CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The dump truck used for transporting loose materials in mining and construction. A typical dump truck is equipped with a hydraulically-operated suspension with closed box structure chassis, a body which is located at the top of the chassis. The chassis supported at the front and rear side suspension of the truck. The purpose of the body is lifted rear side of the vehicle, which is to deposit the materials on the ground. Chassis is an important part of the load carrying member of a rear dump truck over which the entire equipment is structured. Chassis acting as a structural support for power train elements and also enables the dump body carrying full payload. The chassis is neither a serviceable nor a replaceable component as far as the life span of the vehicle is concerned. The life span of a chassis must be equal to or more than 30,000 running hours under normal operating condition of the vehicle.

To increase the fatigue life and its propagation across the chassis and to avoid crack, it is absolutely necessary to have an optional design to withstand the complete load under normal conditions. For this purpose, it is necessary to strengthen the frame and to increase the safety factor of the chassis for an increased fatigue life.
The chassis development processes in the automotive and transport equipment industries are subject to ever higher demands in terms of improved reliability, safety and performance, as well as reduced weight; production cost and development lead time. Due to the demand of huge truck for building and testing prototypes and manufacturing, there is increased emphasis on analytical durability assessment methods. In the case of special purpose vehicles, for which the low production volumes may exclude the possibility of extensive prototype testing, such emphasis would be even more pronounced. The first step of any durability assessment process involves the definition of the loading conditions. The automotive industry is expending constant efforts in correlating ground loading conditions with the customer profiles. Alternatively, employs standardized load time histories derived from extensive field measurements.

In the heavy vehicle industry, particularly in the case of special vehicles, such information is not always readily available. Hence, the need for economical methods to describe loading conditions for design purposes is apparent. The second step in the assessment process involves calculating the stress response to the input loading. In case of automotive industry, this is commonly achieved using the dynamic finite element analysis method. Due to the cost of dynamic finite element analyses, there is an incentive to circumvent the need for analysis. Since calculations could not stipulate the use of dynamic finite element analysis method. Since heavy vehicle structures are usually welded, less complex stress-life method is commonly employed. Therefore it is a common practice to employ multi-parameter strain-life methods, in combination with dynamic finite element analyses, based on very extensive measurement exercises, to conduct analytical fatigue life assessments. It is then verified through intensive durability testing. The expense and complexity of this approach makes its application impractical for low volume "special" vehicles. It has been that demonstrated linear static
stress distribution, simple fatigue calculations and static finite element analysis, can be employed to achieve adequately accurate fatigue life prediction of an automotive chassis.

1.2 CLASSIFICATION OF TRUCK

Generally, truck vehicles are designed for carrying or pulling loads. It is an automotive vehicle suitable for hauling. Definitions vary depending upon the type of truck and its application.

Table 1.1 Truck Classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Gross vehicle weight</th>
<th>Representative vehicles</th>
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<tbody>
<tr>
<td>Light duty truck</td>
<td>Between 1 to 7 Ton</td>
<td>Car, Auto and Van</td>
</tr>
<tr>
<td>Medium duty truck</td>
<td>Between 10 to 20 Ton</td>
<td>Bus &amp; Lorry</td>
</tr>
<tr>
<td>Heavy duty truck</td>
<td>Above 30 Ton</td>
<td>Dumper &amp; Motor Grader</td>
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Trucks can be classified as Light duty truck, Medium duty truck and Heavy duty truck. They are presented in Table 1.1.

1.2.1 Standard Dump Truck

The standard dump truck is a full truck chassis with a dump body mounted onto the frame. The dump body is raised by a hydraulic ram lift that is mounted forward of the front bulkhead, normally between the truck cab and the dump body. The standard dump truck also has a front axle, and one or more rear axles, which normally have dual wheels on each side. The common configurations for standard dump trucks are six and ten wheelers.
1.2.2 Transfer Dump Truck

The transfer dump truck is easily recognizable through the noise made during transfer. A standard dump truck pulls a separate trailer which can be loaded with sand, asphalt, gravel, dirt, etc. The box or aggregate container on the trailer is powered by an electric motor, which rides on wheels and rolls off of the trailer and into the main dump box. The biggest advantage of this configuration is that payload capacity maximized manufacturability of the short and nimble dump truck standards.

