An experimental study of surface waves generated by submerged bodies.

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In this work waves and wave patterns from submerged bodies has been investigated. This is an experimental work and it has been carried out in the towing tank at the Department of Hydromechanics.

The tests has been photographed with a flash close to the water ahead of the body and a powder was spread over the surface to prevent reflexions. This technique gives bright streaks for peaks and dark streaks for troughs. A non-stationary case with varying water depth was video taped with the same idea.

A method of measuring an entire surface displacement field by the technique of stereo photography has been developed. The purpose is to obtain a cheap and fast method to measure the amplitudes of the field.

Two ordinary 35 mm cameras has been used and are hung above the surface, both viewing the same surface section from different angles. The method of stereo photography needs some reference points in the images determined in some coordinate system. A frame surrounding the field has been marked with these points and the coordinates of the points has been determined with a theodolite. The surface is covered with small pieces of paper to visualize it in the stereo image. The images have been analysed with a stereo comparator. The result is the coordinates of all the measured points at the surface, given in the same coordinate system as the reference points. A surface can then be fitted to these measured points.

Two different bodies were tested. A circular cylinder with a spherical bow and an ellipsoid. The influence on the wave pattern from the velocity of the body, depth of submergence and water depth has been studied. Effects such as wave length, spreading angle of the pattern and breaking of bow and stern waves has been investigated.

Different velocities gives different wave lengths and an increase of the velocity gives an increase of the wave length. The amplitudes grows with the velocity and that can cause the waves to break. The bow wave is stable up to a specific velocity where it starts to break and it continues to break for higher velocities. Breaking of the stern wave depends also on the interference between the pattern generated at the bow and the pattern generated at the stern.

The only effect on the wave pattern from depth of submergence was that the amplitudes of the pattern decreases when the depth is increased.

A decrease of the water depth gives an increase of the wave length. This implies that the specific velocities which causes the stern wave to break, due to interference, changes a bit. The specific velocity when the bow wave starts to break decreases with the water depth. Changes in wave length is stronger if the body first travels at deep water and then enters shallow water. Here an increase of the amplitudes is more easily seen than at different tests with constant water depths. The increase of the spreading angle of the waves when entering shallow water, as predicted in linear theory, could not be seen in these tests.

The wave pattern from the ellipsoid is quite different over the body, compared to the cylindrical one, but much the same after the body. For the ellipsoid the bow wave would never break but the stern wave would break in very extreme cases, very high speed or a very small depth of submergence.

The experimental results are going to be compared with results from new numerical methods developed by the department "Centre for Computational Mathematics and Mechanics" at the Royal Institute of Technology. Tests are being done with the ellipsoid and compared to linear theory derived by Smorodin[1].

[1] A.I. Smorodin "Waves at the fluid surface during the motion of a submerged ellipsoid of revolution." PMM Vol 36 nr 1 1972 pp. 148-152