PRINCIPAL STRESS ANALYSIS OF LUFFING JIB USING SOLID WORKS-12

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ABSTRACT

Now-a- days, the tower crane is a basic need in the infrastructure field. The loading & unloading work is performing by the tower crane. Mobile tower crane is a type of tower crane which is used for the purpose of easy handing of material on different location of work station by its portable function. Failure of the tower crane may be occur during due to failure of, its design. This study focus on the prevention of crane damage which occur due to heavy load.

In this study, by using the SOLID WORKS-12 software the crane parts material which is made by plain carbon steel is modeled one-by-one, with specific dimensions. Afterwards the principal stress distribution analysis done by SOLID WORKS-12 software. As the conclusion the safe design of mobile tower crane for 90^0 *at a load of 800 kg on a different length of jib is recommended.*

Key words: *Mobile tower crane* (luffing jib)*, plain carbon steel, SOLIDWORK-12.*

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INTRODUCTION

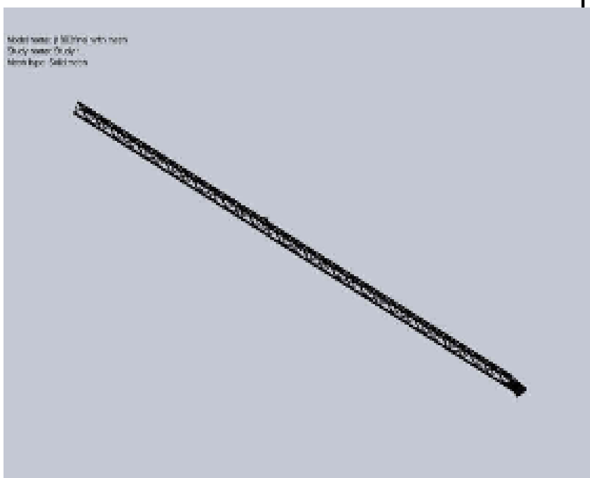
Mobile tower crane are the self erecting/self folding tower crane. Operation can be easily affected by a single operator, through a remote control pod. This crane is mounted on a towable type trailer with compact dimensions for easy transportation. To minimize the dead weight for long distance transportations the counter weight box is designed with trap doors to enable general ballast use as a counter weight. The chassis design enables a short turning radius & easy positioning. Stabilizers are out & down type and can be reiterated into the lower chassis to satisfy the road clearance codes. An optional prime mover with a built in 20KVA generator makes. Mobile tower crane totally independent of any outside electric source and have separate carrier vehicle. The crane uses only a part of the power & generator can be used for other site equipment like mixers, vibrators & job site lighting system. Some mobile tower crane is controlled by a remote. This facilitates the operator position himself in such way that he can see both picking as well as dumping points for precise load & positioning.

In this study, a mobile tower crane is modeled in 3D using *SOLIDWORK-12* computer software. Then, the generated components are meshed in *SOLID WORKS-12* software. The meshed components are mounted on each other and the meshed model of the tower crane is obtained. Finite element analysis is accomplished considering the load combination in FEM norms.

MAIN BODY

The raw material used for construct the main body of the mobile tower crane is plain carbon steel. Carbon steel is by far the most widely used kind of steel. The properties of carbon steel depend primarily on the amount of carbon it contains. Most carbon steel has a carbon content of less than 1%. Carbon steel is made into a wide range of products, including structural beams, car bodies, kitchen appliances, and cans. In fact, there are 3 types of plain carbon steel and they are low carbon steel, medium carbon steel, high carbon steel, and as their names suggests all these types of plain carbon steel differs in the amount of carbon they contain. Indeed, it is good to precise that plain carbon steel is a type of steel having a maximum carbon content of 1.5% along with small percentages of silica, sulphur, phosphorus and manganese.

The following property of the plane carbon steel is used.

Model Reference	Properties
	**Material property**

Material name	**Plain Carbon Steel**
Yield strength	**2.20594e+008 N/m^2**
Tensile strength:	**3.99826e+008 N/m^2**
Elastic modulus	**2.1e+011 N/m^2**
Poisson's ratio:	**0.28**
Mass density	**7800 kg/m^3**
Shear modulus	**7.9e+010 N/m^2**
Thermal expansion coefficient	**1.3e-005 /Kelvin**

Figure 1: Properties of plain carbon steel

The specification of the tower crane is;

S.N.	Height	Reach	Capacity
Horizontal jib position	23 meter	7.5-25meters	2500Kgs.-800Kgs.
Raised jib position	23 meter	7.5-25meters	2500Kgs.-800Kgs.

