

GUIDANCE ON THE SCHEDULING OF GEOTECHNICAL TESTS

INTRODUCTION

This information sheet is designed by Soil Mechanics as an aid to scheduling BS1377 laboratory testing. The information contained within is primarily, but not exclusively, sourced from BS1377, but is in no way intended to substitute for the standard. The information sheet will suit most situations, but if there is any doubt, then BS1377 or the laboratory should be consulted.

TESTING COMPLICATIONS

This aid will hopefully reduce the most common testing complications which include:

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| 1) INSUFFICIENT INFORMATION : | e.g. no hydraulic gradient information on a scheduled permeability or illegible sample labels. |
| 2) MISMATCHED INFORMATION: | e.g. sample labels not matching the schedule information. |
| 3) MISSING SAMPLES: | e.g. samples not supplied to the laboratory or incorrect/inadequate labelling for identification |
| 4) UNSUITABLE SAMPLE: | e.g. a liquid limit test on a gravel. |
| 5) INSUFFICIENT SAMPLE: | e.g. a compaction test on a tub sample or too many tests scheduled on a tub. |

TEST SCHEDULE ACKNOWLEDGEMENT/QUERY FORM

Schedules are checked upon receipt for compatibility, feasibility, completion and fitness for delegation to laboratory staff. In all cases the laboratory will complete and return a form showing the status as Acknowledged (no problems identified) or Queried (clarification is required). In the latter scenario the queries will be detailed allowing an item by item response. Until receipt of an acknowledgement the persons scheduling the tests should not presume that any testing can be progressed on that particular schedule, therefore, rapid response is imperative.

TEST RESTRICTION SHEETS

In the event of any complications (e.g. insufficient sample) arising during the testing stage, a "Test Restriction Sheet" will be generated identifying the testing issue(s) which need to be addressed with suggestions/information where appropriate. It is essential that these are returned expeditiously with clear, positive, actions to deal with the problems including any cancellation of tests. Delays disrupt the flow of testing through the laboratory and can lead to subsequent delays in reporting.

BASIC PRINCIPLES (see overleaf for full details)

- 1) INDEX AND CHEMICAL TESTS
These generally use fine material - if the sample is gravelly, then a bulk sample may be needed.
Very little extra information is required when scheduling, other than dependent options for some chemical tests.
- 2) COMPACTION RELATED TESTS
These generally use a lot of material less than 20mm - a large bulk sample is usually needed.
Occasionally, if the sample contains a lot of coarse gravel, or is susceptible to crushing, then two bulk samples are required.
Very little extra information is required when scheduling.
- 3) CONSOLIDATION, PERMEABILITY AND SHEAR STRENGTH TESTS
These generally use a sample which is undisturbed or recompacted (* see below).
Extra information is always required when scheduling.
- 4) CHALK TESTS
These generally require lumps of chalk.
No extra information is required when scheduling.

MATERIAL TYPES (BS1377)

- Fine grained : Soils containing not more than 10% retained on a 2mm test sieve.
 Medium grained : Soils containing more than 10% retained on a 2mm test sieve, but not more than 10% retained on a 20mm test sieve.
 Coarse grained : Soils containing more than 10% retained on a 20mm test sieve, but not more than 10% retained on a 37.5mm test sieve.

NOTE : Soils with more than 10% of material retained on a 37.5mm test sieve cannot usefully be examined by the BS 1377:1990 laboratory tests without engineering consideration of practicality and the effect on test results, e.g. if more than 10% of material is retained on a 63mm sieve during a particle size distribution test, then at least 50kg is required to make it representative; compaction tests using <70% of the whole sample may be too unrepresentative.

At a glance:	Material Type	Fine (F)	Medium (M)	Coarse (C)
	Grading	<2mm	2-20mm	20-37.5mm
	Includes	Clay, silt, sand.	Fine and medium gravel.	Coarse gravel.

SAMPLE MASSES

Approximate mass of usable sample per container when full.

