WM20

19th International Symposium of Ballistics, 7–11 May 2001, Interlaken, Switzerland

APPLICATION OF LOOSE POWDER LINER SHAPED CHARGES TO AVALANCHE CONTROL

C.A. Weickert[1] and K.M. Powell[2]

[1] *Defence Research Establishment Suffield, PO 4000, Station Main, Medicine Hat, Alberta, Canada, T1A 8K6. Tel 403-544-5331, Fax 403-544-5324.*
[2] *Delta K Explosive Engineering Systems Ltd, 170 London Road, Dunton Green, Kent, TN13 2TA, UK. Tel (01732) 779018, Fax (01732) 779018.*

Shock and blast energy emitted from a simple explosive charge is rapidly attenuated by the porous structure of snowpack. For a small mass penalty, the jet from an appropriately designed shaped charge can induce an additional highly energetic reaction between the jet and target material. The highly directional and penetrative characteristics of this reaction can significantly increase the response of unstable snowpack when positioned above or below the surface, and has recently been shown to be particularly effective at disrupting ice formations within established cornices. Comparisons of experimental results for fifteen charge configurations and the reference avalauncher round are presented.

INTRODUCTION

The most common uses of explosives in avalanche control operations include hand placed/launched charges, nitrogen gas gun launched projectiles (Avalauncher) and 75 mm & 105 mm artillery gun systems. Of these, it is the avalauncher projectile that was chosen as the reference for this research study. The projectile contains a simple bulk charge of 900 g of pentolite high explosive cast into a cardboard tube fitted with a plastic nose cone and base cup. A plastic tail fin assembly, carrying the detonator, safe arming and firing mechanism is fitted immediately prior to firing.

EXPERIMENTS

Fifteen different charge designs were used in the experiments. The diameter of the charges was held constant at 76 mm and the length was adjusted to match the explosive mass of the avalauncher round. The casings were fabricated from polyester resin/fiberglass and were machined to the required dimensions. Four bulk explosive charges were used consisting of C4 (RDX based), DM12 (PETN based), Trigran (TNT/Aluminum pellets) and FIXOR™ (flammable liquid + inert powder = binary explosive). The remainder of the charges consisted of various shaped charge designs hand stemmed with C4 plastic explosive. The experimental liners consisted of loose aluminum (15 micron standard powder or 2–3 micron fine powder) or copper powder (17 micron) contained between 1.3 mm polyester resin/fiberglass skins. The liner assembly was vibrated during loading to consolidate the powder. Hemispherical, cylindrical and conical (30 and 45 degree) liners were tested. The 45 degree loose powder conical liners were compared to conventional 45 degree solid copper and aluminum liners with the same mass. Both central and peripheral initiation on the conical shaped charge designs were tested.

The experimental firings were conducted in a stable 2 m deep snowpack in a level mountain basin area at Alta Ski Resort. The experimental procedure consisted of placing the charge to be tested horizontally at the bottom of a pre-formed borehole at a depth of 1.2 m. The charge was fired and the resulting crater was sectioned and the profile measured. Cracking of the snow layers and heave was also recorded.

