

Research on the influence of solid-liquid two-phase flow on the flow field effect and stability of square reefs

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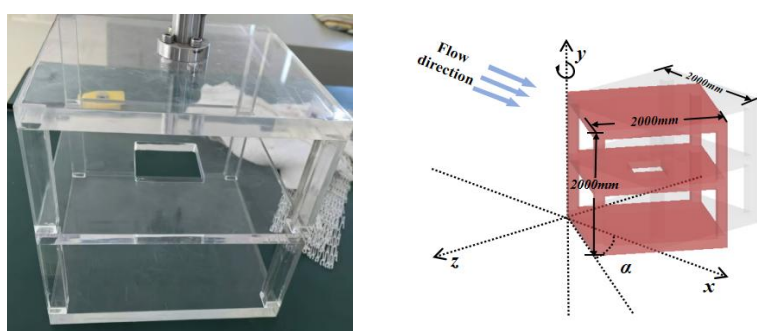
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Background

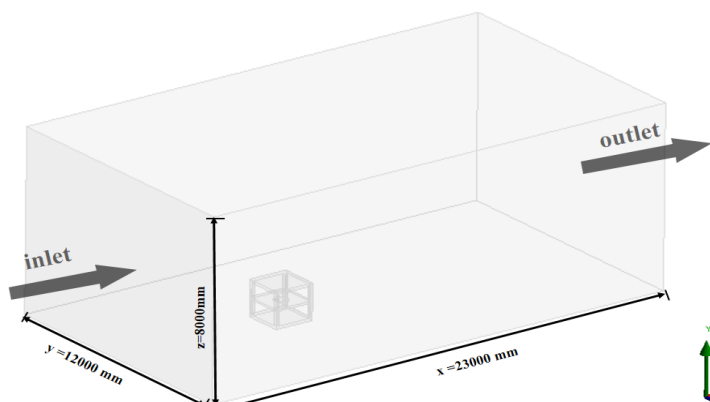
- As an important structure to improve the habitat environment of aquatic organisms, artificial reefs play an important role in the construction of marine ranching projects. In the waters around artificial reefs, due to the driving effect of water flow on sediment, there will be a solid-liquid two-phase flow mixture, which will cause the reef to settle and affect its hydrodynamic performance.
- In this study, the computational fluid dynamics(CFD) method was used to establish the numerical calculation model of solid-liquid two-phase flow field and square reef, and the influence of particle concentration factor and reef settlement depth on the flow field effect and stability of reef was analyzed. The results show that the hydrodynamic performance of artificial reefs in the solid-liquid two-phase flow environment is significantly different from that in the pure water medium. The reef settlement and the increase of particle concentration caused by the solid-liquid two-phase flow will lead to the formation of vortices around the reef body. The purpose of this study is to provide a reference for the site selection of square reefs.

Materials and methods

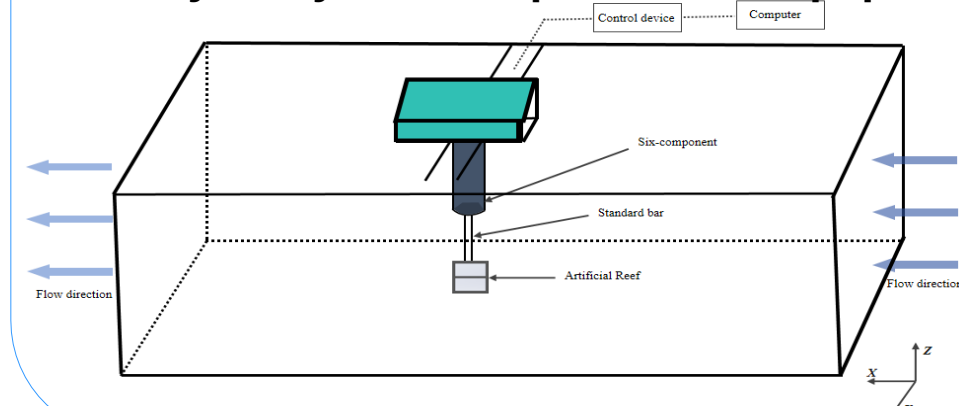
A. Test Object (Square Reef)



