DESIGN ANALYSIS OF LIFTING DEVICE USING HYDRAULIC TELESCOPIC JACK

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ABSTARCT

A Lifting Device is used to lift heavy objects. In the lifting device we are used 4 stage hydraulic telescopic jack. The advantages of telescopic jack are that the height of jack can be adjusting one inside the other (i.e. collapsed height). Present paper includes the analysis of The Device Made Using Hydraulic Telescopic Jack. The maximum load to be lift is 1000 kg up to the height of 40 inch (1016mm). With the help of CATIA the 3-D modelling of a device using 4 stages hydraulic telescopic jack is made. In ANSYS software we mainly do analyses of stress like circumferential stress, longitudinal stress, radial stress and equivalent stress. The components that are going to analyze are telescopic cylinder, plate rod and wheel at last the result are check for validation purpose.

We show result comparing with theoretical value and analysis value. For lifting load carrying capability of device affected by different stress acting on it.

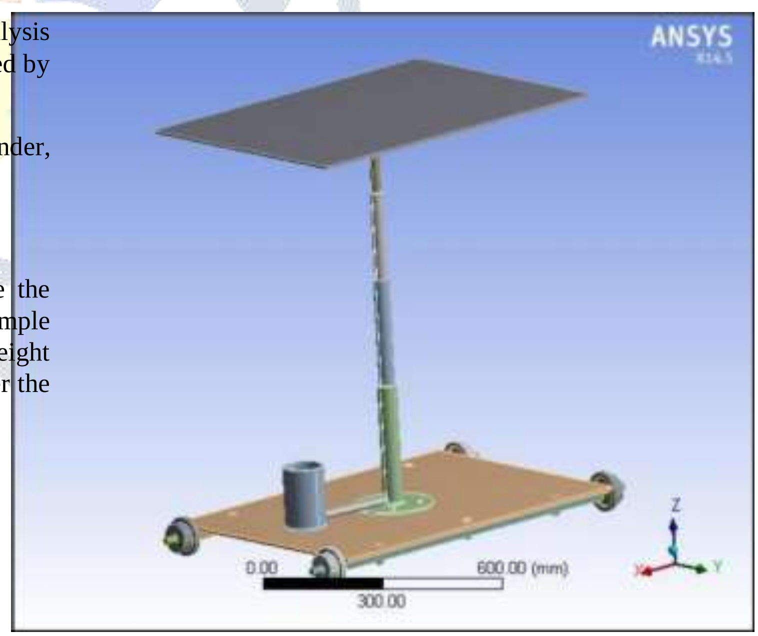
Keyword: -ANSYS analysis of telescopic jack, cylinder, plates, rods, 3D Modelling of Lifting Device.

INTRODUCTION:-

The use of telescopic hydraulic jack is widely increase the utility of the hydraulic jack is more as compared simple hydraulic jack. It overcomes the difficulties of the base height like telescopic jack having the stage which opens one after the next and closed likewise. It also overcome the area constraint over a simple hydraulic jack the loading capacity can be achieve on the basis of variation in length and area of the telescopic jack the working principle of telescopic jack is just similar like simple hydraulic jack. The working principal of telescopic jack is based on Pascal law. The increase in the pressure on the surface of confined fluid is transmitted undiminished through the confined vessel on system.

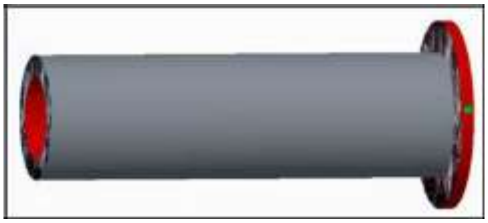
The basic function of the entire hydraulic jack is to produce unidirectional force they actually converts the hydraulic force into mechanical unidirectional force. In this project we mainly design and analyze the jack for TATA NANGIA MOTORS Pvt. Ltd. Hingna MIDC.

