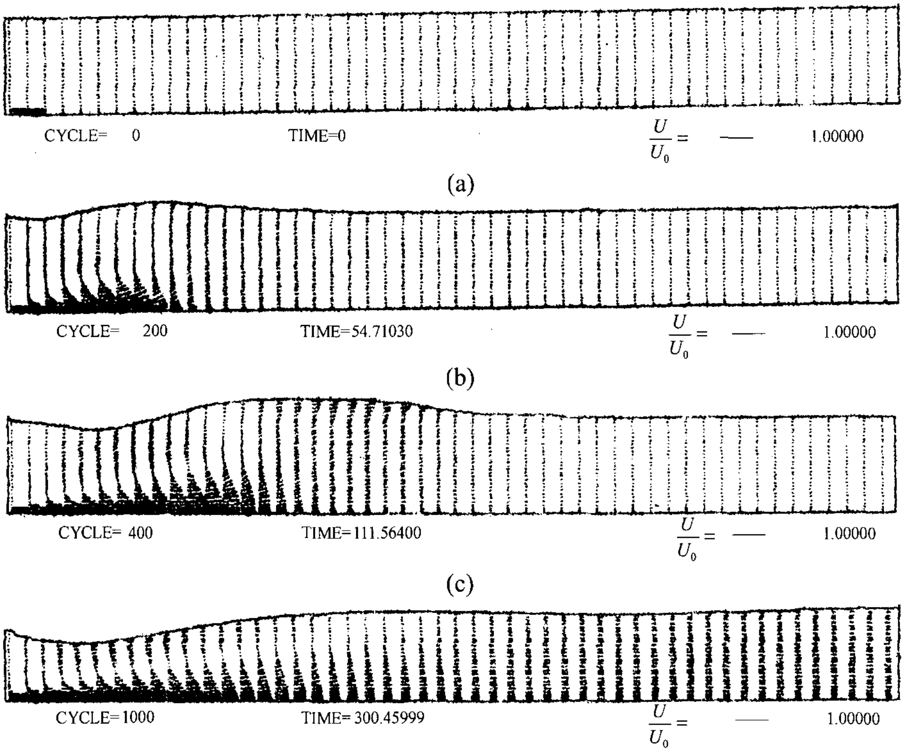
NUMERICAL STUDY OF FLOW STRUCTURE IN SUBMERGED HYDRAULIC JUMP

DAI HUICHAO[1,2] and WANG LINGLING[1]

[1]Hohai University,210098 Nanjing,China ,
[2]China Yangte Three Gorges Project Corporation, 443002Yichang, China.
(Tel: +86-717-6762466, Fax: +86-717-6762204, e-mail: dai_huichao@ctgpc.com.cn)

Underflow energy dissipation is widely used in hydraulic project. In order to keep steady damping ratio, a submerged jump with low submergence factor should be formed in stilling pool. Flow regime of submerged jump has been studied extensively in the past decades. For example, Rouse et al.(1958) studied the turbulence characteristics using an air model despite of the differences between air and water flows. The study gave out some results that were new at that time. Many researchers used experimental method to study the submerged jump. With the development of the Laser Doppler Anemometry (LDA) and the advance in numerical techniques, it is feasible now for further study of the internal turbulence structure of the jump nowadays. Long et al.(1990) have provided valuable experimental data about the turbulence characteristics of jump using LDA method. They also made numerical simulation with the standard $k-\varepsilon$ turbulence model and achieved some results. However, they used the governing equations for steady flow, and the approach used to track the free surface was limited to flows with small surface slopes. F. Ma (2002) also studied the turbulence characteristics of the submerged jump with numerical method. In the present study, the attempt is to simulate the unsteady flow process further, which may start from standstill and develop progressively to a submerged hydraulic jump after the abrupt opening of the sluice gate. In this situation, the velocity normal to the free surface is not zero and thus the free surface is not a streamline. Therefore, the unsteady state governing equations are necessary and will be employed in the current study. The VOF method developed by Hirt and Nichols will be employed to treat the varying moving free surface of hydraulic jumps.

NS equation is integrated and discreted with the finite volume method. Standard $k-\varepsilon$ turbulence model has been used to predict the characteristics of submerged jump. The function of volume method is employed to track the moving free surface. Computational results are presented for Froude number equal to 8.19 and submergence factors equal to 0.24.Numerical predictions include surface profiles, mean velocity, turbulence intensities and shear stressed in the whole domain. These results are compared with available experimental data. They provide insights into both the macroscopic structure and the turbulent structure of submerged hydraulic jumps.



(d)

Fig.1 Flow Vector Field of the Submerged Hydraulic Jump

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