Selçuk ŞAHİN

5rd EMship cycle: October 2014 – February 2016

Master Thesis

Wind Turbine Tower Structure Analytic & FEM Analysis According to Wind Load in Terms of Cost

Supervisor: Prof. Maciej Taczała, West Pomeranian University of Technology, Szczecin, Poland
Internship tutor: Prof. Jeom Kee Paik, Pusan National University, Busan, South Korea
Reviewer: Dr. Hervé LE SOURNE, L'Institut Catholique d'Arts et Métiers (ICAM), Nantes, France

Szczecin, January 2016

Contents:

1. Self-Introduction

Name: Selçuk
Surname: Şahin
From: Turkey
Bachelor Degree:

- Mechanical Engineering in Erciyes University (TUR)
- Erasmus Life Long Learning in University of Galati (RO)
- Erasmus Placement in University of Messina (ITA)

2. Internship Place

Internship was done in The Lloyd's Register Foundation Research Centre of Excellence, Pusan, Republic of Korea. Center is one of the big maritime and ship research place in the world.

3. Objectives and Challenges

What is this thesis?

In this thesis, one site-specific wind turbine tower was developed.

Objectives

Giving a ideas to designing wind turbine tower.

Applying EU Standards on the preliminary design and find ideal tower.

Strength analysis of the tower door opening.

Cost estimation of the tower.

Challenges

Arranging data of wind turbine.

Implementing standards on the turbine.

Modelling door opening of the tower.

Strength analysis.

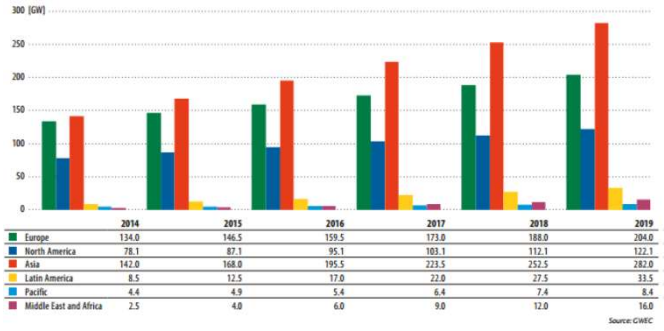
4. Process

Following Steps were Followed During the Thesis Development

1- “Why wind energy”, “Increment of wind energy sector” and “Components of a wind turbine” were explained.

A- “Why wind energy” because sustainable, renewable and infinitive.

B- “Increment of wind energy” can be seen in following figure.

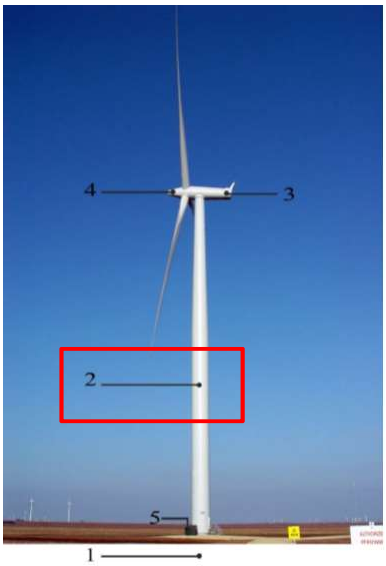


	2014	2015	2016	2017	2018	2019
Europe	134.0	146.5	159.5	173.0	188.0	204.0
North America	78.1	87.1	95.1	103.1	112.1	122.1
Asia	142.0	168.0	195.5	223.5	252.5	282.0
Latin America	8.5	12.5	17.0	22.0	27.5	33.5
Pacific	4.4	4.9	5.4	6.4	7.4	8.4
Middle East and Africa	2.5	4.0	6.0	9.0	12.0	16.0

Source: GWEC

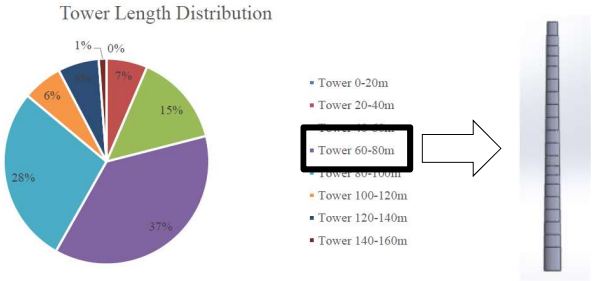
4. Process

C- “Components of a wind turbine”

