International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue-17
December 2017

Design and Analysis of a Skid for Fuel Tank Bracket of a Truck

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ABSTRACT

In today's industries, material handling system is unitary of the significant system. Skids have a massive impact on logistics, packaging and also on the transportation systems. Skids are used in different industries for different resolutions. But mostly, the purpose of skid is in material storage, material handling of heavy parts and transporting cargoes. Reason for using skid is to ensure safe material handling and storage of the material. If the skid is not properly designed then it will fail to handling and storage. This makes the designer to be more cautious about designing of the skids.

A skid is a single-deck loading platform which lacks a bottom deck. Designing is a field of making a part to be sustained in particular condition. In this project, design of skid for fuel tank bracket of a heavy truck is done precisely. So, the skid for fuel tank bracket discussed in this Project was designed with conventional CAD design practices and then analyzed statically with FEA software having gravitational loading of fuel tank brackets. Initially, the design of skid is developed based on the design of fuel tank bracket using NX- CAD software. Two types of skids are developed with same dimensions but with different sections.ie. Solid section and L section skid. The designed skid is later imported into Ansys to perform structural analysis. The analysis was carried out to determine the induced stresses and deflections at various locations on proposed skids. The project also includes the analysis of skid by comparing different materials. Based on the results the best skid is proposed and finally the fabrication drawing of the skid is created and documented in the report.

INTRODUCTION

The term skid and pallet are commonly used interchangeably for load platforms used in material handling systems and logistics applications.

WHAT IS A SKID

A pallet with no bottom deck boards is called as skid.A pallet is considered to be a load platform that includes a bottom deck or face, while a skid has a top deck but no bottom deck. There are inconsistencies in usage, however, as mentioned earlier. For example, a nestable skid is often referred to as a nest able pallet. Skids are also referred to as single deck pallets.

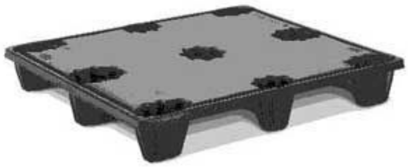

Fig.1.1.Skid is the plastic distribution pallet

It is a flat transport structure that supports goods in a stable fashion while being lifted by a forklift, pallet jack, front loader, work saver, or other jacking device, or a crane. Generally speaking, a skid is considered to be a platform on runners or other vertical supports, such as a skid foundation. A pallet is the structural foundation which allows handling and storage efficiencies.

THE HISTORY OF SKIDS IN MATERIAL HANDLING:

This 1915 platform truck lifted load platforms or skids that did not have a center stringer. The forks came later, as did the modern stringer pallet.

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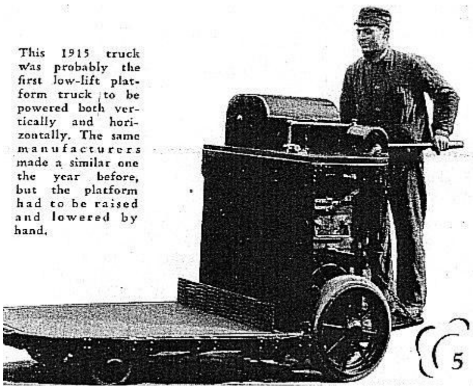

Fig .1.2 1915 platform truck lifted load platforms

Before the emergence of the double-faced pallet in the 1930s, skids or sleds were used in industry for storing and moving materials. These devices typically featured a wood deck and vertical legs fabricated from steel or iron, or wooden stringers. The use of skids for material handling may date back several hundred years, to a time when they were used to skid or sled material over terrain.

Skids or platforms of the early 20th Century typically did not have a support in the center, as they interacted with lift trucks that employed a single lift platform rather than with two forks. The image above displays an early lift truck with such a single lift platform.

The development of pallet forks and pallets with a center stringer provided a significant advantage. With the addition of the center stringer, the reduced span between supports meant that thinner deck boards could still provide adequate stiffness.

