

HABIBI PALIPPUI

# TEKNOLOGI PRODUKSI BANGUNAN LEPAS PANTAI



**Habibi Palippui**

# **TEKNOLOGI PRODUKSI BANGUNAN LEPAS PANTAI**

# TEKNOLOGI PRODUKSI BANGUNAN LEPAS PANTAI

Penulis : **Habibi Palippui**  
Penyunting : **Marwati, S.Sos.**  
Tata sampul : **Rezkiawati, S.Pd**  
Tata isi : **Asjmi., ST.**

Cetakan Pertama, **November 2023**  
ISBN **xxx-xxx-xx-xxxx-x**

Penerbit **Professorline**

📍 Jl. Dg. Ngadde Raya, Parangtambung, Makassar,  
Sulawesi Selatan, Indoneisa

✉ professorline123@gmail.com  
adminbook@professorline.com

📞 +62 853-4177-7525

🌐 [www.professorline.com](http://www.professorline.com)

Hak cipta dilindungi oleh undang-undang.  
Dilarang mengutip dan memperbanyak sebagian atau seluruh isi buku  
baik secara elektronik maupun mekanik tanpa izin tertulis  
**Penerbit Professorline.**

## KATA PENGANTAR

Puji syukur kami panjatkan ke hadirat Tuhan Yang Maha Esa, atas berkat dan rahmat-Nya kami dapat menyelesaikan buku ajar teknologi produksi bangunan lepas pantai. Buku ajar ini merupakan salah satu upaya kami untuk berbagi pengetahuan dan pengalaman tentang bidang yang sangat menarik dan penting bagi perkembangan industri maritim di Indonesia.

Buku ajar ini membahas tentang teknologi produksi bangunan lepas pantai, yaitu teknologi yang berkaitan dengan pembuatan dan perbaikan struktur dan instalasi yang berada di lingkungan laut. Struktur dan instalasi ini memiliki berbagai jenis dan fungsi, seperti anjungan, pipa penyalur, bangunan apung, dan lain-lain. Struktur dan instalasi ini digunakan untuk berbagai keperluan, seperti eksplorasi dan eksploitasi sumber daya alam, transportasi, penelitian, dan pariwisata.

Teknologi produksi bangunan lepas pantai membutuhkan pemahaman yang mendalam tentang konsep, metode, dan aplikasi teknik yang sesuai dengan kondisi dan tantangan yang ada di laut. Kondisi dan tantangan ini meliputi faktor-faktor seperti gelombang, arus, angin, gempa, korosi, dan tekanan hidrostatis. Metode dan aplikasi teknik ini meliputi proses-proses seperti perancangan, fabrikasi, instalasi, operasi, pemeliharaan, dan reparasi.

Teknologi produksi bangunan lepas pantai juga memerlukan fasilitas dan peralatan galangan yang mampu menangani pekerjaan yang kompleks dan berisiko tinggi. Fasilitas dan peralatan galangan ini meliputi hal-hal seperti dermaga, dok, crane, barge, tugboat, dan welding. Fasilitas dan peralatan galangan ini harus memenuhi standar keselamatan, kualitas, dan efisiensi yang tinggi.

Buku ajar ini disusun dengan tujuan untuk memberikan gambaran umum dan penjelasan rinci tentang teknologi produksi bangunan lepas pantai. Buku ini terdiri dari beberapa bab yang membahas tentang berbagai aspek yang terkait dengan teknologi ini, mulai dari jenis dan fungsi bangunan lepas pantai, hingga prosedur dan standar yang harus dipenuhi dalam proses produksi dan reparasi. Buku ini juga dilengkapi dengan contoh-contoh,

gambar, tabel, dan rumus yang memudahkan pembaca untuk memahami materinya.

Buku ajar ini ditujukan untuk mahasiswa, dosen, peneliti, praktisi, dan pengambil kebijakan yang berkepentingan dengan bidang teknologi produksi bangunan lepas pantai. Buku ini diharapkan dapat menjadi sumber referensi yang bermanfaat dan dapat meningkatkan kompetensi dan kualitas sumber daya manusia di bidang ini. Buku ini juga dapat menjadi inspirasi dan motivasi bagi pembaca untuk terus belajar dan berinovasi dalam mengembangkan teknologi produksi bangunan lepas pantai di Indonesia.

Kami menyadari bahwa buku ajar ini masih memiliki banyak kekurangan dan keterbatasan. Oleh karena itu, kami sangat mengharapkan kritik dan saran yang membangun dari pembaca untuk perbaikan buku ajar ini di masa mendatang. Kami juga berterima kasih kepada semua pihak yang telah membantu dan mendukung kami dalam menyelesaikan buku ajar ini, seperti pembimbing, penerbit, editor, reviewer, dan lain-lain.