DISCUSSION

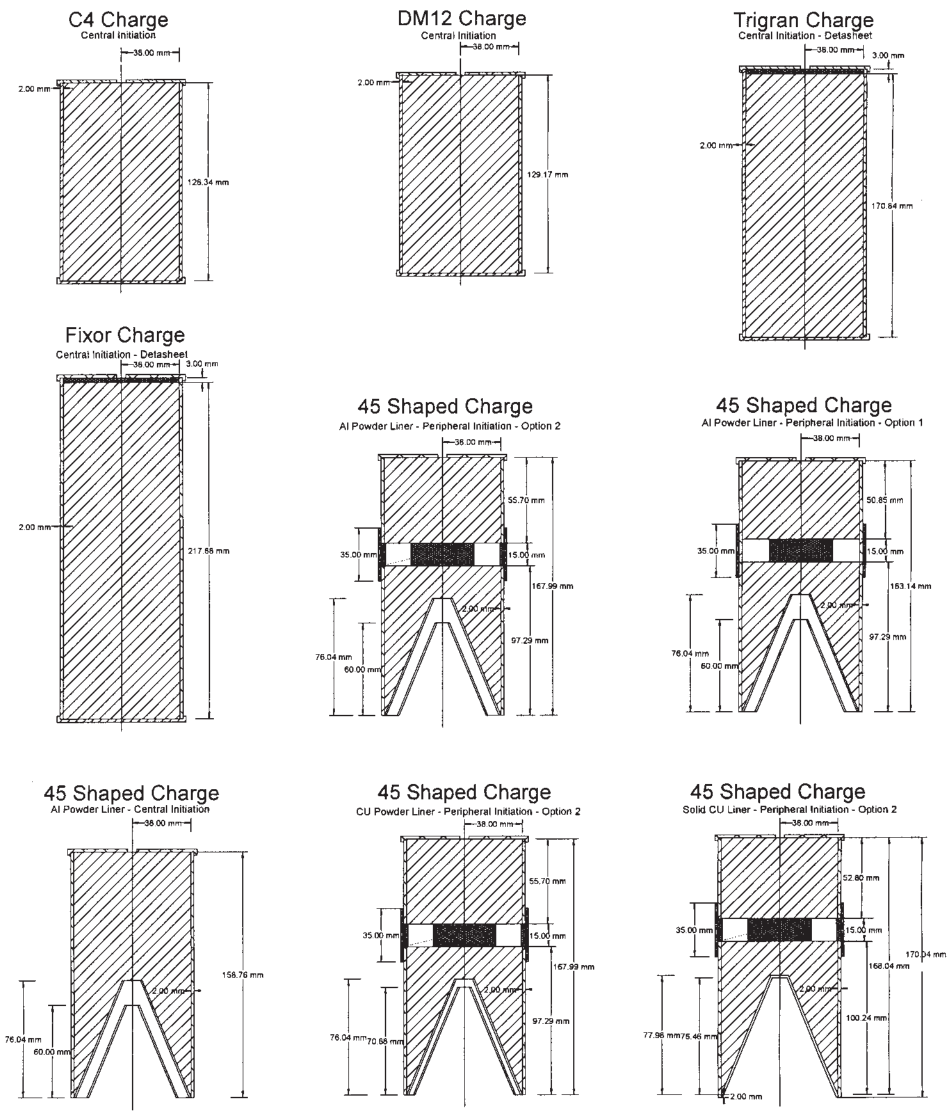
Due to the near blizzard conditions during the trial series it was difficult to record the data. In the crater profile images (not scaled) shown on the right side of the figures pages the major cracking was highlighted with fluorescent orange spray paint. Scaled plots of the profiles and the cracks are given to the left of the images. The approximately horizontal straight line represents the snow level prior to the charge firing. The shaped charges were fired with the resulting jet travelling from right to left.

CONCLUSIONS

The performance of the bulk explosive charges w.r.t. crater size is similar. The aluminized explosive composition Trigran produced cracking to the furthest extent. The peripheral initiation shaped charge results in similar sized craters as for central initiation except there is significantly more cracking. The powder liner shaped charges resulted in larger craters than the solid metal liners. All shaped charge designs resulted in more damage compared to the bulk explosive charges.

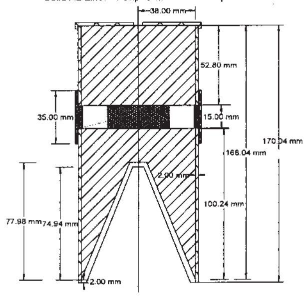
ACKNOWLEDGMENT

The authors gratefully acknowledge the assistance of Tom Storrie, Steve Mowers, Keith Gerrard, Linda Beaupre and Jez Earnshaw for their fine work.


