An Investigation of Higher Order Forces on a Vertical Truncated Cylinder

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Summary

During a model test of Hutton TLP, a "ringing" response was first observed about 20 years ago. This phenomenon is a resonant build up over the time of wave period and this burst-like motion can cause the extreme load on the TLP tether. It is often detected in the large and steep irregular waves but the generation mechanism leading to the "ringing" is not yet well understood. According to the research since then, the higher order harmonic components may account for the "ringing" on the floating offshore structures. The main purpose of the present research is, thus, to measure the higher harmonic forces exerted on a vertical truncated circular column and to compare them with available data.

A vertical truncated cylinder with a diameter of 3.5*inch* and a draft of 10.5*inch* is used as a test structure, which is a scaled model of ISSC TLP column. The cylinder is installed at a distance of 45ft from the wave maker in order to avoid parasitic waves created in the wave flap. Attached to the upper part of the cylinder are two force gages to measure the horizontal (surge) and vertical (heave) forces on the cylinder. The incoming waves are Stokes waves with a slope ranging from 0.06 to 0.24. The forces and waves are measured for 60 seconds with a sampling rate of 50 Hz. Among the recorded data, the first 10 waves are excluded because of transient behavior of the waves and the next 10 waves are used for the spectral analysis.

The horizontal and vertical forces are analyzed up to 5th order harmonics. The horizontal forces are then compared to the values from the theoretical model called "FNV model". In addition, force transfer functions are also investigated. Major findings in this research are below.

1) The first order forces measured are slightly larger than the theoretical values of "FNV model"

2) The "FNV model" considerably overpredicts the second order forces.

3) The larger the amplitude and more extreme the wave slope, the smaller the predictions are compared to the experimental.

4) The higher harmonic forces are significantly smaller than the first harmonic force for all wave parameters.

5) The normalized forces vs. waves slopes are almost constant in the lower harmonics but vary a lot in the higher harmonics.

6) The trend of forces is more nonlinear in the horizontal forces than in the vertical forces as the wave slope increases.

7) The part of the results above is also observed by other researchers and confirmed again through the present work.

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