Design, Fe Analysis & Optimization of Fork Truck Lift of Automated Guided Vehicle

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Abstract:
Automated guided vehicles (AGVs) increase efficiency and reduce costs by helping to automate a manufacturing facility or warehouse. AGVs are employed in nearly every industry, including pulp, paper, metals, newspaper, and general manufacturing. Transporting materials such as food, goods etc are also done.
Fork truck vehicles operate just like Truck, truck without driver. In this thesis work, the stresses which appear in the lifting installation of a fork-lift truck at loading-unloading operations are investigated for given input data like load carrying capacity of truck, maximum pressure inside the cylinder, pallet dimensions. Firstly calculate the effects of various loads on the parts of the fork truck in terms of stresses and then compare calculated Stresses with material allowable stresses (yield stress/F.O.S).

After Comparison of Allowable Stresses with generated stresses, we perform FE Analysis and Compare theoretical stresses with FE generated Stresses. Once FE Analysis Results, theoretical Results and Allowable material stresses are compared. We conclude that whether there is a chance of Optimization or not?

If there is a chance of Optimization then reduce fork truck weight by changing various parameters and validate that design with the help of FE Tools.

Keywords: *AGVs, Fork truck lift, Optimization*

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1. Introduction

Material handling systems using automated guided vehicles (AGVs) are commonly used in facilities such as manufacturing plants, warehouses, distribution centers and terminals. The performance of the material handling system directly affects the performance of the whole facility. Modern AGV systems differ from the classic ones as mentioned below:-

1. Rather than using fixed paths, many modern AGVs are free-ranging, which means their preferred tracks are software programmed, and can be changed relatively easy when new stations or flows are added.

2. A second difference is in the way they can be controlled. Agent technology allows decisions to be taken by these smart vehicles that in the past were taken by central controllers. This leads to adaptive, self-learning systems and is particularly appropriate for large, complex systems with many vehicles and much potential vehicle interference. These developments do not imply that the traditional decision-making problems become obsolete. Rather, they lead to new challenges for research. We both discuss the traditional AGV system decision-making problems and the impact of these developments on decision-making.

Fork Truck is main and crucial Component of Automated Guided Vehicle. Accuracy and Reliability is mainly depending on Fork Truck.

In this Paper, Purpose of the Design of several parts of the Fork Truck is to check whether the Load Sustained members which lift the load from Floor to its Destination Level which is above from the surface of the Ground Floor.

In this Paper first we calculate the Generated Stress in the component of the Fork Truck by manual calculation and these all stresses, strain and Displacement check in the FEA software Pro-Mechanical.

Then we compare these both of the Generated Stress and Calculated Stress for comparison, and also it help us to take the decision whether these all component requires any changes or not.

2. Specification of Fork Truck

Capacity of Fork Truck : - 1000 Kg.
Maximum Pressure Inside the Cylinder :- 150 bar
Pallet Dimension:-
Length :- 1200mm
Width :- 1000mm
Working Height of Truck :- 3580mm
Maximum Height of Truck :- 4190mm
Capacity for Design Fork Truck :- Allowable Capacity * Factor of Safety : - 14715 N
Load carried by one member of Load Carrying Assembly :- 7357.50 N

3. Calculation of Load Carrying Member

M :- Offset Distance for Load * Load Acted
M :- 3678750 N mm
Z :- 4 * t * t2 / 6
σt :- M / Z
t :- 43mm
We have to find the Neutral Axis and Centroidal Axis of the Eccentric Loading.
Rn :- (b – 2t) * (2* t1)+(2*t*h)/{[b*[loge ((Ri + t1) / Ri) + loge(Ro/(Ro – t))]]+[2*t* loge [(Ro – t1) / (Ri + t1)]] }
Rn :- 566.76 mm
Centroidal Axis of the Column Structure Assembly

