

Digger DTR Demining Technologies | Switzerland

GENERAL DESCRIPTION

The *Digger D-2* is a light-weight, remotely-controlled multi-tool mine clearance vehicle developed by the Swiss NGO, Digger DTR. This organisation has 11 years of technical background in mechanical demining, acquired through the development of a vegetation cutter for mine clearance, (Digger D-1) and a multi-tool machine for mine clearance (Digger D-2). Digger DTR has five years of field experience, mainly acquired during tests and operational engagement in North and South Sudan and in Macedonia.

The vehicle consists of an armoured, V-shaped hull made of 10 mm hardened steel which minimises the damage caused by AP mines or UXO detonations. Both the tracks and all air intake latticing around the Digger D-2 are armoured, to make operation possible in vegetation clearance tasks where the ground was not previously touched by the flail. The flail can be used for both AP and tripwire mine clearance and vegetation cutting.

Through a Caterpillar Quick Coupler, every standard Caterpillar tool (such as a shovel) can be attached to the front of the D-2. This makes the vehicle highly versatile.

The system is remotely controlled from 50 m to 500 m range by an operator placed behind a shield in the line of sight. The remote control system is shock-, slash- and dust-proofed and displays data from the vehicle.

Despite its rugged design the machine should not operate in areas where many AV mines are expected.



DIGGER 2 | Operating along runway

CLEARANCE AND CUTTING METHODOLOGY

The rotor on the flail unit operates at approximately 800 rpm, using 26 chains with hardened steel hammers to remove AP mines and vegetation. Clearance depth can be mechanically adjusted from 0 to 200 mm. Depth control is achieved mechanically and hydraulically through an arms pressure regulation system, which guarantees the flail skids at a constant light pressure on the ground, which can be adjusted by the operator according to soil conditions.

Digger D-2 arms can be raised up to 4 m from the ground, allowing the flail to cut any kind of high and dense vegetation.

The Digger's forward speed can be adjusted between 0.03 km/h and 5 km/h, allowing working speeds from 300 to 2,000 m² per hour. A forward speed regulation allows the machine to work always at the most suitable speed.

MACHINES IN USE TO DATE

The Digger D-1 has been used in Switzerland by the Swiss Army to cut vegetation on a military training field with UXO contamination.

One Digger D-2 has been in use in Sudan since early 2006. After six months of testing in September the machine was integrated into a Swiss Foundation for Mine Clearance (FSD) demining team, which was accredited by the UN in October 2006. After accreditation, the Digger D-2 was operated in different areas in Northern Sudan, until the FSD programme ended in June 2007. Despite some unavoidable breakdowns due to extreme working conditions (dust, hard soil, heat), the prototype was never blocked for more than three days. After these tests, the machine was recommended by the UN in Sudan for other mine clearance programmes in Sudan.

This prototype continues to work with Mines Advisory Group in Northern Sudan in 2008.

Series production of the machine began in 2006. The first serial production unit was sold in summer 2007 to The Development Initiative (TDI), which works for the UN around Juba, South Sudan. The unit began working in October 2007 and stopped one year later after the unexpected termination of TDI's contract with the UN.

ENGINE, FUEL AND OIL

The Digger D-2 is equipped with a 4.5 litre, 140 hp John Deere turbo-diesel engine which is cooled by a double heat exchanger and uses a three-stage air filtration system. Fuel capacity is 115 litres with a maximal fuel consumption of 22 litres per hour. The engine oil capacity is 17 litres. Hydraulic fluid capacity is 160 litres. All lubricants can be changed easily through openings in the hull and quick-coupler connections, in order to simplify maintenance.

FACTORY SUPPORT

The Digger D-2 can be delivered with an initial spare parts kit, containing all most-used parts. The manufacturer also offers a "wearing parts kit", which is specifically adapted to each place of operation. Engine parts can also be provided through the international John Deere retailer network. If desired by the customer, Digger DTR provides basic drawings of some parts, such as track links, thus allowing the operator to make field repairs which can reduce breakdown time when supplies are restricted.

Initial training can be provided at the Digger DTR facility in Switzerland or at the client's operation base.

All technical manuals and training material are available in English and are included in the D-2 package.

Digger DTR's experienced technicians provide technical support throughout the world. If available, a Digger technician can be hired by the customer, paid by the user at standard international staff conditions.



DIGGER 2 | Operating from behind shield

MAINTENANCE AND SUPPORT

Daily/weekly servicing is required (30 min/two hours). Recommended crew: one operator (remote control), with basic mechanical skills. The machine can be delivered in a 20 ft container, with complete workshop equipment.



DIGGER 2 | Testing

TESTS AND EVALUATIONS

The D-2 prototype was tested by Digger in Sudan in 2006. After Digger's own tests, it was tested by FSD according to their specific performance trial. The D-2 met all requirements, with the exception of the track system, which had to be improved. With this improvement made, the prototype was accepted by the FSD for their programme in Sudan.