The addition of the bottom pallet deck in the 1930s also meant that unit loads of materials could be more readily stacked in order to improve space utilization in factories and depots. In the Second World War, skids or sleds were used tactically in the Pacific theater of war for pulling supplies over contested beaches during battle, with a rope attached to a vehicle. Double faced pallets were more commonly used for distribution during WW2.

THE MODERN DAY SKID:

Examples of modern skids include wood pallets without a bottom deck or nestable pallets. Many paper pallets would also be classified as skids, such as the IKEA paper pallet pictured below.

Fig .1.3 Example of the paper pallet.

An important advantage of nestable pallets is that of improved cube efficiency. Nested pallets take up less space than empty and stacked. In terms of reduced transportation cost, the transportation of nestable pallets is typically much more cost effective than for double-faced pallets.

HOW IS SKID RELATED TO PRESENT PROJECT

Above we have seen that, the skids play a major role in the material handling. The skids should have the effective strength to bear the load of the components that are placed on them. They also should be able to provide good strength to weight ratio. Here raises the case for the replacement of the convectional material of the skid with another material that provides good strength at less weight and less cost of production. IN this project, the skid for the fuel tank bracket of the truck is to be designed and analyzed with conventional steel, cast iron and aluminum 7075-t6 alloys to find the appropriate material with good desired properties.

3D MODELING OF THE SKID FOR FUEL TANK BRACKET OF THE TRUCK

INTRODUCTION OF CAD:

Computer aided design (CAD) is assistance of computer in engineering

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p-ISSN: 2348-795X
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processes such as creation, optimization, analysis and modification. CAD involves creating computer models defined by geometrical parameters which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real world conditions. There are several good reasons for using a CAD system to support the engineering design function:

- To increase the productivity
- To improve the quality of the design
- To uniform design standards
- To create a manufacturing data base
- To eliminate inaccuracies caused by hand-copying of drawings and inconsistency between drawings

INPUT FOR THE 3D MODELING OF THE SKID:

The drafting data required for the 3d modeling of the fuel tank bracket is obtained from the Asia motor works limited. The designing of the fuel tank bracket is done in NX-CAD. Below figure shows the 2D drawing of the fuel tank bracket with all the required dimensions.

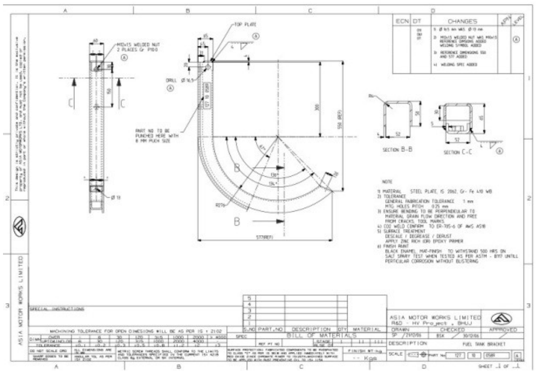

Fig.3.2. Drawings of the fuel tank bracket

DEVELOPMENT OF THE 3D MODELING:

In the process of assembly of the fuel tank brackets to the trucks, the large number of skids that that are produced in the production unit are brought to the assembly unit. In assembly unit the brackets are to be placed near the assembly line. So that it could reduce the working time on the each component. It is also important to check that these brackets do not occupy a large amount of work space.

Here comes the need for the equipment that holds a lot of components in a limited work space and also thereby reducing the working time. Thus a skid is designed to the above created bracket, so that it holds a large number of components in a limited space. I.e. a compact skid with high strength and should accommodate more components.

The part by part development of the skid for the fuel tank bracket is shown in the below steps. The fuel tank bracket developed by the drawings taken from Asia motor works is shown in the below figure.

