International Journal of Robotics and Automation
Vol. 1: Issue 2
www.journalspub.com

CAD and FEA of AGV through Light Sensing

M.S. Gondane, M.W. Nagardhane, P.A. Borkar*
K.D.K. College of Engineering, Nagpur, India

Abstract

Progressions in manufacturing technology permit organizations to quickly deliver products. This has incited a pattern to decrease bulk inventory for fleeting supplies. In spite of the fact that this permits corporations more money related flexibility, it obliges warerooms to suit provisional, particular storage. Enhanced product handling and speed can be accomplished with the execution of an Automated Guided Vehicle, AGV. The AGV utilizes a few practices to finish its goals. These practices have been customized in particular modules, and a parleying function coordinated the events. Priority interrupts were utilized to address the exact timing prerequisites of a few devices. In this paper we outlined and broke down the AGVs which is operated with the assistance of light sensor by utilizing CreO Parametric programming and ANSYS programming separately.

Keywords: automated guided vehicle system (AGVs), CreO, light senor, PLC

***Corresponding Author**
E-mail: mudra11288@gmail.com

INTRODUCTION

AGV through Light Sensing

In this type of guided vehicle, the vehicle will follow the path which is created with the help of light. The mechanism/sensor which is mounted on the vehicle will sense the light and will follow the mentioned path. Generally the guided path is located at the floor but our concept is that, the light path will placed at a certain height from the floor surface. Our AGV will carry weight up to 3 kg. It uses the measurement taken from the sensors and compares them to values given to them by programmers. [1]

In a customary warehouse, human safety oversees the profitability. With the assistance of insightful Computers, the AGV can securely accomplish higher paces. Exactness turning permits it to precisely explore in tight spaces. The AGV is exceedingly adaptable as a consequence of remote correspondence. Its capacity to correspond with different self-governing vehicles gives a consistent operation. Ceaseless coordination between vehicles conveys money saving effectiveness. The presentation of unmanned vehicles onto a distribution center floor effect sly affects safety. With the guide of ecological sensors, the AGV can identify objects in its collision path. Automation takes out vehicle congested driving conditions and their potential for accidents.

For organizations assembling new distribution centers, there are numerous money related advantages to putting resources into intelligent machinery. The workforce required running the warehouse and the extra overhead (e.g., protection) required to backing that overhead will be definitely decreased. Expanded product pivot and quicker dispatching will result in more satisfied clients. Additionally, automation decreases the hazards of individual harm. [2–6]

 © JournalsPub 2015. All Rights Reserved

Integrated System

The AGV worked in a model warehouse, built to scale its essential task was to move pallets inside of the warehouses. An external data produced by an infrared remote control notified the AGV whether a pallet was entering or leaving the warehouse. To get to its destination, the vehicle crossed the warehouse by taking after high complexity lines. At the point when the four sets line devotee module identified a crossing point, the AGV figured out if to turn or go straight by utilizing a calculation that consolidated the vehicles current area and heading. In the principal circumstance, the remote control flagged that a bed was entering the stockroom.

The AGV grabbed the bed off of the approaching delivery dock and dropped it off at one of a few docks at the flip side of the distribution center. Through RF correspondence, the AGV told another self-ruling vehicle, the ASRS, the new area of the bed. The second circumstance took into consideration a bed to be dispatched out of the stockroom. The AGV sat tight for the ASRS to affirm that it dropped off a bed at one of the move docks before it lifted it up and moved the bed to the active delivery dock. While voyaging, the AGV surveyed two forward confronting infrared reach discovering sensors to figure out whether an item was in its forward impact way. In the event that and article was distinguished, the vehicle would stop and sit tight for the check to be cleared. While switching, knock sensors distinguished the event of a back impact, which would forever handicap the vehicle.

The AGV required the capacity to move around a model distribution center worked out of a sheet of plywood and to get beds once it achieved its destination. Two sorts of incitation where expected to meet these destinations. Drive engines and tires included the capacity of development, while a third engine upheld a bed jack.[7]

Wheels and Movement

The AGV was pushed by two 200 R.P.M. D.C. gear head engines, which were joined to the back tires. The tires were 2.2 inches in measurement and one creep wide. With the expansion of the third caster, most of the vehicle's weight lay on the back caster, and the tires were slipping. Thick layers of elastic concrete were painted onto the tires and the vehicle recaptured footing. The AGV had a great turning span as a consequence of the stage format. The tires lived one inch from the center of the robot, which just about permitted it to turn set up.

