



**ROUGHTON** INTERNATIONAL

In association with  
THE UNIVERSITY OF BIRMINGHAM  
and  
THE UNIVERSITY OF NOTTINGHAM



# GUIDELINES FOR THE MODIFIED DYNAMIC CONE PENETROMETER APPARATUS







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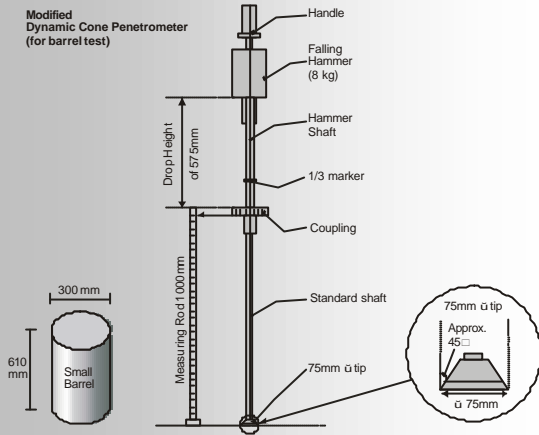
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**GUIDELINES FOR THE  
MODIFIED DYNAMIC CONE  
PENETROMETER APPARATUS**

## GUIDELINES FOR APPLICATION: MODIFIED DYNAMIC CONE PENETROMETER - BARREL TEST TO ASSESS ROAD MATERIALS

- The kit
- The equipment consists of a modified Dynamic Cone Penetrometer (DCP). The modification to the DCP is the addition of a 75mm diameter flat foot and a barrel (small oil drum with a lid).
- Materials which can be tested
- Through the investigations undertaken to date it has been established that the equipment is able to provide an indication of the suitability of various types of material, by comparing the results against a standard chart. However, to date it has only been possible to test a small number of different materials, mainly from two countries (Uganda and Fiji), hence it will be advisable for the equipment to be used with care until more data has been obtained to confirm whether the procedure and results are valid for a wider range of materials.
- It has been noted that the moisture content of the material can have an affect on the results obtained in the barrel. Therefore until further work is undertaken, users should only test materials at a natural moisture content, and preferably 'dry' materials, i.e.: a soil which appears to be dry to the touch.
- Procedure for testing
- The procedure for using the equipment is specified in stages, with diagrams and sample worksheets provided for reference. Due to the amount of data upon which the use of the equipment has been based.
- Staff requirements
- The modified DCP requires ideally three operators, one to raise and drop the weight, one to hold the DCP vertical and one to record the results. However, it would be acceptable for one person to both raise and drop the weight and then record the results. It would obviously slow down the procedure, but as the test is relatively quick to complete, it would be a suitable alternative.



**Figure 1 Modified Dynamic Cone Penetrometer**



**The modified Dynamic Cone Penetrometer being used in a larger barrel during initial field-tests. The large barrel was subsequently swapped for a smaller barrel, to improve ease of use.**

## Overview of the 6 stages of the test

**Stage 1:** Assemble the DCP apparatus and use the 75mm diameter tip provided (refer Figure 1 )

**Stage 2:** Find the material source to be tested and take a representative sample

**Stage 3:** Fill barrel with 200mm of material passing a 20mm sieve and attach the lid. Then roll the barrel to create a standard loose condition for testing.

**Stage 4:** Place the DCP equipment into the barrel and ensure it remains vertical. The 75mm foot should be just resting on the surface of the material and should not be pushed in. However, the tip will penetrate slightly under its own weight, so record the zero reading on form.

**Stage 5:** Undertake the barrel test and record the results. Ensure all results have been recorded, including location, date and material type and then treat the data as shown.

**Stage 6:** Finally plot the cumulative penetration and the number of blows onto the chart provided and ascertain whether the material has potential or not – depending where on the chart the plot appears.

The following tools and apparatus are required to undertake the test:

