Discussion Of The Directional Characteristics Of Explosives Commonly Used In Avalanche Hazard Reduction

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ABSTRACT: All explosives exhibit directional shock wave characteristics, the explosives commonly used for avalanche control also produce these same characteristics. The purpose of this discussion is that an understanding of these characteristics may allow the field worker to maximize the effect and efficiency of the blast. A presentation of the chain reaction and the resulting shock wave that occurs in the detonation process of the explosive is crucial to enhance this utilization.

The directional characteristics of the hand thrown charge is not so much the focus of this discussion. This is due to the random nature of the placement of the hand thrown charge due of the inability to direct the position of the explosive charge. Furthermore the thrown charge is buried within the snow cover in most instances. The fact that the snow directly affects the buried charge blast shock waves has been shown in previous studies and presented within previous ISSW forums.

The directional shock wave dynamics become much more apparent as a placed or deliver charges. Examples of these explosives would be blasts that are delivered by explosive trams, bamboo blasts, or large volume ANFO blasts to create surface or air blasts and shock waves.

The thrust of this discussion will be to portray these shock wave characteristics in such a manner that the field professional may benefit from an understanding of these characteristics when planning and executing an avalanche reduction blast. It is anticipated that the research for this presentation will show some simple field techniques to utilize the information presented.

KEYWORDS: Characteristics, explosives, blasting, avalanche, hazard, mitigation

This discussion will present the dynamics of the chain reaction and resulting shock wave that occurs with the detonation process of explosives used in Avalanche hazard reduction. This discussion will be basic in nature and an understanding of this process could be beneficial to the Avalanche Professional when planning and executing a hazard reduction blast.

The standard hand charge will be included in the discussion. However due to the random nature of placement when thrown the directional characteristics will be of limited value.

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When the standard hand charge is used as booster for a secondary charge such as ANFO or as a placed charge such as an explosive tram or bamboo blast, these characteristics can help the effectiveness of the blast.

The chain reaction begins with the initiation of the detonator assembly. The explosive material in a blasting cap consists of a flash charge and a base charge (figure 1).

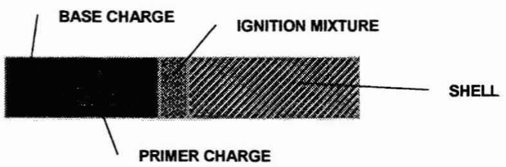

Figure 1 – Blasting Cap

When the flash charge is initiated by the burn of the safety fuse, then the base charge is in turn detonated. This process produces a shock wave that moves in the direction of the chain reaction through the blasting cap (figure 2).

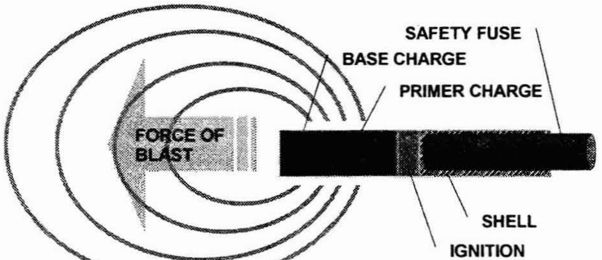

Figure 2 – Blasting Cap with Directional Nature of Shock Wave

The directional shock wave of the detonator will in turn create a directional wave in the detonation of the associated primer (figure 3). In actuality the blast wave portrayed in figure 3 expands 3-dimensionally.

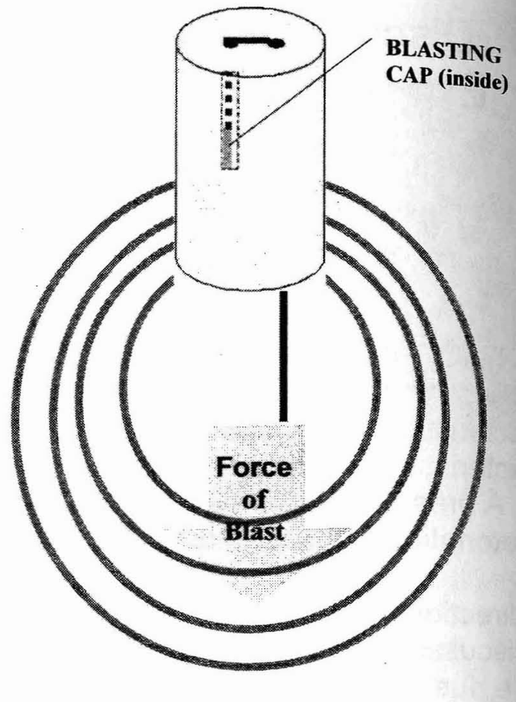

Figure 3 – Primer with Blasting Cap showing directional nature of shock wave

The actual shock wave is going to the back and sides as well as the directional end. The directional effects cause more energy to go in one direction than the other directions, so that the pressure contours are greatly elongated in one direction. It is also important to realize that the further the distance from the point of initiation the directional effects normalize, and the contours become more circular. The shock absorbing nature of the snowpack makes the impact of the initial shock wave a factor to be considered. A tremendous amount of the energy from the blast and shock wave is absorbed by the snow [2]. The closer the explosive is to the snow the greater the importance of considering the directional nature of the shock wave.

