Design and Optimization of Body Mount Bracket of SUV Car

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Abstract—Different software's are applied for solving engineering problems. One of the major areas where software is used in mechanical engineering related problems is Analysis and Optimization of a component. The present project deals with design and optimization of a mounting bracket. Different Optimization techniques were studied and Structural Optimization Techniques in a greater detail were studied. The static stiffness is the basic design parameter in the developing of any component for the automotive industry. very initial stage of the design in the available space envelop is complex and tough. To overcome this issue, an optimization design method for a body mounting system of a SUV is proposed to investigate the effect of the body mounting system on Static stiffness performance The aim of the project is to Design and Optimize the body mount bracket of a truck to meet the stiffness requirement of 5000N/mm in all the three directions i.e.; x, y and z directions. The results show that the presented optimization design for the body mounting bracket can be used to optimize the static stiffness of the heavy vehicles.

Indexed Terms—Design Parameters, Different Types Of Brackets, FEM, Optistruct.

I. INTRODUCTION

An Automobile is a self-propelled vehicle which is used for transportation of goods and passengers. The motor vehicles, both passengers' car and trucks are generally considered to be made up of two major assemblies: Body and Chassis. Chassis is a frame or main structure of a vehicle. The chassis contains all the major units necessary to propel the vehicle. Body is the super-structure of the vehicle. Body is bolted to the chassis. The chassis with the body make the complete vehicle. The truck consists of various assemblies performing their functions smoothly. Although there are many important parts, the cabin is a place where the driver and co-driver are seated. Their weight will be mainly on the floor where it should withstand many loads coming from different ways in different directions. This makes the driver seated without any vibrations and distractions.

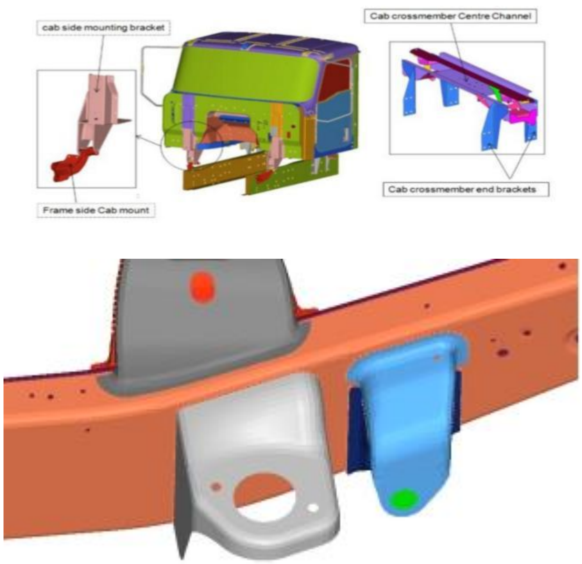
A flat sheet of thin material such as the floor panel is very flexible for out-of-plane loads. The aim of the floor is to carry the local applied loads from their point of application to the major structural components of the vehicle, such as the side frames. Floors are subject to loads normal to their plane. Under such circumstances they do not act as simple structural surfaces. The floor stiffened against out-of the plane loads by added beams arranged into a planar framework. The advantages of tilting cabin than rigid cabin is ease of servicing, less weight, easy for design modifications and provide fewer vibrations.

Growing competition of automotive market has made it more and more important to reduce time and cost of the product development process. One of the most costly phases in the vehicle development process is the field test and high expenses for this phase can sorted to the number of prototypes used and time/efforts needed for its execution. Also, multiple iterations during designing, building and prototype testing are not affordable against the time and cost constraints for developing a product. Today, analytical tools in the form of computer simulation have been developed to such a level that they reliably predict performance.

Hard prototypes cannot be created in early design phase, but, today with the use of CAE virtual models can be created to accurately represent physical models and to take right decisions at the right time.

In Heavy Commercial Vehicle (HCV) cab mounting system is utilized to isolate driver from road generated vibrations. The vehicle cab is typically mounted on the chassis with the help of four supports.

