DESIGN AND ANALYSIS OF PUMP SKID BASE PLATE IN TRANSPORT CONDITION-THROUGH FINITE ELEMENT ANALYSIS

ABSTRACT: The main objective of the paper is to design and analysis the behaviour of the pump skid base plate while transporting to reach the onsite for this we will analysis and ensure the design is safe with various load while transporting. which is a self-contained unit housing one or more pumps along with necessary components such as motors, valves, and piping. Pump skids are commonly used in various industrial applications to facilitate fluid transfer operations. The methodology involves creating a 3D model of the pump skid base plate, defining material properties, applying operational loads boundary condition, and analysing the results of stress and deflection for the pump base skid under transport condition. The primary objective of this paper is to observe different types of baseplates based on the standards specified by American petroleum institute in API610. By achieving these objectives, the study aims to provide the valuable information about the safety of the pump skid base plate in transport condition under various load.

Keywords: Pump Skid Base Plate, Transport condition, API610, FEA

1.INTRODUCTION

Pump skids are usually pre-engineered and pre-fabricated, which means they are built off-site and delivered as a single unit to the installation site. This approach significantly simplifies installation, reduces on-site construction time, and minimizes labour costs. It also allows for customization based on specific application requirements, ensuring that the pump skid is to meet the needs of the industrial process. The pump skid base plate unit mainly consists of centrifugal pump and motor. The design and analysis of pump skid base plates involve multidisciplinary considerations, including structural engineering principles, mechanical design, material science, and optimization techniques. The primary objectives are to transport the pump skid base plate to the installation site for that to ensure safety. However, for petrochemical industry compliance of API 610 is mandatory.

2. LITERATURE REVIEW

Aditi A. Godse and Prof. M.K. Wasekar, (2015)- They studied the design and analysis of skid frame module for its strength and stiffness. They utilized Pro-E for the modelling and hyper mesh for analysis purpose. Abhay C. Suke and B.P. Londhe, (2015)-They studied base frame optimization of multistage centrifugal pump by finite element analysis. They carried out analysis to determine the induced stresses and the deflections at various locations on existing frame. From the experimental and FEA results they deduced that after reducing the weight of the frame, the stiffness of the frame is much good and deformation is nearer to the existing base frame. Greg Towsley, (2009)- They explain about various configuration designs, styles and requirements of the baseplate. Brief explanation for soleplates, cast iron baseplate, fabricated steel baseplate and fibre glass reinforced polyester (FRP) is given. Baseplate specifications are taken from technical professional societies like ANSI B73.1M-2001, ANSI/HI1.3.5-200, and API610. Amit V. Chavan and S.S. Gawade from R.I.T, Sakharale conducted work on Experimental and Finite Element Analysis of Base Frame Rigidity. In petrochemical industry, API 610 mandates rigidity assurance for pump base frames. Structural stiffness testing is conducted per API 610 clause 6.3.5 using a proven procedure. Rigidity tests measure stiffness under various load cases to assess design conformity. Identified shortcomings prompt suggestions for design modifications.

3.METHODOLOGY

This study involves modelling of pump skid Base plate & analysis of stress and deformation under loading condition for transportation

Scope of work

1. Study of various pump skid base plate models for base plate design, customer requirement and their condition
2. Design CAD model, analysis of pump skid baseplate model
3. Material selection of model
4. Applying the operation boundary condition
5. Evaluating the stress and deformation for the model

4.EXPERIMENTAL DETAILS AND PROCEDURES

Step 1: Design of Pump Skid Base Plate

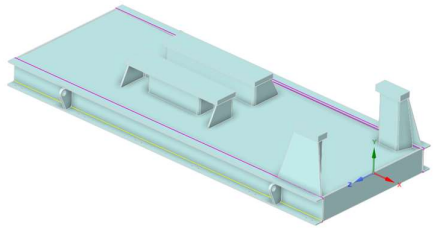

Fig 4.1 Isometric view of base plate

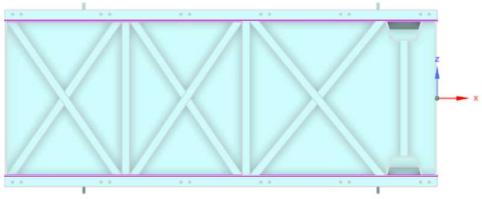

Fig 4.2 Bottom view of the base plate

DESIGN OF PUMP SKID BASE PLATE PROPERTIES	
Volume	2.2604e+008mm^3
Mass	13774kg

Table 4.2

Step 2: Finite Element Analysis

Finite Element Analysis (FEA) is a powerful computational technique used to simulate and analyse the behaviour of complex engineering systems under various loading conditions. FEA enables engineers to predict how a structure will respond to applied forces, allowing for the optimization of design parameters and the assessment of structural integrity. There are many FEA packages tool available for different applications. We use ANSYS Workbench tool for analysis the model under various load condition in transportation.