3-D MODEL OF LIFTIG DEVICE:-



3-D MODELLING OF COMPONENTS Cylinders:-

Stage 1(ro-25mm, ri-20mm)



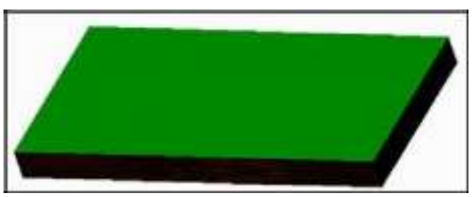
Stage 2(ro-20mm, ri-16mm)

Stage 3(ro-16mm, ri-13mm)

Stage 4(r-13mm solid)

Plates: - (Upper & Lower)

Dimension :(L=640mm, B=900mm, Tu=8mm, Tl=9mm)



Rod: (L=1060mm, W=H=40mm)

Wheel:-

Stages	Inner Radius (	Outer Radius(ro)
Stage1	20	25
Stage 2	16	20
Stage 3	13	16
Stage 4	13 (solid)	

All Dimensions are in mm.

Theoretical calculations are as follows:-For 1st stage

Th/Di = 10/40> 0.1 Therefore this is of thick type

a) Radial stresses [бr]

бr = [pi×ri^2 (1-ro^2/ri^2)]/(ro^2-ri^2)

бr = -17.345 Mpa.

b) Circumferential stress [бө]

бө = [pi×ri^2 (1+ro^2/ri^2)]/(ro^2-ri^2)

= 79.016 Mpa.

c) Axial stress [бz]

бz = [pi×ri^2]/(ro^2-ri^2)

= 30.8355 Mpa.

d) Equivalent stress [von mises stress] [бeq]

бeq =√[$бө^2$+$бr^2$-бr×бө]

= 88.965 Mpa.

e) Failure criteria

½[$(бө-бr)^2$-$(бr-бz)^2$-$(бz-бө)^2$]<= $бy^2$

= 2321.48 <220900. Hence design is safe.

For 2nd stage Th/Di = 8/32> 0.1 Therefore this is of thick type

a) Radial stresses [бr]

$бr = [pi \times ri^2 (1-ro^2/ri^2)]/(ro^2-ri^2)$

бr = -17.345 Mpa.

b) Circumferential stress [бɵ]

$бɵ = [pi \times ri^2 (1+ro^2/ri^2)]/(ro^2-ri^2)$

=79.016Mpa.

c) Axial stress [бz]

$бz = [pi \times ri^2]/(ro^2-ri^2)$

= 30.8355Mpa.

d) Equivalent stress [von mises stress] [бeq]

= 88.965Mpa.

e) Failure criteria

$½[(бɵ-бr)^2-(бr-бz)^2-(бz-бɵ)^2] <= бy^2$

= 2321.48<220900. Hence design is safe

For 3rd stage Th/Di = 6/26 > 0.1 Therefore this is of thick type

a) Radial stresses [бr]
$бr = [pi \times ri^2 (1-ro^2/ri^2)]/(ro^2-ri^2)$ бr = -17.345 Mpa.

b) Circumferential stress [бɵ]
$бɵ = [pi \times ri^2 (1+ro^2/ri^2)]/(ro^2-ri^2)$
= 84.731 Mpa.

c) Axial stress [бz]
$бz = [pi \times ri^2]/(ro^2-ri^2)$
= 33.69 Mpa.

d) equivalent stress [von mises stress] [бeq]

$бeq = \sqrt{[бɵ^2+бr^2-бr \times бɵ]}$

= 94.6036 Mpa.

e) Failure criteria
$½[(бɵ-бr)^2-(бr-бz)^2-(бz-бɵ)^2] <= бy^2$
=2604.877 <220900.
Hence design is safe.

4th stage

Buckling force $=F = (\pi^2 \times E \times I)/le^2$

le = 2l

$I = \pi/64 \times d^4$

$I = 19177.246\ mm^4$

$F= (\pi^2 \times 2 \times 100000 \times 19177.246)/ (2 \times 1016)^2$

=10727.89 N.

