

## Design of a ship barrier in Amsterdam

In Amsterdam a new office building will partly be built in the river "IJ", near Amsterdam Central Station. Cargo ships intensively use the river, which could potentially be dangerous for the building and its users. To prevent the building being damaged by a ship out of course, a barrier structure will be built in the river. This barrier is a so-called "sacrifice structure". A collision is allowed to lead to total loss of the barrier, the building though, should remain intact.

The barrier has been designed based on a prescribed energy absorption capacity. Secondary, a maximum displacement was prescribed to guarantee the ship would be stopped before it reaches the building.

The pre-design consisted of two "combiwanden" [GAARNE VERTALEN], approximately 10 meters separated from each other, and connected by a concrete floor. Thus the structure is by approach a portal structure.

The interaction between the structure and the soil was analysed using a 2D Plaxis model. The complex behaviour of the soil and structure was translated to an equivalent 2D-frame model, supported by springs. The spring properties and column length were derived from the Plaxis model's results. Testing showed 100% equality between the behaviour of the two models.

The frame model was then expanded to a 3D model. The concrete floor was modelled using a cracking capable material model for concrete, combined with reinforcement grids. The structure was loaded displacement controlled. From the load-displacement diagram the absorbed energy was calculated. The reinforcement was iteratively reduced and refined, resulting in a uniform grid in both directions, with heavily reinforced strips near the edges of the concrete floor and between columns. Diana's realistic material models and geometric non-linear capabilities proved to be very useful in this failure analysis.