MATHEMATICAL DESIGN OF MODIFIED SHOCK ABSORBER IN WHEEL CHAIR

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ABSTRACT

Wheelchair is a mobility gadget or devices used to moving physically challenged people from one place to another. This device used during emergency like physically disorder, maternity emergency, road accident, and day to day like its application areas are in sport, in travelling, in house, in Hospital, etc. wheelchairs are classified based on the mode of power used for drive as Manually powered wheelchair, Fuel powered wheelchair and Electric powered wheelchair. This paper focuses on the manually operated tricycle which includes shock absorber. A suspension system or shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb or dissipate energy. In a tri- cycle it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. When a wheelchair is traveling on a level road and the wheels strike a bump, the spring is compressed quickly. The compressed spring will attempt to return to its normal loaded length and, in so doing, will rebound past its normal height, causing the body to be lifted. The weight of the wheelchair will then push the spring down below its normal loaded height. This, in turn, causes the spring to rebound again. This bouncing process is repeated over and over, a little less each time, until the up-and-down movement finally stops. If bouncing is allowed to go uncontrolled, it will not only cause an uncomfortable ride but will make handling of the wheelchair very difficult. The design of spring in suspension system is very important. In this project a shock absorber is designed and a 3D model is created using SOLID WORK software. The maximum weight for this project is 120kg.

KEYWORDS: Shock Absorber, Mathematical Design, Solid Works

1. INTRODUCTION

we have seen many problems from the handicapped person that they need to improve the wheel chair structure and the mechanism of riding that they used. From all observation we conclude that the present wheel chairs are must be modified. Wheelchair is a device providing wheeled mobility and seating support for a person with difficulty in walking and moving around. It provide a mobility device designed for shifting patients, moving physically challenged people from one place to another place. Wheel chair assists for peoples who are had cup patients, challenged children, elder people and difficult them to completing their tasks specifically reaching high and low places. Wheel chairs are used in different application conditions. They are used during emergency like physically disorder, maternity emergency, road accident, and in day to day life by physically challenged people, Old people unable to walk, Physically challenged children, Patient people. Wheel chairs are available to different application areas like in, in sport, in travelling, in houses, in hospital, nursing homes, and in pilgrim place extra. Wheel chair has different merits to people society by reducing stress of work from their parent and it help to gain the fundamental requirements or needs of human necessity. It assists them to develop their social life, and standing for initiation of work

habit by moving attitude and their body by the help of wheel chair. Wheel chair consists of many parts such as tire, caster, brake, commode, cushioned armrest, back rest. The major objective of this is project is design of shock absorber for wheelchair for comfortable for the user. In this paper analyse the heical spring ,testing the joint by on welding, analyse the piston and checking beam force, Force analysis for component Assembly and part drawing ,finally evaluate all the results and discussed . Different Types of Wheelchairs

There are various types of wheel chairs; we are differentiating the wheel chair based on the mode of power used for drive. These wheel chairs are differentiated in to two types as below

1.1 Manually Operated Wheelchairs

Manual wheelchairs are driven with the help of man power as source of energy for moving the chair; these are self-propelled or propelled with the help of attendee. The self-propelled wheelchairs are driven by the user by using the rear wheels (diameter of 20-26‖) which resembles to that of bicycle but has an additional rims know as hand rims are for the movement of the chairs by means of pushing forward or backward. The hand rims are of diameter lesser than the rear wheels. Use of two hand rims at a time gives straight movement of the chair; use of one of the rim gives the turning movement to the chair towards left or right.