Forklift Mechanism

The forklift was made out of wood and mounted to the stage with pivots. Good fortune struck when the pivots could not be introduced impeccably straight. The pivots had additional contact, and the fork did not flounder around despite the fact that they were still moveable. An arm was inflexibly connected to the forks and mounted with the goal that it was parallel to the forks and the other way. An opening in the arm was made with a T-Tech prototyping machine and associated with a servo arm with a pin. At the point when the servo was in its nonpartisan position (zero degrees), the forks were down and parallel to the ground. Changing the servo's heartbeat width moved the servo arm back to negative thirty degrees and the forks up to positive thirty degrees. Wooden stops where mounted on the fork to keep beds from sliding back and colliding with the robot. [8]

Sensors

Infrared Detector

The objective of this task was to build up a robot that streamlines the warehousing process. An infrared remote control permitted the client to powerfully speak with the vehicle on the production line floor. Catches on the remote control related to demands to store or recover a bed. A Sony TV remote control (Sony code # 202) was utilized to send infrared information. Every catch on the remote had an exceptional piece design. At the point when a catch was squeezed, the remote shaped a bundle of information including begin bits, information components, and stop bits. Computerized Signal Encoding was utilized, and the bundle was sent serially through a 40 kHz modulator. Adjusting the sign diminished the likelihood of surrounding infrared crosstalk. After adjustment, the sign was sent to the infrared generator. The AGV utilized a Fairchild Semiconductor infrared identifier to get the sign (Figure 1).

A band pass channel was joined into the identifier so that just 40 kHz signs were acknowledged. At the point when the sensor recognizes infrared warmth, it demodulates the sign and sets the yield stick low. Inside, the sensor utilized a Schmitt trigger to diminish exchanging clamor on the yield pin. This was profoundly alluring in light of the fact that false heartbeats could be mixed up as a component of the approaching piece stream. The yield was associated with the chip's low need outer intrude on, which was designed to a falling edge. In the interfere with subroutine the information was serially changed over into bits by breaking down the length of the high heartbeats.

The sign was initially investigated on an oscilloscope. The specialist saw that the majority of the beats (barring the begin beat) had one of two qualities. There was dependably a 0.25 ms high or low heartbeat which was followed by a 0.75 ms high period (Figure 2). This made it conceivable to have either a 1ms high period or a 0.75 ms high period. The back end of one 0.75 ms heartbeat in addition to the 1ms heartbeat gave an aggregate heartbeat width of 1.75 ms. And, this long heartbeat width never showed up consecutive. [7–10]

COMPONENTS

1. Pneumatic Cylinder
2. Air Compressor
3. Solenoid valve
4. Motor
5. Pneumatic pipes
6. Battery
7. Electronic part
8. Relay
9. IR Sensor

DESIGN CALCULATIONS:-

2.1 Design of Fork

From B.D. Shiwalkar Data Book [T-II-10]
Material – Aluminium Alloy
Sut = 253 N/mm^2
Syc = 211 N/mm^2
E = 72.2 GPa
Weight to be lifted by Fork lift = 3 kg

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

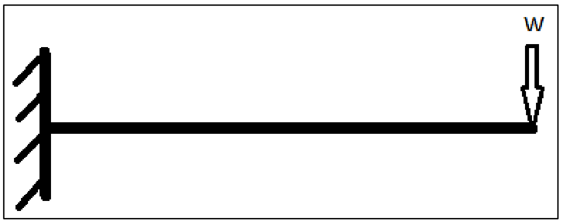


Fig. 1. *Point Load on Fork.*

By point load
Mx = –3×9.81×0.2
= –5.886 Nm

$$\text{Deflection} = \frac{WL^3}{3EI}$$

$$= \frac{0.6 \text{ X } 9.81 \text{ x } 200^3}{3 \text{ X } 72.5 \text{ X } 10^3 \text{ x } \frac{20 \text{ x } 5^3}{12}}$$

$$\text{Deflection} = \frac{WL^3}{3EI}$$

$$= \frac{0.6 \text{ X } 9.81 \text{ x } 200^3}{3 \text{ X } 72.5 \text{ X } 10^3 \text{ x } \frac{20 \text{ x } 5^3}{12}}$$

= 1.04 mm

As this deflection is too small, so our design is safe in point loading.

IJRA (2015) 1–13 © JournalsPub 2015. All Rights Reserved

Case-II: By considering fork as a cantilever beam with uniform distributed load. [5]

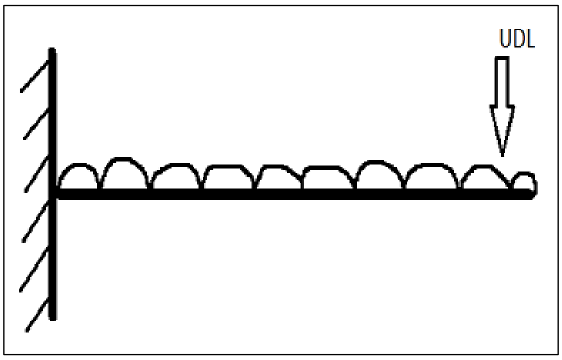


Fig. 2. *Uniform Load on Fork.*

Mx = $\frac{WL^3}{2} = \frac{3 \text{ x } 9.81 \text{ x } 2^3}{2}$ = 0.11772 Nm

Deflection:

Ymax = $\frac{WL^3}{8EI} = \frac{3 \text{ x } 9.81 \text{ x } 200^3}{8 \text{ x } 72.5 \text{ x } 10^3 \text{x} \frac{20 \text{ x } 5^3}{12}}$ =
0.38 mm

As this deflection is too small, so our fork lift is safe in UDL.