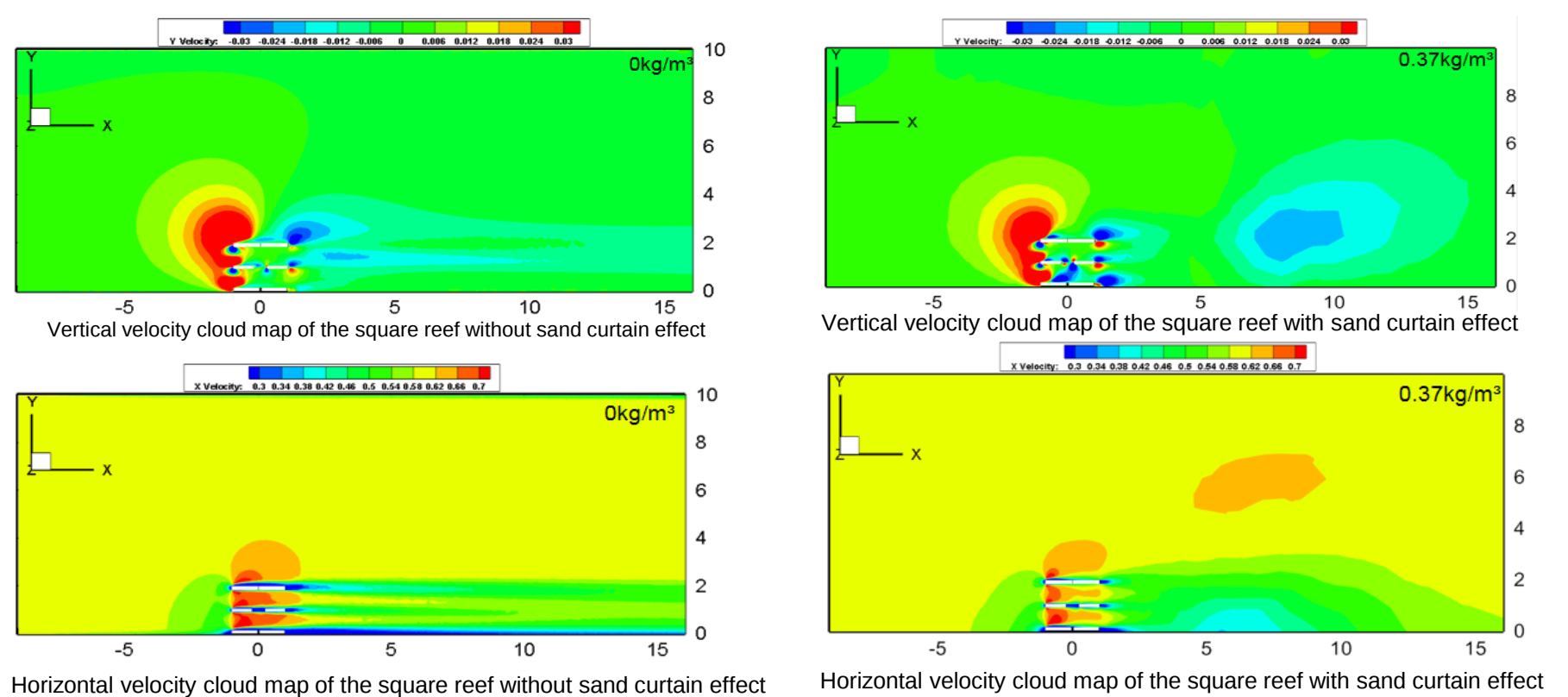
B. Numerical simulation of flow field



C. Hydrodynamic experimental equipment



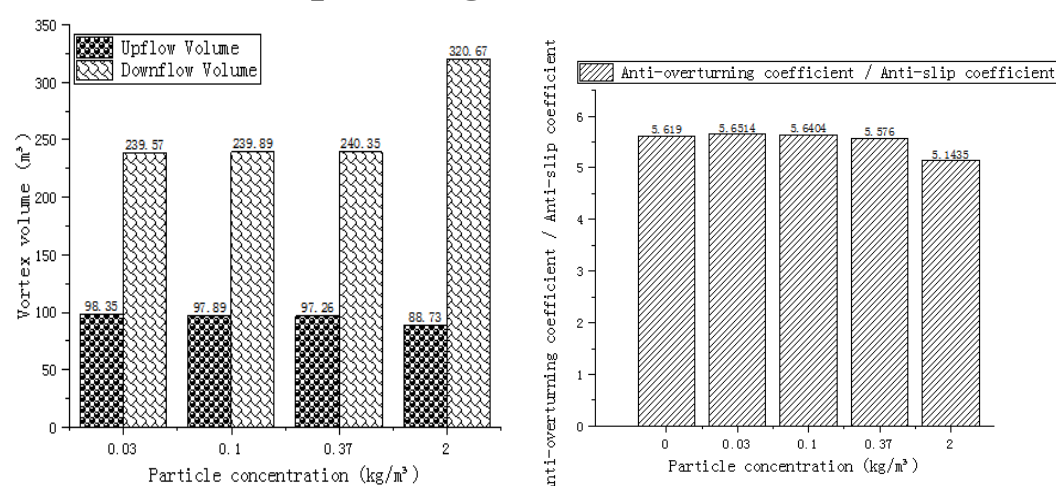
Influence of solid-liquid two-phase flow on flow field effect of artificial reef



