Design and Fabrication of Multi-Purpose Vehicle-1 Chassis

By

Haseeb Haider Khan **NUST201201130BSMME11112F**
Muhammad Hassan Khan **NUST201200901BSMME11112F**

Supervised By

Engr. Mr. M Naweed Hassan

School of Mechanical and Manufacturing Engineering,

National University of Sciences and Technology (NUST),

Islamabad, Pakistan

June, 2016

Design and Fabrication of Multi-Purpose Vehicle-1 Chassis

By

Haseeb Haider Khan **NUST201201130BSMME11112F**
Muhammad Hassan Khan **NUST201200901BSMME11112F**

Supervised By

Engr. Mr. M Naweed Hassan

A thesis submitted in partial fulfillment of the requirements for the degree of Bachelors of Engineering in Mechanical Engineering

School of Mechanical and Manufacturing Engineering,

National University of Sciences and Technology (NUST),

Islamabad, Pakistan

June, 2016

National University of Sciences & Technology

FINAL YEAR PROJECT REPORT

We hereby recommend that the dissertation prepared under our supervision by: {Haseeb Haider Khan (NUST201201130BSMME11112F) and Muhammad Hassan Khan (NUST201201130BSMME11112F)} Titled: {Design and Fabrication of Multi-Purpose Vehicle-1 Chassis} be accepted in partial fulfillment of the requirements for the award of Bachelors of Engineering in Mechanical Engineering degree with (____ grade)

English and format checked by Ms Aamna Hassan, Signature:_____

Guidance Committee Members

1. Name: Dr. Samiur Rahman Shah _____ Signature:_____

2. Name: Dr. Aamir Mubashar _____ Signature:_____

Supervisor's Name: Engr. Mr. M Naweed Hassan Signature:_____

Date:_____

_____ _____
Head of Department Date

COUNTERSIGNED

Date:_____ _____
Dean/Principal

Declaration

I/We certify that this research work titled "*Design and Fabrication of Multi-Purpose Vehicle-1 Chassis"* is my own work. The work has not been presented elsewhere for assessment. The material that has been used from other sources it has been properly acknowledged / referred.

Haseeb Haider Khan
NUST201201130BSMME11112F

Muhammad Hassan Khan
NUST201200901BSMME11112F

Copyright Statement

Dedicated to my parents

Acknowledgments

First of all we would thank ALLAH Almighty, who gave us knowledge and dedication to be able to complete this project.

We are grateful to Principal SMME **Dr. Abdul Ghafoor**, Vice Principal SMME **Engr. Muhammad Sohail** and H.O.D. Mechanical **Dr. Khalid Akhtar** for providing us the opportunity to work on the Final Year Project. We would also acknowledge all the support provided by School of Mechanical and Manufacturing Engineering (SMME) in completing the project.

We would pay our special tribute to **Engr. M. Naweed ul Hassan** for his continuous encouragement, invaluable supervision, timely suggestions and inspired guidance.

We are also grateful to **Dr. Aamir Mubashar** and **Dr. Samiur Rahman** for their motivating and useful remarks.

Mr. Usman Bhutta also worked hard in conducting evaluations and provided us with all the support required to complete the project.

Lastly I would like to pay my regards to the technicians of MRC especially **Mr. Farhad Khan**, **Mr. Faisal Nadeem, Mr. Mubashar**, **Mr. Hafiz Rizwan** and **Mr. Shoukat** who helped us throughout the fabrication phase.

Haseeb Haider Khan **Muhammad Hassan Khan**

Abstract

The deliverable of the project is to design and fabricate the chassis for first prototype of Multi-Purpose Vehicle (i.e. MPV-1). The project is to provide a chassis on which different components of MPV-1 can be mounted. Main purpose of the car is to fulfill the requirement of being low cost vehicle that can be used by families to travel within the vicinity of their locality. The basic aim was to make the chassis simple and light. Different types of chassis were studied and ultimately Ladder Frame Chassis was chosen for Multi-Purpose Vehicle 1. The reason behind choosing Ladder Frame Chassis was that it was simple and could be fabricated in Manufacturing Resource Centre (MRC), SMME. The chassis frame was modelled in Solid Works and stress analysis was done. After the analysis frame was fabricated in MRC. We used the facilities of Manufacturing Resource Centre (SMME) to fabricate and mount different components on the chassis.

