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Design and Structural Analysis of Mechanical Forklift using ANSYS Software

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Abstract-The objective of this paper is to design and analyze a fork of forklift. This paper deals with the study of structural analysis of forklift arm using ANSYS software. The of theoretical calculation comparison with analysis report is done to verify it. Due to selection of forklift material as mild steel it has increased the advantages of design due to its high specific stiffness and strength. Lift by the fork it tries to deform and bend in a particular direction, so in order to study or to prepare design this paper can gives solution for theoretical calculation.

Index Terms-: Forklift; structural analysis.

I. DESIGN [9, 10, 12]

The prototype model of the forklift is prepared in the software of Pro-E 5.0 and then it is converted into .igs format so that it will open in the ANSYS for analysis. The model is scaled by 1:6 ratio of the actual forklift named Landoll of Japanese Company.[14] The analysis is made for lifting 3 kg of weight.

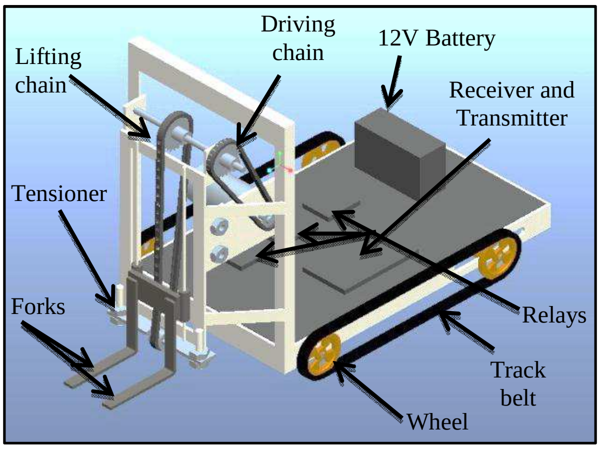

Fig. 1. 3D Model of Forklift

I.I THEORETICAL DESIGN [15, 16]

5.4 Design of Fork [1, 2, 3]

Case 1:- By considering fork as a cantilever beam with point loading.

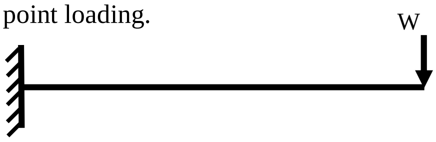

Fig. 2. Deflection on fork by point load

W=3kg

By point load $M_x = -W \times L$

$= -3 \times 9.81 \times 12.5 \times 10^{-3}$

$= -0.367\text{Nm}$

Deflection, $y_{max} = \frac{WL^3}{3EI} = \frac{3 \times 9.81 \times (12.5)^3}{3 \times 2.1 \times \times 10^5 \left(\frac{16 \times 3^3}{12}\right)}$

$= 2.5344 \times 10^{-3}\ mm$

Case 2:- By considering fork as a cantilever beam with uniform distributed load.

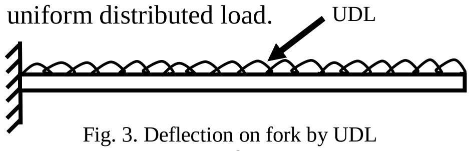

Fig. 3. Deflection on fork by UDL

By UDL $M_x = -\frac{W \times L^2}{2}$

$= \frac{-3 \times 9.81 \times \left(12.5 \times 10^{-3}\right)^3}{2}$

$= -0.0022\text{Nm}$

Deflection, $y_{max} = \frac{WL^4}{8EI} = \frac{3 \times 9.81 \times (12.5)^4}{8 \times 2.1 \times \times 10^5 \left(\frac{16 \times 3^3}{12}\right)}$

$= 0.0188\ mm$

II. STRUCTURAL ANALYSIS [5, 6, 7]

Properties of mild steel material is as follows:

Composition: Carbon → 0.20 % - 0.30%
Manganese : - 0.30% - 0.60%
Properties :
Tensile yield strength - 400 N/mm^2
Compressive yield strength - 250 N/mm^2

