10-16-2018

DDAS: Manual Demining Handtool Design Criteria

HD-AID
Humanitarian DeminingAccident and Incident Database

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Manual demining
hand-tool - design criteria

The research I have carried out on tool development has been based on accident studies, field trials and my experience in both demining and in manufacturing in small workshops. The research led to the evolution of the following criteria and constraints. I believe that these are essential requirements when designing hand-tools for use when excavating anti-personnel blast mines. Tools used during other demining activities may not have the same requirements.

1. The user's hand should be as far as possible from any accidental initiation – usually as least 30cm from the point of any tool.
2. The material used to make the tool must be sufficiently malleable for it to distort rather than break in any AP blast mine detonation – this usually prevents the use of high carbon steels.
3. The tool must be constructed so that it does not readily separate into component parts in any AP blast mine detonation – this usually means that the shaft must be taken right through the handle and that the handle must also be malleable.
4. The tool should be designed so that it is easiest to use at a low angle to the ground by a kneeling or squatting deminer, so encouraging the user to keep his hand beneath the fragment cone associated with many detonations.
5. Whenever possible, the tool should include a blast-guard for the hand using it.

I do not specify that tools should be designed for one-handed use, but I recommend that this be the case whenever possible. The advantage of this centres on the fact that only one hand is exposed at a time. Some deminers favour two handed tools, in which case

the handle for the second hand should also be as far as possible from any accidental initiation.

My own tool designs are not presented as "final solutions". I believe they present a baseline on which others can build, in particular with ergonomic improvements. If the above rules are applied, I am confident that any good design engineer with field experience could do better, and look forward to seeing them do so.

If designing for local manufacture, it is essential to minimise the materials and parts required. It is also essential to minimise the processes and tools that have to be used. For example, if it is necessary to cut a thread onto stainless steel round bar, consider using threaded stock and removing the thread where it is not needed.

The materials that I believe work well are **E304 Stainless Steel** and Medium or High Density PolyEthylene (MDPE/HDPE). Materials to avoid are brittle plastics and hardened metals. It is also wise to avoid natural materials such as wood and leather because their quality varies dramatically between samples so consistent quality cannot be assured. E304 is an American AISI type. The composition is: 18-20% Cr, Chromium; 8-12% Ni-Nickel; a maximum 0.08% C, carbon; a maximum 2% Mn, Manganese; and a maximum 1% Si, Silicon. The UNS designation for 304 is S30400 Annealed, Tensile Strength MPa 518; hardness Brinell 201; ASTM Specification A240.

No design can be considered a success until it has been subjected to blast testing against real or simulated mines containing at least 200g TNT. Do not be tempted to try with a much reduced explosive charge because even cheap garden tools may stay in one piece with the smaller mines. Remember NOT to use a plastic explosive as a substitute for TNT because a similar weight will usually be a harsher test. This is because the VoD (effectively the initial velocity of the blast front) can be much faster. Present the tool at an appropriate angle to the charge, with the tool tip on top of it. Tether the tool to the ground, but let it be thrown back as it would be in a real accident, so use a long tether (such as 15m of strong nylon cord).

And please let me know how it goes....