JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DESIGN AND OPTIMIZATION OF HYDRAULIC JACK BY USING OF FINITE ELEMENT METHOD

N. Srinivasan[1], G. Vasudevan[2], M. Sakthivel[3], S. Venkatesan[4], S. Unnikrishnan[5]

[1]Assistant Professor, [2-5]UG Scholars,

Narasu's Sarathy Institute of Technology, Salem, Tamil Nadu

ABSTRACT

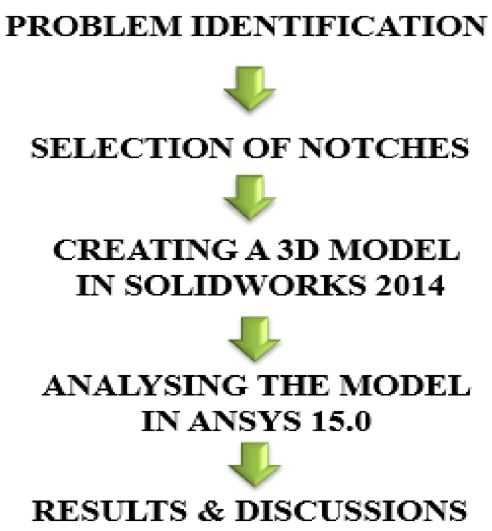
A jack is a tool that used to lift heavy masses for vehicle motors with the aid of using the utility of a far smaller force. In this work designed a brand new form of hydraulic jack with trestle feature. The new version became designed primarily based totally on numerical calculation with loading and no loading situation additionally FEA version of trestle hydraulic jack has been created the use of solid works software in step with layout values. The FEA version became meshed and analyzed with loading situation the use of FEA code ANSYS 15.zero software program, sooner or later concluded that trestle hydraulic jack is appropriate for lifting the heavy load [as much as 50,000N] vehicle.

……………………………………………………………………………………………………......

1. INTRODUCTION

Jack may be typically labeled primarily based totally at the sort of pressure they employ: mechanical or hydraulic. Mechanical jacks carry heavy, mild automobiles and are rated primarily based totally on lifting ability [for example, the wide variety of loads it can carry]. Hydraulic jacks are more potent than mechanical jacks and may carry heavier masses with making use of small effort, its labeled bottle jacks, and ground jacks. Hydraulic jacks depend upon pressure generated with the aid of using stress that is working primarily based totally on Pascal's law. Its states that the depth of stress at any factor in a fluid at relaxation are identical I n all direction. If cylinders [a big and a small one] are linked and pressure is carried out to at least one cylinder, identical stress is generated in each cylinders. However, due to the fact one cylinder has a bigger area, the pressure the bigger cylinder produces may be higher, despite the fact that the stress with inside the cylinders will continue to be the identical. Gurudev mute et al [7] had designed a telescopic hydraulic cylinder for a thousand kg ability with appropriate parameters and base wheels sooner or later concluded that the layout is appropriate for lifting the heavy load. K. sainath et al [3] had designed mechanical hydraulic jack for six ton ability with numerical and breakeven evaluation sooner or later concluded that the designed version is appropriate for lifting as much as 6ton weight. Nitinchandra R. Patel et al [6] had designed a toggle jack the use of numerical and cloth optimization for diverse element of toggle jack, sooner or later concluded that the designed version is with inside the protection region.

2. METHODOLOGY



3. WORKING OF OPTIMIZED [TRESTLE] HYDRAULIC JACK

Hydraulic jack has been advanced for small and medium car automobiles additionally its required semi-professional labours for working this device. Because of solving the axle and preserving the proper function for heading off slippage. In order to keep away from such risks the brand new version Trestle hydraulic jack has been advanced. The current trestle jack become designed without hand lever however the new trestle jack designed with a hydraulic cylinder with hand lever covered with trestle destiny. Normally hydraulic jack is working technique whilst the take care of is operated like up and down motion of the piston so the automobile lifts from the ground. In the trestle jack, the curved floor used to raise the automobile with a small opposite motion of the automobile as proven with inside the determine 1. In hydraulic jack and trestle, jack has a few risks. In order to conquer such dis blessings this trestle hydraulic has been designed in this type of manner that it could be used to raise the automobile very easily with none effect force.

