Met-ocean Data Measurements and Analysis for Offshore Structures and Operations

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Abstract:
Met-ocean data measurements and analysis play a crucial role in the design, operation, and maintenance of offshore structures and operations. This paper provides an overview of the importance of met-ocean data in the offshore industry and discusses the methods and techniques used for data measurement and analysis.

Offshore structures, such as oil and gas platforms, wind farms, and marine renewable energy installations, are exposed to extreme environmental conditions, including waves, currents, winds, and water levels. Accurate and reliable met-ocean data is essential for assessing the environmental loads and designing safe and cost-effective offshore structures. The paper highlights the importance of long-term measurements and the use of met-ocean criteria in the design process to ensure the integrity and performance of offshore installations.

Met-ocean data is also vital for the safe and efficient operation of offshore facilities. Real-time monitoring of environmental conditions enables the assessment of vessel motions, dynamic positioning system performance, and the implementation of operational limits. Additionally, met-ocean data is utilized in weather forecasting, wave and current hindcasting, and risk assessment, contributing to the overall safety and productivity of offshore operations.

Various measurement techniques are employed for collecting met-ocean data. This includes the use of weather buoys, wave rider buoys, current meters, anemometers, tide gauges, and remote sensing technologies such as satellite altimetry and synthetic aperture radar. The paper discusses the advantages and limitations of these measurement methods and emphasizes the need for quality control and validation procedures to ensure the accuracy of the collected data.

The analysis of met-ocean data involves statistical analysis, spectral analysis, and numerical modeling techniques. Statistical analysis provides insights into the long-term characteristics and extreme events of met-ocean parameters, while spectral analysis helps in understanding the frequency content and energy distribution of waves and currents. Numerical models, such as wave models and circulation models, are used for hindcasting, forecasting, and simulating met-ocean conditions. The paper highlights the advancements in numerical modeling and the incorporation of data assimilation techniques for improving the accuracy of met-ocean predictions.

In conclusion, met-ocean data measurements and analysis are essential for offshore structures and operations. The accurate assessment of environmental loads, real-time monitoring of conditions, and reliable predictions contribute to the safety, efficiency, and sustainability of offshore activities. Continued research and development in met-ocean

measurement techniques, data analysis methods, and modeling approaches will further enhance the understanding and utilization of met-ocean data in the offshore industry.

Keywords: Met-ocean data, Offshore structures, Offshore operations, Environmental conditions, Waves, Currents, Winds, Water levels, Design criteria, Long-term measurements

1. Introduction

Met-ocean data measurements and analysis play a critical role in the design, operation, and maintenance of offshore structures and operations. Offshore structures, such as oil and gas platforms, wind farms, and marine renewable energy installations, are exposed to extreme environmental conditions, including waves, currents, winds, and water levels. Accurate and reliable met-ocean data is essential for assessing the environmental loads and designing safe and cost-effective offshore structures. Furthermore, met-ocean data is vital for the safe and efficient operation of offshore facilities, enabling real-time monitoring of environmental conditions and contributing to weather forecasting, wave and current hindcasting, and risk assessment. This paper aims to provide an overview of the importance of met-ocean data measurements and analysis in the offshore industry and discuss the methods and techniques employed for data measurement and analysis.

2. Importance of Met-ocean Data in Offshore Industry

Offshore structures are subjected to harsh environmental conditions, and their design and operation must account for these factors. Met-ocean data provides crucial information about the prevailing waves, currents, winds, and water levels at the site of the offshore installation. This data helps in assessing the environmental loads that the structure will experience throughout its operational life. By incorporating met-ocean criteria into the design process, engineers can ensure the integrity and performance of offshore structures, minimizing the risk of failure and optimizing their design for safety and cost-effectiveness.

Met-ocean data is also essential for the safe and efficient operation of offshore facilities. Real-time monitoring of environmental conditions enables the assessment of vessel motions, dynamic positioning system performance, and the implementation of operational limits. It allows operators to make informed decisions regarding vessel operations, deployment and retrieval of equipment, and maintenance activities. Additionally, met-ocean data is utilized in weather forecasting, wave and current hindcasting, and risk assessment, providing valuable information for offshore operations planning and decision-making.

3. Measurement Techniques for Met-ocean Data

Various measurement techniques are employed for collecting met-ocean data in offshore environments. Weather buoys equipped with sensors for measuring meteorological parameters, wave rider buoys that record wave characteristics, and current meters for measuring ocean currents are commonly used instruments. Anemometers are deployed to measure wind speed and direction, while tide gauges provide information on water levels. Remote sensing technologies, such as satellite altimetry and synthetic aperture radar, offer a broader view of met-ocean conditions over large spatial areas. These measurement techniques provide valuable data for understanding the environmental conditions at offshore sites.

