FLUID STRUCTURE INTERACTIONS
RESEARCH GROUP

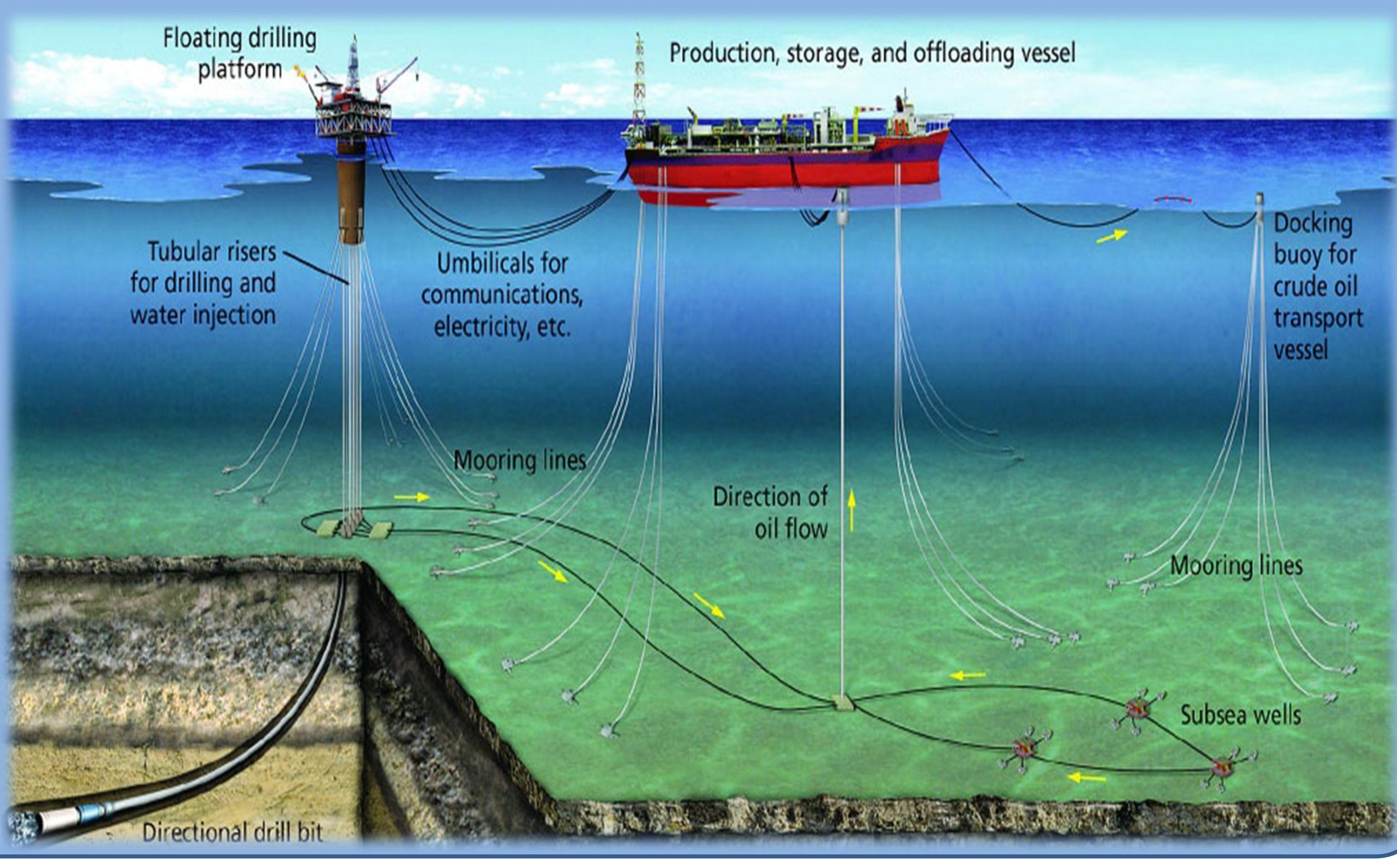
UNIVERSITY OF Southampton
School of Engineering Sciences

Dynamic characteristics of ocean platform with mooring system

Aichun Feng –af2g10@soton.ac.uk-, supervised by Dr Z. Chen and Prof J.T. Xing

Background

- Offshore structures are main tools exploiting natural resources from ocean and normally have three main components: floating vessel, mooring lines, and marine risers.
- Traditional simplified methods are linear and uncoupled with respect to the three components and based on linear free-surface boundary condition.
- The linearization is insufficient under the assumptions of extremely sea conditions. The uncoupled consideration is inadequate to evaluate the interaction effects between the hull and the slender components in deep water. Coupled method is essential to fully evaluate the fluid-structure interaction system.



