Storms at the click of a switch

Model tests have invariably tried to simulate the forces of nature, of wind, wave and currents - the rule-of-thumb being the more reliable the simulation, the better the test. BAS BUCHNER, principle consultant Offshore, reports on the effort to develop top-of-the-range systems for MARIN's new Offshore Basin.

In a model basin waves are generated by wave flaps, instead of by wind, and it is important to ensure that oscillating flaps don't induce effects that simply do not exist at sea – in a basin, very complex control is required.

Waves with a difference

At sea, waves roll on into infinity. However, a model basin is finite, and needs effective beaches to absorb the outgoing waves as much as possible. However, when waves reflect on the models, they generally return to the wave flaps instead of to the beaches – and this process of reflection can interfere with the required wave spectrum. The answer is to use an active reflection compensation system on the wave flaps, absorbing reflected waves by comparing the wave elevation on the wave flap with what is theoretically generated and correcting for the difference.

Current Affairs

There are three forces which create currents: the tide, main global currents and wind. In a model basin current is pump-generated, and must be re-circulated outside preventing re-circulation in the basin itself. It is a constant challenge to generate a stable current in the basin - yet this is vitally important because of its direct loading on the structure, its interaction with waves and the effect it has on low frequency motions. If the current velocity in a basin varies too much at frequencies close to the natural frequency of a mooring system, this can have large (unnatural) effects on the low frequency mooring behaviour.

Simulated Wind

Wind in a model basin can only be generated by local wind fans, whereas in reality it is generated by a global wind field. However, the modelling of fan-generated wind also requires special attention. This is mainly due to the re-circulation of the wind field in the basin and the variation of the wind speed with the distance from the wind fans. So, special attention has to be paid in offshore testing to apply the correct wind load instead of the correct wind speed. The wind load should be correct in the surge, sway and yaw directions for the required wind directions relative to the model. Finally, the wind should be modelled as a constant force or with the appropriate wind spectrum to take into account real wind gusting.

Capabilities of the Offshore Basin

Waves
- Multi-flap wave generators on two sides (0.4 m flap width)
- Multi-directional long-crested and short-crested waves
- Significant wave height Hs=0.4m, Periods T=0.3-3.0s (model scale)
- Effective parabolic wave absorbing beaches
- Active wave reflection control on wave generator flaps
- Higher order control of wave generator flaps

Current
- Adjustable vertical current velocity profiles over complete depth of 10.5m (6 layers)
- Maximum current speed 0.4 m/s surface and 0.1 m/s bottom (model scale)
- Stable current (5% turbulence intensity: standard deviation/mean current velocity)

Wind
- Movable bed of wind fans (24 m wide)
- Constant wind and wind spectra