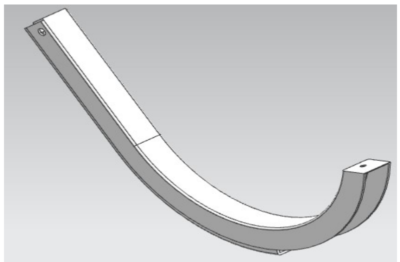

Fig. 3.3. Fuel tank bracket

The bottom frame of the skid should be strong enough to take the load of number of brackets that are placed on it. It should also be able to with stand the load while transferring from production unit to the assembly unit. The bottom base of the skid that takes the whole weight of the brackets and the upper frame, is shown in the below figure.

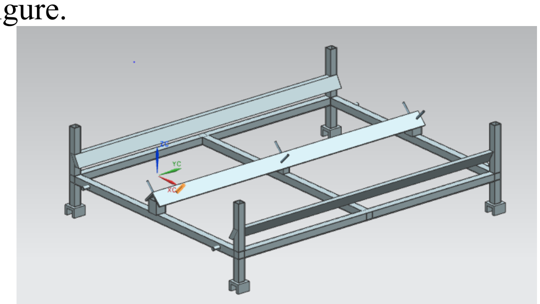

Fig. 3.4.Bottom frame of the skid that holds the brackets.

The supporters of the bracket that lie on the bottom frame of the skid is shown in the

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below figure. These are designed in such a way that they can accommodate 10 brackets.

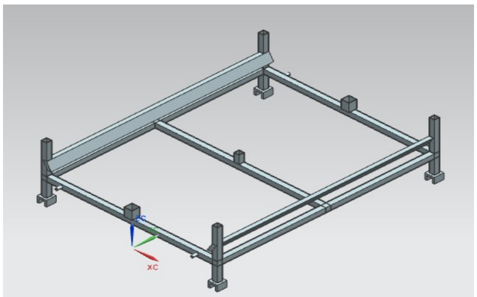

Fig .3.6.Upper frame of the skid.

The top frame of the skid is placed on the bottom frame. The bottom frame is also mounted by the rest blocks and the fuel tank brackets. The total assembly of the skid with the brackets is shown in the below figure.

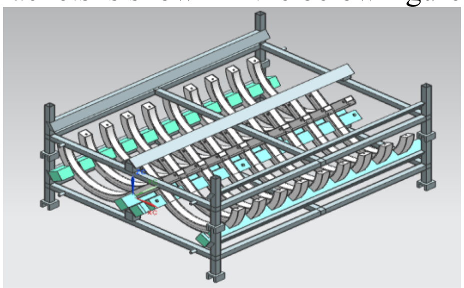

Fig.3.7. Isometric view of the skid with brackets attached to it.

In the above mentioned skid the solid section is considered in designing the frames of the skid. Another skid is also developed with same ability to accommodate equal number of brackets. The new skid is designed with the L-section frames. It will be quite appreciable if the L- section skid is having almost equal strength as of the solid skid. The use of the L section could reduce the weight of skid and there reducing the cost of the skid.

Below figures shows the construction of the frames of the skid with L section.

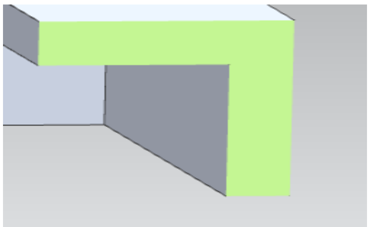

Fig.3.8. Typical L section taken for the construction.

The base frame of the skid with above shown L section is shown in the below figure.

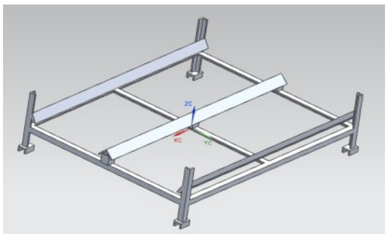

Fig. 3.9. Base frame with L section.

The upper frame of the skid is shown in the below figure.

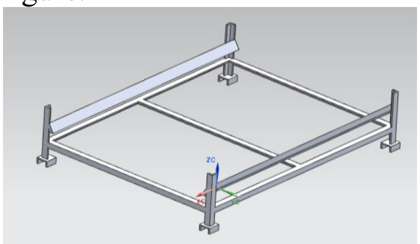

Fig .3.10.Upper frame of the skid with L section.