When using the primer in conjunction with ANFO or other large explosive

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[2] Effects of Explosives on the Mountain Snow Pack, Jon Ueland, Page 205 ISSW proceedings.

blasts, using these directional characteristics to properly plan and execute the blast can result in maximum effect on the snowpack. Simple items such as the direction and location of the primer in relationship to the secondary explosive can make a tremendous difference in the direction of the initial thrust of the blast (figure4,5).

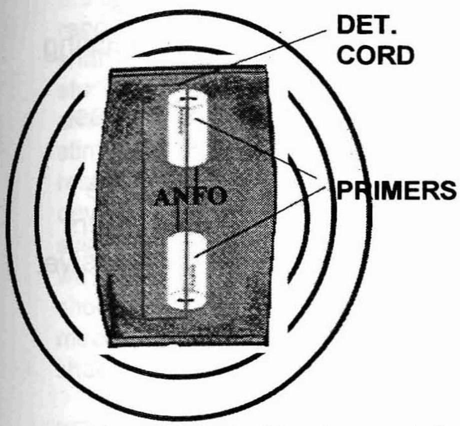

Figure 4 – Large blast with primers, detonation cord, and blasting cap

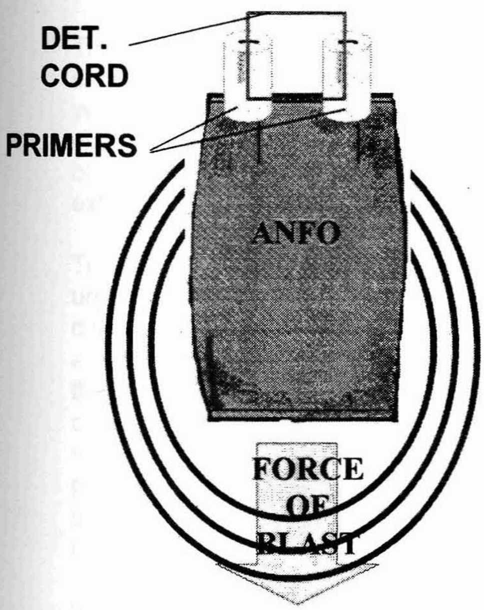

Figure 5 – A vertical ANFO large blast with primers on top

The double priming of a large explosive blast will enhance the effectiveness of the overall blast by allowing the blaster to control the direction of the initial shock wave in a much more favorable manner.

Placing the boosters in proper relationship to each other and the large explosive can create the maximum effect. Linking the boosters together with faster burning detonation cord the allows the boosters control the large blast in terms of direction and speed of detonation (figure 6). It is also possible to direct the energy by the shape of the large explosive prior to detonation.

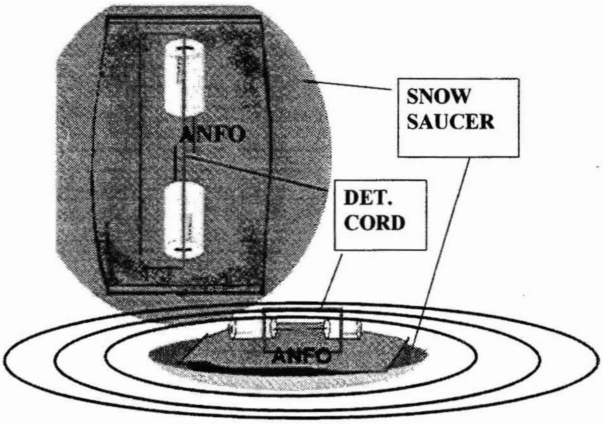

Figure 6 – A horizontal blast with the ANFO flattened out, primers on top or within the explosive

The idea of a flat charge or distributed explosives (figure 6), by using a snow saucer or other similar device and flattening the ANFO, creates better energy distribution on the ground or snow surface. Other ideas that the author has not had the ability to pursue for this presentation is detonation cord arranged in parallel lines can give better blast distribution that the same weight of explosive in a lump charge, or distribution of the explosive into many smaller charges, has great potential to improve effectiveness of the blast[3].

The other concept that needs to be considered is the height of burst effect, which is the concept of bamboo blasts and explosive trams. A huge body of literature exists on the effectiveness of elevated explosions on nuclear weapons. The information demonstrates that the elevated charge will extend the blast pressure to a greater distance that the charge placed on the ground or snow. Although the author does not know at this time what the optimum height of burst effect is for commonly used explosives in avalanche hazard mitigation, it can be assumed and is supported that getting the explosive off the snow can enhance its effectiveness. Development of a simple set of guidelines or table for the optimum elevation for a given charge size would be very helpful.

In conclusion when the blaster has an understanding of the initiation and propagation of the shock waves in explosives, the blaster can plan and execute the best possible avalanche reduction blast.

End.

[3] Fourth International Symposium on the Interaction of Non-Nuclear Munitions with Structures, Eglin AFB, April 17-21, 1989. "Blast Loading from Arrays of Parallel Line Charges," Baker, Baker, Spivey & Esparza.

List of figures

Reference

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