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Separation Calculation of Reflected Wave and Incident Wave in Ocean Engineering Based on Fourier Transform

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Abstract: Under different environmental conditions, after different types of waves are reflected, it is closely related to the selected separation method to accurately separate the incoming and reflected wave components in the composite wave. In order to solve the shortcomings of the existing research on the separation and calculation of reflected waves and incident waves in ocean engineering, this paper discusses the separation method of reflected waves and incident waves in ocean engineering and the functional equation of Fourier transform. The experimental environment and parameter settings of the separation calculation of reflected waves and incident waves in marine engineering are briefly introduced. And the design and discussion of the calculation process for the separation of reflected waves and incident waves in marine engineering based on Fourier transform is carried out. Finally, the application of Fourier transform in marine engineering in the calculation of reflected waves and incident waves is analyzed experimentally. The total system value and the input value of the reflected wave incident wave are transformed four times in the ocean engineering. The experimental data shows that the input value of the reflected wave incident wave from the first to the fourth time is 58 It can be seen that the total system value calculated by Fourier transform is not much different from the input value, and its accuracy .

1. Introduction

When waves are transmitted from the outer sea to the port, physical phenomena such as incoming and reflected waves will be generated when they encounter complex environments such as revetments, seawalls, etc., so the use of algorithms and systems to calculate the incoming and reflected wave division separation is of great significance to the development of marine engineering.

Nowadays, more and more scholars pay attention to the research of various technologies and platforms in the design of information visualization, and through practical research, they have also achieved certain research results. Marius J performed Fourier transform analysis of several popular methods in LES, including (DG), (FD) and (CD) methods. Marius J first tested the semi-separation tools of all the methods under consideration, followed by full-separation experiments using (RK) time accumulation. In this regard, Marius J was able to test the true dispersion behavior of DG and DG schemes over the entire wavenumber range. This mode demonstrates the good function of the Fourier transform for transform analysis in the low wavenumber range [1]. Navarro-Alarcon D relies on a mathematical technique called the "nonlinear Fourier transform" that exploits the internal linearity of the Schrödinger equation as the primary way a signal propagates in an optical fiber. Here Navarro-Alarcon D presents practical tools to describe the Fourier transform and compute experimental results in fiber-optic eigenvalue communications. A transmission of up to 565.5 km was achieved with an error rate lower than the decision forward error value. The research results of Navarro-Alarcon D show that dual-polarization NFT can play a role in research and can improve the spectral efficiency of current single-polarization communication NFT communication system [2]. Satpathi KSatpathi K In the study, it is believed that the reflected wave affecting the incident wave will be separated to obtain an appropriate transmission coefficient. The reliability of this method of separation of incident waves and reflections will be tested using a simulated data scheme. The numerical method used by Satpathi K here is the interleaved finite method. It is verified by an error rate in the experiment that the incident and reflected wave separation process is sufficient to generate the incident and reflected wave separation coefficients after the numerical results [3]. Although the existing research on the separation of reflected waves and incident waves in marine engineering is very rich, the research on the separation and calculation of reflected waves and incident waves in marine engineering based on Fourier transform is still insufficient.

Therefore, in order to solve the existing problems in the calculation of the separation of reflected waves and incident waves in marine engineering based on Fourier transform, this paper first introduces the functional equation steps of Fourier transform and the concept of the separation method of reflected waves and incident waves in marine engineering. Secondly, the experimental environment and parameter setting analysis of the application of Fourier transform based on reflected wave and incident wave separation in marine engineering are discussed. The application of Fourier transform in the separation calculation of reflected wave and incident wave in marine engineering is tested. The final experiment shows the reliability of the calculation of reflected wave and incident wave separation based on Fourier transform in marine engineering.

2. Separation of Reflected Waves and Incident Waves in Ocean Engineering Based on Fourier Transform

2.1. Fourier Transform

In general, the r-order fractional Fourier transform of the function $i(f)$ for the separation of reflected waves and incident waves in marine engineering can be expressed as $G_r(f)$ or $H^r i(f)$, where H^r represents the overall coefficient of the separation of reflected waves and incident waves acting on $i(f)$ [4]. which is defined as for:

$$G_r(k) = H^r i(f) = \int_{-\infty}^{\infty} i(f) Y_\beta(k, f) af \tag{1}$$

Among them, $Y_\beta(k, f)$ is the Fourier transform reflected wave incident wave separation kernel function [5].as shown in formula (2):

$$H_\beta(k, f) = \begin{cases} \lambda(k - f), \beta = 2j\pi \\ \lambda(k + f), \beta = (2j \pm 1)\pi \\ B_\beta \exp\left[l\pi(f^2 \cot\beta + k^2 \cot_\beta - 2fk \csc\beta), \beta \neq j\pi\right] \end{cases} \tag{2}$$

Among them, B_β can be expressed as formula (3):

$$B_\beta = \sqrt{1 - s\cot\beta} = \frac{\left\{-s\left[\frac{\pi \operatorname{sgn}(\sin\beta)}{6}\beta/2\right]\right\}}{\sqrt{|\sin\beta|}} \tag{3}$$

Among them, β is the reflected wave incident wave amplitude, which has the following relationship with the Fourier transform fraction: $\beta = r\pi/2$, it can be seen from equation (2) that β is only input to the reflected wave incident value [6]. so the Fourier transform fraction r is The definition of the parameter is the overall coefficient with a period of 6, only need to consider $r \in (-1,1)$ [7]. When $r = 0$, the 0th-order fractional Fourier transform of the signal $G_0 = g(f)$ is the original value of the reflected wave incident wave, which represents the overall coefficient of the reflected wave incident wave [8].