Fig 1: Existing Model of Trestle Jack [without Hydraulic Cylinder]

3.1 CAD model of Optimized [Trestle] Hydraulic Jack

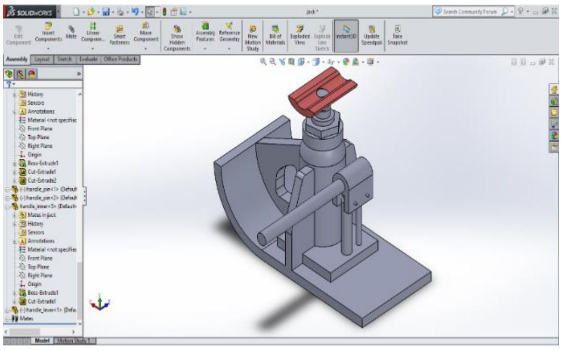


Fig 2: Optimized [Trestle] Hydraulic Jack

The new model trestle hydraulic jack CAD model is shown in fig 2. It has a piston and ram cylinder with handle also with trestle future.

4. DESIGN OF TRESTLE HYDRAULIC JACK

4.1 Design Considerations & Methodology

Load [W] = 05 ton [50,000N]

Operating presser [p] = force/area = 50,000/ π/4*D2 = 23.82 * 106 N/m^2

Lift range [L] =14 inch = 3500mm

Man attempt placed on the handle [e] = 11Kg

Permissible tensile pressure of moderate steel [σt] = a hundred and twenty N/mm^2

No. of strokes for lifting load [n] = a hundred

Permissible shear pressure of moderate steel [τ] = 20 N/mm^2

Permissible compressive pressure of moderate steel [σc] = 20 N/mm2 Permissible compressive pressure of solid iron [σCI] = a hundred and twenty

N/mm^2

Permissible shear pressure of solid iron [τCI] = 35 N/mm^2

4.2 Design of Ram Cylinder

It is a cylinder wherein produces a slideway to the ram. The ram cylinder is made of moderate metal

Let, d = internal diameter of ram cylinder = 47mm

D = outer diameter of ram cylinder = 67mm

P = stress appearing on cylinder = 23.82Mpa

W = load = 50,000N

T = thickness of ram cylinder = 20mm

4.3. Design of Plunger Cylinder

The plunger cylinder is made from moderate metal and is established on the bottom plate. It affords slide manner to the plunger so as to accumulate the pressure.

Let dp= interior dia of plunger cylinder = 12mm

tp = thickness of plunger cylinder Assume the thickness of plunger cylinder [tp] = 10mm

By the use of thickness and interior diameter, we are able to calculate the outer diameter of plunger cylinder Dp = dp + 2t = 12+2[10] = 32mm

Dp = out of doors dia of plunger cylinder = 32mm

Tensile energy of moderate metal [σt] = a hundred and twenty N/mm2

Height of plunger cylinder = 110mm

Without Loading Condition

Pressure Pp = F/A = 122/[0.012]2= 1.08 * 106 N/m2

By LAME`S Equation [Consider with Loading Condition]

$$\sigma_t = \frac{D_i^2 * P_r}{D_o^2 - D_i^2}\left(1 + \frac{D_o^2}{D_i^2}\right)$$

$$= \frac{(0.047)^2 (28.22 * 10^6)}{(.067^2 - 0.047^2)}\left(1 + \frac{.067^2}{.047^2}\right)$$

$$\sigma_t = 84.66 * 10^3 N/m^2$$

$$\sigma t < pr$$

Hence the triggered tensile electricity of M.S. is much less than the permissible value. So, the layout is safe.

4.4. Design of Plunger

Let the plunger is made from slight metal which reciprocates in plunger cylinder to boom the stress of the oil.

Let, W = load appearing on plunger = 50,000N

dp = diameter of plunger = 12mm

Load appearing on plunger = stress × area = 12 × 122 = 1464 N = 149.3kg

We taken Load appearing at the plunger =150kg

4.5. Plunger Displacement

We recognise that Velocity ratio [V.R.] = Assume V.R. = 150;

Let us count on plunger displacement = 15cm

4.6. Design of Lever

A lever is made of slight metallic and is used to use load at the plunger. It is connected to the plunger with the assist of pivot.

Assumptions, 1. Effort placed on lever through man = 25lb = 11kg

Force performing on rod or lever = L/[L-X] * Fx = 200/ [200-20] * 110 = 122 N = 12kg

Required Distance from Fulcrum to load = 180mm

Total period of lever = 200mm

Effort placed on lever through man = 12kg

Outer dia of lever = 25mm

Inner dia of lever = 20mm

Lever is made of slight metallic.

Permissible tensile energy of slight metallic [σt] = 120N/mm^2

4.6.1. With Loading Condition

F = P * A

F = 28.82 * 106 * π/4*[zero.012]2 = 3359.5N = 330kg.