Keywords

Multi Purpose Vehicle

Chassis

Ladder Frame

Off the shelf parts

Fabrication

Table of Contents

List of Figures

List of Tables

Symbols

ANSI 1018	Steel
W,F	Load
τ	Shear stress
Z	Section Modulus
l	Length of pipe
b	Breadth of inner section of pipe
B	Breadth of outer section of pipe
H	Height of outer section
H	Height of inner section
M	Bending moment
E	Total strain energy
σ	Tensile stress
$\boldsymbol{\sigma_{yield}}$	Yield Strength
NA	Neutral Axis

Chapter 1
Introduction

1.1 Background

In this era of cutting edge competition world is thinking of making products that can fulfill more than one specific purpose. Moreover a shift can be observed from heavy weight products towards manufacture of light weight and efficient products, without having any compromising the reliability. Hence, there incepts an idea of making a light weight car that can fulfill more than one purposes with a few replaceable parts. The Vehicle was named as Multi-Purpose Vehicle its first prototype was called as MPV-1

NUST-SMME is part of a consortium to build Multi-Purpose Vehicle along with 4 other universities; namely UET Lahore, CUST, NED and COMSATS.

The main advantage of Multi-Purpose Vehicle is that, it will have same chassis but the upper cabin will be easily replaceable to fulfill the design variants.

1.2 Aim and Objectives

The aim of this project is to incept the idea of low cost Multi-Purpose Vehicle by designing and fabricating the chassis for the initial prototype of MPV-1 and that is essentially targeted to meet the day to day requirement of small lower/middle class families for mobility within their residential bounds.

Main purpose is to check the placement of off the shelf parts on main chassis and recommend if each part may be used with slight or without modification or redesigning of the part is required. The following objectives were identified in order to achieve the overall aim of this research.

- Main Chassis will be a ladder frame chassis on which different components will be mounted.
- Off the shelf parts will be used to keep the design and manufacturing cost low.
- Parameters of the prototype will be same as of the original Multi-Purpose Vehicle.
- Off the shelf parts will be modified to some extent.

- Redesign will be recommended for the parts that do not fit properly on the chassis.

1.3 Methodology

The schematic of overall methodology that was followed during the project is shown in Figure 1.1.

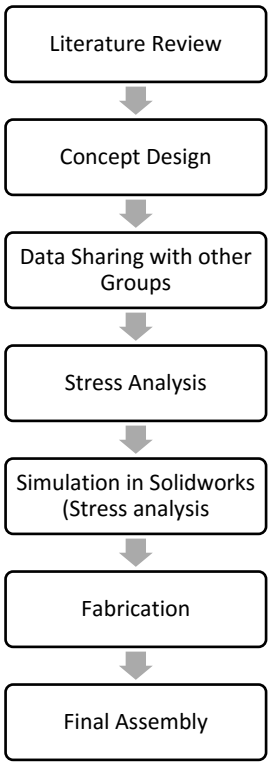


Figure 1.1: Overall Schematic of Research Methodology

1.4 Thesis Structure

The brief description of the contents of the remaining chapters in thesis is described below.

Chapter 2 Literature Review: Chapter provides a summary of the literature that has been reviewed and identified to be relevant to this project. This chapter also includes description of different types of chasses with their advantages and disadvantages.

Chapter 3 Finite Element Modeling: This chapter is divided into two parts. The initial geometry and configuration of Ladder Frame, along with boundary and loading conditions and material model is provided in the first part. First part explains the geometry of material. The second part deals with the steps that have been followed to obtain results and how boundary conditions were applied according to the loadings.

Chapter 4 Results and Discussion: The results of the FEM analysis are discussed in chapter 4 and a manual calculation has also been done to support the design.

Chapter 5 Conclusions and Future Work: This chapter presents the conclusion of the conducted project along with the proposed future work.

Chapter 2

Literature Review

2.1 Types of Chassis

Following are explained, different types of Chassis along with their merits and demerits:

1. Ladder Frame

2. Tubular Space Frame

3. Monocoque

Ladder Frame:

Its construction, indicated by its name, looks like a ladder - two longitudinal rails interconnected by several lateral and cross braces. The longitude members are the main stress member. They deal with the load and also the longitudinal forces caused by acceleration and braking. The lateral and cross members provide resistance to lateral forces and further increase torsional rigidity.