C4 Charge
Central Initiation
38.00 mm
2.00 mm
126.34 mm
DM12 Charge
Central Initiation
38.00 mm
2.00 mm
129.17 mm
Trigran Charge
Central Initiation - Detasheet
38.00 mm
3.00 mm
2.00 mm
170.84 mm
Fixor Charge
Central Initiation - Detasheet
38.00 mm
3.00 mm
2.00 mm
217.88 mm
45 Shaped Charge
Al Powder Liner - Peripheral Initiation - Option 2
38.00 mm
55.70 mm
35.00 mm
15.00 mm
167.99 mm
2.00 mm
97.29 mm
76.04 mm
60.00 mm
45 Shaped Charge
Al Powder Liner - Peripheral Initiation - Option 1
38.00 mm
50.85 mm
35.00 mm
15.00 mm
163.14 mm
2.00 mm
97.29 mm
76.04 mm
60.00 mm
45 Shaped Charge
Al Powder Liner - Central Initiation
38.00 mm
158.76 mm
2.00 mm
76.04 mm
60.00 mm
45 Shaped Charge
CU Powder Liner - Peripheral Initiation - Option 2
38.00 mm
55.70 mm
35.00 mm
15.00 mm
167.99 mm
2.00 mm
97.29 mm
76.04 mm
70.88 mm
45 Shaped Charge
Solid CU Liner - Peripheral Initiation - Option 2
38.00 mm
52.80 mm
35.00 mm
15.00 mm
170.04 mm
168.04 mm
2.00 mm
100.24 mm
77.98 mm
75.46 mm
2.00 mm