Analytical results

To check the calculated data of our design we first design the 3D model then we tested or analyze our design in the ANSYS software. In this analysis process we first check the different parts of our design that is cylinder stages, plate. During this Analysis process we have calculated the stresses, strain, and deformation on each part and that actual data we have compared with a our Analytical calculated data

ANALYSIS RESULTS Analysis on cylinder stages: For

Stage 1:

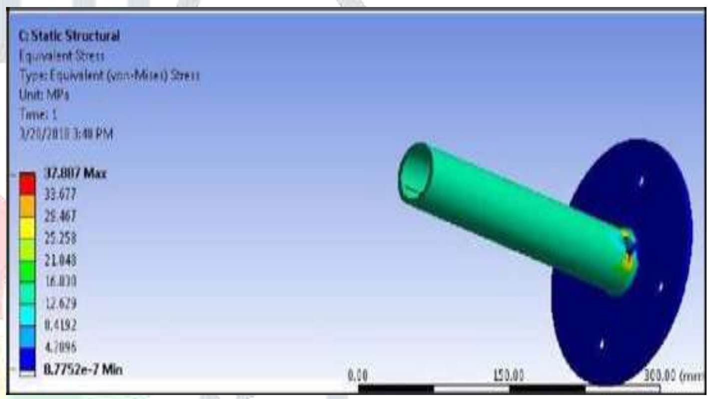


Fig: Equivalent stress for stage 1

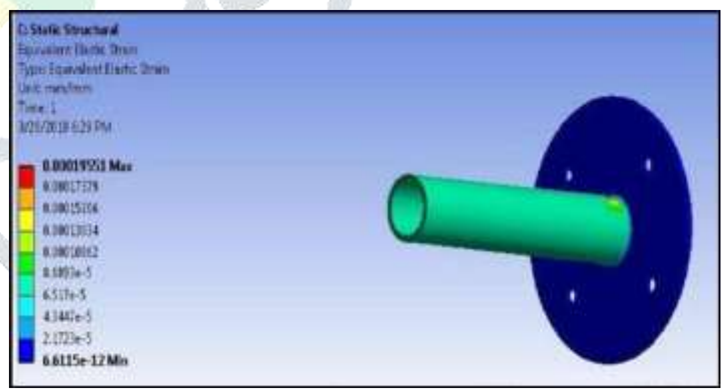


Fig: Equivalent elastic strain for stage 1

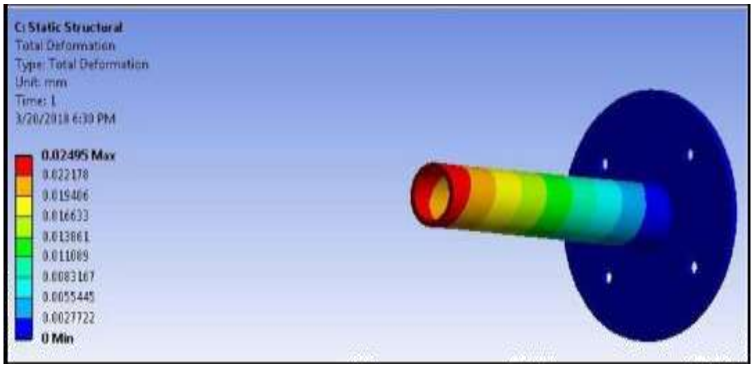


Fig: Total deformation for stage 1 For 1 stage of our hydraulic cylinder,

Maximum equivalent elastic strain = 0.0019551
Maximum total deformation = 0.02495 mm Maximum equivalent stress = 37.887 Mpa

Actual equivalent stress for stage 1 is 37.887 Mpa which is less than Analytical equivalent Stress which is 88.965 Mpa hence our design is safe

For stage 2:

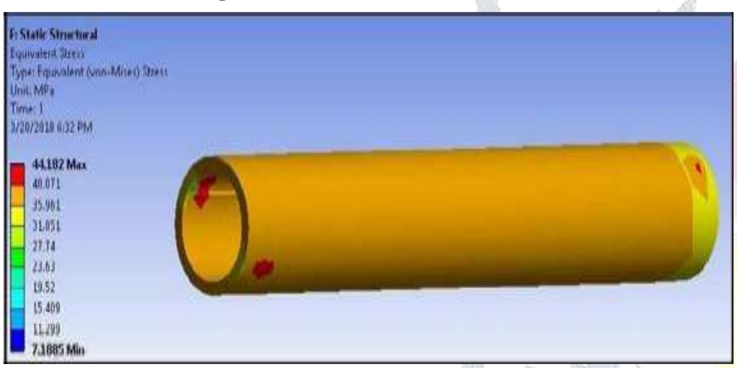


Fig: Equivalent stress for stage 2

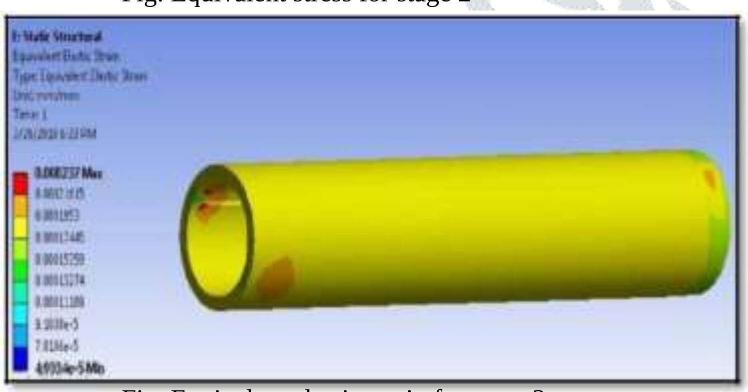


Fig: Equivalent elastic strain for stage 2

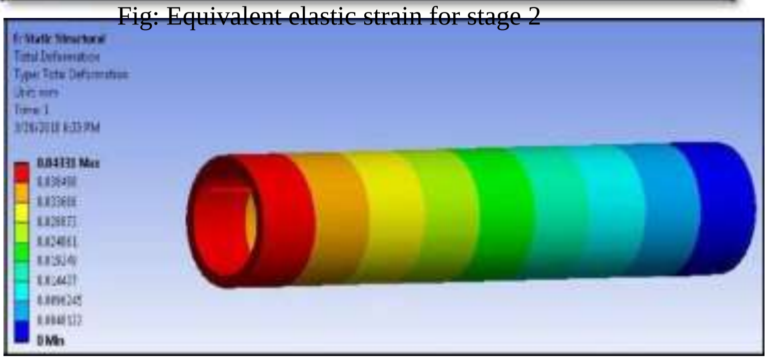


Fig: Total deformation for stage 2

For 2 stage of our hydraulic cylinder,
Maximum equivalent elastic strain = 0.000237
Maximum total deformation = 0.04331 mm Maximum equivalent stress = 44.182 Mpa

Actual equivalent stress for stage 1 is 44.182 Mpa which is less than Analytical equivalent Stress which is 94.6036 Mpa hence our design is safe

For stage 3:

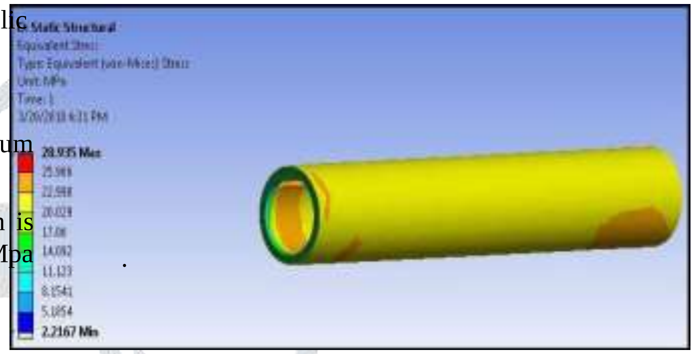


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Fig: Equivalent stress for stage 3