Two other test reports are available on the ITEP website:

1. Chris Leach and G.G. Coley, Pre-Trial Assessment of Digger D2, Defence Research Development Canada, Canada 2006: www.itep.ws/pdf/DiggerD2_PTAfinal.pdf
2. Patrik Blomander, DIGGER D-2 Test and Evaluation, Swedish EOD and Demining Centre, Sweden, 2009: www.itep.ws/pdf/DiggerD2_CWAfinal.pdf

REPORTED LIMITATIONS AND STRENGTHS

Extracts from the Swedish EOD and Demining Centre report include:

“The machine was tested with both flail and tiller. ...The Digger D-2 with flail triggered or neutralised 447 out of 450 mines, 99 % of the targets. Of the 447 mines 416 were triggered and 31 mines neutralised with live fuzes. 3 mines were left live and intact.

“When the machine was using the tiller, it triggered or neutralised 429 out of 450 mines, 95% of the targets. Of the 429 mines 372 were triggered and 58 mines neutralised with live fuze. 20 mines were left live and intact.

“The variation of speed and problem with maintaining the right depth penetration are the main reasons for a low result of triggered mines. ...It was almost the same penetration with flail or tiller. The machine has always been clearing to the required depth and deeper than strictly necessary. The tendency to clear deeper than necessary depends probably on a lack of depth control system.

“The survivability test was performed in two steps. At first the machine was tested with flail and after that with tiller. The target used during the test was the Swedish Anti-Tank Mine 41/47 boosted with 2.25 kg of plastic explosive, giving a total equivalent of 8 kg of TNT. The result was that both flail and tiller shafts were so damaged that further clearing was not possible, but the frame of the tool was not affected. The machine itself showed no damage.”

Limitations

- > The system is designed to operate in AP mine-affected areas only.
- > Difficult to operate with precision from greater distances (which applies to all remotely controlled machines).
- > The system creates huge dust clouds, as occurs with all flail systems in dry environments.

Strengths

- > Manoeuvrable and easy to transport.
- > Can be transported in a 20 ft container.
- > Above-average hill-climbing ability.
- > Light-weight and rugged design.
- > Versatile.

DIMENSIONAL DATA

1. Length without attachment	3,730 mm
2. Length total	5,400 mm
3. Width without attachment	1,660 mm
4. Width total	2,250 mm
5. Clearing Working width	1,800 mm
6. Height Overall	1,920 mm
7. Mass Basic vehicle	6,200 kg
8. Mass Detachable unit(s)	1,000 kg
9. Mass Overall	7,200 kg

OPERATIONAL DATA

10. Wheels Tracks (description)	Steel fabricated tracks Mobile running wheels
11. Ground Bearing Pressure (kPa)	62 kPa
12. Hill climbing ability (in degrees)	30°
13. Number of Chains Chisels Tools	38 chains
14. Beat pattern (hits per m ²) at different operating speeds	8,400 hits per m ² at 0.1 km/h 168 hits per m ² at 5 km/h
15. Length of Chains Tools	390 mm
16. Diameter of drum	Axle 170 mm Flail with chains 950 mm
17. Rotation Speed	700 rpm
18. Clearance Working depth in varying terrain	Up to 200 mm
19. Working Speed (m ² /h)	
> Light Soil Medium Vegetation	2,000 m ² /h
> Medium Soil Medium Vegetation	800 m ² /h
> Heavy Soil Dense Vegetation	300 m ² /h
20. Control of Clearance Working depth	Mechanically, arm pressure regulation
21. Additional attachable working tools	—
22. Armour	Hull 10 mm hardened steel R/C operator shield: shield with FB4 or FB6 ballistic protection norm
23. Remote controlled	Yes
> greatest distance	500 m
24. Transportation	
> short distances	
> long distances	International 20 ft container
> sea transport	Local: Ideally on a 6x6 truck, with palletized loading system
> air transport	

SYSTEM STATUS AND DEPLOYMENT

25. Machines in use	3
26. Other types	Digger D-1, Digger D-3
27. Location of use	North and South-Sudan, Macedonia
28. Totally cleared so far (m ²)	More than 200,000 m ² (stated on June 2009)

ENGINE | FUEL | OIL

29. Engine	John Deere, Turbo Diesel, 4 cylinder
30. Engine power at the flywheel	104 kw / 140 hp
31. Sufficient power supplied to working tool	85 kw
32. Fuel capacity	115 l
33. Fuel consumption	22 l/h
34. Separate engine for working unit	No
35. Cooling system	Liquid cooling
36. Oil capacity (both engines)	17 l
37. Hydraulic oil capacity (both engines)	160 l

COSTS

38. Cost of system	On request
39. Other costs	On request
> training	
> spare part set chains belts	On request
40. Availability for hire	Yes

OTHER

41. Operator comfort	N/A
42. Air conditioning	N/A