Settlement and compaction energy of embankment slope by bucket tamping method

Suman Manandhar, Noriyuki Yasufuku, Kiyoshi Omine, *Taizo Kobayashi, Hemant Hazarika, Satoshi, Suenaga, and **Mitsuru Taniyama
Department of Civil and Structural Engineering, Kyushu University, Fukuoka, Japan
* Department of Civil and Architectural Engineering, Fukui University, Fukui, Japan
**Asakawagumi Construction Company, Wakayama, Japan

1 INTRODUCTION

The research plan remarks on gradual study of assessment of artificial embankment slope in the field. The initial phase of site investigation found that there was higher water content during constructing embankment slope. Then top and slope of the embankment was further assessed with increasing compaction. The result showed that dry densities increased but stiffness reduced due to excessive water content compared to optimum water content (Manandhar et al. 2011). In the second phase, new embankment was constructed with relatively low water content and slopes as well as top of the embankment were assessed with increasing compaction through quantifying the blows in the slope by bucket tamping method and number of passes by vibro-roller at the top at Kainan shi, Wakayama Prefecture, Japan. As a result, relative degree of compaction was increased with compared to first field site and stiffness was also increased with less scattering (Manandhar et al. 2012). At the third phase, same mold was assessed after four months as monitoring and with increasing number of tamping blows on slope and number of passes at the top of the embankment. This paper focuses on settlement and tentative energy of the embankment slope by bucket tamping method during increasing tamping of soil by the bucket of the excavator. The main objective is to assess the relation between settlement, degree of compaction and energy distribution at different time factors.

2 FIELD SETTLEMENT AND ENERGY

Among 25 m long embankment slope, almost half part of the slope was modified by increasing compaction energy by the bucket of excavator as shown by Fig. 1. Tracing the history, first measurement was taken in the entire embankment on September, 2011, assessed the behaviors and present in Western JSCE paper (Manandhar et al. 2012). Initially, embankment slopes (L, M, and N) were built up with 5, 15 and 30 times blow by tamping method. Then, as a continuation of field work, similar measurement was taken at the same place after four months on January, 2012 to understand the time effect as monitoring. Then, previous slopes were modified into three zones named as L2, M2, and N2 by spreading 30 cm layer of soils and again recompacted by bucket tamping method. Slope-L2 was divided into three rows based on surface area of bucket of excavator (164 cm X 81 cm) and blow with 12 times each. At the mean time, 24 and 50 blows were set up to Slopes M2 and N2 respectively (Fig. 1). Afterwards, settlements of soil were measured. Settlement for Slope-L2 was averaged to 9 cm while settlements for slopes M2 and N2 were averaged to 11 cm and 14 cm respectively. Then moisture density gauge measurements calculated degree of compaction at each place and represent in Fig. 2. Degree of compaction was increased at the highest tamping slope.

Further, energy through bucket tamping was calculated using following formula for each slope.

