# Testing the Most Effective Recoil Pads

## Purpose

The purpose of this experiment is to find which materials used for recoil pads are most effective in absorbing recoil. Finding this can help prevent injury in the shoulder and upper arm area caused by large amounts of recoil from some firearms.

## Introduction

This project will be testing which types of recoil pads are most effective in absorbing recoil energy. This idea originated from practicing shooting for a deer season youth hunt in September. While shooting a .50 caliber muzzleloader without a recoil pad, there was noticeable recoil. It was not enough to cause flinching but it still was bothersome. This led to wondering how different recoil pads absorb recoil, and wondering which one is the best at absorbing. The hypothesis formed is that the Sorbothane recoil pad would absorb the most recoil in comparison to other materials.

All guns have recoil energy, whether it is small (around 10 Newtons (N)) or much larger (around 31 N). Recoil energy is the reaction of a gun from the shooting of a bullet. It is calculated by the equation $E = \frac{1}{2}mv^2$, where E is energy, m is the mass of the gun, and v is recoil velocity. Following Newton's Third Law that every force has an equal and opposite reaction, the recoil energy of a gun is equal to the force of gunpowder in a bullet that propels the bullet forward. Gun weight also affects recoil, as the more a gun weighs the less the recoil energy will be. While it is possible for a gun to have recoils of 30 N or more, experts agree that about 20.3 N is the maximum recoil energy for a shooter to feel somewhat comfortable and that more than 27.1 N will cause shooters to develop a serious flinch.

Guns also have recoil velocity. While recoil energy measures how much force the gun will recoil, recoil velocity measures how quickly the gun recoils in meters per second (m/s). Recoil velocity is based off of the Law of Conservation of Momentum, which states that the momentum of objects before an event will be the same as after the event as long as there are no outside forces. The Law of Conservation of Momentum is based off of Newton's First Law, and is written as: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$. The m represents momentum, the u represents the initial velocity, and the v represents final velocity. Recoil velocity is calculated with the equation $v_2 = -(m_1/m_2)v_1$, where $v_1$ is the velocity of the bullet, $v_2$ is the velocity of the gun, $m_1$ is the momentum of the bullet, and $m_2$ is the momentum of the gun. Recoil velocity can vary from 0.2 m/s for a .17 Hornady Magnum Rimfire (HMR) rifle, to 127.5 m/s from a .600 Nitro Express rifle.

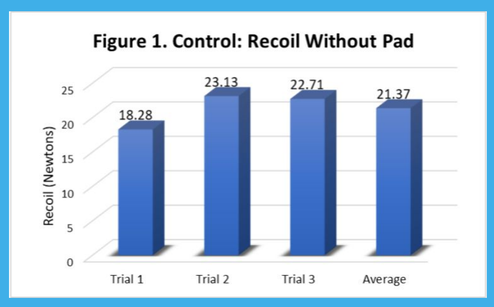
Handling firearms can lead to many different injuries affecting the arm, wrists, and hands. Some of these injuries include open trauma wounds, damage to bones and nerves in the hand, stress fractures, carpal tunnel syndrome, lateral epicondylitis, accelerated joint degeneration, and osteoarthritis. All of these restrict future use of the arm; and therefore, it is very important that the recoil is absorbed to prevent these injuries.

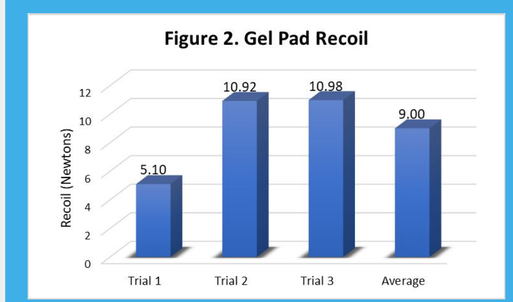
Recoil pads can be made out of hydraulic fluid, sorbothane, air pads, rubber, and viscoelastic gel. FalconStrike is a brand that makes recoil pads with hydraulic fluid. This fluid moves around in the pad to fit the shoulder and then expands by about 10% when the gun is fired. Using an energy conversion dampener kinetic energy is converted into thermal energy, and continues to evenly spread the heat throughout the shoulder. Sorbothane is a viscoelastic polymer and is a polyurethane material that is polyether based. Kick-EEZ is a brand that makes Sorbothane recoil pads, which have shock absorption, good memory, and vibration isolation and dampening. LimbSaver is a brand that makes recoil pads with air pads, also known as AirTech. These pads have an atmospheric chamber that allows uniform energy dissipation and anti-muzzle jump technology and are made with Noise and Vibration Control Material (NAVCOM) which absorbs many frequencies to prevent recoil and vibration. Lastly, Feyachi is a brand that makes a variety of materials for guns. Their gel pad will be used in this experiment.

