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MineWolf Flail and Tiller Machines: Testing the Differences between two Demining Technologies

Heinz Rath
MineWolf Systems GmbH

Dieter Schröder
MineWolf Systems GmbH

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Soil type was the primary factor determining throw patterns. Mine size and depth were relatively unimportant. The depth setting of the flail is likely to affect some values in the data, but the overall trends found for mine size and depth should be similar.

Clearly, more tests of this sort on different makes and sizes of flails are desirable. The Geneva International Centre for Humanitarian Demining plans to continue these tests, but the manufacturers can also conduct tests so they can give advice to purchasers on ladderity of throw, proportion of mines thrown beyond the flail, and likely maximum throw distance under different operating conditions. Consideration should be given to including information about throw patterns in the Mechanical Demining Equipment Catalogue, and eventually to developing a standard test to be incorporated into the International Mine Action Standards.

We thank the Swedish EOD and Demining Centre for supplying equipment, resources and the field site to support the study. Funding was provided by the governments of Germany, Norway and Sweden.

Endnotes, page 112

Rath and Schröder: MineWolf Flail and Tiller Machines: Testing the Differences between two Demining Technologies

MineWolf is the first demining concept, manufactured in Germany by Arthur Willibald Maschinenbau GmbH (AHWI), that overcomes the limitations of flail and tiller machines by combining the advantages of both systems. Extensive tests with live anti-tank and fragmentation mines were carried out at the German Army proving ground to determine whether the MineWolf meets the operational requirements for humanitarian demining. The aim was to discover the effects of detonations on the operator, MineWolf, clearing tools, and cab to work out instructions for reparable.

by Heinz Rath and Dieter Schröder [MineWolf Systems GmbH]

The MineWolf is a mine-clearing device developed especially for humanitarian mine-clearance. It is used for area clearing and cleans up to 2,800 square meters per hour (3,149 square yards/hour), allowing for fast quality control on a demined area. The MineWolf system consists of a fragment-proof AHWI crane tractor, a protected driver’s cab and a mechanically driven mine-clearing device. Both a flail device and a tiller are available.

The flail is likely to initiate or destroy anti-tank mines. With the tiller, the remains of AT mines, the furze and all AP mines left are crushed or imitated. Clearance depths of up to 30 centimeters (11.8 inches) in the soil are achieved with the tiller. Live AT mines, including DM 21, TM 57 and TM 62 mines have been cleared.

The MineWolf was subjected to extensive tests with live anti-tank mines, undertaken in Myanmar, Lower Saxony, Germany, at the Army proving ground. The tests were conducted with a fully-operational MineWolf using both types of mine-clearing devices (i.e., flail and tiller). The vehicle was operated by both remote- and operator-control. During four tests an instrumented Anthropomorphic Test Device (fully instrumented test dummy) was placed on the driver’s seat. The measured values had to be evaluated to view possible risks to the operator during mine clearance.

A total of six remote clearance tests were conducted against live anti-tank mines. Four of these tests led to the detonation of the cleared AT mines and thus to measurable results that could be used to analyze the damage to the demining tool and the MineWolf. Two tests each with the two mine-clearing devices (flail and tiller) were conducted against one DM 21 and TM 57 AT mine each. In order to be able to rule out uncontrollable movements of the MineWolf, it was secured to a recovery tank during the tests by a steel rope. The mines to be cleared were laid one by one centrally and offset in front of the clearing device. After a detonation, the vehicle was stopped immediately and the effects were documented. If required, the clearing device was repaired prior to the next test run.

Test schedule. The testing of the method and timing were conducted in the following order:
1. MineWolf remote-controlled tests with flail and a fully instrumented test dummy (ATD)
2. AT mine tests (DM 21, TM 57 and TM 62)
3. Biomechanical tests with an ATD
4. MineWolf manned tests with flail and tiller using three different operators
5. Fragmentation mine tests (DM 31)
6. Tests with detonations without repair to investigate quality of clearing operations

Figure 1: The MineWolf in action

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**Remote-Control Tests**

Tests performed remotely using the flail and tiller apparatuses were conducted with AT mines TM 57 (6.5 kg TNT), TM 62 P3 (6.5 kg TNT) and DM 21 (5 kg TNT). The remote-control tests were necessary to record the physical effects and potential risks for the operator and MineWolf. These effects were measured by means of an instrumented test dummy, in order to be able to perform a human-related biomechanical assessment. To record the measured values, an ATD was placed on the driver's seat and was fitted with various sensors to measure human-relevant impact information. A total of six remote clearing tests were conducted against live AT mines. Four of these tests led to the detonation; two of the mines were crushed. Little or no flail repair work was necessary after the unmanned tests. Damage to the tiller device is shown in Figures 4 and 5. The repairs shown in Figure 6 are mainly welding work, which could be performed on-site the same day.