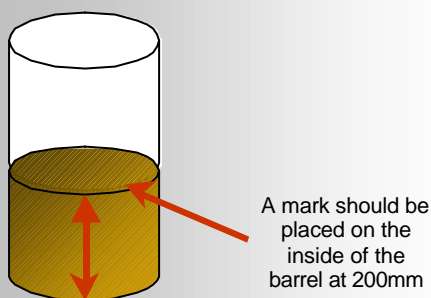
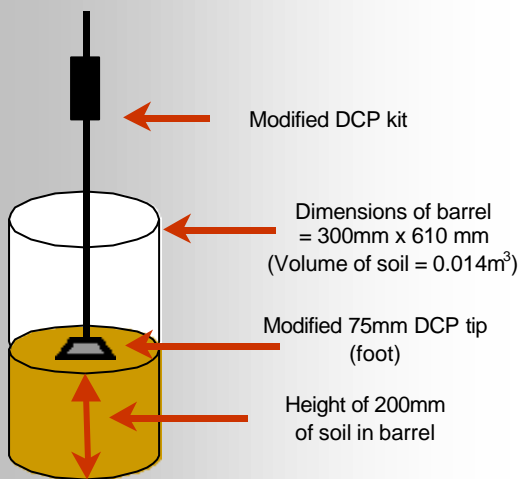
- Modified DCP Apparatus
- Barrel
- Shovel
- Pick Axe
- Sample Bags
- Labels
- Forms for readings
- Writing implements

How do I undertake this type of test?

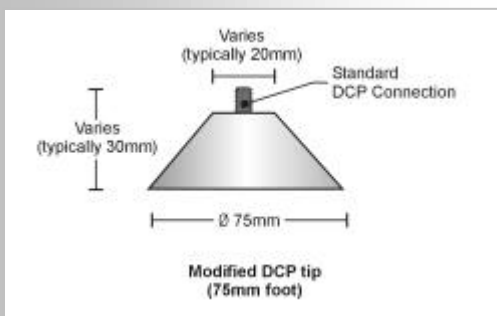


When working on the road - remember to consider the safety of road users and workers, by providing traffic management to prevent accidents.





Photograph of the modified DCP tip (foot)



## ● Stage 1 – Assembly of the DCP

### ● Assembly of the equipment

● The assembly of the DCP is described in the  
 ● Operating instructions for the TRRL dynamic  
 ● cone penetrometer as follows<sup>1</sup>:

● 'The DCP is supplied with two spanners and a  
 ● 'tommy' bar to ensure that the screwed joints  
 ● are kept tight at all times during the testing  
 ● procedure. It is important to check the joints  
 ● during testing to ensure they do not become  
 ● loose. The equipment should be assembled as  
 ● shown in Figure 1'.

● For the testing procedure described here the  
 ● standard tip is removed and replaced with a flat  
 ● tip with dimensions as shown at the bottom of  
 ● this page.

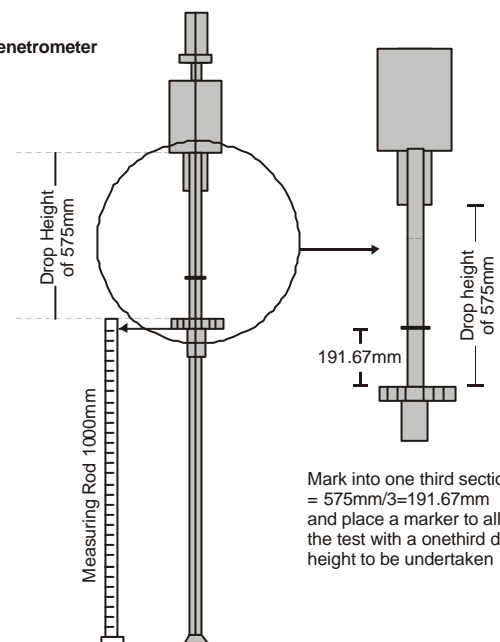
### ● Marking the inside of the barrel

● The inside of the barrel should be marked with a  
 ● line at 200mm to ensure over/ under filling with  
 ● material does not take place.

### ● Marking the hammer shaft into sections

● The standard DCP equipment comes with a  
 ● hammer shaft that provides a standard drop  
 ● height of 575mm. For the modified test it will be  
 ● necessary to mark the shaft into sections, so  
 ● that the test in the barrel may be undertaken  
 ● using 1/3<sup>rd</sup> blows.

Modified Dynamic Cone Penetrometer (for barrel test)





## Stage 2 – The material source

Once the material source has been located in accordance with the advice given in the Field Manual for Borrow Pit Management (produced as part of Element B of the project). The information such as pit location, road name and number, date and material description should be recorded accurately on Form A and also on the borrow pit sampling labels, which should be attached firmly to any sample bags of material taken from the source.

Sampling of material from the borrow pit source should be undertaken so as to ensure a representative sample is obtained for testing.

Approximately 20-30 kg of material is required for the modified DCP test, to ensure the sample is representative. This approximates to 3 or 4 fully loaded shovels of material.