1.2.3 Semi Trailer Dump Truck

The semi end dump truck is a tractor trailer combination where the trailer itself contains the hydraulic hoist. The average semi end dump truck has a 3 axle tractor that pulls a 2 axle semi trailer. The rapid unloading is the main advantages of semi trailer dump truck.

1.2.4 Semi Trailer Bottom Dump Truck

A bottom dump truck is a 3 axle tractor that pulls a 2 axle trailer with a clam shell type dump gate in the belly of the trailer. The biggest advantage of a semi bottom dump truck is its ability to lay material in a wind row unlike the double and triple trailer configurations. This type of truck is also maneuverable in reverse as well.

1.2.5 Double and Triple Bottom Dump Truck

The double and triple bottom dump trucks consist of a 2 axle tractor pulling a semi axle semi trailer and an additional trailer. These types of dump trucks allow the driver to lay material in wind rows without the material having to leave the cab or stop the truck. However biggest disadvantage is the difficulty in going in reverse.
1.2.6 Side Dump Truck

Side dump trucks consist of a 3 axle trailer pulling a 2 axle semi trailer. It offers hydraulic rams that tilt the dump body onto the side, which spills the material to the left or right side of the trailer. The biggest advantages of these types of dump trucks are that they allow rapid unloading and increased weight carrying capacities when compared to other dump trucks. In addition to this, side dump trucks are almost impossible to tip over while dumping, unlike the semi end dump trucks which are very prone to being upset or tipped over. The lengths of these trucks impede maneuverability and also the limit versatility of the chassis.

1.2.7 Off-Road Dump Truck

Off-road trucks resemble heavy construction equipment more than highway dump trucks. They are used strictly for off road mining and heavy dirt-hauling jobs, such as excavation. They are very big in size, and are perfect for having massive amounts of dirt to another location whole digging roads.

Compact truck is one of the most common pickup truck used worldwide. It resembles a mini version of a two-axle heavy truck, with a frame providing structure and a conventional cab, a leaf spring suspension on the rear wheels. The compact truck was introduced to (North America in the 1960s) by Japanese manufacturers. Datsun (Nissan 1959) and Toyota dominated under their own nameplates full the end of the 1970s.

A full size truck is a large truck suitable for hauling heavy loads and performing other functions. Most full-size trucks can carry at least 450 kg in the rear bed, with some capable of over five times that much. In North America, trucks were commonly used as general purpose passenger cars.
They were popular not only with construction workers, but also with housewives and office workers. Thus arose the need for a pickup truck that was bigger than a compact truck but smaller and more fuel-efficient than a full-size pickup.

The Australian utility truck, called “ute”, is the mainstay variety of truck in Australia. The modern design of the ute first rolled off the assembly line at the Ford factory in Geelong in 1934. An American style truck and commonly popular with farmers, it is usually Japanese or Australian built model, such as the Isuzu Rodeo or the Toyota Hilux. These are popular in a variety of forms, two and four wheel drive, single or dual cab integrated tray or flat bed. These kinds of vehicles are also common in New Zealand, where they are also referred to as “utes”. The other type of vehicle commonly referred to as a “ute” is quite different-a two-seater sporty version of typical saloon cars, featuring a “ute”-type integrated tray back Pickup trucks have been used as troop carrier in many parts of the world, especially in those countries with few civilian roads of very rough terrain. Pickup trucks have also been used as fighting vehicles, often equipped with a machine-gun mounted on the bed.

1.3 TRUCK CHASSIS FOR HIGHER TON DUMP TRUCK

Dump truck chassis is mainly used for coal application. The chassis of dump truck carries the coal density varying from 1200 N/mm$^3$ to 1800 N/mm$^3$. Vehicle body consists of two parts; chassis and bodywork or super structure. The conventional chassis, which is made of structured steel members, includes cross-members located at critical stress points along the side members with a box type cross section rail structure.
The vehicle models that have been developed have almost the same appearance since the models developed 50 years ago. It indicates that the evolutions of these structures are still far behind when compared to other countries research and development technology is not fully utilized in our country. This is a major challenge to truck manufactures to improve and optimize their vehicle designs to meet the market demand whole at the same time improving the vehicles durability and performance. Since the truck chassis is a major component in the vehicle system, it is often identified for refining and improving better handling and comfort.

