AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Structural Engineering

Study of Structural Optimization of a Jacket Platform under Earthquake Loading

A Thesis submitted in partial fulfillment of the requirements of the degree of

Master of Science in Civil Engineering

(Structural Engineering)

By

Mahmoud Abou El-Makarem Ahmed Mohamed

Bachelor of Science in Civil Engineering

Faculty of Engineering, Assuit University, 2004

Supervised by:

Prof. Dr. Abdel-Salam Ahmed Mokhtar

Professor of Structural Engineering,

Faculty of Engineering, Ain Shams University

Assoc. Prof. Dr. Bahaa Sharf Ismail Tork

Associate Professor, Structural Engineering,

Faculty of Engineering, Ain Shams University

Dr. Ahmed Abbass Elshafey

Assistant Professor, Civil Engineering,

Faculty of Engineering, Menoufia University

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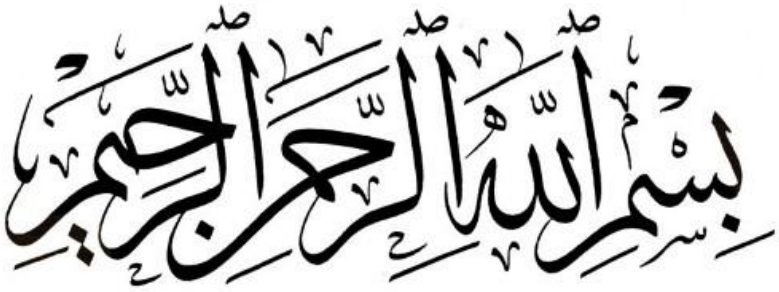
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Examiners' Committee

Name and Affiliation	**Signature**
Prof. Dr. Kamel Sayed Ahmed Kandil	…….
Structural , Menoufia University	
Prof. Dr. Mohamed Nour Eldin Saad Elsayed	…….
Structural , Ain Shams University	
Prof. Dr. Abdel-Salam Ahmed Mokhtar	…….
Structural , Ain Shams University	
Assoc. Prof. Dr. Bahaa Sharf Ismail Tork	…….
Structural , Ain Shams University	

Date:21 August 2017

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Civil Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Mahmoud Abou El-Makarem Ahmed Mohamed

Signature

……...…….

Date: 21 August 2017

Researcher Data

Name	: Mahmoud Abou El-Makarem Ahmed
Date of birth	: 30 January 1983
Place of birth	: United Kingdom
Last academic degree	: Bachelor of Science in Civil Engineering
Field of specialization	: Structural Engineering
University issued the degree	: Assuit University
Date of issued degree	: June 2004
Current job	: Offshore Structural Engineer at Gulf of Suez Petroleum Company (GUPCO)

Abstract

In this thesis, a study of finite element linear time history analysis (Extreme Level Earthquake, ELE) is performed for a jacket platform located in the Gulf of Suez. The analysis is performed according to the earthquake offshore standard API-2EQ. PEER Ground Motion Database is used for selection and scaling of applied earthquake records. One set of three earthquake components (two horizontal and vertical) of acceleration time history records is considered. Each earthquake component applied in one direction considering gravity, buoyancy and hydrostatic pressure loads. Buckling is not considered in this study.

In addition, a study is presented a proposal method of topology optimization of jacket platforms. It is an automated gradually iterative method. The utilized topology optimization is performed under the earthquake loading. This optimization process is utilized in three ways: the first is risk categorization of existing jacket bracing; the second is the generation of topology optimized shape of newly designed platforms; and the third is the retrofitting of existing platforms. Two of these are adopted in this thesis. The third approach is a combination of the other approaches.

By implementing the optimization process, weight reduction is achieved compared to the original weight of the existing platform. In addition, success in topology optimization of jacket bracing of existing platform is leading to risk categorization of jacket bracing.

Risk categorization of individual members according to their impact on the overall stability and strength of the structure is crucial in decision making in retrofitting and visual inspection planning. As is known, underwater visual inspection and retrofitting are extremely costly. This approach has the advantage of decreasing analyses after uncontrolled/unexpected destructions or abusing of jacket bracing, especially for members likely to be under continues risk such as members exposed to ship impact or unplanned cutting during drilling new conductors. To the authors' knowledge, offshore codes do not discuss risk categorization of individual members and their impact on the overall strength and stability of the structure.

The proposed optimization method can be utilized in static and transient analysis. Using it can obtain optimum high-performance new structures, identify redundant elements in existing structures and consequently reducing the time and cost.

Keywords: Finite element, time history analysis, Extreme Level Earthquake, jacket platform, Gulf of Suez, API-2EQ, scaling, earthquake records, topology optimization, risk categorization.

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Prophet Muhammad, the world’s best teacher, peace and blessings of Allah be upon Him, said, "He who does not thank people, does not thank Allah"

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