Design of Compressor

We have,

P= 2 Bar

Power=90 watt

Calculation:

$$90 = \frac{n}{n-1} \text{Ps Vas}[(\frac{\text{Pd}}{\text{Ps}})^{n-1/n}-1]$$

$$= \frac{1.25}{1.25-1} \text{x } 1.013\text{x}10^5 \text{ x Vas x } [(\frac{2}{1.013})^{0.25/1.25}-1]$$

$$\text{Vas} = \mathbf{1.219 \text{ x } 10^{-3} \text{ m}^3/\text{sec}}$$

Volumetric Efficiency:

$$\eta_v = 1+0.05-0.05 \text{ x } (\frac{2}{1.013})^{1/1.25}$$

$$\eta_v = 0.9638$$

we have, $\eta_v = \frac{1.219 \text{ x } 10^{-3}}{\text{Vs}}$

$$V_{as} = 1.264 \text{ x } 10^{-3} \text{ m}^3/\text{sec}$$

$$V_{as} = \frac{\pi}{4} \text{x D}^2 \text{ x L x} \frac{N}{60} \text{x i}$$

$$1.264 \text{ x } 10^{-3} = \frac{\pi}{4} \text{x D}^2 \text{ x } 1.5\text{D x} \frac{500}{60} \text{ x } 1$$

$$\mathbf{D = 50 \text{ mm}}$$

$$\mathbf{L = 75 \text{ mm}}$$

So, we select the compressor with dia = 50 mm and length = 75 mm.

Hence, selecting Leo silver compressor.

Pneumatic Cylinder

We have

Outer dia = 2 cm

Inner dia = 1 cm

Pressure = 3 × 10^5 N/mm^2

Piston force (F_{eff}) = $F_{Forward} - F_{Reverse}$

$F_{Forward} = \frac{\pi}{4} \times D^2 \times P - F_{Frictional}$

$= \frac{\pi}{4} \times (2 \times 10^{-2})^2 \times 3 \times 10^5 - 20$

= 74.24 N

$F_{Reverse} = \frac{\pi}{4} \times D^2 - d^2 \times P - F_{Frictional}$

$= \frac{\pi}{4} \times ((2-1) \times 10^{-2})^2 \times 3 \times 10^5 - 20$

= 3.56 N

$F_{eff} = F_{Forward} - F_{Reverse}$

= 70.67 N

So, we select the Pneumatic cylinder with capacity 10 kN

2.5 Motor

We know

Voltage (V) = 12 V

Current (I) = 0.5 A

Speed (N) = 30 rpm

Torque is calculated by the formulae

Torque (τ) = $\frac{60}{2 \times \pi \times N} \times V \times I$

$= \frac{60}{2\times\pi\times30} \times 12 \times .5$

= 1.90 Nm

So, In terms of mass

Its value is 19.37 kg cm

Weight of our complete AGV is 15 kg and we are using 2 identical motors of 19.37 kg cm torque.

Hence, selecting Johnson DC motor with 12V DC supply and 1.5 Amp current.

Power Consumption

- Compressor = 90 watts

- Solenoid valve = 4.8 watts
- Motor = 18 watts
- Electronics circuits = 5 watts
- Total = 118 watts

So, we select 12 V and 7.5 Amp h Battery which will lasts upto 42 minutes (Figure 3).