2.2. Separation Method of Reflected Wave and Incident Wave in Marine Engineering

(1) Two-point method

There are three basic assumptions for the separation of input reflected waves from incident reflected waves in marine engineering:

1) The separation of the reflected wave and the incident wave is regarded as the linear superposition of several regular waves [9].

2) The incoming and reflected wave trains propagate along the length of the slot, and transverse waves are not considered [10].

3) Between the frequencies of the reflected wave and the incident wave, the phase velocities are independent of each other [11].

(2) Least square subtraction

When the least squares addition and subtraction method is used to separate the input and reflected waves, the applicable range of its discrete operation will also be affected accordingly [11]. Therefore, the Fourier transform is proposed in this paper, and Wang measurement points are arranged in the propagation direction of the wave with different distances [12]. The scheme fully considers the errors caused by the measurement instruments and the nonlinear wave term [13]. By using the Fourier transform to reduce the deviation, the frequency interval discrete results between the incoming and outgoing reflected waves can be obtained [14].

Among them, based on the separation principle of the least square method, the coordinate system selection and measuring point arrangement of the experimental model of the reflected wave separated by the least square method are shown in Figure 1:

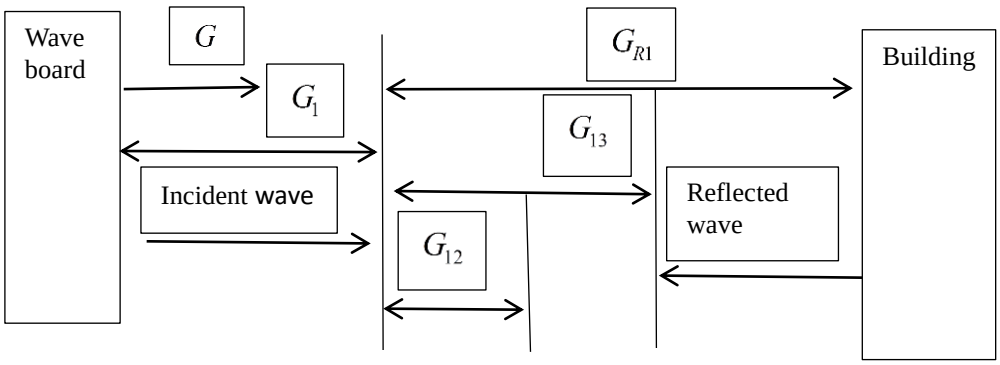

Figure 1. Least squares separation process

3. Investigation and Research on the Separation Calculation of Reflected Waves and Incident Waves in Marine Engineering Based on Fourier Transform

3.1. Parameter Setting of Reflected Wave and Incident Wave Separation Calculation Based on Fourier Transform in Marine Engineering

In order to test the effect of Fourier transform in the separation of reflected waves and incident waves in ocean engineering, this paper analyzes and tests the overall coefficient of reflected waves and incident waves estimated by Fourier transform in ocean engineering[15]. And design the relevant parameters used in wave simulation [16]. As shown in Table 1:

Table 1. Wave simulation parameters

Wave	0.05m
Peak period	1.45s
Water depth	0,8m
Wave reflection coefficient direction	90 °
Sampling time	0.2s
Sample length	0.3m

3.2. Calculation Experiment Environment for Separation of Reflected Waves and Incident Waves in Marine Engineering Based on Fourier Transform

The model test was carried out in the multifunctional pool of the State Key Laboratory of Coastal and Offshore Engineering of a certain school. The pool was 65 meters long, 44 meters wide and 1.5 meters deep [17]. A cage-type wave eliminator is arranged around to absorb wave energy and prevent wave reflection. A segmented multi-directional irregular wave wave generator is installed at one end of the pool. The wave generator consists of 60 groups of wave-making boards with a width of 0.7 meters. The pool can generate multidirectional reflected waves with a maximum

angle of ±70 °[18].

