# DYNAMIC BEHAVIOUR OF OFFSHORE GUYED TOWERS

by

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# C E R T I F I C A T E

(i) We are satisfied that the thesis presented by Mr Amit Dutta is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bona-fide research work carried out by him under our guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

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that he has pursued the prescribed course of research.

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ABSTRACT

The object of the present work is to study the two dimensional dynamic response characteristics of guyed towers under regular waves. Some investigations are also performed on the guyed tower mooring lines to examine their static behaviour. Three guyed towers in about 90m, 350m and 457m water depth available in the literature are considered for the present investigations.

The tower is modelled as a line member with the base taken as fixed against translational movement, but partially restrained against rotation. The effect of mooring system is simulated by an elastic translational spring at the guy attachment point. The (horizontal) nonlinear force-excursion relationship (when considered) of an individual mooring line is determined by an initial value finite segment technique making use of catenary equations and taking into account the stretching effect. The initial stiffness of the mooring system is considered in the tower stiffness matrix, the effect of it's nonlinearity (if present) being accounted for in the load vector by a horizontal load.

The hydrodynamic loading is evaluated taking into account the actual level of free water surface and the associated time variation in added mass. The fluid loading at a point is calculated by considering the structural velocity and the displaced configuration of the tower. Drag and inertia coefficients are taken as either flow-dependent or constant. To evaluate the flow-dependent values the r.m.s. values of the nodal relative velocities are used.

The equations of motion in the modal co-ordinates are solved iteratively in the time domain, using Newmark ($\beta = \frac{1}{4}$) method. A two-cycle technique is applied to expedite the attainment of steady state. Mode superposition and mode acceleration methods are employed to evaluate response quantities.

The effect of lumping the distributed clump weight at a point on the force-excursion relationship of the entire mooring system and hence on the tower response are studied. The influences of different system parameters and sea floor slope on the mooring line behaviour are investigated. Guyed tower behaviour under different wave period/wave height combinations and the errors associated with the approximate solutions are discussed. Effectiveness of the two-cycle technique over the conventional time domain analysis is shown. The advantage of mode acceleration method over mode superposition method from the point of rapid convergence of results using only one or two modes in the analysis has been determined. Finally, the effects of changing deck pay load, mooring system behaviour and base rotational restraint on the tower response are examined.

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