Semoga buku ajar ini dapat bermanfaat bagi pembaca dan dapat memberikan kontribusi positif bagi pengembangan teknologi produksi bangunan lepas pantai di Indonesia. Kami berharap buku ajar ini dapat menjadi salah satu sumber ilmu yang dapat mencerahkan dan memberkahi kita semua.

Makassar, November 2023

Penulis

# DAFTAR ISI

KATA PENGANTAR.....	ii
DAFTAR ISI .....	iii
DAFTAR GAMBAR .....	vii
BAB I KONSEP UMUM PRODUKSI BANGUNAN LEPAS PANTAI... 1	
1.1 Pendahuluan .....	1
1.2 Prinsip Desain Struktur Lepas Pantai .....	4
1.3 Jenis-jenis Bangunan Lepas Pantai.....	5
1.4 Pemilihan Konsep Produksi Bangunan Lepas Pantai .....	31
1.5 Fungsi Struktur Bangunan Lepas Pantai .....	33
1.6 Ancaman dan Bencana Bangunan Lepas Pantai.....	35
1.7 Tantangan Operasi Lepas Pantai- <i>Deepwater</i> .....	39
1.8 Soal Latihan .....	40
1.9 Kesimpulan .....	41
BAB II METODE PRODUKSI BANGUNAN LEPAS PANTAI .....	44
2.1 Pendahuluan .....	44
2.2 Pendekatan Metode Produksi.....	45
2.3 Metode Modular .....	46
2.4 Metode <i>Float-over</i> .....	49
2.5 Metode Lunch.....	50
2.6 Metode <i>Lift</i> .....	52
2.7 Soal Latihan .....	54
2.8 Kesimpulan .....	55
BAB III DESAIN DAN PERENCANAAN PRODUKSI .....	58
3.1 Pendahuluan .....	58
3.2 Studi Kelayakan .....	60
3.2.1 Analisis Pasar.....	61
3.2.2 Estimasi Biaya .....	72
3.2.3 Analisis Risiko .....	81
3.2.4 Seleksi Lokasi .....	87
3.3 Desain Konseptual .....	88
3.3.1 Prinsip Dasar.....	90

3.3.2 Keuntungan .....	91
3.3.3 Metode dan Alat Desain .....	92
3.4 Desain Rinci .....	94
3.5 Perencanaan Produksi .....	95
3.5.1 Tantangan Dalam Perencanaan Produksi BLP.....	97
3.5.2 Mengukur Kinerja Perencanaan Produksi BLP .....	98
3.6 Perencanaan Konstruksi .....	99
3.6.1 Fabrikasi.....	103
3.6.2 Pengujian Kualitas.....	105
3.6.3 Pengiriman ke Lokasi .....	108
3.6.4 Instalasi di Laut .....	109
3.7 Operasi dan Pemeliharaan .....	110
3.8 Soal Latihan .....	111
3.9 Kesimpulan .....	113
<b>BAB IV PROBABILITAS DESAIN STRUKTUR BANGUNAN</b>	
<b>LEPAS PANTAI.....</b>	<b>117</b>
4.1 Pendahuluan .....	117
4.2 Konsep dan Prinsip Probabilitas Desain Struktur.....	118
4.2.1 Pengertian dan Tujuan Probabilitas Desain Struktur.....	121
4.2.2 Perbedaan antara Desain Deterministik dan Probabilitas ....	122
4.3 Analisis Keandalan Struktur Lepas Pantai .....	124
4.4 Desain Optimal Berbasis Keandalan Struktur Lepas Pantai ....	134
4.5 Aplikasi Probabilitas Desain Struktur Bangunan Lepas Pantai	141
4.5.1 Faktor-faktor Ketidakpastian yang Mempengaruhi Desain Struktur Lepas Pantai.....	142
4.5.2 Pendekatan-Pendekatan Probabilitas Desain Struktur Bangunan Lepas Pantai .....	143
4.5.3 Contoh Penerapan Probabilitas Desain Struktur.....	146
4.6 Soal Latihan .....	148
4.7 Kesimpulan .....	149
<b>BAB V FABRIKASI STRUKTUR.....</b>	<b>153</b>
5.1 Pendahuluan .....	153
5.2 Fabrikasi Bangunan Lepas Pantai .....	154

