

# Anti-Vibration Framing Hammer

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**Abstract**— For construction workers and contractors, tasks such as framing work require the continuous use of a hammer. The repetitive impact during use transfers vibrations and shock throughout the worker’s wrists and elbows. The repeated stress on the body of workers has been associated with the development of disabling musculoskeletal disorders such as carpal tunnel syndrome and tennis elbow. Current anti-vibration hammers on the market utilize rigid composite materials in their handles, titanium heads, and rubber grips to reduce vibration. The purpose of this project is to create a more effective design of a framing hammer for reducing vibration by exploring different engineering solutions. This document details the design and assembly of a prototype anti-vibration framing hammer that uses a mass-spring-damper system to dampen the vibrations sent to the handle of the hammer.

## I. INTRODUCTION

Workers who use framing hammers every day for work are at risk of developing musculoskeletal disorders because of the vibration exposure from constantly using a hammer [1]. Being able to reduce the vibrations sent to the user is important so the user is less likely to experience injuries while using the product. In order to create an effective anti-vibration framing hammer, several constraints had to be followed. A couple constraints that had to be followed were maintaining similar dimensions and weight to a normal framing hammer. It was determined from exploring the market that the standard weight of a framing hammer is in the range from 20-30 oz and the standard-length ranges from 14-20 in. It was important to the project that these standard specifications be followed so the general feeling remains the same when compared to a standard framing hammer. Additional constraints that had to be followed for the prototype hammer related to performance. To be effective, the prototype hammer must be able to display similar results in being able to strike a nail into wood just as effectively as well as having lower vibration sensed in the handle when compared to a standard anti-vibration framing hammer.

## II. METHOD AND MATERIALS

The main objective of the project was to implement an innovative engineering solution to dampen vibrations in the head of the hammer before reaching the handle. Although there are many different anti-vibration hammers that already exist, most of these designs focus on materials and or modify

the handle to reduce the vibrations instead of the head. The effectiveness of these hammers has room for improvement to help limit injuries. After considering several potential solutions, the team decided on using a mass-spring-damper system to satisfy the objective. To maximize the vibration dampening in the system while still adhering to size specifications, two spring-dampers in parallel connection were implemented on either side of the handle connection [2]. The springs in the system are made of zinc-plated spring-tempered steel and contain a rate of 37 lbs/in. The dampening components in the system are rings of viscoelastic material that have a durometer of 70 and are cut to a thickness of 3/8 in. Figure 1 below displays the mass-spring-damper system model in the hammer head.

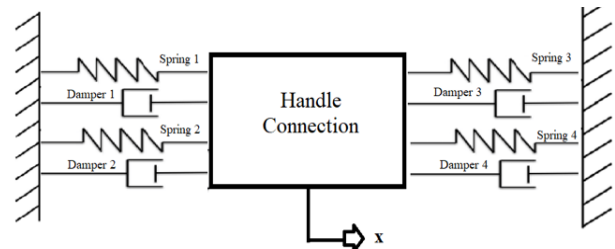


Figure 1: Mass-Spring-Damper System in Hammer Head

### A. Hammer Materials

The materials used in creating the prototype anti-vibration framing hammer were chosen to maintain high strength and durability. To remain effective, framing hammers must endure constant use and have the capability to withstand hundreds of pounds of force per strike [3]. The components used in creating the anti-vibration framing hammer consisted of a mixture of self-machined and purchased parts to help accommodate machining constraints. Table 1 below shows details about the hand-machined components of the hammer.

Machined Components	
Part	Material Specification
Circular carbon steel head	ASTM A108
7075 aluminum connection piece	ASTM B209

Table 1: Self-Machined Components of Hammer

## B. Assembly of Hammer

Once all the machined components were finished and the rest of the parts were on hand, assembly of the hammer took place. The assembly began by press fitting the linear bearings into the connector piece to slide along the linear rod shafts. After the rod shafts were screwed into the hammer head, the components for each spring-damper system were placed on the rod shafts with the connector piece in between. All components were then locked onto the rods by shaft collars in the back. Lastly, the handle was wedged and screwed into the connector piece. Figure 2 details all the components and their location on the hammer. The final prototype created in this project had a total weight of 26.54 oz and length of 17 in.



Figure 2: Final Prototype Hammer

## C. Testing Vibration Dampening Effectiveness

To test the vibration dampening effectiveness of the prototype hammer, a performance test was completed against an anti-vibe framing hammer from the market. The performance test on each hammer consisted of striking a 4x4 in block of wood with relatively the same posture and pace. Figure 3 displays how shock accelerometers were placed on the handles of each hammer to measure acceleration values and signify vibration response.



Figure 3: Testing Setup of Hammers

## III. RESULTS AND DISCUSSION

After testing the prototype hammer against an anti-vibe framing hammer from the market, it was clear that implementing a mass-spring-damper system in the hammer

head was an effective way of dampening vibration before reaching the handle. Shown below in Figure 4, the prototype hammer displayed a 65% reduction in peak acceleration values when compared to the hammer on the market when similar impact parameters were set in the experiment.

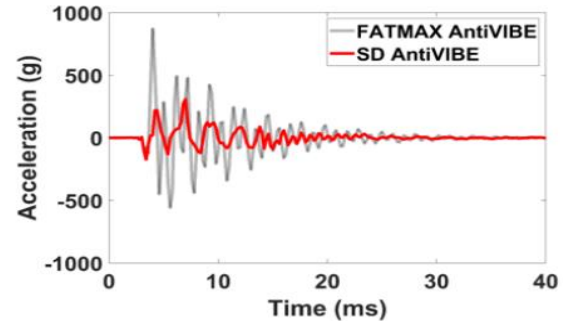


Figure 4: Testing Results

To get the proof-of-concept prototype to be a commercially viable product, there are optimizations in the design that would need to take place. An encasement would be needed to protect the components on the inside from being damaged. Also, a rip claw would need to be added for the hammer to be able to remove nails.

## IV. CONCLUSION

The team was able to manufacture a proof-of-concept design of an anti-vibration framing hammer that was evaluated and tested. The test results signal how mass-spring-damper systems can be effective in helping design framing hammers with less vibration. Further implementation of this technology in framing hammers can work towards limiting worker injuries due to vibration exposure.

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