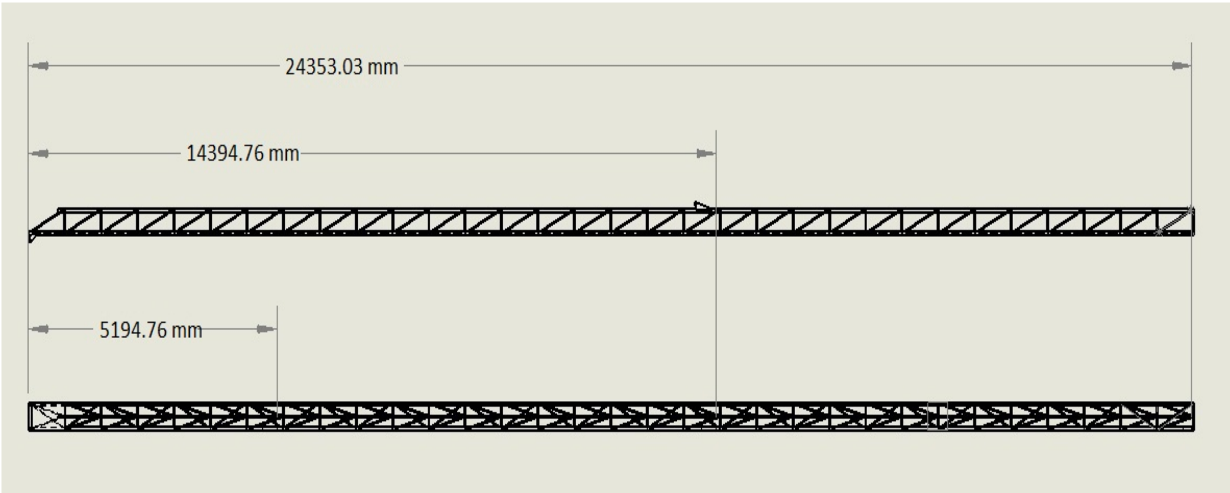


Figure: 2 Top & front view (load is applied on a different length)

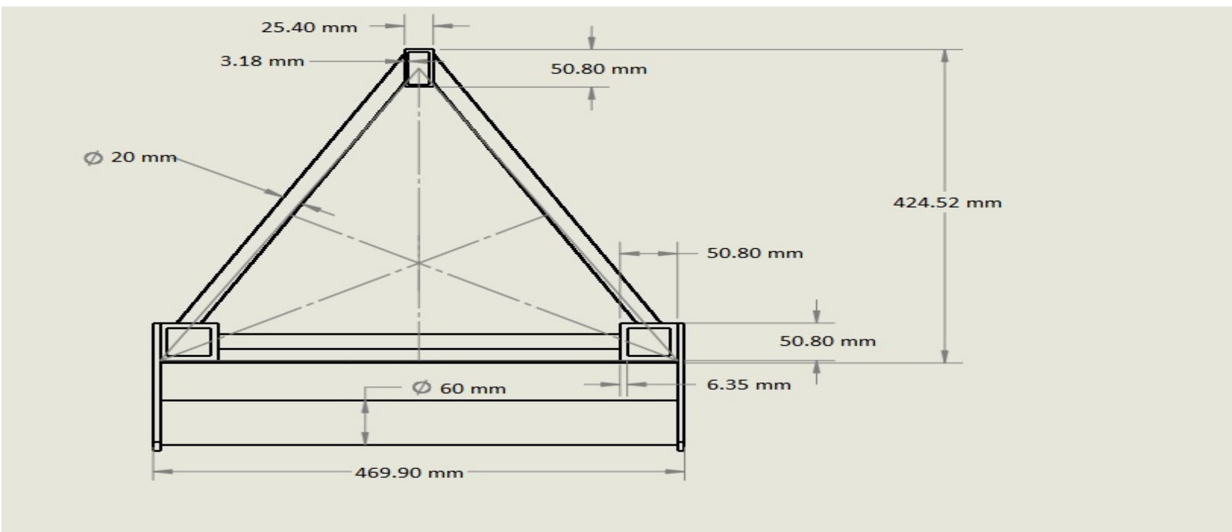


Figure 3: side view of the luffing jib.