Tensile ultimate strength - 500 N/mm^2
Compressive ultimate strength – 415 N/mm^2
Young's Modulus : - 210 GPA
Poison ratio : - 0.3
Density : - 7850 g cm^{-3}
Hardness : - 170 BHN

III. PROCEDURE OF ANALYSIS [4, 16]

A] First of open the ANSYS and select the Static Structural.
B] Enter the Engineering data of the material Mild steel.
C] Now go to the Geometry and then import in the format of .igs file and generate.
D] Go to the model, in that mesh and give face sizing and path conforming method.
E] Apply boundary conditions by giving the fixed support and force in X direction.
F] Generate the mesh and observe the meshing view.
G] Insert the various results which are required such as total deformation, stress etc.
H] View the results and animation.

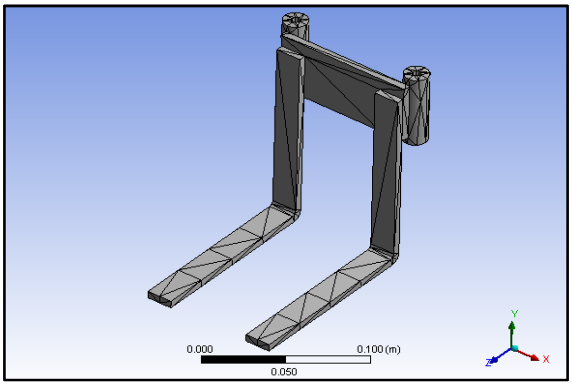

Fig. 4. Meshing View

IV. RESULTS [8, 11]

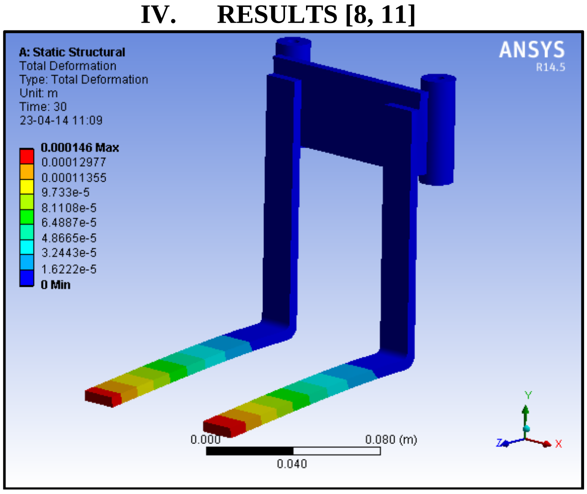

Fig. 5 Total Deformation

Minimum – 0 mm
Maximum – 0.146 mm

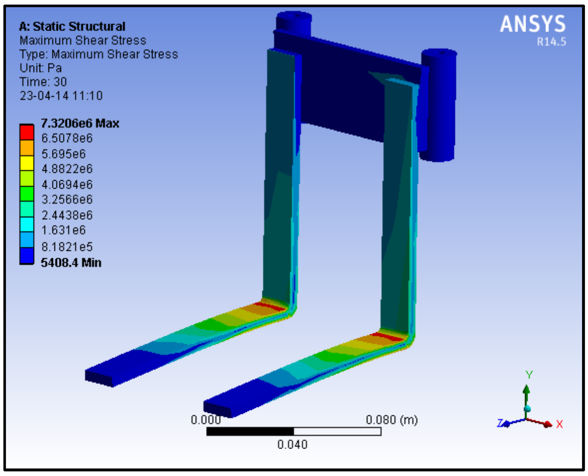

Fig. 6. Maximum Shear Stress.