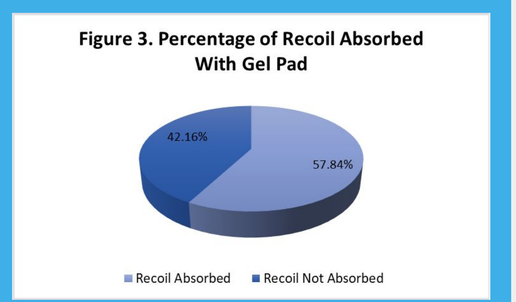
## Hypothesis

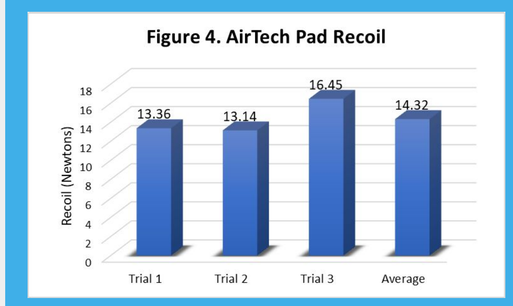
The hypothesis is that the Sorbothane recoil pad will block the most recoil in comparison to the other pads

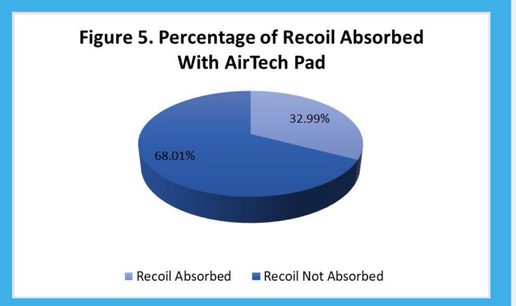
## Results

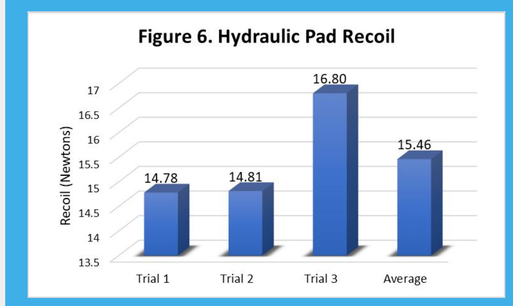


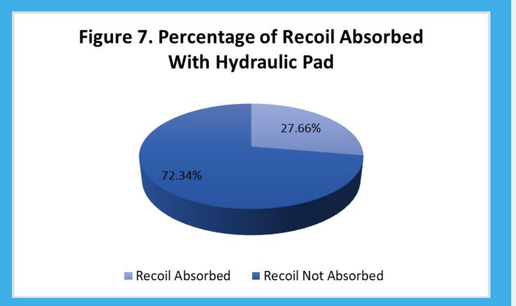



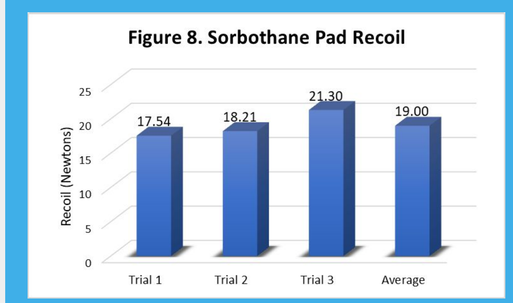



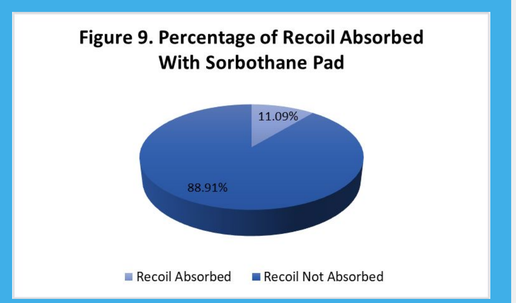



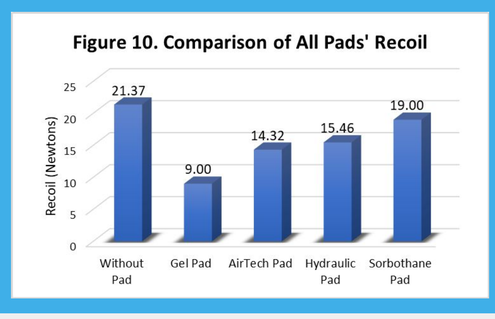





Figure 11. Experiment Setup


Figure 12. Adjusting the Force Meter


Figure 13. Starting Data Collection


Figure 14. Firing the Gun

## Procedure

### Materials

- Remington .22 Caliber rifle
- 15 Remington .22 Caliber bullets
- Gun stand
- Pliers
- Sound muffling earmuffs
- FalconStrike hydraulic recoil pad (Hydraulic Pad)
- Kick-EEZ Sorbothane recoil pad (Sorbothane Pad)
- LimbSaver AirTech recoil pad (AirTech Pad)
- Feyachi gel recoil pad (Gel Pad)
- Vernier Dual-Range Force Sensor (Force Meter)
- Vernier LabQuest Mini (LabQuest Mini)
- Vernier Graphical Analysis program (Graphical Analysis)
- Laptop/Chromebook
- Screwdriver
- Any size screw
- 0.9525 cm drill bit
- 2.54 cm x 5.08 cm x 45.72 cm plywood
- 5.08 cm x 15.24 cm x 60.96 cm plywood
- Table (or other flat surface)
- Clear area

### Procedure

1. Download Vernier Graphical Analysis for chosen laptop or chromebook.
2. Screw the 2.54 cm x 5.08 cm x 45.72 cm piece of plywood to the back of the table vertically.
3. Using the 0.9525 cm drill bit, drill a hole in the wood that does not fully go through the wood.
4. Insert the 12.7 cm x 0.9525 cm rod that comes with the Force Meter in the hole with the screw part inside the hole. If the entire screw part does not fit, drill the hole deeper.
5. Place the wood with the rod perpendicular to the wood screwed to the table making sure that the rod is at the end farthest from the wood screwed to the table.
