Roadway Cratering Research

Presented by

Denis Rickman

Impact & Explosion Effects Branch, GSL
Engineer Research & Development Center, Vicksburg, MS

Roadway Cratering

Objective

Evaluate current roadway cratering methodologies and investigate improved methods/materiel.

Roadway Cratering

Approach

- Coordinate research effort with MANSCEN/Picatinny Arsenal
- Evaluate effectiveness of current demolition methods (FM-250) for producing roadway craters
- Perform tests of the PAM as a potential roadway cratering munition
- Evaluate alternative methods/explosives for use in roadway cratering to determine whether methods requiring less explosive are feasible
- Report results to MANSCEN/Picatinny

Roadway Cratering

Evaluation of Cratering Explosives

Purpose: Evaluate cratering effectiveness of various explosives in precise boreholes (with tamping) as a baseline for further studies of improved cratering methods

40-lb AN charge

C-4

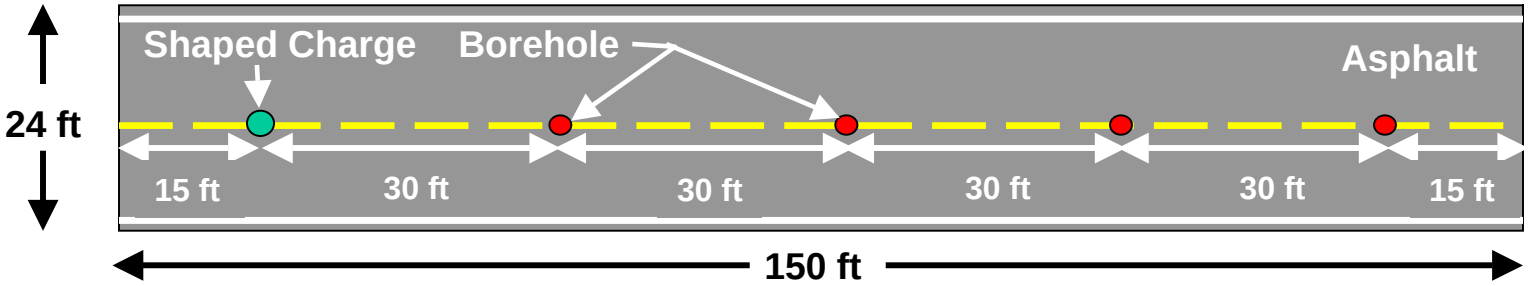
TNT powder

Binex 400 (Sodium perchlorate/ aluminum)

