EFFECT OF COMPACTION ON SEEPAGE FOR HOMOGENEOUS SMALL EARTHFILL DAM EMBANKMENT MODEL

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1. Introduction

Failure of levees and small embankment dams for irrigation reservoirs, has occurred more frequently because of a greater chance of localized heavy rainfall. It is well known that the failure of river embankments is due mainly to scour and erosion by overtopping flow; however there are many causes of failure caused by seepage that occurred in the embankment body 1).

In tropical regions the intense rainfalls originate large and quick variations of the water surface of earth fill dam embankments. Problems related to rapid filling and drawdown conditions due to these oscillations of dam reservoir water level and also due to seepage forces generated by water infiltration at the crown of the earthen embankments are observed. Studies on the improvement mechanisms on the side slopes to reduce the failure effects caused by seepage forces, pore water pressure and internal erosion is of great importance. The slopes adjucent to the reservoirs and rivers often experience instability as a result of fluctuations in water levels adjucent to the slope 2).

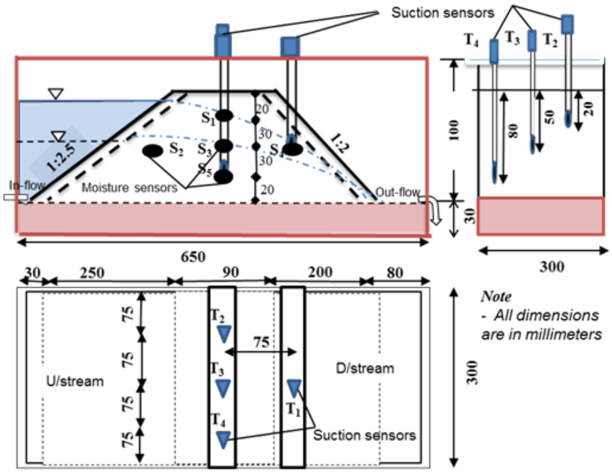

Fig. 1. Laboratory model experimental layout

The objective of this research is to conduct a series of experiment to evaluate the effect of compaction on seepage and pore water pressure reduction for homogeneous and non-homogeneous small earth fill dam embankment which contribute to the failure of side slopes of earth fill dam embankment caused by rapid filling and draw down and evaluate the improvement focusing on slope covering by low permeable soil.

2. Experimental setup

Two-dimensional seepage physical model tests of non-cohesive homogeneous earth fill dam embankment was conducted on scale models. The test facility and general arrangement of experimental set up for this study are illustrated in Fig. 1. The model box has inside dimensions of 650 mm × 300 mm in plan view and is 200 m deep. The side walls of the model box consist of 10 mm thick acrylic board which is rigidly glued to bottom and side edges. The model embankment measures 100 mm in height, 90 mm in crown width, (top) 540 mm in the base. The side slopes are 1:2.5 upstream and 1:2 downstream and the thickness of the foundation soil is 30 mm thick. The non-cohesive soil (Toyoura sand) with specific gravity of 2.646 was used to make a homogeneous embankment model. The saturated hydraulic conductivity is k = 1.55 × 10^{-4} cm/sec. According to the standard proctor test, the maximum dry density and corresponding optimum water contents are ρ_d = 1.56 g/cm^3 and 14.7 %, respectively.

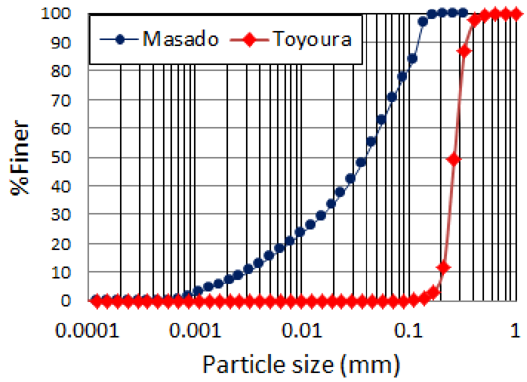

Fig.2. Grain size Distribution

The third case of this experimental series, a small layer of Masado soil was used having the following properties; ρ_d = 1.925 g/cm^3 OMC 12.4 %, G_s = 2.67 and saturated hydraulic conductivity k = 1.164 × 10^{-4} cm/sec.