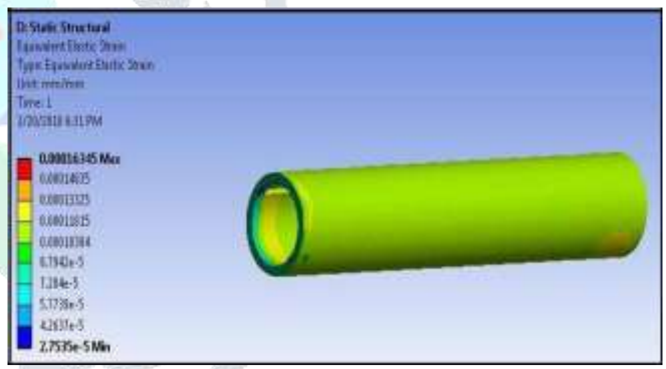

Fig: Equivalent elastic strain for stage 3

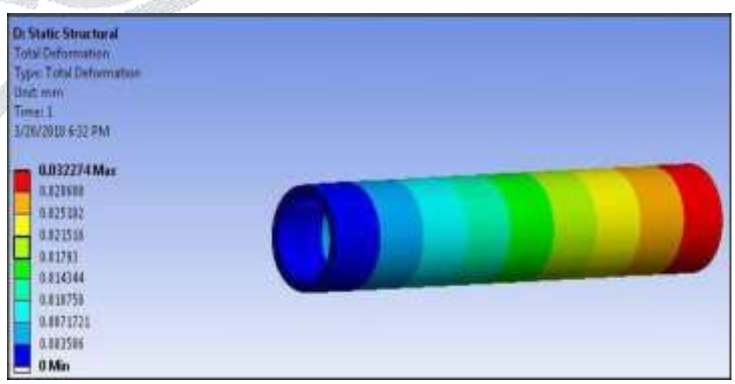

Fig: Total deformation for stage 3

Maximum equivalent elastic strain = 0.00016345
Maximum total deformation = 0.032274 mm

Maximum equivalent stress = 28.935 Mpa

Actual equivalent stress for stage 1 is 28.935 Mpa which is less than Analytical equivalent Stress which is 88.965 Mpa hence our design is safe For 3 stage of our hydraulic cylinder,

For stage 4:

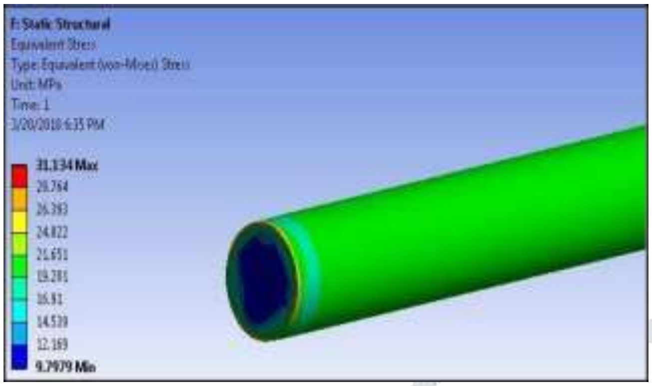

Fig: Equivalent stress for stage 4

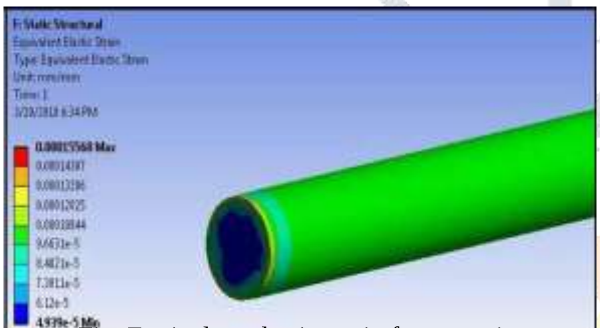

Fig: Equivalent elastic strain for stage 4

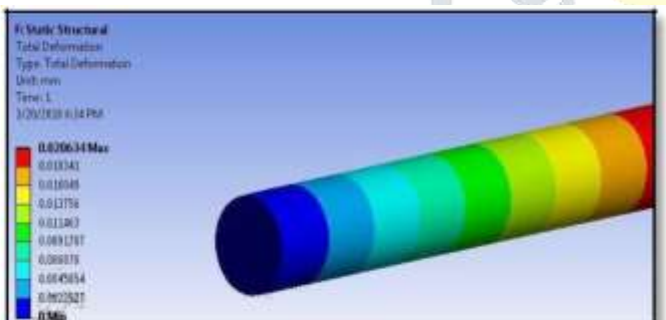

Fig: Total deformation for stage 4 For 4 stage of our hydraulic cylinder,

Maximum equivalent elastic strain = 0.00015568

Maximum total deformation = 0.020634 mm

Maximum equivalent stress = 31.134 Mpa

For Lower Plate and upper plate:

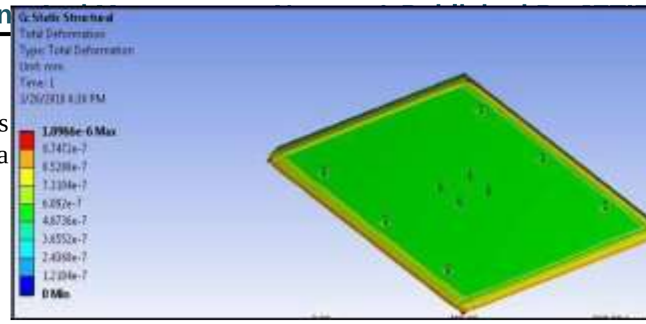

Fig: Total deformation for lower plate

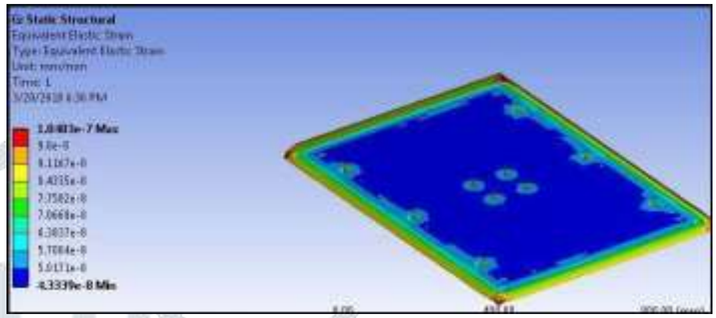

Fig: Equivalent elastic strain for lower plate

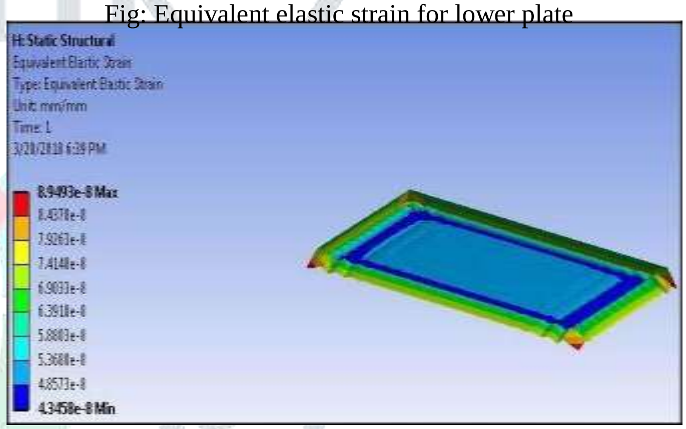

Fig: Equivalent elastic strain for Upper plate

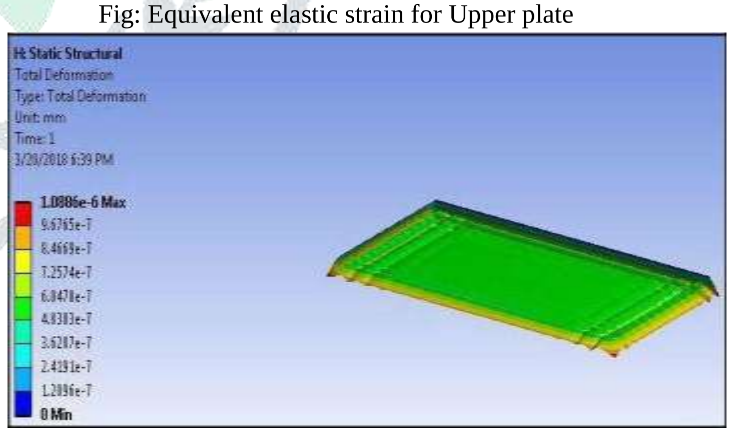

Fig: Total deformation for Upper plate

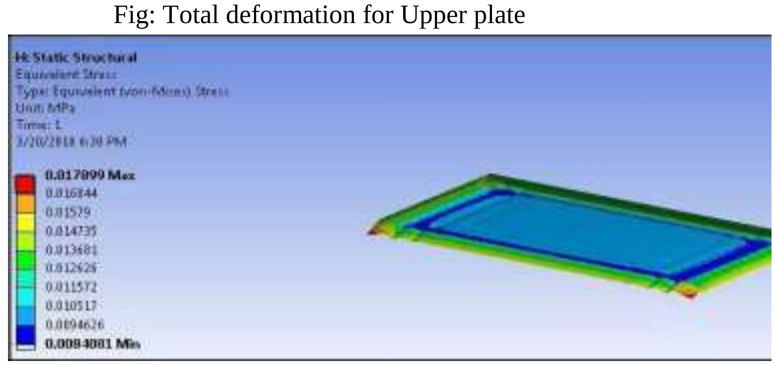

Fig: Equivalent stress for Upper plate

For lower plate of our model,

Maximum equivalent elastic strain = 1.0966×10^{-6}

Max.Total deformation = 1.0483×10^{-7} mm For Upper plate of our model,

Max. Equivalent elastic strain = 8.9493×10^{-8}

Max.Total deformation = 1.0886×10^{-6} mm Max.Equivalent stress = 0.017899 Mpa

Actual equivalent stress for Upper plate is 001760 Mpa which is nearly equal to Analytical equivalent Stress which is 0.017899 Mpa hence our design is safe

Analysis on whole body:

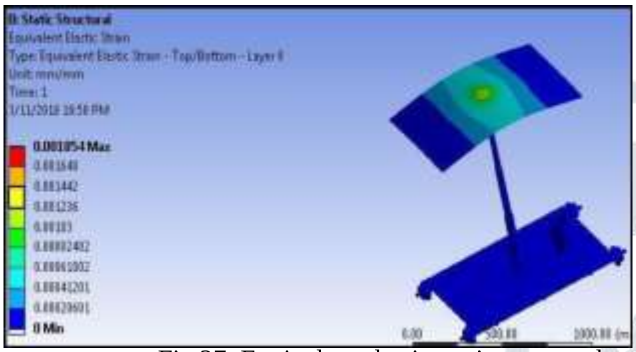

Fig 27: Equivalent elastic strain on complete body

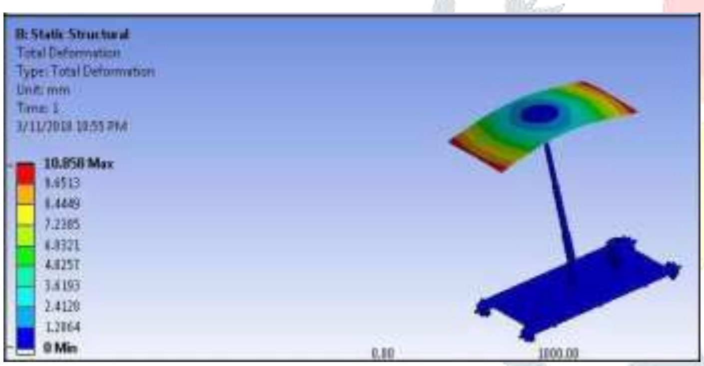

Fig 28: Total deformation on complete body

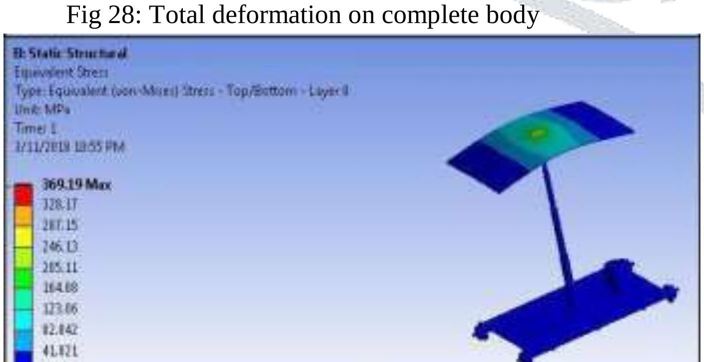

Fig 29: Equivalent stress on complete body

For Complete body,

Maximum equivalent elastic strain = 0.001854

Maximum total deformation = 10.858 mm Maximum

equivalent stress = 369.19 Mpa

Conclusion

Telescopic Hydraulic jack is a special purpose usable jack. It most importantly overcomes the problem of lifting load at variable height without any type of space available restriction. A telescopic jack is associated with different stresses like hoop stress, radial stress and longitudinal stress

Pressure is also analyzed with finite element package of Ansys, The analysis which is carried out is used to satisfy condition between radial stress, longitudinal stress and hoop stress which proves that actual data is less than theoretically calculated data. At last if we vary cylinder diameter and also according to thickness we change the oil then we can lift better load capacity than present load.

Reference

- "Design of lifting device using hydraulic telescopic jack" By Gaurav Mute, Rushabh Gawande, Anil Gadekar, Prashant Ghodeswar, 'IJAERD| Volume 5, ISSUE 02, February - 2018'e-ISSN (o): 2348-4470,p-ISSN (p): 2348-6406.
- "Design and analysis of hydraulic jack for sugar mill setting" By Rohit M. Chavan, M. M. Mirza, R. Biradar, 'IRJET|Volume:04 issue|05 may-17'e-ISSN: 2395-0056, p ISSN: 2395-0072.
- "Design and analysis of Telescopic hydraulic jack" By Ashish Patil, SangamPatil, Sachin Wangaikar, Rajashekar M.S. 'IRJET|Volume:03 issue: 07 July-16'e-ISSN: 2395-0058, p-ISSN:2395-0072.
