Design and Fabrication of Floating Bag

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Abstract - ***The FSMO 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 work is to design and development of floating bag. Our paper 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) increases and decreases significantly when walking; a significant amount of relative movement between the user and the load lowers the load's absolute excursion. A rack and pinion gear, for instance, can be used to send this movement to a motor, which will then transform the mechanical movement into mechanical or electrical energy. By shifting the suspended weight in relation to the wearer, the wearer's body experiences less force when walking or running, which lowers the risk of orthopedic injuries. The FSMO 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.***

***Key Words*: -** FSMO, Suspended-load, Floating bag, backpack, fatigue.

1.INTRODUCTION

Soldiers in the Indian army frequently utilize military backpacks since load carrying is an essential component of field operations. Typically, infantry men are carrying weights that exceed thirty percent of their body weight. The soldier's performance declines as his energy consumption rises with the weight he is carrying.

The vertical displacement of the soldier's center of mass when walking is comparable to the movement of the transported cargo. This causes the acceleration forces produced by the impact of this load on the body to increase significantly, which accounts for the rise in energy consumption. Creating a load carrier system that suspends the load and lessens its vertical displacement is the aim of this project. The suspended load method used in this backpack lowers the vertical movement and forces produced by the weight on the bearer, providing advantages in terms of energy efficiency. It significantly lessens impact pressures while moving, even allowing for comfortable running while carrying large objects.

It is not feasible to transport heavy weapons and ammo to every LOC on wheels. Numerous adverse effects, including back discomfort, altered posture and gait, and injuries, might result from carrying a high load and an enormous quantity of equipment. The activity will undoubtedly get more severe if more effects arise. Due to the numerous essential pieces of gear and supplies that must be carried, the majority of mountain climbers' backpacks weigh more than is advised. Since carrying cargo is an unavoidable part of field operations in the Indian army, soldiers commonly use military backpacks.

Infantry soldiers usually bear loads greater than thirty percent of their own body weight. When a soldier carries a certain amount of weight, his energy consumption increases, which reduces his efficacy. The center of mass of a walking soldier is similar to the movement of the load being pulled. This leads to a large increase in the acceleration forces generated by the impact of the load on the body, which explains the increase in energy consumption. Exoskeletons may eventually be added to FSMO for field applications

2. LITERATURE REVIEW

The comprehensive methodology for the design is based on system engineering design and analysis approach. While giving due importance to the design procedure, the analysis of different methods and procedures were undertaken to design a reliable model for reducing the force exerted by the bag on human body. A number of research papers and analytical documents were referred to which formed the basis of our model. Some of these papers are as discussed further in detail.

As stated by Andy L. Ruina, Laurence C. Rome, et al. According to reference figure 1, an ergonomic backpack with suspended loads has been developed that significantly lowers the dynamic forces on the body (e.g., 82–86%) and, as a result, lowers the metabolic rate for carrying the load (e.g., by 40 W for a 60 lb load). This allows for the carrying of much heavier loads at the same metabolic cost (5.3 Kg more). In contrast to a traditional backpack, which makes it nearly difficult to run while carrying a heavy load, the invention's suspended-load ergonomic backpack allows for the faster and more comfortable transportation of weights at running speeds.

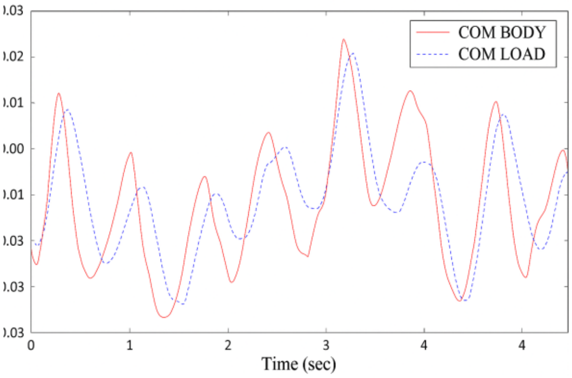

Figure 1 shows vertical excursions for both the load and the carrier moving at 1.5 m/s.

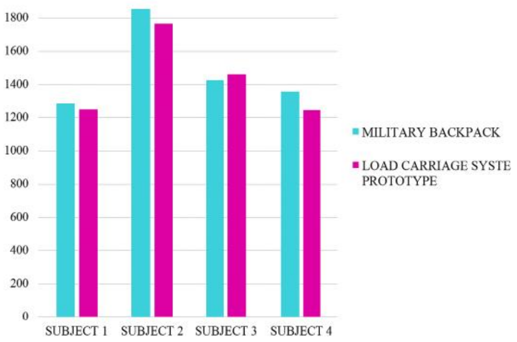

Figure 2: Each subject's total vertical ground reaction force (TVGRF)

