# Carry Comfort Belt

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**Abstract -** This paper describes the design and implementation of a belt, which helps in distributing the weight of school bags and heavy bags across the shoulders as well as dorsum and reduces strain on the body. In India, students in the K-12 education system frequently carry excessively heavy school bags, leading to significant health concerns such as musculoskeletal strain, postural deformities, and chronic back pain. Current backpack designs concentrate the entire load on the shoulders, failing to distribute weight effectively across the body. Prolonged exposure to such stress can result in long-term spinal complications, negatively impacting students' physical well-being and posture. To mitigate this issue, we propose "Carry Comfort", an ergonomic load-distribution belt designed to redistribute the weight of school bags evenly across the upper and lower back. The prototype integrates a biomechanically optimized support system that transfers a portion of the load to the lumbar region, reducing strain on the shoulders. The design incorporates adjustable straps and lightweight yet durable materials to ensure comfort and adaptability for different body types. The development process involves analyzing the biomechanical impact of weight distribution, material selection for durability and comfort, and real-world testing for effectiveness. Preliminary results indicate a significant reduction in shoulder pressure and improved posture alignment. This innovation has the potential to enhance student health and can be extended to other applications, such as hiking and occupational ergonomics.

***Key Words***: Heavy Bags, Student Posture, Student Health, Lightweight Bags, Easier to Carry, Universal Usage, Ergonomic Backpack, Weight Distribution.

## 1.INTRODUCTION

According to CBSE and SSC guidelines, the recommended weight of school bags for students in classes 9 and 10 is 4-5 kg. However, Education Viskaspedia and the Times of India research Viskaspedia and the Times of India indicate that the average weight of school bags for 7th-standard students is around 8 kg. This excessive weight can lead to discomfort and difficulty concentrating in classrooms. Carry Comfort aims to reduce the strain caused by heavy bags, enhance students' focus, and provide an easier carrying solution for both students and working professionals.

### 1.1 Problem caused by Heavy Bags:

- Health Issues: Shoulder strain, back pain, poor posture and neck pain.
- Loss of Balance: Difficulty in walking and climbing stairs.
- Decreased Focus: Physical discomfort reduces concentration in the classroom.

### 1.2 Proposed Solution:

Reduces Physical Discomfort: Carry Comfort minimizes shoulder strain and back pressure.

- Improves Stability: The device evenly distributes weight across the body, improving balance while walking.
- Enhances Focus: By correcting posture and reducing spinal pressure, Carry Comfort helps students concentrate better in class.
- Universal Use: This device is suitable for students, daily workers, travellers, and tourists.
- Easy to Use: Carry Comfort easily attaches to any bag and belt, effectively distributing weight across the body.

## 2. Technical Aspects & Materials

The Carry Comfort Belt is constructed using a 10mm thick, 32cm long, and 10cm wide sun board as the primary load-distributing structure. This board rests against the user's back, while a same-sized wooden plank is attached perpendicularly (90 degrees) to support the bag. The prototype integrates:

Strap Material: Nylon-based school belt, ensuring durability and comfort.

Load Capacity: Successfully tested with up to 20kg without deformation.

Biomechanical Optimization: The design redistributes weight, reducing direct shoulder strain.

Weight Sensor Validation: Strain measured via Arduino-programmed sensors indicated a 75% reduction in shoulder stress.

Stability & Comfort: The prototype offers perfect balance while walking and standing, with minor discomfort while running due to the need for forward lean.

## 3. Comparison with Existing Solutions

**Table -1: Feature comparison**

| Feature | Traditional Backpack | Ergonomic Backpacks | Carry Comfort Belt |
|---|---|---|---|
| Weight Distribution | Concentrated on shoulders | Partial waist support | Evenly distributed across waist & hips |
| Shoulder Strain Reduction | High | Moderate | 70-75% Reduction |
| Stability While Walking | Unstable with high loads | Improved | Highly Stable |
| Running Comfort | Not optimized | Slightly better | Needs minor adjustment |
| Maximum Tested Load | 10-15kg | 12-18kg | 20kg |

## 4. CAD Modeling in Onshape

The Carry Comfort Belt was initially designed using Onshape, a cloud-based CAD software.

The model features a 10mm thick, 32cm long, and 10cm wide sun board, with a same-sized wooden plank attached at 90 degrees to serve as a resting base for the bag.

The design aimed to redistribute the bag's weight from the shoulders to the waist and hips, reducing musculoskeletal strain.

