GOVERNMENT OF BERMUDA

Ministry of Public Works

Department of Works and Engineering | Structures Section

Geotechnical Guidance – Engineered Backfill - Specifications and Method Statement

In the absence of geotechnical laboratory facilities, we are obliged to use a methods-based (field controlled) approach to determine the optimum water content and the minimum compactive effort required to achieve maximum dry density.

This method involves several initial trials in order to estimate the optimum water content (defined as % water content, by mass) and minimum compactive effort (defined by the maximum lift (ie. layer) thickness and the minimum number of passes of the compaction plant) until the optimum moisture content and the maximum dry density is determined. The in-situ density will be measured with a nuclear densometer.

Fill Material - Properties

- Well graded fill material; sand, gravel, crushed rock and durable clean, crushed concrete; Fill material particle size profile to include sand, screenings, 5/8 stone and cobbles up to maximum particle size of 2/3 loose layer thickness and 6" diameter maximum.
- Less than 5% organic material content (ie. biodegradable material including topsoil and wood chips),
- Less than 5% clay content, (clays are prone to shrinkage and swelling)
- Free of hazardous materials and other contaminants,
- Free of metals.

Optimum Moisture Content

The optimum moisture content is a function of the material properties and their size distribution profile. The optimum water content (a.k.a. optimum moisture content, OWC and OMC, respectively) range for local sand is approximately 5.5% to 7.5% by mass.
Since the fill material can broadly be classed as a coarse grained, cohesionless material, it will be reasonably free draining and, as such, the fill should be saturated prior to and during (as necessary, depending on the rate of drainage) the compaction process.

Trials

The fill will be placed in varying lift depths and each lift (layer) will be compacted with varying water contents and varying number of passes.
(The thicker the layer thickness the greater the number of passes will be required to achieve the same degree of compaction/density. This is not a linear relationship, a doubling in thickness will be attended by significantly more than double the number of passes required to achieve the same density)

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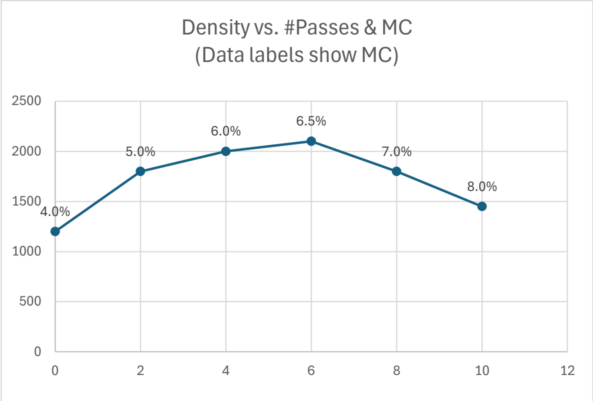
The table that will be used to record the results of the analysis will look similar to the following:
For a large compaction plant such as a 7T vibratory roller*:

TEST	Trial	Lift / Layer Depth (in.)	No. of Passes	Density (Maximum Dry, MDD)	% diff	Moisture content, MC
1	1	4"	**0**	1,200		4.0%
1	2	4"	2	1,800		5.0%
1	3	4"	4	2,000		6.0%
1	4	4"	6	2,100		6.5%
1	5	4"	8	1,800		7.0%
1	6	4"	10	1,450		8.0%
2	7	6"	**0**			
2	8	6"	2			
2	9	6"	4			
2	10	6"	6			
2	11	6"	8			
2	12	6"	10			
3	13	8"	**0**			
3	14	8"	2			
3	15	8"	4			
3	16	8"	6			
3	17	8"	8			
3	18	8"	10			
Placeholder values						



(*A smaller compaction machine, such as 3T static roller, will require the compactive effort to be applied to thinner lifts/layers and include several more passes in order to achieve maximum compaction.) (For reference, on a recent job, a 3T static roller required 15 passes over a 6” lift in order to achieve the required density)

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The optimum water content and the maximum dry density will be inferred from the results of the field analysis of the 4” lift. If the contractor wants to use a thicker lift thickness, then the number of passes required, at the MC determined in the 4” trial/analysis, in order to achieve the MDD determined in the 4” lift analysis, will need to be determined.

Notes:

- The determination of the required compactive effort and optimum water content will be specific to the material being used. The exercise needs to be repeated for each new source or for each different composition of fill material.
- Different materials shall be uniformly distributed across the fill area. There shall be no isolated concentrations of different material. Each lift layer shall be homogeneous.