A Method for Calculating the Hit Number of Anti-ship Missile by Dense Array Weapon System

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Abstract: Dense array weapons are the mainstream weapons for short-range defense at present. The most important part in the study of their damage effect is the calculation of the number of hit bombs of the incoming aircraft. The problem seems very simple, but it is not easy to calculate accurately. In this paper, through mathematical modeling and detailed analysis, the specific calculation method of hit number is given, which provides a theoretical basis for defense and interception problems.

1. Introduction

The development of Dense Array Weapon System has gone through several generations. The second generation of Dense Array Block 1 is the first greatly improved type. The prototype was launched in 1981. From the end of 1981 to May 1982, various tests were carried out at the China Lake Test Site. It was put into production in 1986. It was first installed on the Iowa class battleship Wisconsin in 1988[1-4].

Compared with the previous generation, the most significant difference is that the new four-piece back-mounted planar radar antenna replaces the original 2D reflective scanning antenna. One group is responsible for detecting large-angle (including 90 degree vertical direction) targets, and the other group is responsible for detecting low-angle targets, which makes its search ability and target update rate higher than the early "dense array". Double [6-7].

An additional cartridge box was added to the side of the gun base, so that the loading capacity reached 1550 rounds, and a baffle was installed around the gun base to avoid sea water erosion. In addition, a new barrel gas servo device is used to replace the original hydraulic servo device [8-10]. The firing speed is increased to 4500 rounds per minute, and a new anti-seawater corrosion barrel is replaced with a protective body located around the barrel, which can effectively resist seawater erosion.

As for ammunition, since the decaying uranium piston of MK-149-2 is likely to pollute the environment, the traditional tungsten alloy piston of MK-149-4 is also sufficiently capable of penetrating armor. In order to solve the problem of slow manual loading, the Phalanx Deckloader System (PDS) developed by Block 1 Shift Westinghouse Company put the chain in the warehouse in advance, which shortened the reloading operation time to 4 minutes, and greatly enhanced the engagement energy of the "Dense Array" in high-density attack environment. Power. PDS has been used as active equipment by the navies of the United States, Japan, Israel and other countries.

2. Determination of the average number of hits required

The effective range of the dense array is (1500m) and the time for the anti-ship missile to pass through this distance is T_{fj} second. During this period, the enemy ship is set to evade with its maximum speed, i.e. 15m/s, and its maximum maneuvering distance is about $s_1 = T_{fj} \times V_{jt} = 80m$. At this time, the missile has entered the defense radius of the "dense array" and is very close to the enemy ship. It can be considered that the anti-ship missile has accurately aimed at its future point at

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a distance of meters from the enemy ship and is flying in a straight line towards it. The installation position of the "dense array" on the enemy ship is about s_2 from the stern to the center of the ship. Therefore, the angle between the flight velocity direction of the anti-ship missile and the flight velocity direction of the dense array projectile is approximately as follows:

$$\theta = \arctan(s / k) = 4.8^{\circ} \quad (1)$$

Where $s = s_1 + s_2$ as figure 1 shows.

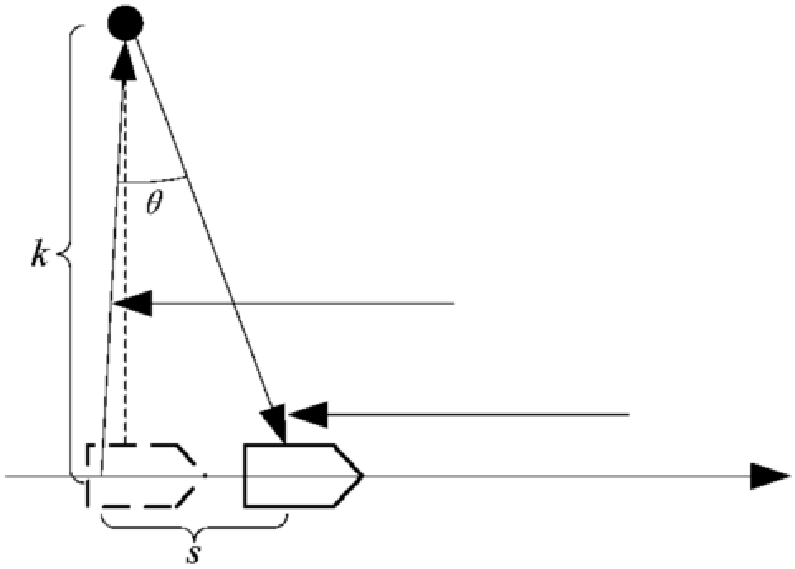

Figure 1 Velocity Angle between Anti-ship Missile and Dense Array Projectile

Assuming that the second stage length a of an anti-ship missile is known as $L = 4600mm$, projecting it into a plane perpendicular to the flight velocity direction of a dense array projectile, the following figure 2 is obtained.