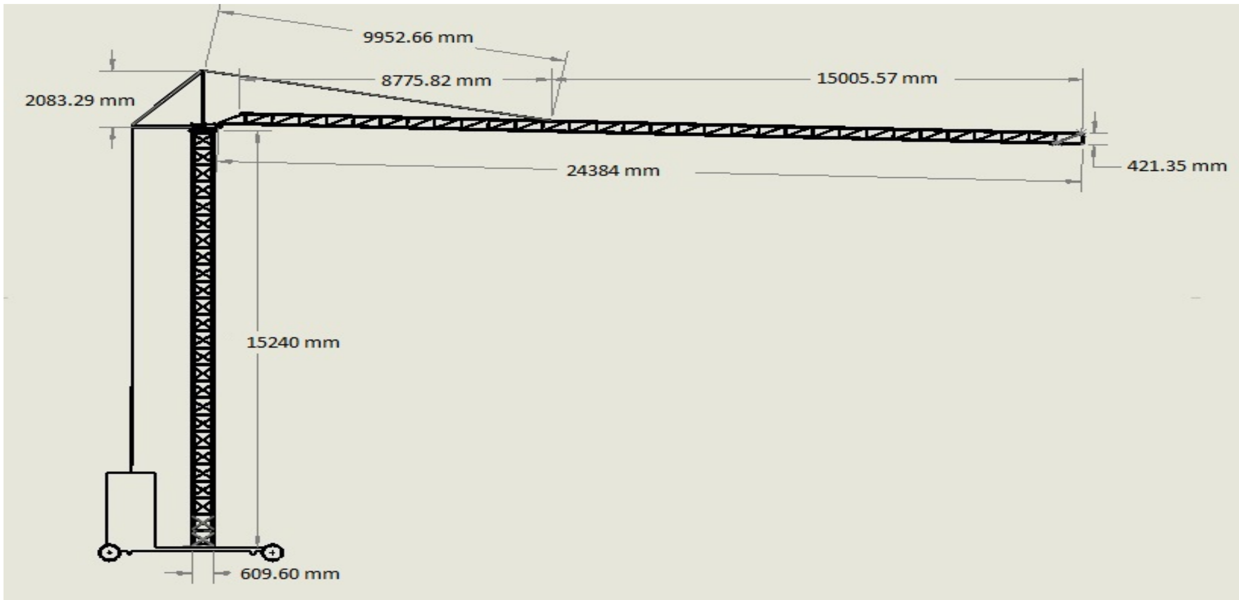
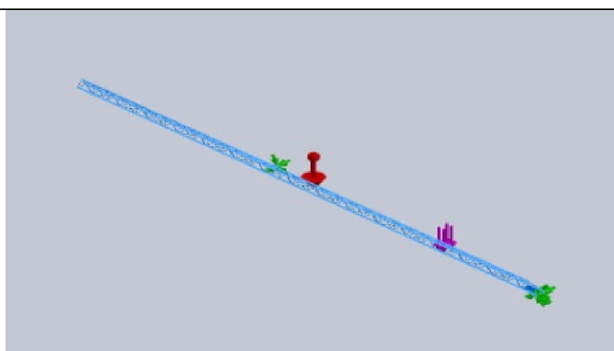


Figure 4: final view of the mobile tower crane

RESULT & DISCUSSION

a). <u>Principal stress on a different axis of the jib</u> (Load applied on the beginning point)

Solid Bodies		
Model reference	**Treated As**	**Volumetric Properties**
	Solid Body	**Mass:668.154 kg** **Volume:0.0856608 m^3** **Density:7800 kg/m^3** **Weight:6547.91 N**

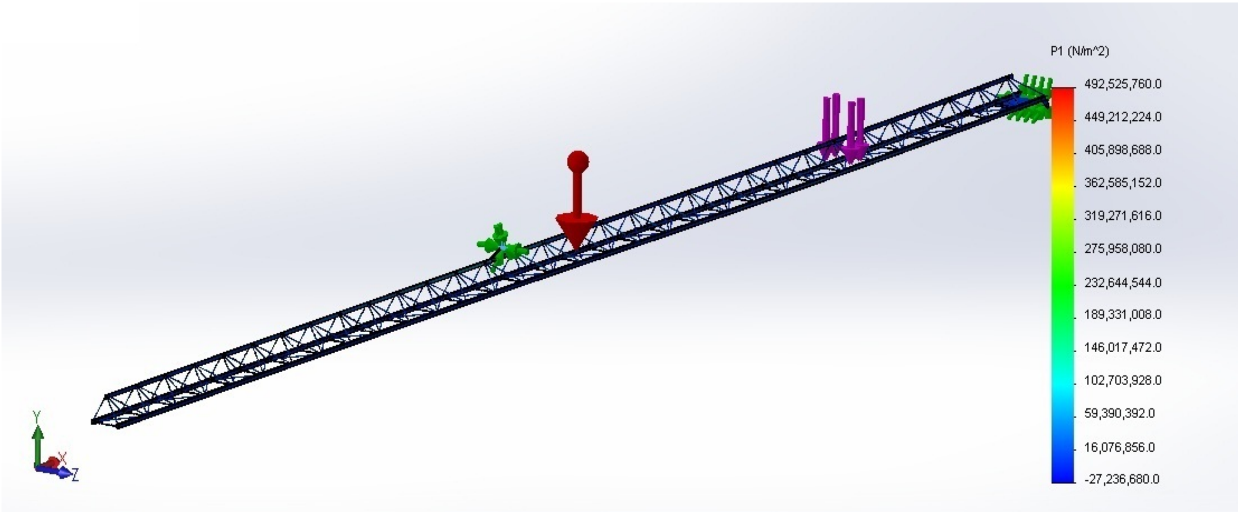

P1 (N/m^2)
492,525,760.0
449,212,224.0
405,898,688.0
362,585,152.0
319,271,616.0
275,958,080.0
232,644,544.0
189,331,008.0
146,017,472.0
102,703,928.0
59,390,392.0
16,076,856.0
-27,236,680.0
Y
X
Z

Fig. a (1)