Material used in the DCP test in the barrel, should not subsequently be used for other testing purposes. The material may be slightly broken down during testing.



A larger version of the barrel being used during preliminary testing in Malawi.



<b>SAMPLE No:</b>	99/66	<b>DATE:</b>	11-11-99
<b>SITE:</b>	Mugil Pit, Dharan Road		
<b>SAMPLE LOCATION:</b>	TP2		
<b>DEPTH OF SAMPLE:</b>	1.2m		
<b>LAB TEST REQUIRED:</b>	PI, PSD, CBR and Heavy Compaction,		
<b>DESCRIPTION:</b>	Sandy angular gravel		
<b>No OF BAGS:</b>	1 of 2		





The modified Dynamic Cone Penetrometer being used in a larger barrel during initial field-tests.



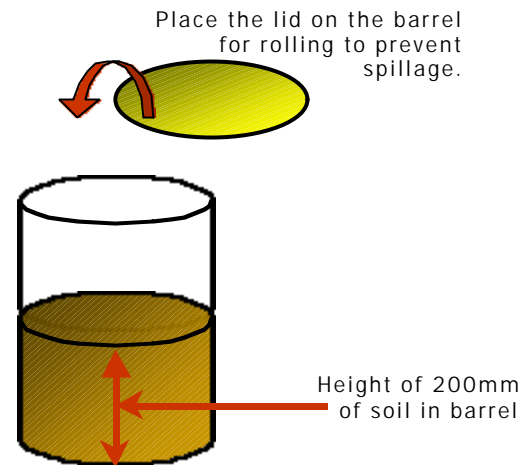
The small barrel being about to be rolled during the initial testing undertaken in Fiji. Notice how much easier the smaller barrel is to handle.



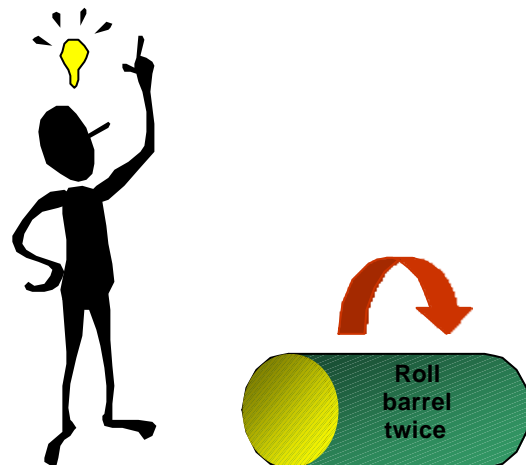
The larger version of the barrel being rolled during the initial testing undertaken in Africa.

### ● Stage 3 Filling & rolling the barrel

- Once the material has been selected, a representative sample should be taken and placed in the barrel to a depth of 200mm. The barrel should be clean and dry to prevent contamination of the sample. The barrel should be cleaned between tests on different materials.



- The lid should be placed on the barrel to prevent the material spilling out while the barrel is turned on its side and rolled 2 revolutions. Rolling ensures the material is in a standard loose condition for testing.



## Stage 4 – Placing the DCP in the barrel

Ensure the barrel is standing on a flat surface

Ensure the DCP equipment remains vertical.

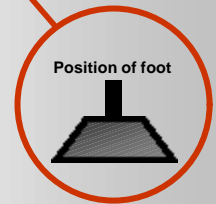
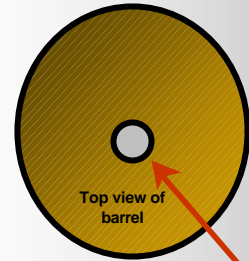
The tip should be resting on the surface of the material in the centre of the barrel and should not be pushed in.

The tip will penetrate slightly under its own weight – but do not push it in.

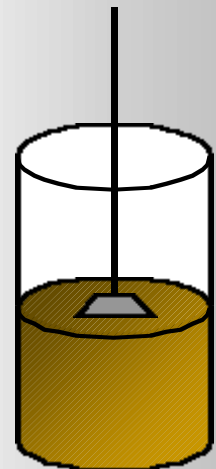
Record the zero reading on Form A.



Place the DCP equipment in the centre of the barrel.

