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Portfolio Paper

Wall Cavitation Caused by Projectile Impact

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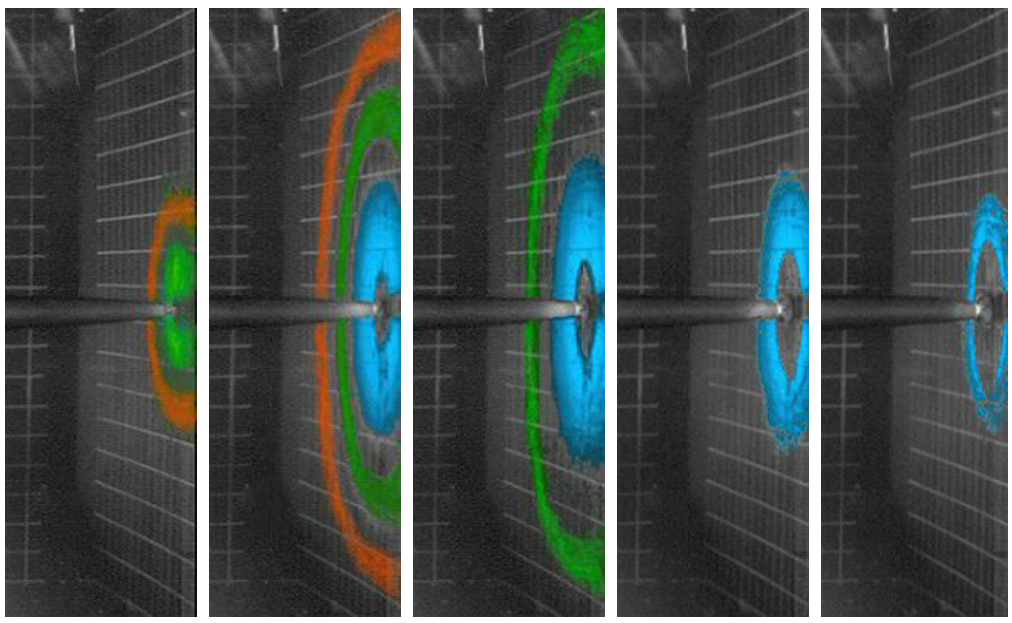

Fig. 1. Cavitation Formation Pattern.

The figure shows a series of five images taken at 139 µsecs apart of a ring pattern formed by cavitation bubbles. These bubbles were a result of a 12.7 mm diameter spherical projectile being propelled at a velocity of 335 m/s (1100 ft/s) through a target panel into a large scale fuel tank simulator that had dimensions of 1.83 m high x 1.83 m wide x 1.17 m long, filled with water, and impinging on the back wall of the tank where it was prevented from exiting. A high-speed digital camera acquired the images at 7207 frames/second through an acrylic side wall of the tank.

Cavitation within water occurs when the local water pressure decreases below a critical value[(1)], which occurs due to the pressure waves emitted from the projectile impact and resulting wall oscillations[(2)]. These rings, pseudo-colored to highlight the effects, represent the low-pressure regions of the pressure waves as they move radially outwards from the impact point, before finally collapsing. The pattern is created due to a combination of the waves moving through the water and surface waves moving through the steel wall. The green ring in the first image matches the speed of sound through the water, while the red ring in the first image moves at a faster rate, consistent with the surface wave speed in steel. After the low-pressure regions pass, the cavitation bubbles collapse[(1), (3)], creating rings absent of cavitation bubbles.

References : (1) Trevena, D. H., Cavitation and Tension in Liquids, Adam Hilger (1987). (2) Bowden, F. P. and Field, J. E., Proceedings of the Royal Society of London, Series A, (1964), 282-1390. (3) Kutruff, K. H., The Journal of the Acoustical Society of America, 106-1 (1999), 190-194.