R :- Ri + [(h2 * t) + (t12 * (b – (2 * t))) + (b – (2 * t)) * t1 * (h – (t1 / 2)] / [(h * 2 * t) + ((b – (2 * t)) * (2 * t1))]
R :- 595.90mm
Distance between the Load axis and Centroidal Axis (R) :- 595.90mm
Distance between the Load axis and Neutral Axis (Rn) :- 566.76mm
e :- Centroidal Axis – Neutral Axis
e :- 595.90 – 566.76
e :- 29.14mm
M :- Load * Centroidal Axis
M :- 15696 * 595.90
M :- 9353246.40 Nmm
Distance between the Neutral Axis and Inner Dimension of Assembled section.
yi :- 566.76 – 500
yi :- 66.76mm
Maximum Bending Stress (σbi) :- M * yi / A * e * Ri
σbi :- 9353246.40 * 66.76 / 6202 * 29.14 * 500
σbi :- 6.9101 N/mm2
Distance between the Outer dimension and Neutral Axis of Assembled section.
yo :- 650 - 566.76
yo :- 83.24 mm
Maximum Bending Stress (σbo) :- M * yo / A * e * Ro
σbo :- 9353246.40 * 83.24 / 6202 * 29.14 * 650
σbo :- 6.628 N/mm2
Stress on the Outer Fiber :- σt – σbo
:- 2.373 – 6.628
:- -4.255 N/mm2

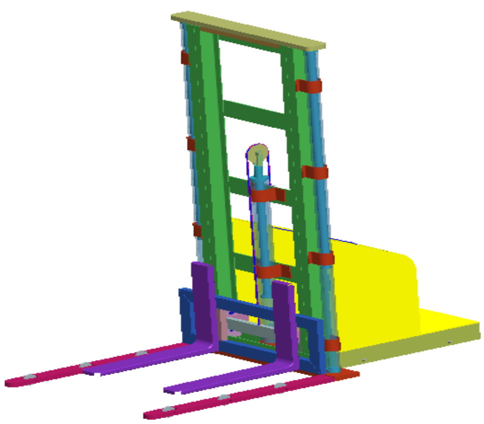

Fig. 1 Modeling of Load Column Structure of Fork Truck

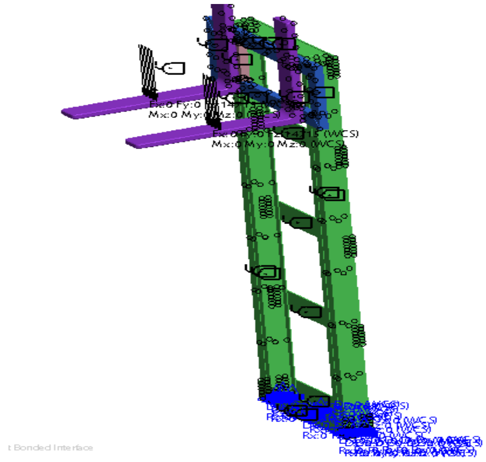

Fig. 2 Boundary Condition for Load Column Structure

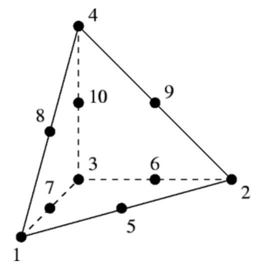

Fig. 3 Meshing of Load Column Structure

Type of Analysis: - 3D
Type of Element: - Tetrahedral (10 Node)