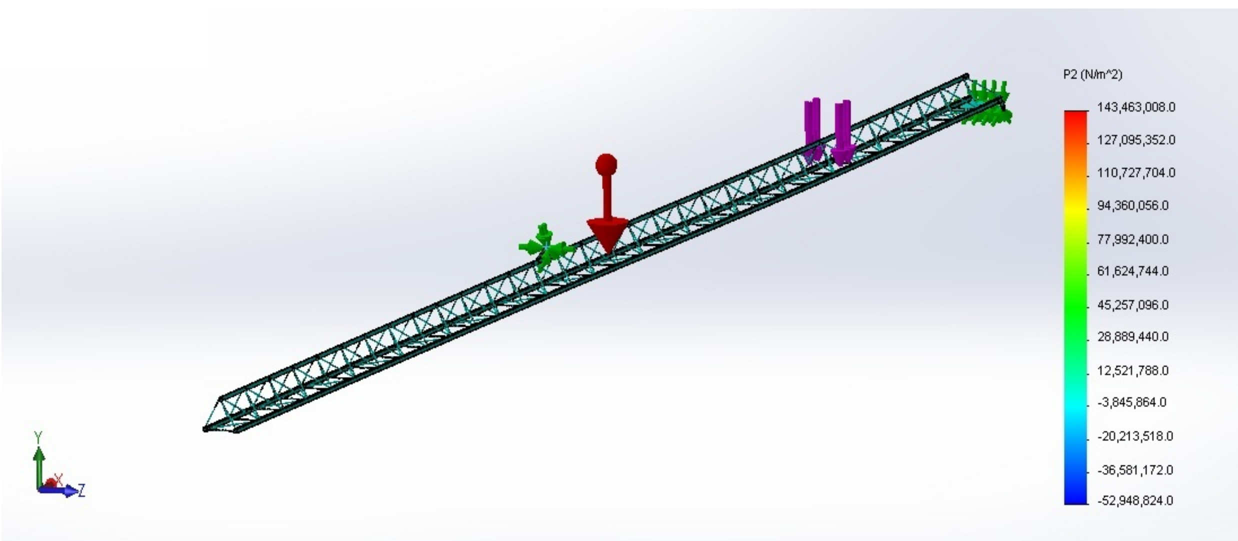

P2 (N/m^2)
143,463,008.0
127,095,352.0
110,727,704.0
94,360,056.0
77,992,400.0
61,624,744.0
45,257,096.0
28,889,440.0
12,521,788.0
-3,845,864.0
-20,213,518.0
-36,581,172.0
-52,948,824.0
Y
X
Z

Fig. a (2)

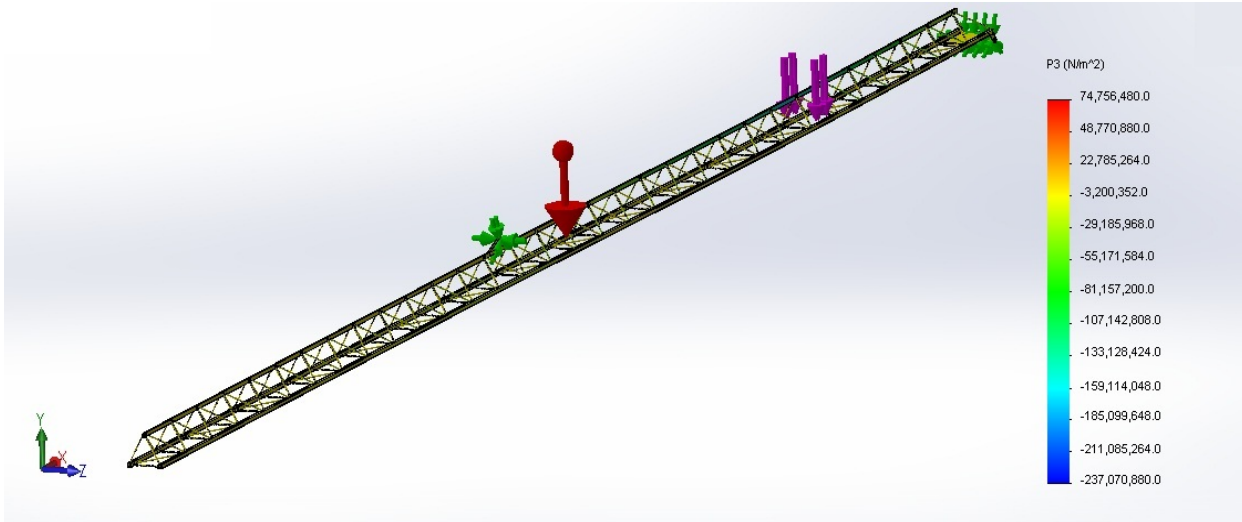


Fig. a (3)