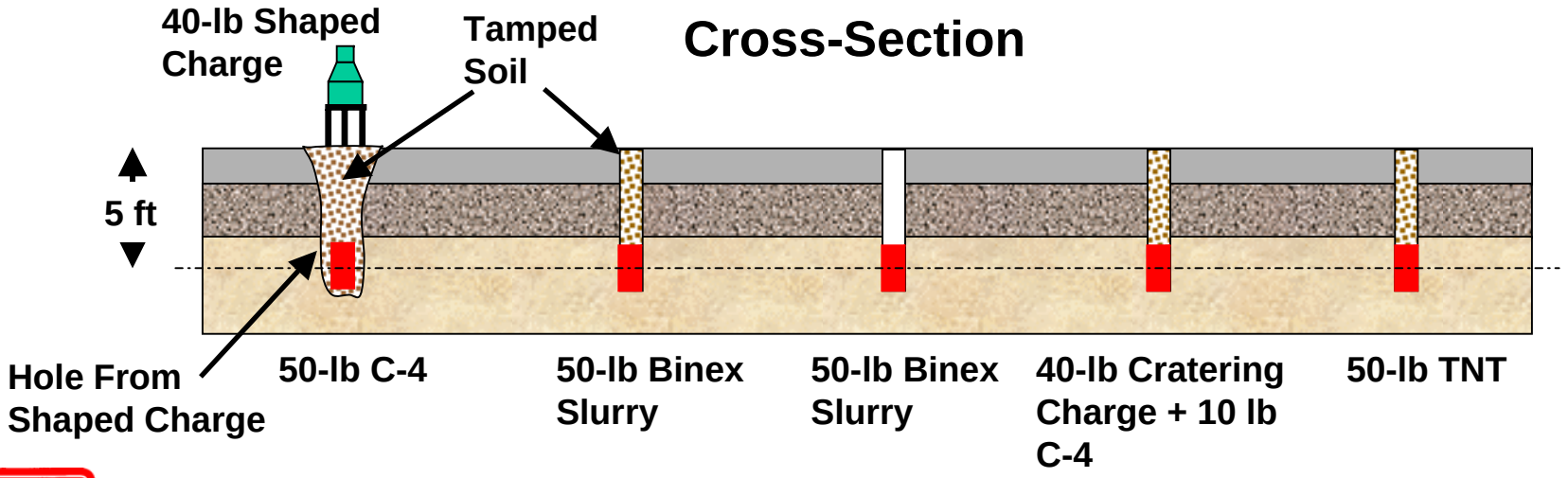
Roadway Cratering

Evaluation of Cratering Explosives

Plan View



Cross-Section



Roadway Cratering

Evaluation of Borehole Effects and Pavement on Cratering

Purpose: Evaluate effect of borehole shape/tamping and the presence of pavement on cratering efficiency. Use 50 lb of C-4 as the explosive charge.

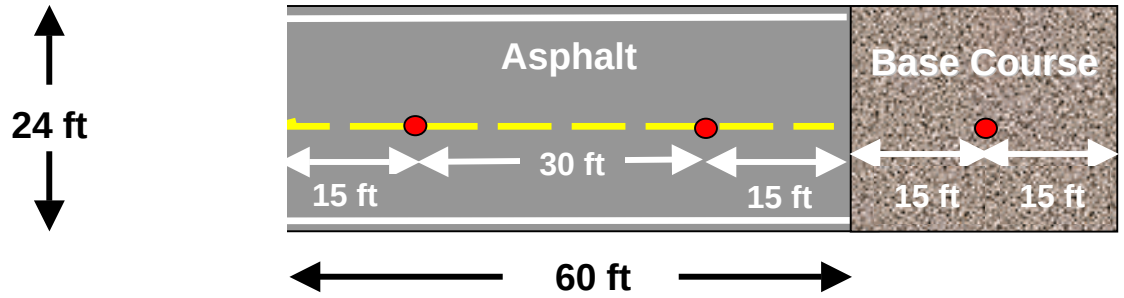
Investigate:

1. **Cratering efficiency of charges placed in a shaped-charge created hole**
2. **Effect of leaving borehole untamped**
3. **Effect of pavement/no pavement**

