第Ⅲ部門　Preliminary Study on Effects of Enlarged Core Structure on Seepage and Dynamic Performance of Heightened Reservoir Dam

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INTRODUCTION

An inclined-type core structure which is one of the methods to heighten a reservoir dam for preventing flood disaster and to secure water resources, may have the technical permeable and seismic subjects compared with other heightening methods. Firstly, the joint between the old existing core and newly enlarged one which is proposed in this paper is afraid to have different ranges of strength and permeability. Secondly, an inclined-type core structure is afraid to be affected by the settlement of the base ground and the seismic motion due to the stress concentration at the core joint.

Therefore, this study was conducted to investigate the effects of an enlarging core scale, in which the width or height were changed at the joint to strengthen the core joint, decrease the seepage, and increase the dynamic performance for discussing the appropriate design method of the heightened dam.

CORE ENLATGING METHODS

Table 1 shows the field scale of the target reservoir (Gyeryong dam, South Korea) subjected in this study. It shows that the storage capacity is 40% an increased after heightening the height of the reservoir by 2.8 m.

To reinforce the old and new core joint, the scale of the core joint was enlarged by using depth b shown in Fig.1.

Here, Case 1 (Actual heightened dam) is the basic model without any change in the Depth b or width of the core joint. The other three models simulate three different core joint structures, in which the

Table 1 Field scale of the target reservoir

Dimension	Before heightening work	After heightening work
Dam type	Zoned earth fill dam	
Height	14.30 m	17.10 m
Length	288 m	300 m
Width of dam crest	6.00 m	6.00 m
Flood water level	60.95 m	62.00 m
Full water level	59.43 m	61.00 m
Storage capacity	3,412,410 m^3	4,717,730 m^3

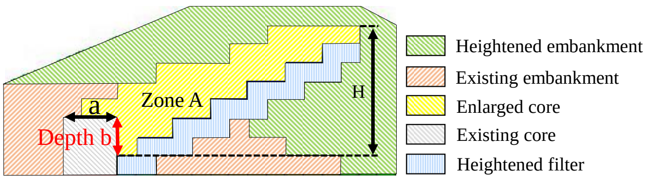

Fig.1 Definition of the scale of enlarged cores

core width enlarged from three different depth b (Case2, b: 0.7 m; Case 3, b: 1.4 m; Case 4, b: 2.1 m) below the core joint.

SEEPAGE AND DYNMAIC ANALYSIS

An unsteady-state seepage analysis was performed using the program VGFlow2D to investigate the seepage characteristics related to the safety for piping in the scale of the enlarged core. For conditions of numerical analysis, the water level was raised from the foundation (0m) to the flood level (14.7 m) over ten days, and the flood water level was maintained until the seepage line stabilized. Table 2 shows the parameters used for the seepage analysis.

Meanwhile, the dynamic effective stress analysis (UWLC) program was used for evaluating the dynamic performance (Shear stress that occurred in core joint). Table 3 shows the parameters used for the dynamic analysis. The parameters were the same as those applied to the evaluation of slope stability of the Gyeryong reservoir based on the data provided by the KRC Corp. Young's modulus

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Table 2 Parameters used for the seepage analysis

Materials	Soil-water characteristics under unsaterated condition				
	Coefficient of permeability k(m/s)	Voulumetric water content θ_r	Saturated water content θ_s	α (1/m)	n
Existing EMB	1.57E-06	0.221	0.565	1.470	6.656
Heightened EMB	5.75E-07	0.221	0.565	1.470	6.656
Existing core	1.14E-07	0.078	0.535	4.760	1.248
Enlarged core	3.11E-08	0.078	0.535	4.760	1.248
Existing filter	1.00E-05	0.000	0.365	5.478	1.629
Heightened filter	5.45E-05	0.000	0.365	5.748	1.629
Foundation	5.00E-11	0.078	0.535	4.760	1.248

