IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

Design And Development Of Floating Backpack

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Abstract : A suspended-load backpack is a device that is designed to capture the mechanical energy created as a suspended backpack load oscillates vertically on the back during gait. The objective of the current study was to evaluate the effect of a suspended-load backpack system on selected temporal and kinetics parameters describing gait. The purpose of this project is to design and development of floating bag. Our project proposes to design a backpack that permits the load to move relative to the wearer during walking and running so that the large movements between the load and the wearer of the backpack reduce the fluctuations of vertical motion of the load with respect to ground. Because the hip (and thus the pack body) goes up a down a good deal during walking, a large relative movement between the wearer and the load reduces the absolute excursion of the load. This movement may be, in turn, transferred to a motor through, for example, a rack and pinion gear, to convert the mechanical movement to electrical or mechanical energy. Such movement of the suspended-load relative to the wearer also reduces the forces on the wearer's body while walking or running, thus reducing the likelihood of orthopedic injury. The suspended-load backpack includes a suspension system having a first portion connected to shoulder straps directly or through an interface and a second portion connected to the pack body and a compliant mechanism that permits the second portion of the suspension system and the pack body to move up and down relative to the first portion of the suspension system in accordance with a gait of the wearer of the backpack.

Keywords- suspended-load, Floating bag, backpack, fatigue

- **INTRODUCTION**

In Indian army, load carriage is an unavoidable part of field operations which is the reason why soldiers often make use of a Military backpack. Infantry soldiers usually carry loads weighting more than 30% of their body weight. When the soldier carries certain weight, his energy expenditure increases, which causes a reduction in performance.
The transported load has a movement similar to the vertical displacement of the center of mass of the soldier while walking. This leads to a significant increase in the acceleration forces generated by the action of said load on the body which explains the increase in energy expenditure.

- **OBJECTIVES**

1. Muscle fatigue due to prolonged use of conventional backpacks
2. Reduces the endurance capabilities
3. Reducing the chances of injuries such as stress fractures, knee pains and backpain

- **METHODOLOGY**

  - Methodology of design refers to the study of the chronological structure of design projects. The following phases are usually involved in any design project. To give the project a particular form and structure, and before we started with the actual design, we carried out preliminary studies regarding material property, material selection and design aspects of the raw material which we will use to construct the project, the construction of the project includes the structure of frame, pulleys, shaft, springs, bolts and elastic rope.
  - To begin with, we started to select the raw materials for making the frame for our mechanism as it is the most crucial part of the project on which all the other components are supposed to be mounted. We then came to the pulleys which is mounted on the immovable frame. Then we attached the movable frame with the immovable frame with the help of elastic rope which enables the up and down motion of the backpack.

- **SELECTION OF COMPONENTS**

1. **Nylon pulley**

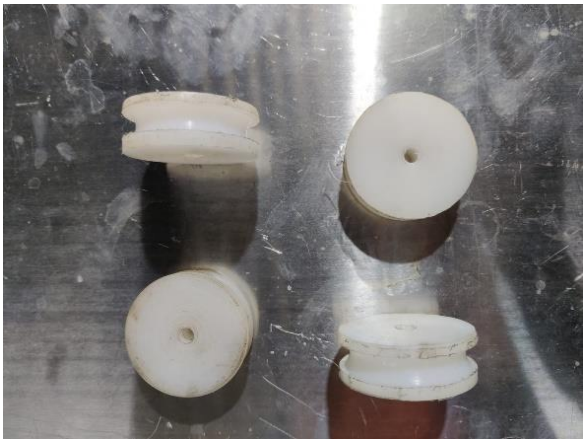


Fig No. 1 Nylon Pulley

A pulley is a grooved wheel that holds the cable, rope, or wire on a pulley system. The pulley is situated on an axle or bearing within the pulley, and an operator can adjust the amount of force and direction necessary for lifting. The pulley's movement helps reduce friction and wear on the rope or cable. Pulleys can be found in forklifts, cranes, cable stranding machines, and wire drawing machines.

Nylon is a popular material for pulleys because of its durability and versatility. In fact, nylon pulleys offer a number of advantages over their metal counterparts. Learn more about the benefits and applications of pulleys.

2. **Linear-motion bearing :**

A linear-motion bearing or linear slide is a bearing designed to provide free motion in one direction. There are many different types of linear motion bearings. Motorized linear slides such as machine slides, X-Y tables, roller tables and some dovetail slides are bearings moved by drive mechanisms. Not all linear slides are motorized, and non-motorized dovetail slides, ball bearing slides and roller slides provide low-friction linear movement for equipment powered by inertia or by hand. All linear slides provide linear motion based on bearings, whether they are ball bearings, dovetail bearings, linear roller bearings, magnetic or fluid bearings. X-Y tables, linear stages, machine slides and other advanced slides use linear motion bearings to provide movement along both X and Y multiple axis.

Fig No. 2 Linear motion bearing

3. Pop rivet

A rivet is a permanent mechanical fastener. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite to the head is called the tail. On installation, the rivet is placed in a punched or drilled hole, and the tail is upset, or bucked (i.e., deformed), so that it expands to about 1.5 times the original shaft diameter, holding the rivet in place. In other words, pounding creates a new "head" on the other end by smashing the "tail" material flatter, resulting in a rivet that is roughly a dumbbell shape. To distinguish between the two ends of the rivet, the original head is called the factory head and the deformed end is called the shop head or buck-tail

Fig. No. 3 Pop Rivet

4. Fasteners (nut and bolt):

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten two or more parts together. The two partners are kept together by a combination of their threads' friction, a slight stretching of the bolt, and compression of the parts to be held together.