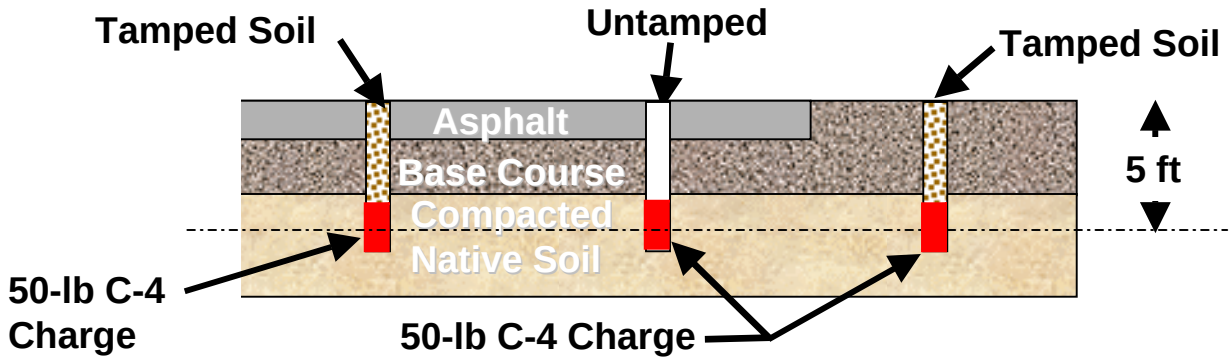
Roadway Cratering

Evaluation of Cratering Explosives – Baseline Study

Plan View



Cross-Section



Roadway Cratering

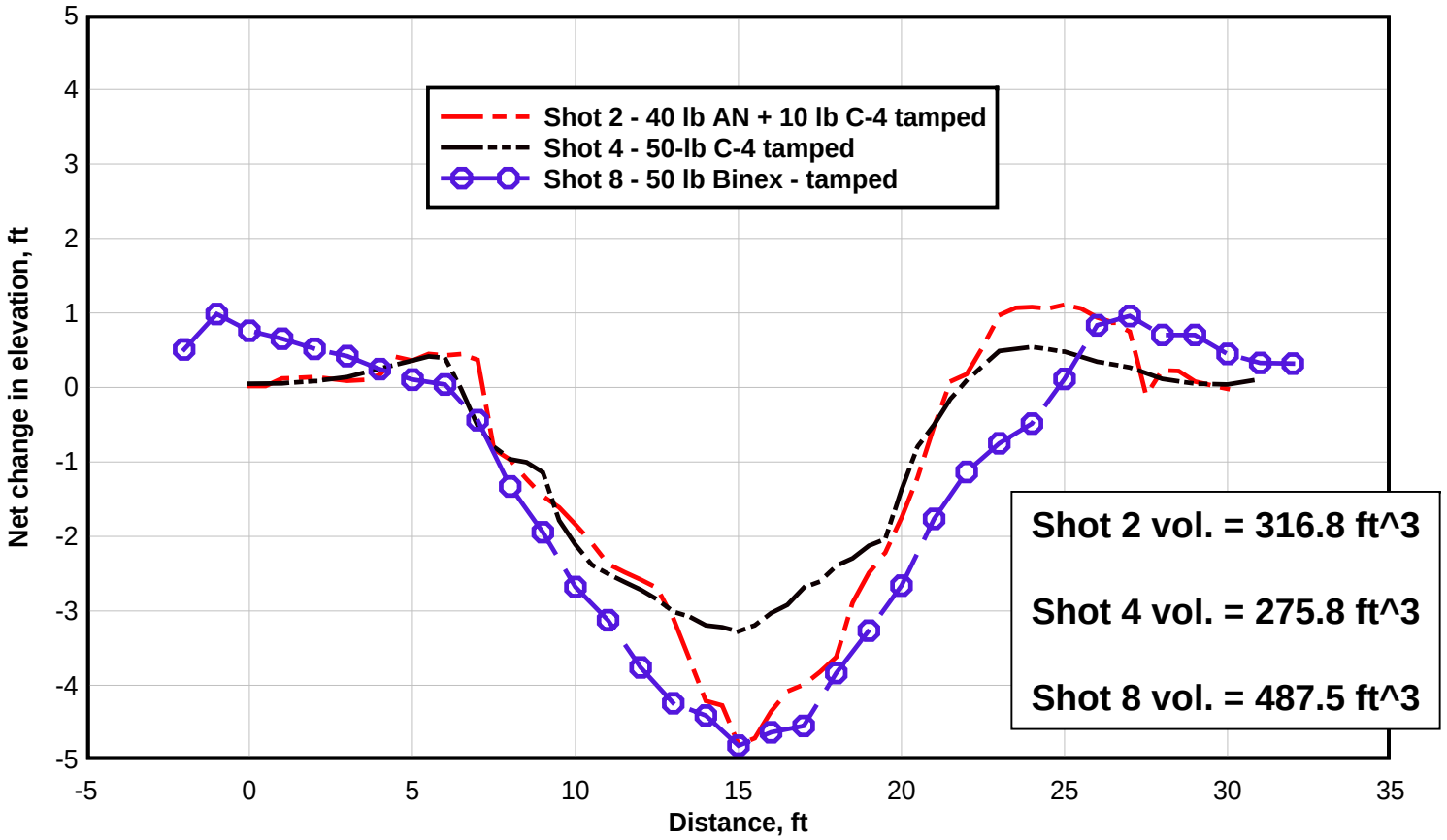
Sample Roadway Craters – 50-lb Charges

40-lb AN Charge
+ 10 lb C-4

50-lb C-4 Charge

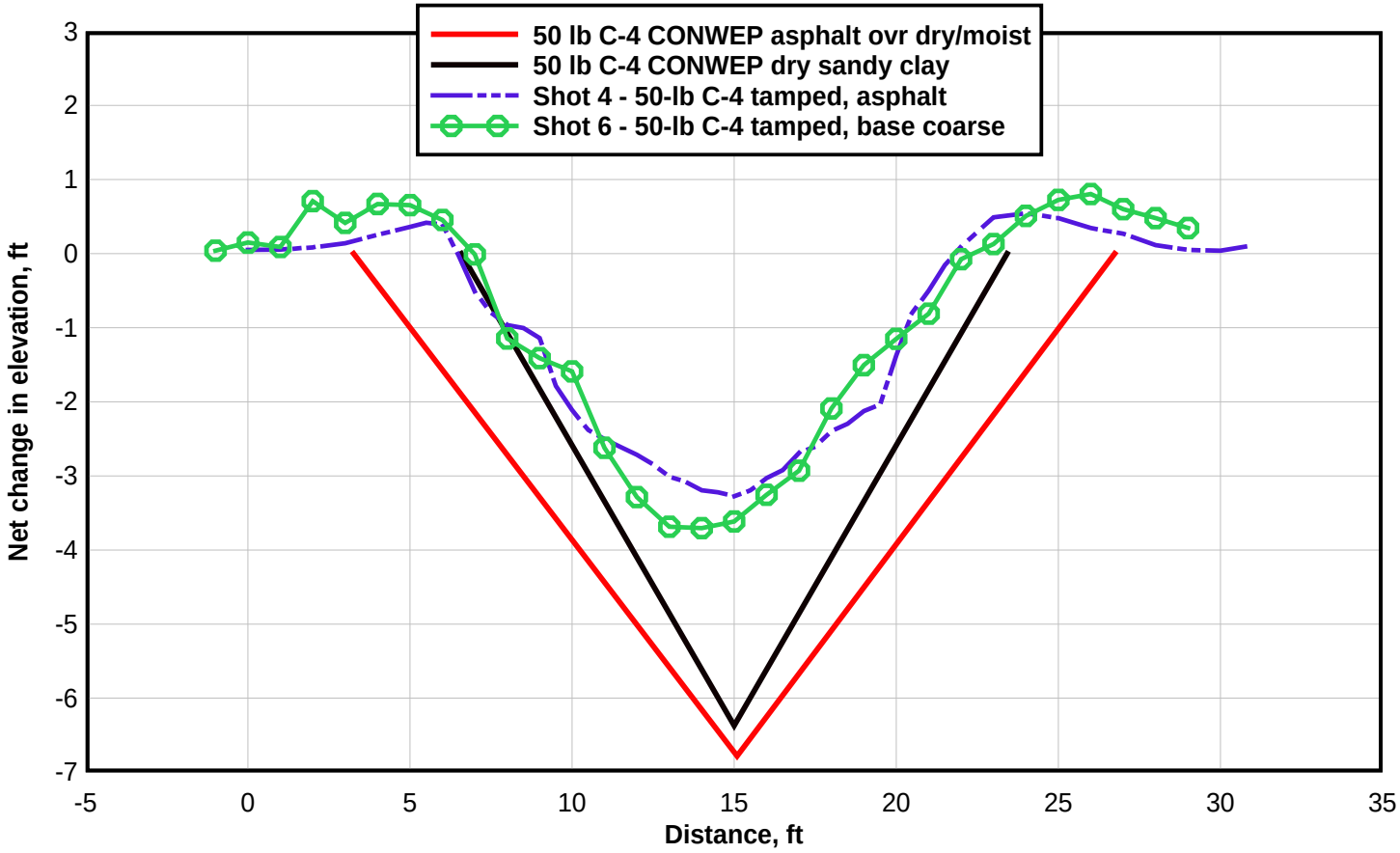
Roadway Cratering

Roadway Craters – Tamped 50-lb Charges AN/C-4/Binex Comparison



Roadway Cratering

Roadway Craters – Tamped 50-lb C-4 Charges Asphalt Overlay vs. Soil



Roadway Cratering

Based upon the results, the following observations were made:

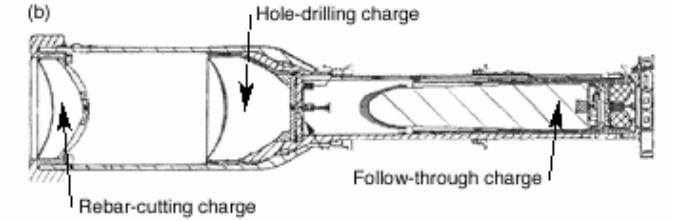
- Roadway crater size appears to be unaffected by asphalt cover
- CONWEP currently predicts larger craters for asphalt cover than for bare soil; this needs to be corrected
- The 40-lb AN cratering charge performs well relative to C-4 and TNT
- The best cratering explosive evaluated was Binex 400
- Binex crater volume was >50% larger than that for AN and >75% larger than for C-4
- Binex may be of interest as a COTS item for demolitions