The frame of the truck chassis is a backbone of the vehicle and integrates the main truck component systems such as the axles, suspension, power train, cab and trailer. The typical chassis is a ladder structure consisting of two C channel rails connected by cross-members. Almost all the chassis development varies in design, weight, complexity and cost. However, the effects of changes on the frame and cross-members are not so well understood in terms of vehicle response during riding especially on bumpy and off road conditions. For example, if the torsion stiffness of a suspension cross-member is lowered, the effects on the vehicles roll stability, handling, ride and durability. Therefore, the main focus is to find out the behavior of truck chassis. To improve the current design for better riding quality suitably to customer needs and higher fatigue life.

After years of steady, predictable model changes, the automobile industry is in the midst of the most intense product changeover. To accomplish the need to design a moderate car, the structural engineer needs to use imaginative concepts. The demands on the automobile designer increased and changed rapidly, first to meet new safety requirements and later to reduce weight to satisfy fuel economy requirements. Experience could not be extended to new vehicle sizes, and also performance data was not available in
the case of new criteria. Hence, the finite element method and a computer
dependent numerical technique have opened up a new approach to vehicle
design.

Every vehicle has a body, which is opposed to carry both the loads
along with its own weight. The body of the vehicle consists of two parts;
chassis and bodywork or superstructure. The conventional chassis frame,
which is made of pressed steel members, can be considered structurally as
grillages. The chassis frame includes cross-members located at critical stress
points along the side members. To provide a rigid and box-like structure are
secured the two main rails in a parallel position. The cross-members are
usually attached to the side members by connection plates. The joint is riveted
or bolted in trucks and is welded in trailers. When rivets are used, the holes in
the chassis frame are drilled these holes are approximately larger than the
diameter of the rivet. The rivets are then heated with an incandescent red and
driven home by hydraulic or air pressure. The hot rivets conform to the shape
of the hole and tighten cooling. An advantage of this connection is that it
increases the chassis flexibility. Therefore, it is important to prevent high
stresses in the critical area of the chassis. The side and cross-members are
usually open-sectioned, because they are cheap and can easily attach with
rivets.

Customer demand for cost and weight reduction makes the same
priority (Power to weight ratio) and payload increase is priority. Thus, vehicle
design typically represents a trade-off between performance and safety, since
durability, especially of safety components is of great importance. For a
development engineer this means that the design of the components must be
adapted. The operating conditions as accurately as possible. In order to
achieve these goals, durability tests are performed through a combination of
physical testing, on road at a proving ground test track, and through servo-
hydraulic road test simulator in laboratory. Operating loads to which that vehicle has been subjected on a proving ground test track are simulated in laboratory wherever possible for both cost and time purposes. A predetermined number of loading cycles on servo-hydraulic test machine simulate a specific number of kilometers traveled. Performing tests with several vehicles and observing fatigue characteristics as deformations and/or cracks help us in determining the durability of the automobile. Thus, the main concern development of automobile manufacturers is the durability life approval of individual components, individual assemblies and complete vehicle. Many studies have been focused on the fatigue failures and/or fatigue design of automotive components. The most common component failure is that of chassis caused by overload. However, failures of chassis can prove to be catastrophic with serious consequences. In some cases, a consequence of these in-service failures results in the recall of all affected vehicles followed cost. Several researchers studied the failures of the elements of power transmission system and other automotive components. However, studies related to failures of structure and durability tests were analyzed.

1.4 IMPORTANT ISSUES IN CHASSIS DESIGN

A major challenge of the truck manufactures is to improve design and optimize the same to meet the customer requirements whole simultaneously providing better chassis durability and performance. Since the truck chassis is a major component in the vehicle system. Therefore, it is often identified for refinement and improvement to enable better handling, comfortably and life of the chassis.