The final assembly of the skid with rest blocks mounted on it is shown in the below figure.

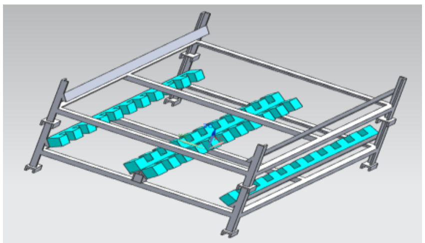

Fig. 3.11.Final assembly of the L section skid.

FEM ANALYSIS OF THE SKID FOR FUEL TANK BRACKET

Finite Element Methods (FEM) and Finite Element Analysis (FEA) are two most popular mechanical engineering applications offered by existing CAE systems. This is attributed to the fact that the FEM is perhaps the most popular numerical technique for solving engineering problems. The method is general enough to handle any complex shape of geometry (problem domain), any material properties, any boundary conditions and any loading conditions. The generality of the

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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FEM fits the analysis requirements of today's complex engineering systems and designs where closed form solutions are governing equilibrium equations are not available. In addition it is an efficient design tool by which designers can perform parametric design studying various cases (different shapes, material loads etc.) analyzing them and choosing the optimum design.

STATIC ANALYSIS OF THE SKID FOR FUEL TANK BRACKET WITH STEEL MATERIAL:

3D model of the skid was developed in NX-CAD from the papers. The model was then converted into a Para solid to import into ANSYS. A Finite Element model was developed with solid elements. The elements that are used for idealizing the fuel tank bracket were described below.

Initially load calculations for the skid are done. Static Analysis was done by applying the calculated load for three different materials (Mild Steel, Aluminum Alloy-7075-T6 and Cast Iron). From the analysis the displacement and maximum principle stresses are calculated and tabulated. The material properties used for the analysis and the description of elements used for analysis are given below.

MATERIAL SPECIFICATION:

The mechanical properties of the materials i.e. Mild Steel, Aluminum 7075-T6 and Cast Iron, used for the static analysis of the skid are shown in the below table:

Sl. no	Parameter	Mild Steel	Aluminum 7075-T6	Cast Iron
1	Young's Modulus (Pa)	200e9	72e9	190e9
2	Poisson's ratio	0.3	0.33	0.27
3	Density (Kg/m^3)	7850	3100	7300
4	Yield Stress, бy (Pa)	248e6	185e6	275e6

Table. 4.1. Iron, used for the static analysis of the skid

LOAD CALCULATIONS FOR THE SKID OF FUEL TANK BRACKET OF THE TRUCK:

Mass of the single bracket = 7.519 Kgs
Mass of twenty brackets = 150.38 Kgs
Weight of the twenty brackets = 1475.22N

ELEMENT TYPE:

The element type used for the static analysis of the skid for the fuel tank bracket is SOLID 186. Solid186 is a higher order 3-D, 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions.

The element supports plasticity, hyper elasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyper elastic materials.

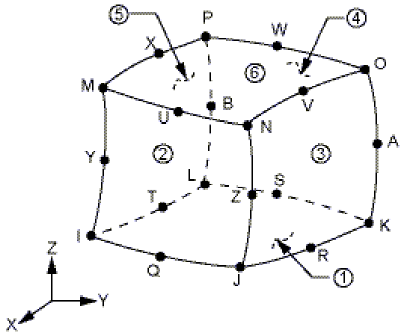

Fig. 4.1.Solid186 element geometry.

GEOMETRIC MODEL:

The assembly of the skid for the fuel tank bracket is done in NX-CAD. Here, the fuel tank brackets are dislodged from the model and then the model is converted into the parasolid file. The 3d model of the skid that

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is considered for the static analysis is shown in the below figure.