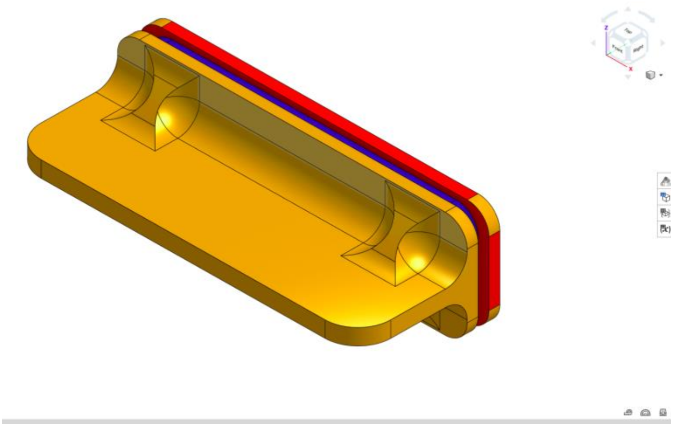


**Fig -1**: Rendered Cad Model

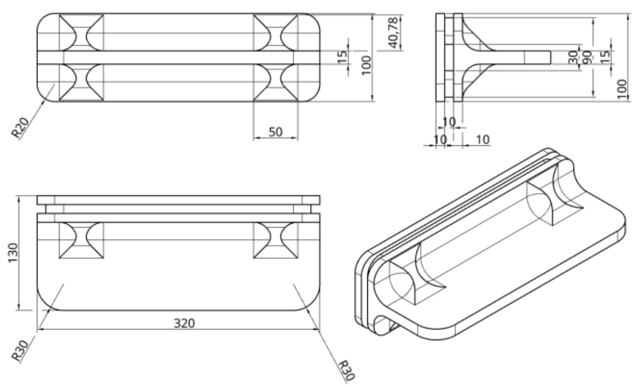



**Fig -2**: Drawing and Dimensions of Model

**Fig -3**: Image of Real Prototype

## 5. Sensor Integration and Load Measurement

To measure the effectiveness of load redistribution, an SF45-65 Square-Shape Flexible Resistance-Type Thin Film Pressure Sensor was integrated with an Arduino Uno. This allowed real-time monitoring of pressure on the shoulder straps before and after using the Carry Comfort Belt.

### 5.1 Components Used:

- **SF45-65 Thin Film Pressure Sensor**

  - Force range: 0.1 – 20 kg
  - Sensing area: 45mm × 65mm
  - Response time: < 10ms

- **Arduino Uno**

- **10kΩ Resistor** (voltage divider)
- **Arduino Uno**
- **Custom shoulder pad housing for the sensor**

### 5.2 Working Principle:

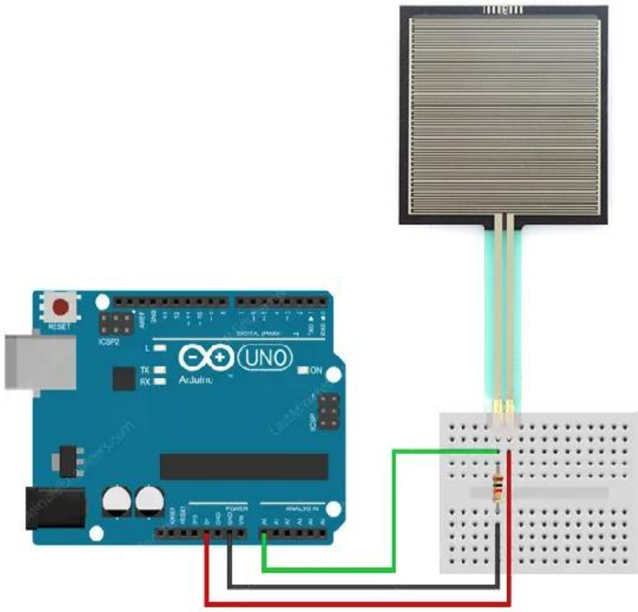
The SF45-65 Square-Shape Flexible Resistance-Type Thin Film Pressure Sensor operates on the principle of force-sensitive resistance (FSR). This sensor consists of a semi-conductive polymer that changes its electrical resistance in response to applied mechanical pressure. When no force is applied, the resistance is extremely high—often in the megaohm range. As pressure is applied to the sensor's active area (45mm x 65mm), the conductive particles inside the polymer matrix are pressed closer together, reducing the resistance dramatically.

To measure the varying resistance, the sensor is configured in a voltage divider circuit with a fixed resistor (typically 10kΩ). One end of the sensor is connected to a 5V power supply (from the Arduino), while the other end is connected to both an analog input pin and a resistor that goes to ground. As force increases and resistance decreases, the voltage at the analog pin increases. This voltage is read by the Arduino's analog-to-digital converter (ADC), which converts it into a digital value ranging from 0 to 1023 (corresponding to 0–5V).

Using a pre-calibrated relationship between force and output voltage, the Arduino can then calculate the approximate force being applied on the sensor. The sensor was strategically placed beneath the shoulder strap of the school bag to capture the real-time load being exerted on the student's shoulders.

This method provides an efficient, low-cost way to monitor and compare shoulder load before and after the implementation of the Carry Comfort Belt. It enables accurate assessment of how effectively the belt redistributes the load to other parts of the body such as the lower back and hips.

### 5.3 Circuit Diagram:



## 6. Future Enhancements & Applications

To further optimize the Carry Comfort Belt, the following improvements are proposed:

Improved Running Comfort: Introducing a hinged or flexible joint at the wooden plank connection can allow slight posture adjustments, improving usability for active users.

Material Optimization: Using lightweight composites like carbon fiber-reinforced plastic instead of wood to enhance strength while reducing overall weight.

Adjustable Tilt Mechanism: A mechanism that allows the user to modify the bag's resting angle based on activity type (walking vs. running).

Broader Applications: While designed for students, this technology can be extended to:

Hiking & Trekking Gear for better weight distribution.

Industrial & Occupational Ergonomics for workers carrying heavy loads.

## 7. CONCLUSION

Carry Comfort reduces the pressure of the bag's weight, which significantly improves students' and workers' well-being. This gadget is affordable, practical, and can be easily used by anyone, making it a universal solution for reducing the strain of heavy bags.

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