The chassis of the vehicle is the backbone of a vehicle and integrates the main truck component systems such as the front and rear axles, suspension, power train, cabin and body. To provide a box type structure, the
cross-members secure the two main rails in a parallel position. The cross-members are usually attached to the side members by connecting of rolled plates, also upon as the torque tube. The joint is welded into the rail structure of the truck chassis. When welds are used, the main focus should be on edge preparation cleanup of the welding area and provision of back-up plates. An advantage of this connection is that it increases the chassis strength and rigidity while preventing also high stresses are prevented in critical areas. Chassis development is varies in design, weight, complexity and cost. However, the effects of changes to the box structure and cross-members are not well understood in term of vehicle response whole riding especially on bumpy and off - road conditions. If the torsion resistance of a rear rail structure is minimum in is important to study the effect on the vehicle’s roll stability, handling, ride and durability. It is important to analysis are the behaves to improve of truck chassis. How to avoid field failure and improve the current design for better riding quality and suitably to customer needs.

In all, research studies focus on improve the existing condition for betterment of riding quality, comfortably and fatigue life. There are major areas need to be established in the study to come out with proper investigation on truck chassis especially research methodology on experimental and computational analysis. The ultimate result would be improvement of vehicle quality, reliability, flexibility, efficiency, low production cost and high fatigue life.

In the early days of vehicle design and manufacture, the chassis was the frame above which the body was mounted; the axles were mounted below by means of their springs, together with any associated steering and braking systems. During the 1920s, pioneers began studying the implications of eliminating the chassis frame and attaching the wheels whether mounted on axles or independently - directly to the body. It quickly emerged that to
achieve similar orders of stiffness in bending and especially in torsion, a load carrying body should be made lighter and also more compact than an unstressed body mounted on a chassis frame. By the 1950s the stress-carrying "unitary" body had become the industry standard. The terms "chassis" had not disappeared, but had rather been transferred to those systems between the body and the road surface - the suspension linkages, springs and dampers, and the wheels themselves - together with the closely associated steering and braking systems, essential for controlling the vehicle. Some observers regard chassis systems and suspension systems as synonymous. However, this disregards the interdependence of suspension, steering and braking systems and the fact that they are integrated to an increasing degree, especially at the electronic level. It may also be argued that even in the early days of motoring when complete chassis were delivered to coachbuilders for body installation, the steering and the brakes (such as they were) were already installed. In present-day terms, therefore, the terms "chassis engineering" or "chassis systems" embrace a hierarchy of technologies and features that may be outlined as follows:

Suspension: This includes the choice of basic geometry for optimum wheel location, the mounting of suspension members on the body (including the use of sub-frames), the springing medium and the provision of damping of vertical wheel movement.

Steering: Includes the optimization of front suspension geometry for steering, the choice of steering system, the provision of power assistance, the satisfaction of safety requirements, and the provision of "augmented stability" through interaction with the braking system.

Braking: Refers to the choice of friction system, the design of the operating linkage, the provision of servo assistance, the satisfaction of safety
requirements, the provision of anti-lock braking and other enhancements such as emergency brake assist.

Wheels and tyre: Include choice of wheel and tyre size, choice of wheel material and tyre configuration, choice of spare wheel configuration or "run flat" technology.

As noted in the outline above, chassis engineering is subject to many legislated safety requirements with profound engineering implications. Two requirements are put forward (in almost all markets) to "split" the braking system in such a way that a single failure will not compromise safety, and all steering systems (except in specialized vehicles with a low maximum speed) should consist entirely of mechanical linkages. In the latter respect, revised legislation is be needed, certainly within the EU, if "steer by wire" is ever to be acceptable.

Reducing chassis engineering cost is especially difficult in the light of consumer demands for better refinement and riding comfort, and for higher vehicle performance (placing greater demands on the quality of steering, handling and road holding). Electronic systems today play an increasing role in chassis systems, and this trend will continue into future as well most electronic systems are how capable of new precisions but they also involve cost.