Table 3 Parameters used for the dynamic analysis

Materials	Cohesion (kPa)	Angle of internal friction (deg.)	Unit weight (kN/m^3)	Saturated unit weight (kN/m^3)	Poisson's ratio	Young's modulus (kPa)	Model
Existing EMB	31.00	30	19.70	21.02	0.35	2.46E+05	Modified R-O model
Heightened EMB	16.70	24	18.25	19.42	0.35	2.46E+05	
Existing core	26.00	12	19.28	21.38	0.45	2.20E+05	
Enlarged core	34.30	9	17.65	19.57	0.45	2.20E+05	
Existing filter	0.00	33	18.63	19.63	0.33	2.46E+05	
Heightened filter	0.00	33	18.63	19.63	0.33	2.46E+05	
Riprap	0.00	45	22.56	22.56	0.23	1.61E+06	
Foundation	18.19	35	20.62	22.00	0.30	6.00E+06	Elastic model

was obtained from the Comaba earth fill dam in Japan, which is similar in size, shape, and height to the Gyeryong dam. The dynamic analysis was conducted in two kinds of process by input waveform as follows; sinusoidal wave 0.16 s (Analysis result from natural period study) applied to the analysis model to understand a direction response due to the core shape. Then, four types of ground motions measured at fill dams in Japan are used: Gongen Dam in 1995[1)], Minogawa Dam in 1995[1)], Aratozawa Dam in 2008[2)] and the Isibuchi Dam in 2008[2)]. The design seismic coefficient of the area where Gyeryong reservoir was determined to be 0.1584 (150 GAL) based on the design standard.

ANALITICAL RESULT AND CONCLUSION

Seepage Analysis

Fig.2 shows the result of leakage quantity and hydraulic gradient, and flow velocity at the core joint. In all the cases investigated in seepage analysis, the risk of core enlargement-induced piping based on the safety standard is low. In addition, flow velocity at the core joint was gradually reduced, thus the enlarged effect of the core joint against concentration leak can be indicated.

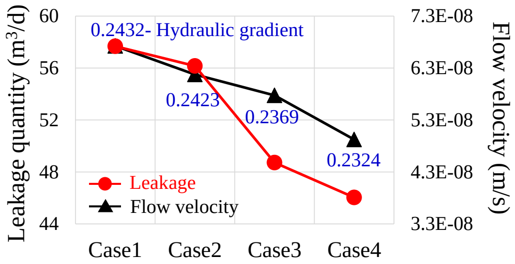
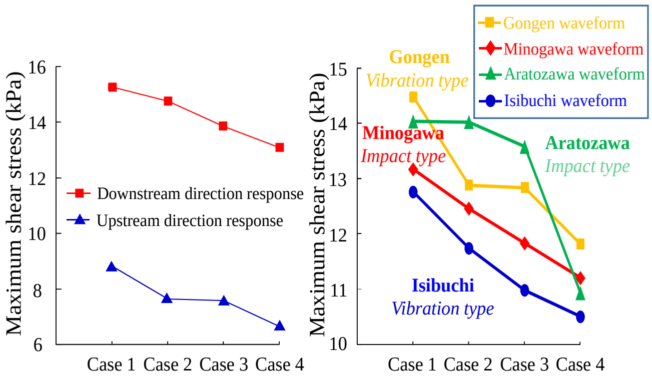


Fig.2 Result of seepage flow analysis



(a) Sinusoidal wave (b) Ground motions

Fig.3 Maximum shear stress at the core joint

Dynamic Analysis

Fig.3 shows the result of the maximum shear stress that occurred in core join for input sinusoidal wave and four types of ground motions. In sinusoidal wave (See Fig.3a), the shear stress is more affected by downstream direction response than that of upstream direction response. This implies that the downstream direction tends to be deformed easily.

In all ground motions (See Fig.3b), the shear stress acting on the core joint generally decreased, as the scale of core increased. In addition, the irregular tendency in the degree of decrease has appeared. This implies that an optimal configuration between the core structure and the scale can be obtained.

REFERENCE

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