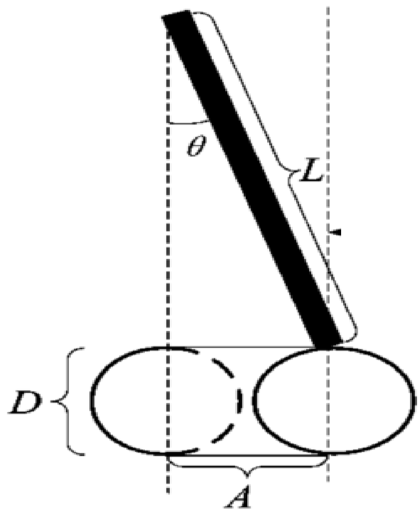

Figure 2 A schematic diagram of the missile area of an anti-ship missile

The range the missile sweeps is:

$$A = L \sin\theta = 380mm \quad (2)$$

Assuming the length of the lethal part of an anti-ship missile is L_z, the ratio of lethal area is

$$m = Lz / L = 65.2\% \quad (3)$$

3. The Calculation of Hit Number of Anti-ship Missile by "Dense Array"

The dense projectiles fired by the "Dense Array" artillery are distributed in a conical area, as shown in Figure 3. Because the apex angle of the scattered cone is very small, for the convenience of calculation, the area covered by the "dense array" projectile can be transformed into a cylindrical area. Finally, we can get the schematic diagram of "dense array" intercepting anti-ship missiles, as shown in Fig. 3.

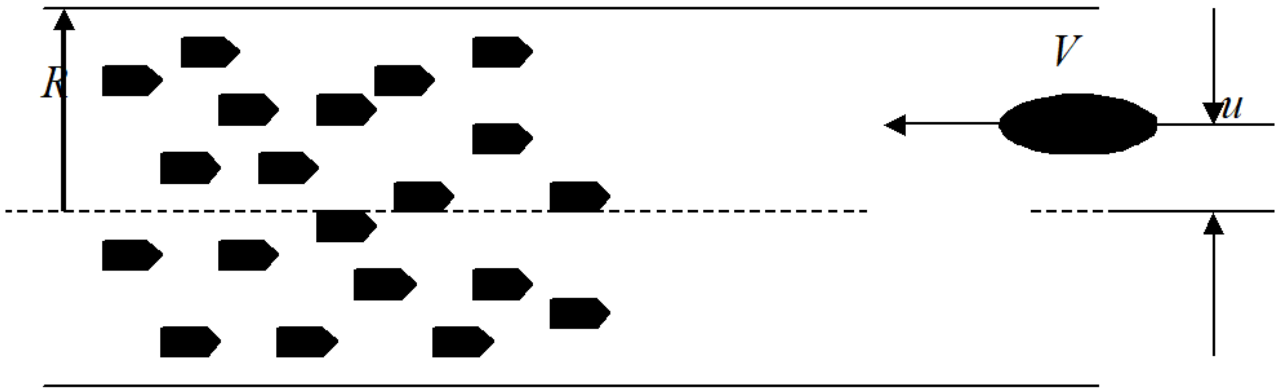

Figure 3 Schematic Chart of Dense Array Projectile Hitting Anti-Ship Missile

The tracking accuracy of the "dense array", the fire system accuracy and the fire control system accuracy constitute the system error when shooting, that is, the deviation of the projectile dispersion center to the target center. The average lineage dispersion error can be obtained.

According to "a dense array usually takes only several seconds to destroy a target." It can be seen that the model of "dense array" intercepting anti-ship missiles is effective and credible.

4. Conclusion

Through detailed mathematical modeling and analysis, a dense array system based on the concept of average hit number is presented to estimate the number of hit projectiles of an incoming aircraft, thus providing a mathematical model and basic data for in-depth damage assessment and penetration probability research.

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