4. Application Research on the Separation of Reflected Waves and Incident Waves in Marine Engineering Based on Fourier Transform

4.1. Calculation Process Structure of Reflected Wave and Incident Wave Separation in Marine Engineering Based on Fourier Transform

In this paper, the Fourier transform is used to calculate the overall coefficient of the directional spectrum of the incoming and outgoing reflected waves in the synthetic wave field in which the incoming and outgoing reflected waves are superimposed in marine engineering. The process structure for the separation and calculation of reflected waves and incident waves in marine engineering based on Fourier transform is designed. The specific calculation process is shown in Figure 2:

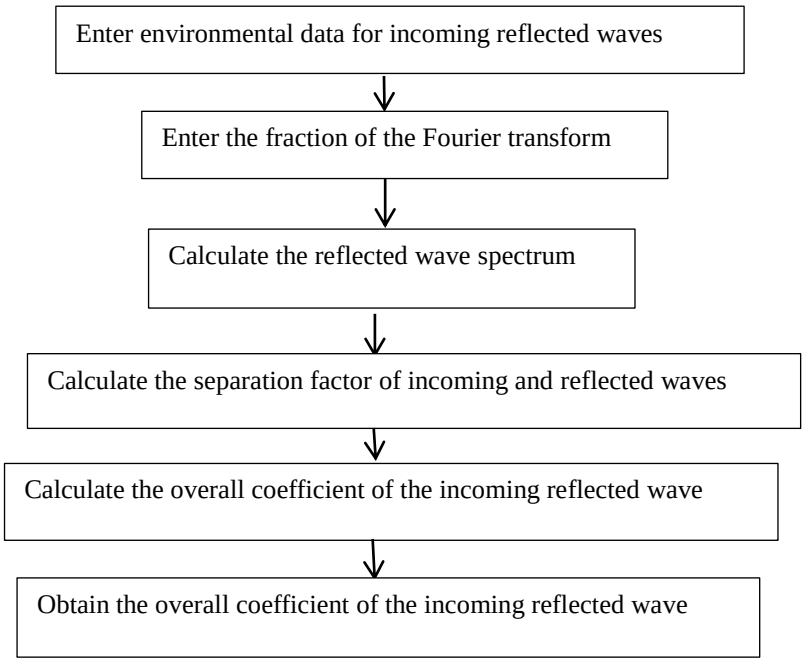

Figure 2. The calculation flow of the Fourier transform for the separation of reflected waves and incident waves in marine engineering

The specific calculation steps are as follows:

(1) Input the simulated value of the reflected wave incident wave in the marine engineering, mainly including the wave speed, water depth and the wave direction of the reflected wave incident wave.

(2) Enter the value of the fractional function equation of the Fourier transform, and use formula

(3) Calculate the separation coefficient of incoming and reflected waves, and determine the response operator of incoming and reflected waves in marine engineering.

(4) Calculate the total system value of incoming and reflected waves, and collect discrete signals of incoming and reflected waves in marine engineering.

(5) Obtain the total system value of the incoming and reflected waves, and sort and compare the calculated total system value of the incoming and reflected waves in the ocean engineering with the input value of the incoming and reflected waves.

4.2. Calculation and Application of Reflected Wave and Incident Wave Separation Based on Fourier Transform in Marine Engineering

In order to further test the reliability of the Fourier transform separation method, this paper uses the Fourier transform method to calculate and test the overall reflection coefficient calculated value of the reflected wave incident wave separation and the input value of the reflected wave incident wave in marine engineering. This method can transform the data of reflected waves and incident waves in ocean engineering into the space of fractional equation of Fourier transform for analysis, and transform the fractional order in this space to search and extract the separation of reflected waves and incident waves in ocean engineering. The overall reflection coefficient of , the specific data are shown in Table 2:

Table 2. Input values and overall reflectance data

Test	Incident wave input value	Reflected wave input value	Comprehensive separation calculated value
Test1	59.45	62.35	61.25
Test2	56.62	56.35	55.69
Test3	62.56	62.34	62.35
Test4	61.25	61.48	60.89

Figure 3. Input value of incoming reflected wave and Fourier transform to calculate separation value

As can be seen from Figure 3, the four-time calculation results of the overall reflection coefficient of the incoming and reflected wave directional spectra calculated by the Fourier transform algorithm are compared with the input values of the incoming and reflected wave directional spectra. The experimental data show that in the first In the second to fourth tests, the

input value of the input and reflected wave directional spectrum and the overall value curve calculated by the Fourier transform algorithm are very close, that is to say, the difference between the calculated value and the input value is very small, and the calculated result The accuracy is relatively high, and the results show that the Fourier transform algorithm can accurately extract the overall reflection coefficient of the reflected wave and incident wave separation in marine engineering.

5. Conclusion

Therefore, in order to enrich the research on the separation and calculation of reflected waves and incident waves in marine engineering based on Fourier transform, this paper first briefly introduces the concept of Fourier transform of functional equations for the separation method of reflected waves and incident waves in marine engineering. On the basis of the analysis and discussion of the separation calculation of reflected wave and incident wave in ocean engineering by Lie transform, the experimental environment and parameter settings of the application of Fourier transform based on the calculation of reflected wave incident wave separation in marine engineering are investigated and designed. Secondly, the design and analysis of the calculation process model framework for the separation of reflected waves and incident waves in marine engineering based on Fourier transform is carried out. The results verify the reliability of the calculation of the separation of reflected waves and incident waves in marine engineering based on Fourier transform.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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