Where M = most bending second

I = second of inertia = permissible tensile electricity

Y = distance among outer maximum layer to impartial layer

Z = phase modulus

Figure 3: Lever Mechanism of Hydraulic Jack

Click Here to view

Let us take Rc= F= 330kg

Ra + Rb = 330kg

Ra + eleven = one hundred thirty

Ra =330-eleven

Ra = 319kg

Bending second at C = zero

Bending second at B = 319*9.81*zero.20-[330*9.81*zero.18] = 43.sixteen N-m [sagging]

Bending second at A = zero

4.6.2. Without Loading Condition

F = P * A

F = 1.08 * 106 * π/4*[zero.012]2 = 122N = 15kg.

Let us take Rc= F = 15kg

Ra + Rb = 15 kg

Ra + eleven = 15

Ra = 15-eleven

Ra = 4kg

Bending second at C = zero

Bending second at B = 4*9.81*zero.20-[15*9.81*zero.18] = -18.78N-m = 18.78N-m [hogging]

Bending second at A = zero

Maximum bending second is much less than the designed value. Hence layout is safe.

4.7. Design of Reservoir

The following assumptions are made for this layout of reservoir

The extent of oil circulated withinside the gadget is 850 c.c

Volume of oil withinside the reservoir= 1150 c.c

L = peak of reservoir = a hundred and seventy mm

We undertake internal dia of reservoir [d] = 87mm

Assuming thickness of reservoir [d] = 4mm

Therefore outer dia of reservoir [Dr] = 95mm

4.8. Design of Base

Fix the size of base plate as l× b × tb = 430 × 200 × 20

Where l = period of base

b = width of base

tb =thickness of base.

A base is made of moderate steel. Permissible compressive pressure of M.S [σc] = 20 N/mm2

Compressive place of base = 154 × 138

= 21252 mm2

Permissible shear pressure of moderate steel [τ] = 20 N/mm2

Shearing place = π × d × tb = π × 47 × 20 = 2953.1 mm2

Where d = internal dia of ram cylinder tb = thickness of the bottom plate

Load performing on base = 50,000N

Checking for compressive power σc= 50,000/ 21252 = 2.35 N/mm2

The permissible compressive pressure of moderate steel [τ] > checking for compressive power [σc]

Checking for shear power τ = 50,000/ 2953.1 = 16.ninety three N/mm2

The permissible shear pressure of moderate steel [τ] > checking for shear power [σc] The brought about shear and compressive stresses are much less than the permissible valve. Hence the layout is safe.

5. ANALYTICAL ANALYSIS OF TRESTLE HYDRAULIC JACK USING FEM

The FEA version of trestle hydraulic jack became meshed the use of FEA code ANSYS software program, it`s proven withinside the fig 3.

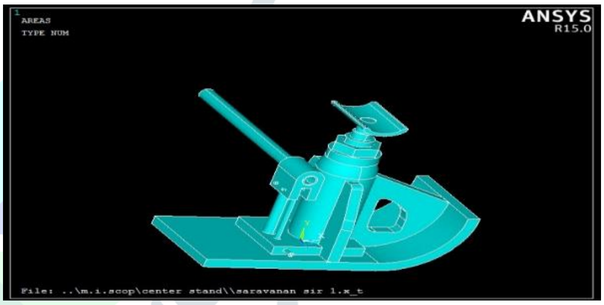


Fig 3: FEA Model of Trestle Hydraulic Jack

The Displacement vector sum [DSV] fee became received the use of the FEA code ANSYS, it`s proven withinside the fig 4. Also, it`s found that the most displacement has befell on the pinnacle of the jack.

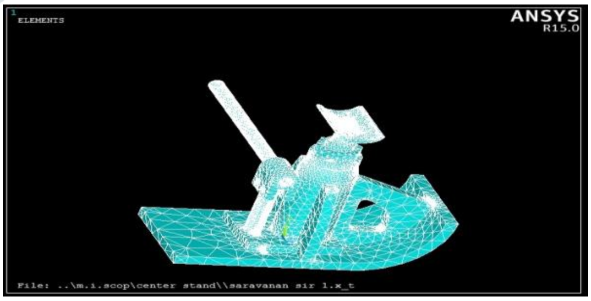


Fig 4: Meshed View of Trestle Hydraulic Jack

The Von-misses strain fee became received the use of FEA code ANSYS, it`s proven withinside the fig 5. Also, shape the fig 5 it`s found that the most strain vicinity in jack could be very less. Its discovered that this version has withstood that quantity of load.

