

Pilot Study to Improve Bearing Capacity of Open Dump Waste Site for Low Rise Housing

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ABSTRACT

Urbanization is the physical growth of urban areas as a result of global change. The facilities like education, healthcare system, employment avenues, civic facilities and social welfare are reasons attracting people to urban areas. As the land cost is increasing tremendously and decreasing availability of good construction site is building up pressure on the engineers to utilize even the poorest site either by providing special type of foundation or by improving ground in urban centres. In this context literature is reviewed for use of landfill site for housing. The site exploration for old dump site was carried out to assess subsoil characteristics. The objective was to evolve strategy for economical feasible ground improvement technique to obtain permissible bearing capacity of 150 kPa and settlement not more than 50 mm. The exploration of site was done by DCPT to find the bearing capacity. The site can be used for construction of low rise housing for rehabilitation of displaced persons under TP scheme within city area utilizing old landfill sites.

1. INTRODUCTION

As the land cost is increasing tremendously and decreasing availability of good construction site is building up pressure on the engineers to utilize even the poorest site either by providing special type of foundation or by improving ground. The weak subsoil deposits pose the problems of low bearing capacity and excessive settlement over long period of time. This may be overcome by the recently developed method of ground improvement. It can be effectively utilized to force the soil to behave according to the project requirement rather than having to change the project to meet the limitation due to weak ground. Solid waste disposal in landfills is the most economical form of disposal of waste particularly in the developing country. As the old and closed landfills are having the limited end use in terms of recreational uses like gardens and golf courses, it is now the demand of time to gain some return from the old landfills like infrastructure, commercial and low income residential development.

Cost of land in Surat city has reached to sky. To satisfy need of land Surat city limits has been expanded and more area is included by Surat Municipal Corporation (SMC).

SMC is planning to make the city zero slum in forth coming years. For that, slum rehabilitation policy is prepared by SMC (SMC Report, 2008). So for this purpose a large area is required within city limit. If landfill area can be used for the purpose it may be the economical solution.

In this context literature is reviewed for use of landfill site for housing. The site exploration for old dump site was carried out to assess subsoil characteristics. The objective was to evolve strategy for economical feasible ground improvement technique to obtain permissible bearing capacity of 150 kPa and settlement not more than 50 mm. The exploration of site was done by DCPT to find the bearing capacity.

2. LITERATURE REVIEW

It is a challenging job for the engineers to design the structure on the closed landfill based on the settlement condition and to determine the suitable foundation. Pile load tests and plate load tests should be conducted as per the site requirements (Laxmikanta Tripathi, 2008).

Before carrying any construction work on MSW landfill, site improvement must be done, for that

compressibility and low bearing capacity of the waste material underlying the construction must be taken into consideration. To provide sufficient bearing capacity, pile foundations are typically used. Downdrag on the piles due to waste settlement is a major problem (Odud, 2000). Due to the large settlement potential landfill redevelopment using shallow foundations is generally restricted to low rise structures of one or two stories with raft foundations. A relatively new form of ground densification known as rolling dynamic compaction has been used to redevelop an old waste tip site. Rolling dynamic compaction was accomplished using 8t non circular (4 sided or square) impact module towed in a frame by a 4-wheel drive tractor, a technique utilized for various applications around Australia for more than 20 years.

Rolling dynamic compaction over the refuse filled area was controlled by surface settlement monitoring, with rolling continuing until effective refusal was observed, i.e. there was no further significant measurable settlement. Effective refusal was determined in this case by averaging the measured settlements over the whole area and observing the rate of increase on a plot of impact roller passes versus average settlement (Avalle and McKenzie, 2005).

Ground improvement using the rolling dynamic compaction (RDC) method has proven to be successful for residential development overlying an old waste tip. A constant surface wave system was used to monitor the compaction effectiveness. Shear wave velocity measurements were taken to evaluate the waste material stiffness parameters before and after the dynamic compaction process. This allows the assessment of the degree of improvement achieved on site with the use of RDC (Bouazza and Avalle, 2006).

Dynamic Consolidation is also the ground improvement technique used for the landfill sites. This method is used to reduce void space, increase density and reduce long term settlement of the fill. By increasing the density, it increases the storage capacity of the landfill and also increases the bearing capacity of the same. Reducing the long term settlement, roads, parking bays and lighter structures can be designed on shallow foundations on closed landfills (Ir Kenny Yee, 1999).

The dynamic cone penetration test (DCPT) was carried out on open waste dump site as this test is very simple and quick and other method like SPT is not suitable because drilling is very difficult on site. This paper will describe the DCPT tests carried out on Bhatar Open Waste Dump site.

Dynamic Cone Penetration Test

The Dynamic cone penetration test (DCPT) is a quick test to set up and run. This test has been conducted by driving the cone by blows of hammer. The number of blows for

driving the cone through a specified distance was a measure of the dynamic cone resistance. DCPT has been conducted as per (IS: 4968 – Part I – 1976, reaffirmed 1997). A dynamic cone test has been performed by using a 50 mm cone without bentonite slurry. The number of blows for every 10 cm penetration was recorded. The number of blows required for 30 cm of penetration was taken as the dynamic cone resistance. The method adopted to improve open waste dump site properties was low pressure cement grout. In a hole of 5cm having 6m depth was grouted with low pressure cement grout as shown Fig.2. The cement grout used was having proportion 1:10. After a period of one week Dynamic Cone Penetration Test was carried out at 450 mm away from the hole to check the improvement in the geotechnical properties of landfill. Two Dynamic cone penetration tests were carried out on either sides of hole.



