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Design Optimization & Strength Assessment Of Commercial Vehicle Fuel Tank Mounting Bracket Using Finite Element Analysis

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ABSTRACT
One of the most important functions of the fuel tank in the automotive industry is to transport gasoline to the engine and to provide it with fuel. The goal of the design optimization efforts that are being undertaken in this research is to provide a more effective fuel tank mounting bracket for commercial vehicles. The design of the bracket that will be used to install the fuel tank is a component of this project that calls for geometry and finite element modeling. For analysis, the Optistruct solver was used, while Hypermesh was utilized for finite element modeling, and Pro-E was utilized for geometric modeling. The primary objective of this endeavor is to conduct a static assessment of mounting bracket assembly. It is possible that it will be easier to comprehend metal component assemblies with the assistance of the strategies that are offered in this study.
Keywords: *FEA, Fuel Tank, Hypermesh, Optistruct*

INTRODUCTION

There are preliminary studies that suggest that the Indian automobile industry is exhibiting signs of health, which is excellent news for both consumers and companies simultaneously. The market rates were affected, and the level of competition in the automobile industry was significantly reduced as a result. Each and every company in the automobile sector has to rise to the occasion and carve out a specific area for themselves to operate in. The cost of the automobile is an essential consideration from a basic point of view. Therefore, it is essential for every company to keep a close watch on the rate of pricing in the market and make every effort to maintain the price of the automobile at the lowest feasible level. The researchers came to the conclusion that the assessors, which comprise every component of the engine and body as well as any necessary extras and equipment, have an effect on the entire price of the car. It has been established, on the basis of the findings of the overall assessment, that a reevaluation of three-wheeler vehicles is required in order to discover methods to reduce the costs of these vehicles without compromising the quality of their design. Due to the fact that they are in charge of transporting the gasoline tank, the design of the brackets that are used to install the fuel tank is of utmost significance from a safety management perspective. A gasoline tank and mounting bracket suitable for a normal vehicle are shown in Figure 1.

Fig -1: fuel tank and mounting bracket of truck

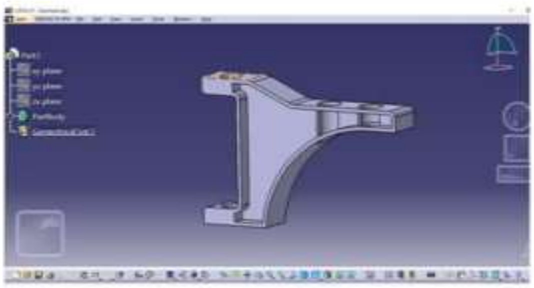
According to Umesh and his colleagues, the mounting bracket for the fuel tank has been the focus of their study on finite element analysis. In order to provide a stable foundation for the gasoline tank, a fuel tank attachment bracket is used. It is the major concern that the bracket is subjected to static stress since it has the potential to cause structural collapse as a result of excessive vibration and strain. Tatsuo and his colleagues also conducted study of this nature throughout their time. Increasing the efficiency of the assembly process, ensuring the safety