Roadway Cratering

PAM (Penetration-Augmented Munition) Evaluation

Purpose: Work with USAES/MANSCEN and Picatinny Arsenal to evaluate the PAM (XM-150) as a one-step roadway cratering tool

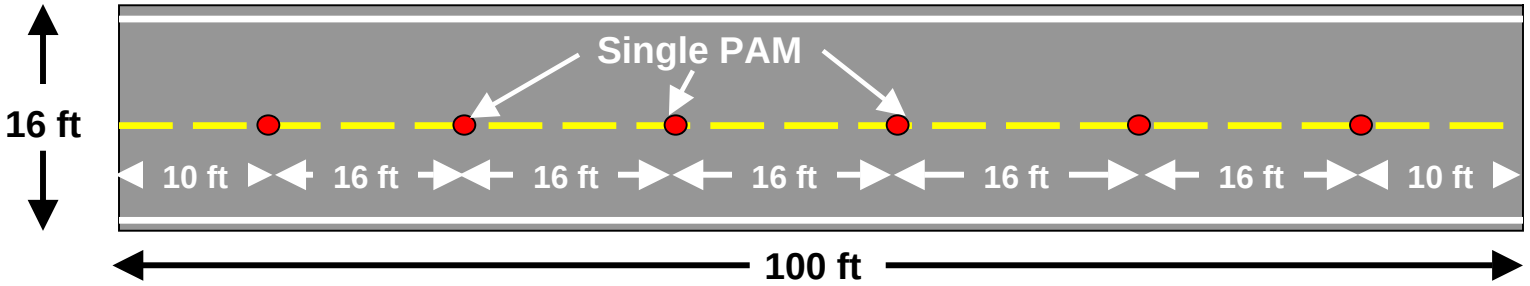
PAM Physical Characteristics:
Weight: 35 lb
Length: 33 in.
Diameter: 8 in.
Target: Reinforced concrete bridge supports
Attachment: Silent stud driver
Initiation: Blasting cap, detonation cord, or any standard military detonation device
Performance: Single-shot defeat of 5 ft x 6 ft reinforced concrete pier
Defeat mechanism: Shaped charge, hole-drilling charge, and follow-through warhead (4.7 lb LX-19)
Shipping container: TOW 2A container