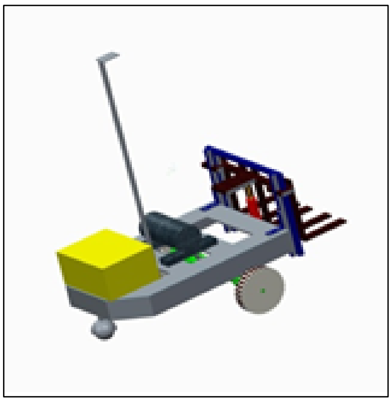
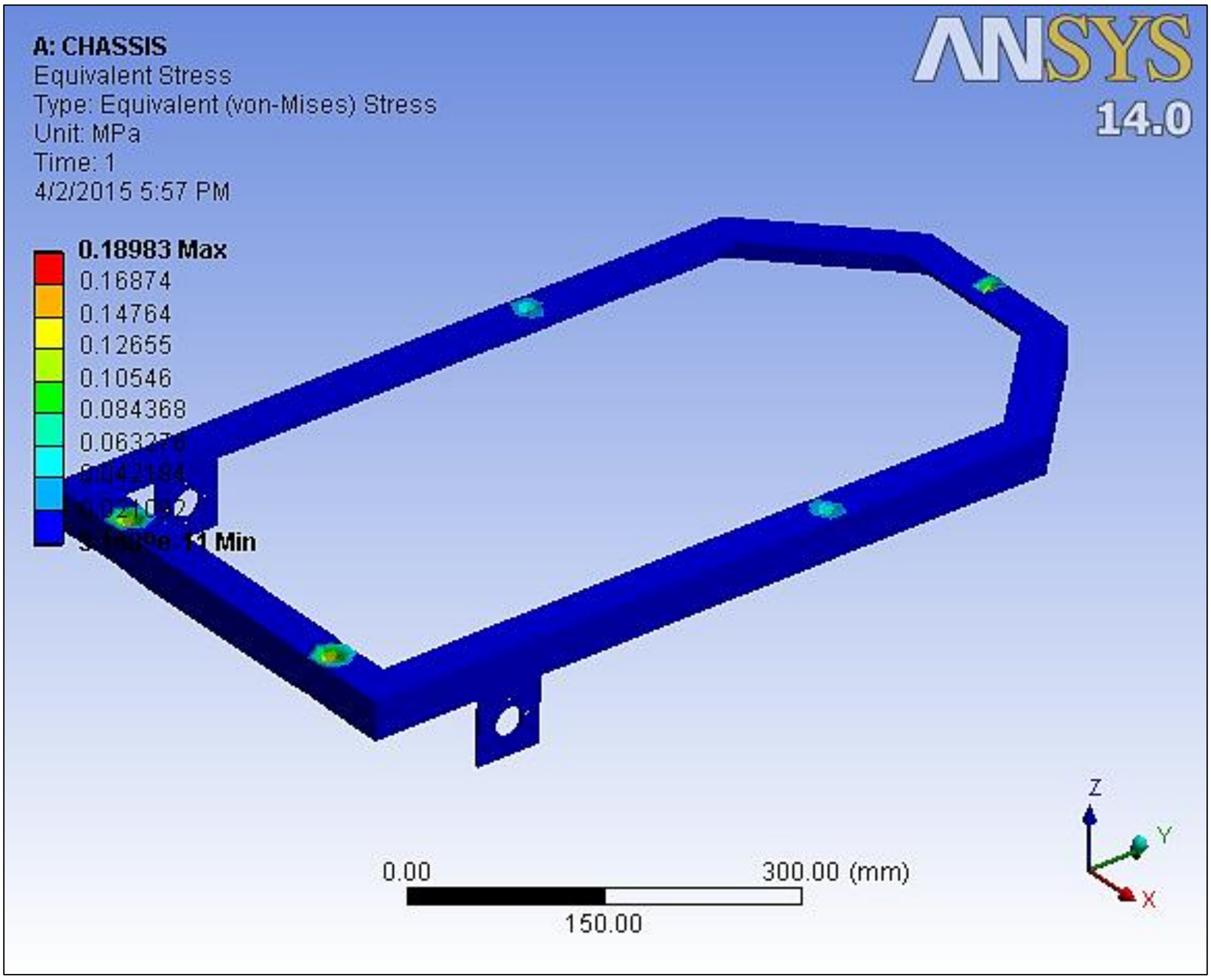