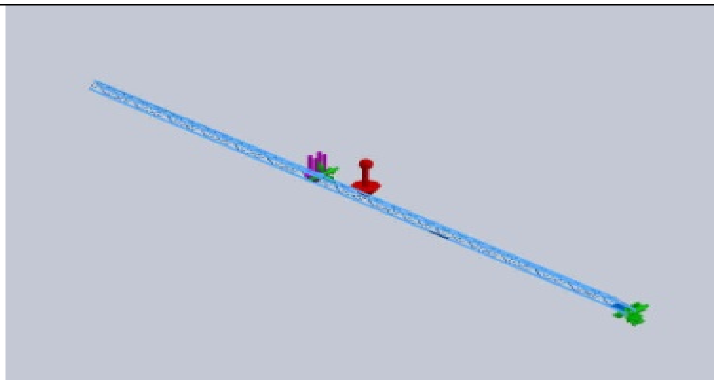
The above result showed the principal stress distribution for an applied load of 800 kg at a distance 5194.76 mm from fixes and hinge point at the beginning. The three mutual perpendicular principal stresses on their principal axis, which is P1 P2 P3 respectively. The P1, P2, P3 are lie on the X-axis Y- axis and Z- axis. In the solid works analysis the positive sign convention indicate the tensile stress on the body where as the negative sign convention indicate the compressive stress on the body. If result having both sign convention (positive & negative), so its mean that the body is in pure banding.

By the solid works analysis the result shown that [fig a (1)] the maximum principal stress (P1) which is lie on the X-axis is 492,525,760.0 N/m^2 & the minimum principal stress is -27,236,680.0 N/m^2.

Now on the second [fig a (2)] result analysis shows the maximum principal stress (P2) which is lie on the Y-axis, is 143,463,008 N/m^2 & the minimum principal stress is -52,948,824.0 N/m^2.

And the third [fig a (3)] result analysis shows the maximum principal stress (P3) which is lie on the Z-axis, is 74,756,480.0 N/m^2 & the minimum principal stress is -237,070,880.0 N/m^2.

b). <u>Principal stress on a different axis of the jib</u> (Load applied on the middle point)

Solid Bodies		
Model reference	**Treated As**	**Volumetric Properties**
	Solid Body	**Mass:668.154 kg** **Volume:0.0856608 m^3** **Density:7800 kg/m^3** **Weight:6547.91 N**

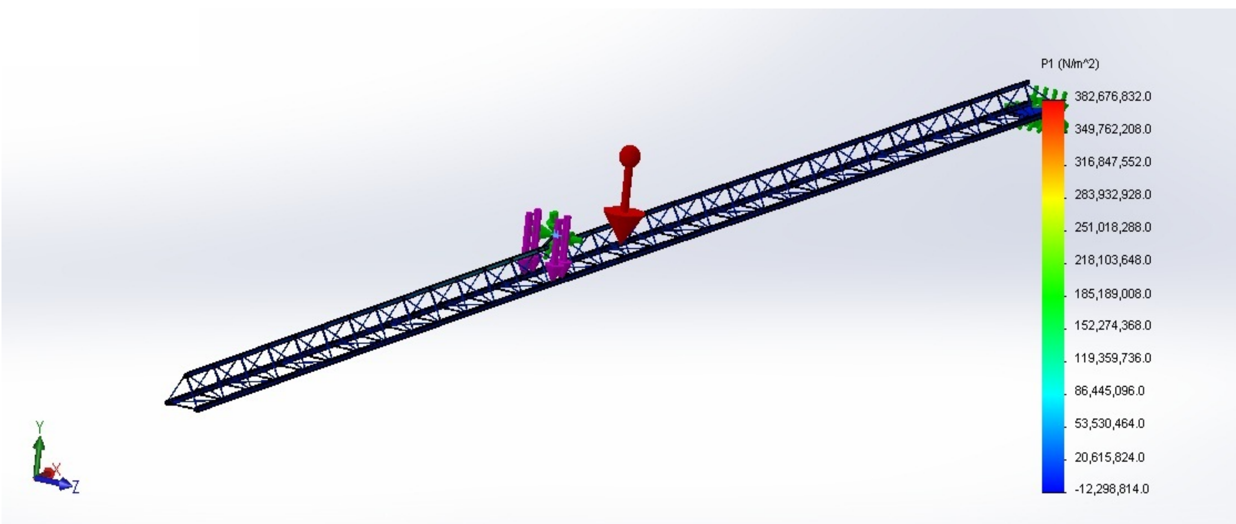


Fig. b (1)

