

SOIL STABILISATION

Guidelines for Best Practice

PREFACE

Britpave, the British In-situ Concrete Paving Association, was formed in 1991. It is active in all areas of transport infrastructure including roads, airfields, light and heavy rail, guided bus, safety barriers and drainage channels, soil stabilisation and recycling.

The Association has a broad corporate membership base that includes contractors, consulting engineers and designers, suppliers of plant, equipment and materials, academics and clients, both in the UK and internationally.

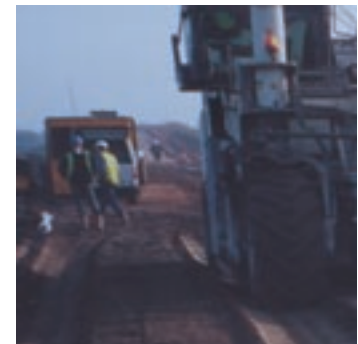
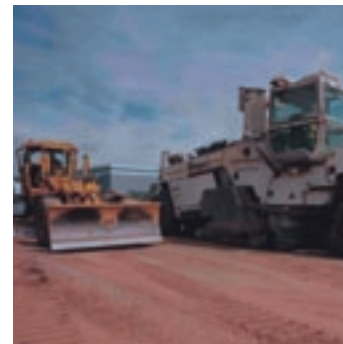
Britpave provides members and clients alike with networking opportunities and aims to develop technical excellence and best practice in key cement and concrete markets through its publications, seminars and website.

Britpave has produced this publication to provide guidelines for all those involved in soil stabilisation. The information is based on current knowledge of Britpave members experienced in the design and execution of soil treatment.

These guidelines give basic information on the procedures required for the execution of a successful soil stabilisation project. They also indicate the responsibilities of the client, designer and contractor to carry out specific functions and to ensure that the required expertise is available to make appropriate and informed decisions at steps throughout the project. Recommendations for monitoring work in progress and establishing comprehensive record systems are also included.

This publication can be used to assess the information that is required to specify a soil stabilisation project and schedule the detailed testing that is required for a successful outcome. It can also be used as a checklist throughout the contract to ensure that each phase is correctly carried out and completed, and that the appropriately qualified staff exist within the contractor's organisation.

Brief notes on the relevant standards applicable to each step have been included for guidance, but these are not exhaustive. Further details can be found in other Britpave publications* or via the Britpave website.



* *Stabilised soils: as subbase or base for roads and other pavements, 2004.*

PHASE 1	Desk study					
ACTIVITY/PURPOSE	RESPONSIBLE ORGANISATION	NECESSARY COMPETENCE	RELEVANT STANDARD/LEVEL OF EXPERTISE	MONITORING SYSTEM	RECORD SYSTEM	COMMENTS
Desk study Review all available data applicable to soil conditions and pavement design	Project designer	A recognised professional qualification in pavement design and experience in the interpretation of geotechnical data.	HA Specifications for Highway Works and British or European Standards.			This phase gathers all the existing available data to determine what additional information and investigation is required. It may indicate what particular design methods are appropriate for the project.

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PHASE 2

PHASE 2	Ground Investigation (GI) to assess the feasibility of soil stabilisation					
ACTIVITY/PURPOSE	RESPONSIBLE ORGANISATION	NECESSARY COMPETENCE	RELEVANT STANDARD/LEVEL OF EXPERTISE	MONITORING SYSTEM	RECORD SYSTEM	COMMENTS
<p>Soil identification</p> <p>To identify the soil mineralogy and to assess its suitability for treatment.</p>	Project designer or testing organisation.	The services of a suitably experienced geologist/geotechnical engineer are required to visually identify soil types and mineralogy.	A recognised level of professional experience and academic qualifications is required, along with adherence to BS 5930.	CVs of all professional staff to be submitted to the client.	Trial pit logs and sample descriptions are to be kept on record.	The detailed logging of the soil types and identification of any visible minerals is of utmost importance. The effect of these materials on the soil stabilisation process should be assessed.
<p>Soil sampling</p> <p>To take representative soil samples for detailed testing to establish its suitability for stabilisation.</p>	Testing organisation or stabilisation contractor.	Laboratory technicians should be suitably trained or qualified and should be experienced in sampling soils to obtain the best information about the mineralogy. Sampling patterns and frequency of sampling may need to be adjusted in order to obtain maximum benefit.	Sampling and sample storage should be carried out in accordance with recommendations laid down in HA74 and TRL 447 or other appropriate British or European Standards.	Third party audit as part of Accreditation Scheme.	Details of the types of sample, their locations and other relevant details are all to be recorded in a comprehensive log.	Depending on the organisation of the project, a stabilisation contractor may be involved at this stage or in phase 4. This will depend on the experience of the project designer and whether he is able to specify the testing and treatment required. It is recommended that as many samples as possible are taken at this stage to determine the extent of the material variability. A written report addressing all the issues identified in HA74 and TRL report 447 should be made available for the client and verified by a suitably experienced professional.