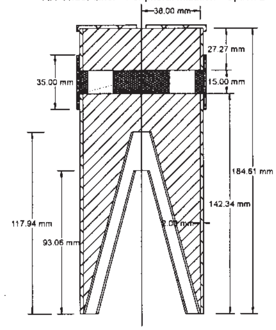
45 Shaped Charge

Solid AL Liner - Peripheral Initiation - Option 2



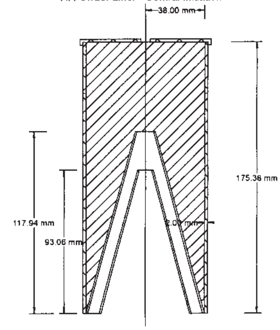
30 Shaped Charge

Al Powder Liner - Peripheral Initiation - Option 2



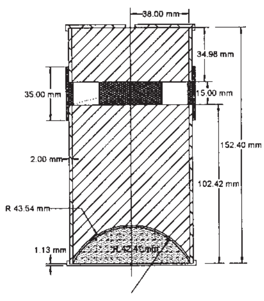
30 Shaped Charge

Al Powder Liner - Central Initiation



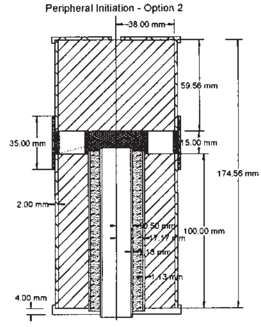
Hemi Charge

Peripheral Initiation - Option 2



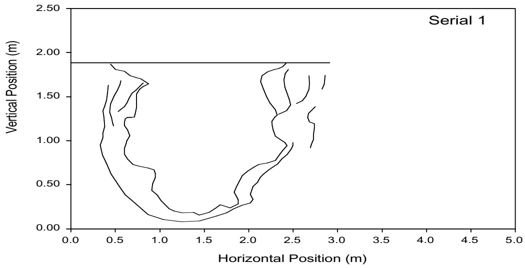
Cylindrical Liner Shaped Charge

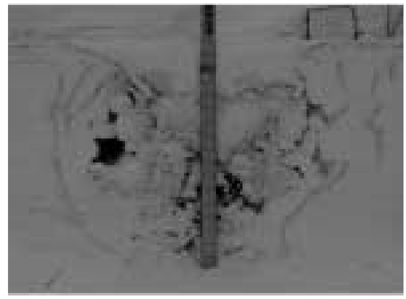
Peripheral Initiation - Option 2

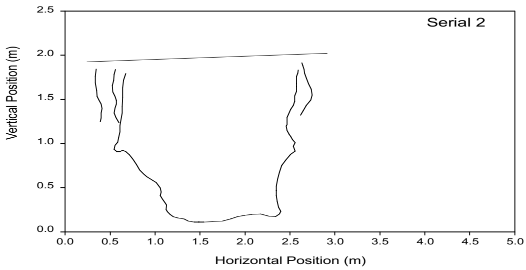


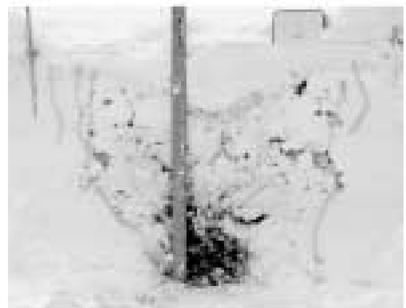
Avalauncher Round

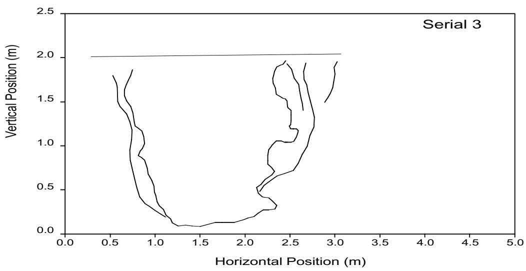
Serial	Charge #	Liner	Initiation	Comments
1	-	-	CI	Avalauncher Round
2	1	-	CI	C4 Explosive
3	2	-	CI	DM12 Explosive
4	3	-	CI	Trigran Explosive – Detasheet Booster
5	4	-	CI	FIXOR Explosive – Detasheet Booster
6	5	Al Powder	PI-2	45° Liner Shaped Charge
7	5	Fine Al Powder	PI-2	45° Liner Shaped Charge
9	6	Al Powder	PI-1	45° Liner Shaped Charge
10	7	Al Powder	CI	45° Liner Shaped Charge
11	8	Cu Powder	PI-2	45° Liner Shaped Charge
12	9	Solid Cu	PI-2	45° Liner Shaped Charge
13	10	Solid Al	PI-2	45° Liner Shaped Charge
14	11	Al Powder	PI-2	30° Liner Shaped Charge
15	12	Al Powder	CI	30° Liner Shaped Charge
16	13	Al Powder	PI-2	Hemi Charge
17	14	Al Powder	PI-2	Cylindrical Liner Shaped Charge

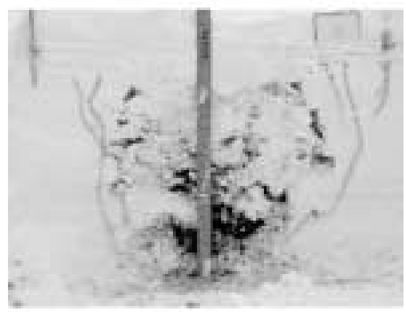

Serial 1
Vertical Position (m)
2.50
2.00
1.50
1.00
0.50
0.00
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)

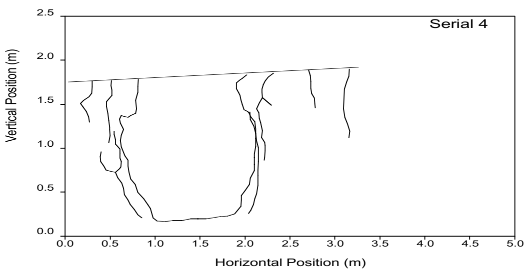


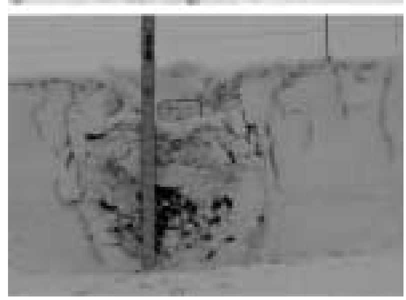

Serial 2
Vertical Position (m)
2.5
2.0
1.5
1.0
0.5
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)