Aims

- Evaluate loads and motions of floating structures in waves based on the nonlinear theory.
- Analyse the dynamic characteristics of mooring and riser system.
- Estimate the interaction of these three parts and their coupled dynamic.

Proposed Numerical Methods

For floating structure

Structure's motion equations in the time domain can be expressed as follows

$$\sum_{j=1}^{6}((M_{ij}+m_{ij})\ddot{x}(t)+\int_{0}^{t}K_{ij}(t-\tau)\dot{x}(t)d\tau+C_{ij}x(t)=F_e(t) \qquad (1)$$

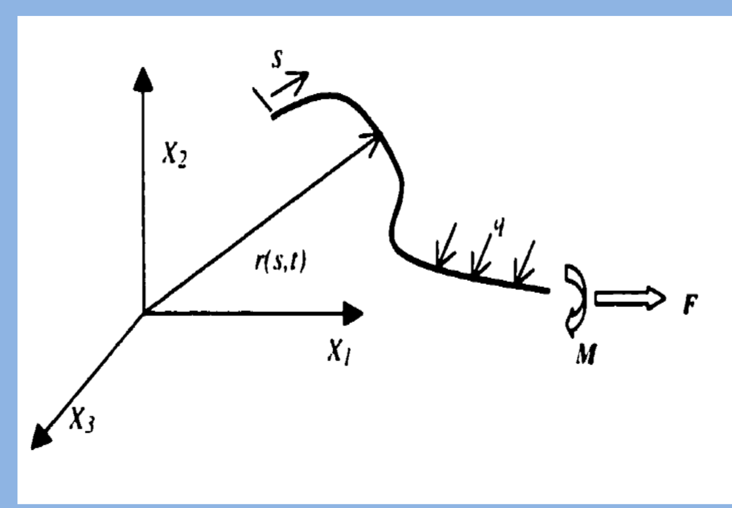
For Mooring line

The momentum conservation equation for slender rod with respect to a position vector can be written as

$$-(Br_k^{''})+(\lambda r_k^{'})+q_k=\rho\ddot{r}_k \qquad (2)$$

$$\lambda = T - B\kappa^2 \qquad (3)$$

The application of finite element method to Equations (1) and (2) produces the motion of structure and mooring line tension in each time step.



Case study

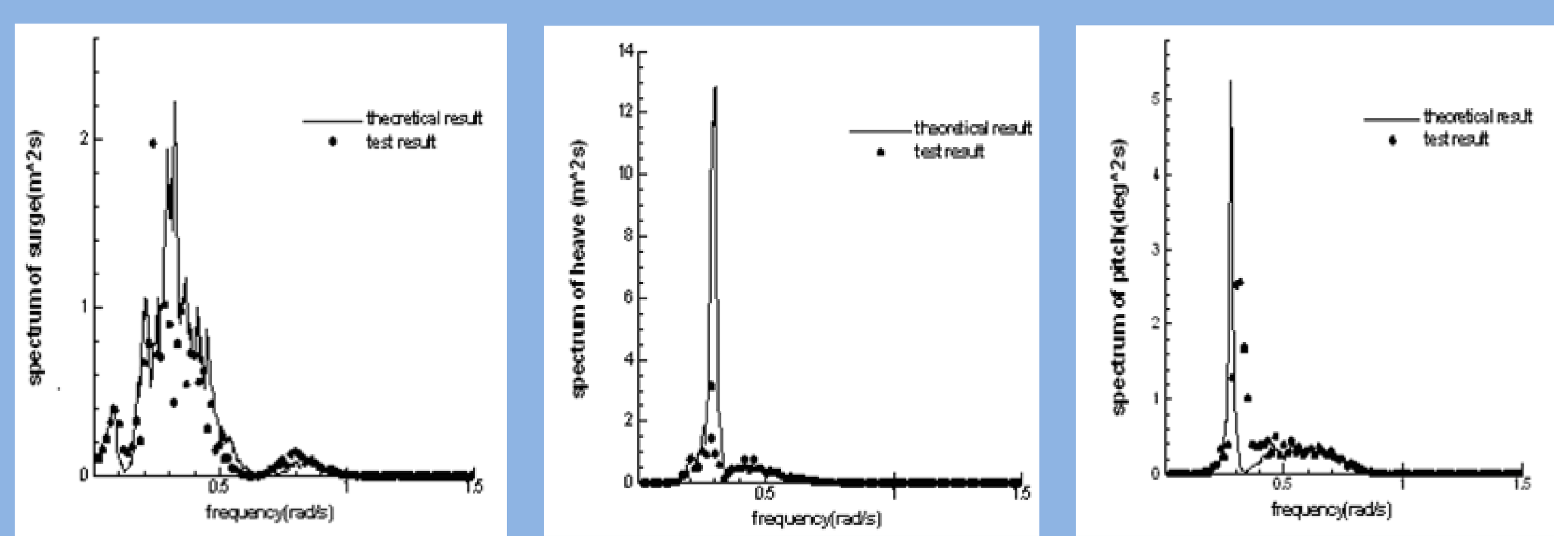
The dynamic characteristics of a semi-submersible system are simulated in the time domain based on linear theory.

