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RESEARCH ARTICLE OPEN ACCESS

Design and Analysis of Mechanical Forklift

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Abstract:

This Paper deals with the Design and Static structural analysis of forklift Fork using ANSYS R16.0. The Design Calculations of Fork are compared with Structural Analysis Report. The Lifting of Fork makes the Deformation and bending of fork. Due to selection of forklift material as mild steel it has increased the advantages of design due to its high specific stiffness and strength. This paper gives solution for theoretical calculations.[2]

Keywords **—Forklift, Fork, Mesh, Stress, Solution, Static Structural Analysis**

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1. CAD MODEL

The CAD Model of Forklift is prepared in the software of CATIA V5R16 and then it converted into .stp or .igs format. So it will open in ANSYS for analysis and for to get Solution. The CAD model is scaled in 1:1 ratio of Project forklift. The analysis is made for lifting 250 Kg of Weight.

1.1 CAD Model of Forklift Assembly

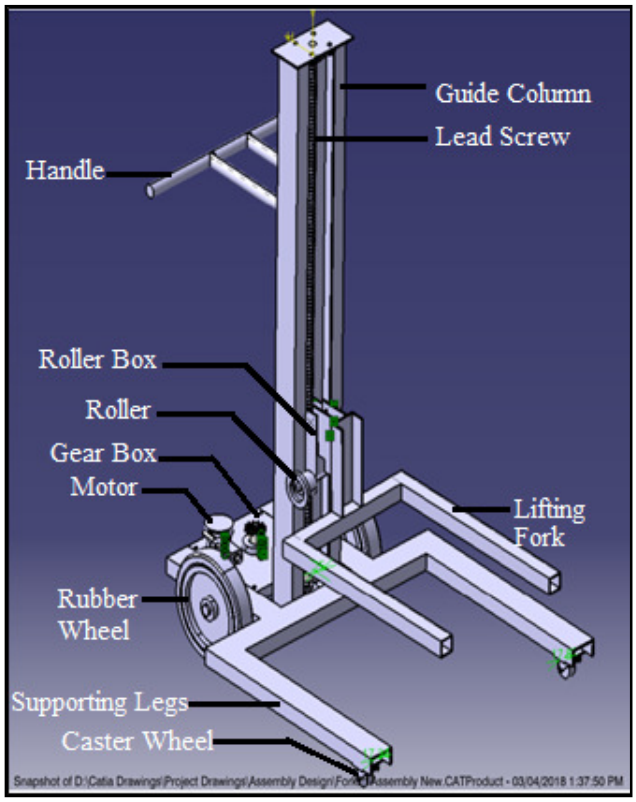


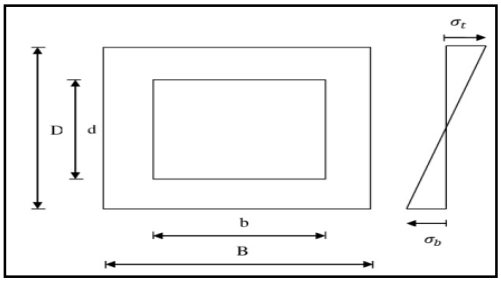
Fig- 1: CAD Model of Forklift

2. DESIGN

The design of mechanical forklift is derived as follows. Determine maximum load capacity, forces acting on component. The mild steel material is selected due to malleability, ductility, strong & low cost. [1]

2.1 Design of Fork

- Outer face height (D) = 50.8 mm
- Outer face width (B) = 50.8 mm
- Inner face height (d) = 44.8 mm
- Inner face width (b) = 44.8 mm
- Length of fork (L) = 600 mm



