

Measuring Penetration Resistance with a Scala Penetrometer

Disclaimer: this is a draft guide and introduction to using the Scala Penetrometer. It is not an authoritative statement of any NZ Standards. The responsibility for working in conformity to project specifications lies with the user.

Scope

This test is used to measure the in situ penetration resistance of soils by means of a dynamic cone penetrometer. It is limited to fine grained materials. The results may be used to estimate the field CBR of cohesive soils.

Procedures: There are two main ways to think about the test: blows per distance, or distance per blow.

For Foundations.

For testing the site of building foundations to NZ Standard 3604 the approach is to count how many blows per 100mm up to 300mm of penetration. This can be done by watching the graduations on the rods (i.e. not using a tape measure or rule).

For CBR Estimates.

Operators wanting to get data for a good estimate of CBR do one or more hammer drops then measure with a tape or metre rule to record a precise amount of penetration.

For Layers

The penetrometer readings will also identify the upper and lower positions of layers of different strengths.

Safety: Is there any gas, water, electricity or telephone service where you are testing?

To what depth will you be testing?

For NZS 3604 The tip of the penetrometer has to be driven to a specified depth below the underside of the proposed footing: That depth is 1.2 metres or twice the width of the widest footing, whichever is the deeper.

(a) Remove coarse material.

Excavate material such as crushed rock or gravel that would be too hard to penetrate with the penetrometer cone or that might damage the penetrometer.

(b) Measure how much you removed.

Measure the depth from the surface level to the top of the layer where you will testing. Measure it to the nearest 10mm and record.

(c) "Bed" the cone.

Hold the penetrometer vertical with the cone's point on the surface of the layer to be tested: gently tap the hammer on the anvil until the widest part of the cone has started to penetrate the surface.

NZ Standard: Working to NZS 3604 you may set the penetrometer cone in a probe hole augured for the purpose, but in this case you do not count any hammer blows until the cone tip is 300mm below the top of the hole.

If you are working to NZS 3604 and using a tape measure or metre rule you should measure from a board placed on the ground.

In any case when you are measuring from the ground up, once the cone is bedded in this measure is your depth at zero blows.

Measure from the ground or board to a reference point on the penetrometer such as the bottom of the anvil.

(d) Raise the hammer to its upper stop at the handle and let it drop to the anvil.

If the amount of penetration achieved is less than 20mm:

Make more hammer blows until the depth is 20mm or until there have been 8 blows without getting 20mm penetration.

If you keep hammering with so little penetration you are likely to break something, there may be an obstruction. If you think there is likely to be an obstruction, move the test area a little and start again. There might be a very hard top layer with softer ground underneath. More investigation may be required. You can still do the penetrometer test on the softer layer, if one is found.

If the amount of penetration achieved is more than 20mm:

Take the depth reading to the nearest millimetre and record the depth and the number of blows.

(e) Continue drops until a series of eight consecutive blows achieves less than 20mm depth.

Sometimes when a hard layer lies above a soft layer an extra blow will cause a lot of penetration as the cone breaks through to the soft layer. In this case the distance penetrated with this final blow should not be considered with the reading for the hard layer: you should record the approximate depth of the hard layer.

Take depth readings to the nearest 1mm for each blow or series of blows recording the depth and number of blows.

The amount of depth achieved with a series of blows should not be more than 50mm. I.e. if you are doing three blows and advancing 150mm between readings, that is too much distance between recordings.

NZ Standard.

If you are working on a site for foundations to NZS 3604 the main consideration is how many blows per 100mm.

The Standard says that the soil for the foundations is assumed to have a safe bearing pressure of 100kPa when:

The number of blows per 100mm depth of penetration below the underside of the proposed footing at each test site exceeds:

- (i) Three [blows per 100mm] down to a depth equal to the width of the widest footing below the underside of the proposed footing.
- (ii) Two [blows per 100mm] at greater depths.

Do not neglect the other common sense points in the standard, e.g. at the location of your tests there should not be soft peat, organic soil or soft clay with gravel below the level of the proposed footings.

The following tables are for estimating CBR from penetrometer readings.

By convention reporting is as follows:

For CBR values of 5 or less – to the nearest 0.5 units

For CBR values of 5 to 20 – to the nearest whole number

For CBR values greater than 20 – to the nearest 5 units

**Table 1: Field CBR Estimated from Scala Penetrometer
(Table From Country Roads Board)**

Penetration In Millimetres

Estimated Field CBR

less than...	1 blow	2 blows	4 blows	8 blows
5	50 +	50 +	50 +	50 +
6	50	50 +	50 +	50 +
	32	50 +	50 +	50 +
10	22	50	50 +	50 +
	18	39	50 +	50 +
15	14	32	50 +	50 +
	12	26	50 +	50 +
20	10	22	50	50 +
	9	20	45	50 +
25	8	18	40	50 +
	7	16	36	50 +
30	6	14	32	50 +
	6	13	29	50 +
35	5	12	26	50 +
	5	11	24	50
40	4.5	10	22	50
	4.5	10	21	47
45	4	9	20	45
	4	9	19	43
50	3.5	8	18	40
	3.5	8	17	38
55	3.5	7	16	36
	3			
60	3			
	2.5			
65 - 70	2.5			
75 - 100	2			
100 - 160	1.5			

Table 2: Example of test records with field CBR Estimated

Number of Blows	Depth in mm	Penetration mm	Estimate CBR	Layer CBR
0	881			7
1	847	34	5	
1	813	36	5	
1	786	27	7	
1	756	30	6	
1	730	16	8	
1	703	27	7	
1	678	25	8	
1	657	21	10	
1	634	23	4	
1	610	24	8	
1	587	23	9	
2	542	45	9	
2	500	42	10	
2	458	42	10	13
2	412	46	9	
2	374	38	11	
2	345	24	14	
2	313	32	13	
2	285	28	16	
2	255	30	16	
2	228	27	16	
2	193	35	12	
2	158	35	12	