Fig. 1: DCPT Conducted at Bhatar Open Waste Dump Site



Fig. 2: Application of Low Pressure Cement Grout

Bearing Capacity of Site Before Treatment from Dynamic Cone Penetration Value (N_c)

Dynamic cone penetration value at 2.1 m depth from result of DCPT given in Fig. 3.

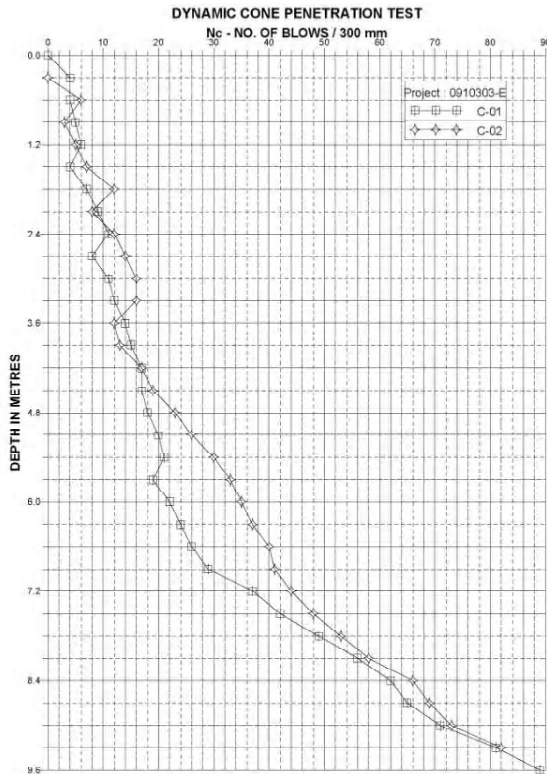


Fig. 3: Test Result of DCPT at Bhatar Old Waste Dump Site [Before Improvement]

$N_c = 9$ as the depth of footing = 2.1 m,

For $\phi_u = 0$, soil: Saturated clay (Desai, 2005)

$$C_u = 8 N_c = 72 \text{ kPa}$$

According to IS 6403-1981 the Safe Bearing Capacity will be 216 kPa.

Applying water table correction, taking factor of submergence 2,

$$\text{Safe Bearing Capacity} = 108 \text{ kPa}$$

Bearing Capacity of Site After Treatment of Grouting from Dynamic Cone Penetration Value (N_c)

Dynamic cone penetration value at 2.1 m depth from result of DCPT given in Fig. 4.

$N_c = 14$ as the depth of footing = 2.1 m,

For $\phi_u = 0$, soil: Saturated clay (Desai, 2005)

$$C_u = 8 N_c = 112 \text{ kPa}$$

According to IS 6403-1981 the Safe Bearing Capacity will be 336 kPa.

Applying water table correction, taking factor of submergence 2,

$$\text{Safe Bearing Capacity} = 168 \text{ kPa}$$

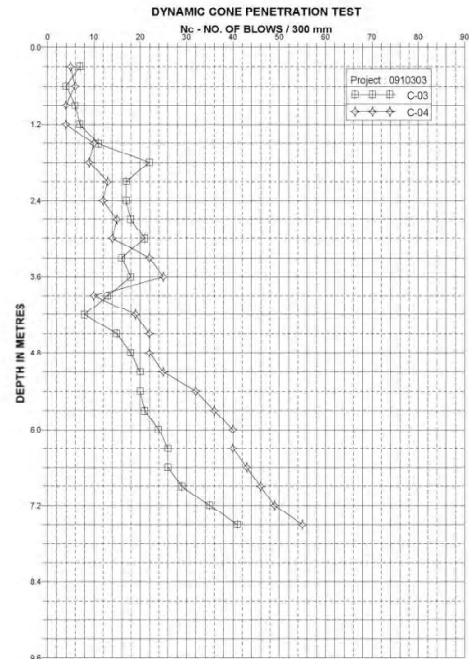


Fig. 4: Test Result of DCPT at Bhatar Old Waste Dump Site [After Improvement]

The DCPT test on open waste dump site gives the bearing capacity of 108 kPa, which is increased by 55% after application of low pressure grouting i.e. Safe Bearing Capacity will be 168 kPa. The grouted depth could have net Safe Bearing Capacity of 168 kPa even after flooding.

3. CONCLUSION

1. Study aimed to establish that the ground improvement techniques are feasible for old waste dump sites. After application of ground improvement technique, the waste fill can safely take pressure of footings of G + 4 building of economical weaker section (EWS). The clearance of environment aspect is assumed.
2. Low pressure grout judged by DCPT after a week, has given good improvement. Detailed study is required for particular site and cost effectiveness of techniques and material shall be checked for a final economical solution.
3. Field pilot quick exploration by Dynamic Cone Penetration Test for Bhatar site, proved feasibility of use of landfill old plot (area 23 hectare). It can be considered for low cost housing schemes for EWS and demolished labour colonies within the city.

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