Water Velocity on Offshore Platforms due to Hurricane Waves

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In approximately one year from September 2004 to September 2005, three Category 5 hurricanes (Ivan, Katrina, Rita) hit the Gulf of Mexico (*1*). Well over 80% of the 4,000 oil and gas production platforms in the Gulf were directly impacted by the hurricanes. The hurricanes destroyed or caused extensive damage to 190 platforms (*2*). In most cases the platform damage was caused by greenwater wave loading on the deck. In situations where one must consider the possibility of wave overtopping and greenwater rushing onto the deck, the mechanics of wave loading become very complex and are poorly understood. One of the major sources of uncertainty is the velocity field of the greenwater flow itself. Laboratory experiments were recently conducted to address this problem.

A simplified 1:168 scale model platform based on a typical tension leg platform was installed in a wave flume where extreme waves are generated through wave focusing. The extreme wave breaks right in front of the model structure and impinges on the structure. Greenwater rushes onto the deck after the impingement. By Froude scaling, the laboratory generated wave is equivalent to a maximum individual full scale wave measured by a National Data Buoy Center buoy during Hurricane Ivan (*3*).

A new image based technique called bubble image velocimetry (*4*) was employed for the velocity measurement of the multi-phase bubbly greenwater flow. The mean velocity was obtained by averaging 20 repeated experiments. The measured magnitudes of the maximum horizontal and vertical velocities help to explain why objects mounted on the deck or on the vertical face of the column are susceptible to damage under greenwater loading.

References

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