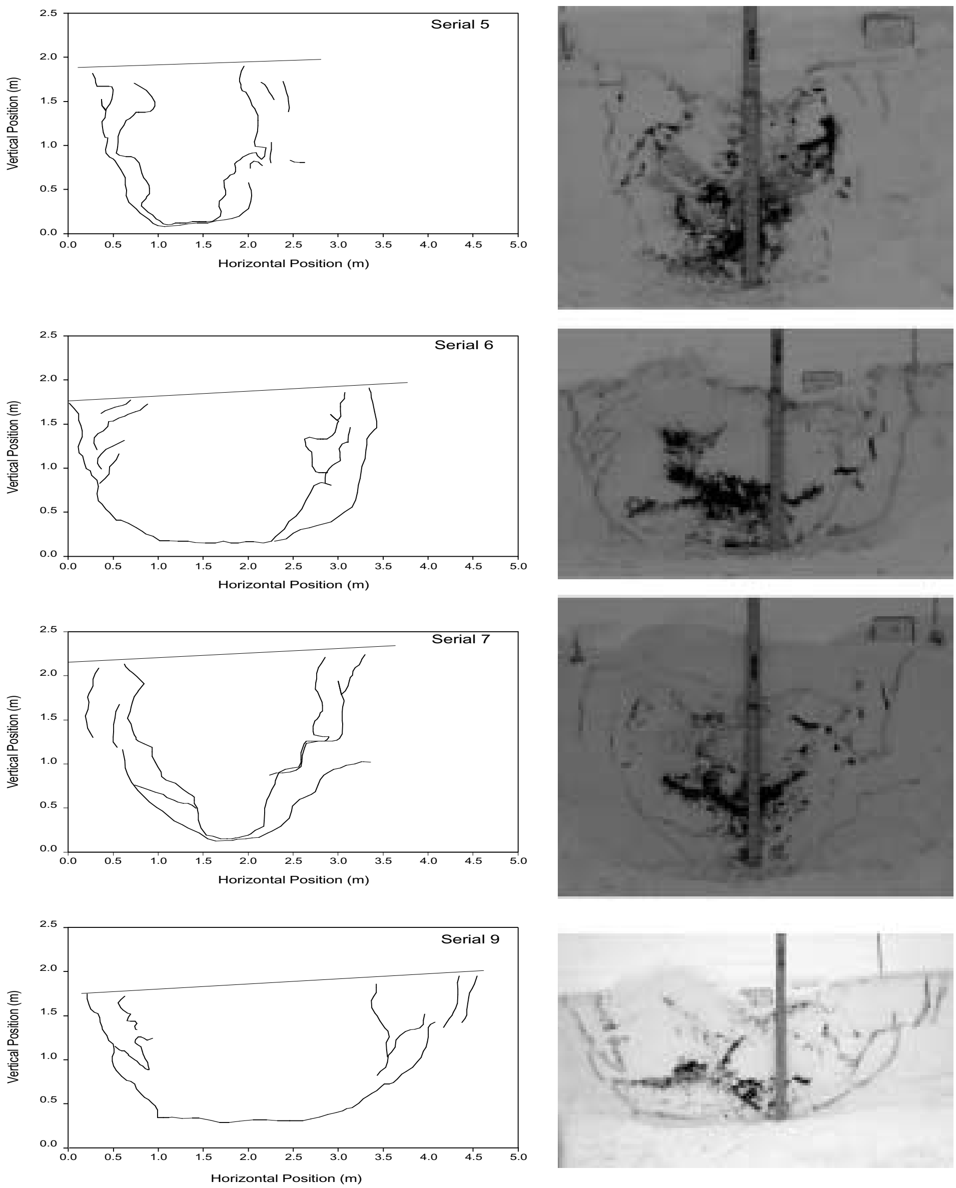



Serial 3
Vertical Position (m)
2.5
2.0
1.5
1.0
0.5
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)