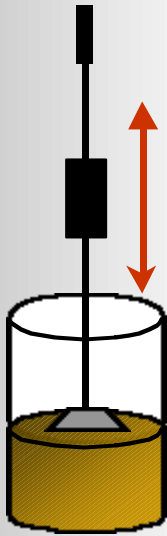


Form A for recording results			
Location of test:	of		Date:
Road Name:	Road No:	Pit Name:	Operator:
Material description:			
Blows	Depth mm		
Zero	50		
1/3			
2/3			
1			





● **Stage 5 – Undertaking the barrel test**



- Each test should be carried out as follows:
- 
- Using 1/3 blows (the apparatus should be marked to show where the hammer should be raised to) raise the hammer to the marker and
- allow it to freely drop (do not lower with hands)
- – then the depth penetrated should be read off the DCP and recorded on Form A.
- 
- The penetration should be recorded after every 1/3 blow of the hammer. Repeat the dropping of the hammer and the recording of the penetration, until the tip is heard to hit the bottom of the barrel, or alternatively, until the penetration ceases.
- 

**Form A for recording barrel test results**

Location of test:		Date:	
Road Name:	Road No:	Pit Name:	Operator:
Material description:			
Test		Cumulative	
Blows	Depth mm	Blows	Depth mm
Zero	50	0	
1/3	75	1/3	
1/3	100	2/3	
1/3	125	1	
1/3	150	1 1/3	
1/3	175	1 2/3	

Write penetration in this column

- 
-

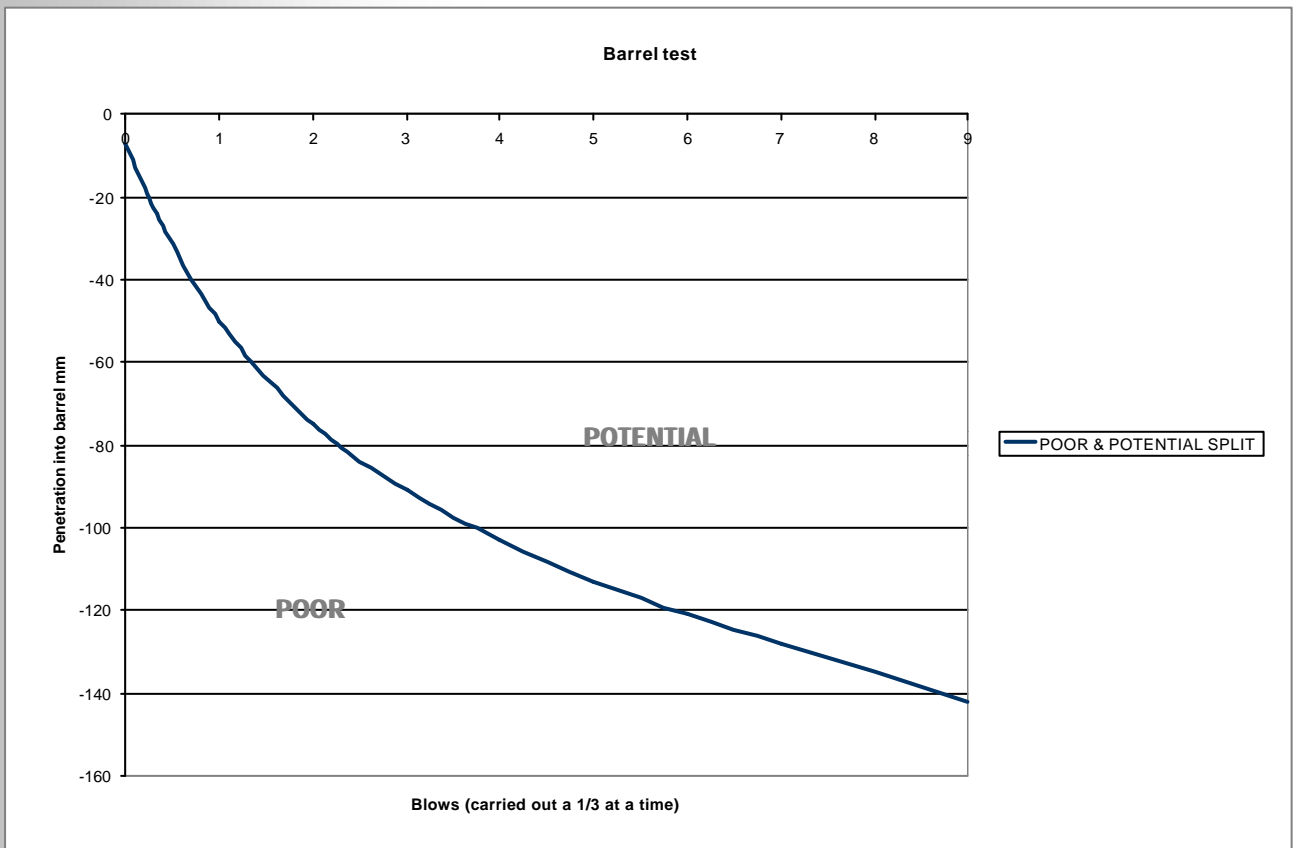
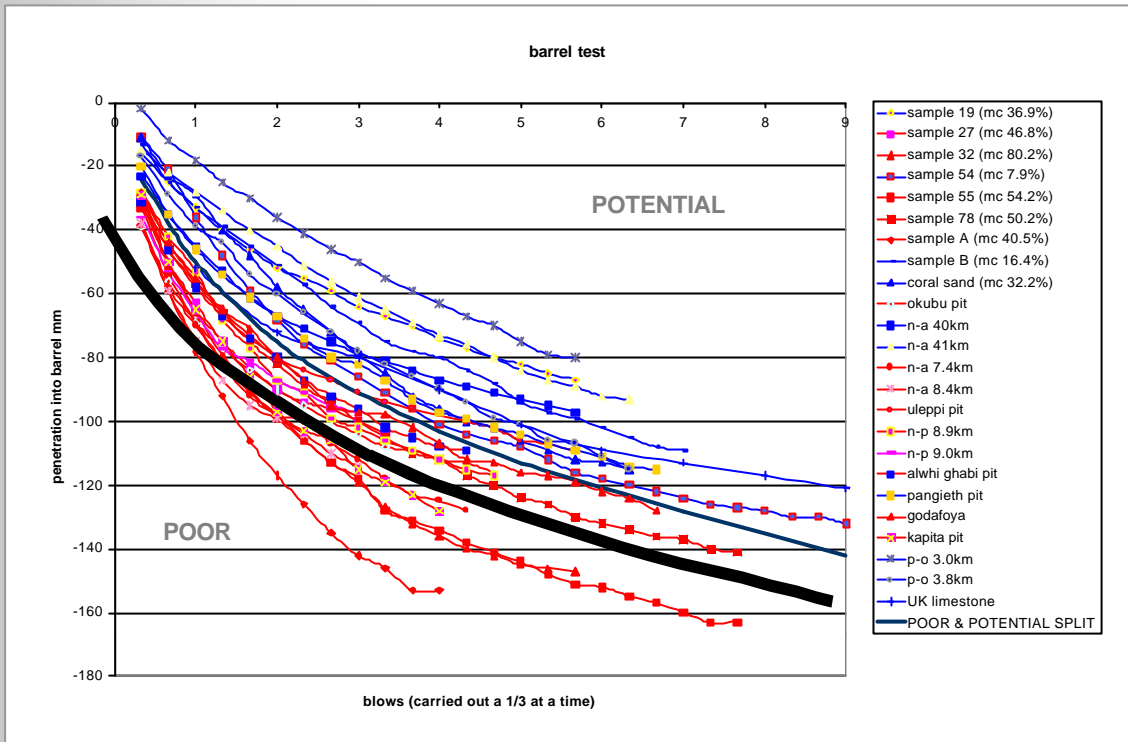
## Stage 6 – Analysis of the results