**Biomechanical Results**

The remote-control tests were a necessary prerequisite to performing the manned tests. The results of the biomechanical assessment and the blast-pressure measurement had to rule out any hazard to the operator when clearing live anti-tank mines.

The results of the biomechanical measurements with the fully instrumented dummy were within a very acceptable range. This assessment was based on the instrumented AT mine types DM 21, TM 57 and TM 62 and refers to mine detonations that occurred in the area of the clearing device.

The assessment of the blast pressure load in the driver's cab showed that the blast pressure load is very low in the cabin and damage to the car is not expected if adequate car protection is worn.

In summary, it can be stated that the operator in the driver's cab of the MineWolf is not subjected to an intolerable risk of injury by the explosion of a DM 21 or TM 57 anti-tank mine if the mine detonates in the area of the mine-clearing device (both types were successfully detonated during the test). The risk of injury is very low and far below the allowed limits for mine-protected vehicles of the German Army, which are based on international standards. Even in the case of repeated successive loads, no serious consequences are expected. Temporary light disturbances like headaches or muscular pain, however, cannot be excluded.

During the four tests, all human-related criteria were tested to the extent that they could be evaluated.

**Manned Tests**

Test personnel conducted the manned tests with the AT mines TM 57 (6.5 kg TNT) and TM 62 P3 (6.5 kg TNT). The assessment of the blast pressure load in the driver's cab showed that the blast pressure load is very low in the cabin and damage to the car is not expected if adequate car protection is worn.

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Figure 1: The operation of the MineWolf was not affected by fragment hits from the AP fragmentation mine DM 31.

Damage to the clearance machine included one worn wheel and two bent cross-sprots (the cross-sprots, or star brads, were deformed by an area of 30 by 130 centimeters (11.8 by 5.1 inches). The damage seemed to be more severe than compared to the previous tests with the TM 57. The mine crater in the ground was of normal size. There was no clearing debris caused by the clearing device as a result of the damage suffered by this vehicle.

The TM 57 was also affected on the top contact with the mine-clearing device. The hit and the mine fuze DM 56A1B1 was initiated. The hit was detected through the protected operator cab were detected. The operation of the MineWolf was not affected by the fragment hits.

Final Summary of Results

The complete and final summary of results from testing is taken from the German Federal Armed Forces Technical Center for Weapons and Ammunition’s Final Report: MineWolf Clearing of Live Mines.1 The mine-clearing MineWolf system with both accessory devices is suitable for clearing live anti-tank mines. The use of the flail device for clearing anti-tank mines caused only minor damage that could be repaired with a limited effort so that there was no need for repairs at all. Together with the use of the still live anti-tank mines, however, resulted in considerably greater damage, which could only be repaired with a substantially greater effort than those caused with the flail. The repairs, mainly welding work, would have had to be performed at the same site that day.

The load on the operator plus mine clearance system is within the manageable and acceptable range. This finding is a result of the biomechanical evaluation of ATDU dummy measurements and through questionnaires of the three operators. It applies to the examined mine types of TM 57 and 60 Y and only mentions mine deminers that occur in the area of the clearing project.

In addition, taking into account the results achieved by MineWolf clearing operations in Bosnia-Herzegovina, Croatia and southern Sudan, these results confirmed that the new concept is the basis for developing the demining process from ground preparation to mine clearance and shows improvement over other methods and systems with regards to effectiveness, quality and cost. (See Endnotes, page 112)

The Mine Action Express, [Brief on page 8-8]


2. J. L. Cottrill, "Plant Protection Against ERW, Hvidtfeldt [from page 22]


6. “Editor’s Note: Some mines and anti-personnel mines are coming to the end of their useful life. In the field, some have been replaced by newer models, no longer relevant and in the interests of community reintegration, have been considered for decommissioning. In most cases, however, old landmines have been cleared; therefore, even more “unique” and “special” landmines face the condition of having to last as long as possible for social and community reasons.

Explosive Remnants of War in Afghanistan, Dismantle and Hassle [from page 20]


2. The operations were conducted by the Action Group on Landmine Clearance and the MineWolf project team. The test site was selected for the availability of similar terrain conditions. In certain regions, the new Anasazi canister multishoots (33 square inch) spheres, the state-of-the-art metal detecting and x-ray systems and equipment, including the method of detection of the mine in order to determine its size and distance to an object or subject.

3. It is assumed that the improvements in our understanding of conditions currently affecting post-conflict demining and de-mining in the region will be even more significant.

4. The use of mechanical means for humanitarian de-mining.

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