Mitigation of shock waves for UNDEX conditions

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Shock waves travel fast and far in homogeneous and largely incompressible media like water. Hence, the effects of underwater explosions (UNDEX) are experienced far from the explosive charge. In order to reduce these effects mitigation techniques, like bubble screens, are frequently applied. However, the effectiveness of bubble screens as applied at full scale (in full sea conditions with waves, water currents) has not been proven. The positioning of large air filled tubes underwater with a diameter of over 100 meters requires mild sea conditions, is time consuming and rather expensive. Hence, other mitigation techniques are sought which are more effective and less involving to deploy. Initial mitigation experiments have been performed in a large water tank using 300 gram SEMTEX10 charges, to study the mitigating effect of air filled (closed) water tubes positioned very nearby the explosive charge. The charge was placed centrally on the bottom of the 3 m deep water tank (5 m diameter). A tourmaline pressure sensor was placed about 0.5 meter below the waterline and 3 m from the charge. In all experiments the pressure sensor had a direct 'line-of-sight' with the charge. The steel tubes were 300 mm in length and had a diameter of 150 mm and the tube openings were closed by a polymer lit. The mitigating effect was determined by comparing the pressure profile of underwater shocks obtained with and without the air-filled steel tubes. In this work only 3-4 tubes were used per experiment, while the distance to the charge was about 100 mm. The tubes were directed as a cross with one of their openings facing the explosive charge. Both the peak pressure and impulse of the primary shock wave was reduced with 40% using 3 steel tubes and 50% using 4 tubes. Considering the fact that none of the parameters (such as tube dimensions, number of tubes and their distance to the charge) had been optimized the observed mitigating effect is quite large. Apart from the experimental set-up and results, also the working mechanism for this shock mitigation technique will be discussed.