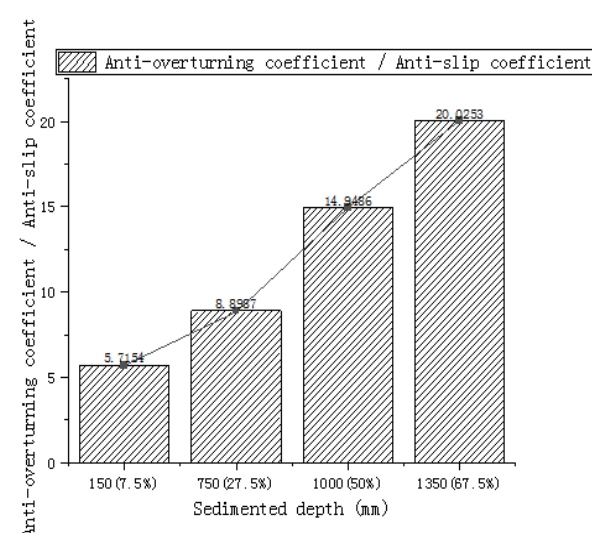
- The flow field effects of square reefs show significant differences in pure water medium and solid-liquid two-phase flow operating environment. In the pure water medium, a large range of updrafts are generated on the front side of the reef, and a semi-circular vortex updraft is formed at the rear cavity in the middle.
- In the solid-liquid two-phase flow environment, the main downward flow occurs on the rear side of the back flow surface of the reef, and an elliptical vortex-like downward flow is formed at the cavity on the front side of the upstream flow.

Results

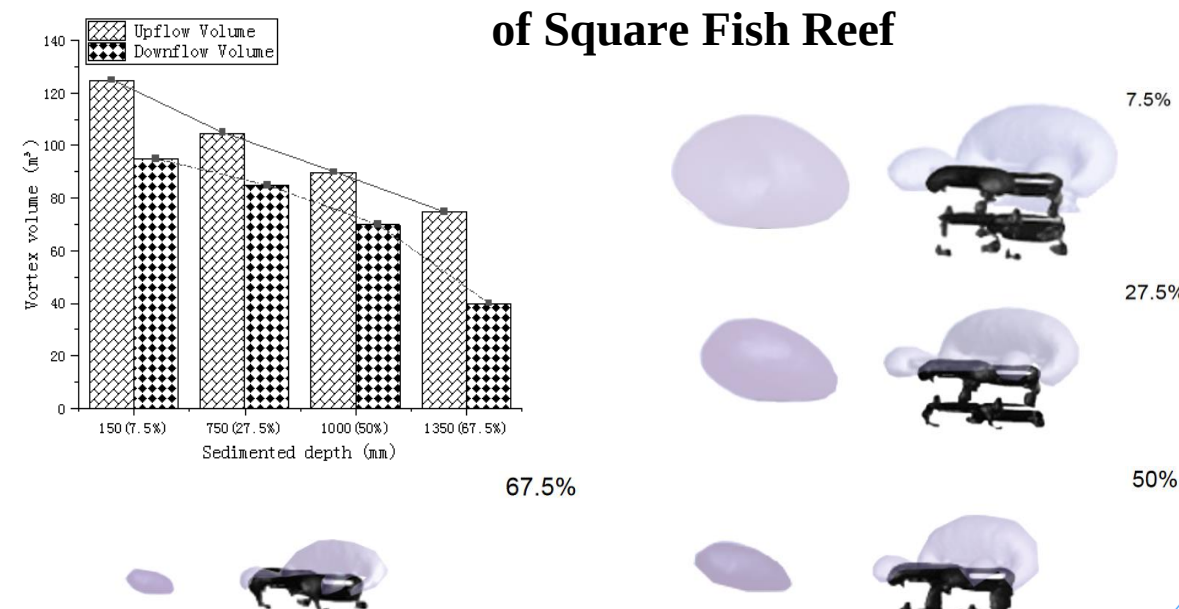
Comparison of square reef vortex volumes in two operating environments



Comparison of flow field characteristics at different settlement depths



Comparison of upflow Volume at Different Settlement Depths under the Sand Curtain Effect of Square Fish Reef



Conclusions

- In terms of flow field effect, the particle concentration of the flow field increases from 0.03kg/m³ to 2kg/m³, the volume of the upflow decreases by 8.4%, and the volume of the downflow increases by 24.1%, indicating that the change of particle concentration in the flow field has limited influence on the flow field effect of the reef, It is not conducive to the formation of vortices around the reef.
- In terms of stability, the particle concentration in the flow field increased from 0.03kg/m³ to 2kg/m³, and the anti-slip coefficient and anti-overturning coefficient decreased by 8.5%, indicating that the change of particle concentration in the flow field had limited influence on the stability. When the reef settlement is 67.5%, the anti-overturning coefficient and anti-slip coefficient increase by 71.9%, indicating that the settlement can increase the stability of the reef.