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FIM – Flow-Induced Motion of Three-Column Platforms

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Experiments regarding the flow-induced motion (FIM) on an array of three floating cylinders with low aspect ratio ($H/L = 15$), and three different distances between column centers ($S/L = 2$, 3, and 4) were carried out in a towing tank. The array of three cylinders was elastically supported by a set of four linear springs to provide low structural damping on the system. Three different section geometries were tested, namely, circular, square, and diamond. Three different current incident angles were tested: $\theta = 0$, 90, and 180 degrees. These configurations of the three-column arrays were selected to cover the range of the main floating offshore wind turbine (FOWT). The aims were to understand the FIM of the three-column systems and to compare the results of the single column and an array of four cylinders. The range of Reynolds numbers covered $10{,}000 < Re < 110{,}000$. Concerning the geometry of the column sections, the amplitude results showed larger amplitudes for the three-cylinder array than the single-cylinder case and the four-cylinder array for circular and diamond cases, in which cases the phenomenon was similar to vortex-induced motion (VIM). On the other hand, the amplitudes for the single square case were higher than for the array of cylinders; in this case, the galloping phenomenon was predominant. Concerning the distance between column centers, the amplitude results for the three-cylinder array with $S/L = 3$ and 4 were very similar. Yet the three-cylinder array with $S/L = 2$ acted as a single cylinder because the proximity of the cylinders changed the wakes around them. Finally, concerning the incident angle effects, the changes in the angle significantly affected the arrays with $S/L = 2$; therefore, only the in-line motions were slightly modified for the cases with the larger distances between columns.

NOMENCLATURE

A_x	characteristic amplitude in the in-line direction
A_y	characteristic amplitude in the transverse direction
A_{yaw}	characteristic amplitude for the yaw motions
D	column characteristic dimension due to the current incident angle
GM	metacentric height
H	column height above the water line
H_m	vertical position of the mooring line fairleads
H_t	height of the water level of the towing tank
H/L	column aspect ratio
KG	distance between the center of gravity and the base
L	length of the face dimension of the column
L_m	in-line position of the mooring line fairleads
L_t	length of the towing tank
m	mass
m^*	mass ratio
R_{XX}	radius of gyration around X axis
R_{YY}	radius of gyration around Y axis
R_{ZZ}	radius of gyration around Z axis
Re	Reynolds number

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KEY WORDS: Flow-induced motions, vortex-induced motions, galloping, three-cylinder array, geometry section of the columns, distance between columns, current incident angle, model tests.