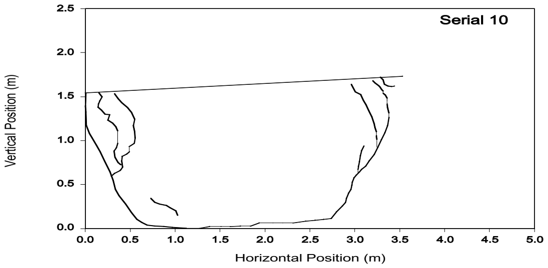

Serial 4
Vertical Position (m)
2.5
2.0
1.5
1.0
0.5
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)

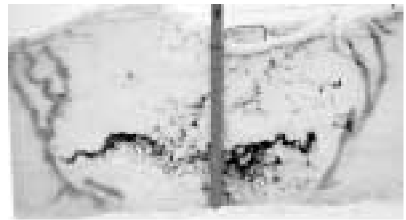


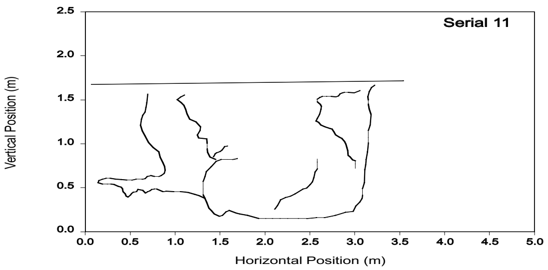

Serial 5
2.5
2.0
1.5
1.0
0.5
0.0
Vertical Position (m)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)
Serial 6
2.5
2.0
1.5
1.0
0.5
0.0
Vertical Position (m)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)
Serial 7
2.5
2.0
1.5
1.0
0.5
0.0
Vertical Position (m)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)
Serial 9
2.5
2.0
1.5
1.0
0.5
0.0
Vertical Position (m)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Horizontal Position (m)

