METHOD STATEMENT FOR DRILLING & SAMPLING WITH ARCHWAY COMPETITOR RIG

General

The Competitor is designed to sink boreholes up to 130 mm diameter through soils and weak rock, including clays, silts, sands, gravels and chalk. The rig is primarily used for shallow site investigations to a maximum depth of 10 metres, and for carrying out in-situ tests (SPT and DP) to a maximum depth of 15 metres. In practice, the actual depth achieved is dependent on local ground conditions.

The rig consists essentially of a mechanized drop-weight that repeatedly falls onto an anvil, driving attached sample tubes or probe rods into the ground. The method can therefore be classified as a form of **drive sampling** in which a tube or split tube sampler having a sharp cutting edge at its lower end is forced into the ground by dynamic impact (BS 5930: 1981)**.**

After driving samplers to the required depth, they can be simply extracted using an integral hydraulic ram on the rig. No separate jacking system is required.

Soil samples obtained by this method can be classified as either disturbed, or undisturbed, depending on the type of sampling apparatus used in conjunction with the rig (see below for characteristics of compatible sampling apparatus).

Although the rig operates primarily as a soil sampling tool, the Competitor is also capable of conducting Standard Penetration Tests (SPT and SPT(C)) and Dynamic Probing (DP), to BS 1377: Part 9: 1990. The drop weight and drop height can be adjusted on the Competitor to suit either test.

The rig has the facility to drive casing into the ground, simultaneously with a soil sample tube. Using this system means that any overburden/loose ground can be sampled without hole collapse, ensuring that successive samples are accurate from the depth taken. This system also allows for the easy installation of standpipes, gas monitoring tubes or other instrumentation, within the restrictions of the borehole diameter.

The Competitor can be used in conjunction with a concrete core drill fastened to the anvil at the base of the rig. This enables hard surfaces to be cored prior to sampling or testing the ground underneath. There is however no facility for rotary coring of the sub-surface at depths greater than 1 metre BGL.

The Competitor method has been found to be significantly more efficient than Cable Percussion Boring in situations where several shallow boreholes (<10 m. depth) are required. The rig can be mobilized rapidly between different borehole locations and there is virtually no set up time. Under favourable conditions 30 metres of borehole sampling can be achieved during one 8-hour shift.

The method is ideally suited for restricted access and limited-headroom work. The rig can pass through a domestic doorway and work inside a building with a minimum headroom of 2750 mm. The rig is adept at sampling on slopes and embankments up to 20 degrees. However, the method is limited in the depth and diameter of sampling that is possible. The maximum borehole diameter produced by the Competitor is 130 mm, and the maximum sample diameter is 100 mm, reducing as the borehole becomes deeper.

Sampling Procedure

A) The Operator when working as a sub-contractor shall communicate with the Engineer/Client prior to visiting the site to determine the nature and scope of the work required. The Operator shall ascertain the nature and location of any risk and the level of precautions recommended for safe site work. The Operator shall also ascertain whether the Engineer/Client is providing any special measures to prevent or adequately control exposure to contamination, e.g. portable hygiene facility, disposable clothing etc. Communications should be in writing, and shall be incorporated into the contract documentation at the specification and procurement stage of the project.

B) The locations to be drilled are to be shown on a site plan or as indicated by the Engineer/Client. Such locations are to be clearly agreed and marked out on site before proceeding.

C) At each borehole position the Operator shall test the ground for buried cables using a CAT or similar device prior to drilling. If any doubt exists concerning the safety of drilling at a particular location, a trial pit shall be dug by hand or an alternative borehole position shall be agreed in consultation with the Engineer/Client.

D) The sampling rig is moved into position over the prospective borehole. Stabilizing legs are fitted to the base of the rig and secured by locking pins. The rig is then jacked level to ensure maximum stability during the sampling procedure. Using the rig hydraulics, the sliding carriage is raised and the sample tube is screwed onto the anvil adaptor. The carriage is then lowered until the cutting edge of the sampling tube rests on the ground surface. The hydraulic cylinder is lowered and the drop-weight is activated, driving the sampler into the ground. Once the sampling tube has been driven to its full length, the hydraulic cylinder is activated pulling the sample tube from the ground.

E) Sampling proceeds to greater depths by successively adding drill rods between the sample tube and the anvil adaptor, repeating the procedure described in (D) above. In order to reduce any tendency of the sampler tubes to stick within the borehole, the diameter of the sample tube used may be decreased as the borehole becomes deeper. A succession of sample tubes in reducing diameters may be used to obtain the full depth of the hole.

