Performance of Flail Hammers

Frédéric Guerne
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Performance of Flail Hammers

The following article discusses the strengths and weaknesses of flail hammer use in the demining field. The author leans on his field experience with the Digger Foundation to analyze types and usage of these tools. In doing so, he aims to give advice on the best methods for using failures to achieve the best results.

by Frédéric Guerne  [ Digger Foundation ]

Examples from the field show that when carrying out ground preparation work with demining machines, the parameters that influence the users’ operational choices can be based on ill-suited criteria. A number of factors need to be considered before employing flails in the field, some of which are described here. This article does not detail a full scientific study, but instead shares some practical experience from the field. The article provides information regarding the strengths and limitations of different flail hammer designs, as well as advice on the best way to use these tools. Our conclusions about flail hammers come from using the Digger D-2 during demining operations in Sudan, and from tests carried out by the Digger Foundation to improve the performance of the D-2 in Sudan.

The article also stresses the point that demonstrations of machines in short runs or lanes cannot be expected to highlight all the key parameters involved, in particular the life span of wearing parts such as hammers. Those factors must be analyzed in detail through field tests. Digger’s field experience can hopefully provide insight and guidance for others to apply to their own contexts.

Flail Hammers

Two of the most important parameters of flail hammers, their shape and material composition, heavily influence the efficiency, lifespan, and price of hammers. Identifying the best possible hammer, i.e., the design that provides the best results depends on the projected use and the need for finding the best balance between these aspects.

Influence of the Hammer Shape on Digging Efficiency

We define efficiency as the ability of a flail hammer to penetrate soil under specific conditions to a given depth using the least possible fuel. This is because a flail hammer is the lower fuel costs. These considerations assume that the desired digging depth is the depth setting of the flail. It is not acceptable to improve efficiency simply by decreasing depth.

To the best of Digger staff knowledge, and from what has been observed in the field, the most widely used hammer shape is the mushroom-shaped hammer. This hammer design provides good digging efficiency—the sharper the cutting edge is, the more efficient the hammer will be.

Using the Digger D-2 electronic load-sensing control, the efficiencies of different hammer shapes and designs were compared by simply measuring the time spent working as soon as the sharpness reduces, the digging efficiency is lost, and the hammer loses its advantage.

Life Span

The Digger Foundation’s experience in Sudan has greatly influenced the design of Digger hammers with 3-mm tungsten coating on the bottom surface. During Digger operations in Sudan at first, the traditional thick, mushroom-shaped hammers were used. In the conditions we met, however, especially of two to three times, compared to the non-tempered (150 HB) square-shaped hammers. In North Sudan, a lifetime of around 14–18 hours was finally reached.

Digging Efficiency

The remaining question was how to combine a long life span with a sufficient cutting and digging efficiency. The answer was to develop a hammer with a new shape—one with a sharper cutting edge than square hammers that could also be used for a long time without needing to be replaced. These new hammers are made of the same standard steel, square-shaped bar used for the square hammers, but are cut at an angle and have a chain attachment off-center.

The use of the costly tungsten coating (about 12 euro or US$17 for the coating of one hammer when producing a minimum of 200 at one time) provided the best compromise between harshness and shock resistance. Though this type of coating increased the lifetime by a factor of four to six compared to the uncoated steel (150 HB), it was still not acceptable (i.e., less than three hours’ operating time before being worn out). Six different tungsten coating systems were then tested, from thin (1.5 mm) to thick coatings (3–5 mm). This testing was done using iron projection and flame deposition.

One of the downsides of using a hard tungsten coating was the associated cost. Eventually, the cost/life span ratio was deemed uneconomical and Digger then moved to using square-shaped hammers, which have a longer life span. With this hammer type, using 150 HB steel, the advantage is that the hammers can wear more than 30 mm before having to be replaced.

This new solution and design increased the life span by a factor of two in comparison to the expensive, tungsten-coated “mushroom” version. The hammers could now be used for six to seven hours. However, researchers deemed a life span of six hours was still not sufficient and sought other solutions to further increase the life span of the hammers.

The steel hammer (150 HB) was replaced by one that can be tempered (about 200 HB). This process had the advantage of being significantly less expensive than tungsten coating. With this improvement, the life span of the hammers was increased by a factor of two to three times, compared to the non-tempered (150 HB) square-shaped hammers. In North Sudan, a lifetime of around 14–18 hours was finally reached.

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The faster a flail rotates, the greater
the hammer design is the rotating speed of
with an appropriate design than to use low-cost
be engaged, which can increase the price of the
(steel quality, tempering process, etc.) have to
Square-shaped hammer.

<table>
<thead>
<tr>
<th>Hammer Type</th>
<th>Lifetime under extreme wear conditions (North America) (failing hours)</th>
<th>Lifetime under average normal wear conditions (South Sudan) (failing hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square shape, tempered hammers (380 HB) (hard)</td>
<td>14–18</td>
<td>60–80</td>
</tr>
<tr>
<td>Square shape, untempered hammers (150 HB) (soft)</td>
<td>6–7</td>
<td>30–40</td>
</tr>
<tr>
<td>Square special shape, tempered hammers (380 HB)</td>
<td>14–18</td>
<td>60–80</td>
</tr>
</tbody>
</table>

The cost is about 20% less than the tempered version. These hammers are especially recommended for vegetation cutting.

Summary Comparison Between Life Span and Digging Efficiency

| Table 2 |

Frederic Guerne worked for 10 years in Peace Corps in Africa as a digger development engineer. Since 1998, he has worked for Humanitarian Demining and has found a nonprofit organization, the Digger Foundation, which manufactures demining-assistance machines.

Latin Victims Are Invisible, Invited and Said [on page 12]:
3. For more information about the UN, go to: http://www.un.org. 4. For more information about the UN, see: http://www.un.org.