

MARINE TRANSPORT PREDICTION METHODOLOGY

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ABSTRACT – Marine transport is an excellent way of transport for both passengers and cargos. Some advantages of marine transport are efficiency, low environmental impact, and congestion reduction of existing infrastructures. However, there are some uncertainties related with marine transport in the case of special cargos (large structures, convoys, etc.). One of the most important uncertainties in the Short Sea Shipping (SSS) planning is the identification of met-ocean conditions which could affect marine operations in the selected route, or in refuge areas close to the route. Other variables under consideration are the type of vessels (towed or self-propelled barges and ships), speed and cargo capacity. In this paper the transportation of four jacket structures from Santander harbor to Aberdeen port, in the North Sea, is analyzed and planned aiming the optimization of several objectives: success rate, navigation time, refuge ports needed along the year, seasonal variation of transport capacity, etc.

KEYWORDS – Transport, climate, marine operations, hindcast, sea routes

INTRODUCTION

The North Sea is currently the most attractive region for offshore wind industry. Both resource available, and the bathymetry of this area are some of the reasons that explain the international interest in this sector.

Current and future North Sea offshore wind developments need complex supply chains, which involve countries out from the North Sea, like Spain, Portugal or the Atlantic coast of France. However, the distance and the rough met-ocean conditions of the North Atlantic areas introduce some uncertainties over the suppliers from those countries.



Fig. 1. Jacket structure on a barge.

The purpose of the present work is to develop a methodology for the strategic analysis of different shipping routes and alternatives for special marine

transports, like jacket structures or other large structures typical of the offshore sector. To achieve this objective, a transportation simulator have been developed at IH Cantabria. Based on long term hindcast met-ocean databases, statistical analysis of transport success rates, as well as other transport parameters like the number of pieces potentially shipped per month or season can be obtained.

The methodology is able to reproduce different shipping methods (Heavy lift vessel, Towed barges or Towed structures) considering different speeds and operative thresholds in terms of wave height, period and wind speed, applied to the route. The decision-making proposed algorithm classifies every travel attempt in direct transport or indirect transport because delayed departures or because of the use refuge ports.

METHODOLOGY

A comprehensive strategy covers different parameters that may influence the success of the transport. Mean variables are concerned with met-ocean conditions, and its relation with ships seakeeping. The marine climate in a given area of the ocean (statistical distribution of sea state parameters) varies on a seasonal scale (month) and annual scale (years). Consequently, shipping is modulated throughout the year and has an associated uncertainty, as the marine climate fluctuates. The met-ocean variables of interest involved in this process are the significant wave height, peak wave period and wind speed.

Once the route has been selected climate data between two selected ports, an analysis of the transport is carried out. This include the definitions of the structures to be transported, and the type of available boats (Heavy Lift Vessels, towed barges, or towed structures). The model developed employs an algorithm for decision-making verifying hourly that thresholds conditions, previously established, are not exceeded. These thresholds conditions support the navigation as a function of a window weather forecast. If the threshold parameters are exceeded at any time, the algorithm selects the optimal port of refuge in which to perform scale based on the same criteria of accessibility and proximity to the port of destination.

Results presented are based in a transport between Santander and Aberdeen ports, based in a large number of

simulations between 1980 and 2005 to undertake a detailed statistical analysis of the results.

THE CONCEPT OF TRANSPORT CAPACITY FORECAST

Recent development of offshore wind farms in the North Sea is requiring a mass production of large structures. European shipyards and steel industry are working in the construction of these structures that will be transported from production facilities to storing areas in ports, close to the offshore wind farms, but the transport capacity is affected by weather, and several parameters are involved in this problem.

A. VESSEL CHARACTERIZATION

Different vessels are employed to transport heavy structures. Three main groups can be identify: heavy lift vessels, self-propelled barges, and towed barges.

Each ship has different characteristics, and speed, cargo capacity, weather restrictions due to stability characteristics, and natural periods of loaded ships must be identified in any case, as it is going to be the framework of the study.