F) Sampling shall continue until the depth required by the Engineer/Client is reached, or until a "refusal" occurs, whichever occurs first. A refusal is defined as occurring when penetration of the sample tube ceases, or is barely perceptible. When penetration stops, the drop weight may be observed to "bounce" on the anvil and at this point drilling must cease immediately in order to prevent mechanical damage to the rig. If requested by the Engineer/Client the depth at which a refusal occurs may be confirmed by carrying out a Standard Penetration Test (see below)

G) Care must be taken when withdrawing sample tubes from the ground as the mast of the rig is not designed to withstand full cylinder force at the travel extremes of the carriage. Once the sample tube is clear of the ground, the hydraulics must be made safe before the sample tube is unscrewed and the sample extracted.

H) The preparation for and methods of taking samples, together with their size, preservation and handling will be in accordance with British Standard BS 5930: 1981 - Code of Practice for Site Investigation, and the Contract Documents.

I) Samples will be labelled both inside and out with the project name, project number, hole number and depth of top of the sample. All samples will be protected from temperatures below 5 and above 25 degrees Celsius, and from wetting or drying out due to weather exposure.

Sampling Apparatus

A) The sampling apparatus shall be selected on the basis of the quality of the sample that is required, and should be assessed largely by the suitability of the sample for appropriate laboratory tests, in accordance with BS 5930: 1981. The appropriate apparatus should be selected in close consultation with the Engineer/Client.

B) A **Window Sampler** consists of a steel tube incorporating a longitudinal slot or "window" along one side, through which a soil sample can be removed. Typically, such tubes range in diameter from nominal 90 mm to the smallest diameter nominal 40 mm. The tube may be chamfered at its lower end to form a cutting edge, or provided with a heavy-duty cutting shoe. The sample tubes have an area ratio ranging from 24% for the largest diameter tubes to 64% for the smallest diameter tubes. The soil profile obtained by this method can be visually examined and photographed if necessary. Pocket penetrometer tests can be carried out on the sample through the open window of the tube. In the process of removing a sample from the tube, the soil becomes highly disturbed and can only be regarded as a Class 3 sample as defined by BS 5930: 1981. Therefore the samples obtained are only suitable for classification, determination of moisture content or for contaminant analysis. In geo-environmental investigations care must be taken to thoroughly clean out the tubes between successive uses, to prevent cross-contamination of samples. This can be problematic on sensitive sites where use of a jet wash or steam cleaner may cause unacceptable disturbance.

C) A **Windowless Sampler** is very similar in principle to a Window Sampler (see B, above) but in this case the sample tube lacks a window, and incorporates a plastic liner that retains the sample. The plastic liner greatly facilitates handling, presentation and preservation of the soil sample and enables a complete ground profile to be presented to the Engineer/Client for subsequent analysis. Windowless Samplers range in diameter from nominal 100 mm down to nominal 50 mm. The area ratio of a Windowless Sampler is somewhat greater than a Window Sampler of the same diameter, due to the presence of the plastic liner and the thicker cutting shoe required to retain it. Soil samples are disturbed by driving process and can be regarded as Class 3 samples. The major advantage of using Windowless Samplers is that the plastic liner greatly reduces the possibility of cross-contamination between successive samples. This is the preferred method of sampling in geo-environmental investigations.

D) A **Shelby Tube Sampler** (or Thin-walled Sampler) is used for soils that are particularly sensitive to sampling disturbance, and consists of a thin-walled steel tube with a chamfered cutting edge. Samples of nominal diameter 75 mm or 100 mm are generally obtained and the area ratio is about 10%. These samplers are suitable only for fine soils up to a firm consistency, and free from large particles. They generally give Class 1 samples in all fine cohesive soils, including sensitive clays. It is to be noted that disturbance at the base of the borehole will occur in weak soil below a certain depth due to stress relief. Shelby tubes that penetrate well below the base of the borehole are therefore preferable, but in practice tube length is restricted by the weight of sample that can be retained successfully during extraction of the sampler.