According to Camilla Perez's research, Evan Campo et al. Soldiers frequently utilize military backpacks because, as reference figure 2 illustrates, load carrying is an inevitable aspect of field activities in the military. Typically, infantry men are carrying weights that exceed thirty percent of their body weight. The soldier's performance declines as his energy consumption rises with the weight he is carrying. The vertical displacement of the soldier's center of mass when walking is comparable to the movement of the transported cargo. This causes the acceleration forces produced by the impact of this load on the body to increase significantly, which accounts for the rise in energy consumption. Creating a load carrier system that suspends the load and lessens its vertical displacement was the aim of this research. According to the results, while using the created prototype to carry a load

instead of the traditional military backpack, there is a decrease in both the vertical excursion of the load and the overall vertical ground reaction force. Gait phase lengths are significant spatiotemporal factors in many circumstances, such as after treatments, according to a research by Matthias Lochmann et al. that provided an additional technique for hiking a backpack to lessen force and load on the back portion of the body (see figure 3). Even though walking speed has a significant impact on gait phases, the impact of varying speeds has seldom ever been examined in the literature. Using infrared cinematography and an instrumented treadmill, we investigated the lengths of the stance subphases and the swing phase at 12 distinct walking speeds, spanning from 0.6 to 1.7 m/s, in 21 healthy people

In order to identify broad patterns, we divided the stance phase into loading response, mid-stance, terminal stance, and pre-swing phases. We then conducted regression modeling of all phase lengths with speed. The stance duration reduced and the swing duration rose by 0.3% as the speed increased by 0.1 m/s. With speed, all separate stance subphases underwent considerable changes.

Figure 1 Result of discomfort level experience by male.

Chenglong Fu claims that the method for resolving the earlier issue An Elastically Suspended Backpack Design An elastically suspended backpack with a tunable damper is shown in figure 4 and is made to accommodate varying walking load needs depending on the population and application scenario. It provides positive damping in the generator mode and negative damping in the motor mode. The damping tuning system's mechanism is illustrated, and the connection between damping and system parameters is deduced. Different ideal phases of the load movement, which are obtained by gait analysis, match to requirements based on demographics and application conditions.

A spring-damper-mass model is used to study suspension damping for the desired phase in order to create the damping tuning system's parameters. Silva FR, Muniz AMS, Cerqueira LS, and Nadal J state that the concept of obesity is About half of the population is overweight, and biomechanical changes in gait in overweight persons (see figure 5) are a significant worldwide public health concern. Numerous studies have examined how obesity affects gait, but none have examined the impact of gait on overweight subjects. They may modify their stride patterns to lessen the strain on their lower limb joints as a result of their increasing weight. These changes in gait suggested that this cohort may be more susceptible to musculoskeletal disorders.

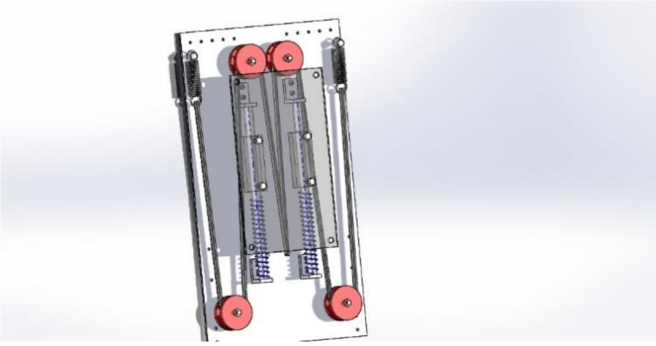

Figure 2 Model of FSMO

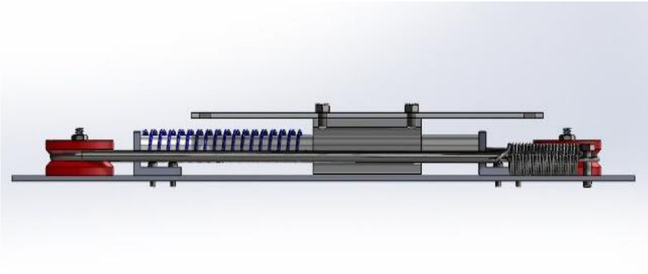

Figure 3 Side View

The study of the chronological organization of design work is referred to as methodology. Any design job typically involves the following stages. We conducted preliminary studies on the material properties, material selection, and design aspects of the raw materials that we will use to construct the FSMO in order to give the work a specific form and structure. The FSMO is constructed using a frame, pulleys, shaft, springs, bolts, and elastic rope. Since the frame of our mechanism is the most important portion of the project and is where all the other components are meant to be installed, we started by choosing the raw materials to make it. Next, we arrived to the pulleys that are fixed to the immovable frame. After that, we used elastic rope to connect the moveable and immovable frames so that the backpack could move up and down.

i. Improve the capacity for endurance.
ii. Lessens backbone and shoulder injuries.
iii. Soldier weariness is reduced.
iv. Keep extra rations, ammo, etc. on hand

3. STUDIES AND FINDINGS

to create a load-carrying system that lowers the load's vertical displacement while suspending it. When compared to the traditional military backpack, the developed prototype will reduce the vertical excursion of the load and the total vertical ground reaction force when carrying a load. This will assist military forces in transporting supplies, equipment, personal belongings, ammunition, and clothing during training or field operations.

