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REVIEW ARTICLE

DESIGN AND ANALYSIS OF PNEUMATIC BAG AIR JACK

Timur Choban Khidir*, Bilal Mohammed Qasim, Ayaz Aydin Abduljabbar

Department of Mechanical Engineering, University of Kirkuk, Iraq.
Corresponding Author Email: timur_uluhan@uokirkuk.edu.iq

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ARTICLE DETAILS

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ABSTRACT

Drivers need lifting device jack with notch fits in place under the vehicle in the proper location during changing tires, also in workshops or maintenance centers jacks required for maintenance and refurbishment of parts, this device made the job faster and easy. Traditional car trailers use a mechanical feature to allow the human to raise the vehicle by manual force, by using the screw thread power or hydraulic jack which uses hydraulic power. The other way for lifting cars are pneumatic air bags, these bags are highly effective in industrial, maintenance applications and construction. In order to study this modern technology development and obtain good air bag design, which can lift and sustain the weight of more than 1200 kg estimated car weight, Solid works software used to analyze the weak points of pneumatic airbag. In this paper pressure used 249809.6 N/m^2 by imposing a weight of 1250 kg, Using natural rubber an as air bag material with two cases of thickness 1 mm, 3 mm, three behaviors of air bag tested (Von Mises stress, Strain and Deformation in two directions) analyzed, the results shows that the 1 mm thickness cannot sustain the load and pressure and weakest area lays between connection natural rubber and metal cast iron which contact the body of the car.

KEYWORDS

Pneumatic triple bag, Air jack, natural rubber, maintenance center.

1. INTRODUCTION

During repair and maintenance of cars, it is necessary to lift a car (sometimes one tire, or all the car) from ground to change a tire or maintenance the car, different type of jacks have been developed for this purpose, however, traditional manually jacks operate and it need substantial and skilled effort from the user, in the same time traditional jacks are heavy, large and also difficult to carry or fix in the proper position under the car, also in commercial and maintenance centers services stations are commonly equipped with large and high adequate position car lifting required.

The design of pneumatic triple bag air jack is tough and built to last for a long time. Triple pneumatic bag air Jacks are the preferred jacking tool on frame racks which necessary and highly effective in maintenance applications, construction and car tires change [1]. It also used in aircraft construction and maintenance, shifting pipelines and railroad. Drivers who are physically weaker (young drivers, women and senior citizens,) may face Great difficulties in traditional jacking a vehicle [2]. In case of an emergency case or tire repair, also from time gaining the traditional vehicle jacks require the driver to retrieve the jack from the car. Fix it under the vehicle in the proper location, and then manually rotate the screw thread or start handling the hydraulic jack in order to lift the vehicle [3]. This process is time consuming, while the pneumatic air bag jack can put in any location under car frame, this invention is very easy and pretty helpful, it basically uses the air from the exhaust of the car or external compressor to inflate an air bag that is strong enough to hold up the car [4]. This lifting will take less than a minute. Once it lifts the car high enough the air source supply need to turn off. The air bag will stay inflated. When the tire replaces or maintenance finish has just released the valve, flatten it out and continue driving. The required lifting height of the car can be controlled by further inflating the airbag [5-7]. The air bag is designed to be used in such lever type applications and can sustain the shearing force.

2.SPECIFICATIONS OF PNEUMATIC AIR BAG JACK

1-Capacity: (1.25 ton)
2-Pressure: (2.498 Bar)
3-Min height: (15 cm)
4-Max Height: (42 cm)

Table 1: Specifications of natural rubber material

Item	Property	Value	Unit
1	Elastic Modulus	10000	N/m^2
2	Poisson's Ratio	0.45	N/A
3	Tensile Strength	20e+006	N/m^2
4	Mass density	960	Kg/m^3

3.METHODOLOGY

3.1 CAD-Models

The solid model of bearing component is created in Solidworks V.2016 software.