PHASE 3	The design and specification of the stabilisation process					
ACTIVITY/PURPOSE	RESPONSIBLE ORGANISATION	NECESSARY COMPETENCE	RELEVANT STANDARD/LEVEL OF EXPERTISE	MONITORING SYSTEM	RECORD SYSTEM	COMMENTS
<p>Soil suitability testing</p> <p>To determine the suitability of the soil for stabilisation and to identify any potential problem areas.</p>	Testing laboratory or stabilisation contractor.	Technicians should possess appropriate training or qualifications and be experienced in the testing of treated soils.	Third party accreditation e.g. UKAS, BSI or MCERT. Laboratory tests should be carried out in accordance with HA74, TRL 447, BS 1377 and BS 1924 Pt 2 to monitor the presence of sulfates, organics and other deleterious material.	A third party audit as part of an Accreditation Scheme. All test results should be checked against relevant performance specifications by a knowledgeable engineer to ensure the soil is suitable for treatment.	A record should be presented in a typed format and provided to the engineer.	A ground investigation may have been carried out at an earlier stage in the project. Some of this data will be useful to assess the suitability of soil stabilisation but additional data will almost certainly be required. Testing can be carried out by an impartial third party or the stabilisation contractor. In the latter case the engineer should be satisfied with the standard of the testing and the interpretation of the results.
<p>Testing to determine treated soil strength parameters</p> <p>Having determined the soil suitability, detailed testing is carried out to assess the strength parameters achievable.</p>	Testing laboratory or stabilisation contractor.	Technicians should possess appropriate training or qualifications and be experienced in the testing of treated soils.	Laboratory tests should be carried out in accordance with HA74, TRL 447, BS 1377 and BS 1924 Pt 2. All British or European standards applicable to a particular soil test method should be followed.	A knowledgeable engineer should check all test results against relevant design specifications.	A record should be presented in a typed format and provided to the engineer. In particular this should include binder additions, curing regimes and compaction standards used.	This testing should determine whether the treated soil will be volumetrically stable and can achieve the strength parameters laid down in the pavement design; alternatively it should determine the treated soil properties to enable a design to be carried out. Binder addition will be determined at this stage. Many factors determined during laboratory testing will be used for controlling construction. The engineer should be aware of these factors.
<p>Determine the pavement design</p> <p>The strength parameters determined from the testing regime are used in the design of the pavement.</p>	Project designer or stabilisation contractor.	A professional qualification in the design of pavements.	HA MSHW specifications and British or European Standards.	Design calculations may be checked by a third party if required.	The submission of detailed written design calculations.	The responsibility for the pavement design can rest with the project designer or the stabilisation contractor depending on the terms of the contract. Assumptions made in the design process must consider the limitations of the construction process. Layer thickness and compaction requirements must be considered in addition to strength factors.