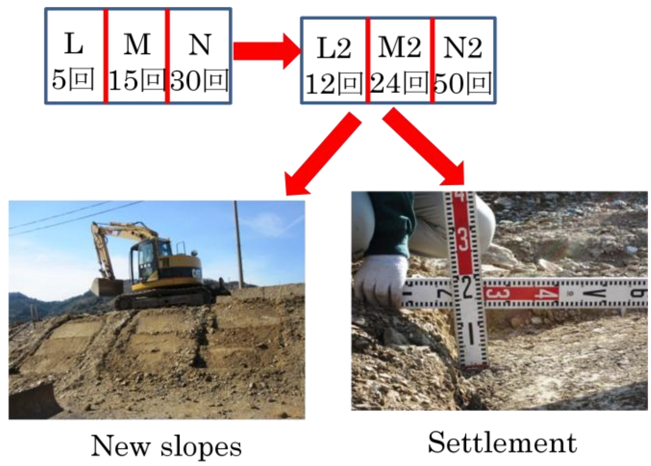

Fig. 1 Recreating new slopes with increasing tamping blow

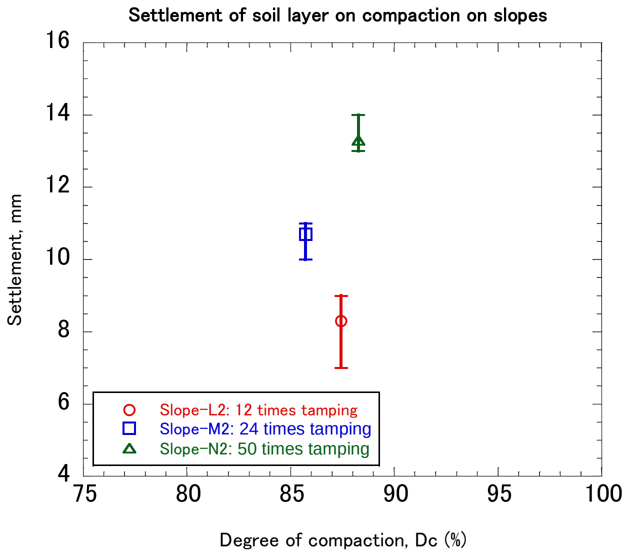

Fig. 2 Settlement of soil slope layer during compaction

$$E_C = \frac{W_R.H.N_L.N_B}{V} \qquad (1)$$

Where, E_C is energy in kJ/m^3, W_R is the weight of the bucket, H is the average height between soil slope surface and bucket which tamps perpendicular to the soil slope, N_B is the number of blow, N_L is the number of layer and V is the volume of 30 cm thick soil which comes to contact with surface area of bucket of the excavator during compaction. Here, tamping is provided by the operator and assumed the height of tamping soil with the average acceleration due to gravity. Generally tamping is given from the height of 50 cm above the soil surface. The energies were calculated for all slopes having different tamping blows during September 2011 and January 2012 as shown by Table 1.

Key Words: embankment slope, settlement, bucket tamping, degree of compaction, water content

Table 1 Computation of compaction energy by bucket tamping method

Blow	Settlement cm	Dc %		w_{av} %		Thickness of soil cm	Vol. of compacted soil cm^3	Energy E (J/cm^3)	Energy E (kJ/m^3)
		09/2011	01/2012	09/2011	01/2012				
5	3.8	81.5	86.2	8.8	8.4	26.2	35806.7	30.8	3082.2
12	8.3		87.4		8.9	21.7	29656.7	89.3	8931.2
15	9.2	85.4	84.9	9.2	8.2	20.8	28426.7	116.5	11647.1
24	10.7		85.7		9.25	19.3	26376.7	200.8	20083.7
30	11.2	88.3	91.5	9.1	8.1	18.8	25693.3	257.7	25772.3
50	13.3		88.3		9.3	16.7	22823.3	483.5	48355.1

3 RESULTS AND DISCUSSIONS

In order to understand the trend of settlement during bucket tamping, settlement curve was plotted against number of bucket tamping as shown by Fig. 3. At first, settlement increased all of sudden. When tamping increased soil slope was become hardened and ratio of rapid settlement was reduced. Fig. 3 shows that at 50 blows, average settlement reached to 14 cm which is nearly half of the thickness of the spreading soil. In this aspect, it can be assumed the expected final settlement if further tamping blows are set up more than 50 times (Fig. 3). When settlement of soil reached near to half (15 cm) of the initial soil thickness, settlement will not occur further and measured the maximum stiff ground which will increase the degree of compaction more than 90 %. In addition, from this curve, the average settlement can easily be known for each blow. At this instance, if 5, 15, and 30 tamping blows are given, tentative settlements can be understood to be 3.8 cm, 9.2 cm, and 11.2 cm respectively. At the same time, at the same energy distribution degree of compaction was affected due to changed in water contents in slopes L, M, and N as shown by Fig. 4. Initially occupied by high water content slope decreased little bit degree of compaction. Similar results can also be observed in high compaction energies slopes of L2, M2 and N2. But if compaction energy is increased for high water content slope, degree of compaction can also be increased.

4 CONCLUSIONS

The field investigation of settlement of soil slope by bucket tamping method indicates that if soils are settled nearly half of the original thickness, degree of compaction as well as stiffness of slope can be achieved. In order to increase the degree of compaction of high water content slopes, compaction energy must be increased by bucket tamping method.

5 ACKNOWLEDGEMENT

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6 REFERENCES

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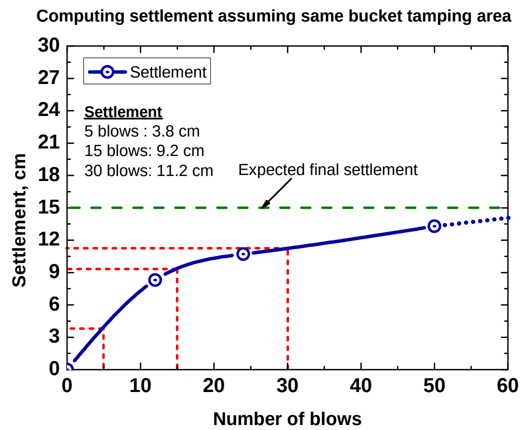

Fig. 3 Settlement curve of embankment slope with increasing compaction energy.

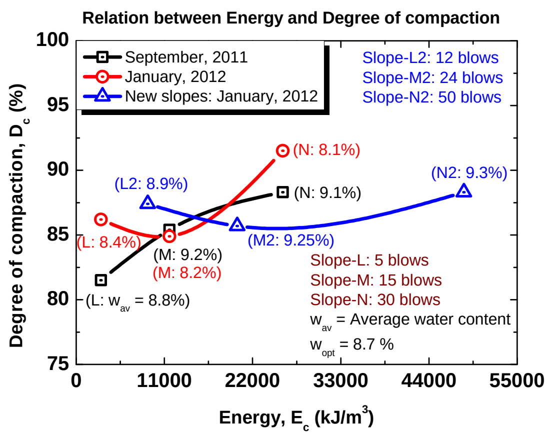

Fig. 4 Compaction curve and dry densities by RI

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