4.1 Material selection

Steel is a popular choice for engineering structures because it is strong, flexible, and simple to work with. Structural steel is easy to fabricate and it has high strength and light weight and it is also it can carry heavy loads.

MATERIAL PROPERTIES		
S.NO	PROPERTIES	VALUES
1	Material	Structural Steel
2	Density	7850kgm^-3
3	Youngs modulus	2E+05
4	Poisson's ratio	0.3
5	Tensile yield strength	250MPa
6	Tensile Ultimate strength	460MPa

4.2 Mesh Geometry

We use hexahedral element to mesh the geometry

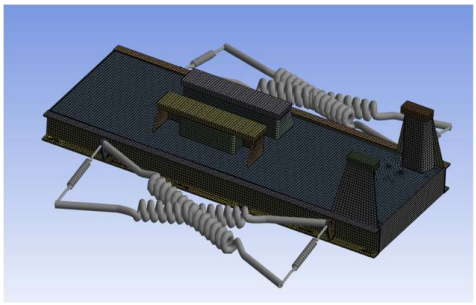

Fig 2.2 Geometry Mesh

Statistics	
Mesh type	Hexahedral element
Element order	Linear
Element size	25mm
Total Nodes	73714
Total Elements	36549

Table 2.2

4.3 Applying the Boundary condition

Step 1: Load condition of Base plate

Point mass act the weight of the object that are Mounted on the pump skid base plate**.** There are two Point mass act in the base plate they are motor and centrifugal pump.

S.NO	POINT MASS	WEIGHT
1	Motor	10 ton
2	Centrifugal pump	2 ton

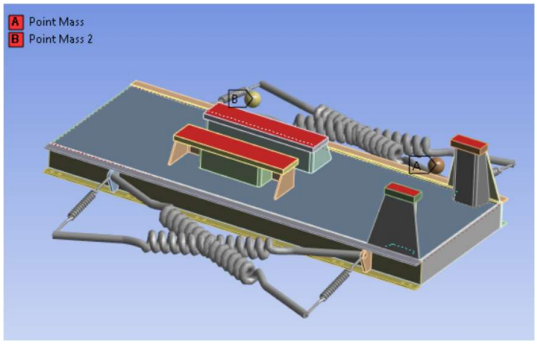

Fig 2.3.1 Point mass

Step 2: Transport condition

In transport condition, there will be fixed and frictionless support, acceleration and gravity force will also act on the pump skid base plate

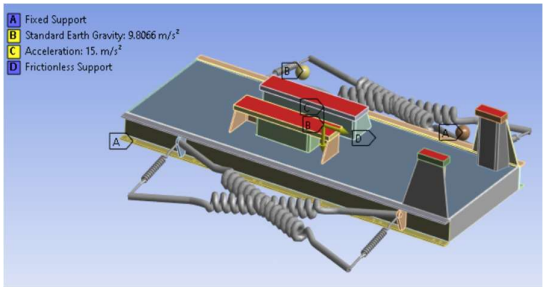

Fig 2.3.2 Transport condition

5.Case Study and Result

5.1 Case 1

In this case Acceleration 15m/s^2 acts in X direction. For this Total deformation and Equivalent Stress show in below figures.