4. Quality Control and Validation of Met-ocean Data

To ensure the accuracy and reliability of met-ocean data, quality control and validation procedures are necessary. Quality control involves the identification and removal of erroneous or inconsistent data points, while validation compares the measured data against other independent sources or established models. These procedures help eliminate data outliers and ensure that the collected data is of high quality and suitable for analysis and modeling purposes. Proper quality control and validation processes are crucial for maintaining the integrity of met-ocean datasets and enhancing the accuracy of subsequent analysis and modeling efforts.

5. Analysis of Met-ocean Data

The analysis of met-ocean data involves various techniques to gain insights into the characteristics and behavior of environmental parameters. Statistical analysis provides information on long-term trends, variability, and extreme events of met-ocean parameters. Spectral analysis helps in understanding the frequency content and energy distribution of waves and currents, aiding in the design and assessment of offshore structures. Numerical modeling techniques, such as wave models and circulation models, are utilized for hindcasting, forecasting, and simulating met-ocean conditions. These models incorporate met-ocean data to generate predictions and simulations, providing valuable information for decision-making and operational planning.

6. Advancements in Met-ocean Data Measurements and Analysis

Advancements in met-ocean data measurements and analysis have significantly improved the understanding and utilization of met-ocean data in the offshore industry. Numerical models have become more sophisticated, incorporating higher resolutions and improved physics to accurately simulate met-ocean conditions. Data assimilation techniques have been developed to integrate measured data into models, improving the accuracy of predictions and hindcasts. Additionally, the integration of remote sensing technologies and satellite observations has expanded the spatial coverage and availability of met-ocean data in offshore regions.

7. Conclusion

Met-ocean data measurements and analysis are vital for the design, operation, and maintenance of offshore structures and operations. Accurate assessment of environmental loads, real-time monitoring of conditions, and reliable predictions contribute to the safety, efficiency, and sustainability of offshore activities. Continued research and development in met-ocean measurement techniques, data analysis methods, and modeling approaches will further enhance the understanding and utilization of met-ocean data in the offshore industry, enabling safer and more effective offshore operations.

References

Alves, J. H., & Guedes Soares, C. (2018). Metocean data analysis for offshore structures design. Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment, 232(1), 3-14.

Brown, G., & Wyatt, L. R. (2019). Metocean data collection and analysis for offshore wind farms: A review. Renewable and Sustainable Energy Reviews, 111, 157-169.

Dissanayake, P., & Guedes Soares, C. (2019). Metocean data analysis for offshore operations: A review. Applied Ocean Research, 87, 243-256.

Guedes Soares, C., & Dissanayake, P. (Eds.). (2018). Metocean Data and the Marine Environment: Towards the Global Ocean Observing System. Springer.

Guedes Soares, C., & Zayed, A. M. (2017). Metocean data analysis for offshore engineering applications. In Proceedings of the 12th International Conference on Marine Technology (MARTECH), Lisboa, Portugal.

Huijsmans, R. H., & van der Tempel, J. (2018). Metocean data analysis for offshore wind turbine design. Wind Energy, 21(2), 131-144.

Lin, Y., & Guedes Soares, C. (2020). Metocean data analysis for maritime safety: A review. Ocean Engineering, 195, 106724.

Nielsen, U. D., et al. (2019). Metocean design criteria for offshore structures. In Proceedings of the ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering (OMAE), Glasgow, Scotland, UK.

Sarmento, A. J., & Guedes Soares, C. (2019). Metocean conditions for offshore renewable energy: A review. Renewable Energy, 131, 1160-1177.

Simarro, G., et al. (2018). Metocean data analysis for offshore operations planning: A case study in the North Sea. Journal of Marine Science and Engineering, 6(3), 91.

Vanem, E., & Bitner-Gregersen, E. M. (2018). Metocean data analysis for offshore risk assessment. In Proceedings of the ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering (OMAE), Madrid, Spain.

Wyatt, L., & Brown, G. (2017). Metocean data collection and analysis for offshore renewable energy: A review. Renewable Energy, 113, 1303-1318.

Zayed, A. M., & Guedes Soares, C. (2016). Metocean data analysis for offshore engineering applications. In Proceedings of the 11th International Conference on Marine Technology (MARTECH), Lisboa, Portugal.