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Influence of Sudden Submergence and Drawdown on the Behaviour of Footing

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ABSTRACT: Many states of our nation experienced unprecedented floods in the past few years, causing widespread damage to structures and embankments. This paper investigates the impact of floods on the settlement behaviour of shallow foundation. The results of a series of laboratory scale load tests to determine the influence of sudden submergence and drawdown on the settlement of footings are presented. The effects of three types of submergence are studied; due to sudden rise of ground water, drawdown and due to sudden inflow of surface water. Laboratory scale load tests on model circular footings are carried out in a masonry tank, which has arrangements for pumping in water and drawdown. The influence of rate of submergence on settlement is studied by varying the discharge of inflow of water. It is observed that the settlement of footing considerably increases due to sudden submergence of footing.

KEYWORDS: Flood, Settlement, Shallow foundation, Laboratory scale load test, Circular footing.

I. INTRODUCTION

Urban flooding is a phenomenon that occurs where there has been a man-made development within the existing floodplains or drainage areas (e.g., new residential communities, retail establishments, commercial buildings, parking lots, etc). Damages to the building during inundations can be the result of not only the direct activity of the flood wave and surface water, but also changes in groundwater flow conditions, including the increase of their piezometric level. In the past few decades many researches have been carried out to investigate the analysis of settlement in foundation due to rise of ground water. It has been proved that there is an increase in settlement resulting in decrease in bearing capacity during inundation.

Rise of ground water level is believed to increase the settlement significantly and had been a topic of research for many years. Some of the studies which have been conducted in this field are the effect of Submergence on Settlement and Bearing Capacity by Monir Kazi et.al (2015). They conducted simple laboratory experiments and have shown that the sand bed settles significantly when it is submerged under water for lower values of relative density. Terzaghi (1943) postulated that the submergence of the sand reduces the soil stiffness by half, which in turn doubles the settlement. Stress and pore water pressure changes in partially saturated soils under strip footings had been studied by Mohammed Yousif Fattah et.al(2014) They reported that there are two phenomena governing the behaviour of footing represented by settlement (negative vertical displacement) and heave (positive vertical displacement). An increase of load on the foundation will increase the settlement and the failure surface will gradually extend outward from the foundation in heave behaviour. Adel asakereh et.al (2015) evaluated the effect of water table rise on settlement of footing in coarse grain soil ,also the effect of soil elasto-plastic parameters include the effect of changes in modulus of elasticity, cohesion, internal friction angle and dilation angle of soil on the bearing capacity and settlement efficiency was calculated. Amy B. Cerato et.al(2007) were investigated the scale effects of shallow foundation bearing capacity on granular materials to further evaluate the trend of decreasing bearing capacity factor, N_{γ} , with increasing footing

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width, B. Ernesto Ausilio et al. (2017) They derived the analytical expression, allowing the bearing capacity of strip footings resting on a soil where the water table is at some depth below the footing base to be calculated.

There is a scope for further investigations to identify the effect of other important factors (e.g. depth of embedment, footing width, soil gradation and different intensities of discharge in settlement behaviour of shallow footings with changing groundwater level. Many researchers have carried out numerical and experimental work to study the settlement and bearing capacity of soil in the past decade.

This paper investigates the impact of floods on the settlement behaviour of shallow foundation by carrying out a series of laboratory scale load tests. The influences of sudden submergence and drawdown on the settlement of footings are investigated. The effects of two types of submergence are studied; due to sudden rise of ground water and also due to sudden inflow of surface water.

II. LABORATORY SCALE LOAD TEST

The experimental investigation was carried out at the Geotechnical Engineering Research Laboratory of LBS Institute of Technology for Women, Thiruvananthapuram. The details of materials used, experimental setup and methodology are presented below.

1) MATERIALS USED

The sand used for granular bed was well graded sand (SW). Properties of the sand are presented in Table 1.

Table 1. Properties of Sand

Property	Sand
Dry Unit Weight (kN/m ³)	17
Specific Gravity	2.3
Cohesion (kPa)	2
Angle of Shearing Resistance (°)	30

III. EXPERIMENTAL SET UP

Laboratory scale load tests are conducted in a test bed and loading frame assembly. The test beds are prepared in a tank which is designed keeping in mind the size of the model footing tested and the zone of influence. The dimensions of the test tank are 1000mm length x 750mm width x 750mm depth. Model circular footing having diameter 100mm is fabricated with mild steel. The loading tests are carried out in the loading frame fabricated with ISMB 300. The load is applied using a hand operated mechanical jack of capacity 50 kN. The applied load is measured using a proving ring of capacity 10 kN. Plumbing arrangements were given as, two inlet pipe at the bottom of the tank for raising the ground water level at various discharges at longitudinal and lateral direction, Another inlet at top of the tank for giving submergence due to surface flow, an outlet pipe for measuring the drawdown.