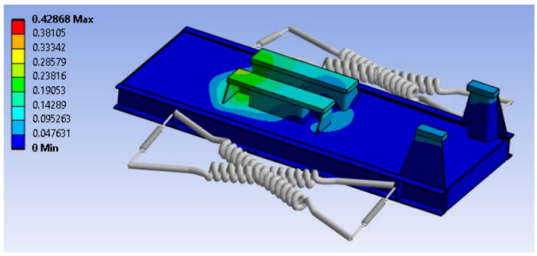

Fig 5.1.1 Total deformation

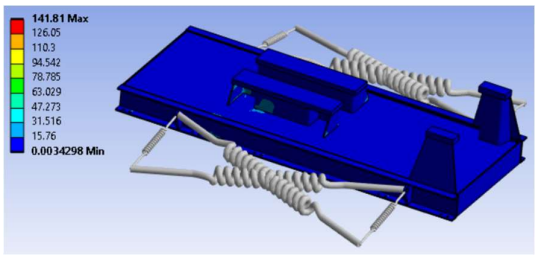

Fig 5.1.2 Equivalent Stress

5.2 Case 2

In this case Acceleration 15m/s^2 acts in Z direction. For this case Total deformation and Equivalent Stress show in below figures.

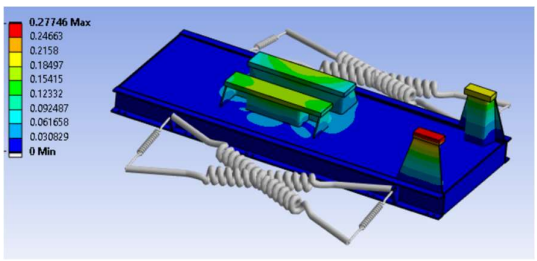

Fig 5.2.1 Total deformation

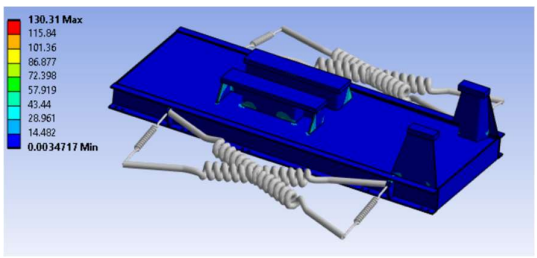

Fig 5.2.2 Equivalent Stress

5.3 Case 3

In this case Acceleration 15m/s^2 acts in (-X) direction. For this case Total deformation and Equivalent Stress show in below figures.

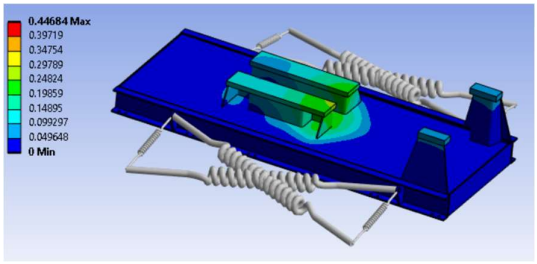

Fig 5.3.1 Total deformation

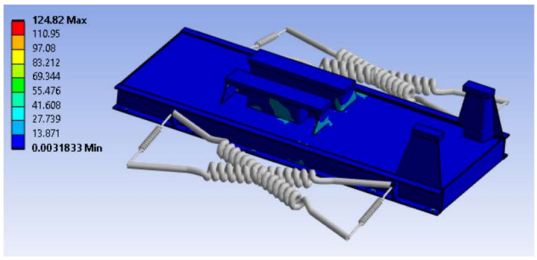

Fig 5.3.2 Equivalent Stress

5.4 Case 4

In this case Acceleration 15m/s^2 acts in (-Z) direction. For this case Total deformation and Equivalent Stress show in below figures.

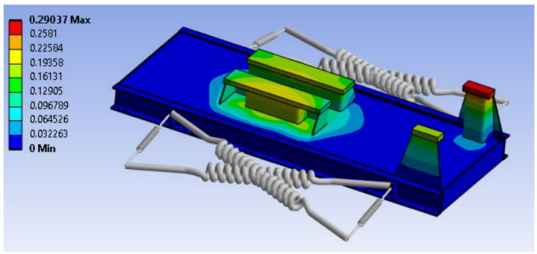

Fig 5.4.1 Total deformation

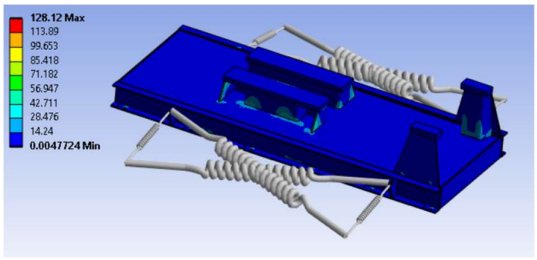

Fig 5.4.2 Equivalent Stress

5.5 Case 5

In this case Acceleration 15m/s^2 acts in (XY) direction. For this case Total deformation and Equivalent Stress show in below figures.