5.2.1 <i>Fit up and Assembly</i> .....	155
5.2.2 <i>Weld out</i> .....	157
5.2.3 <i>Sweep blast dan Primer</i> .....	159
5.2.4 <i>Intermediate coat</i> .....	161
5.2.5 <i>Erection</i> .....	162
5.2.6 <i>Clean up prior to painting and spot blast</i> .....	164
5.2.7 <i>Top coat and Touch up</i> .....	165
5.3 <i>Quality Assurance (AQ)</i> .....	168
5.4 <i>Quality Control (QC)</i> .....	169
5.4.1 <i>Material Control</i> .....	171
5.4.2 <i>Welding control</i> .....	171
5.4.3 <i>Dimensional control</i> .....	172
5.4.4 <i>Painting / Coating Inspection</i> .....	173
5.5 <i>Load out</i> .....	<b>Error! Bookmark not defined.</b>
5.5.1 <i>Self Propelled Modular Transporter (SPMT)</i> .....	177
5.5.2 <i>Skidding</i> .....	178
5.5.3 <i>Lifting</i> .....	180
5.6 <i>Soal Latihan</i> .....	183
5.7 <i>Kesimpulan</i> .....	185
BAB VI <i>TRANSPORTASI DAN INSTALASI</i> .....	188
6.1 <i>Pendahuluan</i> .....	188
6.2 <i>Transportasi Struktur</i> .....	190
6.2.1 <i>Persiapan Transportasi Struktur Offshore</i> .....	201
6.2.2 <i>Pemilihan Moda Transportasi</i> .....	202
6.2.3 <i>Pengangkutan Struktur Offshore</i> .....	205
6.2.4 <i>Penerimaan Struktur Offshore</i> .....	208
6.3 <i>Peluncuran Struktur</i> .....	210
6.3.1 <i>Slide Launch</i> .....	210
6.3.2 <i>Float-out</i> .....	211
6.3.3 <i>Upending</i> .....	213
6.4 <i>Instalasi Struktur</i> .....	218
6.4.1 <i>Instalasi Terapung</i> .....	220
6.4.2 <i>Instalasi Tetap</i> .....	230

6.5 Soal Latihan .....	232
6.6 Kesimpulan .....	233
BAB VII PEMELIHARAAN.....	236
7.1 Pendahuluan .....	236
7.2 Inspeksi Visual .....	239
7.2.1 Metode Inspeksi .....	240
7.2.2 Cara Inspeksi .....	242
7.2.3 Kelebihan dan Kelemahan Inspeksi.....	243
7.3 Pembersihan dan Penghapusan Kotoran Bangunan <i>Offshore</i> . 244	
7.3.1 Pembersihan .....	245
7.3.2. Waktu Pembersihan .....	247
7.4 Perbaikan dan Penggantian .....	248
7.5 Pelumasan dan Penyetelan.....	250
7.6 Pengujian dan Kalibrasi.....	252
7.7 Pemantauan dan Evaluasi.....	254
7.8 Soal Latihan .....	255
7.9 Kesimpulan .....	257
DAFTAR PUSTAKA .....	261

# DAFTAR GAMBAR

Gambar 1.1 Perkembangan <i>Fixed platform</i> di GOM berdasarkan kedalamannya .....	2
Gambar 1.2 Struktur Bangunan Lepas Pantai .....	3
Gambar 1.3 Jenis Platform Produksi Minyak dan Gas Lepas Pantai .	7
Gambar 1.4 Perbedaan Tipe Struktur Bangunan Lepas Pantai beserta kedalamannya selama bertahun-tahun .....	8
Gambar 1.5 Komponen Bangunan Lepas Pantai .....	9
Gambar 1.6 <i>Fixed Offshore Platform</i> .....	10
Gambar 1.7 Elemen Struktur Jacket .....	12
Gambar 1.8 Proses Pengangkutan Struktur ke Lokasi Pemasangan di Laut .....	18
Gambar 1.9 Tipe Platform <i>Semi-submersible</i> .....	23
Gambar 1.10 Tipe Spar Platform .....	25
Gambar 1.11 FPSO/FSO .....	27
Gambar 1.12 Tipe <i>Tension leg platform</i> (TLP) .....	29
Gambar 1.13 <i>Offshore Disasters</i> .....	38
Gambar 1.14 <i>Lift Installation</i> .....	53
Gambar 5. 1 <i>Assembly of jacket for cognac platform</i> .....	155
Gambar 5. 2 <i>Loadout</i> dengan SPMT .....	178
Gambar 5. 3 <i>Loadout</i> dengan <i>Skidding System</i> .....	179
Gambar 5. 4 <i>Loadout</i> dengan <i>Lifting</i> .....	181
Gambar 5. 5 <i>Lifting</i> menggunakan <i>Crane Tongkang</i> .....	181
Gambar 6. 1 Kapal Tongkang Mengangkut Struktur .....	203
Gambar 6. 2 Helikopter .....	204
Gambar 6. 3 <i>Upending Sequence of Jacket Crane Assisted</i> .....	217