of the piping, and making the fuel tank mounting structure more practical are all benefits of this technology. When the gasoline tank is positioned on the tank supporting frame, it is secured to the frame by means of a belt. Installing the pipe and seal that will prevent leaks is something that you may do in conjunction with the tank. It is necessary to secure the tank to the frame in order to ensure that the frame is attached to the body of the vehicle. Because to this configuration, there is no longer a need to physically connect each fuel tank to the body of the vehicle, which saves both time and work. The study that was carried out by Pavan B. and his colleagues provides a comprehensive description of the process of improving the natural frequency of the engine bracket via the use of finite element analysis and a variety of lightweight materials. The use of lighter vehicle components is a known and reliable method for accomplishing the aims of efficiency in fuel consumption and environmental protection. An examination of the engine mount bracket assembly was carried out using finite element analysis (FEA) and modal analysis. The results of this study revealed that the brackets composed of magnesium alloy provide the highest acceptable frequency. Dhillon and his colleagues looked into whether or if there was anything like. When a car is driven, the engine is held in place by brackets that are attached to the fundamental construction of the vehicle, which is also referred to as the chassis. One of the most important parts of the vehicle is how the engine is mounted. In order to get a ride of superior quality and dependable performance, it is necessary to place and geometrize the mount brackets in the appropriate manner. Modeling, finite element analysis, modal analysis, and mass optimization are some of the topics that are discussed in this paper. Additionally, engine bracket optimization for FSAE automobiles is presented.
Calculations of fatigue strength and durability were used in order to guarantee the engine safety of the FSAE car. This was done due to the fact that the brackets of these high-performance automobiles have a tendency to encounter continuous vibration. During his study, Michael Davis looked at the most effective methods for building fuel tanks for high-speed vehicles. Creating a gasoline tank that is suitable for a high-speed vehicle is not a simple task to do. The construction of a fuel tank that is dependable involves careful consideration of a number of different physical characteristics. This research investigates the basic design of the fuel tank and examines a number of models that have been proposed for sloshing in the tank. The purpose of this investigation is to ascertain the amount of gasoline that is still present in the petrol tank.
Late in the 19th century and early in the 20th century, the United States of America was the origin of the heavy-duty truck. During World War I, large trucks were a vital means of transportation for the transportation of supplies both inside the country and also to other countries. Steel was chosen as the material for the construction of the gasoline tanks of the heavy-duty trucks because of its excellent strength and durability. When it comes to storing flammable gases and liquids, the fuel tank is the perfect placement. Because diesel fuel contains a significant amount of flammable elements, it is imperative that fuel systems for vehicles comply to high safety regulations. Diesel fuel is used in a significant number of countries across the world. When designing a gasoline tank, it is essential to take into consideration critical issues such as determining the required volume, choosing the shape, and settling on a position. Unwanted vibrations in the fuel system of the chassis and body of the vehicle may develop as a consequence of disturbances in the road and the fuel tank system. The vibrations that are caused by the road may be kept under control with the assistance of a fuel tank bracket that is both sturdy and muffled. Placing the fuel tank on the frame of the vehicle may be accomplished by the use of brackets, straps, or a combination of the two.

OBJECTIVE

1. To pinpoint the bracket's weak spots where stress might build up and cause failure.
2. To maximize the design of the bracket so it is stronger and uses less material.

COMPLETE DESIGN OF A FUEL TANK MOUNTING BRACKET



Fuel Tank Construction

Certain gasoline tanks are still made by experienced metalworkers or, in the case of bladder-style tanks, by hand, despite the fact that the vast majority of tanks are manufactured by machines. Tanks that are used for tractors, motorcycles, airplanes, and automobiles are all included in this category, as are tanks that are repaired or made to order. When it comes to the construction of gasoline tanks, there is a certain protocol that must be followed. The artisan would often construct a replica out of foam board in order to get the precise size and shape of the tank with which he was working. Following are some of the structural design aspects that need to be taken into account, including the placement of the tank's outlet, drain, fluid level indicator, seams, and baffles. The next thing that the artisan has to do is decide on the alloy, temper, and thickness of the sheet that will be used for the tank. After the sheet has been cut to the appropriate shapes, the basic shell, ends, and baffles of the tank are constructed by bending various pieces of the sheet. Lightning holes may be found in the baffles of many different types of fuel tanks, however they are most often encountered in racecars and aircraft. It is via the use of these flanged holes that both these stronger baffles and the lighter tank are accomplished. In order to provide room for the fuel-level sending unit, drain, filler neck, and fuel pickup, holes are bored at the very end of the construction process. They might be drilled into the flat shell during the manufacturing process, or they could be inserted at a later time. By employing rivets, it is possible to secure the ends and baffles. In order to prevent tanks from leaking, the heads of rivets are often brazed or soldered.

Automotive Fuel Tanks

The greatest distance that a vehicle powered by a combustion engine can go on a full tank is calculated by multiplying the tank capacity by the fuel efficiency, which is expressed in miles per gallon. It is possible that a larger tank may improve the maximum distance traveled, but this will come at the expense of an increased fuel consumption owing to the larger size of the tank and the heavier overall weight, especially while it is full. Consequently, the volume of the fuel tank is the result of a compromise that was made during the period of design. The fuel tank capacity of the majority of compact vehicles ranges from 45 to 65 liters (12 to 17 US gal), but the original Tata Nano stood out with a capacity of 15 liters, which is equivalent to four US gal. Big rigs, such as SUVs and trucks, often have gas tanks that are much larger. A one-of-a-kind fuel system is developed for each and every new vehicle in order to realize the greatest possible use of available space. For the same model of car, other fuel system designs are also made. These designs are determined by a number of criteria, including the region, the nozzle model, the fuel type (gasoline or diesel), and the kind of vehicle.