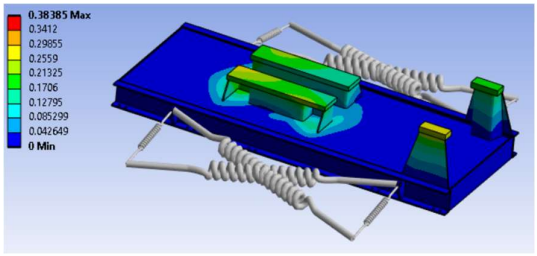

Fig 5.5.1 Total deformation

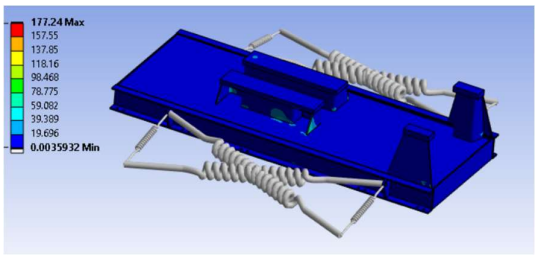

Fig 5.5.2 Equivalent Stress

5.6 Case 6

In this case Acceleration 15m/s^2 acts in (-XZ) direction. For this case Total deformation and Equivalent Stress show in below figures.

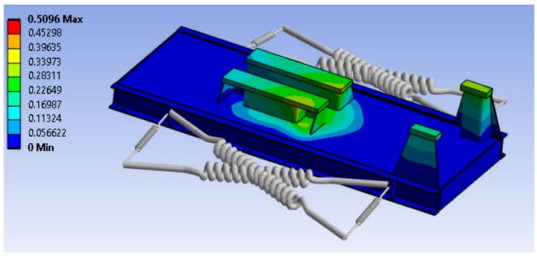

Fig 5.6.1 Total deformation

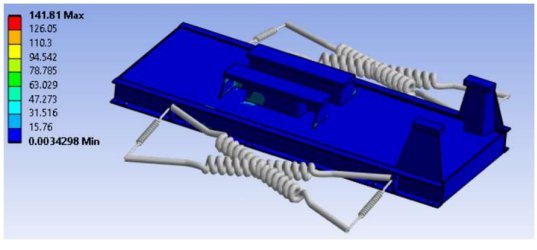

Fig 5.6.2 Equivalent Stress

6. GRAPHICAL ANALYSIS OF RESULT

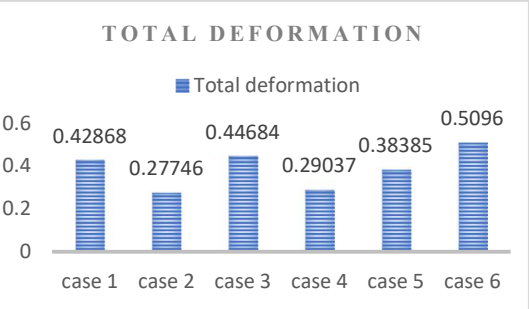

Fig 6.1 Total deformation

From the graph we analysis the Total deformation has maximum deformation is 0.55mm which is below the 1mm. Hence the design is safe in transport under the various load condition from one site to another site.

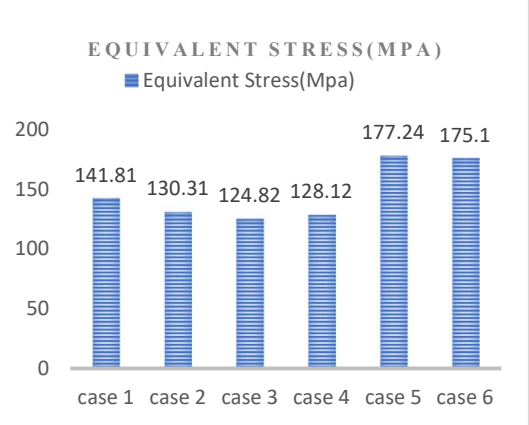

Fig 6.2 Equivalent Stress

From the graph we analysis the Equivalent stress has maximum stress is 178MPa which is below the yield strength of 250MPa. Hence the design is safe in transport under the various load condition from onsite to another site.

7.Conclusion

From the above we studied that pump skid base plate is safe in transport condition through the finite element analysis

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