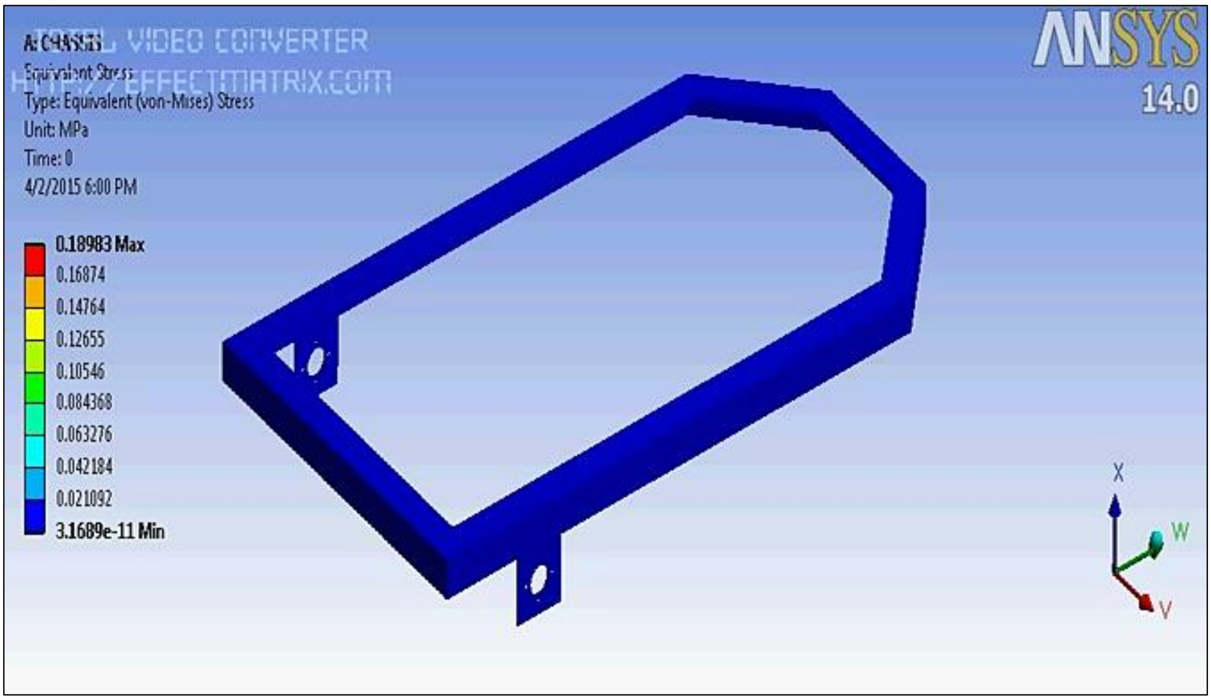
Fig. 3. *CAD Model*.

CAD MODEL

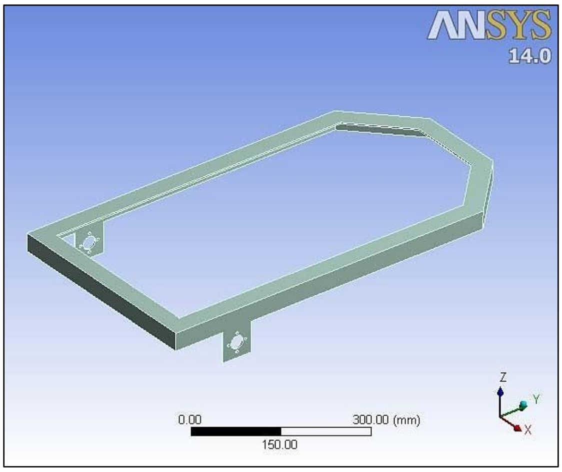
RESULT AND ANALYSIS

Chassis and Stress Induced





First Saved	Thursday, April 02, 2015
Last Saved	Thursday, April 02, 2015
Product Version	14.0 Release
Save Project Before Solution	No
Save Project After Solution	No



Material Data

Aluminium alloy

Static Structural (A5)

Model data are given in Tables 1–14.

Table 1. *Model (A4) > Analysis.*

Object name	Static structural (A5)
State	Solved
Definition	
Physics type	Structural
Analysis type	Static structural
Solver target	Mechanical APDL
Options	
Environment Temperature	22 °C
Generate input only	No

Table 2. *Model (A4) > Static Structural (A5) > Analysis Settings.*

Object Name	Analysis setting
State	Fully defined
Step controls	
Number Of Steps	1.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Program Controlled
Solver controls	
Solver Type	Program controlled

Weak Springs	Program controlled
Large Deflection	Off
Inertia Relief	Off
Restart controls	
Generate Restart Points	Program controlled
Retain Files After Full Solve	No
Nonlinear controls	
Force Convergence	Program controlled
Moment Convergence	Program controlled
Displacement Convergence	Program controlled
Rotation Convergence	Program controlled
Line Search	Program controlled
Stabilization	Off
Output controls	
Stress	Yes
Strain	Yes
Nodal Forces	No
Contact Miscellaneous	No
General Miscellaneous	No
Calculate Results At	All Time Points
Max Number of Result Sets	Program Controlled
Analysis data management	
Solver Files Directory	C:\Users\Anubhav\Desktop\VIPLAV PROJECT\CHASSIS ANALYSIS_files\dp0\SYS\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Delete Unneeded Files	Yes
Nonlinear Solution	No
Solver Units	Active system
Solver Unit System	nm

Table 3. *Model (A4) > Static Structural (A5) > Loads.*

Object Name	**Fixed Support**	**Fixed Support 2**	**Force**	**Force 2**	**Force 3**
State			Fully defined		
Scope					
Scoping Method	Geometry selection				
Geometry	4 Faces	1 Face	1 Vertex		
Definition					
Type	Fixed Support		Force		
Suppressed	No				
Define By			Components		
Coordinate System			Global Coordinate System		
X Component			0. N (ramped)		
Y Component			0. N (ramped)		
Z Component			–30. N (ramped)	–10. N (ramped)	