The semi-submersible system is belong to SEDCO-700 series moored in 295m water, while the mooring system is composed of 12 mooring lines. Each mooring line consists of chain-wire-chain-wire. The mooring system is connected to the bottom of the pontoon.

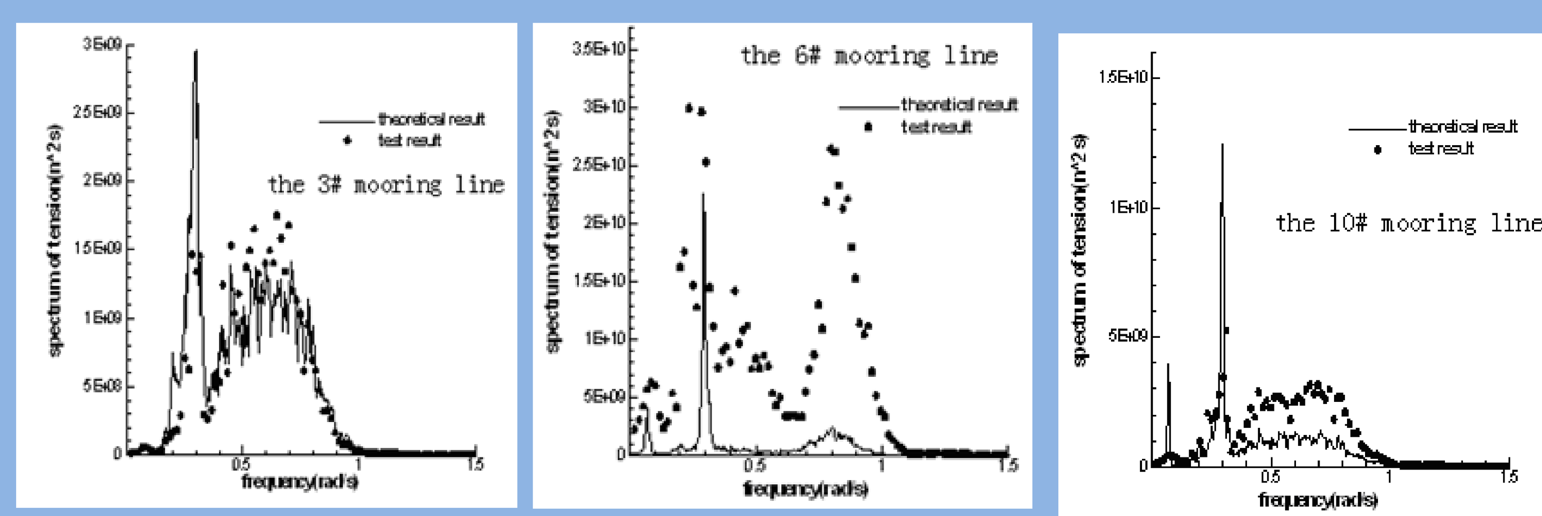
Results

As the wave direction is 0 degree along the x-axis, the longitudinal motion is dominant. Surge, heave and pitch results are obtained.

❖ Following top three figures show a good agreement between numerical results and experiment results with respect to the motion of the structure .



❖ Comparison of numerical and experimental results of the tension of mooring lines (3#,6#,10#).



The dynamic characteristics based on linear analytical theory conforms the experiments at the resonance in low frequency and wave frequency.

Future work

It should be mentioned that there is a distinct discrepancy in the low frequency peak between the theoretical analysis and model test. This is mainly caused by nonlinear effect.

The nonlinear effect becomes more evident when the structure encounters extreme sea condition. Thus nonlinearity investigation is essential to estimate the dynamic motion of the integrated system and is the focus of our future research.