The saving of weight in chassis system components, as discussed later, is of more value than merely reducing the vehicle's mass to improve its performance. Reducing the weight of wheels, tyres, suspension components and most brake system components also reduces the unsprung mass - the total mass of all components between the road surface and the springs – This in turn improves both ride comfort and road holding. Therefore, much work has gone into studying ways of the weight of both suspension and brake system
components. However, to some extent these efforts have been negated by the recent tendency to fit ever larger and wider (and therefore heavier) wheels and tyres.

Chassis systems determine many of the fundamentals of vehicle behavior and "character", in particular riding comfort noise levels on one hand, and the quality of steering, handling and road holding on the other. These are not, by and large, the qualities that influence the decision to buy, which is largely dependent on external appearance, visible features and price. However these aspects (together with reliability) play a large part in determining customer satisfaction during vehicle operation, which may in turn influence the decision for or against a repeat purchase.

Chassis engineering has been emerging in the recent years of the most effective means of determining the "character" of a vehicle. It has been shown that measures as simple as stiffening the suspension mounting bushes can significantly alter the subjective impression of steering response and handling, for example. This provides an easy and cost-effective means of differentiating between versions of a single model to match a range of customer expectations.

Steering and braking systems, in contrast, are more often engineered by specialist suppliers working in close collaboration with the VMs. Many of these specialists, For example Akebono, Bosch, Delphi, Teves, Valeo and ZF, are extremely large operations in their own right (with interests extending well beyond chassis engineering), have a wide range of VM customers, and have also pioneered the adoption of modern technologies, from ABS to electric power steering to ESP. The size of the market for OEM chassis systems may be gauged from the fact that 50 million light duty vehicles are manufactured, worldwide, annually. In chassis engineering terms that are 200 million "corners" since there has been a tendency, ever since
independent suspension became well-nigh universal, to regard each wheel as being linked to his own chassis system (linkage, spring, damper, brake, and - at the front of the vehicle - steering). A modern trend is to use "corners" (less wheels) to be supplied by Tier-One operations as complete sub-assemblies. As the volume manufacture of light-duty vehicles has spread beyond the three main industrial areas, these Tier-One suppliers tend to expand their own operations, or to license their technology, to extend their coverage to match. It is difficult to see how any new operation could now be created in serious competition with those existing and very powerful players. The Tier-Two operations associated with suspension parts, including springs and to some extent dampers are a different case altogether. Although this tier has seen some amalgamation in the recent years, myriad small suppliers still exist and new ones are being created (or existing companies are adapting their product ranges) to satisfy demands in the emerging vehicle manufacturing areas.

1.5 SIGNIFICANCE OF FE ANALYSIS OF CHASSIS DESIGN

It is important to have a substantial knowledge about the chassis design and analysis, whose effects are required to be minimized. It quickly emerges that to achieve truck chassis stiffness in bending and (especially) in torsion, a load carrying body could be made stronger and more compact than the unstressed body mounted on a chassis frame. Chassis had not disappeared, but had rather been transferred to those systems between the body and the road surface. In present day, chassis system embraces a hierarchy of technologies and features like mounting of suspension member on the chassis, engine and transmission mounting brackets mounted on the chassis. The chassis design is also subject to universal constraints of cost and weight. Consumer demands better refinement, quality of material, and riding comfort, and higher vehicle performance (Placing greater demands on the quality of steering, handling and road holding). Chassis design determines many of the
fundamentals of vehicle behavior and "character" in particular, ride comfort, quality of material, handling and road holding. Chassis design has proved to be one of the most effective means of determining the "character" of a vehicle. Each and every aspect of a chassis was examined constantly and improved and the result is that only the best has survived.

In the early days of vehicle design and manufacture, the chassis was the frame on which the body was mounted. The axles were mounted below by means of their springs, together with any associated steering and braking systems. The model constructed on the basis of finite element analysis is one of the most popular among the researchers of chassis design process over the last few decades. Finite element models are generally capable of incorporating almost all the characteristics and properties by changing geometrical dimensional details and their properties, loading conditions, different types of solver based on the definition of the problems and its application.