Figure 1
Model (A4) > Static Structural (A5) > Force
Solution (A6)

Table 4. *Model (A4) > Static Structural (A5) > Solution.*

Object name	Solution (A6)
State	Solved
Adaptive mesh refinement	
Max refinement loops	1.
Refinement depth	2.
Information	
Status	Done

Table 5. *Model (A4) > Static Structural (A5) > Solution (A6) > Solution Information.*

Object name	Solution ***Information***
State	Solved
Solution information	
Solution output	Solver output
Newton–Raphson Residuals	0
Update interval	2.5 s
Display points	All
FE connection visibility	
Activate visibility	Yes
Display	All FE Connectors
Draw connections Attached To	All Nodes
Line color	Connection Type
Visible on results	No
Line thickness	Single
Display type	Lines

Table 6. *Model (A4) > Static Structural (A5) > Solution (A6) > Results.*

Object Name	Equivalent Stress	Total Deformation
State	Solved	
Scope		
Scoping Method	Geometry selection	
Geometry	All bodies	
Definition		
Type	Equivalent (von-Mises) Stress	Total Deformation
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Integration point results		
Display Option	Averaged	
Results		

Minimum	3.1689e-011 MPa	0. mm
Maximum	0.18983 MPa	2.4913e-005 mm
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	

Table 7. *Model (A4) > Static Structural (A5) > Solution (A6) > Stress Safety Tools.*

Object Name	Stress tool
State	Solved
Definition	
Theory	Max tensile stress
Stress Limit Type	Tensile yield per Material

Table 8. *Model (A4) > Static Structural (A5) > Solution (A6) > Stress Tool > Results.*

Object name	Safety factor
State	Solved
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Safety Factor
By	Time
Display time	Last

Table 9. *Aluminium Alloy > Alternating Stress Mean Stress.*

Alternating Stress MPa	Cycles	Mean stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

Table 10. *Aluminium Alloy > Strain-Life Parameters.*

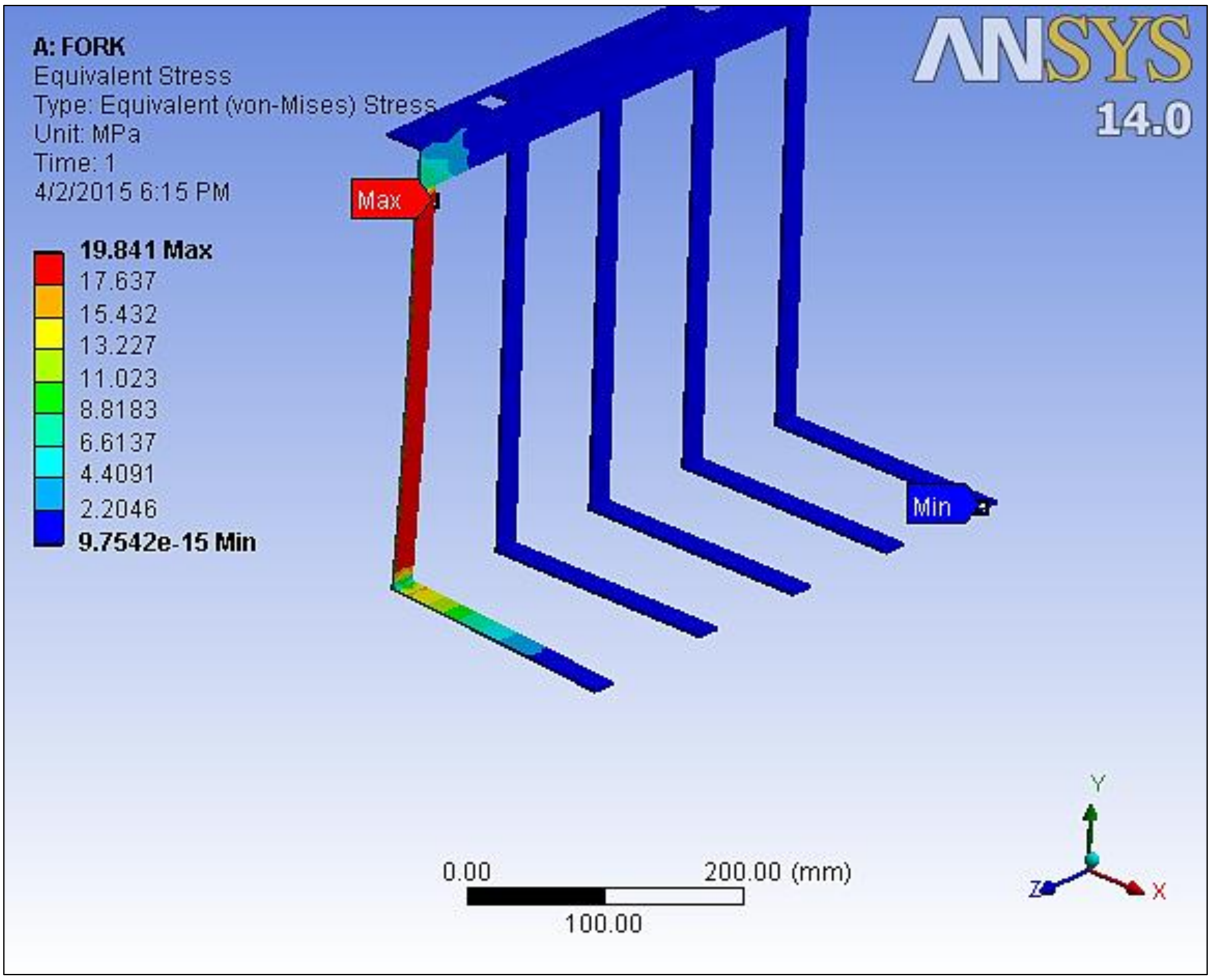
Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

