Project Title: Design and Optimization of Offshore Structures Under Environmental Loadings

Supervisor's Name: Dr. Khurshid Alam

Co-Supervisor(s):

Sources of Fund: Nil

Research Field(s): Offshore Engineering, Fluid-Structure Interaction, Finite Element Analysis, Modal Analysis

Summary and Problem Statement:

Offshore structures are widely used for exploitation of ocean oil and gas resources and power generation. The design and analysis of offshore structures are arguably one of the most challenging tasks faced by engineers. Ocean waves and wind are the key factors influencing the design of offshore structures. Designing and optimization of offshore structure using experiments is challenging task since the conditions for conducting experiments are not conducive. Such experiments are not financially economical.

Response of offshore structures under dynamic loading mimicking ocean waves and winds has extensively been studied using analytical, experimental and numerical approaches [1-7]. Despite several research studies reported in the literature, no study has been performed to model fluid-structure interaction involved between environmental loads (ocean or wind) and solid structure. In addition, previous studies are lacking in optimizing the structure for geometry and material under various modes of environmental loading conditions.

This study will be step forward to analyse a simplified offshore structure under wave-induced forces. The dynamic environment mimicking the pressure of the ocean waves and winds on the structure will be studied using series of numerical simulations. Hydrodynamic characteristics of the structure-fluid interaction and associated structural response will be studied. The results obtained from simulations will be validated against experimental and analytical results.

Keywords:

Offshore Structure, Fluid-structure Interaction, FE Modeling, Dynamic Analysis

Objectives:

1. To generate solid model of the offshore structure and fluid medium (ocean waves and wind) around it.
2. To select appropriate geometric (bar/link sizes) and response parameters (displacement/stresses) for design optimization.
3. To model interaction between the solid and fluid bodies.
4. To optimize the structure for extreme weather conditions.
5. To validate structural response of the model with experimental and analytical studies available in

the literature.

Tentative Methods of Approach:

1. Solid modeling using CAD program (ANSYS Design modeler, Solidworks).
2. Importing the model for analysis
3. Modeling environmental loading
4. Coupling fluid and structure domains
5. Analyzing and obtaining structure response

Required backgrounds and skills

Backgrounds:

Computing Skills:

Solid Modeling (Solidworks/AutoCad/Catia etc.), Finite Element Analysis (ANSYS/ABAQUS/COMSOL etc.), Dynamic Analysis, Computational Fluid Dynamics (CFD/FLUENT/CFX etc.)

Other requirements:

References:

1. N. Haritos. Introduction to the Analysis and Design of Offshore Structures– An Overview. EJSE Special Issue: Loading on Structures (2007). 55-65.
2. Ying Tu, Michael Muskulus, Øivind Asgeir Arntsen. Experimental Analysis of Slamming Load Characteristics for Truss Structures in Offshore Wind Applications. Journal of Ocean and Wind Energy: International Society of Offshore and Polar Engineers. 2015; 2(3): 138–145.
3. Bredmose, H, Slabiak, P, Sahlberg-Nielsen, L, and Schlütter, F (2013). Dynamic Excitation of Monopiles by Steep and Breaking Waves: Experimental and Numerical Study. Proc ASME 32nd Int Conf Ocean Offshore Arctic Engineering, Nantes, France, V008T09A062.
4. Wen-hua Wang, Ya-zhen Du, Lin-lin Wang, Yu-xin Yao, Hao Gao and Yi Huang. Experimental analysis on behaviour in waves for sandglass-type floating body. Ships and Offshore Structures; 12(3): 433-441.
5. Kraskowski Marek, Pastwa Katarzyna, Kowalczyk Sebastian, Marcinkowski Tomasz. Numerical and experimental analysis of the wave induced forces on the tripod support structure. Laboratory study. Bulletin of the Maritime Institute in Gdańsk. 2017;32(1):21-29.
6. Shehata E. Abdel Raheem. Elsayed M. A. Abdel Aal, Aly G. A. Abdel Shafy, Fayez K. Abdel Seed. Nonlinear Analysis of Offshore Structures under Wave Loadings. 15WCSE Lisboa, 2012.
7. H. Karadeniz. Spectral Analysis of Offshore Structures Under Wave and Earthquake Loadings. Stochastic Analysis of Offshore Steel Structures, Springer Series in Reliability Engineering, DOI: 10.1007/978-1-84996-190-5-4, Springer-Verlag London 2013.