MULTIPURPOSE UTILITY BAR

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ABSTRACT

The crow bar is a simple and effective demolition tool, but it is limited in its range of capabilities. The multipurpose utility bar design is an affordable, modular tool that can be used for many different tasks. Comfort and ease of use were important features that were incorporated into the design while maintaining the strength and durability characteristics of standard demolition tools, shown in Figure 1 below.

Figure 1: Benchmark Tools

DESIGN OBJECTIVES

Market research and literature review confirmed the desire for a tool that was versatile, strong, and easy to use. The purpose behind the design of this utility bar was to fulfill these specifications. A standard 24 in. crowbar was purchased as a benchmark to ensure a competitive final design. Benchmark testing and further research led to the following performance requirements, shown below in Table 1.

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Design Goal</th>
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<tbody>
<tr>
<td>Bending Strength</td>
<td>&gt; 65% of Benchmark</td>
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<tr>
<td>Ease of Use</td>
<td>Contoured Rubber Grip</td>
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<tr>
<td>Versatility</td>
<td>&gt; 5 Attachments</td>
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<tr>
<td>Portability</td>
<td>45 cm, &lt; 1.05 kg</td>
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<tr>
<td>Light Weight</td>
<td>&lt; 1.05 kg</td>
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<tr>
<td>Ergonomics*</td>
<td>&lt; 100 kPa (Hand Pressure)</td>
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Table 1: Performance Requirements of Proof-of-Concept Model (*Based on average values)

MODELING

Figure 2 and Figure 4 show the SolidWorks and proof-of-concept models, respectively. Each model was created with the intention of emphasizing the key aspects of the design. Six different attachments were modeled to enhance the versatility of the utility bar. These attachments include a (A) short chisel, (B) claw hammer, (C) long chisel, (D) scraper, (E) nail puller, and (F) shovel. UPrintPlus was used to make a rapid prototype of the short chisel attachment. This attachment, along with the machined shaft, handle, and locking mechanism were combined into the full assembly of the proof-of-concept model, depicted in Figure 4.

Figure 2: SolidWorks Model of Utility Bar Showing Various Attachment Configurations

ANALYSIS

In order to minimize weight a hollow steel tube was used as the main shaft of the bar. Hand calculations and FEA analysis were employed to determine both the physical dimensions and the material properties required to handle the expected loads. The results of the stress analysis are shown in Figure 3 below. It was clear early on that the strength of the bar would be limited by the interface between the shaft and each attachment. A static analysis showed that as the length of the mating portion of each attachment entering the main shaft approached zero, stresses approached infinity.

Figure 3: ALGOR Stress Analysis of Proof-of-Concept (top) and Benchmark (bottom)

CONCLUSION

A lightweight, versatile, comfortable, and easy to use utility bar that has sufficient strength relative to a standard crowbar satisfied the original design goals. User comfort was improved by providing a larger surface area by which human force could be applied. An easy to use and secure locking mechanism for different end attachments was vital to enhance the versatility of the bar. Further development would see the production of all of the attachments (Figure 2) through the use of sand casting or some other form of cast manufacturing.

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