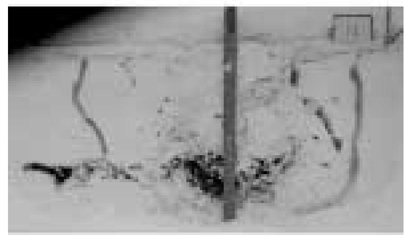
Home

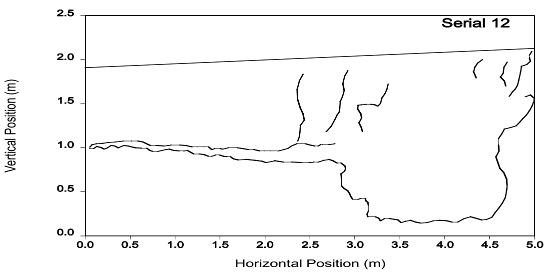
Table of Contents

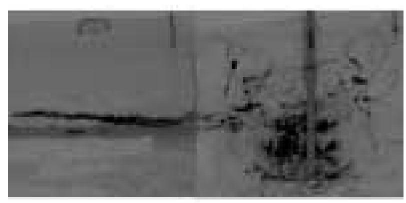


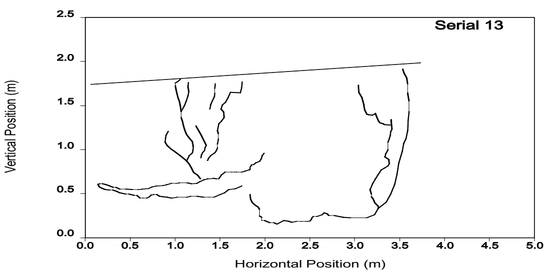


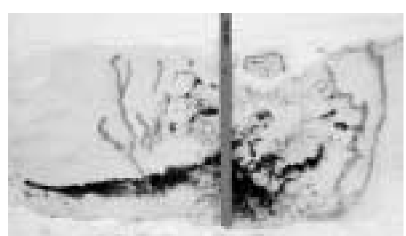


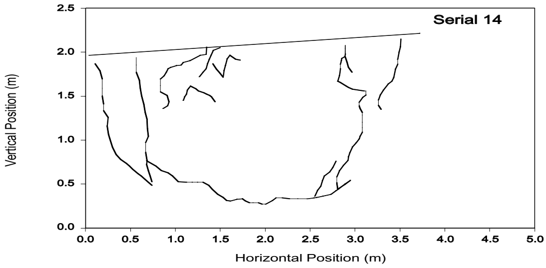


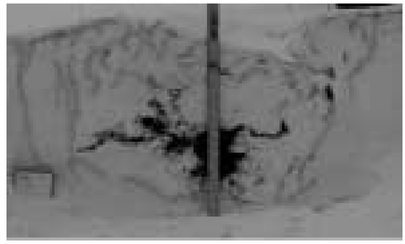


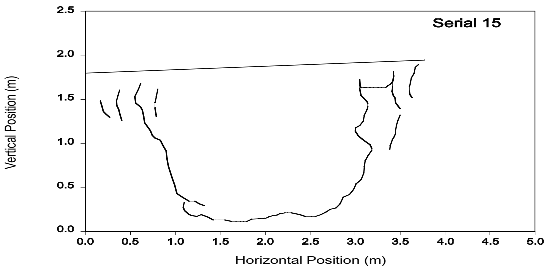


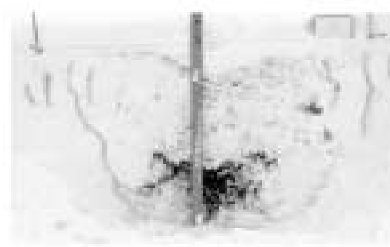


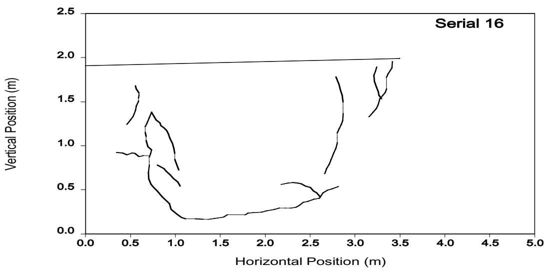


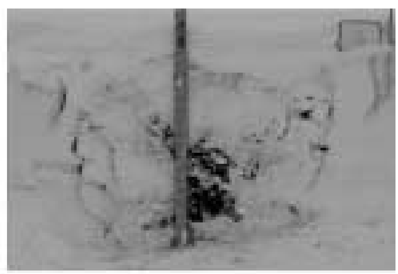

Serial 14
Vertical Position (m)
Horizontal Position (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

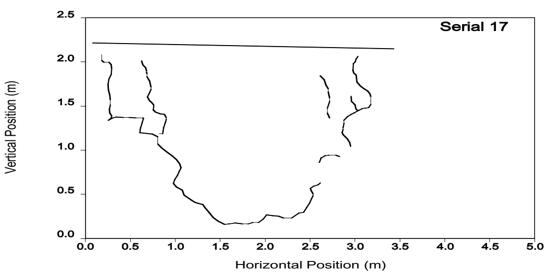



Serial 15
Vertical Position (m)
Horizontal Position (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0




Serial 16
Vertical Position (m)
Horizontal Position (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0




Serial 17
Vertical Position (m)
Horizontal Position (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0