Submarine Cable Route Optimizing System Based on Marine Environmental Conditions

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ABSTRACT

The number of submarine power transmission projects has been rapidly increasing in recent years, which has raised the demand for quick and accurate estimation of project costs. However, the installation costs of submarine transmission cables heavily depend on marine environments including the sea depths at which cables are run. Therefore, project budget estimation requires sophisticated know-how, and frequent and long-term reviews.

To solve this issue, we have developed a submarine transmission route design optimization system that minimizes installation costs by quantitatively evaluating the effects of various marine environmental conditions on route design.

KEYWORDS

Submarine Cable, Installation, Route Design, Marine Environment

INTRODUCTION

Following the global boost in the exploitation of renewable energy resources such as offshore wind power in recent years, long-distance submarine power transmission projects between regions and nations have been growing rapidly, mainly in Europe. Similar projects have also started to be planned in Asia and North America.

Conventionally, such long-distance submarine power transmission projects require years of review and enormous costs from planning to construction. During the initial stage of cable route planning, in particular, it is necessary to collect and analyze many types of marine information such as sea depth, seafloor geology, and fishery areas from each dedicated databases. In addition, the process of planning transmission routes based on this data is mutually entangled with cable costs and laying costs, which largely depend on marine environments, resulting in a significant impact on the profitability of the entire project.

Therefore, the task of planning a submarine transmission route on paper by combining different types of information with consideration given to complex elements requires a high degree of know-how for engineers, as well as a large amount of time and cost to study. In addition, the resulting route is often difficult to validate objectively.

Under the circumstances of the current exponential spread of the exploitation of renewable energy, the planning and implementation of long-distance submarine power grids are urgent matters. There is strong demand for a technique that can quickly determine and evaluate the lowest-cost submarine transmission route quantitatively, considering complex elements comprehensively.

Accordingly, we have developed an optimized submarine power transmission route planning technique, which quickly and automatically calculates the optimal route between two arbitrary nodes with the minimum cost based on marine environments, and implemented the technique in software.

MARINE ENVIRONMENT INFORMATION DATABASE

We started by building a database of marine environment information, which is necessary for designing submarine transmission routes. Priority was given to the following five types of marine data required for route planning and each data is collected in the range of Japan's exclusive economic zone (EEZ).

(1) Sea depth: Utilize bathymetric chart [1] issued by Japan Hydrographic Association

(2) Submarine geology: Classified into four types: mud, sand, gravel and rocks based on the marine geology map [2] issued by the Geological Survey of Japan

(3) Fishery areas: Designated by Japanese Marine Cadastre [3] issued by Japan Coast Guard

(4) Harbor areas: Designated by the national land information [4] issued by the Ministry of Land, Infrastructure, Transport and Tourism

(5) Military drill areas: Uniformly define SDF exercise are and US military exercise area as military drill area based on data issued by the ministry of Defense [5] and the Japan Coast Guard [6]

As shown in Fig. 1, each type of data is stored in corresponding layers.

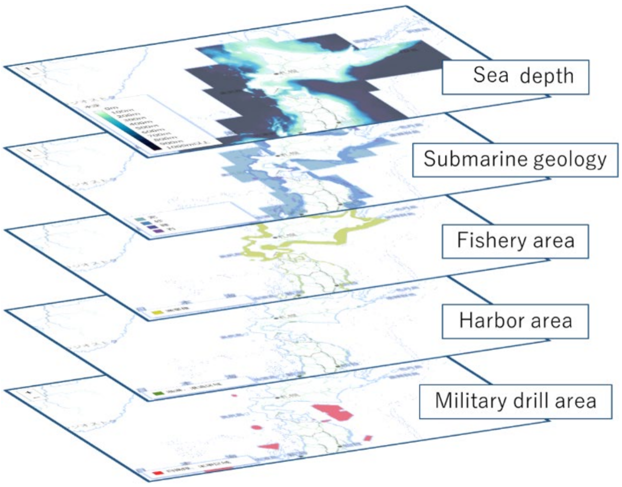

Fig. 1: Layers of Marine Environment Information Data

Natural environmental conditions such as sea depth and seafloor surface geology have a direct impact on methods