1.2 Manual Tricycle

It is a tricycle having one front and two rear wheels or vice versa based on different design consideration, for hand motion for handicapped person. The driver drives and controls the motion of tricycles simultaneously using his hands to make the tricycle adaptable to any handicapped child or individual, to give them the maximum use of their limbs; to exercise their limbs in the best therapeutic manner; and to allow for growth an changes and improvements in this muscular coordination

1.3 Electric Powered Wheelchair

The wheelchair that runs by means of Electric motor is known as electric-powered wheelchair, this wheel chair requires navigational controls, usually a small joystick mounted on the armrest. For users who cannot manage a manual joystick, head switches are provided and chin-operated joysticks are provided, other specialist controls may also be provided for independent operation of the wheelchair. Motorized wheelchairs are useful for those unable to propel manually or who require travelling for a long distance which creates difficulty for manual operation. These wheel chairs are not only used by traditional mobility impairments but also by cardiovascular patients

1.4 Fuel Powered

Fuel powered wheelchairs are wheelchairs driven by fuel to drive the motor. It iswellconstructed both in size and strength in relation to other manual and powered wheelchair

1.5 Solar Powered Tricycle

Solar plays a very important role in our day to day life. We have developed the solar tricycle especially for the handicapped person. In this paper it is discussed that how solar power is utilized for providing the power to the tricycle, which will reduce the efforts of the handicapped person.

2. COMPONENTS OF MODIFIED WHEEL CHAIR

This design Wheel chair comprises the following parts

2.1 Shock absorber

Shock absorbers convert the kinetic energy of a load into heat which is dissipated into the atmosphere. They stop a moving load with no rebound and without transmitting potentially damaging shocks to equipment. In its most general form, a shock absorber consists of a double-walled cylinder with space between the concentric inner and outer walls,a piston, some means of mechanical return for the piston, and a mounting plate. The piston usually is returned to its initial position by a spring, which can be mounted externally around the piston rod or internally on the inside of the cylinder body.

2.2 Beam

A beam is a structural element that primarily resists loads applied laterally to the beam's axis. Its mode of deflection is primarily by bending. The loads applied to the beam result in reaction forces at the beam's support points. The total effect of all the forces acting on the beam is to produce shearforces , bending moments within the beam, that in turn induce internal stresses, strains and deflections of the beam. Beams are characterized by their manner of support, profile (shape of cross-section), length, and their material.

2.3 Base Frame

The base frame it is one of the part that give the function of supporting the beam and shock absorber from the table tensile and bending .It

also give for the wheelchair attractive stricture. It joined both side by welding operation the steal because it low cost, availability.

2.4 Hand frame

For cushion and seat back rest shape of the frame is circular hallow section (CHS) used to comfort for user and support both side the person

2.5 Wheel

This design of wheel chair it is select the wheel from the previous design of wheel because of it consider purchase from market. Since it take the standard cycle wheels stated in the design parameter section the wheel needs to be adjustable for different furrow dimensions. So enough space is provided along the axle to slide it sideways and fix where required.

3. SOLID WORKS

The SOLIDWORKS is a mechanical design automation application that lets designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings and assemblies. part drawing and assembly drawing of wheel chair were drawn by solid work software. all the drawing given below.