## DAFTAR PUSTAKA

- [1] Da-yong Zhang and Q. Yue. "Major challenges of *offshore* platforms *design* for shallow water *oil* and gas field in moderate ice conditions." *Ocean Engineering*, 38 (2011)
- [2] Siti NorAdha Binti Tuhaijan, K. John and M. S. Liew. "Wave-current interaction on *offshore* spar platforms." 2011 National Postgraduate Conference (2011)
- [3] R. Fainstein and M. Tygel. "Seismic Technology - *Offshore* Exploration and Production." (2018).
- [4] Grace, D. John and L. Angeles. "Exploration and development of the *offshore* Gulf of Mexico." *AAPG Bulletin*, 75 (1991).
- [5] Yunizar Putra, Yessi Nirwana Kurniadi and Nur Laeli Hajati. "Perancangan Struktur *Jacket* dan Topside Anjungan Lepas Pantai Ditinjau dari Analisis Inplace." (2017).
- [6] A. Bos and T. M. Ligterink. "Influence of Ocean Transport on the *Design* of Onshore and *Offshore* Constructions, Modules, Topsides, *Jackets* and Towage on FPSO *Design*." (2013).
- [7] A. Stacey and J. Sharp. "Safety factor requirements for the *offshore* industry." *Engineering Failure Analysis*, 14 (2007): 442-458.
- [8] S.K.Chakrabarti,"Handbook of *Offshore* Engineering," *Offshore* Structure Analysis, Inc.Plainfield, Illinois, USA, Elsevier, Vol.1, 2005.
- [9] Mohamad khaled Abed El Rahim and Moath Al Husban. "Analysis of the Lebanese *oil* and gas exploration in the Mediterranean Sea: An overview and analysis of *offshore* platforms." , 2 (2021): 25-29.
- [10] L.C. Yu, L.S.King, A.T.C.Hoon, and P.C.C.Yean," A Review Study of *Oil* and Gas Facilities for Fixed and *Floating Offshore Platforms*," *Research Journal of Applied Sciences, Engineering and Technology*, Vol.10, No.6, 2015.

- [11] Palmquist, M., 2008. Hurricanes enter the *offshore oil* drilling debate. Pacific Standard, 19 September
- [12] Sadeghi, K., 2007. An overview of *design*, analysis, construction and *intallation* of *offshore* petroleum platforms suitable for cyprus *oil/gas* fields. GAU J. Soc. Appl. Sci., 2(4): 1-16.
- [13] Replumaz, I., 2013. n.d. Technip (2013).
- [14] MODEC Inc., 2014. Tokyo, Japan Aishvarya Lakshmi A/P Kandasamy, April 2014 FYP, UTAR Kampar. Case Study of Oil and Gas Production Facilities for Fixed and *Floating Offshore Platforms*.
- [15] Net Resource International Ltd., 2012. *Offshore Technology Focus*. Retrieved from: <http://www.nridigital.com/index.html> (Accessed on: December 1, 2014).
- [16] J. Page. "Flexibility in Early Stage *Design* of U. S. Navy Ships: An Analysis of Options." Journal of ship production and *design*, 28 (2012): 128-133.
- [17] Minjoo Choi, S. O. Erikstad and Hyun Chung. "Operation platform *design* for modular adaptable ships: Towards the *configure-to-order* strategy." Ocean Engineering (2018).
- [18] Masoud Seyyedattar, S. Zendehboudi and S. Butt. "Technical and Non-technical Challenges of Development of *Offshore* Petroleum Reservoirs: Characterization and Production." Natural Resources Research, 29 (2019): 2147-2189. <https://doi.org/10.1007/s11053-019-09549-7>.
- [19] C. Amaechi, Ahmed Reda, Harrison Obed Butler, I. A. Ja'e and C. An. "Review on Fixed and Floating *Offshore* Structures. Part II: Sustainable *Design* Approaches and Project Management." Journal of Marine Science and Engineering (2022).
- [20] Michael P. Broadribb. "What have we really learned? Twenty five years after *Piper alpha*." Process Safety Progress, 34 (2015).

