Safety Investigation on the Environmental Friendly Consolidation Methods Using HEC-RAS Model

College of Life & Environmental Sciences, Konkuk University
Kim, Sun Joo ○ Ko, Jae Sun An, Min Woo

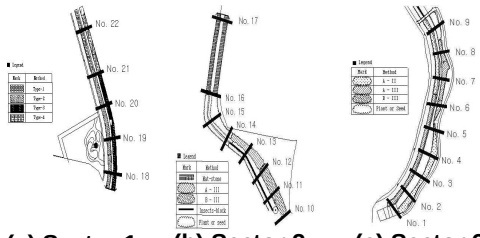
I. Introduction

This study has been carried out at 'the 2nd Drainage canal' locate at the Songsam Myun, Yeoju Gun of Kyunggi province and a small tributary stream 'Dongmak' at the Wonju of Kangwon province in order to 1) survey the characteristics of plant distribution at the littoral zone and the safety of Environmental Friendly Canals and Stream consolidation methods, 2) to simulate the hydraulic characteristics of various methods according to roughness coefficient and shear force with HEC-RAS model, and 3) to examine the effect of the Environmental Friendly Canals during the event of flood and to adjacent channel based on the results from the HEC-RAS model and provide elemental information for deciding the adequate plan of the method and maintenance.

II. Methods and Material

1. Studied area

Studied drainage, Yeoju, is consist of 3 distinguishable sectors of 'using water and controlling water management type', 'water favorable type', and 'ecosystem preserve type'. The level test of drainage on its cross section was executed in 22 points (in 20m intervals) in order to study the different cross section characteristics of the sectors.



(a) Sector 1 (b) Sector 2 (c) Sector 3

Fig.1 The cross section survey of each section (Yeoju drainage canal)

Sector 1, the down stream of consolidation canal, is constructed with the vegetation concrete method for 140m. Six cross section of the sector was surveying in this section of the drainage and used for simulation.

180m long Sector 2 is constructed with Environmental Friendly vegetation revetment method type (cf. A-II, A-III, B-III) and Mat-stone method has been applied to the bottom of a bridge pier. The upstream of the drainage, sector 3, is made with A-II type, A-III type, and B-III type for 110.63m, 96.59m, and 94.66m, respectively.

In the case of Dongmak stream, results of 13 level tests of 30m intervals starting from the upstream of which constructed in breast wall porous concrete block and vegetation concrete were used for modeling.

2. Application of HEC-RAS to the studied area.

The Manning roughness coefficient applied in this study was simulated according to the safety test has been carried out with the permissible velocity of the channels lined with grass that was suggested in the Open-Channel Hydraulics (Chow 1950).

The roughness coefficient range of Yeoju drainage has been limited to 0.03~0.045 due to the interferences of vegetations in the vegetation method section and much inflow of soil particles; different values were given according to the characteristics of the applied methods, channel, vegetations in slant.

For the comparison of the identical method, model has been also applied to the Dongmak stream at Wonju that is constructed by vegetation concrete method.

III Results and Discussion

1. Flow velocity and shear force changes according to the changes of roughness coefficient

Flow velocity and shear force were simulated at the design flood of 16㎥/s with various roughness coefficient. Slant was easily eroded soils when the maximum water velocity and shear force of Chow's suggested range of channels lined with grass was applied; for the grass mixture permissible velocity was 1.23～1.54 m/sec.

2. Comparison of hydraulic characteristics according to the construction methods

Table 1 and 2 show the simulation result of the sections at which various construction methods were applied at Yeoju drainage and the result of Dongmak stream's vegetation method section which shares similar cross section and hydraulic characteristics at the design flood of 12㎥/s, respectively.

When the vegetation considered roughness coefficient of 0.035~0.045 was applied,

Dongmak stream showed water velocity range of 1.10～1.53m/sec and shear force range of 31.09～37.43N/m^2 to the revetment except for the channel. The similar hydraulic characteristics of 1.27～1.43m/sec water velocity and 22.68～43.61N/m^2 of shear force was shown at the Yeoju drainage canal.

Table 1. Shear force and flow velocity of the respective methods

revetment methods	vegetation	roughness coefficient(n)	slant max. mean velocity(m/s)	slant max. shear force(N/m^2))
Mat-stone method (No. 14)	Liriope platyphylla Wang et Tang, Phragmites japonica Steudel, etc.	0.025	2.61	54.74
		0.03	2.27	53.17
		0.035	2.0	50.72
		0.04	1.78	47.06
Vegetation Concrete methods (No. 19)	Forsythia koreana Nakai, phragmites Communis Trinius, Lythrum anceps Makino, etc.	0.025	1.43	37.21
		0.03	1.34	23.47
		0.035	1.27	19.02
		0.04	1.22	14.96
Insect habitation block method (No. 10)	Aster Koraiensis Nakai Lythrum anceps Makino, etc.	0.025	1.49	28.11
		0.03	1.38	23.32
		0.035	1.31	18.85
		0.04	1.22	15.06
Wooden pile & brushwood methods (No. 7)	Typha latifolia Linne, Phragmites japonica Steudel	0.025	2.89	46.67
		0.03	2.02	45.45
		0.035	1.77	43.58
		0.04	1.57	38.34

Table 2. The comparison of Same method by regional groups

application region	methods	vegetation	revetment hydraulic factor		roughness coefficient(n)		
					0.045	0.04	0.035
Wonju Dongmak stream	- Vegetation porous concrete methods - slope range 1/300-1/500	Phragmites japonica Steudel, Pennisetum alopecuroides, etc. stand : good distribution : density	mean Velocity (m/sec)	left bank	1.10	1.23	1.39
				right bank	1.22	1.36	1.53
			shear force (N/m^2)	left bank	32.3	31.71	31.09
				right bank	37.43	36.34	36.25
Yeoju drainage canal	- Vegetation porous concrete methods - slope range 1/250-1/300	Phragmites japonica Steudel, Lythrum anceps Makino, etc stand : good distribution : density	mean Velocity (m/sec)	left bank	1.26	1.27	1.31
				right bank	1.37	1.39	1.43
			shear force (N/m^2)	left bank	22.68	29.31	41.05
				right bank	25.77	33.31	43.61

IV. Summary and Results

Safety investigation on the consolidation methods of Environment-Friendly canals in this study has been carried out according to the procedure as follows. 1) HEC-RAS modal input data was achieved by in-situ. measurements. 2) Water flow velocity and shear force was simulated at the design flood of 16㎥/s with various roughness coefficient 3) with simulated hydraulic data, the safety of applied methods on the stream and the water way has been compared and examined.

The results of this study can be summarized as follows.

When the design flood of Dongmak stream (12m^3/sec), that shares similar cross section and hydraulic characteristics with Yeoju drainage canal, was applied for the simulation, the water velocity range to the revetment was 1.10～1.53m/sec and shear force range was 31.09～37.43N/m^2 in the Dongmak stream, and those of Yeoju drainage were similarly ranged in 1.10～1.53m/sec and 22.68～43.61N/m^2 for the water velocity and shear force, respectively.

Although both methods are Environmentally Friendly and safe, the analysis results of roughness coefficient, water velocity and shear force of the two methods shows that Mat-stone method somewhat more resistant to rapid water velocity and roughness coefficient and thus less mass movement and loss occurs than the vegetation revetment methods. The characteristics of Mat-stone method stated above make it Environmental-Friendly and stable engineering method.