The settlement of model circular footing is measured using two dial gauges kept diametrically opposite to each other. The model circular footing is placed exactly beneath the centre of loading jack to avoid eccentric loading.

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Figure 1. Loading frame



Figure 2. Plumbing Arrangement

1) PREPARATION OF TEST BED AND FLOODING CONDITION

The initial test is conducted with sand alone in the test tank. Sand is filled in layers of 5 cm thickness and is compacted using a plate vibrator. Piezometers are placed between these layers on opposite side of footing for measuring the head of water. After the preparation of sand bed, the circular footing is placed at the centre of the tank. Two dial gauges are fixed diametrically opposite to each other to measure the deformation. The given load measured by means of a proving ring, simultaneously the settlement measured by means of two dial gauges placed diametrically opposite to each other.

The two inlet pipe at the bottom of the tank is opened for the first discharge, when the water level reaches the significant depth, the measurement of settlement commences. Tests are carried out at different discharges. The inlet pipe at the top of the tank is opened and fills the tank just above the level of footing there by creating the surface flooding. The settlement values are then measured from the dial gauges corresponding to the time intervals. The corresponding head can be measured by means of the level of water in the piezometers. Then the outlet valve is opened for simulating the drawdown condition.

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Figure 3. Test setup for Laboratory Scale Load Test

Table 2. Discharge parameters varied in laboratory scale load test

Variation of discharge	Full	3/4	1/2	1/4
Longitudinal discharge ($\times 10^{-6} \text{m}^3/\text{s}$)	1.63	1.48	1.36	1.16
Lateral discharge ($\times 10^{-6} \text{m}^3/\text{s}$)	1.63	1.4	1.28	1.11

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IV. RESULT

The rise of ground water corresponding to the longitudinal and lateral discharges of water is shown in figure 4.