- [21] H. Bryne and Eilif Dahl. "Oil Rig Disaster in the North Sea." *Prehospital and Disaster Medicine*, 1 (1985): 357 - 359.
- [22] J. Pramudito, "Tantangan Logistik Operasi Lepas Pantai: Studi Kasus pada Operasi Pengeboran Migas di Lepas Pantai Indonesia," *Prosiding Seminar Nasional Manajemen Teknologi XVIII*, 2013.
- [23] A. Bos and T. M. Ligterink. "Influence of Ocean Transport on the Design of Onshore and Offshore Constructions, Modules, Topsides, Jackets and Towage on FPSO Design." (2013).
- [24] Na Lu and T. Korman. "Implementation of Building Information Modeling (BIM) in Modular Construction: Benefits and Challenges." (2010): 1136-1145. [https://doi.org/10.1061/41109\(373\)114](https://doi.org/10.1061/41109(373)114).
- [25] K. Chaitanya and Sajith Nair. "Design of Leg Mating Unit for Float-over Intallation of Decks." (2013). <https://doi.org/10.1115/OMAE2013-10707>.
- [26] K. Sekita, M. Sakai and Tetsuo Kimura. "MODEL TESTS ON VARIOUS LAUNCHING METHODS FOR LARGE OFFSHORE STRUCTURES." (1980).
- [27] Dong-Hoon Jeong, M. Roh and S. Ham. "Lifting simulation of an offshore supply vessel considering various operating conditions." *Advances in Mechanical Engineering*, 8 (2016).
- [28] M. A. Simanjuntak and Yosua Christananda. "The Feasibility Study Framework of Mixed Use Construction Project in Bitung, North Sulawesi, Indonesia." *Imperial journal of interdisciplinary research*, 3 (2017).
- [29] B. Yeter, Y. Garbatov and C. Soares. "Risk-based maintenance planning of offshore wind turbine farms." *Reliab. Eng. Syst. Saf.*, 202 (2020): 107062. <https://doi.org/10.1016/j.ress.2020.107062>.
- [30] Thomas Y. Lee and Eric T. Bradlow. "Automated Marketing Research Using Online Customer Reviews." *Journal of*

- Marketing Research, 48 (2010): 881 - 894.  
<https://doi.org/10.1509/jmkr.48.5.881>.
- [31] Nella Oktaviana Wahyudi, M. Agustini and Agatha Ferijani. "SWOT Analysis for Determining Marketing Strategy: A Case Study on Coal Mining Related Service Firm." *Journal of Management and Business Environment (JMBE)* (2023).
- [32] B. Johnston, A. Foley, J. Doran and Tim Brian Littler. "Levelised cost of energy, A challenge for *offshore* wind." (2019).
- [33] E. Cocodia. "International Codes and Standards Applicable to Cost Estimating Relationships for Floating Production *Systems*." (2008): 205-216.
- [34] Rui Zhang, Wen-Chyuan Chiang and Cheng Wu. "Investigating the impact of operational variables on manufacturing cost by simulation optimization." *International Journal of Production Economics*, 147 (2014): 634-646.
- [35] B. Sarker and Tasnim Ibn Faiz. "Minimizing maintenance cost for *offshore* wind turbines following multi-level opportunistic preventive strategy." *Renewable Energy*, 85 (2016): 104-113.
- [36] R. Chandrasekaran and R. V. Kumar. "Application of Logistic Regression to Predict Over Target Baseline of *Software* Projects." *International Journal of Computer Applications*, 44 (2012): 1-6.
- [37] K. Gkoumas. "A Risk Analysis Framework for *Offshore* Wind Turbines." (2010): 1965-1972.
- [38] E. Cocodia. "Risk Based Fuzzy Modeling of Cost Estimating Relationships for Floating Structures." (2008): 129-142.
- [39] R. Tiusanen, Jere Jännes and J. Liyanage. "Evaluation of RAMS+I Factors Affecting Different *Offshore* Wind Turbine Concepts." *International Journal of Offshore and Polar Engineering*, 23 (2013): 137-142.

- [40] P. Babu and D. Reddy. "Existing methodologies in the *design* and analysis of *offshore* floating nuclear power plants." *Nuclear Engineering and Design*, 48 (1978): 167-205.
- [41] M. Baker. "The reliability concept as an aid to decision making in *offshore* engineering." *The Aeronautical Journal* (1968), 92 (1988): 8 - 8.
- [42] C. Amaechi, Ahmed Reda, Harrison Obed Butler, I. A. Ja'e and C. An. "Review on Fixed and Floating *Offshore* Structures. Part II: Sustainable *Design* Approaches and Project Management." *Journal of Marine Science and Engineering* (2022).
- [43] Amaechi, C., Reda, A., Butler, H., Ja'e, I., & An, C. (2022). Review on Fixed and Floating *Offshore* Structures. Part II: Sustainable *Design* Approaches and Project Management. *Journal of Marine Science and Engineering*.
- [44] P. Palermo. "*DESIGNER'S VIEW OF WELDING REQUIREMENTS FOR ADVANCED SHIP STRUCTURES.*" *Welding Journal*, 55 (1976).
- [45] X. Gros. "3 – Non-destructive Testing Techniques." (1996): 43-81. <https://doi.org/10.1016/B978-034067648-6/50005-0>.
- [46] A. Bos and T. M. Ligterink. "Influence of Ocean Transport on the *Design* of Onshore and *Offshore* Constructions, Modules, Topsides, *Jackets* and Towage on FPSO *Design.*" (2013).
- [47] Florian Stempinski, Sebastian Wenzel, J. Lüking, L. Martens and M. Hortamani. "Modelling *Intallation* and Construction of *Offshore* Wind Farms." (2014).
- [48] C. Amaechi, Ahmed Reda, Irish Mpho Kgosiemang, I. A. Ja'e, A. K. Oyetunji, M. A. Olukolajo and Ikechi Igwe. "Guidelines on Asset Management of *Offshore* Facilities for Monitoring, Sustainable Maintenance, and Safety Practices." *Sensors* (Basel, Switzerland), 22 (2022).
- [49] Sari Amelia, Jing Shuo Leow, Bisri Hasyim, Dega Damara Aditramulyadi, H. Kang, O. Yaakob and W. Punurai. "Onshore