A chassis is the supporting frame of a sub frame structure and other systems. It gives the chassis strength and rigidity, and helps increase the vehicle crash-resistance through energy absorption. If a car were a human body, the chassis can be listened the skeleton. During a fall, a person with strong bones is likely to be hurt less than someone with weak bones. The same is the case of a car in an accident. The chassis helps keep a vehicle rigid. A strong chassis will keep the back end of a car from falling out of alignment with the front end, while remaining as stiff and unbending as possible.

The chassis is especially important in ensuring low levels of noise, vibration and harshness (NVH) throughout the vehicle. Not only does a reduction in NVH allow for a more pleasant driving experience, but by putting less stress on connecting components it can help increase the life span of these components. The key determinant permitting reduced levels of NVH
is energy absorption. By having a high level of energy absorption, NVH levels are lowered, but more importantly, passenger protection can be enhanced in the event of a collision. Plastic is making inroad into the chassis market. Innovations in plastic technology have brought about the development of successful chassis applications that would not be possible using materials.

An increased demand on trucks has been increased not only on cost and weight, but also the overall complete vehicle features. This results in increasing focus on optimization and modularization, which together with the large number of vehicle variants, makes it necessary to use efficient analysis methods. Finite Element-based vehicle analysis has become an important part of the development process for many of vehicle features. A standard dump truck is a truck chassis with a dump body mounted to the frame. The bed is raised by a hydraulic ram mounted under the front of the dumper body between the frames, and the back of the bed is hinged at the back to the truck. The tailgate can be configured to swing on hinges or it can be configured in the "High Lift Tailgate" format wherein pneumatic rams lift the gate open and up above the dump body.

Kim et al (2009) proposed the hybrid superposition method that combined finite element static and Eigen value analysis with flexible multi body dynamic analysis. Johansson et al. presented a method for complete vehicle analysis based on FE-technique used for analysis of complete vehicle features such as vehicle dynamics and durability (Karaoglu et al 2000). To introduced an improved procedure which is based on the modal stresses of FEMBS hybrid structures. In present work a finite element model has been build up to a 6 wheel standard dump truck chassis in order to simulate the effect of stepping a block the following cases (a) When stepping the block zigzag i.e., with one rear wheel side (The right side). (b) When stepping the block with both rear wheels.
A dynamic stress analysis with the necessary boundary and loading condition have been applied on the model using ANSYS software also, many evaluating points have been distributed along the chassis to evaluate the induced stresses and also the deformations on the chassis during the two case studies. The results show important differences between the two case studies especially in the torsion and deformations results obtained from the chassis model. Also, vibration modes have been analyzed during the loading conditions. The effects of changing the stepping conditions on the resulted stresses and also deformations on the chassis of the truck to find the best stepping condition have been investigate precisely. Heavy duty vehicle plays a more and more important role in highway transportation. The early damages caused by heavy load reduce the road service life and ride comfort. Highway maintenance brings huge economic losses, while serious road failure threatens traffic safety. Stochastic dynamic loads are assumed to increase pavement damage approximately 20–30% more than static load. Although researchers have long been aware of the effect of dynamic load on road damage, its role is limited to static load on the base of experience amendment in actual pavement design. There are several modeling methods of vehicle for simulating the dynamic tire force. Gillespie used simplified quarter-car model to predict ride vibrations and wheel dynamic loads. Lu established a half-vehicle model to study the rules of vehicle dynamic load caused by road roughness.

Cabin presented a multiple degrees-of-freedom (DOF) heavy commercial vehicle for harsh vibrating conditions. With the rapid development of computer technology, function virtual prototype technology has been widely applied in vehicle industry. Researchers try to utilize multi-body dynamics software to research vehicle ride comfort and road-friendliness. The objective of this work is to analyze tire dynamic load through numerical simulation and experimental test. Multi-body dynamics theory is used to establish a nonlinear virtual prototype model of heavy duty vehicle all the parameters in this model is derived from a real heavy duty vehicle DFL1250A9. The virtual model is verified by the field test results. Based on the validated model, tire dynamic force and DLC are analyzed respectively for different speed, mass and road surface roughness.
1.6 OBJECTIVE OF THE RESEARCH WORK

The need of the present work is to contribute to the understanding of finite element simulation of chassis design and its analysis. Though a lot of research work have been carried out with regard to finite element analysis of chassis. Only few studies have attempted simulation of chassis. The present research work is different in respect of modeling, design and analysis of heavy vehicle chassis for various effects of stress distribution.