The sensors measuring the volumetric water content and Pore water pressure were installed at various depths. The volumetric water content sensors (ECH$_2$O-EC-5) were installed horizontally at different depths (i.e., 20 mm, 50 mm, 80 mm, below the embankment top surface). Four min-tensiometers were installed vertically from the top of model embankment surface at various depths. One tensiometer T_1, was placed downstream 50 mm below the top embankment surface level, while the other three (3), T_2, T_3, and T_4 were placed at the top of the embankment surface at 20 mm, 50 mm and 80 mm depth respectively.

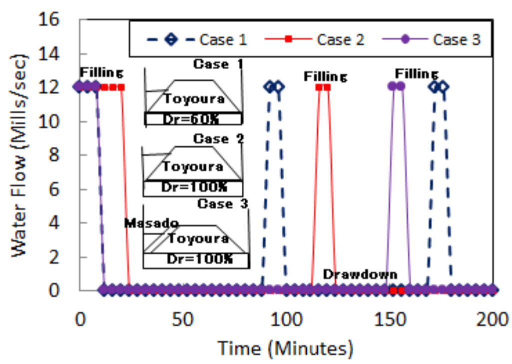

Fig.3. Water flow during filling and drawdown

The water supply system consists of a plastic water tank with inlet water valve which raised ***(filling)*** water upstream at a constant speed of 12 mil/sec until when reaches maximum water level (MWL) 80 mm from the bottom of the embankment, followed by ***drawdown*** immediately by water seeping through the embankment until when reaches the minimum level 40 mm from the bottom of the embankment, then the filling started again.Water flow during filling and drawdown condition in all three cases is shown by fig 3 above.

Key word: Erosion, Rapid filling and Drawdown, Seepage
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3. Results and Discussion

Fig.4. Shows matric suction values measured by four Tensiometers and their respective analysis in response to filling and falling drawdown of water level under three different cases, when D_r = 100 %, D_r = 60 % and when D_r = 100 % but the upstream embankment slope covered by a thin layer of Masado soil, represented by fig 4a,4b, and 4c respectively.