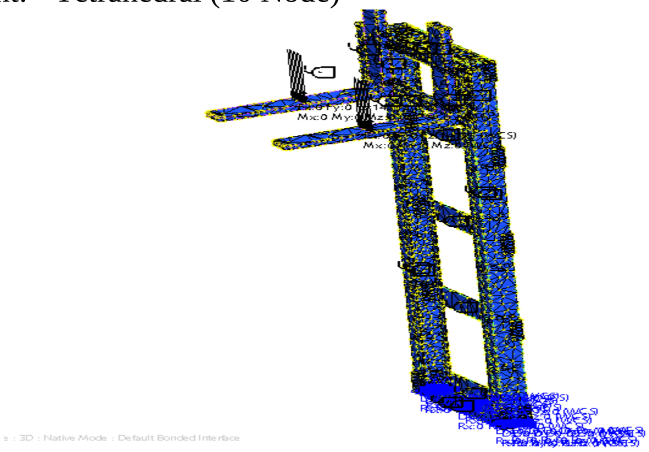

Fig. 4 Meshing Model

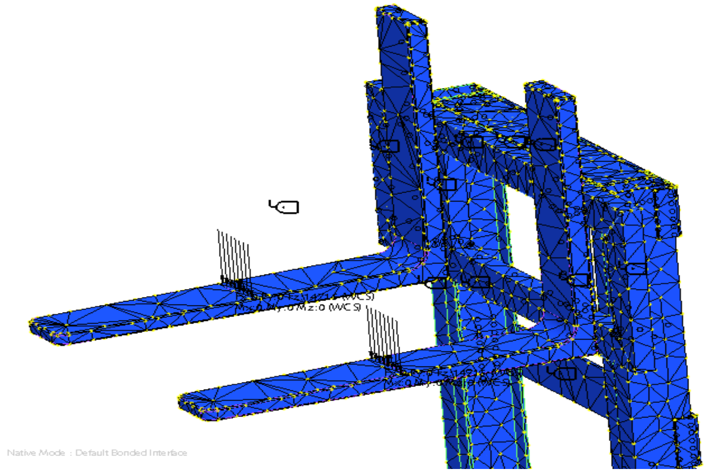

Fig. 5 Column Structure with stress report

4. Results of Analysis

Parameter Value
Stress Calculated in Design 6.628 N/mm^2
Generated Stress 0.000 N/mm^2
Generated Displacement 0.000 mm
Generated Strain 0.000

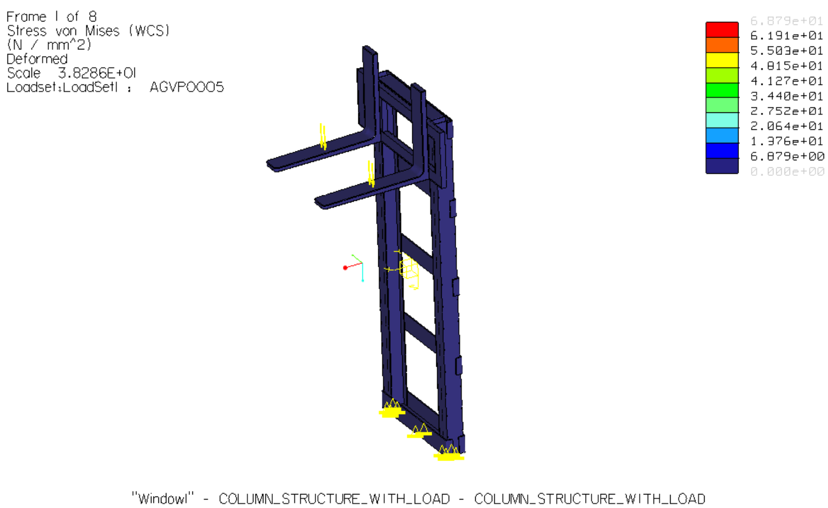

Fig. 6 Column Structure with displacement report

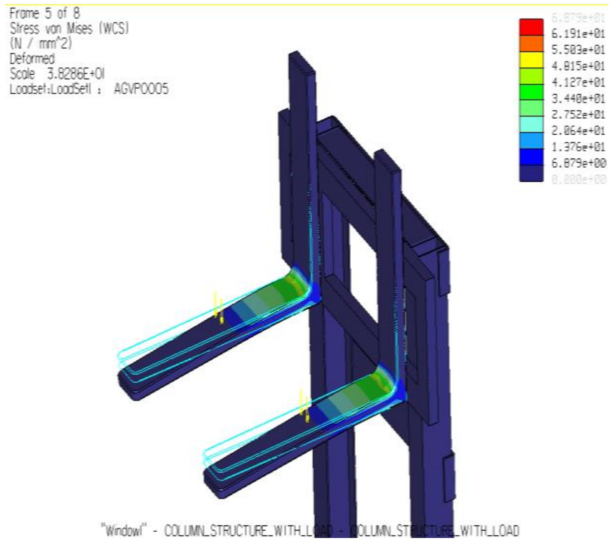

Fig. 6 Column Structure with strain report

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