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Analysis of the "Structural Strength of the Pallet Frame"

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***Abstract*— Packaging is one of the most important parts of the transportation of finished goods. The main objective during transportation is to make sure that the finished goods reach the desired destination or place safely. So it becomes important to hold the finished goods by some kind of fixture without disturbing their (finished products) geometrical and design features and also it is very important to understand the loads occurring during the transportation before designing the fixture/pallet. Normally during transportation many types of pallets like, wooden pallet, plastic pallet, and metal pallet etc are used. Generally the standard pallets are used in all companies, because they are easily available in market. But while transporting the complex and heavy finished products the pallet design is crucial. The design of such pallet frame and its structural integrity is considered and analyzed using the software like hyper mesh and Abacus. The maximum stress observed in the pallet frame is found well below the yield strength of the material considered. So the structure is safe.**

I. INTRODUCTION

Packing is one of the most important parts of transportation of finished goods. The world becomes faster day by day and due to this region all process to be completed within the customer time demand. In this process packing is very important to contribute the safe dispatch. Internal and external transportations use different types of pallet like wooden, metal, plastic etc. In the transportation of finished goods, proper packing is very important to prevent it from any types of damage to the product. As far as the packaging is concerned, for the safe transportation of engine, pallet frame design is required.

In packing, selection of pallets is also important. In olden day's many countries would use the wooden pallets for packing. The wooden pallets is lighter in weight, easily available in market and manufactures with the less cost. Similarly plastic and metal pallet is alternative to wooden pallet for their compatibility and flexibility.

Metal pallets are high strength and suitable for heavy material transportation. We can design different types of engine pallets by make with slight changes in the metal pallet. Metal pallet is subjected to under the stresses of compression and tension when the pallets move from one place to another place with the product.

II. LITERATURE SURVEY

Yaman *et al* [1] worked on the manufacturer's mixed pallet design problem and formulate the problem as a mixed integer linear program. In this paper used company data for conducting a computational study to investigate efficiency of the formulation and impact of mixed pallets on customer's total costs. Lip H Teh et al [2] designed double-sided high-rise steel pallet rack frames and made analysis with the help of 3D linear buckling analyses; it demonstrated that the global buckling behavior of high-rise steel storage rack frames may not be revealed by 2D buckling as 3D interaction modes are involved.

III. CONCEPT OF MODEL

There are two concepts of metal pallet, one is bolt concept and other one is welding concepts. in our project welding concepts to be used because The welded joints are good strength than the bolt joints. The welded joint pallets are more beneficial because of minimum time required for pallet assembly and manufacturing. Major drawback of welded joints pallet is the mounting of engine legs are not replaceable when it gets damage and total pallet is needed to be scrapped.

IV. METHODOLOGY

- The CAD model is generated Pro-E software and is exported as .stp or iges natural file.
- The .stp file is imported into HYPERMESH software for disctretization/meshing. Once the geometry imported into the software, the midsurface are extracted and assigned with the proper thickness.
- 2D shell mesh is carried out on the midsurface.
- Materials with the following (Table.1) mechanical properties are assigned to the meshed surface.

Proper boundary conditions and loads are applied on the structures and exported in solver deck format.

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The below table.1 is mentioned the detail specifications of metal pallet frame.

Sl.no	Pallet specifications	
1	Material of pallet	MS355
2	Yield strength	355MPa
3	Modulus of elasticity	2.1E5 N/mm^2
4	Poisson's ratio	0.3
5	Density	7850kg/m^3
6	Pallet weight	300Kg
7	Product weight	280Kg
8	Number of parts	5
9	Application	Transportation

Table .1 detail specification of the metal pallet frame

V. BOUNDARY CONDITIONS AND LOADING

a) BOUNDARY CONDITION: Bottom of the pallet is fixed in all dof.

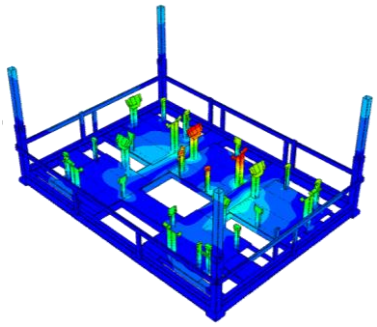

Fig.1 Boundary Condition

b) LOADING CONDITION: Mass of the product/engine is applied at 5 locations on the plated frame as shown in the below figure 2.

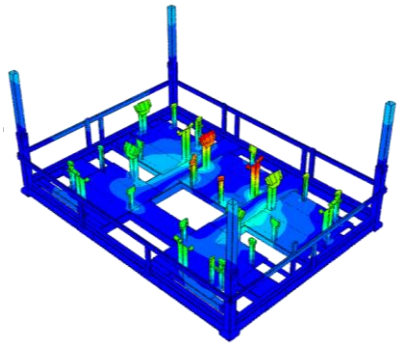

Fig.2 Loading Condition

c) ANALYSIS

The CAD model is built as per the requirements. And further the model is meshed with HYPERMESH 12.0 software boundary and loading conditions are applied. The meshed model is then analyzed with ABAQUS software for the purpose of different conditions i.e. breaking condition, vertical condition, and side condition.

VI.RESULTS AND DISCUSSIONS

The structural analysis of pallet frame was done using FEA analysis software under different conditions like, breaking condition, vertical/bumping condition, and side/turning condition.

a) Vehicle Breaking Condition

The vehicle breaking analysis is required when the finished goods is transport outside from the factory like sea shipment and on road by vehicles (trucks).