The suspended load method used in this backpack lowers the vertical movement and forces produced by the weight on the bearer, providing advantages in terms of energy efficiency. It significantly lessens impact pressures while moving, even allowing for comfortable running while carrying large objects.

i. Muscle soreness brought on the extended usage of traditional backpacks.
ii. Decreases the capacity for endurance.
iii. A higher risk of ailments such back discomfort, knee pain, and stress fractures.
iv. Brachial plexus or surrounding nerves experiencing backpack palsy

4.DESIGN AND VALIDATION

1. Design consideration

Let us design the bag for weight of 20 kg maximum

Length of shaft = 250 mm

Now, shaft will fail under bending

Weight on each shaft be 10 kg

W=10 kg= 100 N.

For simply supported beam

M= W X L / 4

The shaft diameter = 12 mm

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

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

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

$Z= 169.668 \text{ mm}^3$

σ_b (induced)= M/Z = 6250/169.668= 36.83 N/mm^2

As induced bending stress is less than allowable bending stress i.e., 689 N/mm^2 design is safe

2. Design of Spring

The square pipe is expanded upwards by the spring. Due to the square pipe's size constraint, we used a trial-and-error technique to choose a spring with an inner diameter of 16 mm.

Di = 15 mm

For average service life = 545 N/mm^2.

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 = D/d = 18.6/1= 10.33

C = 10.33

Wahls factor

K = [4C – 1 / 4C-4] + 0.615 / C

K = 40.32/37.32+(0.615/10.33)

For C =10.33 K= 1.13

Now to find 'P',

We know

Shear stress = 8 K P Do/ 3.14 d^3

P = 8 x 1.13 x 18.6 / 3.14 x 1^3

P = 58.84 N

P = 5.99 kg

This is the force that a single spring can apply; since we are employing two springs, the maximum load that a spring can apply is 12 kg.

3. Selection of Pulley

Pulley of diameter 50 mm is used

Load capacity of rope

4. Design of bolt

The bolt must be securely attached since it will be subject to rotational force. C-45 steel stress. The bolt's standard nominal diameter is 5.5 mm. According to the design data book table, the diameter of an M6 bolt is 6 mm.

Let's examine the strength: Additionally, the bolt's initial strain at complete belt tightening.

20 kg load is acting on nut bolt = 200N

P = 200 N is the value of force

P = 200 N

Also, P = Π /4 dc^2x σ

σ = 200 x 4 / 3.14 x $(5.5)^2$

= 8.42 N / mm^2

The calculated σ is less than the $\sigma_{tensile}$ and σ_{shear} hence our design is safe.

5.RESULTS & DISCUSSION

A project's field trials are an essential component. In addition to providing an overview of the FSMO's operational state, it also informs us of model deficiencies and mistakes so that they may be fixed.

Our backpack's field tests are conducted on college property in order to meet the following requirements

1. Walking without load.
2. Walking with the traditional load system used by soldiers (the carried mass weighted 20 kg).
3. Walking with the load carriage system prototype (the carried mass weighted 20 kg).

The field trial was conducted and results are as follows

1. Fast running by 3 individuals and their experience with varing weight
2. Jumping with the backpack
3. Fieldcraft movements

CONCLUSION

Our task is to address the musculoskeletal and physiological issues that a soldier may encounter while on duty. The dynamic forces exerted on the body are lessened by this bag pack's double-frame and pulley system design. It makes long marches less taxing on the body and lowers the risk of damage from excessive pressure on the knees, neck, or back. An exoskeleton system with a third arm can lessen the dynamic forces acting on the body. This can be expanded in the future to include casualty evacuation and small-scale electrical generating.

8.FUTURE-SCOPE

We might be able to make the project even better. We considered a few potential future extensions that may be incorporated into the basic model to increase its effectiveness and further reduce the need for human labour. Utilizing other lightweight materials, such as composite and Kevlar, can further reduce weight.

1. Mechanical energy may be transformed into electrical energy to produce small amounts of power.

2. Motorola batteries in the field may be charged using this energy.

3. To keep the weapon in firing position during lengthy marches, an additional arm might be supplied.

4.In addition, it can offer a GPS and GSM module to pinpoint the soldier's precise location.

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