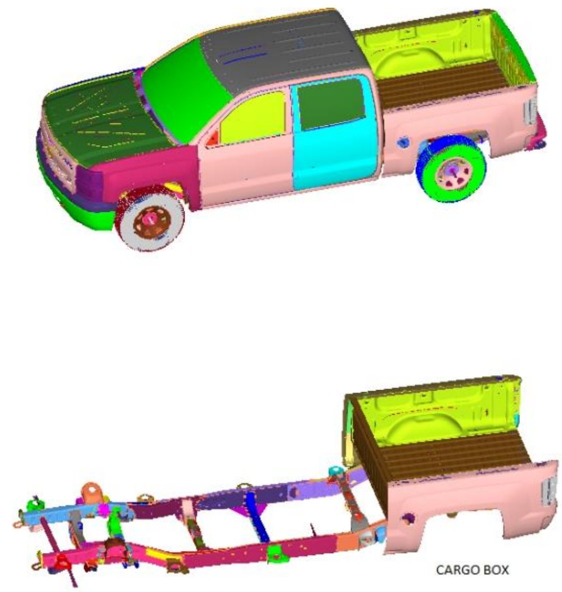
At the rear end it is mounted on Cab cross member center channel. Isolators are used to mount the cab on this center channel. The center channel is attached to the frame through cross member end bracket. The front side of the cab is mounted on the frame using an assembly of two brackets namely cab side mounting bracket and frame side cab mount. The cab side mounting bracket is joined to frame side cab mount using a bushing to provide vibration isolation. The frame side cab mount is bolted with the frame rail. The front cab mount also gives facility to tilt the cab for inspection/maintenance of the under-cab systems. The cab mounting system with its main components



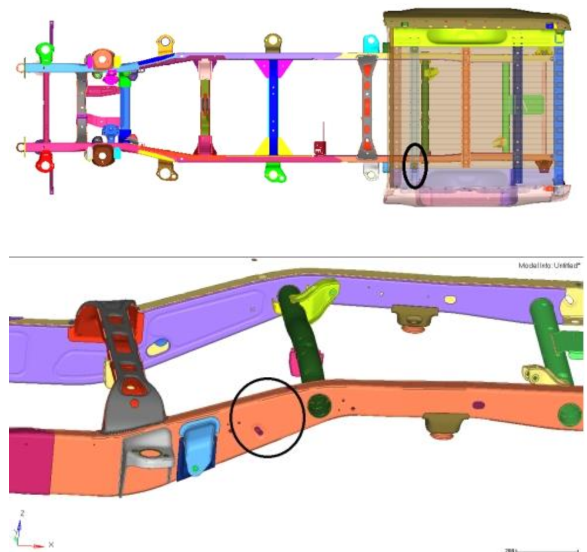
Schematic Diagram of Cab Mounting System

II. PROBLEM DEFINITION

To design a cab mount bracket for a Cargo Box pick-up vehicle as specified by the customer. The bracket is designed for a space envelop of 120 x 160 x 220 mm having the loading location of (682,2122,138) (specified by costumer w.r.t global coordinates) to be placed at the location as shown in fig 2.1. The bracket is to be designed for stiffness requirement of 5000N/mm in all the three directions (i.e., x, y and z directions)



Full Vehicle with Cargo Box



Location of the bracket

III. CATIA MODELLING

CATIA (Computer aided three dimensional interactive application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company dassault systems Written in the C++ programming data , CATIA is the cornerstone of the Dassault Systems product life management software suite. CATIA offers a solution to model complex and intelligent products through the systems engineering approach. It covers the requirements definition, the systems architecture, the behaviour modeling and the virtual product or embedded software generation. CATIA can be customized via application programmed interfaces. CATIA V5 & V6 can be adapted using Visual Basic and c++ programming languages via CAA (Component Application Architecture); a component object models (COM)-like interface.