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PHASE 4

PHASE 4	Trials to confirm the design on site					
ACTIVITY/PURPOSE	RESPONSIBLE ORGANISATION	NECESSARY COMPETENCE	RELEVANT STANDARD/ LEVEL OF EXPERTISE	MONITORING SYSTEM	RECORD SYSTEM	COMMENTS
<p>Trial stabilisation of site soils</p> <p>Test samples from the site treated soils to ensure that site parameters match those used in the pavement design.</p>	Stabilisation contractor.	<p>The services of a suitably qualified engineer are required to ensure that all aspects of site work are carried out correctly.</p> <p>The permanent site foreman should be experienced in soil treatment and be able to demonstrate he understands the principles of the technique being undertaken.</p>	<p>A recognised level of professional and academic qualifications and certification of specialist skills is required.</p> <p>Site work should be carried out to HA specifications or other agreed standards and in accordance with the data determined during phase 2 testing.</p>	Ensure that all phase 2 data is monitored and recorded as it is used on site and that site-specific items such as pulverisation, treatment depth and compaction are examined and agreed.	All parameters are to be recorded in writing and referred to a grid system that allows treatment areas to be identified in the future.	<p>The appointment of a stabilisation contractor may occur at this point, or earlier, depending on the experience of the project design team.</p> <p>It may not be feasible to carry out a separate site trial but this may be the first part of the permanent works. It is essential however that all the phase two parameters are verified and that site-specific items are checked and agreed. Any factors that vary from the original soil assessment and testing should be investigated and final treatment details agreed.</p>
<p>Monitoring soil parameters and stabilisation performance</p> <p>Ensure that all factors from the laboratory testing and design phases are achieved during site treatment.</p>	Testing organisation.	Technicians should possess appropriate training or qualifications and be experienced in the testing of treated soils.	<p>Laboratory tests should be carried out in accordance with HA74, TRL 447, BS 1377 and BS 1924 Pt 2. All British or European standards applicable to a particular soil test method should be followed. Results and data from phase 2 testing should be available.</p>	Data from phase 2 regarding the treatment process should be monitored and recorded. Site-specific details of pulverisation, treatment depth, binder addition accuracy and compaction should be measured and recorded. Samples for testing to confirm phase 2 design compliance should be taken.	All measurements and test results are to be recorded in writing and cross-referenced to the batch of soil treated. These should be discussed with the engineer as early as possible to confirm the results of the site work against the phase 2 design and specification.	<p>The testing organisation may be an independent body or part of the service provided by the stabilisation contractor. The engineer should ensure that all the data relating to the performance of the site treated soil is compatible with the phase 2 testing and treated soil specification. This should be assessed at an early stage. Full compaction of the treated soil is particularly important.</p>
<p>Transfer of design information to site</p> <p>The effective transfer of design information to the site staff to ensure the specified treatment is achieved.</p>	Stabilisation contractor.	The ability to compile detailed information and instructions to guide the site staff in the correct treatment process.	Compliance with an agreed and audited QA system or standard company forms including all necessary information.	Details of the transfer of information should be available to the engineer and client.	Written records of the data transfer sheets should be included in the site file.	<p>This process has to be carried out thoroughly to ensure the knowledge gained from phases 1 and 2 are handed down to the site staff. Detailed written instructions for the site staff about the required treatment process are essential.</p>

PHASE 5	Site control and testing					
ACTIVITY/PURPOSE	RESPONSIBLE ORGANISATION	NECESSARY COMPETENCE	RELEVANT STANDARD/ LEVEL OF EXPERTISE	MONITORING SYSTEM	RECORD SYSTEM	COMMENTS
<p>Monitoring site control parameters</p> <p>Monitoring of binder addition, treatment thickness, pulverisation, MCV, compaction and factors listed in HA specifications plus other factors determined in phase 1 & 2 investigations.</p>	Stabilisation contractor or testing organisation.	Technicians should possess appropriate training or qualifications and be experienced in the testing of treated soils.	Third party accreditation e.g. UKAS, BSI or MCERT	Comparisons should be made between the parameters determined during the phase 1 & 2 investigations and those being generated during construction. Minimum deviation should be achieved to ensure the design requirements are met.	All site tests should be recorded in writing and presented to the engineer or client within 2 working days.	Detailed monitoring of the design parameters determined in phases 1 and 2 is essential to ensure the design strengths are achieved. In addition, the MCV at compaction and the full compaction of the treated layer are an imperative. For multi-layer systems the level and depth of each layer should be recorded.
<p>Monitoring laboratory-derived parameters</p> <p>Some soil properties such as swelling, lab CBRs, accelerated curing and triaxial testing are monitored in the laboratory. Soil samples need to be taken during site treatment for this purpose.</p>	Stabilisation contractor or testing organisation.	Technicians should possess appropriate training or qualifications and be experienced in the testing of treated soils. The correct sampling and storage procedures should be observed.	Third party accreditation e.g. UKAS, BSI or MCERT	Comparisons should be made between the parameters determined during the phase 1 & 2 investigations and those being generated during construction. Minimum deviation should be achieved to ensure the design requirements are met. Certain maximum or minimum standards may be applicable from national specifications.	All tests should be recorded in writing and presented to the engineer or client as soon as possible. Progress on some tests, i.e. swelling, can be communicated as they progress. Details of the location from which the samples are taken need to be recorded.	Detailed monitoring of the design parameters determined in phases 1 and 2 are essential to ensure the design strengths are achieved. Long-term test results need to be reviewed regularly as considerable progress can occur between sampling and test results.
<p>Protection of treated material</p> <p>Care needs to be taken to treat the finished area correctly to avoid damage by traffic or weather.</p>	Stabilisation contractor and client	The stabilisation contractor needs to advise the client of the correct treatment of the completed area and whether any curing period is required.	As specified by the stabilisation contractor or in the appropriate specification.			Treated soils can be damaged by inappropriate use after completion. It is very important to follow the correct trafficking and curing regimes.



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