Tubs (0.5 Litre)	1kg	Bulk bags	25kg
Tubs (1.0 Litre)	2kg	U100, 450mm long	6kg

*UNDISTURBED SPECIMENS OR SPECIMENS RECOMPACTED FROM DISTURBED SAMPLES.

For specimens that are recompacted from disturbed samples, the moisture content and *either* the compactive effort (2.5/4.5kg effort) *or* a specified bulk or dry density are needed. When preparing undisturbed specimens some material will be removed, so always provide extra sample, e.g. when preparing from a U100 tube for a consolidation test, the height needs to be 25mm plus at least 10mm either end (45mm total).

OTHER CONSIDERATIONS

If the sample is unsuitable in its natural state, then other specific engineering options may be included, e.g. break down oversize material and include in test; if too gravelly for triaxial test replace with PSD. Where possible such options are better defined before testing rather than after the sample has undergone a degree of preparation which could adversely affect the replacement test.



Type	TEST NAME	Mass required based on			TEST COMMENTS	SCHEDULING COMMENTS
		F	M	C		
Index Tests	Moisture content	50g	350g	4kg	In the specific case of 'natural moisture content' the term 'natural' is regarded as the condition of the material on receipt by the laboratory, unless specifically known to the contrary. As such this does not automatically infer any relationship to the in-situ condition. Moisture content is regarded as water content and the default drying temperature is 105-110°C.	-
	Atterberg Limits (LL/PL)	500g	1kg	2kg	Only the sample passing a 425micron sieve is used. Four point liquid limit will be performed unless scheduled otherwise or sample is only sufficient for one point test.	Standard test does NOT include natural moisture content, schedule separately
	Density (Linear)	500g	1kg	2kg	Requires specimen as rectangular prism (block) or right cylinder (tube). 'Natural' bulk/dry density should only be determined from undisturbed samples.	Ensure undisturbed samples scheduled or specify method for testing disturbed
	Particle Size Distribution (PSD)	150g	3kg	17kg	Wet sieve analysis will be performed unless dry test is scheduled. Wherever possible cohesive soils are tested without pre-drying. Sedimentation can be scheduled alone (fine soils), omitted, specifically required or a dependent option (% passing 63um from sieving).	Specify hydrometer or pipette and the percentage passing the 63 micron sieve at which a sedimentation should be performed.
	Particle Density (Small pyknometer)	100g	100g	-	Definitive method for samples with particle sizes up to 2mm, but coarser material can be crushed for inclusion if appropriate. Most appropriate method for use in calculations for tests using small specimens, eg Oedometer consolidation.	-
	Particle Density (Gas Jar)	1kg	2kg	4kg	Suitable for samples with particle sizes up to and including coarse sized gravel. Some larger gravel can be crushed for use in the test. May be more applicable to tests using large particle sizes such as compactions in CBR mould (for air voids).	-
Strength Tests	Undrained unconsolidated triaxial (UU)	6kg	6kg	12kg	Undisturbed or recompacted* specimen(s). Cylinder nominally 2:1 height:diameter ratio tested as single, multistage or multiple specimens. Maximum particle size 20mm (ideally not >2mm for 38mm specimens). For a suite of tests the quantities need to be multiplied by the number of tests (3 x 38mm normally taken from same plane in U100).	Specimen diameter, recompaction or remoulding details (if required). Cell confining pressure (x3 for a suite or multistage).
	Consolidated undrained triaxial (CU)	6kg	6kg	12kg	As for UU plus: Side drains are normally fitted unless material type or test schedule precludes this. (Vertical drains unless spiral specified). Saturation can be by incremental cell and back pressure or at constant moisture content (cell pressure only). Consolidation can be undertaken with various drainage conditions but normally to top with pore pressure measured at centre base. Failure criteria are peak deviator stress (CU/CD), peak stress ratio (CU), constant shear stress and pore pressure (CU), constant shear stress and volume (CD).	Specimen diameter, recompaction or remoulding details (if required). Effective cell pressure (x3 for a suite or multistage). Method of saturation (default - back pressure). Failure criterion (defaults - peak deviator stress for single stage, peak stress ratio for multistage CU).