Advantage:

- It is easy and cheap to manufacture.
- When talking about loadings such as carrying heavy payloads and impacts, they are very strong indeed.

Disadvantage:

- Since it is a 2-D structure, torsional rigidity is very much lower than other chassis, especially when dealing with vertical load or bumps.
- The vehicle's overall height will be greater due to the floor pan sitting above the frame instead being inside.

Tubular Space Frame:

The principal of Tubular Space Frame Chassis is as follows:

“It should be possible to build a chassis where every single member has a bracing attachment, and has no twisting forces acting on it - just compression and tension.”

It is this principle that applies to Space Frames - removing bending forces acting on chassis members to make them smaller, thinner and lighter at the same time as building a stiffer overall structure.

Advantages:

- Very strong in any direction

- There's nothing that exotic about the materials and principles used, and if one is willing to dedicate the time to it, a very stiff, light structure can be assembled without any special techniques.

Disadvantages:

- The downside is, with all those tubes running everywhere; you aren't left with much space, which isn't good for carrying loads.
- The design relies on even distribution of loading, so isn't suited to carrying a couple of tons on the back of a truck, for instance.

Monocoque Structure:

It is known that shaped sheet metal can be used to make chassis sections as well as body panels. Therefore, the body panels themselves can be used as chassis members, and thus eliminating unnecessary weight from having both. This type of structure is called as a Monocoque ("single shell"). The idea is simply a progression of the using pressed panels as "sandwich tubes" for the floor, and doing the same for the side panels as well. A Monocoque is like space-frame built from pressed metal sheets.

Advantages:

- Since complicated shapes can be pressed, rather than just using straight tubes, so we can build a stiff structure that still has plenty of room inside, without great tubes running everywhere.
- Although lacking the absolute strength of a heavy ladder-frame chassis, the pressed-steel-panel Monocoque is currently the best compromise available once cost and production concerns are taken into account, and is likely to remain so for several years to come.

Disadvantages:

- The thinner material used in Monocoque designs compared to tubular-based structures is easier to buckle.
- Damage to exterior will compromise integrity of the structure.
- Repairs and modifications are difficult.

Chassis for MPV-1

Ladder Frame Chassis was designed and fabricated for MPV-1 at Manufacturing Resource Center (MRC), SMME. Reason for choosing ladder frame chassis was its easy to build characteristic. The decision was taken while keeping in view the resources available at MRC.

Chapter 3
Finite Element Modeling and Simulation

3.1 Introduction

The finite element modelling was performed using the commercially available finite element code SolidWorks, which is developed by Dassault Systèmes, Providence, RI, USA. The model of chassis was built as an assembly by mating different members that were made individually.

3.2 Initial Geometry and Configuration

The material used for chassis was Mild Steel. The properties of material are given below. The geometry of pipe was box channel as shown in figure:

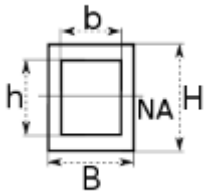


Figure 3.1: Geometry of Material used for Chassis

Property	**Mild Steel AISI 1018**
Elastic Modulus (E)	205 GPa
Yield Strength (σ_{yield})	370 MPa

Table 3.1: Material Properties of Mild Steel AISI 1018

3.3 Loading and Boundary Conditions

For doing the stress analysis of chassis the given pay load was considered. Stress analysis in SolidWorks was done with static loading. Pay load given was 250 kg (i.e. 2450 N). With

observation it was found that there are six loading members on the frame. The pay load was divided equally on those six members and results were obtained.