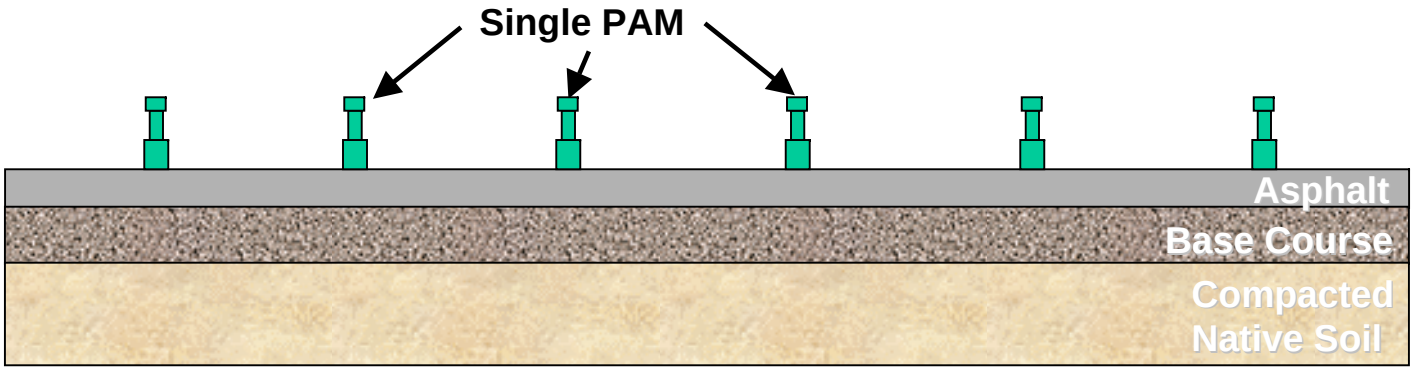
Roadway Cratering

PAM Evaluation

PAM cratering effectiveness tests – Plan View



PAM cratering effectiveness tests – Cross-section



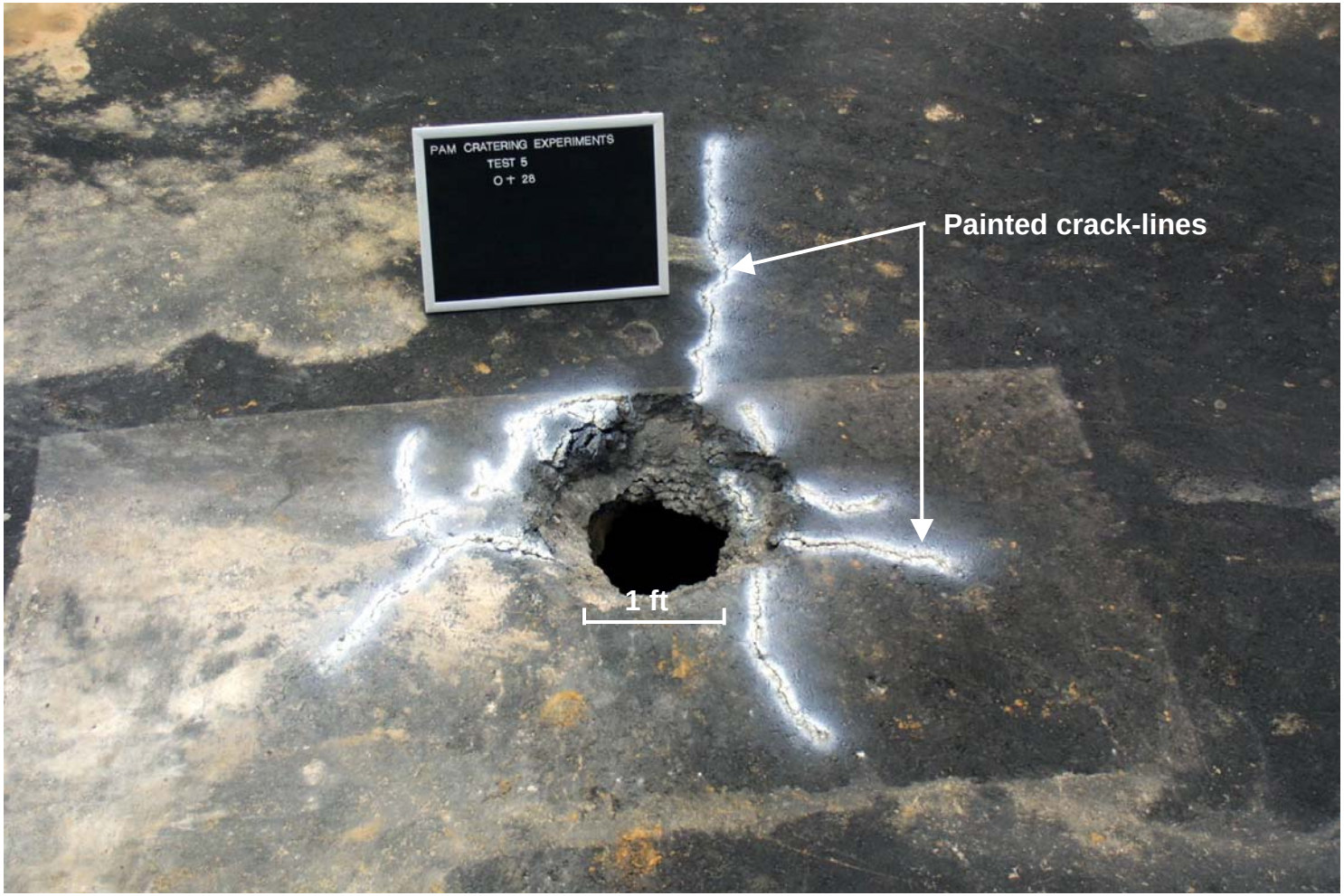
Roadway Cratering

Results Overview

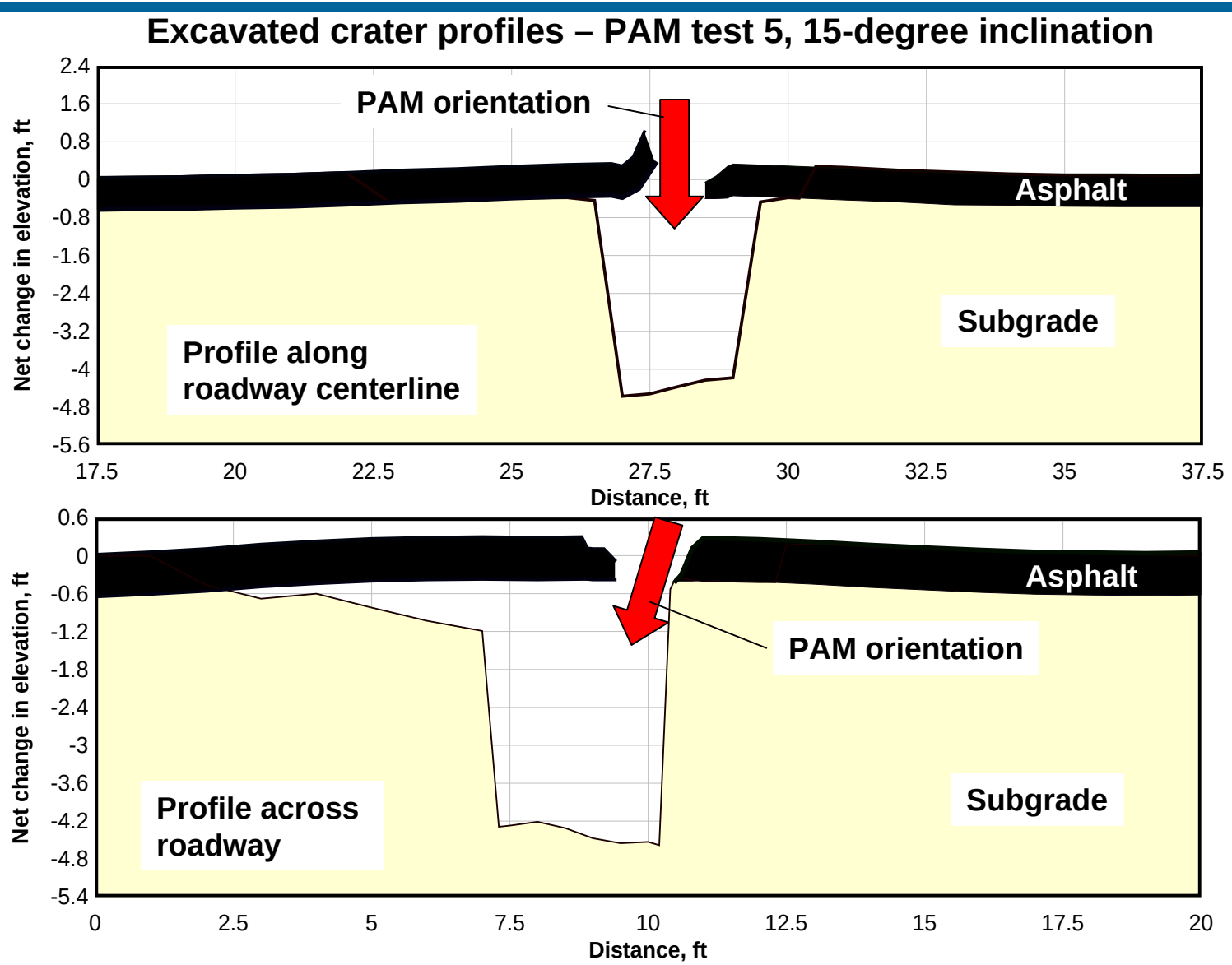
- The PAMs produced camouflet-type craters in which a hollowed-out area extended beyond the hole cut through the roadway surface
- Vertically-oriented PAMs caused little or no local heaving of the roadway; PAMs inclined at 15-30° off vertical caused more pronounced roadway heaving and cracking

Roadway Cratering

Crater overview – PAM Test 5, 15-degrees off vertical



Roadway Cratering



Roadway Cratering

Summary-PAM

Based upon the results, the following observations were made:

- The PAM appears to have potential for development as a roadway or runway cratering tool
- A larger follow-through charge is needed to produce fully excavated craters.
- Based upon the depth of the follow-on charges (~4 ft) at detonation, CONWEP calculations show that it is likely that the charge size will have to be at least doubled (from 4.2 lb to 8.4 lb+) to maximize the crater volume produced