DCP test – Dynamic cone penetration test Principle, Procedure, Calculation

What is DCP test?

The dynamic cone penetration test is a test carried out to find the resistance value of the cone against the soil that helps us to determine different mechanical properties of soil such as strength, bearing capacity, and so on.

If you are a Civil Engineer, Then you might know, we need to perform different types of in-situ tests for soils. The penetrometer test is one of them. It is done to determine the different mechanical properties of soil. There are namely three types of penetrometer test:
Standard Penetration Test (SPT)
Static Cone Penetration Test (SCPT)
Dynamic Cone Penetration Test (DCPT)

All these tests measure the resistance of the soil strata to penetration by a penetrometer. SPT is carried out in a hole while SCPT and DCPT are carried out without a hole.

Today, we will be discussing Dynamic Cone Penetration Test in depth.

Why is the dynamic cone penetration test needed?

- To determine the strength, bearing capacity, location and thickness of sub-layers of the soil.
- To monitor the condition of granular layers and subgrade soils in the pavement section over time.
- To determine the right solutions for the sites of the customer especially when soft soils are involved.

Equipment is required to carry out the Dynamic cone penetration test?

Dynamic cone penetrometer (DCP) is used to carry out the DCPT.

Dynamic cone penetrometer is a simple portable instrument that
can be taken to anywhere.

It consists of:

- A standard diameter steel rod
- A hardened conical tip and
- A hammer

Difference between Static cone penetration test and Dynamic cone penetration test (SCPT and DCPT)

<table>
<thead>
<tr>
<th>S.N.</th>
<th>The static cone penetration test</th>
<th>The dynamic cone penetration test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>It is useful on very soft and loose soils.</td>
<td>It is useful for hard soils such as dense gravel soil or cohesionless soils.</td>
</tr>
<tr>
<td>2.</td>
<td>In this test, the cone is pushed in the ground by thrust and not by driving.</td>
<td>In this test, the cone is driven in the ground.</td>
</tr>
<tr>
<td>3.</td>
<td>In this test, the cone used is called split spoon which takes the soil sample inside it.</td>
<td>In this test, the cone used has closed-end and does not require samples.</td>
</tr>
<tr>
<td>4.</td>
<td>This test gives continuous measurement.</td>
<td>This test gives blow counts at the rate of 1.5m depth intervals.</td>
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</table>
SCPT and DCPT

DCP test - Dynamic Cone Penetration Test

Principle

The basic principle of this test is to measure the resistance offered by the soil layers to the cone used for conducting the test.

Apparatus required for DCP test

- A cone (50 mm without bentonite slurry)
- Driving rods
- Driving head
- Hoisting equipment
- A hammer (made up of mild steel or cast-iron with a base plate of mild steel weighing 640N i.e. 65kg).

Procedure
1. The initial reading on the dynamic cone penetrometer is recorded.
2. Then, the dynamic cone penetrometer is kept with the cone resting vertically on the ground where the test is to be carried out.
3. Now, the cone is driven into the soil by the freefall of hammer of 750 mm each time.
4. Then the number of blow of every 10mm penetration is recorded.
5. This process is repeated until when the cone does not reach the required depth.

**Observation Table**

<table>
<thead>
<tr>
<th>No. of blows</th>
<th>Cumulative no. of blows</th>
<th>Penetration depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>20 (say)</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>And so on until required depth is reached</td>
</tr>
</tbody>
</table>
Calculation

Calculation of this test relies on correlations based on blow counts.

\[ \text{CBR} = \frac{292}{\text{DPI}^{1.12}} \]

\[ \log(\text{DPI}) = -1.05 + 2.03 \times \log(\text{SPT}) \]

where \( \text{CBR} = \) California Bearing Ratio

\( \text{DPI} = \) DCP penetration index = penetration depth per blow

\( \text{SPT} = \) Standard Penetration Test

- Now the penetration curve is made by placing DCP penetration (in mm) in Y-axis and no. of blows in X-axis.
- Also, for knowing the CBR variation with depth, a semi-log graph is plotted between depth of penetration in ordinary scale in X-axis and CBR value in log scale in Y-axis.

Advantages of Dynamic Cone Penetration Test
This test does not need a borehole.
This test can be performed quickly so that it covers a large area making it economical.

Disadvantages

- This test cannot be performed on cohesive soils or very loose cohesionless soil.
- It is not possible to determine the mechanical properties of soil by this test if the soil is at a great depth and friction along the extension rod is significant.

Factors affecting DCP test

There is a various factor which affects this test such as:

- Alignment of DCP rods
- Damaged cone tip
- Depth of testing
- The apex angle of the cone
- Hammer weight
- Freefall height of hammer
- Moisture content
- Material composition
- Intensity of compaction

Precaution
1. The reading should be taken numbers of time to reduce the error.
2. During freefall of hammer, it should be raised to a standard height otherwise the penetration value will decrease.
3. DCP test should not be done during monsoon because it will decrease the strength of the soil and test result will not be accurate.

I hope this article remains helpful for you.

Happy Learning – Civil Concept

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