B. ROUTE DEFINITION

Selection of marine routes are designed aiming to reduce navigation hours. Direct and indirect routes are evaluated based on the possibility to overcome any environmental threshold. When a dangerous threshold is identified for vessel and/or cargo, the vessel is conducted to the closest refuge port, and the trip continue with the next positive whether forecast.

C. MET-OCEAN DATA

Main parameters of a transport capacity tool are data related with environmental actions that could affect the transport success. Wind and waves are analyzed on the route to identify the possibility to accomplish the shipment.

The databases used, related to the dynamics of waves and wind, have been GOW [5] reanalysis of waves in deep water zone 61 with a resolution of 0.1 °, and Seawind [6] reanalysis of wind hours with a resolution of 30 km.

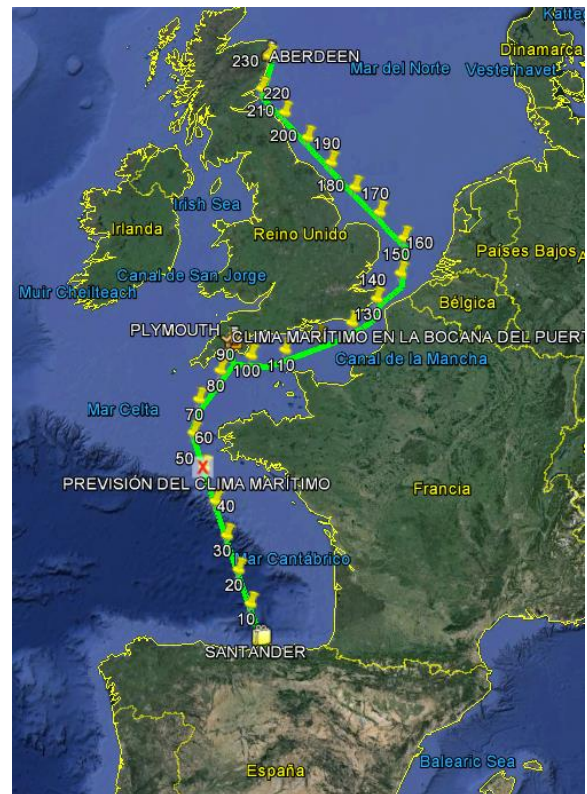


Fig. 2. Santander-Aberdeen direct route. Map: Google Earth.

RESULTS

The presented methodology provides the rate of successful transportation depending on the met-ocean conditions. These met-ocean conditions are evaluated hourly for 25 years period. This provides statistics of the optimal conditions for successful transports, which shows a clear seasonal variability.

As can be observed in Fig 3, refuge ports are classified in order to identify the most critical areas of the route, and the need of a refuge port in Breast-Lorient area.

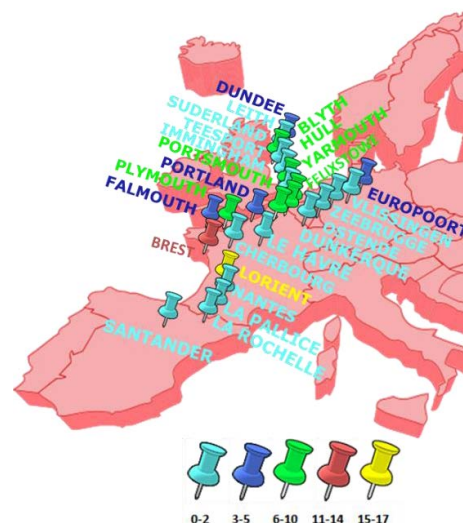


Fig. 3. Refuge ports use prediction in the route Santander-Aberdeen.

CONCLUSIONS

Several conclusions can be obtained from the application of this methodology, which could help in the optimization of transport routes in the development of different projects that will require massive transport of large structures. Transport cost could be reduced with the analysis of refuge ports, fabrication and destiny harbors, selected vessels, or speed rates.

In this work it is evident that the duration of a transport operation is linked to the availability of adequate navigation conditions or more specifically, to the persistence over time of these conditions. Therefore, when planning a transport operation it is essential to understand the environment in which it operates.

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