AN EXPERIMENTAL STUDY ON DOWNSTREAM RECIRCULATION ZONE OF SINGLE GROYNE CONDITIONS

HONG KOO YEO[1] , JOON GU KANG[2]and SUNG JUNG KIM[3]

[1,2] Senior Researcher Dept. of Water Resources Research,
Korea Institute of Construction Technology,
([1]e-mail: yeo917@kict.re.kr, [2] jgkang02@kict.re.kr)
[3] Senior Researcher Dept. of Water Resources Research,
Korea Institute of Construction Technology
(e-mail: jinx9482@kict.re.kr)

1. INTRODUCTION

Groynes usually are installed along the river side and those are used for various purposes including flow and erosion control and bank protection. Recently, the concern of groynes that provide us with ecological environment and improvement of scenary near river has greatly increased for naturalized river and ecological river restoration. In River Design Criteria of Korea the groyne is classified into permeable, impermeable and mixing type groyne according to the permeability of water. The impermeable groyne is classified into lateral, parallel, and combined type groyne as allocation of structure, and overflow and non-overflow type as permissible design stage. The non-overflow type groyne that is not submerged during flooding time is often installed in big river has high bank or levee. The height of overflow type groyne is set as low flow stage and thus it is submerged in flood period. It is often installed at the reach that has steep slope and sediment transportation of bed load type (Nikitin, 1995). The permeable type groyne, since some of flow permeates through the groyne structure, has the function of mitigation of flow velocity and promotion of sediment deposit. Thus it has relatively low resistance against flow and good stability of structure itself and easiness of maintenance. In this paper the experiments of downstream recirculation zone as the basic factor of installation interval and tip velocity as the basic factor of maximum scour were carried out in the various conditions of permeability, approaching velocity, and groyne length. Several empirical equations are proposed by the results.

2. EXPERIMENTS

The experiments were composed of 4 cases as the ratio of groyne length to channel width, 0.10, 0.15, 0.20, and 0.25, and 5 cases as permeability, 0%(impermeable), 20%, 40%, 60%, and 80%. The tip velocity of the groyne was measured at the middle layer (60% of the water depth) by using ADV (Fig. 1). The measured data of ADV were time averaged for every minute. The velocity field was measured by using LSPIV technique. The acquired images were transformed into the velocity field by using CACTUS 3.1. Fig. 2 show the measurement and flow pattern of permeable type groyne experiment. Fig. 8 and Fig. 9 show an example of the application. Since the object of this study is comparison and verification of the effect of the groyne design factors the LSPIV technique that can provide a vast amount of velocity field data is considered a useful tool in this study.

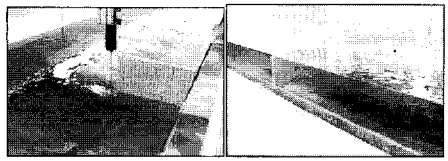

Fig. 1 velocity measurement and
The observation of flow patten

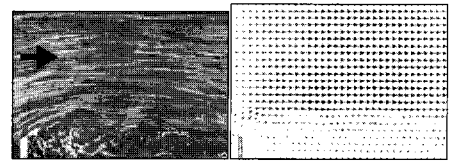

Fig. 2 Velocity vector field from LSPIV

3. CONCLUSIONS

In this study the tip velocity of the impermeable and permeable type groyne was measured by ADV and the flow pattern in the recirculation zone was measured by use of LSPIV technique. The analysis was focused on the tip velocity, that is closely related to the cause of maximum scour and the separation length and incidence angle in the recirculation zone as criteria of installation interval. From the experimental results the following conclusions can be drawn:

The incidence angle is an angle between the line of the approaching flow direction and the line connected tip of structure with separation point. Most of all measured incidence angles have slight deviation as increasing the groyne length. They have the values of about 5° for impermeable, about 6° for 20% permeable, about 10° for 40% permeable and about 20° for 60% permeable groyne. In cases of 80% permeable groynes it was measured that the incidence angle was decreasing from 45° to 30° as increasing groyne length. This relationship could be expressed as the empirical equations with the permeability.

The separation length, defined as the length from the installed groyne to the separation point, can give useful information for the installation interval according to the incidence angle. If it has the same permeability the separation length increases as the groyne length increases. However the variation of the dimensionless form by groyne length is inconsiderable. It is obvious the separation length varies with the permeability. It was measured about 12.5 times for impermeable, 10 times for 20% permeable, 5.7 times for 40% permeable, 3 times for 60% permeable, and 1.8 times for 80% permeable groyne.

In further studies the experiments related on the effect of the installation angle, series of groynes and scour, etc. will be carried out, and some of them are now in progress. The additional experiment of incidence angle in bended channel will raise the applicability of the suggested equations. The verification from the hydraulic model test for the local condition is necessary before the practical work, and all of the results in this study and future studies will give basic information for design and help the wide use of groyne as a useful technique for river ecosystem.