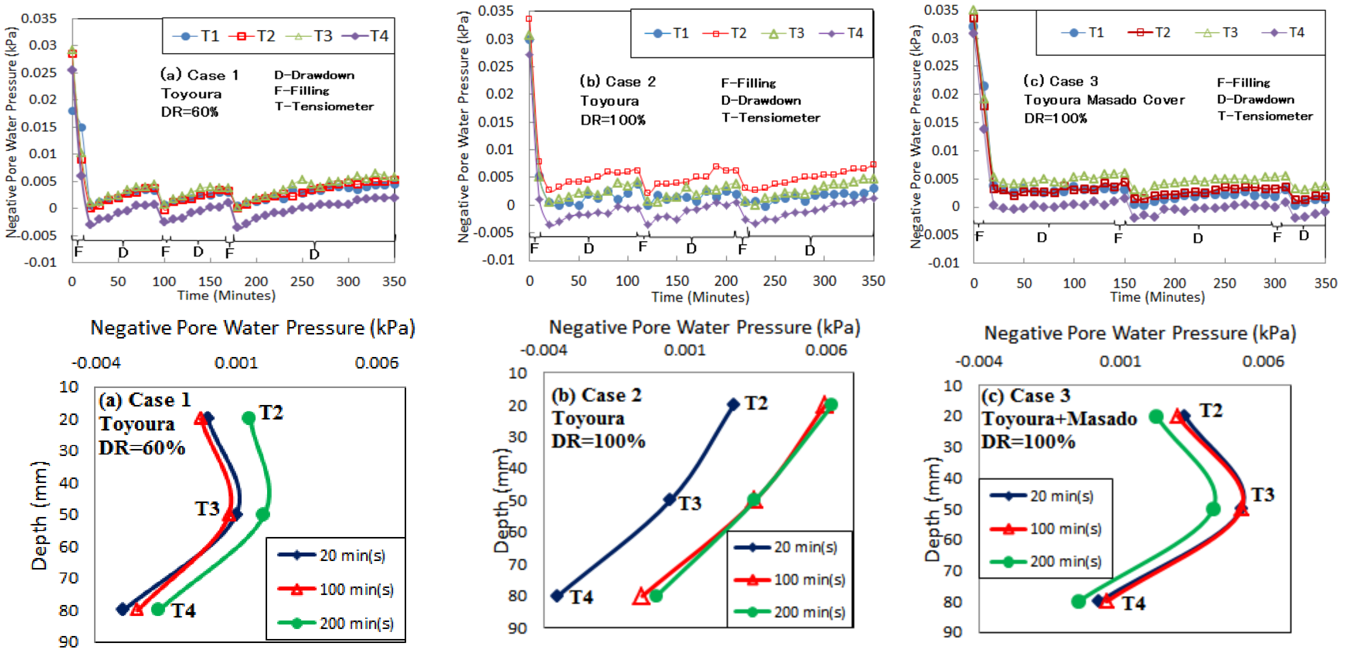

Fig. 4 .(a), (b) and (c) Matric suction values in three cases, D_r =100 %, D_r = 60 % and when the embankment was covered by Masado soil

In all three (3) cases, all four tensiometers shows similar behaviour as the water level was raised and draw down. Each tensiometer shows that the initial matric suction was maintained until water rose to the soil near the tensiometer 1). From the analyzed figures, it appears that the tensiometers T_4 located deep (80 mm near the foundation) has low suction values while T_2

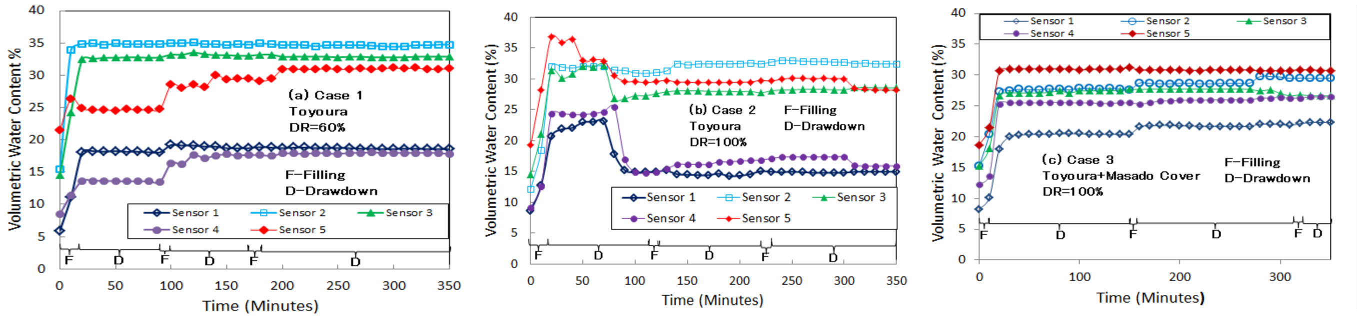

Fig.5. Volumetric water content against time for 3 cases, D_r = 100 %, D_r = 60 % and when the embankment was covered by Masado soil

located at 20 mm deep from the top of the embankment read high values

The changes in the volumetric water content are shown in Fig. 5. The results indicates that sensor 5 located at 80 mm deep shows higher values after the first filling and no significant changes in water content after the first circle of filling and drawdown, Fig. 6 justifies the variation of volumetric water content and the drop of phreatic line in horizontal direction, at time t = 150 minute, no significant change in volumetric water content for case 3, but for case 1 and 2 a difference of about 15~20 % in volumetric water content between sensor 2 and sensor 3 indicates the drop of phreatic line and hence the decrease in seepage forces which resulted the sudden decrease in water content. When water is filling the embankment, there is high seepage at deep depth

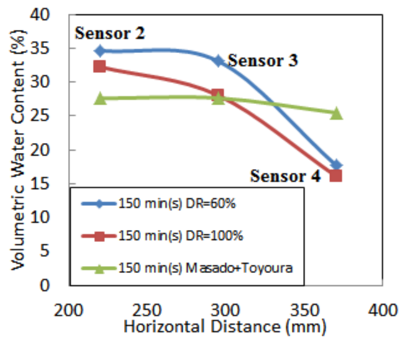

Fig. 6. Variation in Volumetric water content with horizontal distance

4. Conclusion

Comparing all three cases, Case1 (D_r = 60 %) it takes short time to complete one circle about 90 minutes, (filling and drawdown) compared to 112 minutes of the second case (D_r = 100 %) and 150 minutes of the3rd case (D_r = 100 % + Masado soil Cover). This implies that compaction has positive impact on seepage and pore water pressure for earth fill dam embankments.

5. Reference

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