	Consolidated drained triaxial (CD)	6kg	6kg	12kg		
	Laboratory Vane	100mm diameter >100mm long			Soft to firm cohesive samples only. BS1377 Laboratory vane is more accurate and more expensive than hand held methods.	Make sure to differentiate from hand held : Pilcon, Torvane, Geonore etc
	Small shearbox	1kg	2kg	10kg	Undisturbed specimen or recompacted* from disturbed samples or loosely poured cohesionless soils. Small shearbox has maximum particle size 2mm in a 60 or 100mm square box with height 20-25mm. Large shearbox has maximum particle size 20mm (sometimes extended to 37.5mm) in a nominally 300mm square box with height up to 150mm. Specifications allow for tests in inundated or dry box conditions dependent upon engineering considerations. For samples which are susceptible to crushing then the quantities need to be multiplied by the number of sets to be tested. Shearing rates are based on consolidation parameters derived in test.	Specimen size, recompaction / remoulding details (if required). Normal stresses (usually set of 3). Peak only or peak and residual strengths. Inundated or dry box. Any specific requirements, eg reversal method.
	Large shearbox	35kg	35kg	35kg		
	Ring shear	500g	N/A	N/A	Only the sample passing a 1.18mm sieve is used, remoulded into a 100mm outer x 70 mm inner annulus, 5mm thick. Undisturbed specimens are not a realistic option. Specimen mass is of the order of 40g. Test is essentially multistage with normally 3 to 5 increments of normal stress. 'Ultimate' residual angle of shearing resistance is determined on the assumption that c'r = 0.	The test moisture content. The normal stresses required.
Compaction Related Tests	California bearing ratio (CBR)	6kg	6kg	12kg	Only the sample passing a 20mm sieve is used (may not be appropriate if retained >25%). Can be carried out on either a recompacted* specimen or an undisturbed sample recovered in a CBR mould. Normally a surcharge of up to 10kPa (~ 16kg) can be applied.	Recompaction details, surcharge, soaked or not, and whether one or both ends to be tested.
	Compaction (Heavy/4.5kg)	10kg	25kg	50kg	Only sample passing a 20mm sieve is used in a litre mould or 37.5mm in a CBR (approx 2.3L) mould but may not be appropriate if >30% larger than 20mm. Only material below 20mm can be used if a CBR test is to be performed. For samples which are susceptible to crushing these quantities need to be at least doubled. Vibrating hammer test normally applicable only to non-cohesive materials. Unless a particle density test is scheduled, an assumed or assessed value is used for air voids calculations (usually 2.65 Mg/m ³).	Ensure sufficient usable material by amalgamating samples if necessary. Bults from boreholes may be quite small. If more than one test type is scheduled on same sample, eg 2.5kg and 4.5kg, the laboratory will create separate specimens for reporting of the tests and AGS data.
	Compaction (Light/2.5kg)	10kg	25kg	50kg		
	Compaction (Vibrating hammer)	50kg	50kg	50kg		
	Max & Min Density	6kg	16kg	30kg	Only suitable for samples with less than 10% clay/silt and at least 90% passing a 37.5mm sieve. Two methods available for each parameter, appropriate method normally selected by laboratory on basis of material grading.	-
	MCV (relationship)	6kg	6kg	12kg	Only sample passing a 20mm sieve is used. For samples which are susceptible to crushing (may be inappropriate) these quantities need to be doubled. Standard test normally comprises a range of four moisture contents to obtain moisture content / MCV relationship.	Method of interpretation, best fit or steepest line, as a general instruction for the contract consistent with proposed site method.
	MCV (one point)	3kg	3kg	6kg	Only material passing 20mm is used. Test is normally carried out at natural (as received) moisture content.	As above, both use steepest line as default.
