LABORATORY STUDIES OF VORTEX-INDUCED VIBRATIONS OF DEEP WATER RISERS

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Abstract. In developing oil and gas reserves in deep water, the offshore industry needs tools for predicting the motion of very long riser pipes. In a typical installation, tensioned risers may reach vertically down 1000m or more from the sea surface to the bed, and in currents they are known to be subject to vortex-induced vibrations. Because of the likelihood of fatigue damage, and of impacts between neighbouring risers, considerable efforts have been directed at understanding the interaction between vortex excitation and response, and at the development and performance of suppression devices. In a current that is not uniform with depth, the motion of a riser may exhibit several modes simultaneously. From the fluid mechanics point of view this is an enormously challenging problem. Reliable numerical predictions are a distant prospect. This paper reviews measurements of vortex-induced vibrations of tension risers carried out at reduced scale and in conditions (usually in the laboratory) that are likely to provide some insights into the physics of the process. It discusses some practical problems and results. Particular attention is given to a recent series of experiments in which a 28mm diameter model riser, 14m long, was towed through a non-uniform block current. Reference to typical offshore conditions helps to explain why the number of such investigations is small. For a riser of diameter 0.25m, length 1000m, mass 125kg/m (about 2.5 times the displaced mass), and a top tension of 1MN (about 1.5 times the submerged weight), a shear current with velocities between zero and 0.5m/s is likely to excite many modes up to about the 15th. The highest two or three of these differ in frequency by less than 10%, and have wavelength-to-diameter ratios of over 200. Laboratory measurements can capture only some of these features and have to compromise on others. Consequently, our understanding of thefluid/structure interaction in these conditions is rather poor.

Keywords. vortex-induced vibrations, laboratory measurements, tension risers.