Fig– 2: Hollow Section of Bar

Moment of Inertia of Fork (I) –

$I = \frac{1}{12}[BD^3 - bd^3]$

$I = \frac{1}{12}[6659702.81 - 4028209.56]$

$I = 219291.10\ mm^4$

Case I] Consider Two Fork with Point Load –

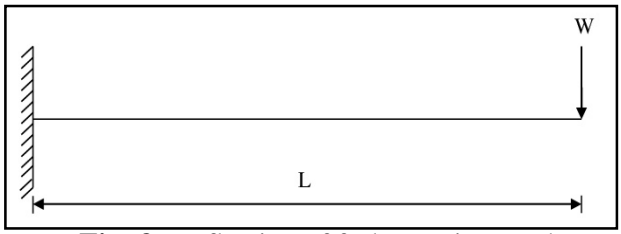


Fig- 3: Deflection of fork at Point Load

1. **Moment of Inertia for two fork (I) –**

$I = I_1+I_2$

= 219291.10 + 219291.10
$I = 438582.2\ mm^4$

2. **Bending Moment (M_A) –**

$M_A = -W \times L$
$= - 2450 \times 600$
$M_A = - 1470000$ Nmm

3. **Deflection (y_{max}) –**

$Y_{max} = \frac{WL^3}{3EI}$

$= \frac{2450 \times 600^3}{3 \times 210 \times 10^3 \times 438582.2}$

$Y_{max} = 1.91$ mm

Case II] Consider Two Fork with Uniform Distributed Load –

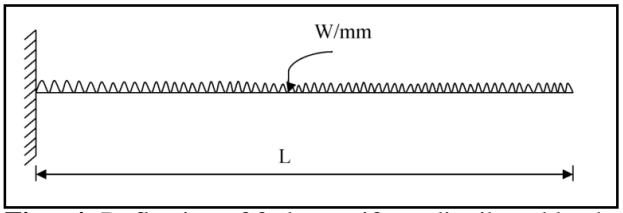


Fig – 4: Deflection of fork at uniform distributed load

1. **Moment of Inertia for two fork (I) –**

$I = I_1+I_2$
= 219291.10 + 219291.10
$I = 438582.2\ mm^4$

2. **Find W/mm –**

$\frac{W}{mm} = \frac{W}{L}$

$= \frac{2450}{600}$

$\frac{W}{mm} = 4.08$ N/mm

3. **Bending Moment (M_A)-**

$M_A = \frac{-w \times L^2}{2}$

$= \frac{(-4.08 \times 600^2)}{2}$

$M_A = -734400$ Nmm

4. **Deflection (y_{max})-**

$y_{max} = \frac{WL^4}{8EI}$

$= \left(\frac{4.08 \times 600^4}{8 \times 210 \times 10^3 \times 438582.2}\right)$

$y_{max} = 0.71$ mm

3. STRUCTURAL ANALYSIS

3.1 Material Properties

Compositions-
Fork Material: Mild Steel
Carbon Contains: 0.20-0.30 %
Manganese: 0.70-0.90 %
Silicon: 0.40%
Sulphur: 0.04%
Phosphorous: 0.04%

Mechanical Properties-
Tensile Yield Strength (S_{yt})= 400 N/mm^2
Compressive Yield Strength (S_{yc})= 250 N/mm^2
Youngs Modulus (E)= 210x 10^3 N/mm^2
Poissons Ratio (μ)= 0.3
Density (ρ)= 7800 kg/mm^3

3.2 Steps for Structural Analysis

1. Open ANSYS and Select Static Structural Analysis
2. Enter the Engineering data of the material Mild steel.
3. Select Geometry and then import in the Format of .stp or .igs file and generate.
4. Select model, in that mesh and give face sizing and path conforming method.
5. Apply boundary conditions by giving the fixed support and force in Z direction.
6. Generate the mesh and observe the meshing view.
7. Insert the various results which are required such as total deformation, stress etc.
8. View the Result