After Stage 6 of the test has produced values for blows and corresponding depth, plot these values on a chart . The purpose of the chart is to guide the user in selecting materials for use in road maintenance and construction. It is intended that the chart should be used as a pre-selection process. Curves which are plotted on the chart and appear below the line (POOR materials section of the chart) are generally thought to be not suitable for use in road maintenance. (The California Bearing Ratio of material, when compacted, is likely to be low and Plasticity of the material is likely to be high).

The chart should be used as an initial decision tool, to ascertain whether the material is worthy of laboratory testing. Samples which yield plots above the line (POTENTIAL materials section of the chart) may be suitable for use as road materials and should undergo further laboratory testing to decide. If the plot appears below the line, it is likely the material will not be worthy of further testing.



It is important to take time when calculating and analysing the data!



**BLANK COPY of Form A for recording barrel test results**

Location of test:		Date:		
Road Name:	RoadNo:	Pit Name:		
Material description:		Operator:		
Test		Cumulative		Notes
Blows	Depth mm	Blows	Depth mm	
Zero		0		
1/3		1/3		
1/3		2/3		
1/3		1		
1/3		1 1/3		
1/3		1 2/3		

<sup>i</sup> Information Note, Operating instructions for the TRRL dynamic cone penetrometer, Overseas Unit, TRRL, 1986, p2-3