Safety

It is very important to ensure that the system in which a gasoline tank is put is designed and constructed correctly in order to guarantee the system's safety. The mixture of gasoline vapors and air that is contained inside a fuel tank that has not been shattered is often quite safe since it is much beyond the flammability constraints and would not ignite even in the presence of an ignition source, which is an exceedingly unrealistic scenario. The bunded oil tanks provide a safe and secure location for the storage of household heating oil as well as other potentially hazardous chemicals. When compared to oil storage tanks that just have one skin, bunding is often the option that insurance companies insist on. BattleJackets and rubber bladders are two examples of the technologies that have been developed and used in order to protect the fuel tanks of military vehicles in conflict zones from the attacks of hostile forces.

INTRODUCTION TO CAD/CAM/CAE

Each and every facet of design, development, manufacturing, and other areas is influenced by computers, making them an essential component of the contemporary world in which we live. As a result of their extensive use, computers have become vital in a number of different businesses. The global market of today is characterized by intense competition across a broad variety of parameters, such as price, quality, consistency, availability, packaging, inventory, delivery, and many more. Needs, as opposed to local preferences, are driving businesses to adopt innovative approaches such as computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE), and so on.

Need for CAD, CAE & CAM

With the use of computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM), enterprises have been able to achieve their objectives in a shorter amount of time and, ultimately, have their goods reach the market in the anticipated time frame with improved quality and consistency.

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This has resulted in a healthy and standard competition. In general, it has led to a rapid increase in both cognitive and action responses.

Introduction to CATIA

Creating complicated and precise designs is made possible with the help of CATIA, which is a sophisticated application. During this in-depth course, you will not only learn the fundamentals of CATIA's capabilities for constructing parts and assemblies, but you will also learn how to make basic drawings of these essential components.

Feature-based

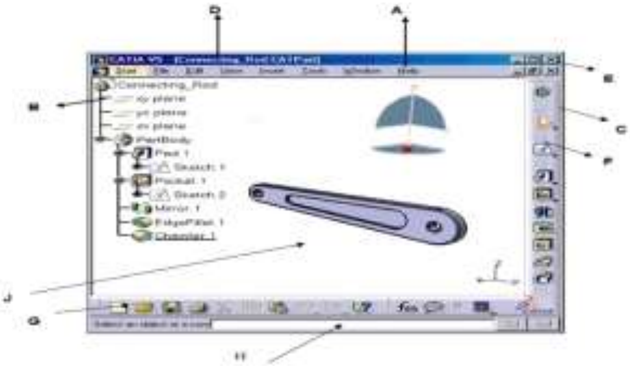
Each component that makes up a CATIA document is analogous to a component that is part of an assembly; they all collaborate to produce the total. These components are described by their features. Pads, pockets, holes, ribs, fillets, chamfers, and drafts are just some of the features that might be included throughout the process of document creation. It is instantly treated to the features as they are produced, and the work item is treated to them.

Solid Modeling

In computer-aided design (CAD) systems, the solid model is the kind of geometric model that is the most thorough. It has each and every piece of surface geometry and wireframe that is necessary in order to distinguish the edges and faces of the model. Not only can solid models provide geometric information, but they also convey their "topology," which is the connection between the geometry on the model. An example of a potential application of topology is the discovery of the points where faces (surfaces) and edges (curves) cross. With this intelligence, adding features is a simple process. A fillet, for example, may be constructed by selecting an edge and assigning it a radius. This is all that is required.

Fully Associative

There is a complete associativity between a CATIA model and the drawings, components, and assemblies that correspond to it. In the event that you make a modification to the model, all of the drawings, components, and assemblies that are associated with it will immediately be updated. Similarly, the model represents changes that have occurred in the environment around the drawing or assembly.



Workbenches

There is a possibility that you may need access to the tools that are kept on a workbench if you are producing your own components. When moving between the primary workbenches, there are two different ways to do so:

CONCLUSION

Using numerical simulation, we were able to effectively anticipate the Eigen values and Eigen vectors of the fuel tank mounting bracket assembly. This was accomplished by mathematical modeling. An analysis of the results obtained from each iteration of the design process led to the discovery of the following discoveries. The results of our static structural investigation lead us to the conclusion that, in contrast to basic and other design adjustments, the brackets with multi stiffeners, also known as design modification 3, create the lowest levels of von mises stress (384 MPa) and deformation (0.59 mm). Based on the results of the normal mode study, the multi-stiffener fuel tank mounting bracket has an outstanding initial natural frequency of 73 Hz, which is much higher than the initial natural frequency of other stiffeners.

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