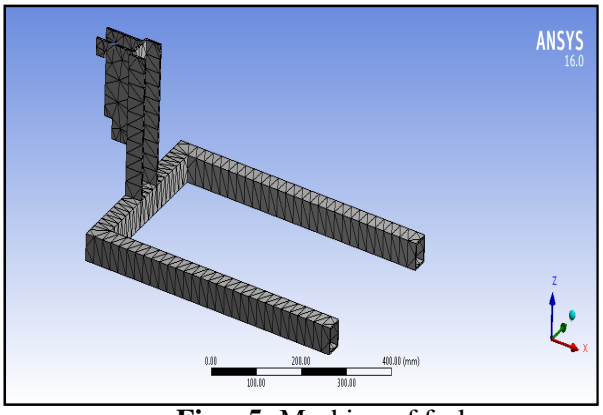


Fig – 5: Meshing of fork

3.3 Results

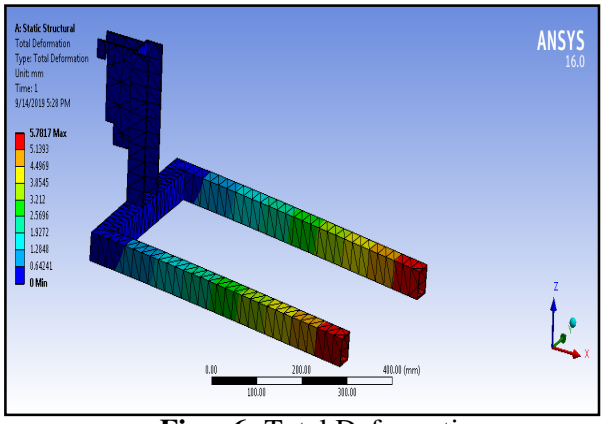


Fig – 6: Total Deformation

Minimum – 0 mm
Maximum – 5.7817 mm

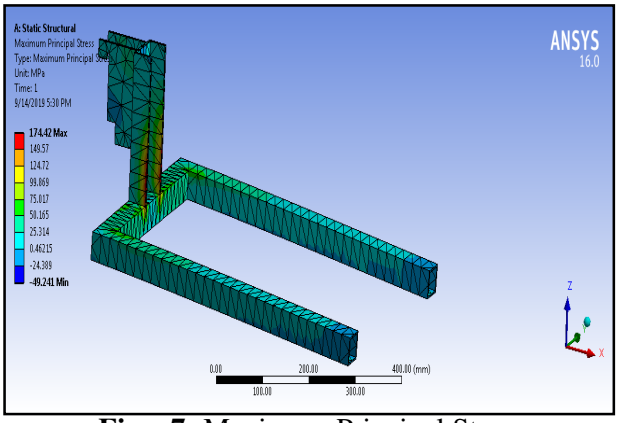


Fig – 7: Maximum Principal Stress

Minimum – -49.241 MPa (Negative)
Maximum – 174.42 MPa

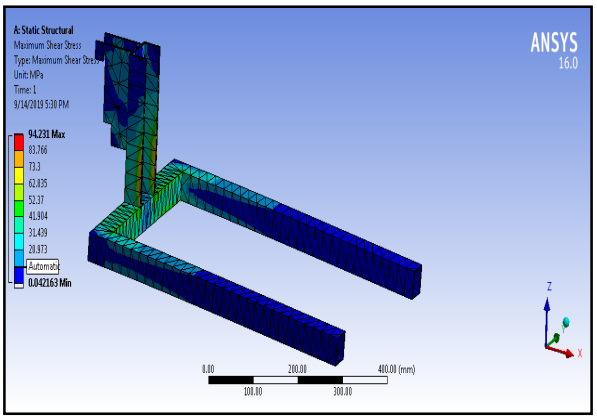


Fig – 8: Maximum Shear Stress

Minimum – 0.04216 MPa
Maximum – 94.231 MPa

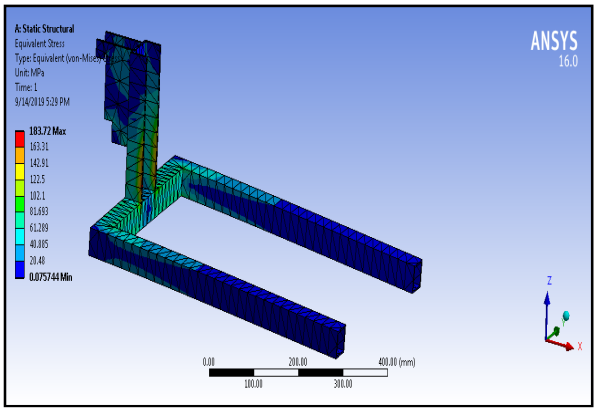


Fig – 9: Equivalent Stress (Von-Mises)