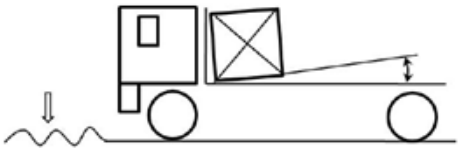

Fig.3 Vehicle Sudden Breaking

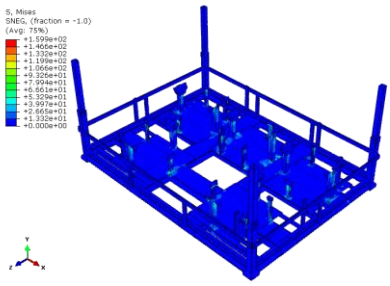

Fig.4 Max. Stress: 160 MPa

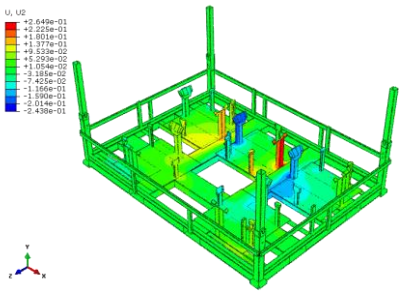

Fig.5 Max .Displacement: 0.2649mm

The above figures 4 and 5 explain the condition of when the vehicle is suddenly applied by the break. The finished goods can move in the forward direction with inertia load. Due to this reason all the welding joints and corners are need to be checked for weak locations.

b) Vehicle Vertical/Bumping Condition

This analysis is required when the finished goods is transport outside from the factory like sea shipment and on road by vehicles (trucks)

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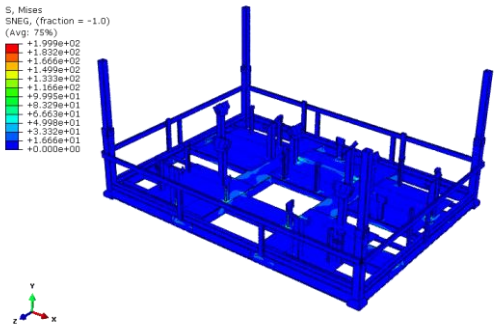

Fig.4 Max. Stress: 200 MPa

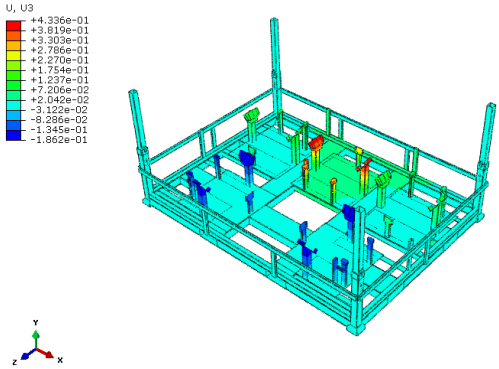

Fig.7 Max. Displacement: 0.4336mm

The above Figures 6 and 7 explain the condition of when the vehicle is moving on a road bumps. The finished goods can move in the upward direction with the inertia load. Due to this reason all the welding joints are need to be checked for week location.

c) Vehicle side/Turning condition

This analysis is required when the finished goods is transport outside from the company like sea shipment and on road by vehicles (trucks).

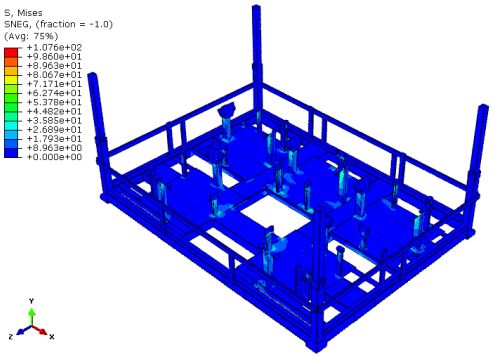

Fig.8 Max. Stress: 108 MPa

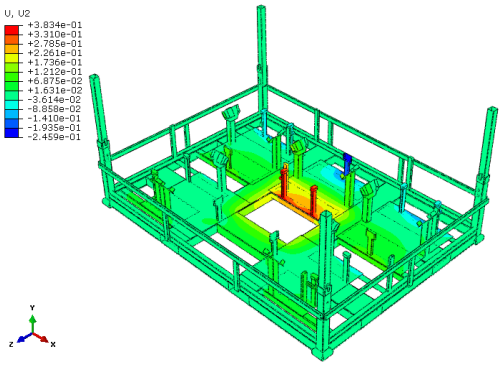

Fig.9 Max. Displacement: 0.383mm

The above figures 8 and 9 explain condition of when the vehicle moving on a curved road. The finished goods can move in the vehicle side with the inertia load. Due to this reason all the welding joints are need to be checked for week location.

Sl. No.	Load conditions	Type of Analysis	G Load	Yield Strength (MPa)	Max. Stress (MPa)	Max. Displacement (mm)	FOS
1	Breaking	Structural	1.5	355	160	0.2649	2.2
2	Vertical	Structural	2	355	200	0.4336	1.7
3	Side	Structural	1.1	355	108	0.383	3.2

Table2. Analysis Results of Different Loading Conditions

VII.CONCLUSION

With the reference to above table, the maximum stress observed in the pallet frame is 199MPa, which is well below the yield strength of the material of the pallet i.e. 355MPa. So the structure of the pallet is safe hence the design.

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