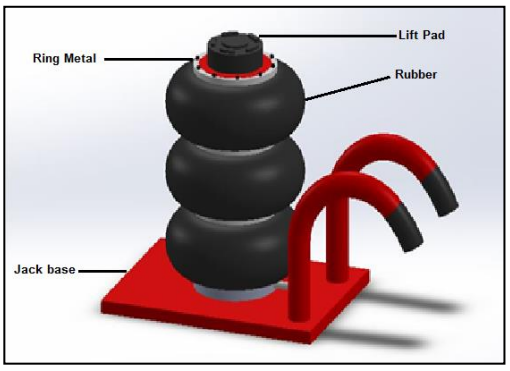

Figure 1: Isometric view of CAD model of pneumatic triple bag air jack

3.2 Meshing of Pneumatic Bag Air Jack

In this study, SOLIDWORK SIMULATION is used for a meshing of pneumatic bag air Jack. It creates sufficient meshing as shown in a figure below.

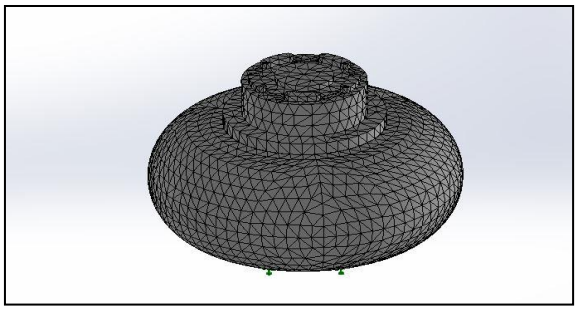

Figure 2: Meshing of Pneumatic Bag Air Jack

4. RESULT ANALYSIS

Test of pneumatic bag air jack [Von Mises stress, ESTRN and deformation] done by applying pressure P = 249809.6 N/m^2 for two different thicknesses of pneumatic bag air jack, t = 1 mm and t = 3 mm.

