Benefits & Reasons for Lime / Cement Stabilisation / Modification

Introduction

Soil modification / stabilisation, in terms of pavement / fill construction is the process of pulverising (usually utilising in-situ mixing machines), moisture conditioning and controlled addition of cementitious binders with existing site won soil materials, that with compaction, trimming and testing provides a finished material that meets a specified highways or construction requirement.

Such a process improves soil characteristics, normally required to meet construction earthworks placement criteria in terms of moisture content, density, strength (CBR%), permeability, plasticity index and shrink swell characteristics etc. Further or enhanced binder addition; can also be utilised to achieve finished earthwork characteristics, far in excess of that which would normally be expected from a natural material, placed at or around its optimum moisture condition.

Most material types; clay through to crushed rock are suitable for treatment, subject to the choice of the most appropriate binder (generally Lime for Cohesive materials – Cement for Granular materials).

Seeking specialist advice early during the design / feasibility stage, enables planning for the most efficient and economic use of the existing materials on site, even if these materials would have normally been considered as being unacceptable for use in the works.

Modification / Stabilisation

Lime and/or cement stabilisation is often used to improve the properties of site won materials, to enable their use in road pavements and other like areas, such as building foundations and general building site plateaus.

Lime stabilisation of clay material reduces entrance cracking, whilst increasing the stiffness of the material (bulk earthworks fill).

The use of cement as a binder, after lime treatment, can further increase the strength and durability towards that of concrete (Capping / Sub-base replacement). Spread rates (kg/m2) are varied in accordance with the potentially differing ground conditions and results required from the material. Additional mat tests are carried out in order to confirm and adjust the required spreading rate.

Various binder blends other than Lime and Cement are also used, such as slag (GGBS) or fly ash (PFA), are commonly utilised for further benefit, dependant on site conditions and finished specification required.

General Benefits of Soil Stabilisation

- ◊ Saturated / wet sites can be treated to provide a working platform within a day for project continuation during wet periods/seasons in case of cohesive materials, granular materials may need longer to allow nominal curing / drying of granular materials.
- ◊ Wet and saturated fill materials can be recovered to allow them to be placed and compacted in accordance with given earthworks specifications.
- ◊ Strength gains / finished strengths of more than 5% CBR can be achieved with a nominal addition of binder.
- ◊ In cohesive material, the addition of lime reduces its Plasticity Index (PI).
- ◊ Will generally reduce the amount of imported material required.
- ◊ Provides an increase in production during wet periods.
- ◊ Can provide a substantial cost saving especially were the process eliminates potential disposal costs of unsuitable materials.
- ◊ Increased quantities of a binder and or a mix of binders (Lime followed by Cement) are added; to provide both the benefits gained by modification, with substantial gains in finished strength of more than 15% CBR and up to 50% CBR.
- ◊ Again, in cohesive material, the addition of lime reduces its Plasticity Index (PI), but if enhanced quantities of Lime and or Cement added, enhanced finished strengths are achieved.
- ◊ The Stabilisation process can recycle existing pavements and pulverise materials to meet the pulverisation requirements necessary for capping a subbase replacement.

Stabilisaton Process & Machinery

Insitu stabilisation procedures vary depending upon the type of project and the binder used. Mixing machinery suitable for the process is purpose built for modification / stabilisation.

A range of purpose built equipment has been developed according to specific requirements of various site conditions and design specifications for the process to be effective.

Dust free equipment is also available, this equipment avoids many of the environmental issues associated with potential “binder / dust blow” across any potential site.

Preparation

Prior to commencing it is important to ensure the commencing formation surface is prepared ready for the chosen process to proceed.

In some circumstances, it is preferable that the commencing formation is also processed in-situ to provide suitable substrata to compact the following placed layers, mixing plant can generally treat 300mm from the commencing surface, without requiring further excavation.

Immediately prior to processing, the surface / layer should be ripped to the required depth to identify and remove unsuitable material such as obstacles, organics and material too hard to treat.

Spreaders

There are a range of purpose built binder spreaders available, including dozer towable units for particularly boggy sites.

Selection of the correct spreader ensures efficient working and even distribution of the range of binders used in the modification / stabilisation processes.

Leading technologies are incorporated into all tractors and spreaders to ensure accurate binder spread rates and containment of dust.

On board computers linked to load cells and farm scan distance measuring devices assist in assuring accurate spread rates.

All spreader trucks have sealed bulk bins to ensure the product does not start to react until it is on the ground ready to be mixed into the pavement.

Spread rates (kg/m2) are varied in accordance with the potentially differing commencing ground conditions.

Additional mat tests are carried out in order to confirm and adjust the required spreading rate.

Water Bowsers

Especially during the drier months, water must be added to ensure optimum moisture content is maintained for compaction.

Depending on soil conditions and moisture content water can be added before and or after spreading any binder or directly into the mixing chamber by linking the water truck to the mixer where appropriate.

Not only is water vital to ensure optimum moisture content at compaction, water initiates the necessary chemical reactions with most binders.

Compaction

Compaction commences after mixing.

Typically, stabilised materials are compacted to 95% compaction. however higher compaction.

Insitu mixing up to 300mm in a single layer requires compaction equipment large enough to achieve density throughout a layer this thick.

Typically, large self-propelled vibratory pad foot rollers are used initially for deep compaction followed by a similar smooth drum to complete compaction of the full layer.

Final Trimming

It is normal to commence trimming the pavement before the completion of the compaction operation, ensuring good bonding of any corrected shape before is finished.

If high strength Cement stabilised layers are being formed, final trimming and finishing should be completed with 2 – 3 hours maximum after the initial addition of cement.

Considerations for Stabilisation

By seeking advice early during the development stages of a project you can ensure savings are maximised by optimising the use of modification / stabilisation in the design, look to reduce double handling and to minimise potential import / export of materials.

To assess a site accurately in terms of modification and or stabilisation, ideally the following information needs to be available:

- ◊ Geotechnical data including site conditions, material type and depth, sub-grade and existing pavement material.
- ◊ Sulphate testing – providing total sulphates in accordance with TRL guidance.
- ◊ Chemical contamination, testing analysis and assessment report.
- ◊ Any temporary construction / access requirements (note these can often be greater than the final construction requirements).
- ◊ Any temporary crane / piling platform requirements (proposed crane and or piling rig specifications required) – platforms need to be designed for their specific use and loading.
- ◊ Any potential access restrictions – binder deliveries are by road tankers, generally daily.
- ◊ Available loading / storage areas – Lime or Cement would require a static site based silo, if two binders are used then two silos would be required.
- ◊ Geometric site layout proposed.
- ◊ Existing OGL.
- ◊ Proposed areas to be treated.
- ◊ Volumes of expected bulk fill.
- ◊ Specification requirements; typically in terms of densities required, CBR strengths required, bearing to be achieved.
- ◊ Proposed award and commencement dates.