Although later versions of CATIA V4 implemented NURBS, V4 principally used Piecewise polynomials surfaces. CATIA V4 uses a non-manifold solids engine. Catia V5 features a parametric solid/surface-based package which uses NURBS as the core surface representation and has several workbenches that provide KBE support. In April 2012, Dassault Systems announced the industry's best multi-version compatibility, allowing V5 and V6 users to share and edit parts at the feature level. OEMs or suppliers in all industries gained the flexibility to modify and exchange designs, whether they are V5- or V6-native, as they progress through the design process. V5-6R2013 extends the scope of this capability to include features created in the Freestyle workbench. V6 parts created in V6R2013x containing features created in the Freestyle workbench can be transferred with all their specifications to CATIA V5-6R2013. V6 models can be transferred "as specifications" to V5, retaining features created in, for example, V6's Part Design, Sketcher, Generative Surface Design, and Freestyle workbenches and knowledge ware. This extension demonstrates the continuing compatibility and synchronization between V5 and V6, as well as the enrichment of V5 solutions with select V6 technology.

IV. FINITE ELEMENT METHODS

The finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in engineering schools and industries. In more and more engineering situations today, we find that it is necessary to obtain approximate solutions to problems rather than exact closed form solution.

It is not possible to obtain analytical mathematical solutions for many engineering problems. An analytical solutions is a mathematical expression that gives the values of the desired unknown quantity at any location in the body, as consequence it is valid for infinite number of location in the body. For problems involving complex material properties and boundary conditions, the engineer resorts to numerical methods that provides approximate, but acceptable solutions.

The fundamental areas that have to be learned for working capability of finite element method include:

- Matrix algebra.
- Solid mechanics.
- Variation methods.
- Computer skills.

Matrix techniques are definitely most efficient and systematic way to handle algebra of finite element method. Basically matrix algebra provides a scheme by which a large number of equations can be stored and manipulated. Since vast majority of literature on the finite element method treats problems in structural and continuum mechanics, including soil and rock mechanics, the knowledge of these fields became necessary. It is useful to consider the finite element procedure basically as a Variation approach. This conception has contributed significantly to the convenience of formulating the method and to its generality.

- Advantages of FEM:

The FEM is based on the concept of discretization. Nevertheless as either a variational or residual approach, the technique recognizes the multi dimensional continuity of the body not only does the idealizations portray the body as continuous but it also requires no separate interpolation process to extend the approximate solution to every point within the continuum. Despite the fact that the solution is obtained at a finite number of discrete node points, the formation of field variable models inherently provides a solution at all other locations in the body. In contrast to other variational and residual approaches, the FEM does not require trail solutions, which must all, apply to the entire multi dimensional continuum. The use of separate sub-regions or the finite elements for the separate trial solutions thus permits a greater flexibility in considering continuum of the shape.

Some of the most important advantages of the FEM derive from the techniques of introducing boundary conditions. This is another area in which the method differs from other variational or residual approaches. Rather than requiring every trial solution to satisfy the boundary conditions, one prescribes the conditions after obtaining the algebraic equations for assemblage.

- Limitation:

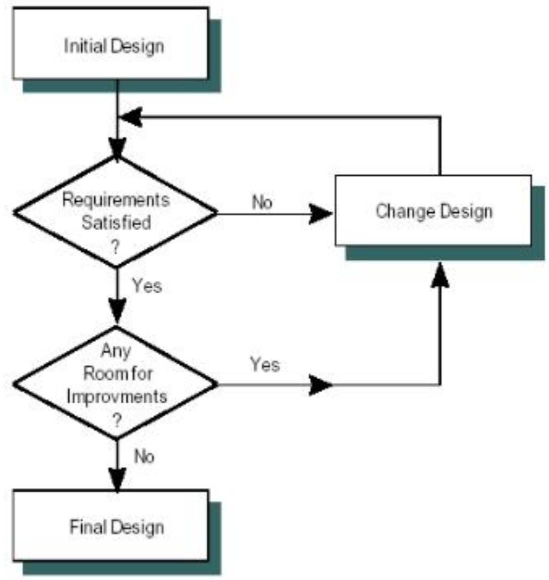
One limitation of finite element method is that a few complex phenomenons are not accommodated adequately by the method as its current state of development. Some examples of such phenomenon form the realm of solid mechanics are cracking and fracture behavior, contact problems, bond failures of composite materials, and non-linear material behavior with work softening. Another example is transient, unconfined seepage problems. The numerical solution of propagation or transient problem is not satisfactory in all respects. Many of these phenomenon's are presently under research and refinements of the methods to accommodate these problems better can be expected.