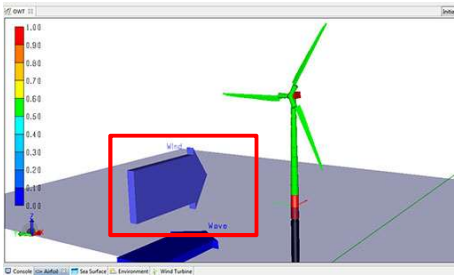


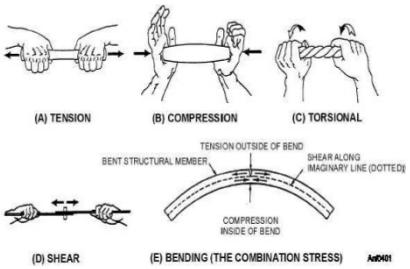
4. Process

2- Collecting wind turbines data from all over the world. Probabilistic preliminary design was done by using 500 real case tower types.



3- Applying real case loads on the tower and implementing standards





Strength calculations for real loads V.S. Strength calculations for standards.

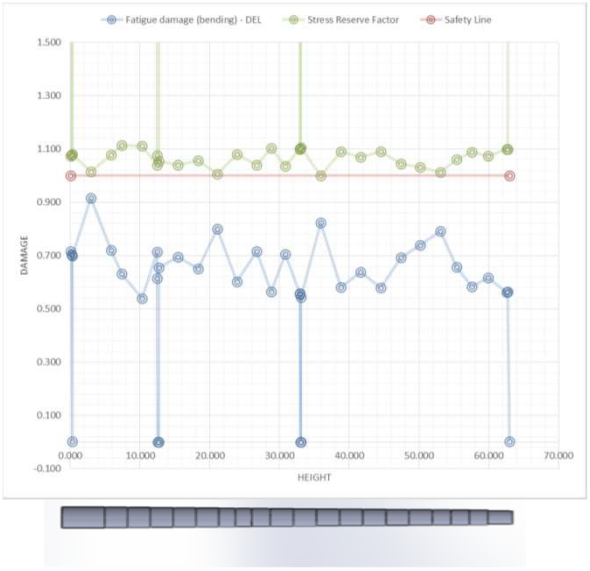
Buckling, dynamic and fatigue analyses

EC3 Eurocode 3: Design of Steel Structures
EC3-1-1 Eurocode 3: Part 1-1: General Rules
EC3-1-4 Eurocode 3: Part 1-4: Supplementary Rules for Stainless Steel
EC3-1-5 Eurocode 3: Part 1-5: Plated Structural Elements
EC3-1-6 Eurocode 3: Part 1-6: Strength and Stability of Shell Structures
EC3-1-9 Eurocode 3: Part 1-9: Fatigue

