Study on Phreatic Line of Zoned Type Earthen Dam with Different Earth Material

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Abstract— The position of the phreatic surface influences the stability of the earth dam because of potential piping due to excessive gradient and sloughing because of the softening and weakening of the soil mass as it touches the downstream slope. When the pervious earth material are placed at outer and impervious earth materials are placed at central portion of the earthen dam, these type of dam are called Zone type earthen dam. The main advantage of this type of dam is that, it does not require huge amount of same earth materials, Central impervious core material are more effective to resist the seepage through the dam body. In this paper a laboratory model is constructed and analysis with an intension to keep the stability of the zone type earth dam against seepage of water with different pool level. The experimental arrangement, data acquisition system and variable measures in the scale down model study in smooth bed are given below. Boards are kept 10 mm to carry forward the experiment.

Key words: Zoned Type Earthen Dam, Seepage, Stability of Earthen Dam

I. Introduction

The focus of the main scope the stability studies are directed at the evaluation of seepage of zoned type earth dam. The model study is done in transparent glass chamber and different type colour dye are used to finding the actual path of phreatic line or top seepage line. In these model study the upstream side slope was kept 1:1 and downstream side slope 1:6 at pervious zone and inside side slope of core material was kept 1:3 both side. In laboratory, the soil is compacted by tamping heavy roller and semi- heavy tamping bar. The role of drainage system is very vital as it shifts the phreatic surface ensuring the safety of downstream toe. The proper of seepage analysis and stability analysis consider on just steady-state condition and provided inverted filter for downstream safety.

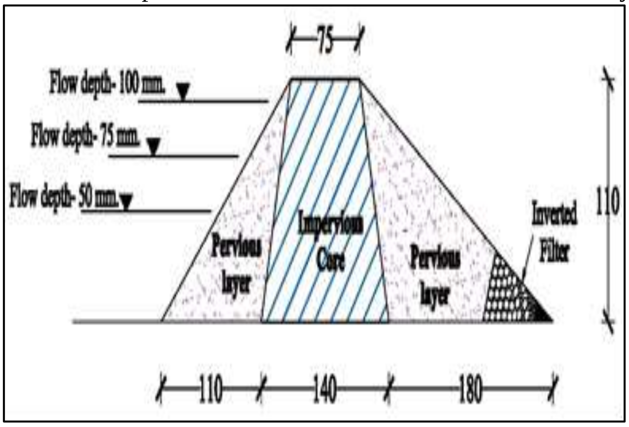

Fig. 1: Model of C/S View of Zoned Type Earthen Dam in Different Flow Conditions

Experiment No.	Flow condition	Observation time (hour)	Depth of flow (mm.)
1	60 % coarse sand + 40 % clay at outer layer Saturated compacted clay at impervious core	24-26	50
2	60 % coarse sand + 40 % clay at outer layer Saturated compacted clay at impervious core	24-26	75
Experiment No.	Flow condition	Observation time (hour)	Depth of flow (mm.)
3	60 % coarse sand + 40 % clay at outer layer Saturated compacted clay at impervious core	24-26	100
4	Only dry coarse sand In dry condition and well compacted of 75 % clay + 25 % fine sand at impervious core	24-26	50
5	Only dry coarse sand In dry condition and well compacted of 75 % clay + 25 % fine sand at impervious core	24-26	75
6	Only dry coarse sand In dry condition and well compacted of 75 % clay + 25 % fine sand at impervious core	24-26	100

Table 1:

Fig. 2: Model of Zoned type Earth Dam in Transparent Glass Chamber

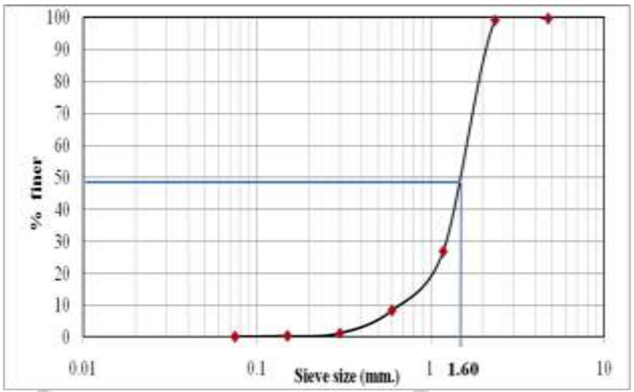

Fig. 3: Grain size distribution curve for 100 % Coarse Sand at outer pervious layer