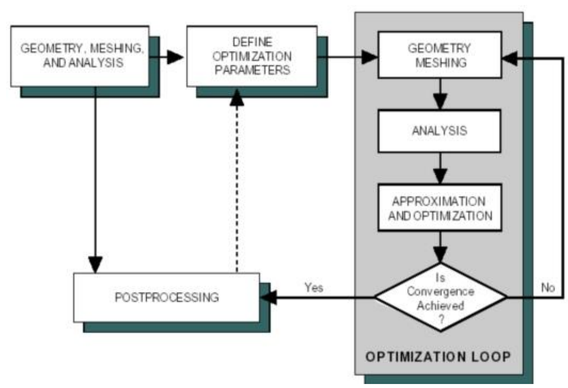
V. INTRODUCTION OF OPTIMIZATION

Optimization is the act of obtaining the best result under given circumstances. In design, construction, and maintenance of any engineering system, engineers have to take many decisions at several stages. The aim of all these decisions is to minimize the effort required or to maximize the desired benefit or both. Since the objective of these decisions can be expressed as the function of certain decision variables, optimization can be defined as the process of finding the conditions that give the maximum or minimum value of a function. In other words Optimizing means finding the best result for a given set of conditions or circumstances.

- DESIGN OPTIMIZATION

Design can be defined as interplay between "what we want to achieve" and "how we want to achieve" in an engineering process [1]. Traditionally, engineering design has been carried out by the experience or intuition of expert engineers. Engineering design is an iterative process, as shown in Figure-1.1. The design is continuously modified until it meets evaluation and acceptance criteria set by the engineer. Mathematical and empirical formulae aided by years of engineering judgment and experience has been useful in the traditional design processes to verify the adequacy of designs.





Optimization by evolution: There is a close parallel between technological evolution and biological evolution. Most designs in the past have been optimized by an attempt to improve on an existing similar design. Survival of the resulting variations depends on the natural selection of user acceptance.

Optimization by intuition: The art of engineering is the ability to make good decisions, without being able to provide a justification. Intuition is knowing what to do, without knowing why one does it. Although the knowledge and tools available today are so much more powerful, ultimately intuition continues to play an important role in technological development.

Optimization by trial-and-error modeling: The first feasible design is not always the best design, so the design model is exercised for a few iterations, in hope of finding an improved design. This mode of operation cannot be referred to as optimization but can be a technically acceptable job done rapidly and economically.

Optimization by numerical algorithms: This is the area of current development in which mathematically based strategies are used to search for an optimum. Computers are widely used for such an approach.

VI. OPTIMIZATION TECHNIQUES

Linear programming permits the designer to make optimal decisions in complex situations. It is an optimization method that is applicable for the solution of problems in which the objective function and the constraints appear as linear functions of the design variables. The constraint equations in a linear programming (LP) problem may be in the form of equalities or inequalities. The simplex method continues to be the most efficient method of solving LP problems, in spite of many other methods being developed.

There are a number of applications of the LP. LP was efficiently used first in the petroleum industry. An oil refinery has the choice of buying crude oil from different sources with differing compositions and at differing prices. It can manufacture different products, such as aviation fuel, diesel fuel, and gasoline, in varying quantities. The constraints may be due to the restrictions on the quantity of the crude oil available from a particular source, the capacity of the refinery to produce a particular product, and so on. A mix of the purchased crude oil and the manufactured products is sought that gives the maximum profit. Linear programming has been successfully used in the food processing industry, paper mills, in the optimal routing of messages in a communication network etc. It has also been applied to formulate and solve several types of engineering design problems, such as the plastic design of frame structures.

VII. CONCLUSION

From the above results summary, concluded that Iteration 9 design got the greater stiffness values the target 5000 N/mm. Through this project an attempt was made to learn about Optimization and the techniques involved in Design Optimization. Topology Optimization was performed to finalize the shape of the bracket.

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