**Lime Stabilisation of Cohesive Soils for Capping Layers using Quicklime**

The treatment of soils with Quicklime to produce capping material in accordance with highway agency specification

**Introduction**

The treatment of soils was introduced in a Department of Transport Guidance Note in 1975 to extend the full capping material specification to hospital and industrial building sites. The introduction of capping material was also prompted by the extension of the Building Regulations to cover healthcare facilities.

Quicklime is a primary source of calcium oxide and is available as a fine white powder, produced from the calcination of limestone, a carbonate rock. It is produced from any source with adequate carbon content, which is then heated to produce lime that is then crushed and ground into a fine white powder.

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The treatment of soils with Quicklime to produce capping material involves a chemical reaction, known as ‘Stabilisation’, which causes the silica and alumina in the clay to dissolve and form a calcium silicate hydrate gel. This gel is responsible for the improvement in the engineering properties of the soil.

Compaction characteristics, moisture condition value (MCV), plastic limit and liquid limit are important parameters to consider when determining the suitability of soils for capping material.

The addition of Quicklime (Calcium Oxide) to any soil causes a reduction in moisture content as water is used in the hydration of the calcium ions. This chemical change is known as ‘Modification’ and is responsible for the change in soil properties. The addition of Quicklime also causes a reduction in the plasticity of clays and a long-term improvement in strength due to the ‘Stabilisation’ reaction.

Lime/ggbs 1.5% - 2% 1.5% - 3.5%
Lime only 2.5% - 4.5%

**Preliminary Site Study and Investigation**

The site study will vary according to the stage at which soil stabilisation is considered for the project. Guidance Note in 1976 and the full capping specification into the SHW and HA74. Capping is required to achieve a soaked CBR of not less than 15% after 7 days and an average swell of no more than 5mm or 10mm.

The density of the treated and untreated soils should be determined to ensure that both the treated and untreated soils are suitable for use in the construction of the capping material.

Dense, permeable soils are more likely to be encountered in the construction of capping material. These soils are less likely to contain clay particles that can be affected by the action of water or chemicals. The density of the treated and untreated soils should be determined to ensure that both the treated and untreated soils are suitable for use in the construction of the capping material.

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**The Testing Procedure**

The testing procedure carried out in the laboratory should reflect the long-term performance of the capping material. The testing procedure should include the following:

- **Laboratory procedures**
- **Field procedures**

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Construction

The Construction process consists of the following steps:

1. Spreading lime on the prepared formation using purpose made spreaders.
2. Mixing the soil and lime together with a rotovator/mixer.
3. Water may need to be added through spray bars in the mixer hood. (Integrated machines are now available that will carry out spreading and mixing in one operation.)
4. Lightly compact to seal the surface.
5. Leave to mellow.
6. Remix to achieve pulverisation requirements. Add water if required.
7. Fully compact and trim to level.

If cement or ggbs are to be added this will be carried out after the mellowing and remixing stage.

The addition of lime to a cohesive soil will cause a reduction in density and some bulking to occur. This effect should be addressed at the laboratory design stage to determine the slightly increased formation level after treatment.

Pulverisation and mixed content are important factors in producing a suitable sub-base. The following test is a useful guide:

Moisture content of the soil and all stages of construction is measured on the MCV test [6]. Generally, an upper limit of 12% is given though there is a wide range of optimum moisture content for lime stabilisation. Laboratory testing should be performed to determine the optimum moisture content for lime treatment.

Moisture content should be measured at least every 6 months to ensure the soil is wet of optimum and that the binders have sufficient moisture for complete hydration. This is crucial to achieve optimum performance.

At final compaction a maximum MCV of 12 should be specified in order to produce a layer with minimal air voids which is necessary for a successful sub-base treatment.

Benefits

As with all stabilisation techniques the main benefit is to be able to utilise and stabilise all the site won material for a variety of applications. This speeds up construction and eliminates tipping and the import of primary aggregates.

Now that treatments using cement and ggbs have been approved by the Highways Agency, as well as lime, a wide range of different soils from granular to cohesive can be treated.

There is also the option to use one thick layer of stabilised subbase material in place of capping and subbase as details in HD25. Details of stabilised pavement materials are available in Technical Data Sheet 3.

References


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