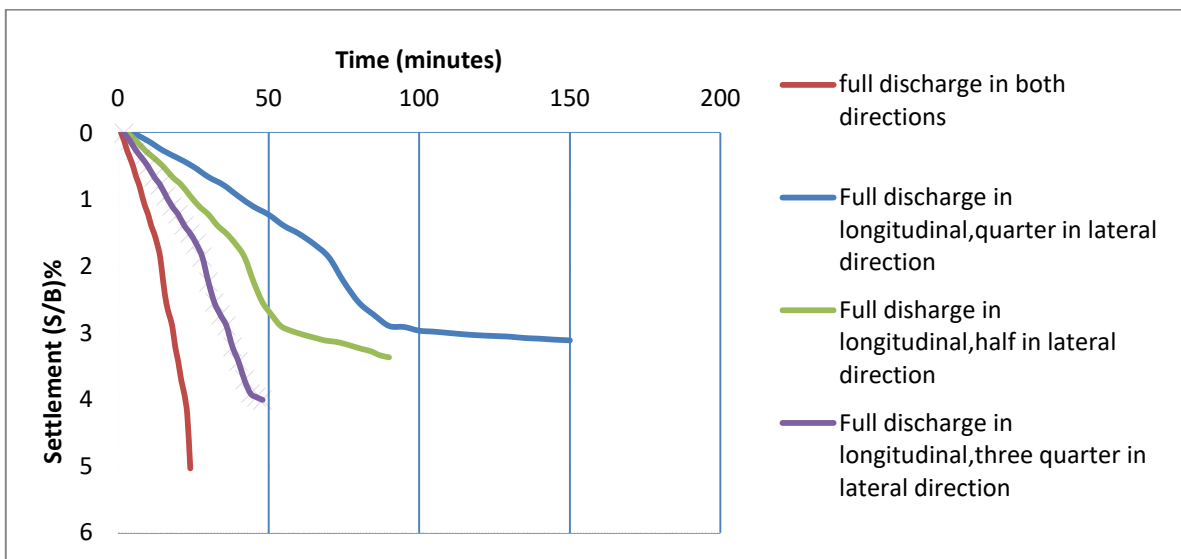


Figure 4. Rise of Ground water table

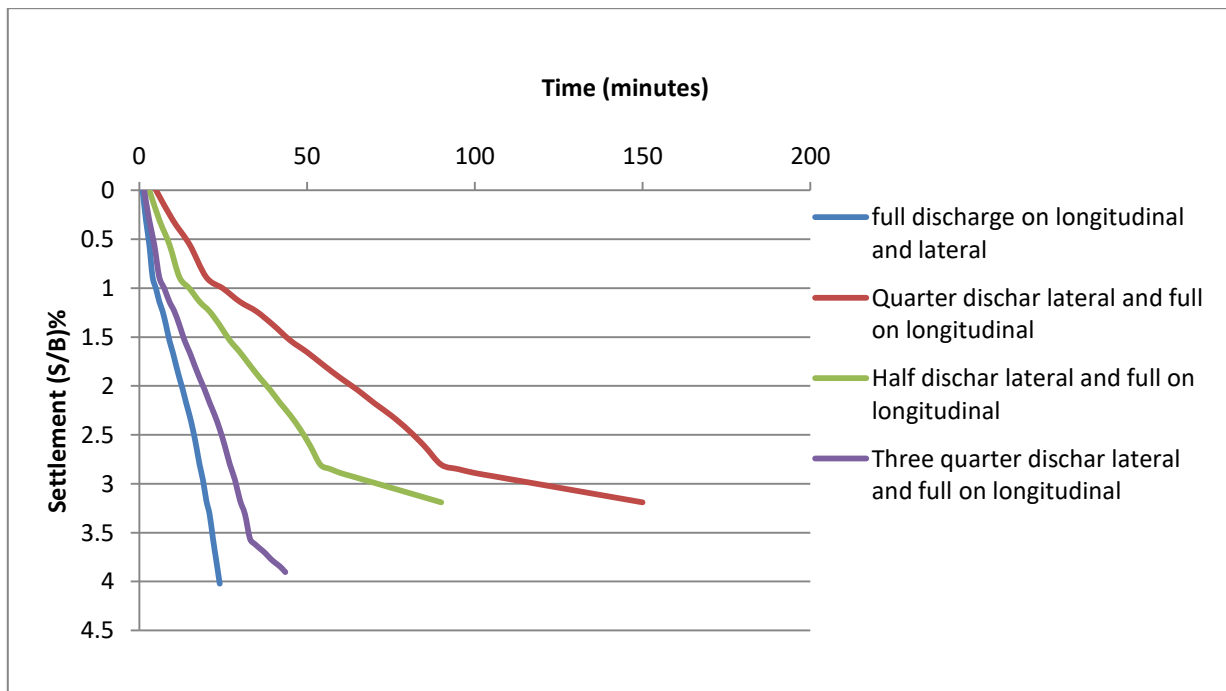


Figure 5. Drawdown condition

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V. DISCUSSION

From figure (4) it is observed that within a short span of 30minutes, settlement rate is more than 5%, when there is full discharge on the lateral and longitudinal direction. Then the discharge on the longitudinal direction kept constant at full rate and varying the discharge at three quarter opening of valve in lateral direction gives a settlement of 4% in 50 minutes, correspondingly, half discharge in lateral direction shows a settlement of more than 3% in 90minutes. The settlement rate is comparatively less for the quarter discharge, ie 3% in 150minutes. In case of ground water rise, the discharge on the longitudinal direction is kept constant and varying the rates of discharge on the lateral direction, it is observed that rate of settlement increases with increase in discharge

The drawdown condition in figure (5) shows the settlement increases with time. The value (4% in 30minutes) goes on increasing at a rapid rate for the full discharge condition. It is observed that the draw down settlement rate is less when compared to the rise of ground water.

VI. CONCLUSION

- In case of ground water rise, the rate of settlement increases with increase in discharge.
- In drawdown condition, settlement increases with time.
- The settlement increases at a rapid rate for the full discharge condition.
- The increase in settlement is due to hydrostatic pressure that develops with increase in head.
- The higher discharges compress the soil, where the effective stress in the soil increases, causes the settlement of footing

REFERENCES

- 1) Adel asakereh, Alireza akbari(2015) "Effect of groundwater and various parameters on bearing capacity of shallow Foundations using finite element method "International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 05
- 2) Amy B. Cerato , Alan J. Lutenegeger(2007) "Scale Effects of Shallow Foundation Bearing Capacity on Granular Material"Journal Of Geotechnical And Geoenvironmental Engineering / ASCE ,volume 133,Issue 10
- 3) Ernesto Ausilio ,Enrico Conte(2017) "Influence of groundwater on the bearing capacity of shallow foundations"Canadian Geotechnical Journal · 42(2):663-672
- 4) Mohammed Yousif Fattah.et.al(2014) Stress and pore water pressure changes in partially saturated soils under strip footings ,International conference for Engineering sciences,University of Mustansiriya,Baghdad
- 5) Monir Kazi Sanjay Kumar Shukla,Daryoush Habibi(2015) "Effect of Submergence on Settlement and Bearing Capacity of Surface Strip Footing on Geotextile"Reinforced Sand Bed, Int. Journal of Geosynth. and Ground Eng. (2015) 1:4
- 6) Shariful Islam.M (2019) "Soil improvement technique by sand piling" ,International Journal of Research in Engineering & Science :volume 3 Issue 2
- 7) Terzaghi K, "Theoretical Soil Mechanics," John Wiley and Sons. New York, NY, USA, 1943