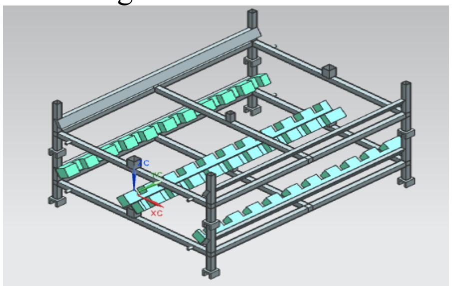


Fig. 4.2. Final required model

FINITE ELEMENT MODEL:

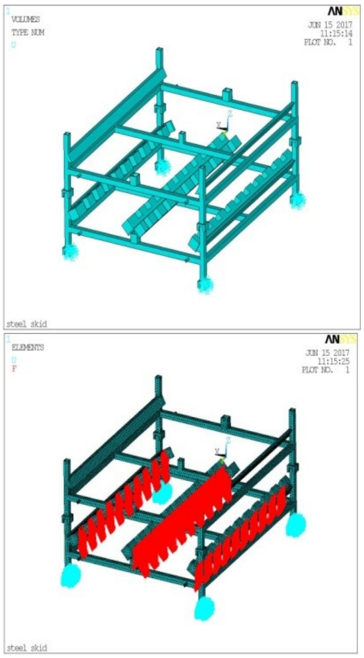
The parasolid file is imported into the ANSYS to perform the static analysis. The finite element model was developed with the solid 186 element. The finite element model is shown below.

Fig. 4.3. Finite element model of the skid

BOUNDARY CONDITIONS:

The boundary conditions and loading used for static analysis of skid are as follows:

- The bottom faces of the skid are constrained in all DOF as shown in the below figure.
- The above calculated load is applied on the surfaces that bear the weight of the fuel tank brackets.



4.4. Applied boundary conditions

RESULTS OF STATIC ANALYSIS:

The deflections and the stresses developed from the static analysis of the skid with the steel material are plotted below.

DEFLECTIONS:

The maximum deflections obtained in the X-direction are plotted in the below figure.

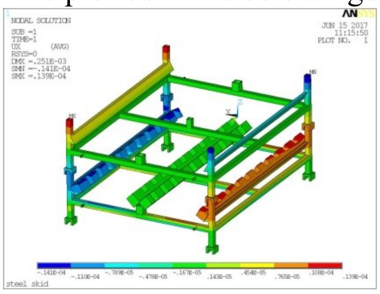


Fig. 4.5. The deflection in X-direction

The maximum deflections obtained in the Y-direction are plotted in the below figure.

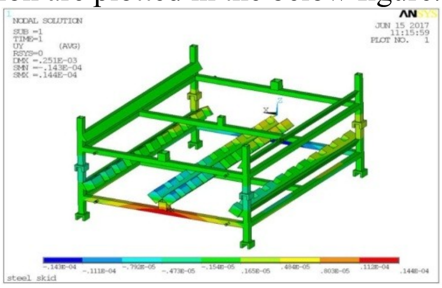


Fig. 4.6. The deflection in Y-direction

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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CONCLUSION

From the above discussions,

- It is found that, amount of von Mises stress developed in the static analysis of the solid skid and L shaped skid with three different materials is almost equal and very well below the yield strength of each respective material. There by indicating that the both the skid made with all the three materials are safe.
- It is also found that, the maximum deflections obtained in the skid with two different sections and for three different materials is very negligible. I.e. less than 1mm.
- It is also found that, there are large variations in the weight of skids for different materials and different sections for the same strength (approximately). I.e. weight of the aluminum skid is very much reduced when compared to the weight of steel and cast iron skids.
- The factor of safety obtained for the aluminum might be less than that of the steel and cast iron, but it is very much high when considered in the real time situations. I.e. approximately more than four times of general conditions.

Thus it can be concluded that the convectional steel or cast iron skids can be replaced by the aluminum skid which can provide same strength with reduced weight and thereby reducing the cost of the skid. There could be further marginal reduction in the cost of the skid if the L section is preferred over the solid skid.

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