- Yard Readiness for Upcoming *Oil* and Gas *Offshore* Structure Decommissioning Projects in Indonesia." Day 2 Wed, December 01, 2021 (2021).
- [50] M. Karpenko, H. Heinzl, Thore Broderson and Alan McClintock. "Repair rates in structural steel fabrication." *Welding in the World*, 64 (2020): 419-427.
- [51] Doan Thanh Dat, Le Thi Hong Giang, Nguyen Dinh Dung, Hoang, Anh Tuan and Nguyen Thi Le Hien. "*Design and assembly of an apparatus system based on the Villari effect for detecting stress concentration zone on ferromagnetic materials.*" , 10 (2020): 60-66.
- [52] A. Kim, S. Kainuma and M. Yang. "Surface Characteristics and Corrosion Behavior of Carbon Steel Treated by *Abrasive blasting.*" *Metals* (2021). <https://doi.org/10.3390/met11122065>.
- [53] A. Momber, S. Koller and H. Dittmers. "EFFECTS OF SURFACE PREPARATION METHODS ON *ADHESION OF ORGANIC COATINGS TO STEEL SUBSTRATES.*" *Journal of protective coatings & linings*, 21 (2004): 44-50.
- [54] Chen Fei-ying. "Development of anti-high temperature and anti-corrosion epoxy modified silicone *coating.*" *Electroplating & Finishing* (2010).
- [55] M. Mohammadi, C. Richter, D. Pak, C. Rebelo and M. Feldmann. "Steel hybrid onshore wind towers installed with minimal effort: Development of *lifting* process." *Wind Engineering*, 42 (2018): 335 - 352.
- [56] In-Tae Kim and Y. Jeong. "Fatigue strength improvement of welded joints by blast cleaning for subsequent painting." *International Journal of Steel Structures*, 13 (2013): 11-20.
- [57] J. Pontes, E. V. Bendinelli, C. C. Amorim, Marcos Martins de Sá and A. Ordine. "Effect of Corrosion Inhibitor Used in Surface Treatment on the Anticorrosive Performance of an Epoxy Paint

- System*." *Materials Sciences and Applications*, 07 (2016): 593-609.
- [58] Shunsuke Kishigami, Y. Matsumoto, Yuki Ogawa, Yoshiaki Mizokami, D. Shiozawa, T. Sakagami, M. Hayashi and Noriyasu Arima. "Quantitative Deterioration Evaluation of Heavy-Duty Anticorrosion *Coating* by Near-Infrared Spectral Characteristics." *Engineering Proceedings* (2021).
- [59] Riadhi Sanjaya Hidayat. "ANALISIS PENGENDALIAN KUALITAS DENGAN METODE STATISTICAL PROCESS CONTROL (SPC) DALAM UPAYA MENGURANGI TINGKAT KECACATAN PRODUK PADA PT. GAYA PANTES SEMESTAMA." , 3 (2019): 379-387.
- [60] Gudisa Bereda. "*Quality Assurance and Quality Control*. current furtherances and hereafter point of view." *Journal of Analytical & Pharmaceutical Research* (2021).
- [61] A. Kaelin. "*Quality Control and Quality Assurance*." *Journal of protective coatings & linings*, 22 (2005): 58-64.
- [62] D. Broadhurst, R. Goodacre, S. Reinke, J. Kuligowski, I. Wilson, M. Lewis and W. Dunn. "Guidelines and considerations for the use of *system* suitability and *Quality Control* samples in mass spectrometry assays applied in untargeted clinical metabolomic studies." *Metabolomics*, 14 (2018)..
- [63] S. V. Ranganayakulu, Samrat Goud Burra and S. Ravi. "Characterization of Weldments Defects through Non Destructive Evaluation Techniques." *Indian journal of science and technology*, 10 (2017): 1-9.
- [64] N. Whitehouse. "Inspection of Paints and Painting Operations." *Reference Module in Materials Science and Materials Engineering* (2019).
- [65] Fikri Bashar Yalchiner, R. Agrawal, F. Kamal and Oussama Takieddine. "Detailed *Finite Element Analysis* of 180 M Deck