Fig No .4 NUT BOLTS

- **DESIGN**

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form ofelectronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used. 3D wireframe is basically an extension of 2D drafting (not often used today). Each line has to be manuallyinserted into the drawing. The final product has no mass properties associated with it and cannot have features directly added toit, such as holes. The operator approaches these in a similar fashion to the 2D systems, although many 3D systems allow using the wireframe model to make the final engineering drawing views.

Top end systems offer the capabilities to incorporate more organic, aesthetics and ergonomic features into designs. Freeform surface modelling is often combined with solids to allow the designer to create products that fit the human form and visual requirements as well as they interface with the machine.

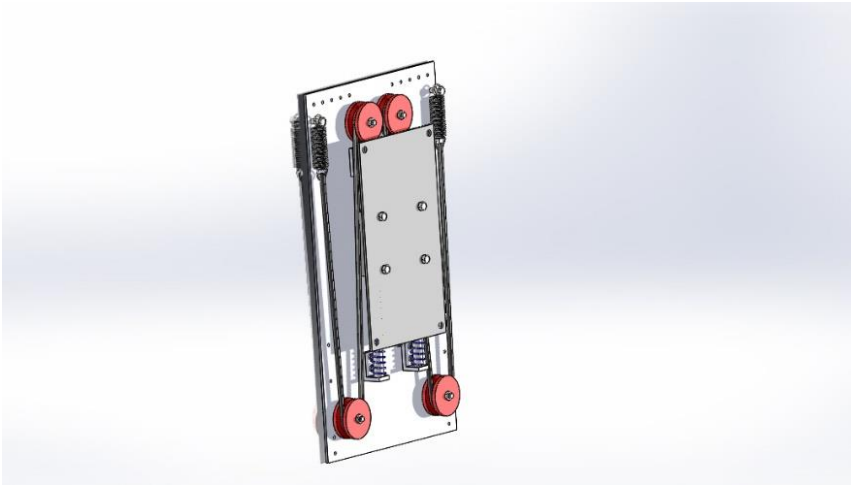


Fig. No.2 3D Model of Project

- **CALCULATIONS**

- **DESIGN OF ROD:**

Let us design the bag for weight of 20 kg maximum

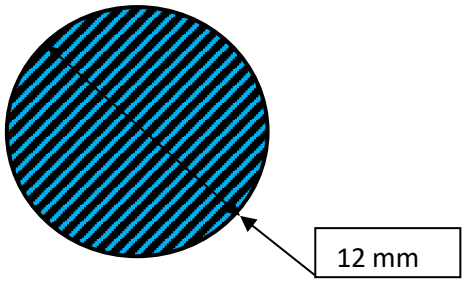
Length of rod = 250 mm

Now, rod will fail under bending

Weight on each shaft be 10 kg = 100 N say.

Two set of bearings are used so

W=10 kg= 100 N



For simply supported beam

M= W X L / 4

The rod diameter = 12 mm

M = 100 x 250/4 = 6250 N-mm

$Z = \pi/32 \times d^3$

$Z = \pi/32 \times 12^3$

$Z = 169.668\ mm^3$

σ_b(induced)= M/Z = 6250/169.668 = 36.83 N/mm²

As induced bending stress is less then allowable bending stress i.e., 68.9 N/mm^2 design is safe.

- **DESIGN OF SPRING:**

The spring is used to absorb the shock load of bag partially. we select spring with inner diameter 15 mm due to size restriction of rod.

Di = 15 mm

For average service life = 545 N/mm².

Wire diameter = 1.8 mm

Outer diameter of spring = Di + 1.8 x 2

Do = 18.6 mm.

Calculating the load bearing capacity of spring

Spring index = C = Do/d = 18.6/1.8= 10.33

C = 10.33

Wahls factor

K = [4C – 1 / 4C-4] + (0.615 / C)

K = 40.32/37.32+(0.615/10.33)

K = 1.08+0.05 = 1.13

For C =10.33 K= 1.13

Now to find 'P',

Shear stress = $\frac{8\ K\ P\ Do}{3.14\ d3}$

P = $\frac{545 \times 3.14 \times 1.8 \times 1.8 \times 1.8}{8\ x\ 1.13.18.16}$

P = 58.84 N

P = 5.99 kg

This is the force applied by single spring we are using 2 springs hence maximum 12kg load will be applied by spring.

- **RESULT:**

Field Trials is an integral part of a project. It not only gives the idea of the working condition of the project, but

we also come to know about the problems in the model and the errors that have been made so that they can be rectified.

- Shocks & Jerks are absorbed by helical compression spring up to 12kg load.
- Floating bag mechanism increases the endurance capability of body.
- Eliminates backpain and knee injury, increases overall physical activities performance.

- **TRIAL**

We conducted the trial of the project at the college ground. All the members of the syndicate were present and the trial was done in the presence of our guide.

Condition:

A. WALKING WITH THE TRADITIONAL BACKPACK USED BY SOLIDERS
B. WALKING WITH THE FLOATING BACKPACK (PROTOTYPE)

Result:

1) FAST RUNNING BY INDIVIDUALS IN COMPARE WITH TRADITIONAL BACKPACK
2) EASY JUMPING AND FIELD MOVEMENTS.
3) INCREASE IN INDIVIDUALS' PERFORMANCE AND JERKS ARE REDUCED.

ACTUAL MODEL:

Fig. No. Actual Model

- **CONCLUSION:**

- Our product is going to cater the physiological and muscoskeletal problems faced by a soldier on duty.
- It helps in long marches with less stress on body, also reducing chances of injury from too much strain on back, neck or knees.
- In future this can further be enhanced to small scale electricity generation and casualty evacuation.

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