4.1 When thickness of Rubber 1 mm

4.1.1 Von Mises analysis

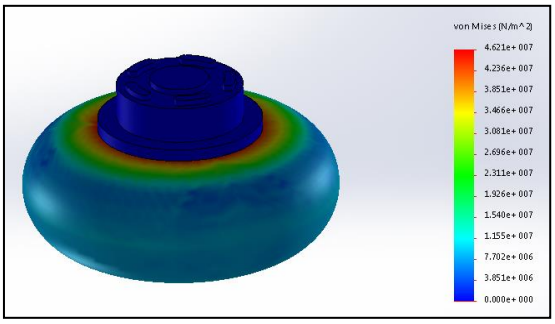

Figure 3: Von Mises stress for Pneumatic Bag Air Jack

4.1.2 Strain analysis

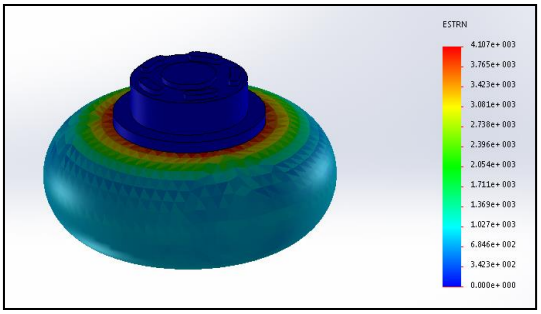

Figure 4: Strain analysis for Pneumatic Bag Air Jack

4.1.3 Deformation analysis

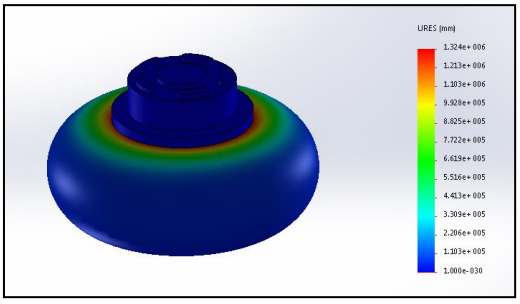

Figure 5: Deformation analysis for Pneumatic Bag Air Jack

4.1.4 Deformation analysis for X-axis

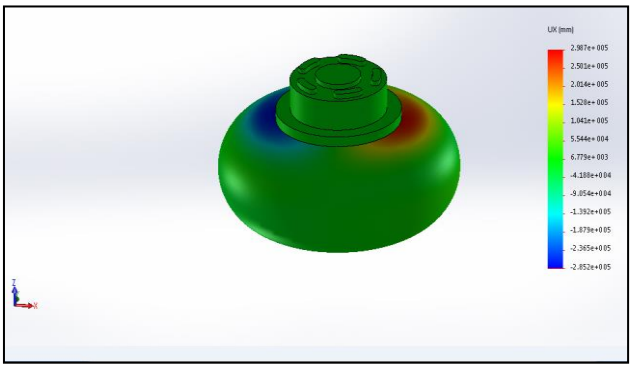

Figure 6: Deformation X-axis analysis for Pneumatic Bag Air Jack

4.1.5 Deformation analysis for Z-axis

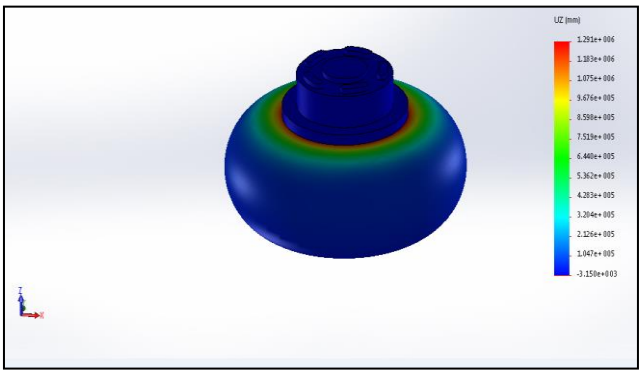

Figure 7: Deformation Z-axis analysis for Pneumatic Bag Air Jack

4.2 When thickness of Rubber 3 mm

4.2.1 Von Mises analysis

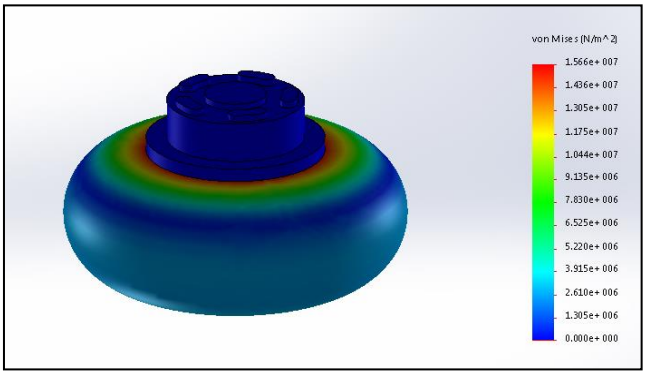

Figure 8: Von Mises stress analysis for Pneumatic Bag Air Jack

4.2.2 Strain analysis

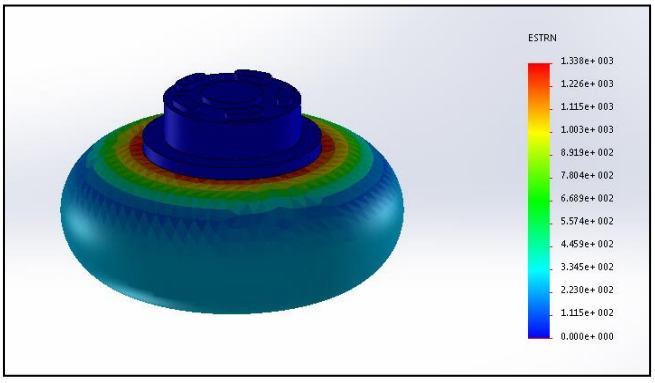

Figure 9: Strain analysis for Pneumatic Bag Air Jack

4.2.3 Deformation analysis

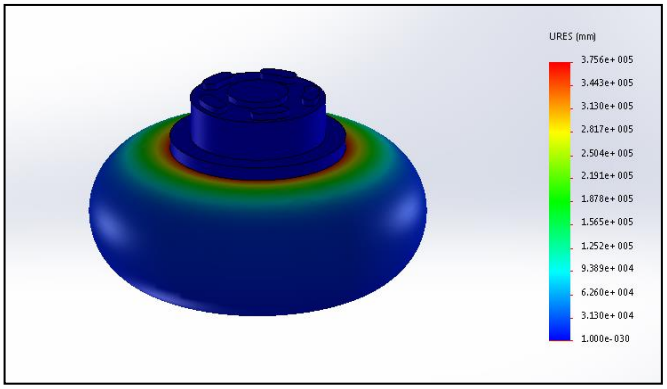

Figure 10: Deformation analysis for Pneumatic Bag Air Jack

4.2.4 Deformation for X-axis analysis

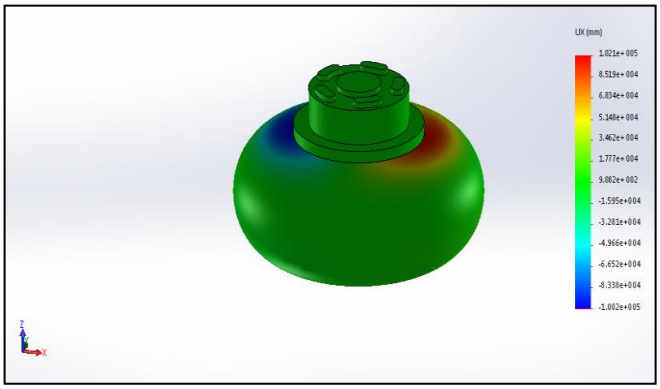

Figure 11: Deformation X-axis analysis for Pneumatic Bag Air Jack

4.2.5 Deformation for Z-axis analysis

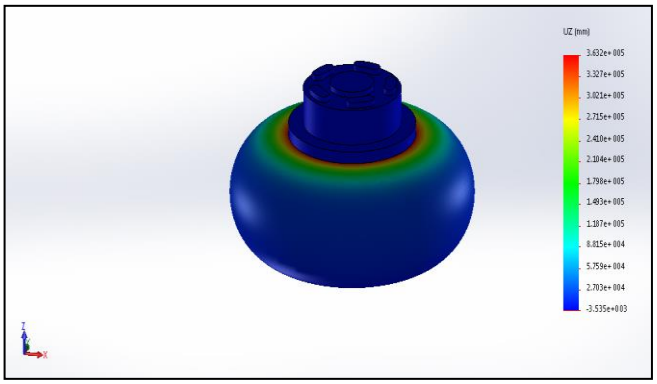

Figure 12: Deformation Z-axis analysis for Pneumatic Bag Air Jack

Table 2: Summary of results

Item	Rubber Thickness (1 mm)	Rubber Thickness (3 mm)
Von Mises stress N/m²	4.621e+007	1.566e+007
Max allowable stress N/m²	20e+006	20e+006