- Cargo / *Launch Barge B42.*" Day 4 Thu, November 14, 2019 (2019).
- [66] J. Tod. "Temporary Works Toolkit: Part 14: *Lifting*, moving and jacking." *The Structural Engineer: journal of the Institution of Structural Engineer*, 95 (2017): 26-32.
- [67] J. de Boer. "The Benefits of Jacking and *Skidding* for Rapid *Intallation* of Under- and Overpasses." *Structural Engineering International*, 21 (2011): 419 - 425.
- [68] T. Luong, Santosh Kurundwade and Wahyudin Trisnawan. "Heavy *Lift* Performance of Seven Champion Under Wave Conditions." Day 3 Wed, November 14, 2018 (2018).
- [69] Siti NorAdha Binti Tuhaijan, K. John and M. S. Liew. "Wave-current interaction on *offshore* spar platforms." 2011 National Postgraduate Conference (2011): 1-5.
- [70] R. F. Busby. "Underwater inspection, testing, monitoring of *offshore* structures." *Ocean Engineering*, 6 (1979): 355-491.
- [71] U. R. Tuzkaya, Semih Önut and G. Tuzkaya. "A Strategic Planning Methodology for the Multimodal Transportation *Systems*: A Case Study from Turkey." *J. Appl. Math.*, 2014 (2014): 931456:1-931456:23.
- [72] H. Ding, Zun-tao Feng, Puyang Zhang, Conghuan Le and Yaohua Guo. "Floating Performance of a Composite Bucket *Foundation* with an *Offshore* Wind Tower during Transportation." *Energies* (2020).
- [73] C. Amaechi, Ahmed Reda, Harrison Obed Butler, I. A. Ja'e and C. An. "Review on Fixed and Floating *Offshore* Structures. Part I: Types of Platforms with Some Applications." *Journal of Marine Science and Engineering* (2022).
- [74] M. El-Reedy. "*Offshore* structure platform *design*." *Offshore Structures* (2020).

- [75] J. Zhao, L. Zhang and H. Wu. "Motion performance and mooring system of a floating offshore wind turbine." *Journal of Marine Science and Application*, 11 (2012): 328-334.
- [76] Jun Ye, Spandan Roy, M. Godjevac, V. Reppa and S. Baldi. "Robustifying Dynamic Positioning of Crane Vessels for Heavy Lifting Operation." *IEEE/CAA Journal of Automatica Sinica*, 8 (2021): 753-765.
- [77] S. Samarakoon and R. Ratnayake. "Residual Service Life Prediction of Offshore Concrete Structures With Chloride-Induced Damage: The State of the Art." (2013).
- [78] H. Terán, Oscar B. Arteaga, F.S. Alcocer, Richard R. Navas, Stalin Mena and Eduardo Cárdenas. "Application of Multiple Methods of NDT for the Evaluation of Welded Joints in a Steel Bridge ASTM-A-588." *Solid State Phenomena*, 287 (2019): 12 - 8.
- [79] M. Jahanshahi, S. Masri and G. Sukhatme. "Multi-image stitching and scene reconstruction for evaluating defect evolution in structures." *Structural Health Monitoring*, 10 (2011): 643 - 657.
- [80] A. Khalil, K. Heiza and O. Nawawy. "STATE OF THE ART REVIEW ON BRIDGES STRUCTURAL HEALTH MONITORING (TOOLS AND INSPECTION)." , 11 (2016): 1-20.
- [81] B. Gerwick. "Construction of Marine and Offshore Structures." , 62 (2007): 91-91.
- [82] Fujie Yu, Qingzhong Li, Yao Wang and Yuan Chen. "Optimization of tool orientation for improving the cleaning efficiency of offshore jacket-cleaning systems." *Applied Ocean Research* (2021).
- [83] Kai Li, Hongliang Yu, Yiqun Xu and Xiaoqing Luo. "Scheduling Optimization of Offshore Oil Spill Cleaning Materials Considering Multiple Accident Sites and Multiple Oil Types." *Sustainability* (2022).