E) **U100 Samplers** can be used in all cohesive soils and in weak rock, such as chalk, producing a nominal 100 mm diameter sample. In non-sensitive, fine cohesive soils the equipment may give Class 1, or more likely Class 2 samples. In brittle or closely fissured materials such as weak rock, hard clay and stoney materials the sampler gives Class 3 samples. The design of the sampler to be used in conjunction with the Competitor rig consists of a 115 mm OD sample barrel, enclosing a thin aluminium liner with an internal diameter of 101.6 mm. A cutting shoe screws onto the base of the sample barrel and retains the aluminium liner. The area ratio is 29.5%. The sample barrel may be driven into the ground concurrently with, but slightly in advance of a 128 mm OD casing tube. This prevents the borehole from collapsing during extraction of the sampler. Once the upper section of the borehole has been stabilized, the U100 can be driven below the casing to the required depth. Sample recovery can be improved by inserting a core catcher between the cutting shoe and the sample barrel, but when using the core catcher sample quality is unlikely to be better than Class 3. The aluminium liner containing soil sample can be removed directly from the sample barrel, and can be provided with plastic end caps. To enable extrusion of the recovered sample using a standard laboratory universal extruder, the aluminium liner is designed to fit neatly inside a standard steel U100 sample tube.

Standard Penetration Test

A) The Standard Penetration Test (SPT) shall be carried out as per BS 1377: 1990

B) The SPT Assembly shall be lowered to the base of the hole and then any penetration due to self-weight shall be recorded.

C) The test involves the driving of a standard sampler tool a distance of 450 mm into the bottom of a borehole using the standard weight of 63.5kg falling through 760 mm.

D) During the test, the number of blows for two increments of 75 mm, or the penetration of the tool after 25 blows will be recorded as the "seating drive". The seating drive will be terminated after 150 mm penetration or 25 blows, whichever is reached first and the test drive will then be started.

E) After the seating drive, the number of blows required for each of four increments of 75 mm penetration will be recorded as the test drive. The test drive will be terminated after 300 mm penetration or a total of 50 blows, whichever is reached first. In the case of weak rocks, a total of 100 blows for a test drive will be recorded. If the full penetration is not obtained then the number of blows and actual penetration for the increments will be recorded.

F) A small disturbed sample from the split spoon sampler will be taken, or a bulk disturbed sample of soil in the zone of the test if no split spoon sample is available.

G) The details of the SPT will be recorded on the borehole log. The size and depth of the casing and depth of water will be recorded.

H) The test can also be conducted in gravels or gravelly sand in which case the open drive shoe may be replaced by a solid 60 degree cone, but when this is used the result should be reported separately from the standard test using the open drive shoe, and with the preface SPT(C).

Dynamic Probing

A) Dynamic Probing Test (DP) shall be carried out as per BS 1377: 1990

B) The test involves driving a solid steel or cast iron 90 degree cone into the bottom of the borehole. The cone is driven at a rate of between 15 to 30 blows per minute and the number of blows is recorded for each 100 mm increment iof penetration

C) Heavy Dynamic Probing (DPH) involves the use of a cone 43.7 mm in diameter, driven by a weight of 50 kg falling through 500 mm. Super Heavy Dynamic Probing (DPSH) involves the use of a cone 50.5 mm diameter driven by a weight of 63.5 kg falling through 760 mm.

D) The diameter of the driving rods shall not exceed 35 mm and their mass shall not exceed 6 kg/metre.

E) Driving shall be done continuously as far as this is practicable. Any interruptions which are longer than 5 min. shall be recorded in the borehole log.

F) A torque measuring wrench shall be used to rotate the extension rods at a rate of 1.5 turns every metre in order to observe the friction and to record the maximum torque required to rotate the rods at each test level.

G) The test report shall conform to the requirements of clause 3.2.5 in BS 1377: Part 1 : 1990.

Installations

On completion of the borehole, either standpipes or monitoring wells can be installed. The installation usually consists of an open-ended tube, perforated near the base, which is inserted into the borehole to allow the monitoring of water and/or gas. Spoil, gravel or bentonite is backfilled around the tube. A lockable cover may be installed at the top of the borehole if so requested by the Engineer/Client.

Reinstatement

A) On completion of the work, the boreholes may be backfilled with arisings or reinstated with imported material, usually gravel.

B) If the borehole is to have instrumentation installed then this will be to the instructions of the Engineer/Client.

C) Backfilling will be carried out sensibly in layers, and each borehole will be properly reinstated so that no depression is left. The surrounding areas will be reasonably clean and clear of any debris.

D) Any tracks, paths, fences etc. used for access will be reinstated and all spoil will be removed in a workman-like manner.