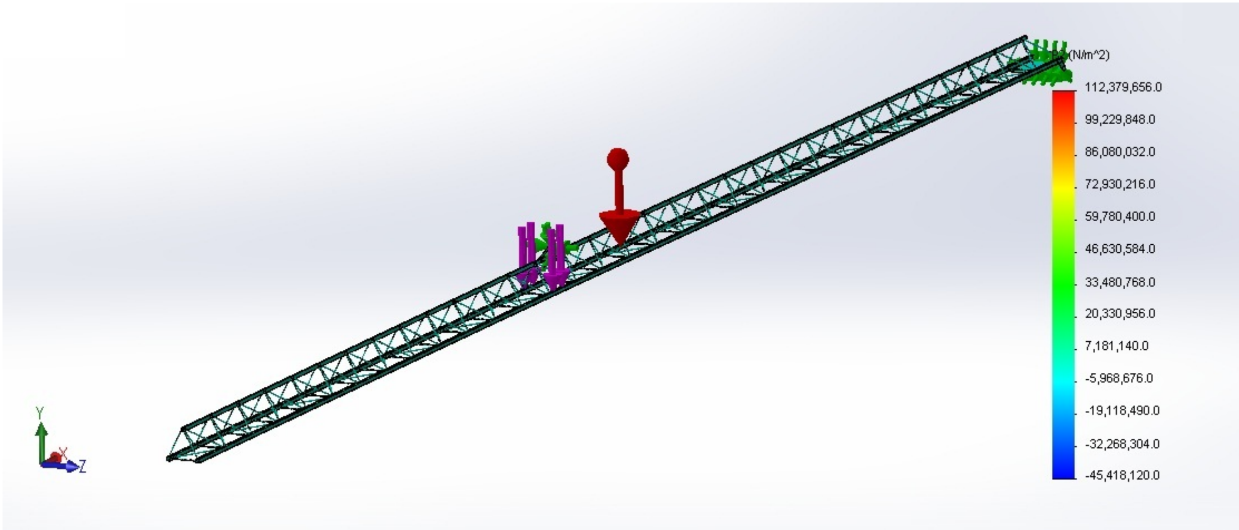


Fig. b (2)

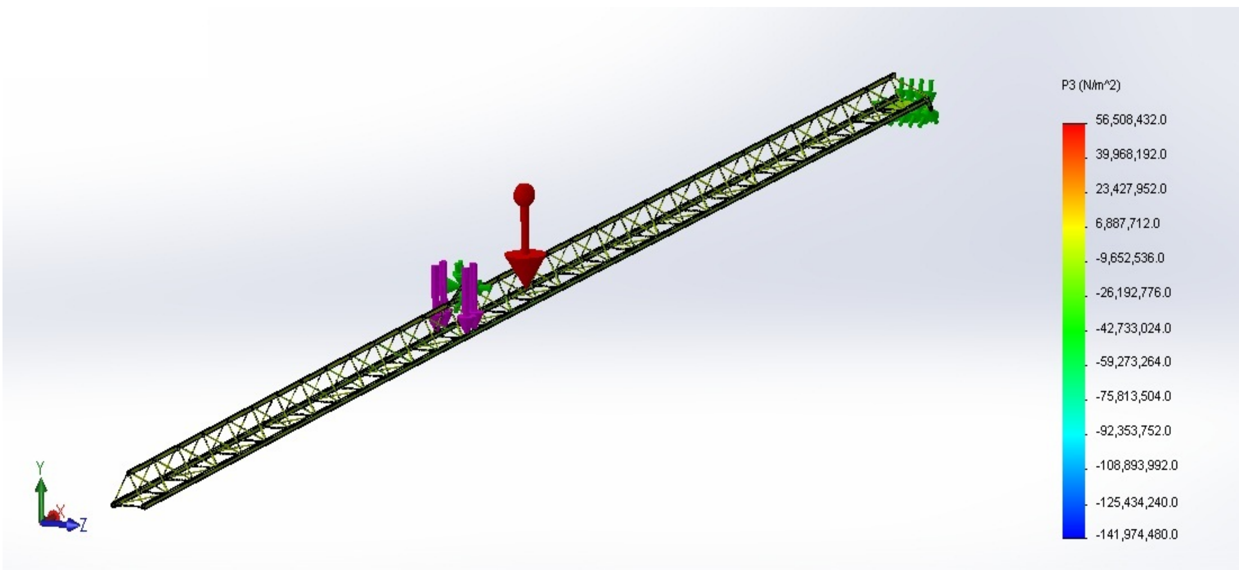


Fig. b (3)

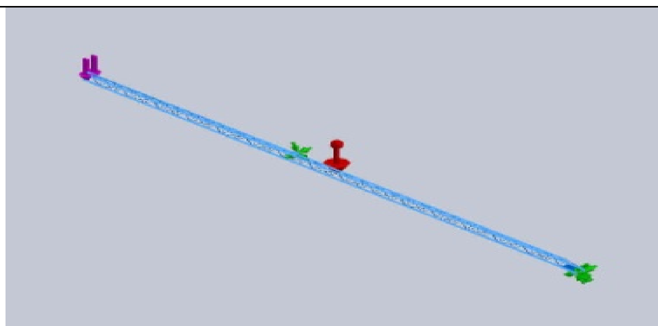
The next analysis principal stress on a different axis of the jib (Load applied on the middle point) showed that principal stress distribution for an applied load of 800 kg at a distance 14394.76 mm from fixes and hinge point at the beginning. The three mutual perpendicular principal stresses on their principal axis, which is P1 P2 P3 respectively. The P1 P2 P3 are lie on the x axis y axis and z axis.