Minimum - 0.075744 MPa
Maximum - 183.72 MPa

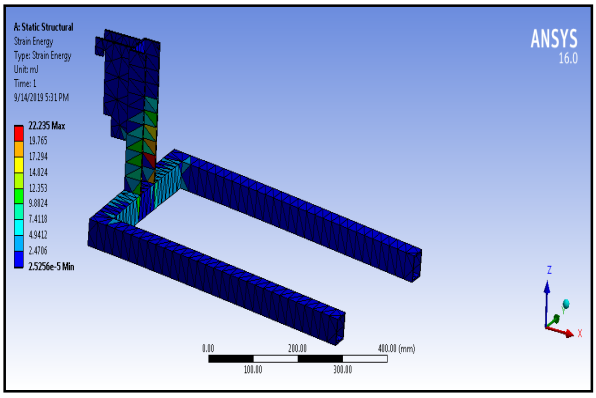


Fig – 10: Strain Energy

Minimum – 2.5256x 10-5 mJ
Maximum – 22.235 mJ

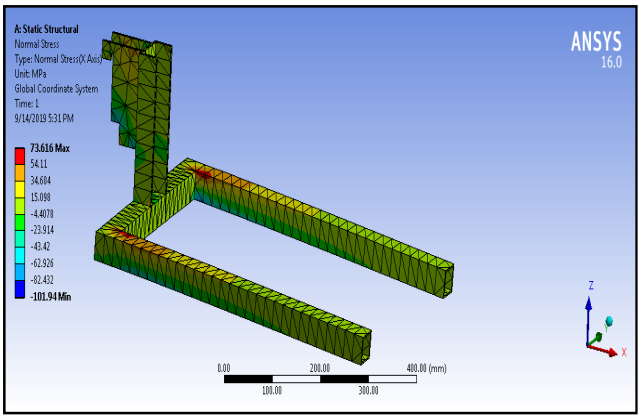


Fig – 11: Normal Stress

Minimum – -101.94 MPa (Negative)
Maximum – 73.616 MPa

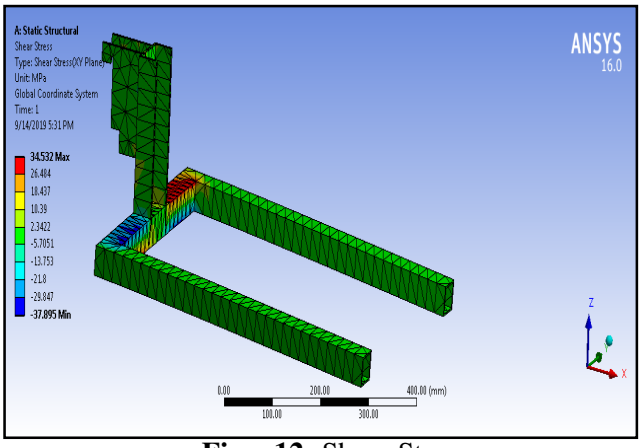


Fig – 12: Shear Stress

Minimum – -37.895 MPa (Negative)
Maximum – 34.532 MPa

4. CONCLUSION

By Using the Mild Steel Material for the Fork the Deformation is minimum. The Results shows Mild steel is Strong wear resistance & Impact strength. The theoretical calculations is safe as it has Compared with ANSYS Results.