- [84] Geovana Drumond, I. Pasqualino, B. Pinheiro and S. Estefen. "Pipelines, risers and umbilicals failures: A literature review." *Ocean Engineering*, 148 (2018): 412-425.
- [85] Bonfiglioli Riduttori S.p.A.. "Lubricants and Lubrication." (1995): 273-283.
- [86] I. Expósito, M. Sánchez and I. Cuiñas. "Computing the Influence of Environmental Conditions in Electromagnetic Measurements Uncertainty." *IEEE Transactions on Antennas and Propagation*, 67 (2019): 4084-4090.
- [87] C. Chin. "Sensing *System* for *Offshore* Structure." *Journal of Marine Science: Research & Development* (2013).
- [88] Petronas Malaysia, 2013. Gumusut Kakap Semi-FPS Project for Sabah *Shell*. Retrieved from: <http://www.petronas.com.my/media-relations/media-releases/Pages/article/Sucessfully-Deliveryof-Gumut-KakapSemi-FPS-.aspx>
- [89] [https://www.ewea.org/annual2011/fileadmin/ewec2011\\_files/documents/Workshops/ORECCA/ORECCA\\_EWEA\\_2011\\_Diego\\_Vannucci.pdf](https://www.ewea.org/annual2011/fileadmin/ewec2011_files/documents/Workshops/ORECCA/ORECCA_EWEA_2011_Diego_Vannucci.pdf)
- [90] <https://www.mermaids-rock.com/wp-content/uploads/downloadable/50%20Years%20of%20the%20Oil%20Field.pdf>
- [91] X.K. Dang, and T.D. Tran," Modeling Techniques and Control Strategies for Jack-Up *Rig*: A State of the Art and Challenges," *IEEE Access*, PP(99):1-1, 2021.
- [92] <https://jisoonyamasela.wordpress.com/2018/10/06/anjungan-lepas-pantai/>
- [93] Okoro, Uzoma & Kolios, Athanasios. (2018). Multicriteria risk assessment framework for components' risk ranking: Case study of a complex *oil* and gas support structure. *Journal of Multi-Criteria Decision Analysis*. 25. 10.1002/mcda.1651.
- [94] [https://id.m.wikipedia.org/wiki/Berkas:Thunder\\_horse,\\_oil\\_platform,\\_sinking,\\_July\\_2005\\_U.S.\\_Coast\\_Guard\\_picture.jpg](https://id.m.wikipedia.org/wiki/Berkas:Thunder_horse,_oil_platform,_sinking,_July_2005_U.S._Coast_Guard_picture.jpg)

- [95] <https://www.alvinburhani.net/loadout-di-indonesia/>
- [96] [https://cdn.southampton.ac.uk/assets/imported/transforms/content-block/UsefulDownloads\\_Download/2015F191205A4FB492B68B6FC2FC4501/alecture7%20choo.pdf](https://cdn.southampton.ac.uk/assets/imported/transforms/content-block/UsefulDownloads_Download/2015F191205A4FB492B68B6FC2FC4501/alecture7%20choo.pdf)
- [97] <https://www.istockphoto.com/id/foto/helikopter-mendarat-di-rig-pengeboran-lepas-pantai-gm666223332-124190811>
- [98] B. Ellingwood. "LRFD: implementing structural reliability in professional practice." *Engineering Structures*, 22 (2000): 106-115.
- [99] C. Cornell, F. Jalayer, R. Hamburger and D. Foutch. "Probabilistic Basis for 2000 SAC Federal Emergency Management Agency Steel Moment Frame Guidelines." *Journal of Structural Engineering-asce*, 128 (2002): 526-533.
- [100] R. Melchers. "The effect of corrosion on the structural reliability of steel *offshore* structures." *Corrosion Science*, 47 (2005): 2391-2410. <https://doi.org/10.1016/J.CORSCI.2005.04.004>.
- [101] F. Imanudin, "Analisis Keruntuhan Berbasis Keandalan Pada Bangunan Lepas Pantai Tipe *Jacket* Terhadap Kemiringan Akibat Settlement. Undergraduate thesis, Institut Teknologi Sepuluh Nopember, 2018.
- [102] M.A. Ahnaf. Analisis Keandalan Struktur Anjungan Lepas Pantai Tipe *Jacket Tripod* di Perairan Selat Makassar. Tesis sarjana, Institut Teknologi Bandung, 2021. [online]
- [103] F.G. Aprianto, and R.L.Tawekal, "Desain dan Analisis Struktur Anjungan Lepas Pantai Tipe 4 Kaki di Perairan Sumatera Bagian Tenggara," Tesis sarjana, Institut Teknologi Bandung, 2010. [online] <https://tekniklepaspantai.itb.ac.id/wp-content/uploads/sites/441/2021/11/15516069-Faza-Ghani-A.pdf>
- [104] R.L.Tawekal, and R. Heriana, "Analisis Keandalan Anjungan Lepas Pantai Tipe *Jacket* Berdasarkan Kapasitas Fatigue pada Sambungan," *Jurnal Teknik Sipil*, Vol.14, No.2, 2007.

[105] Budiarto, "Studi Probabilitas Respon Struktur dengan Dua Derajat Kebebasan Menggunakan Metode Elemen Hingga," Tesis sarjana, Universitas Kristen Maranatha, 2006. [online] [https://repository.maranatha.edu/3080/1/0421021\\_Abstract\\_TO C.pdf](https://repository.maranatha.edu/3080/1/0421021_Abstract_TO C.pdf)