Strain (mm)	4.107 e+003	1.338 e+003
Deformation (mm)	13.24 e+005	3.756 e+005
Deformation X-axis (mm)	2.907 e+005	1.021 e+005
Deformation Z-axis (mm)	12.91 e+005	3.632005

5.CONCLUSIONS

In this study the pneumatic bag air jack analyzed and compared for a 1 mm and 3 mm thicknesses natural rubber bag which its specifications shown in table 1. After pressure of 249809.6 N/m² applied, maximum results of von mises stress for two different thicknesses analyzed, when thickness equal 1 mm the maximum stress reached 4.621e+007 N/m², while in 3 mm thickness the maximum stress reached 1.566e+007 N/m² as shown in figures 3 & 8 respectively. According to reached results the 1 mm thickness exceeds 31% the allowable stress, which is equal 20e+006 N/m², while 3 mm 21.7% less than allowable stress and can sustain the applied load. In addition, the deformation behavior of rubber appears in both models and increase by increasing the pressure, deformations in both cases presented in figures 5 and 10 respectively, comparing the total deformation, x-axis and z-axis results, the all type deformation decrease by increasing the rubber thickness. Deformation of the pneumatic bag air jack, in 1 mm all directions as shown in figures 6 and 7 greater than bag air jack 3 mm as shown in figures 11 and 12. Max stress and deformation in all axis reach a maximum in the connection joint between rubber and ring metal. In order to improve sustain of pneumatic bag air jack under pressure, this joint area need to be improved by increasing the thickness around the ring.

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