By the solid works analysis the result shown that [fig b (1)] the maximum principal stress (P1) which is lie on the X-axis is 382,676,832.0 N/m^2 & the minimum principal stress is -12,298,814.0 N/m^2.

Now on the second [fig b (2)] result analysis shows the maximum principal stress (P2) which is lie on the Y-axis, is 112,379,656.0 N/m^2 & the minimum principal stress is -45,418,120.0 N/m^2.

And the third [fig b (3)] result analysis the maximum principal stress (P3) which is lie on the Z-axis, is 56,508,432.0 N/m^2 & the minimum principal stress is -141,974,480.0 N/m^2.

c). <u>Principal stress on a different axis of the jib</u> (Load applied on the last point)

Solid Bodies		
Model reference	**Treated As**	**Volumetric Properties**
	Solid Body	**Mass:668.154 kg** **Volume:0.0856608 m^3** **Density:7800 kg/m^3** **Weight:6547.91 N**

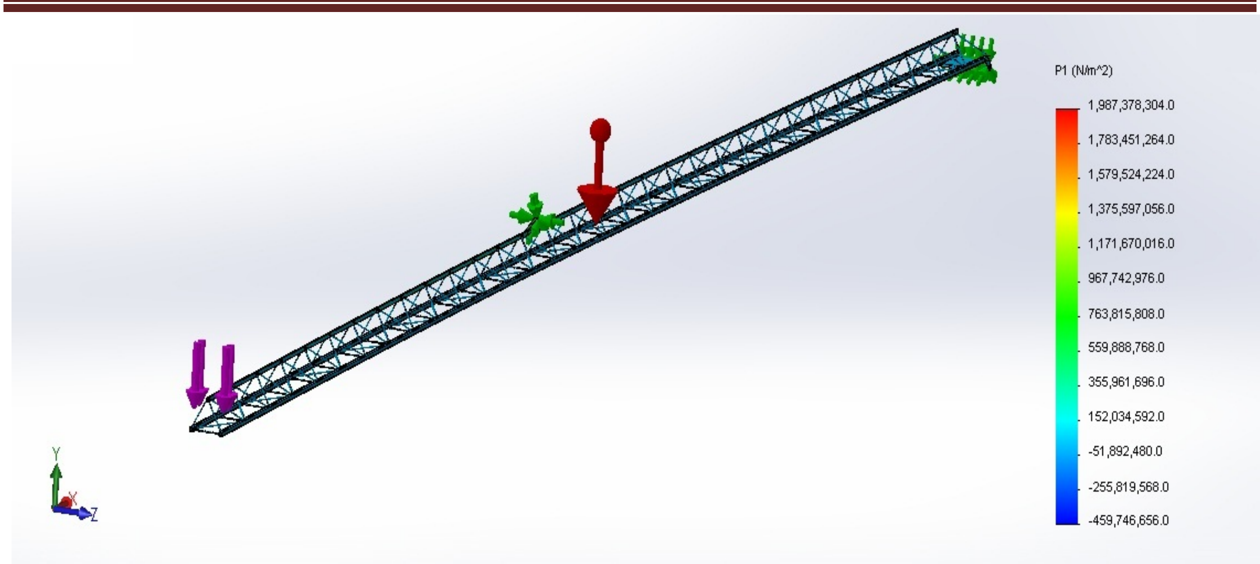

P1 (N/m^2)
1,987,378,304.0
1,783,451,264.0
1,579,524,224.0
1,375,597,056.0
1,171,670,016.0
967,742,976.0
763,815,808.0
559,888,768.0
355,961,696.0
152,034,592.0
-51,892,480.0
-255,819,568.0
-459,746,656.0
Y
X
Z

Fig. c (1)

