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NUMERICAL CALCULATIONS OF TARGET STRENGTH FOR LARGE SCALE BETSSI MODELS

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Abstract: This article presents numerical calculations of target strength using FEM with far field equations. First a comparison between FEM with far field equations and FastBEM is made to show that the former can be used for a large-scale acoustical calculations. Then calculations of monostatic and bistatic target strength using different boundary conditions for several models from Benchmark Target Strength Simulation workshop are shown. Finally some of the results are compared to the results of the same calculations done by different science centres using different methods.

Keywords: Target Strength, FEM, FastBEM

1. Introduction

The acoustic field that exists in the sea or ocean comprises natural and artificial sources with wide range of frequencies – from fractions of hertz up to few hundred kilohertz [1, 2]. The artificial disturbances contain a number of discrete components originating from the submarines and ship's hull and equipment connected to hull. Structure vibrations and structural noise may be reduced by passive and active isolation, by passive and active vibration and sound absorbers or by active control [3] or changing the characteristics of radiated sounds.

Around year 2001 an idea was conceived for cooperation of various European science centres in developing a generic submarine model (nicknamed BeTSSi – Benchmark Target Strength Simulation) [4, 5]. Some time ago a second BeTSSi was appointed. This time the intention was to evaluate the performance of different numerical methods the participants used and developed over last decade.

The aim of this paper was to test whether a FEM model with the far field equations could be used for modelling Target Strength of an object from a large distance (normally impossible to model by using pure FEM). Preliminary results are compared to results when using BEM and then the results are confronted with similar models made by different scientific teams from several European research centres.

2. Results and Discussion

For target strength (TS) calculations we used BeTTSi model 1 and 2. Model 1 has a very simple geometry and was already used for the comparison between FEM with far field equations and Fast BEM. Model 2 has a more complex geometry which should be more useful when comparing the results with other science centres.

For TS calculations both models were modelled using element size of 0.2 m, which allowed for balance between accuracy and time needed for calculations. Calculations of TS were performed for the frequency of 1 and 3 kHz. Types of analyses included Monostatic and Bistatic (source located at an angle of 240° and 300°) TS calculations for both Hardwalled (HWBC) and Real Boundary Conditions (RBC).

Fig. 1 presents a comparison of calculated bistatic (BS) TS α=240° with hard walled boundary conditions for different science centres. It can be seen that the results obtained using FEM with far field equations are very similar to those obtained using different methods. A bistatic target strength calculations were chosen for this comparison, because of the better angular resolution of the results. Hard walled boundary conditions were chosen because with full reflection the differences resulting from using different calculation methods should be smaller.

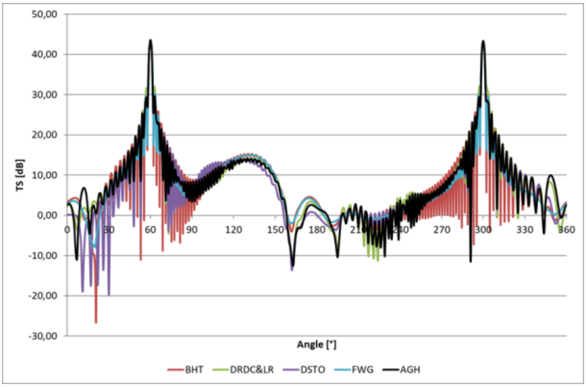

Fig. 1. Comparison of a BS TS for model 1, α=240° with HWBC between different science centres.

3. Concluding Remarks

Obtained results for target strength calculation when using FEM with far field equations are similar to those from other science centres (and different methods). But it should be noted that for higher frequencies a smaller size of elements would be needed which in turn could significantly increase calculation time (especially for the monostatic target strength as it requires a separate calculation for each position of the source).

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