Numerical simulation and analysis of target strength of underwater buried objects

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Acoustic scattering from objects buried in water-sand sediment is the key to target detection. It is also a research hotspot in areas of acoustic scattering. Indeed, it plays an important role in practical engineering applications in refloating wreckage, detection of torpedo and so on. In the underwater acoustic field, the acoustic targets strength of subsea buried objects is a significant parameter to determine burial position and depth of buried objects. And, the precondition of obtaining the acoustic targets strength is how to precisely calculate the acoustic scattered field of the objects which is illuminated by the incident acoustic wave. Normally， the analytical methods can only solve simple geometric model problems effectively, but it will be very difficult to solve problems of the complex geometric model. In order to solve the complex geometric model problem, we have to resort to the numerical method.

As is well-known, the conventional finite element method (FEM) is a versatile and powerful numerical method for acoustic computation, which is used to investigate and computation. Because the grid area of the radiation field can't be infinite, it is difficult to deal with the problem of external acoustic field with acoustic finite element method. To solve this problem, an automatic matching layer (AML) technique is used to truncate the infinite domain into the finite domain and absorb the sound wave propagating outward.

In this work, we mainly analyzed the influence of several typical factors, such as 1) the burial depth of buried objects, from just buried to buried depth up to two feature size of buried object 2) the grazing angle of incident wave which is the residual angle between the direction of the incident wave and the seabed, 3) absorption coefficient of seabed sediment, which is used to simulate different submarine sediment media 4) the frequency of incident acoustic wave.

From the obtained numerical result, the following conclusions can be found:1) The target strength of solid torpedo decreases with the increase of burial depth. The higher the frequency, the more serious the attenuation of target strength caused by burial depth.2) When the grazing angle is small, the change of target strength with the change rate of grazing angle is relatively larger. However, the change rate of target strength is relatively smaller with a large grazing angle.3) The changes in the sound absorption coefficient of submarine sediment will change the target strength amplitude of buried objects, but, basically, can't change the number and shape of resonance peaks. The results obtained in this paper will provide good guidance for the engineering applications of underwater buried target detection.

Keywords—Buried objects, Target strength, Numerical simulation, FEM, Acoustic scattering,