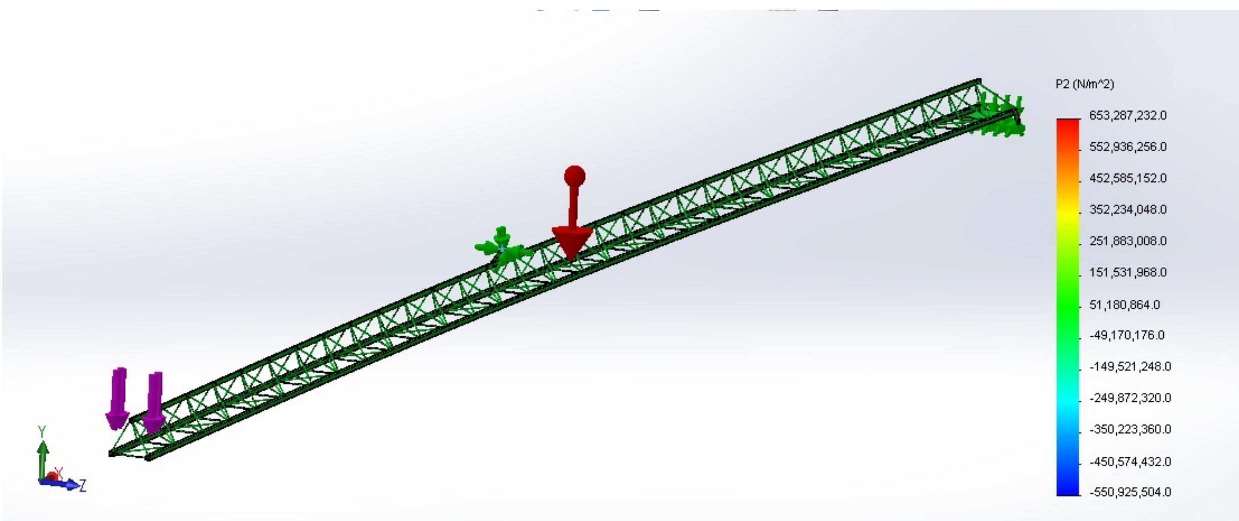

P2 (N/m^2)
653,287,232.0
552,936,256.0
452,585,152.0
352,234,048.0
251,883,008.0
151,531,968.0
51,180,864.0
-49,170,176.0
-149,521,248.0
-249,872,320.0
-350,223,360.0
-450,574,432.0
-550,925,504.0
Y
X
Z

Fig. c (2)

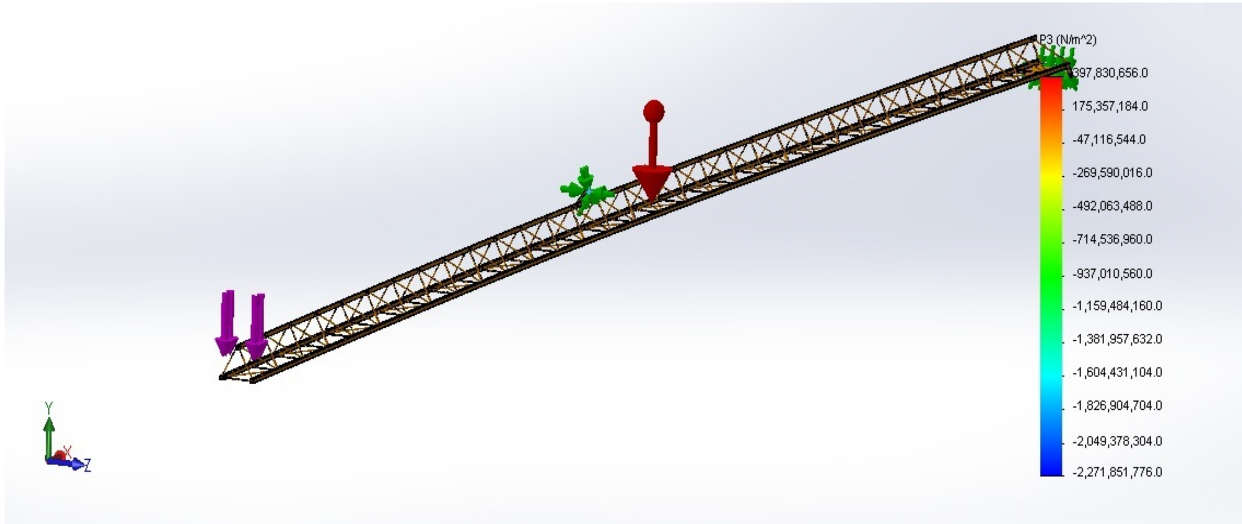


Fig. c (3)

The next analysis principal stress on a different axis of the jib (Load applied on the last point) showed that principal stress distribution for an applied load of 800 kg at a distance 24353.03 mm from fixes and hinge point at the beginning. The three mutual perpendicular principal stresses on their principal axis, which is P1 P2 P3 respectively. The P1 P2 P3 are lie on the x axis y axis and z axis.

By the solid works analysis the result shown that [fig b (1)] the maximum principal stress (P1) which is lie on the X-axis is 1,987,378,304.0 N/m^2 & the minimum principal stress is -459,746,656.0 N/m^2.

Now on the second [fig b (2)] result analysis the maximum principal stress (P2) which is lie on the Y-axis, is 653,287,232.0 N/m^2 & the minimum principal stress is -550,925,504.0 N/m^2.

And the third [fig b (3)] result analysis the maximum principal stress (P3) which is lie on the Z-axis, is 397,830,656.0 N/m^2 & the minimum principal stress is -,2,271,851,776.0 N/m^2.

CONCLUSION

Analysis result of luffing jib tower crane reveals that the compressive stress is maximum in Z-direction at all applied load condition and analysis of the diagramed shown that the generation of compressive stress is maximum in the luffing jib (which shows by the negative value of principal stress) as compared to tensile (which shows by the positive principal stress).

So in loading and unloading by the luffing jib the factor of safety in Z-direction should be highly taken into consideration.

REFERENCE

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