A- Buckling

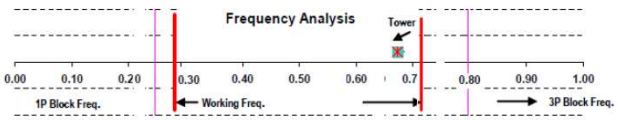
4. Process

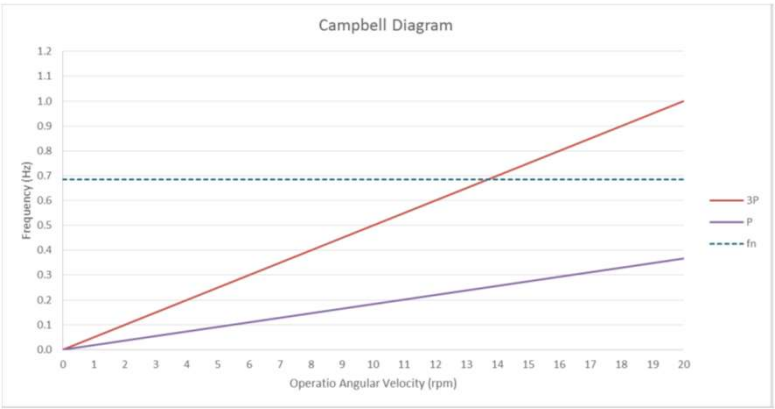
B- Fatigue



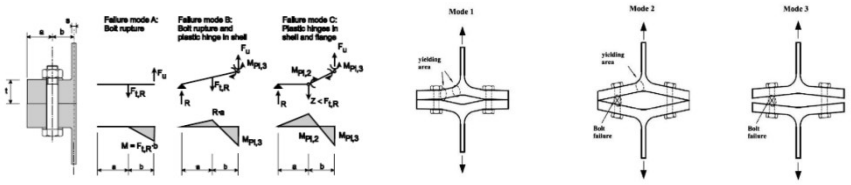
4. Process

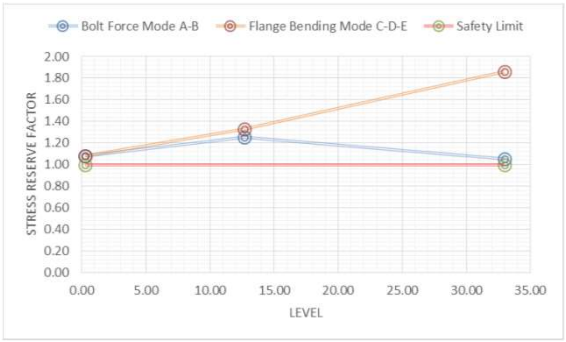
C- Dynamic





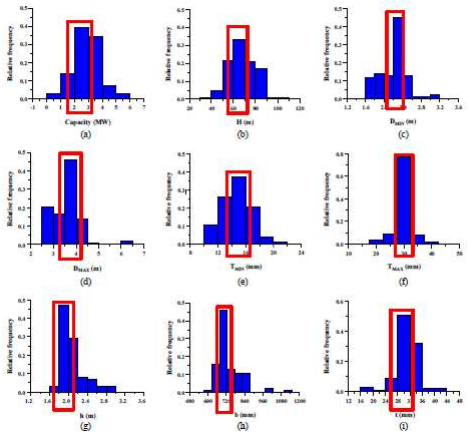
4- Flange design





5- What is the most critical area for wind towers?

6- How ideal door opening can be found?



4. Process

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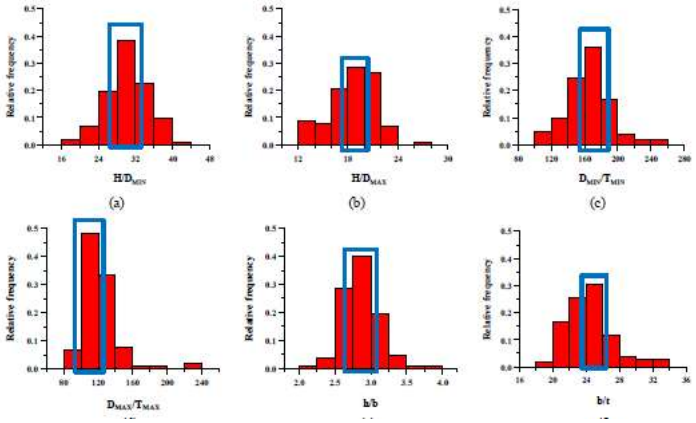

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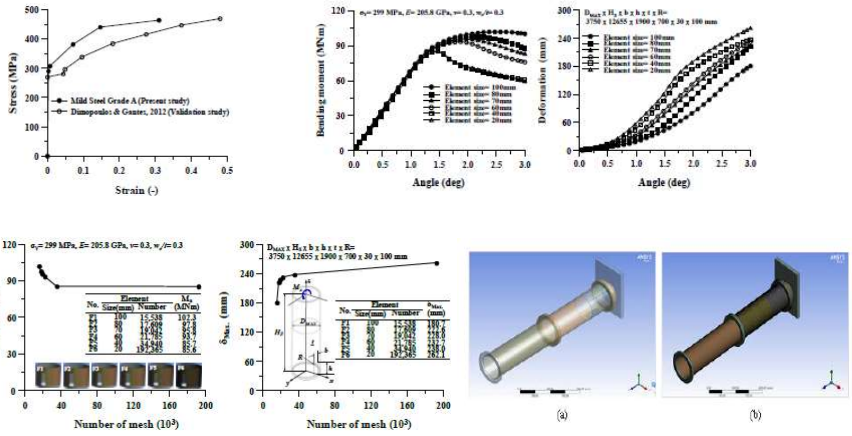