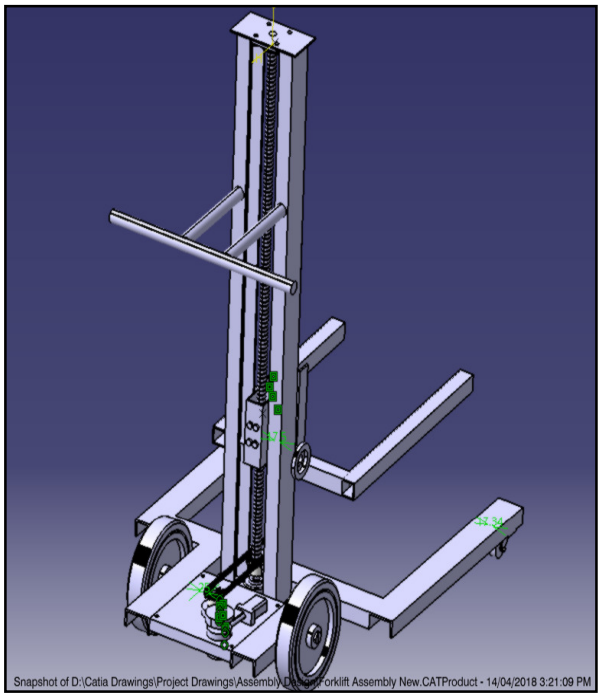


Fig- 13: Rear View of Forklift

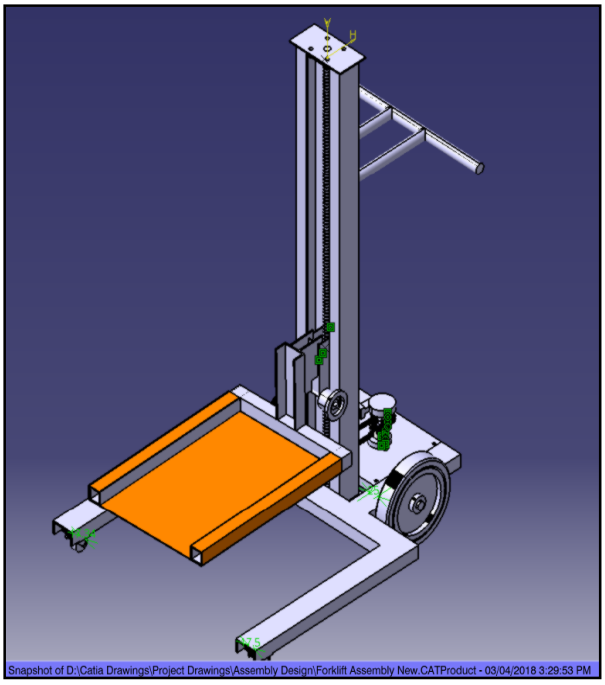


Fig- 14: Flat Pallet Attachm

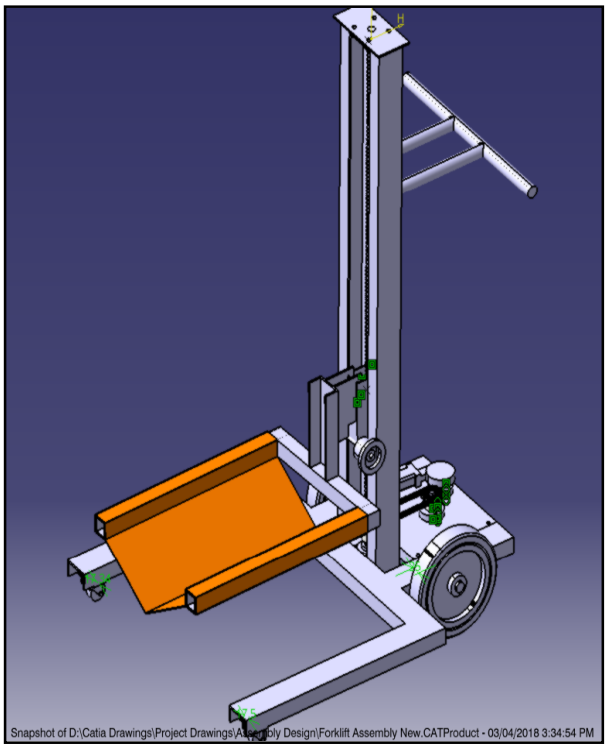


Fig- 15: V Pallet Attachment

Fig- 16: Forklift

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