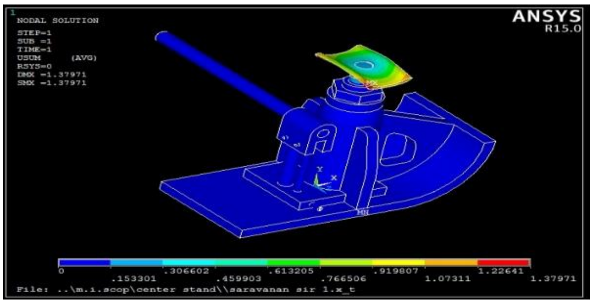


Fig 5: DSV [Deflection] of Trestle Hydraulic Jack

Von-misses stress fee became received the use of FEA code ANSYS, it`s proven with inside the fig 6.

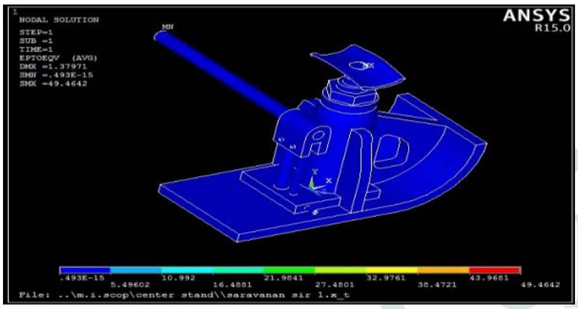


Fig 6: V. Stress of Trestle Hydraulic Jack

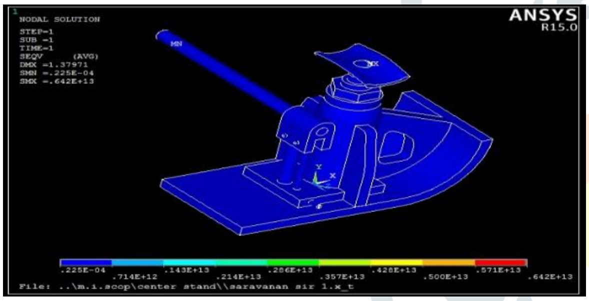


Fig 7: V. Strain of Trestle Hydraulic Jack

6. RESULTS AND DISCUSSIONS

DSV [Deflection], stress and strain values of Trestle Hydraulic Jack (Analytical Method)

S. No	Load	Analysis	Analytical value
1	50000N	Deflection	1.3 mm
2		Stress	64.2 Mpa
3		Strain	49.4(no units)

7. CONCLUSIONS

The following effects may be investigated from the above evaluation

As consistent with the Numerical cost of the strain cost of Trestle Hydraulic Jack beneath loading, circumstance is much less than the layout cost.

The Analytical cost of strain and stress and deflection values of Trestle Hydraulic Jack is much less than the layout cost. From that it may be concluded that the designed Trestle Hydraulic Jack is beneathneath the protection place while it`s in beneathneath loading circumstance.

Numerical end result and analytical end result each are similar. So the layout parameters are validated numerical and analytically from that it concluded that layout is safe.

From that, above Numerical and Analytical [FEA] evaluation concluded that Trestle Hydraulic Jack is appropriate for heavy load [as much as 50,000 N] lifting Application.

7. References:

1. "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.
2. "Selection of Telescopic jack with mechanical synchronization EC-TCS", GMV.
3. "Design and analysis of Telescopic hydraulic jack" By Ashish Patil, Sangam Patil, Sachin Wangaikar, Rajashekar M.S.IRJET|Volume:03 issue: 07 July-16"e-ISSN: 2395-0058, p-ISSN: 2395-0072.
4. "Design of lifting device using Hydraulic telescopic jack" Gurudev mute et al IJAERD , vol:05 issue:02 Feb-18" p-ISSN-2348-6406
5. "Design of toggle jack considering material selection of screw- nut combination" By Prof.Nitinchandra R. Patel et al IJIRSET|Volume:02 issue: 05 May-13" p-ISSN: 2319-8753.
6. "Design of mechanical hydraulic jack" By K. Sainath, Mohd.Salahuddin Mohd. Jibran Baig, Ali Farruky, Mohammd Siddique Ahmed, Mohd. Riyazuddin, Faraz Ur Reham Azahr, Md Saffi, „IOSRJET|Volume:04 issue|07 july-17"pp15-28|ISSN [e]:2250-3021, ISSN [p]:2278-8719.