Minimum – 0.005408 N/mm^2
Maximum – 7.3206 N/mm^2

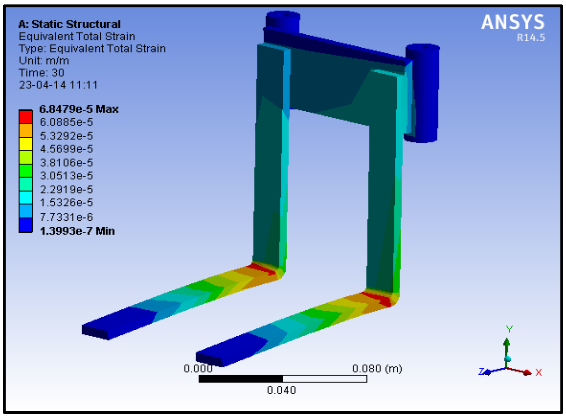

Fig. 7. Equivalent Total Strain

Minimum – 1.3993 x 10^{-7}
Maximum – 6.8479 x 10^{-5}

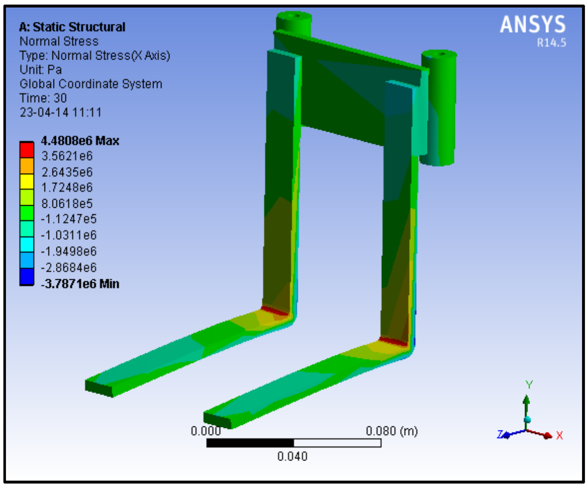

Fig. 8. Normal Stress

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Minimum – -3.7871 N/mm^2
Maximum – 4.4808 N/mm^2

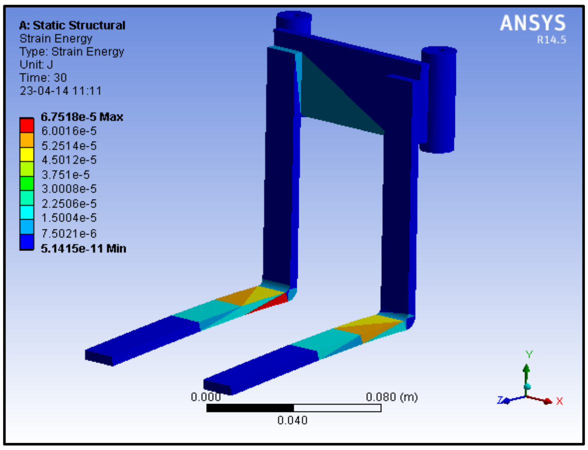

Fig. 9. Strain Energy

Min - 5.1415 x 10^{-11} J
Max -6.7518 x 10^{-5} J

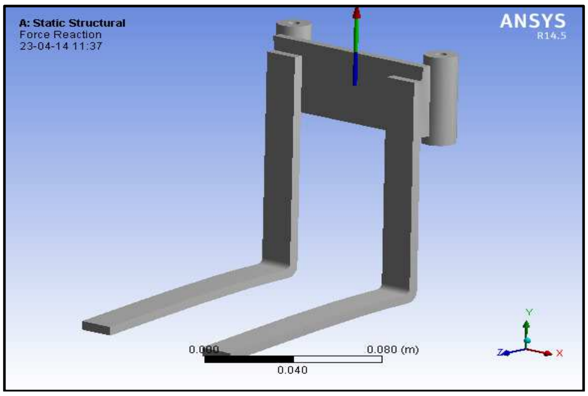

Fig. 10. Force Reaction

Min - 4.387 x 10^{-8} N

V. CONCLUSION

Using mild steel the deformation is minimum and as the load varies the deformation also varies. So it can be seen that the theoretical calculations are safe as it has been compared with results from ANSYS software.

VI. FUTURE SCOPE

Further part is extended for comparison of theoretical and actual calculation, for main component of forklift i.e shaft, for dynamic analysis, that will really helpful to decide its life.

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