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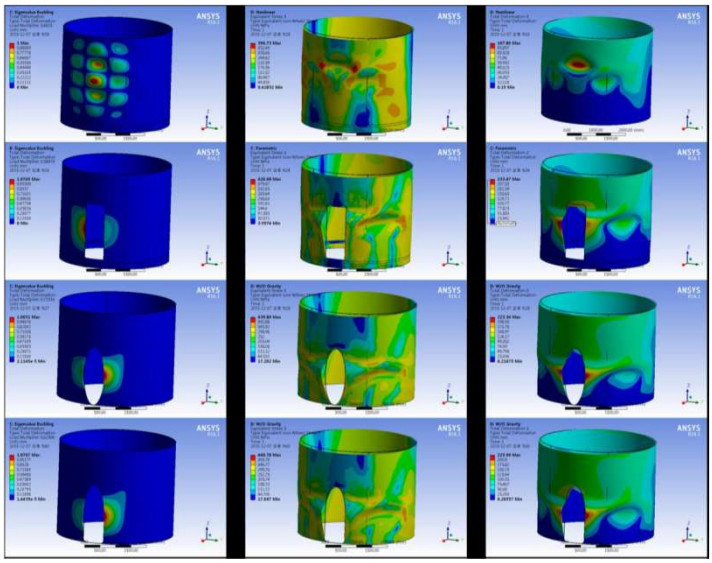

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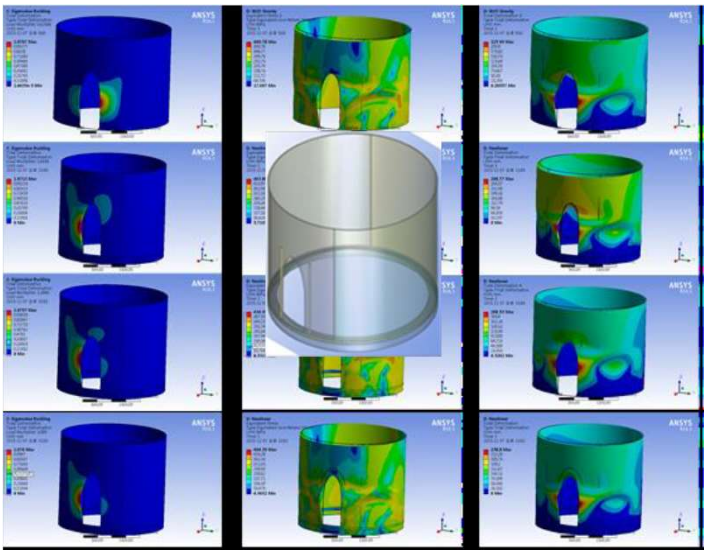
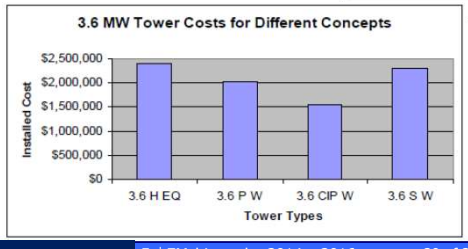


6- Cost estimation

Table 25: Tower cost breakdown for 3.6-MW (Lanier and Way 2005)

	3.6 MW All Tubular Steel Wind Design	
	Cost	% of Total
Mobilization & Site Development	262466 $	11%
Foundation Construction	200056 $	9%
Shop Fabrication of Steel Tube and Flange Rings	1138083 $	50%
Field Erection of Steel Tube	127070 $	6%
Tower Concrete Fabrication	0 $	0%
Field Erection of Precast and Post Tensioning	0 $	0%
Jack-Up of Steel Tube within Hybrid Tower	16354 $	1%
Complete Concrete To Steel Connection and install Nacelle and Rotor	20400 $	23%
General Contractor Mark-ups	529330 $	100%
Total Cost	2293759 $	



5. Conclusion and Future Works

Conclusion

1- Site-Specific wind tower was designed.
2- Model satisfied EU Standards.
3- Door opening analyses was done and verified.
4- Basic cost analyses was done.

Future Works

1- Instead of probabilistic method, optimization can be used.
2- Big tower database can be created and used.
3- More door opening types can be used.
4- Cost estimation can be done more professionally.

6. Thank You

Thank you and Questions?
Wind Turbines in Jeju Island – South Korea