International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Determination of In-situ Field Density on Rock Fill Strata: Experimental Methodology

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Abstract: ***Backfilling is the process of replacing or reusing the soil that is removed during building construction to strengthen and support a structure's foundation or any other structural member, in rocky terrain there is scarcity of borrow earth backfilling was done by filling with rocks to control the project cost. No codal provision is available for rockfill compaction testing against density, a methodology has been develop for compaction and density is calculated and in no case density should not be less than 1900 kg/cum. The aim of this paper is to crop out the issue of backfilling when project authorities deviate from specified item of backfilling given in schedule of quantities due to non-availability of borrow earth and no provision for compaction methodology and density measures is available in Indian Standard Codes.***

Keywords: backfilling, compaction, density, methodology, rockfill

1. Introduction

In construction, backfilling is the process of replacing or reusing the soil that is removed during building construction to strengthen and support a structure's foundation or any other structural member [1]. But in rocky terrain excavation is done on rocks upto required depth of foundation and excavated material is only excavated rocks. Many standards and specification suggested that backfilling should be done with borrow earth, soil and sand. Soil/ borrow earth is limited available in rocky areas hence backfilling will become a bottle neck as directly impact the financial cost due to non-availability of borrow earth, the option is left that backfilling should be done either by crushed sand or borrow earth,. In order to control the cost of project and utilizing the excavated rock most economical option is backfilling the structure with the rocks but problem has risen that no codal provision is available for compaction testing when backfilling is done with rocks. In Modern day rockfill construction must rely heavily on past experiences for guidance in determining acceptable procedures for the placement and compaction of large rock fragments in a compacted fill structure. The conventional earthfill field and laboratory test methods for controlling lift thickness, gradation, moisture content, and compaction are not applicable to rockfills and must be modified to a site specific compactive effort specification using large-scale test fills and heavy vibratory roller compactors.

In concurrence with the construction procedure of rockfill dams and water bounded macadam roads philosophy was opted that rocks should be used in backfilling material for low laying areas, under floors and around structures where there is scarcity of borrow earth and methodology was prepared on assumption that compacted density of rockfill should be atleast 85% of the excavated rock density.

1.1 Limitations of other methods

Indian Standard has specified different methods for calculating the in situ density like sand replacement method, core cutter, water displacement method and proctor density for establishing the density in laboratory. All the methods are either useful on fine grained soil or coarse soil [2], sand replacement method is also used in road work where aggregate size is restricted upto 110mm beyond this no other test was specified in the code.

2. Methodology of experiment

The earth for filling should be rock soil mass not exceed 150mm in size sorted from available cutting areas and filling should be done in loose thickness of layer upto 400mm. Voids should be filled with smaller size material to ensure well graded and compacted fill. Compaction of the rock and soil mass should be done by ramming, watering and with roller to achieve required density.

3. Field Testing For Density

Each layer should be tested in field to achieve required density before laying next layer. Due to stone compaction test like core cutter, sand replacement etc. is not performed in this event, the compaction should be determined at site by excavating a pit of size 600mm x 600mm x 300mm (depth) in compacted area. The excavated soil-rock mass should be weighted. In excavated pit polythene sheet was layed and filled with water upto the top level ensuring that there is no seepage.

Weight of water so filled in pit should be determined; alternatively standard sand may be used for filling the pit for determining the density.Density of soil mass is equal to the weight of excavated fill material/weight of water filled in pit. In no case density should be less than 1900 Kg/cum for soft rock and 2000 Kg/cum for hard rock. [3]

3.1 Theory opted for calculating density

Density (γ) = Weight (W)/Volume (V)
Density of fill material (γ_F) = W_F/V_F (a)
Density of Water = W_W/V_W (b)
Volume of excavated fill material from pit = Volume of water fill in the pit
Equating equation (a) and (b)

γ_F = Weight of fill material/Weight of water
$\gamma_F$density of filled material

3.2 Percentage of Voids and Filler material

To determine the percentage of voids and filler material sieve analysis should be carried out and by weighing the sample and 100% passing through 4.75 mm sieve size should be term as filler material. There being no IS sieve having an aperture larger than 100 mm a perforated plate complying with IS : 2405-1963and having a square aperture of 160 mm is used.

Indian standard soil classification system (ISSCS) [3] classified the soil into group according to size as given below

Table 1: Indian standard soil classification system (ISSCS)

Very coarse soils	Boulder size		> 300 mm
	Cobble size		80 - 300 mm
Coarse soils	Gravel size (G)	*Coarse*	20 - 80 mm
		Fine	4.75 - 20 mm
	Sand size (S)	*Coarse*	2 - 4.75 mm
		Medium	0.425 - 2 mm
		Fine	0.075 - 0.425 mm
Fine soils	Silt size (M)		0.002 - 0.075 mm
	Clay size (C)		< 0.002 mm

4. Result and Conclusion

A field trial was conducted on 300 sqm area having elevation difference of 1.8 m as per above methodology and density is determined as given in Table 2

Table 2: Result of Field Trial

Sample No	Weight of filled material (kg)	Weight of Water (kg)	Density of filled material (kg/cum)
1	219.88	115	1942
2	212.08	110	1928
3	246.13	125	1969
4	206.49	106	1948
5	225.93	117	1986

IS Code does not specify any method for compaction when backfilling is done by rock and fines, an experimental methodology was develop to find the density of rockfill on assumption that in no case density of rockfill should be less than density of well graded sand i.e 1900 kg/cum. From above result it has been observed that density of rockfill is greater than of sand and this will help in crop out the issue of backfilling when project authorities deviate from specified item of backfilling given in schedule of quantities due to non-availability of borrow earth and standards, further studies are required to generalized the methodology on strata when filling is done with rocks upto size 150mm.

References

[1] Dr. B.C. Punmia, " Building Construction"
[2] IS: 2720: (Part XXVIII)- 1974 " Methods of test for soil"
[3] Roy E. Hunt, "Geotechnical Engineering Investigation handbook
[4] Indian standard soil classification system