Table 11. *Aluminium Alloy > Isotropic Elasticity*.

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	70000	0.35	77778	25926

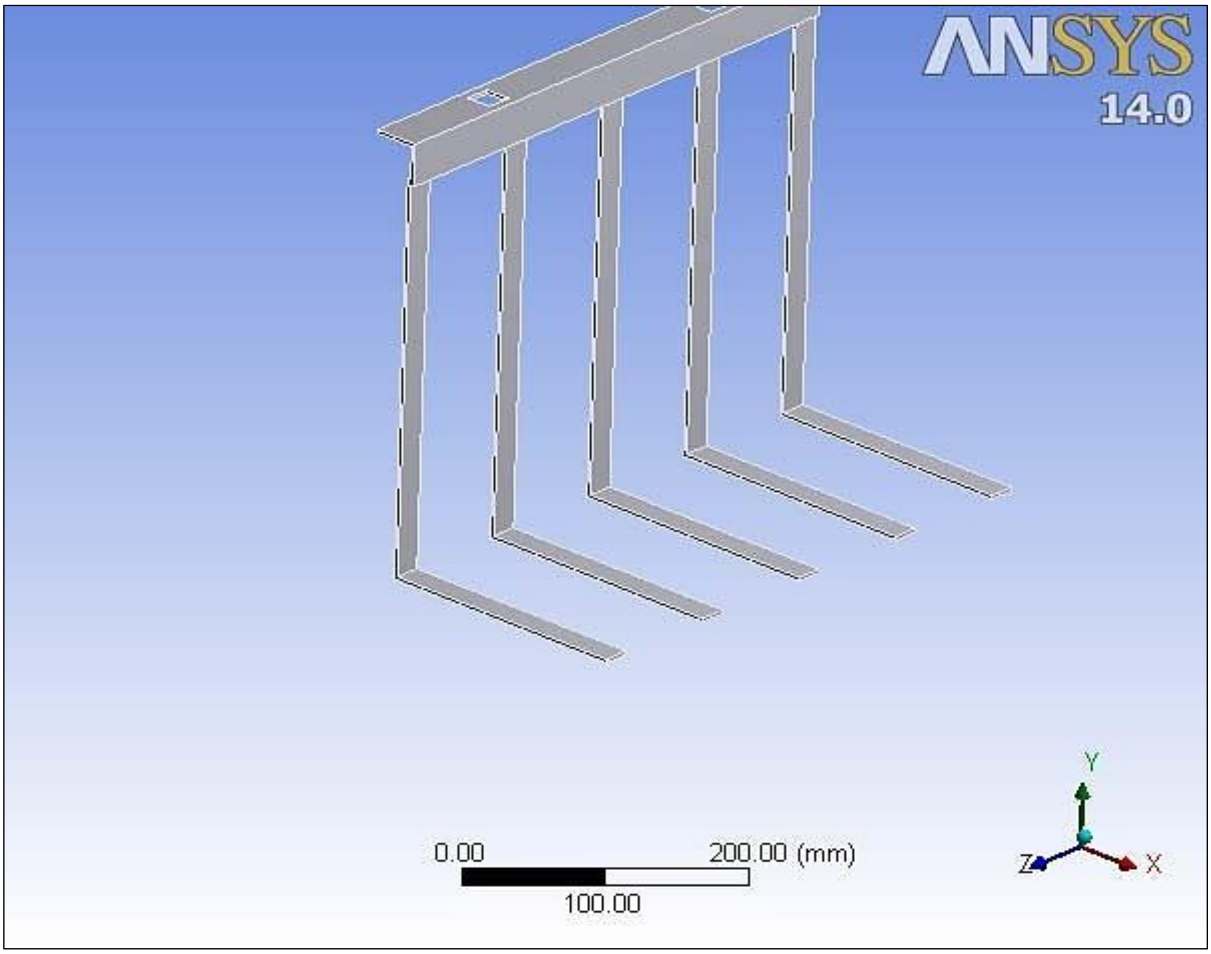
Fork

Stress Induced



Project

First Saved	Thursday, April 02, 2015
Last Saved	Thursday, April 02, 2015
Product Version	14.0 Release
Save Project Before Solution	No
Save Project After Solution	No



Solution (A6)

Table 12. *Model (A4) > Static Structural (A5) > Solution*.

Object Name	*Solution (A6)*
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	
Status	Done

Table 13. *Model (A4) > Static Structural (A5) > Solution (A6) > Solution Information*.

Object name	Solution Information
State	Solved
Solution information	
Solution output	Solver Output
Newton–Raphson residuals	0
Update interval	2.5 s
Display points	All
FE connection visibility	
Activate visibility	Yes

Display	All FE Connectors
Draw connections Attached To	All nodes
Line color	Connection Type
Visible on results	No
Line thickness	Single
Display type	Lines

Table 14. *Model (A4) > Static Structural (A5) > Solution (A6) > Results*.

Object Name	Equivalent Stress	Total Deformation	Equivalent Elastic Strain
State		Solved	
Scope			
Scoping Method		Geometry selection	
Geometry		All bodies	
Definition			
Type	Equivalent (von-Mises) Stress	Total Deformation	Equivalent Elastic Strain
By		Time	
Display Time		Last	
Calculate Time History		Yes	
Identifier			
Suppressed		No	
Integration point results			
Display Option	Averaged		Averaged
Results			
Minimum	9.7542e-015 MPa	0. mm	6.1395e-019 mm/mm
Maximum	19.841 MPa	17.458 mm	2.8602e-004 mm/mm
Information			
Time		1. s	
Load Step		1	
Substep		1	
Iteration Number		1	

CONCLUSION

From the above results and their analysis we conclude that the design is safe and operational. All the allowable stress values become less than the design stress. Also the values of stress which were found with the help of analytical method and by using ANSYS software coincided eventually.

