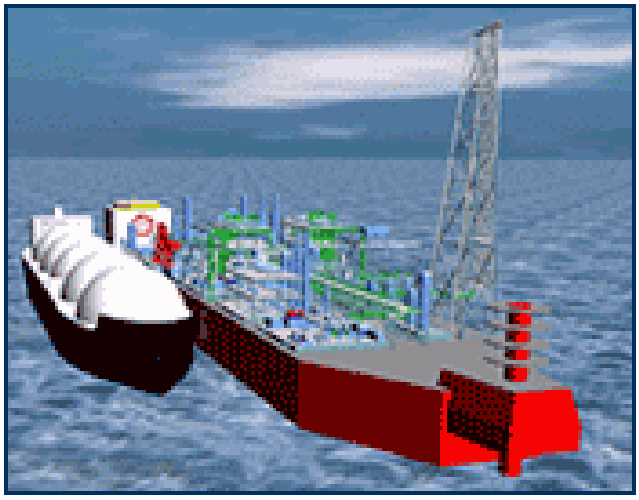
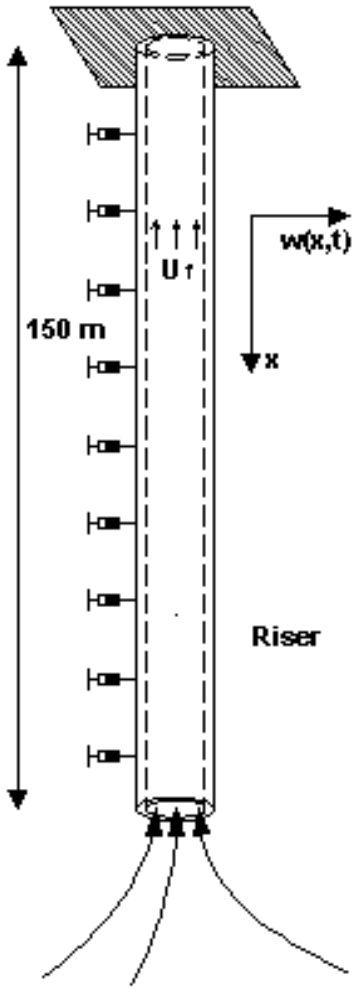
Graduation Presentation



# Forced vibrations and stability analysis of a vertically hanging riser conveying fluid

Up to now liquid natural gas (LNG) processing takes place on land and requires a large area for the needed amount of cooling installations. The goal of Shell was to develop a production plant located on a floating barge (ship) and that is moored over a gas field. If the cooling water is directly pumped up from the surrounding water, the size of such a LNG barge can be reduced substantially. Vertically hanging pipes will be connected to the bottom of the barge so that cold water from 150 meters below the sea level can be pumped up. These pipes are called *vertically hanging water intake risers*.






In this graduation project the analysis of the dynamic behaviour of the water intake riser is carried out. The response of the riser is studied on the hand of a linear, one-dimensional model that is capable of describing the in-plane vibrations of the riser.

The first objective of this graduation project was to calculate analytically the response of the riser to external forces, like the direct wave loading, the water current and the motions of the barge.

The second objective was to determine whether the riser behaves stable or not. The instability can be caused by the internal fluid flow. If instability occurs, the displacement of the riser grows exponentially in time. The energy for this growth is supplied by the pumps on board of the barge that suck water into the riser. **It appears that for the risers conveying fluid instability may be an even more dangerous phenomenon than resonance**.

With the help of the D-decomposition method it was shown that the vibrations of the riser may become unstable. For the vertically hanging risers conveying fluid unstable behaviour occurs at all fluid velocities, if no external damping is taken into account. After adding external distributed damping the critical velocity, starting from which the riser becomes unstable, increases. However, the critical velocity remains low. **It is shown that for common values of the external damping (drag) the system may behave unstable.**

People who are interested are kindly invited to attend the presentation.

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| Student: | Guido Kuiper |
| Date: | Friday 8 february 2002 |
| Time: | 16.00h |
| Location: | Lecture room F<br>Faculty of Civil Engineering |

Graduation committee:
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