earthworks improvement using quicklime

The treatment with quicklime of unsuitable earthworks material to produce general fill

Unsuitable earthworks materials can be improved with quicklime to enhance geotechnical properties. This treatment involves:

- Mechanisation in material handling, which significantly strengthens the site due to the removal of moisture and a reduction in material and equipment change from site to site.
- Quicklime added as an admixture can be used in any long-term dense material, which occurs either as clay or sand in cohesion/ductility high material and chalk materials.
- The site investigation and geotechnical analysis can be carried out at the same time as the material is placed in the formwork. Stabilisation will be covered in Chapter Seven of the Highway Authority’s handbook 'Highways and the Environment'.

The nature of improvement

The addition of quicklime to cohesive, granular and chalk materials causes a reduction in moisture content as the chemical change is known as 'Modification' and is additional to the drying process. This reaction essentially improves bearing capacity and strength.

Quicklime treatment of soils was introduced into a Department of Transport Guideline Note in 1959 and has been used extensively since then. The treatment of unsuitable earthworks material has been covered in a range of papers and standard work and has been used at the Channel tunnels, the M60 Motorway, Rockingham Motor Speedway at Corby and the Channel Tunnel.

Performance on site:

As far as possible the construction method should identify the different groups of materials that exist on the site and the classes they fall into. It will then be possible to determine the maximum amount of quicklime that will be required before they are used. The nature of treatment between strength and quicklime will vary in importance to the different soils. Generally speaking a higher volume of quicklime can be used with the specification for the acceptability material and with the fines and the moisture content PCV and plastic limit that are corrected by using quicklime.

Quicklime is applied at a rate of 2% to 5% by weight of the material to be treated in order to achieve the necessary improvement. The quicklime is added to the material in the form of a slurry. The amount of quicklime required to achieve the necessary improvement is determined by testing but 2% addition by weight will substantially improve many soils.

The mixture should be compacted to a high standard with additional quicklime added if necessary to achieve the necessary improvement. In fact due to the superior nature of the improved soil productivity is often higher with less down time due to the weather.

The procedure described above describes the technique of the treatment of quicklime. It can be widely employed in earthmoving operations and does not delay the rate of construction due to the superior nature of the improved soil productivity. It is often carried with less down time due to the weather.

Material can be treated either in situ or after transporting to the point of use. However this is carried out, it is important that the procedure ensures that all the parts of the improved soil mix with the correct proportions of quicklime and that untreated material is not included in the finished construction. UK conditions often determine that material is transported to the point of use but on some larger contracts deep layers are treated and moved to the point of use by scrapers. Either system is equally permissible and further improvement sometimes occurs as treated material is moved and compacted.

Material may be carried to site in bulk or in units that are mixed on site. Further guidance should be sought from the agent of origin.

Construction

The site investigation results will give an indication of the optimum location of the unsuitable material, the material content, plastic or organic content and the classes the material falls into. Therefore, an investigation should be carried out before any earthworks material is moved to the point of use. The quicklime is added to the material in the form of a slurry. The amount of quicklime required to achieve the necessary improvement is determined by testing but 2% addition by weight will substantially improve many soils.

Considering the weak nature of the soil the spreading of lime is usually best carried out using a broad spreader. This is carried out by hand but the use of bar hammers and purpose-made male tools is acceptable providing adequate mixing can be achieved.

The amount of quicklime required to achieve the necessary improvement is determined by testing but 2% addition by weight will substantially improve many soils.

Material can be treated either in situ or after transporting to the point of use. However this is carried out, it is important that the procedure ensures that all the parts of the improved soil mix with the correct proportions of quicklime and that untreated material is not included in the finished construction. UK conditions often determine that material is transported to the point of use but on some larger contracts deep layers are treated and moved to the point of use by scrapers. Either system is equally permissible and further improvement sometimes occurs as treated material is moved and compacted.

Material may be carried to site in bulk or in units that are mixed on site. Further guidance should be sought from the agent of origin.

The procedure described above describes the technique of the treatment of quicklime. It can be widely employed in earthmoving operations and does not delay the rate of construction due to the superior nature of the improved soil productivity. It is often carried with less down time due to the weather.
The treated material will have to meet the pulverisation, compaction and MCV requirements of the general fill specification. If testing to confirm these parameters is not carried out in the laboratory then it will have to be confirmed on site by undertaking tests. These laboratory tests will have already confirmed the requirement that can be achieved at site, and the type of lime that can be used to meet this requirement is essentially the same as that used in the laboratory tests. If the nature of the soil has changed between testing and construction, then the spread rate may vary depending on whether the treated soil meets the specified MCV values. Laboratory values should also be confirmed at site to ensure that adequate mixing has taken place.

The laboratory test should also be used at site to confirm the specification for the material meets the requirements detailed above. The spread rate of the quicklime will need to be confirmed at site to ensure it is the same as that determined in the laboratory. If the nature of the soil has changed between testing and construction then the spread rate may require adjusting to achieve the desired MCV results. Laboratory values should also be confirmed at site to ensure that adequate mixing has taken place.

To achieve these results the spread rate of the quicklime will need to be checked to confirm it is the same as that determined in the laboratory. If the nature of the soil has changed between testing and construction then the spread rate may require adjusting to achieve the desired MCV results. Pulverisation checks should also be carried out to ensure that adequate mixing has taken place.

As site testing should be carried out in addition to those checks given in the specification for highway works, the method of compaction can be for the most appropriate for that classification.

For each classification the MCV test is crucial to control acceptability in case test it is a measure of moisture content, compaction, bearing ratio and shear strength.

The MCV test is not so relevant for granular soils and chalk in these cases the direct measurement of moisture content is the preferred method.

Specification

A simple and concise specification for the treatment of unacceptable earthworks materials is described in BLA Specification Data Sheet No 1 (ref 4).

Benefits

Lime Improvement is a quick and simple operation that can be incorporated into any earthmoving contract by establishing a new stage in the existing contract. Because the nature of the soil is changed to a more suitable material, productivity is often enhanced. The cost of mixing unacceptable soils will need to be considered on the new additional work that is being undertaken. Exact addition rates should be determined by simple tests as described earlier.

One of the great advantages of improving soils with quicklime is the ability to retain all material on site. This eliminates the need to remove material to tip and saves the cost of tipping and haulage charges. This often has an impact on the construction programme as it is usually considerably quicker to treat soil on site rather than dig, dump and replace.

www.britishlime.org