6. Set up the gun stand and place the rifle on it so that the butt of the gun is in line with the rod.
7. Place the Force Sensor on the rod using the hole in the back of the sensor and tighten the screw on the sensor until it cannot be screwed anymore. Make sure the sensor area of the Force Sensor is in the middle of the butt of the gun.
8. Connect the Force Sensor to the LabQuest Mini and connect the LabQuest Mini to the laptop or Chromebook. Keep the laptop and LabQuest Mini out of the way of the area around the gun.
9. Set the Force Sensor to ±50N.
10. Turn the safety of the gun on and load it with a bullet.
11. Open Vernier Graphical Analysis and create a new experiment. Check to see that the current force is zero.
12. Put on sound muffling earmuffs to prevent any hearing damage from the noises from the gun.
13. Click "Collect" on the Graphical Analysis, turn off the safety on the gun, and use the pliers to squeeze the trigger back.
14. After the gun has fired, check that the data is recording and click "Stop" to stop the data collection.
15. Save the data and open a new experiment.
16. Turn the safety back on and reload the gun with another bullet.
17. Repeat steps 13-16 two more times without a recoil pad.
18. Repeat steps 13-16 three times after attaching each recoil pad.

## Conclusion

In this experiment, the Gel Pad absorbed the most recoil with an average absorption of 57.84%. The AirTech Pad absorbed the second most recoil with an average absorption of about one third of the recoil. The Hydraulic Pad absorbed the third most recoil with an average blockage of 27.66%. Lastly, the Sorbothane Pad absorbed the least recoil with an average absorption of 11.09%. In conclusion, the hypothesis that that the Sorbothane Pad would absorb the most recoil in comparison to other materials was not supported.

## Credits

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