The objectives of the present research work are presented below:

i) Create 3D CAD model of the chassis for find out the stress distribution of an FEA model.

ii) To determine the linear static analysis of a vehicle chassis for stress distributions.

iii) Based on FE Analysis to modify vehicle chassis by calculating & varying frame thickness, where the critical area of the chassis.

iv) Localized system FE Analysis of vehicle chassis for the stress and deflection of the frame structure.

v) Determine the fatigue life and stress distribution on the chassis experimentally by fatigue test method.

vi) Finally validate and compare the results to determine fatigue life of the chassis.

1.7 PLAN AND FORMULATION OF THE RESEARCH WORK

To achieve the above mentioned objectives, it is necessary to study the essentials of finite element analysis of chassis structure reported in literature. Hence, as an experimental test study, it was considered important to
create a 3D model and finite element analysis of chassis structure and compare the experimentally measured bending and torsion stress distribution.

After experimental validation of bending and torsion stresses in the chassis, the developed finite element analysis will be used to compute the stress results. The developed finite element model is further utilized for predicting of stress by changing size of the rear rail structure plate thickness. The plan of the present research work is presented in Figure 1.1.

Figure 1.1 Plan of Research Work
1.8 SEQUENCE OF THE RESEARCH WORK

[Diagram showing the sequence of research work with subheadings and steps]

- Literature Review
  1. Concept of Design
  2. Customer Need
  3. Study of Competitive Model

- Selection of Design Process
  1. Material
  2. Design Sequence
  3. Preliminary Design

- FE Simulation
  1. CAD Model
  2. Meshing
  3. Apply Boundary Conditions
  4. Solver
  5. Results

- Experimental Determination
  1. Fabrication Chassis
  2. Set up with Strain Gauges
  3. Data Monitoring Control Unit
  4. Loading Calculation
  5. Bending and Torsion

- Validation of the FE Model
  1. Post Processing Results
  2. Experimental Results

- Fatigue Analysis of Chassis
  1. Von Mises Stress
  2. Safety Factor
  3. Fatigue Life

- Modification of Chassis Parameter
  1. Width of the Box Section
  2. Thickness of the Fabricated Plate

- Fatigue Analysis of Chassis
  1. Von Mises Stress
  2. Safety Factor
  3. Fatigue Life

Conclusion

Figure 1.2 Sequence of Research Work
The scope of the research is confined to developing a 3D finite element analysis of static and fatigue strength of a chassis and the investigating of effects of chassis design parameters to minimize stresses and increase the fatigue life of the chassis. The thesis is structured accordingly and it’s the chassis structure detailed below.

Chapter 2 review of literature in finite element simulation of chassis. First, deals with the literature related to simulation of static and dynamic analysis histories involved in the chassis design and analysis of bending, torsion and fatigue life analysis. Secondly, it covers the work in the development of static and dynamic simulation of chassis frame analysis for off-highway application with an emphasis on the prediction of fatigue life and stress distribution of the critical area. It also covers some of the earlier works related to modeling, design and analysis of an automotive chassis.

Chapter 3 deals with the design and development of 3-D CAD model for FE simulation, meshing and analysis of chassis. Fatigue life of bending and torsional load cases for finding out the life of the chassis are compared with results published in the literature. It also describes the chassis finite element model to predict the distribution of bending and torsional stresses after changing the design parameter of the chassis.

Chapter 4 describes the re-design and FE analysis of an existing chassis to perform design calculation like section modulus, bending and torsional load calculation. Localized system analysis has been done and results incorporated in an existing chassis.
Chapter 5 deals design with fatigue failure analysis of a chassis has been run around 3.5 million cycles for determine the fatigue life and safety factor of a chassis.

Chapter 6 covers measurement of stresses in the chassis by experimental method and on the basis of the FE method and Validation of the chassis based on literature study and predicted stress field obtained in the previous chapters.

Chapter 7 covers the overall conclusions of the research work and scope of the future work.