BENCHMARK
ENGINEERING

DYNAMIC CONE PENETROMETER

User Guide

THE BEST CHOICE FOR THE MOST EXPERIENCED ENGINEERS, BUILDERS AND EXCAVATORS

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Dynamic Cone Penetrometer - User Guide by Elson Abraham

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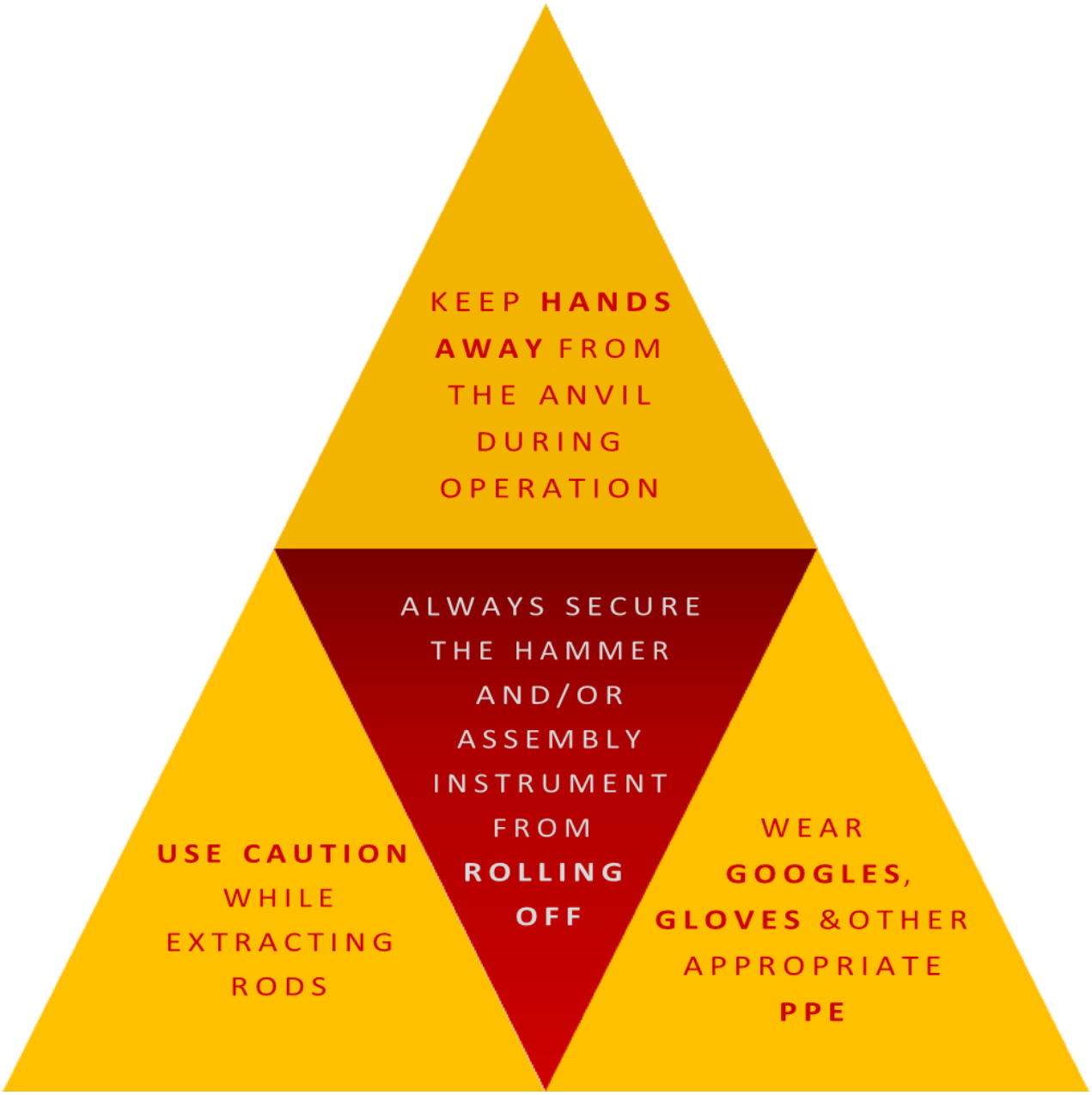
1. INTRODUCTION

Benchmark Engineering has an excellent reputation for manufacturing high-precision, high-quality machined products. From 2009-2011, the Benchmark Dynamic Cone penetrometer was developed in collaboration with local and national geotechnical engineering firms. It is designed and manufactured in Western Australia with the finest standards of precision, accuracy, and reliability. We are confident that our penetrometers are tough, strong, and long-lasting.