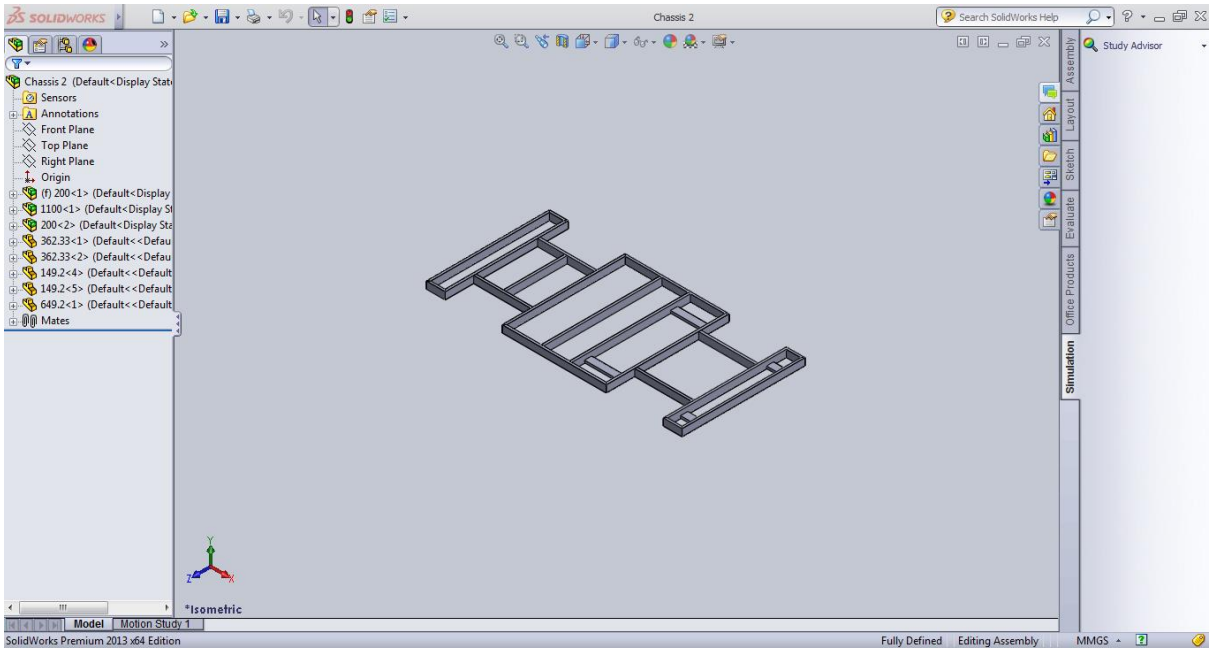


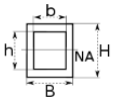
Figure 3.1: Final Model of MPV-1 Chassis

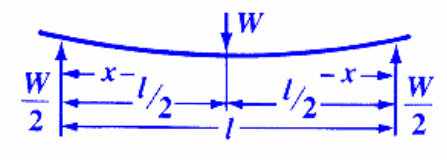
Chapter 4

Results and Discussion

4.1 Results and Discussion

Finite element analysis supported the designed chassis. In order to support FEM results manual calculation was also done for the longest bar of 600mm, considering it to be a simply supported beam.

B = 25.4 mm (1in)	**H = 76.2 mm (3in)**	
b = 22.4 mm	h = 73.2 mm	
I = 205747 mm^4	Z= Section Modulus = 5386 mm^3	



Open Calculator

Stress between load and support points

$$s = -\frac{Wx}{2Z}$$

Stress at center of constant cross section

$$-\frac{Wl}{4Z}$$

Deflection between load and support points

$$y = \frac{Wx}{48EI}(3l^2 - 4x^2)$$

Maximum deflection at load

$$\frac{Wl^3}{48EI}$$

Figure 4.1: List of formulae of calculation

Using above formulae the stress comes out to be 12 MPa which is less than yield strength of Mild Steel AISI 1018.

Chapter 5

Conclusions and Future Work

5.1 Achievements

For MPV-1 off the shelf parts were used and modified also whenever needed. We used Mild Steel box channel pipe of 3in by 1in cross section. We were able to decide the parameters for MPV. After using Engineering knowledge and research we come up with a solution that Ladder frame will be suitable for such kind of vehicle. Our Prototype can be further used to design the ladder frame for 660 CC Engine. We also provided the frame to physically check the feasibility of using off the shelf parts also.

5.2 Future Work

We manufactured Multi-Purpose Vehicle's first prototype (MPV-1). The cabin of MPV-1 is to be built. Seats are to be installed on the frame. The proper transmission from engine to wheels has to be done. Electronics of the Vehicle needs to be installed. Proper assembly of accessories on dash board and on other various part of vehicle is also to be improvised.

References

[1] Rajpot, R.K. (2007). A textbook of automobile engineering. Laxmi Publications

[2] Budynas, R.G, Nisbett, J.K 2011, *Shigley's Mechanical Engineering Design*, 9th edn. McGraw Hill, New Yor006B