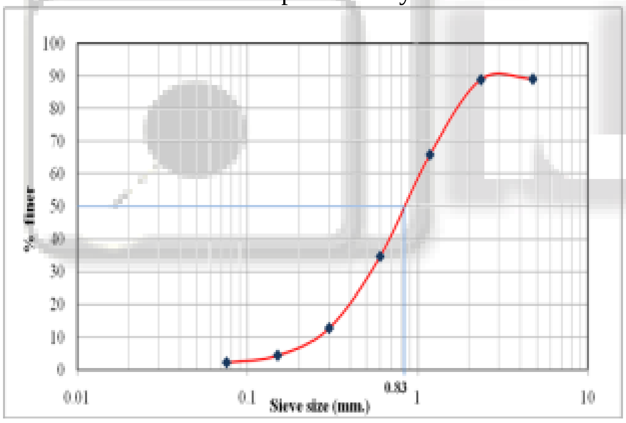

Fig. 4: Grain size distribution curve for (60 % coarse sand+40 % clay) at outer pervious layer

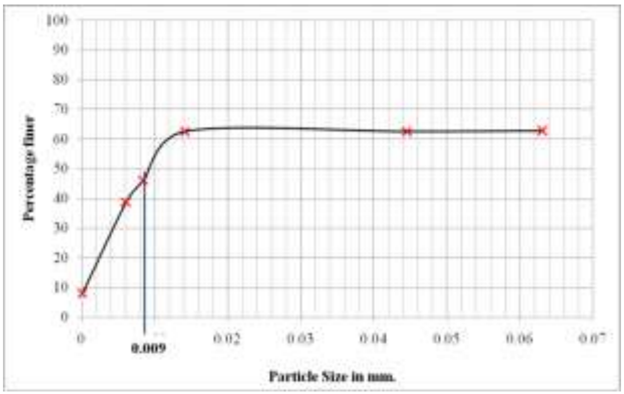

Fig. 5: Grain size distribution curve for 100 % Saturated compacted clay at impervious core Curve from hydrometer analysis

Fig. 6: Phreatic Line or Top Seepage Line when Depth of Water 50 mm. 75 mm, and 100 mm

II. EXPERIMENTAL OUTCOME EXPERIMENT- 1, 2 & 3

Experiment No.	Type of used Earth Materials	Mean Particle Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.)	
				X	Y
1	Coarse sand at outer layer	1.60	50	0	0
				10	27
				20	27
	75 % Dry clay + 25 % fine sand at impervious core	0.044		30	29
				40	30
				50	28
				60	28
Experiment No.	Flow condition	Mean Particle Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.)	
				X	Y
2	Coarse sand at outer layer	1.60	75	0	0
				10	15

				20	16
	75 % Dry clay + 25 % fine sand at impervious core	0.044		30	16
				40	13
				50	12
				60	12
Experiment No.	Flow condition	Mean Partcle Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.)	
				X	Y
3	Coarse sand at outer layer	1.60	100	0	0
				10	15
				20	17
				30	17
				40	15
				50	15
				60	15
				70	16
				80	17
				90	18
				100	18
	75 % Dry clay + 25 % fine sand at impervious core	0.044		110	18
				120	19
				130	19
				140	20
				150	20
				160	20
				170	20
				180	21
				190	21.5

Table 2:

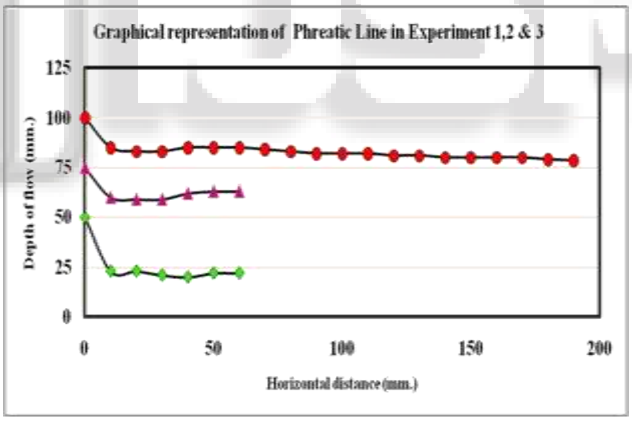

Fig. 7: Behaviors of Phreatic lines at the flow depth at u/s of 50 mm., 75 mm. and 100 mm., holding constant earth materials (75% dry clay + 25 % fine sand at impervious core and coarse sand at outer layer)

III. EXPERIMENTAL OUTCOME EXPERIMENT- 4, 5 & 6

Experiment No.	Type of used Earth Materials	Mean Particles Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.)	
				X	Y
4	60 % coarse sand + 40 % clay at outer pervious layer	0.83	50	0	0
				10	6
				20	9
	Saturated compacted clay at central impervious core	0.009		30	19
				40	27
				50	27
Experiment No.	Type of used Earth Materials	Mean Particle Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.)	
				X	Y

5	60 % coarse sand + 40 % clay at outer pervious layer	0.83	75	0	0
				10	10
				20	29
	Saturated compacted clay at central impervious core	0.009		30	36
				40	40
				50	41
				60	41
Experiment No.	Type of used Earth Materials	Mean Particles Size (mm.)	Depth of flow (mm.)	Co-ordinates from top level of water (mm.) X	Y
6	60 % coarse sand + 40 % clay at outer pervious layer	0.83	100	0	0
				10	8
				20	9
				30	11
				40	10
				50	10
				60	9
				70	7
				80	13
	Saturated compacted clay at central impervious core	0.009		90	14
				100	18
				110	20
				120	25
				130	31
				140	41
				150	48
				160	48
				170	47

Table 3:

Fig. 6: Phreatic line or top seepage line when depth of water 50 mm. 75 mm, and 100 mm

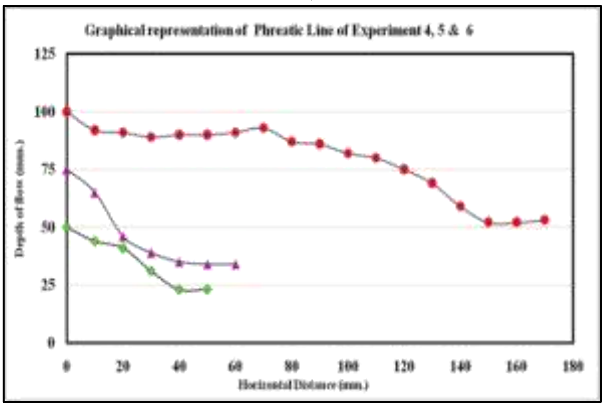

Fig. 8: Behaviors of Phreatic lines at the flow depth at u/s of 50 mm., 75 mm. and 100 mm., holding constant earth materials (Saturated compacted clay at impervious core and 60 % coarse sand + 40 % clay uniformly mixed at outer layer)

IV. RESULTS & CONCLUSION

In Experimental 1, when the depth of flow at upstream was 50 mm. then water cannot penetrated the impervious core easily. But Experimental 2, when the depth increases to 75 mm. the impervious core thickness is reducing, so water seeps the impervious core more easily than experiment no 1. Experiment no 3 then the highest poll level, i.e. 100 mm. are using the water from the upstream the downstream seeps very faster, because of the thickness of impervious are reducing and the earthen dam settle down 3 mm. So 100 mm. water is not allowed to zoned type earth dam.

In experimental 4 and 5, the depth of water 50 mm and 75 mm the seepage line cannot penetrate dam core section. But in experimental no. 6, when the depth of water 100 mm. The seepage water penetrates the dam impervious core section.

In this investigation, (experiment- 4,5 & 6) saturated compacted clay at impervious core and 60 % coarse sand + 40 % clay uniformly mixed at outer layer is more effective than (experiment- 1, 2 & 3) 75% dry clay + 25 % fine sand at impervious core and coarse sand at outer layer.

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