REFERENCES

1. Kishore Kumar K., Krishna M., Ravitej D., *et al*. Design of Automatic Guided Vehicles, *Int J Mech Eng Technol*. 2012; 3(1): 24–32p; *J Impact Factor*. 2011 – 1.2083 (Calculated by GISI).
2. Schulze L., Behling S., Buhrs S. Automated guided vehicle systems: a driver for increased business performance, *Proceedings of the International Multi Conference of Engineers and Computer Scientists*. 2008 Vol II IMECS 2008, 19–21 March, 2008, Hong Kong, 1–2p.
3. Piyare R.K., Singh R. Wireless control of an automated guided vehicle, In: *Proceedings of the International Multi Conference of Engineers and Computer Scientists*. 2011, Vol 2 March 16–18, 2011 Hong Kong ISBN: 978-988-19251-2-1 ISSN:2078-0958(print): ISSN:2078-0966 (online).

4. Takai I., Ito S., Yasutomi K., *et al*. LED and CMOS image sensor based optical wireless communication system for automotive applications, *IEEE Photon J*. 2013; 5(5): 1.
5. Butdee, Suthep, Suebsomran, *et al*. Control and path prediction of an automate guided vehicle, In: *9th Global Congress on Manufacturing and Management*. 12-14, November, 2008, Gold Coast, Australia. Volume 31, Issue 2, December, 2008 442p.
6. Ugale Sachin S., Pagare Aakash G., Varvatkar Vishal V., *et al*. Design and structural analysis of mechanical forklift, *Int J Res Advent Technol*. 2014; 2(5): 234p.
7. Assaad M., Yohannes I., Bermak A., *et al*. Design and characterization of automated color sensor system, *Int J Smart Sens Intell Syst*. 2014; 1-12: 1p.
8. Agarwal P., Tiwari R.K., Banyal S, *et al*. Color/metal sensing sorting system, *Int J Eng Res Manag Technol*. 2014; 1(2): 168p.
9. Snyman C.J., van Niekerk T.I. Development of a navigation system for an autonomous guided vehicle using android technology, *Int J Sci Eng Res*. 2013; 4(6): 3027p.
10. Hossain S.G.M., Ali M.Y., Haq. Automated guided vehicles for industrial logistics – development of intelligent prototypes using appropriate technology, *IEEE*. 5: 239p.