The penetration test has a long history of use in geotechnical engineering. We only manufacture penetrometers that are compliant with all relevant Australian Standards. Many engineers and professionals have used Benchmark penetrometers in the field and found them to be high-performing, durable, and resistant to wear. We supply a wide variety of configurations with Penetrometer kits. Please see our website or contact us for more information.

Figure 1: Benchmark Engineering building in 2021

2. SAFETY NOTICE



- Please strictly adhere to the instrument's guidelines for usage, care, and handling safetly. The manufacturer cannot be held responsible for damages caused by inappropriate use of the product.
- Do not tamper or modify the device for any reason.
- During transportation or storage, ensure the hammer is supported enough to reduce bending of the penetrometer rod. We recommend using the carry case for transporting.

3. DESCRIPTION OF DEVICE

The Penetrometer is a simple hand-held device that can be used to measure the strength and density of soil. At Benchmark Engineering, we produce mainly 2 types of penetrometers. The Dynamic Cone Penetrator (DCP) is described in detail in Australian Standard AS 1289.6.3.2. The physical layout of DCP is summarized in this section and illustrated in Figure 1.

3.1. Dynamic Cone Penetrator (DCP)

The DCP is made up of a 9kg sliding weight that provides a defined amount of energy by falling down a 510mm height into an anvil block. This energy is used to drive a 16mm steel rod with a cone tip end into the ground. The steel rod is usually scribed in 50mm increments up to the length of the rod. The device's gross mass is less than 20kg, making it quite portable. The weight is lifted and released by hand, with some care necessary to ensure that:

- the weight is hoisted through the whole 510mm height,
- there is no impact on the upper stop at the top of the lift, and
- the weight is released cleanly and allowed to freefall without interference.

In order to extend the depth of testing, more rods can be attached after the hammer has been driven. In some very loose condition, the greatest practicable depths are in the order of 5 or 6 m. Beyond these depths, recovery of the rods becomes difficult, and the danger of rod loss due to damage becomes too significant.

Figure 2: Benchmark Dynamic Cone Penetrometer

4. HARDWARE

4.1. Hammer

The 9kg hammer is manually lifted to the bottom of the stopper in the upper shaft, and then dropped on the anvil to transmit energy to the lower shaft to penetrate dirt.

4.2. Upper Shaft

The upper shaft is a 16mm diameter steel shaft on which the hammer slides. The length of upper shaft allows the hammer to drop a distance of 510mm.

4.3. Anvil

The Anvil is the hammer's lower stopping mechanism. It also serves as a link between the top and lower shafts. This enables disassembly, which decreases the size of the instrument for transport. *

4.4. Lower Shaft

The lower shaft is a 16mm diameter steel shaft, approximately 1m long and marked in 50mm increment for recording the penetration.

4.5. Cone

The cone measures 20mm in diameter and 50mm in length. The other dimensions are shown in Figure 1 and it is also available on the Benchmark website.

