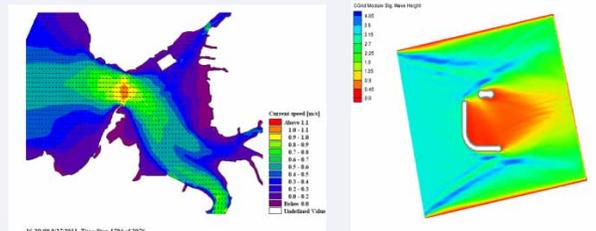


## Coastal Engineering & Hydraulic Modeling

The services offered by Zebec in hydraulic numerical modeling can be broadly classified into the following sub sections:

- Hydrodynamics studies
- Sediment transport studies
- Wave transformation studies
- Wave disturbance studies
- Dredging and dispersion studies
- Oil spill studies



### Hydrodynamic modeling

These studies are used to estimate currents, surface elevations due to tides, river flows and storm surges. This information is used as one of the inputs in the design of port structures. The currents and surface elevations obtained from these studies are essential inputs for assessment of sedimentation, dispersion during dredging & dumping.

### Sedimentation transport

This is useful to estimate the backfilling of dredged channels, morphological changes in sea, river & estuarine environments.

### Wave transformation

This involves the transformation of waves from offshore to the near-shore areas. This near shore wave data is a necessary input for design of coastal structures and estimation of downtime for transshipment operations.

### Wave disturbance studies

This is useful in estimating the disturbance due to short waves in the port basin. It helps in understanding the total operational days of the port.

### Dredging and disposal studies

Dredging studies are used to estimate the extent of spreading of the bed material which is brought into suspension during dredging operations.

Dredged material disposal studies are used to estimate the changes in seabed level and ambient sediment concentrations during dumping operations.

### Oil spill studies

These studies are carried out to simulate the oil slick mobility, amount of oil left on the water surface, evaporation and evolution of the oil properties in ambient environmental conditions. Mitigation measures and response in an emergency can be planned.

## ***Vessel Manoeuvring Simulation Studies***

Simulation tools are capable of providing realistic and accurate inputs to the design of ports and approach channels.

The purpose of simulation is to identify and mitigate the risks for the mariner operating in a specific waterway, channel and port area. It also includes the placement and technical specification of manoeuvring aspects.

### ***Modelling of port environments***

Software will be used to model the new proposed port or an existing port which includes the channel alignment and depths, position of navigational buoys, alignment of berths, terrain including coastline and topography, and shore features such as buildings and prominent structures. The extent of features added to the port environment can be planned based on the study duration and client budget.

### ***Modelling of vessels***

A client-specific vessel design can be modeled to assess the safe manoeuvrability in the port approaches and off the berth.

### ***Simulations***

Our ship captains with years of experience in handling of various types of vessels will manoeuvre the selected vessel models through the channel and berth approach multiple times. The operational limits will be defined, which permit the vessel to manoeuvre safely with or without tug assistance, and also allow sufficient controlling options for unforeseen circumstances.

Site environment conditions such as currents and winds can be varied as per the range of conditions that may be encountered at the site. The limiting weather conditions for safe vessel arrival and departure can be defined.

The runs can be subsequently replayed and analyzed. We can then recommend modifications to the channel alignment, turning circle or berth layout based on the outcome of the simulations, and the simulations can be re-run in the revised layout.

### ***Training of pilots***

Pilots can be familiarized with the new port layout using the port and vessel models in varying environmental conditions prior direct exposure to the real-world scenario.