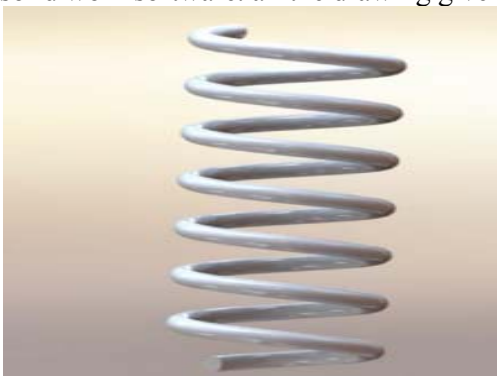

Fig 1 Shock Absorber Coil Spring

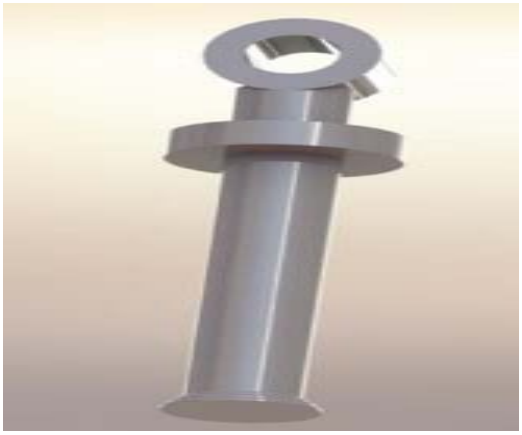

Fig 2 Piston

Fig 3 Cylinder

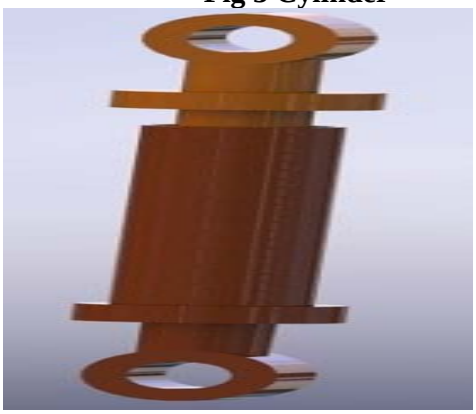

Fig 4 Cylinder with piston

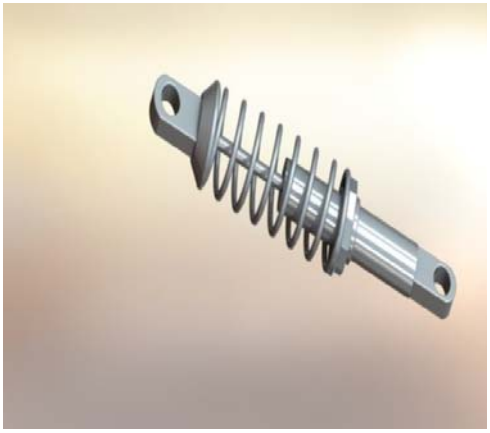

Fig 5 Shock absorber

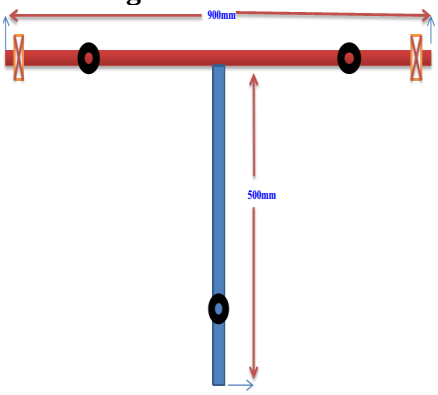

Fig 6 Beam

Fig 7 Hand frame

Fig 8 Base frame

Fig 9 Wheel

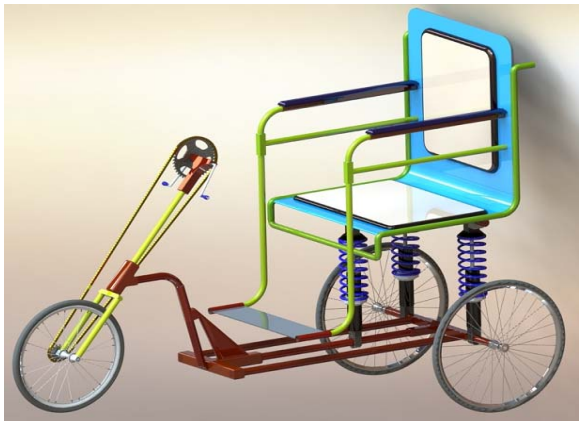

Fig 10 Wheel chair assembly

4. ANALYTICAL DESIGN

The analytical calculations for the spring, piston with cylinder, vibration, beam and welding were done using the basic design formulae.