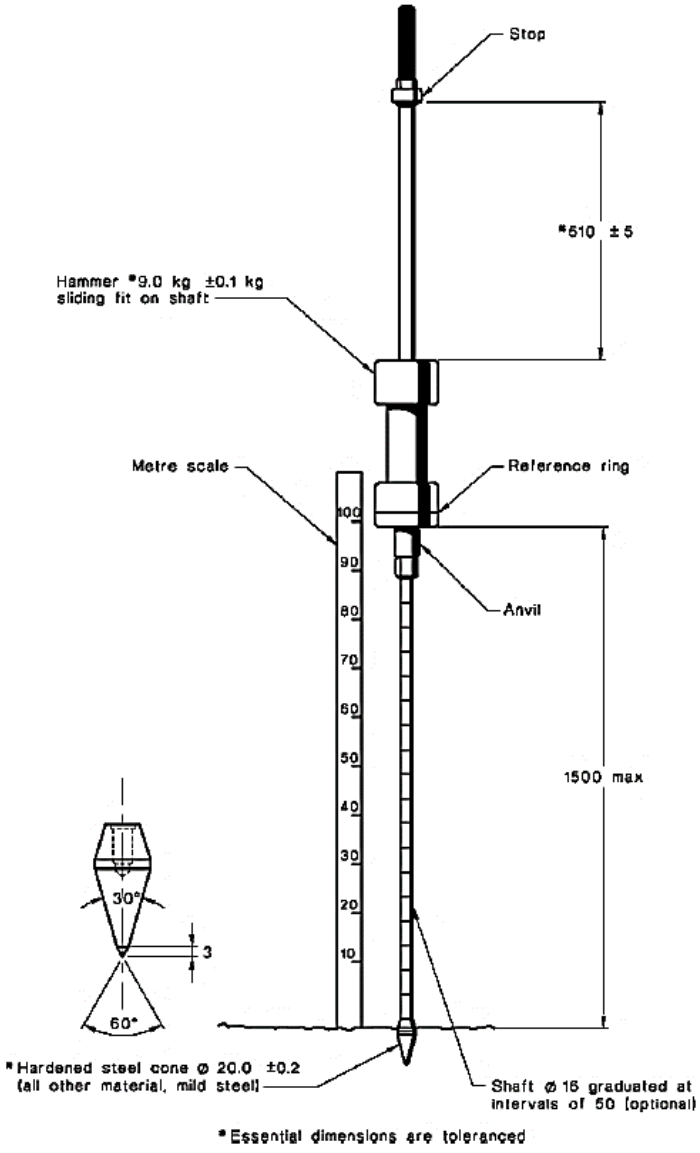


Figure 3: Dynamic Cone Penetrometer (Australian Standard AS 1289.6.3.2)

*Applies to 2-piece models only

5. TEST PROCEDURE

The Dynamic Cone Penetrometer (DCP) test is a relatively quick field test to determine the penetration resistance of the soil. The density of soil is measured to evaluate its strength and ability to resist settlements. The compactive effort and moisture content are the two most essential factors in ensuring optimum density. By compacting the soil at or near optimal moisture content, you create the ideal conditions for any kind of compactible soil to sustain these strength properties. The following procedure is based on AS 1289.6.3.2-1997.

NOTE: Before initiating this test, the whereabouts of probable subsurface utilities such as **gas**, **water**, and **electricity** should be identified.

Preparation of site: Unearth to the level to be tested. Remove any material, such as crushed rock or gravel, that will be too difficult to penetrate with the penetrometer or that may cause damage to the instrument. Check if the drop height is 510mm.

- Record the depth from the surface level to the top surface of the layer to be tested, approximated to the closest 10mm.
- Hold the penetrometer vertically with the point of the cone on the surface of the layer to be tested, and gently strike the anvil with the hammer until the broadest section of the cone begins to penetrate the surface.
- Raise the hammer to the stop and let it drop freely onto the anvil. Count how many drops it takes to drive the penetrometer and record either blows per mm or mm per blows whichever is most applicable to your application.
- Material type, moisture condition and location of ground water should be recorded.
- Record the analysis readings to a tabular section similar as Table 1 to do further calculations.

(Australian Standard AS 1289.6.3.2)

NOTE: Selection of the appropriate correlation is a matter of professional judgment.

Calculations: The results can be recorded as blows/100mm and soil density/consistency. Calculations to determine California bearing ratio (CBR) are available online if required. Refer to Australian Standards 1289.6.3.2 for more information.

Relation to correlation versus density is dependent on moisture and is unreliable if moisture is not controlled well and a professional judgment is required.

NOTE: Stop the test when eight strikes create a penetration of less than 20mm to avoid damage to the instrument.

Table 1: DCP Data Sheet

DCP DATA SHEET						
Project: Location: Material Classification:			Date of Test: Personnel: Weather condition:			
No. of Blows (blows/100mm)	Cumulative penetration (mm)	Penetration between reading (mm)	Penetration per Blow (mm)	DCP index (mm/blow)	CBR %	Moisture %

Table 2:Density Correlation HB 160-2006 (Australian Standard AS 1726-1993)

Consistency	Very Soft to Soft (VS-S)	Firm (F)	Stiff (St)	Very Stiff (VSt)	Hard (H)
No. of Blows	< 1	1 to 2	3 to 4	5 to 10	> 10
Density	Very Loose (VL)	Loose (L)	Medium Dense (MD)	Dense (D)	Very Dense (VD)
No. of Blows	<1	1 to 2	2 to 3	4 to 8	>8

6. MAINTENANCE

- Testing with the penetrometer causes wear on the metal parts that make up the device.
- Periodic examinations of the penetrometer for fatigue or damage are suggested in order to guarantee optimal service life.
- We will repair or replace any worn or broken parts with original Benchmark penetrometer parts.
- Prior to each test, the drive rod and hardened point should be thoroughly cleaned. Maintaining the drive rod's cleanliness and oil lubrication is essential.

We offer a one-year guarantee and have spare parts readily available for you in our workshop. Our dedicated team is committed to providing you with exceptional customer and after-sales service.

7. REFERENCES

Australian Standard AS 1289.6.3.2. (1997). Soil strength and consolidation tests—Determination of the penetration resistance of a soil—9 kg dynamic cone penetrometer test. *Standards Association of Australia*.

Australian Standard AS 1726-1993. (1981). Geotechnical site investigations. *Standards Association of Australia*.