcoal color.
- 5000 series are alloyed with magnesium, derive most of their strength from solution hardening, and can also be work hardened to strengths comparable to steel
- 6000 series are alloyed with magnesium and silicon, are easy to machine, and can be precipitation hardened, medium strength, weldability, and corrosion resistance.
- 7000 series are alloyed with zinc, and can be precipitation hardened to the highest strengths of any aluminum alloy.
- 8000 series are a miscellaneous category (Kalpakjian et al., 2001)

2.5 Machining of Aluminum

Aluminum is generally very easy to machine, although the softer grades tend form a built-up edge. It will result in poor surface finish. So the high cutting speeds, high rake angles and high relief angles are recommended. There are two type of the machining process which is conventional and unconventional. (Kalpakjian et al., 2001)

2.5.1 Bending Process

Bending is a process by which metal can be deformed by plastically deforming the material and changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength. The surface area of the material does not change much. Bending usually refers to deformation about one axis. Bending is used not only to form flanges, seam, and corrugations but also to impart stiffness to the part.

The terminology used in bending is shown in Fig. 2. In bending, the outer fibers of the material are in tension, while the inner fibers are in compression. Because of the Poisson's ratio, the width of the part (bend length) in the outer region is smaller and the inner region is larger than the original width. This phenomenon may easily be observer by bending a rectangular rubber eraser.

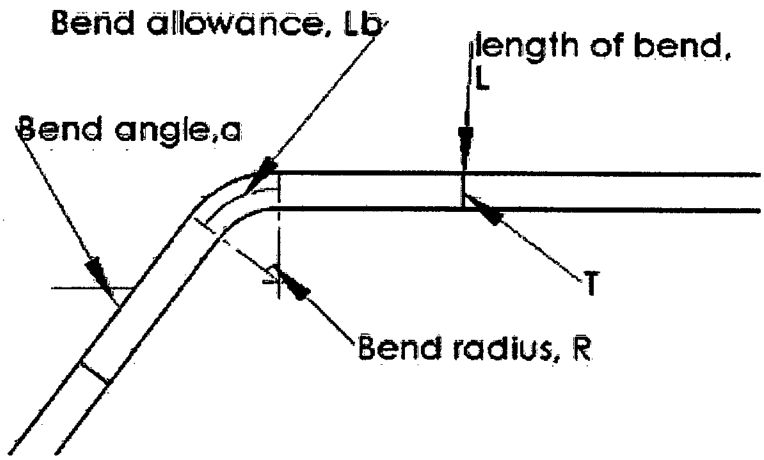

Figure 2.1: Bending terminology

2.5.2 Cutting Process

Cutting process is remove material from the surface of a workpiece by producing chips. The conventional cutting process are milling process, sawing process, turning process and other. The unconventional or advanced machining processes are chemical machining, laser-beam machining, abrasive water-jet machining and etc. Advanced machining process is offer major technical and economic advantages over traditional machining methods

2.5.2.1 Water-Jet Machining

Water-jet cutting is a process used to cut materials using a jet of pressurized water as high 60,000 pounds per square inch (psi). This is because the water-jet machining is suitable for contour cutting flexible material. It would not thermal damage to the material. Additions, the process parameters and typical material removal rate or cutting speed are varies considerably with material. The advantages of this process are:

a) Cuts can be started at any location without the need for predrilled holes

b) No heat is produced

c) No deflection of the rest of the workpiece take place

d) Little wetting of the workpiece take places

e) The burr produced is minimal (Kalpakjian et al., 2001)

2.5.3 Finishing Process

For many applications aluminium needs no protection or decorative coating, the surface supplied is entirely adequate without further finishing. Mechanical finishes such as polishing, embossing, sand blasting or wire brushing meet a variety of needs. Where the plain aluminium surface does not suffice, any of a variety of surface finishes may be applied. Chemical, electrochemical and paint finishes are all used. Many colours are available in both chemical and anodised finishes.

2.6 Joining Process

Almost any method of joining is applicable to aluminum i.e. riveting, welding brazing or soldering. A wide variety of mechanical aluminum fasteners are available and simplify the assembly of many products. Adhesive bonding has been successfully employed in many applications including aircraft components and some building applications.