Consolidation	Oedometer Consolidation	500g	1kg	2kg	Undisturbed or recompacted* specimen. Maximum particle size 4mm. Nominally 75mm diameter, 20mm high, tests up to 3200kPa. For tests on highly compressible materials (eg peat) it may be prudent to schedule less stages but to extend specific stage(s) to monitor secondary consolidation behaviour, Cv being replaced by Csec.	Recompaction or remoulding details (if required). Loading sequence (usually 4-6 pressures). Swelling pressure prior to test, if required.
	Hydraulic Cell (Rowe)	500g	1kg	2kg	Undisturbed or recompacted* specimen. Maximum particle size 5mm in a 75mm or 100mm diameter x 25 to 30mm high cell. Cells of other sizes, 150mm and 250mm, are available but may require special sampling techniques if undisturbed specimens to be tested. For saturation and details of drainage conditions, see BS1377 Part 6 and/or consult the laboratory.	Recompaction or remoulding details (if required). Saturation method and drainage conditions. Loading sequence (usually 4-6 pressures).
Permeability Tests	Falling Head Permeability	5 kg	8 kg	12kg	Undisturbed or recompacted specimen. Nominally 100mm diameter x 130mm high. Maximum particle size 20mm. Test not covered by BS1377 but is detailed in K.H. Head Manual of soil laboratory testing. Best suited to range between 10 ⁻⁵ and 10 ⁻⁹ m/s. Saturation can be difficult.	Recompaction or remoulding details (if required).
	Triaxial Permeability	4kg	6kg	10kg	Undisturbed or recompacted specimen. Cylinder normally 100mm diameter x 100mm high but other sizes can be tested. Maximum particle size nominally 10mm. Can be BS1377 Part 6 method or Accelerated method to Environment Agency specification P1-398 (some materials may not be suited to the latter). Suited to range between 10 ⁻⁵ and 10 ⁻¹¹ m/s but >10 ⁻⁷ m/s may require correction for calibrated pipeline losses. Ensure flow in and flow out are to be measured/reported.	Recompaction or remoulding details (if required). Test type (default BS1377). Effective consolidation pressure. Hydraulic gradient or differential pressure
	Constant Head Permeability, (granular soils)	10kg	10kg	20kg	Prepared from disturbed samples. Largest commercially available cell is 115mm diameter. Maximum particle size 10mm. Only suitable for samples with less than 10% clay/silt. Suited to range 10 ⁻² to 10 ⁻⁵ m/s. Recompaction to specified density is of limited accuracy due to arrangement of cell. Falling head test can be used as a quick check if hydraulic gradient cannot be established for lower range materials.	Specify preparation density and/or method, eg loose or dense or medium dense hand tamped or loosely poured underwater
Chemical Tests	pH and Sulphate	150g	600g	4kg	All sample except gravel greater than 2mm is crushed and used, although gypsum larger than 2mm is representatively crushed and included. Always check expression of results and units used (normally SO4 in % or g/L from geotechnical lab). Other, possibly non-BS1377, testing may also be required to determine aggressivity to concrete (see BRE SD1).	Specify Acid or Water soluble extract Any dependent options, eg nitrate, magnesium etc (not covered by BS1377)
	Carbonate Content	50g	200g	2kg	All sample except gravel greater than 2mm is crushed and used (the only exception to this is the carbonate test where all sample is crushed and used).	-
	Water Soluble Chloride	750g	2kg	4kg	LOI is normally used for peat and other organic soils with more than 10% organic material. For some soils not all loss on ignition is necessarily organic content.	-
	Loss on ignition (LOI)	150g	600g	4kg	Organic content (dichromate oxidation) is normally used for finely disseminated organic material up to about 28% by mass.	-
	Organic Matter Content	150g	600g	4kg		-
Chalk	Crushing Value	-	2kg	4kg	Only chalk (no flint) retained on a 10mm sieve can be used. Material graded to 10-20mm for test with lumps larger than 20mm broken to size.	-
	Carbonate Content	50g	200g	2kg	Results reported as % CO ₂ . For chalk content (CaCO ₃) multiply CO ₂ by 2.275. For pure chalk maximum CO ₂ content = 44% (100% CaCO ₃).	-
	Saturation MC	A large fist sized lump or bigger			Bulk density and moisture content determined. Saturation moisture content calculated from derived dry density assuming particle density of chalk to be 2.70 Mg/m ³ .	-