4.1 Wheel chair data

Size of wheelchair =light , Weight of both tires(un-sprung mass)= 25Kg, Basement frame Height=1000mm, Length= 1500mm, The maximum load of person = 120kg

For Spring

Modulus of rigidity G = 80000 Pa,
Mean shear stress =214.7MPa
$Stress\ amplitude$ =41.04Mpa,
C = spring index = 5,
Wahl's stress factor= 1.052,
Mean diameter of a coil D=40 mm ,
Diameter of wire d = 8mm,
Total no of coils n1= 10,
Outer diameter of spring coil D0 = 48 mm,
No of active turns n= 8 ,
For single shock absorber weight = w/2= 1617N
Compression of spring (δ) = 111.98mm,
Solid length, Ls=n‟×d=8×8=64mm,
Free length of spring, Lf = solid length+ maximum compression + clearance between adjustable coils = 78.1mm,
Spring rate, K =5, Pitch of coil, P = 11.16 Natural frequency(ωn)= 0.894 rad/sec,
Forced frequency (ω)=31.42 rad/sec, Frequency ratio(r)= 0.74

For Piston

Material - Grey cast iron

Design of piston can be calculated by stress assume diameter piston rod start by dividing force into three $F_P = \frac{F}{3} = \frac{981}{3} = 327N$

Assume the diameter of the piston $d_P = 20mm$,

$$\text{working stress} = \frac{F_P}{A} = \frac{327}{\frac{\pi * 20^2}{4}}$$

$$= 10.4\ {}^{N}/_{mm^2}$$

$$\text{Factor of safety} = \frac{\text{yild stress}}{\text{working stress}} = \frac{35mpa}{10.4\ {}^{N}/_{mm^2}}$$

FOS= 3.36

Area of piston $A=\frac{\pi * d^2}{4} = \frac{\pi * 20^2}{4} = 314mm^2$

The thickness of piston head $T_h = \sqrt{\frac{3PD^2}{16\sigma_t}} = \sqrt{\frac{3*31.22mpa*20^2}{16*35mpa}} = 15.7mm \sim 16mm$

$D_o = D_I + 2 * T_h = 20.5 + 2 * 9 = 38.5mm$

Let D_o = Outside diameter of the cylinder in mm
D_i = Inside diameter of the cylinder in mm

For Beam

Material-40C8 Steel type, Length=900mm, Width=1450mm, Thickness= Φ 23mm, Maximum shear force=419.85N, Maximum bending force=587779N, Factor of safety=1.755

For Welding

Material= E60xx Electrode, Load=392.4N, Length=500mm.Diameter=23mm,
Thickness =4mm, Size=5.567mm,
Cross section area=284.36mm^2

For Vibration

helical spring rate takes in parallel $k_{equ} = k_1 + k_2 + k_3$

The E4quivalent stiffness of helical spring (Keq.)

$k_{equ} = 3K$

Because the number of spring is three.

$Keq.$ = 3x 80N/mm

$Keq.$ = 240N/mm

The Equivalent dumping constant ($Ceq.$)

$Ceq = c1 + c2 + c3, c1 = c2 = c3$

$Ceq = 3C$

$Ceq = 2\,x\,\sqrt{(Keq\,x\,m\,x\zeta)}$

ζ = 1, because the dumping must be critical dumping

$$\text{Ceq} = 2\,\text{x}\,\sqrt{240 * 33.3 * 1}$$

Ceq = 179.06 N-s/mm

$$\text{dumping C} = \frac{179.06}{3} = 59.688\text{N} - \text{s/m}$$

The force that transmits to the base is calculated as:

$$\text{Ft} = \sqrt{(\text{KA})^2 + (\text{CAW})^2}$$

$$\text{Ft} = 346.6\ \text{N}$$

5. CONCLUSION

We have designed a Shock Absorber, base frame, hand frame, wheel and assembly of wheel chair. We have modeled the all parts using 3D parametric software called solid works. The shock absorber design is modified by changing the parameters and stress and welding analysis also were done.

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