論文 / 著書情報
Article / Book Information

題目(和文)	数値流体力学的アプローチの導入に基づく防波堤及び魚礁の新しい設計・施工法の開発
Title(English)	Development of novel design and construction methods introducing computational fluid dynamics approach for breakwaters and artificial reefs
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学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	情報環境学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士　（　工学　） Doctor of
学生氏名： Student's Name	三井　順	指導教員（主）： Academic Advisor(main)	灘岡和夫　教授
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis presents novel design and construction methods for breakwaters and artificial reefs by introducing a CFD approach with associated laboratory experiments. Firstly, a general-purpose numerical wave flume is developed. Then the stability of armor blocks covering a rubble mound of a composite breakwater against tsunami overflow is investigated. A new practical and accurate design method of armor concrete blocks is developed. This study also addresses construction of artificial nursery reefs for snow crabs. The falling behavior of the fish reef blocks in water is investigated by laboratory experiments and numerical computation and an accurate and low-cost placement method by free-fall is developed.

This thesis consists of 7 chapters. In Chapter 1, Background, objective, and outline was described.

In Chapter 2, a versatile numerical wave flume was developed by using an OpenFOAM CFD model based on an unstructured grid. The validation of the water surface profile and wave forces acting on a structure were confirmed through the dam-break tests. It was confirmed that wave generation method by reproducing a motion of a wavemaker could generate the waves accurately and that the processes of wave propagation, deformation, and wave breaking could be reproduced appropriately. The validation of the porous model was also examined through the following two tests: (1) the wave transmission coefficient of a sloping breakwater and (2) the effectiveness of a detached breakwater against tsunami.

In Chapter 3, the stability of the armor units against overtopping jet caused by tsunami with rapid water level rise was examined. The flat-type armor block with large holes showed high stability against the water jet in the experiments. Numerical analysis revealed that the holes in the blocks reduce the uplift force acting on the block and improve the stability against impinging water jet. Reinforcement by placing heavier blocks along the toe of the slope enhanced the total stability of the armor layer. The wave profile of the tsunami and the impinging jet were accurately reproduced by numerical computation based on the VOF method. The stability of the armor blocks was predicted qualitatively by numerical analysis which took the 3-dimensional shape of the block into account.

In Chapter 4, the stability of the armor units against steady overflow of tsunami was investigated. Two important factors for armor stability were found. These were the impingement position of the overflow jet and the harbor-side water level. Two failure modes of overturning and sliding were observed in the experiments. Numerical analysis revealed that the stability was predicted by the balance of the moment of a block in the case of overturning mode. In the sliding mode, it was necessary to consider the balance of forces of all the blocks on the slope. Wave-dissipating blocks installed in two layers showed a toughness against tsunami, namely, scouring was hard to progress rapidly even when many blocks displaced. The harbor-side flow field was favorably reproduced by the numerical computation method which solved the overflow nappe above the water surface and the flow field on the harbor-side separately.

In Chapter 5, the applicability of the Isbash formula, which is the conventional design method for the armor units based on the flow velocity, against tsunami overflow was examined. In the case of concrete blocks, the Isbash constant depends on the width of the water jet. The Isbash formula tends to overestimate the slope effect in the case of concrete blocks. A new practical design method for the armor units against tsunami overflow also has been proposed. The features of the method are the following: (1) Overflow depth is used to represent the external force and this enables the calculation more easily and robustly than the conventional method using flow velocity. (2) Two formulae are used corresponding to the two failure modes of overturning and sliding. (3) The influence of the impingement position of the water jet and the influence of the harbor-side water level are taken into account. The validity of the new method was confirmed by comparing with the experimental results.

In Chapter 6, an economical placement method for fish reef blocks utilizing free fall in the deep sea was presented. A new fish reef block which falls with stable behavior in water was developed by laboratory experiments and numerical computation. The newly developed block is based on a cube-shaped frame structure with extra shelf areas attached to the upper and lower frames to act as stabilizers. The numerical computation revealed the mechanism of the stabilization due to the stabilizers. A stochastic model based on experimental results showed that the distribution of the placement position as a result of the swing motion was sufficiently small and well within the required accuracy. A quick prediction method for the placement position was also developed to determine the release point of the block during actual construction in the presence of ambient current.

Finally, conclusions and future work were described in Chapter 7.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).