UNIVERSITY OF KWAZULU-NATAL	*Standard Operating Procedure* PRG pollution research group	**Effective Date:** 20 June 2013	**Version:** ***002***
		Reviewed: 1 Nov 2017	
SOP_MP_07 Mechanical Properties_ Penetrometer Testing			Page #: ***1 of 4***

Standard Operation Procedure – Penetrometer Use for Testing of Faecal Sludge

1. Introduction

- Semi-Automatic Cone Penetrometer is used to carry out penetration tests that will be used to calculate shear stress.
- Penetration tests are performed on products e.g. petroleum and the civil engineering industries to determine consistency and shear stability of lubricating greases or soil for design and quality control purposes.
- The test is based on the measurement of penetration into the soil/ sludge sample of a standardised cone of specified mass.

2. Scope and Application

- Faecal sludge samples are obtained from different sources like: **(i)** mixed excreta samples from community ablution blocks and **(ii)** mixed excreta samples from household urine diversion toilets.
- Characterisation of the rheology (flow properties) of samples is necessary for the accurate design of new toilet systems.
- Human excreta can potentially host significant levels of pathogens, and as such is classified as a biologically hazardous material.
- Suitable precautions must be taken when handling samples.

3. Apparatus

- Cone penetrometer with standard cone of mass 50 grams.
- Sample cup of diameter 40 mm and 55 mm deep.
- A stop clock or stopwatch readable to 1 second.
- Two palette knives or spatulas.

4. Materials & Equipment Required

- Metal trays (preferably non-stick).
- Paper sheets for cleaning faeces, equipment and general cleaning.
- Laboratory spoons for loading the penetrometer cup with the sample.
- Rubber spatula to scrape any sample out of a cup.
- A knife or flat sharp object to scrape excess material over the cup.
- Brushes for washing instruments after use.
- 70% ethanol for disinfection of equipment, splashes and spills.

5. Safety Precautions

General

The following general safety precautions should be taken:

- Cover any small open wounds with waterproof dressings. If wounds are large or open, do not carry out laboratory work.
- Always use gloves, laboratory coat and closed shoes while working in the laboratory.
- Wear a face-shield when disposing of samples down the sluice (risk of splash back).
- Dispose of samples as specified by the Faeces Sample Disposal SOP.
- Clean all soiled equipment thoroughly after use.
- Any equipment that will be taken out of the laboratory into a 'clean' environment (e.g. camera) should be handled only with clean gloves and disinfected using 70% ethanol spray after use.
- Dispose of the used gloves in the appropriate waste bin after sample handling and disposal and cleaning of equipment is complete.
- Clean hands using antiseptic soap.
- Disinfect hands after washing with soap.

Where mixed samples are being handled (i.e. those from field location sources such as community ablution blocks), additional care must be taken as sharps may be present in the faecal matter. Samples should not be handled directly with gloved hands, but rather with a spoon or spatula.

Maintain 'clean' and 'dirty' work areas

The basement laboratory where excreta samples are processed should be considered in its entirety a 'dirty' area, however within this 'clean zones' should be designated for any items that will later be taken out of the laboratory:

- Sample boxes and equipment used to handle samples should only be placed on wipe-clean surfaces - plastic or metal top workbenches or trays.
- Any 'clean' items that will be taken out of the laboratory– e.g. camera and paper forms used to record results– should be kept on a clean tray or segregated clean area of the workbench.

- ‘Clean’ items should only be handled whilst wearing clean gloves.

Specific safety precautions for the penetrometer:

- Use metal trays as the work area for loading the penetrometer cup with the sample and for the placement of tools, which are in direct contact with the sample, in order to prevent any environmental contamination from the sample.
- Use paper sheets and DO NOT place samples directly on any surface.
- Clean and disinfect the equipment after use.

Protective safety equipment must be worn at all time in the lab. Dust masks that prevent smell are essential and must be worn when working with samples.

6. Calibration

7. Procedure

1. Take a sample of about 300g (to fill the cup) from the container.
2. Push a portion of the mixed sludge into the cup with a palette knife taking care not to trap air.
3. Strike off excess soil with the straightedge to give a smooth level surface.
4. With the penetration cone locked in the raised position lower the supporting assembly so that the tip of the cone just touches the surface of the soil. When the cone is in the correct position a slight movement of the cup will just mark the soil surface.
5. Lower the stem of the dial gauge to contact the cone shaft and record the reading of the dial gauge to the nearest 0.1 mm.
6. Release the cone for a period of 5 secs ± 1 sec. If the apparatus is not fitted with an automatic release and locking device take care not to jerk the apparatus during this operation.
7. After locking the cone in position lower the stem of the dial gauge to contact the cone shaft and record the reading of the dial gauge to the nearest 0.1 mm. Record the difference between the beginning and end of the drop as the cone penetration.
8. Lift out the cone and clean it carefully to avoid scratching.
9. Repeat 1 to 5.
10. If the difference between the first and second penetration readings is not more than 0.5 mm record the average of the two penetrations.
11. If the second penetration is more than 0.5 mm and less than 1 mm different from the first, carry out a third test. If the overall range is then not more than 1 mm record the average of the three penetrations. If the overall range is more than 1 mm remove the soil from the cup, remix and repeat 1 to 5 until consistent results are obtained.

Notes:

- Results for fluids with a low viscosity tested at low shear rates, may be inaccurate due to the effects of surface tension (e.g. water).

- Samples can dehydrate over time.
- It is recommended that the cup is covered for long tests (over an hour in duration).
- All tests will be performed at a standard temperature of 25°C.

At the end:

- Dispose of all waste samples according the SOP for faeces sample disposal.
- Clean all apparatus after use.
- Store remaining samples appropriately.
- Update sample database with tests carried out on each sample.

APPROVAL OF STANDARD OPERATING PROCEDURE

PRG Head: Prof C.A. Buckley

Signature: ……

Date: ……

Author: Merlien Reddy

Signature: ……

Date: ……