



## **Role of vegetation on the attenuation of forces on structures due to Cnoidal waves**

V. Sundar (1), L. Norayanan (1), and K. Murali (2)

(1) Indian Institute of Technology Madras, Ocean Engineering, Chennai, India (vsundar@iitm.ac.in), (2) Indian Institute of Technology Madras, Ocean Engineering, Chennai, India (murali@iitm.ac.in)

The evaluation of forces on structures in the marine environment due to ocean waves is absolutely essential in the planning and development of mitigation measures against natural coastal hazards and dictates their design. Further, studies on the forces on coastal structures due to regular and random waves are well entrenched in literature, whereas, that due to shallow water waves are rather scanty. The recent tsunami has added a new dimension on the role of vegetation on the forces on structures. Due the propagation of tsunami, a number of signature studies have revealed that structures fronted by vegetation have suffered minimum damage compared to that in its absence and as also reported by Yanagisawa (2008).

In the present paper, the results from an experimental study to investigate the effect of vegetation on a typical structure located onshore over a slope of 1:30 are reported. The tests were carried out in a wave flume of length 72m, width 2m and 2.7m depth. The water depth at the toe of the slope was 1m. Slender flexible cylindrical members that represent plantation along the coast have been adopted for the tests. Experiments were carried out for different G/B ratios of 0, 0.5, 1 and 1.5. (Where G is the distance between front face of vegetation/ green belt and the rear face of the building and B is width of the building). Experiments were repeated for three widths of Green belts (BG) and for each of the green belt, two different diameters of the cylinders of 10mm and 3.0mm were used. The forces on structure were measured with load cells in the presence and absence of the green belt. The Cnoidal waves covering a range of Ursell parameter between 18 and 700 were employed for the experiments. The different vegetal and flow parameters in a non-dimensional form have been identified. The variation of non-dimensionalised force over the slope in the presence and absence of vegetation as a function of the Ursell parameter, Relative rigidity and Reduced velocity for different dimensionless SP/D of the green belt (where SP is the spacing between plantation/diameter of plantation) clearly indicates that there is a significant reduction in the force due to the presence of vegetation. Prior to the experiments with the green belt, for the purpose of validation tests were carried out on the force measurements of waves over a plane slope, the results of which compared with existing results exhibited a good agreement. The details of the experimental set-up, procedure and analysis and discussion of the results are reported in this paper.

It has been found that,

- The non-dimensional Forces on the structure increases by about 80 %, when the distance between the structure and the Green Belt is in the range of 0.5B to 1.5B.
- The most favorable location for the Structure is adjacent to the Green Belt or away from the Green Belt by more than twice the width of the structure. For this configuration, the forces were found to reduce to an extent ranging between 50% and 90%.

### **References**

Yanagisawa, H., Koshimura, S., Got, K., Miyagi, T., Imamura, F., Ruangrassamee, A. and Tanavud, C. "The reduction effects of Mangrove forest on a tsunami based on field surveys at Pakarang Cape, Thailand and Numerical Analysis" *Estuarine, Coastal and shelf Science*, Oct 2008, pp 1-11.