- "Selection of Telescopic jack with mechanical synchronization EC-TCS", GMV.

- KCC co. Ltd pneumatic and hydraulic.
- "Design and analysis of Telescopic hydraulic jack for increase load capacity" By JigneshVasava Prof. Hitesh Raiyani, 'IJSRD|Volume:04 issue|03 may-16'ISSN: 2321-0613.
- "Design of mechanical hydraulic jack K. Mohd.SalahuddinMohd. JibranBaig,AliFarruky, Mohammd Sidc Ahmec Riyazudd Faraz RehamAzahr,MdSaffi, 'IOSRJET|Volume:04 july-17'pp15-28|ISSN (3021,ISSN (p):2278-871
- **http://lakeice.squarespace.com/be aring-strength/**
- **http://googleweblight.com/i?u=http://www.hamiltoncaster.com/Wh eels/Metal-Wheels&grqid=SKpYsF5h&hl=e n-IN/**
- **https://www.google.co.in/url?q=https://en.m.wikipedia.org/wiki/Axle_load&sa=U&ved=0ahUKEwizkPmsrbrVAhUKKCYKHSnlAGoQFgguMAA&usg=AFQjCNH6 WV8-V8Y7CGn75c6Rmi9erR7CyQ**
- **http://www.iosrjen.org/Papers/vo l4_issue7%20(part-1)/D04711528.pdf**
- [Hydraulic Systems and Fluid Selection] is good, have a look at it! http://www.machinerylubrication.com/Read/277/hydraulic-systems-fluid
- https://www.google.co.in/url?sa=t&source=web&rct=j&url=https://yuk en-usa.com/pdf/special/Basic_Hydraulic_And_Components_(Pub._ES-100-2)_.pdf&ved=2ahUKEwjRvcaostnYAhVCvrwKHY77AhEQFjAAegQIBRAB&usg=AOvVaw3GI4Hjnc Y5Ilrvm5zNFZ8G
- https://www.e4training.com/hydraulic_calculators/hydraulic1.php
- https://www.hydraproducts.co.uk/h ydraulic-calculators/oil-pipe-diameter.aspx
- http://www.valvehydraulic.info/hyd raulic-circuit-design/hydraulic-systems-components.html

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