# *PAVEMENT TECHNOLOGY ADVISORY*
# *- DYNAMIC CONE PENETROMETER -*
# *PTA-T4*

## WHAT IS A DYNAMIC CONE PENETROMETER?

The Dynamic Cone Penetrometer (DCP) is an instrument designed to provide a measure of the in-situ strength of fine-grained and granular subgrades, granular base and subbase materials, and weakly cemented materials. A schematic of the DCP is shown in Figure 1. The 8-kg (17.6-pound) weight is raised to a height of 575 mm (22.6 inches) and then dropped, driving the cone into the soil or other material being tested.

DCP testing is conducted according to Illinois Test Procedure 501, in which the number of blows to achieve 150 mm (6 inches) of penetration is counted. Alternatively, the depth of penetration may be measured after each blow when extremely soft materials are encountered. In either case, the output of the DCP test is a penetration rate (PR), expressed in mm (inches) per blow.

## BENEFITS OF THE DCP

The DCP offers the following benefits:

- **Low cost -** The DCP can be manufactured in-house or purchased commercially (for approximately $700 to $1400).
- **Easy to use -** An operator can be trained in a matter of minutes.
- **Large Penetration Depth -** Data can be collected to a depth of 900 mm (36 inches) compared to a maximum of 300 mm (12 inches) for other hand-held testing devices.

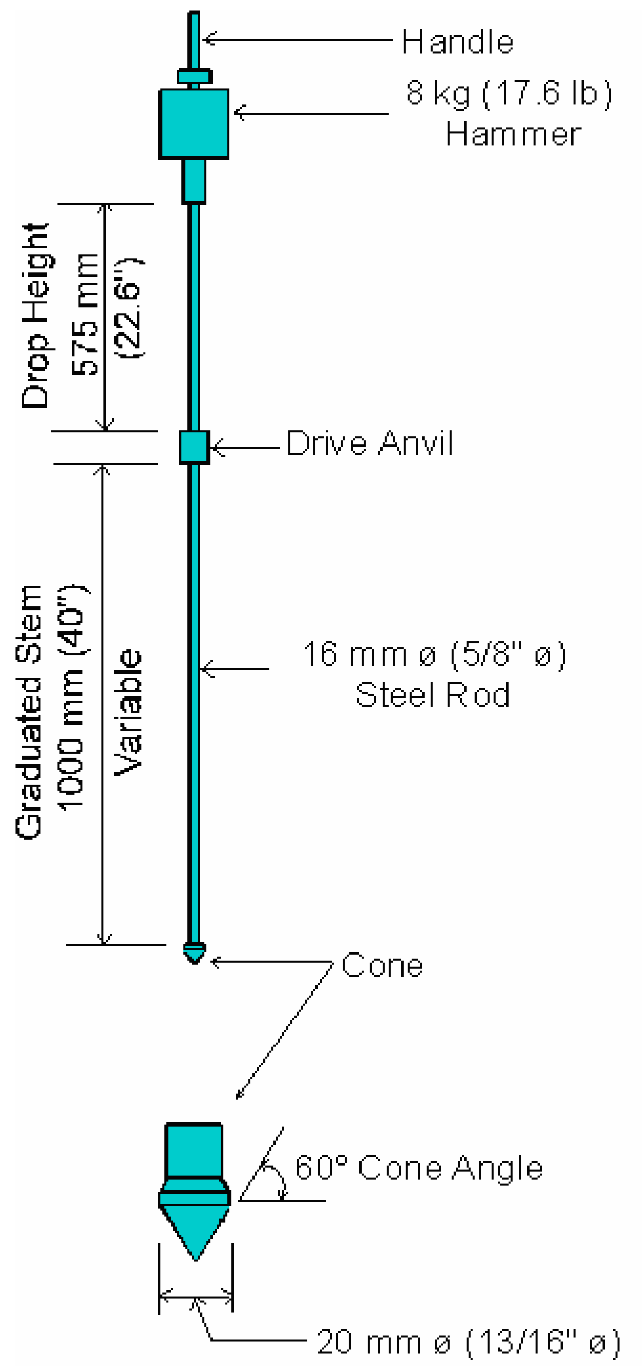


**Figure 1: Schematic of DCP**

- **Fast -** A large amount of data can be taken quickly, and the PR values are easily converted into other indices, such as the Immediate Bearing Value (IBV), used to determine subgrade stability.

## CONVERTING PR TO IBV

Research has shown a good correlation between the DCP's PR and the IBV for granular materials and fine-grained subgrade soils. Figure 2 can be used to convert the PR into an equivalent IBV:

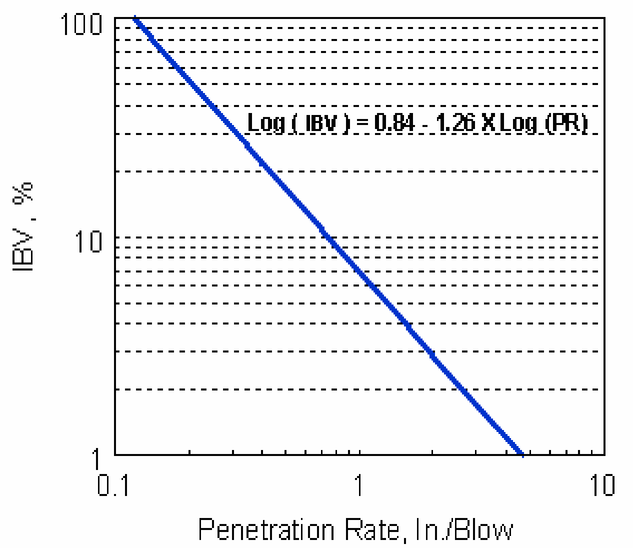


**Figure 2: IBV - PR Correlation**

The IBV is similar to the California Bearing Ratio (CBR), except that IBV testing is conducted on a 100-mm (4-inch) molded sample instead of the CBR's 150-mm (6-inch) sample. Further, the penetration test for determining the IBV is conducted immediately after compaction instead of after waiting 96 hours. Because of the differing procedures, the IBV and CBR values for the same material are different.

## USES OF DCP / IBV DATA

The Illinois Department of Transportation (IDOT) frequently uses the DCP to check subgrade stability before and during construction activities. The subgrade must be sufficiently stable to prevent excessive rutting and shoving during and after construction, and must also provide adequate support for the placement and compaction of the layers to be constructed.

IDOT requires a minimum subgrade IBV of 6 to 8 percent for construction activities. Values less than 6 percent require a subgrade treatment prior to construction (see *PTA-D7*). In such cases, the IBV can be used to determine the necessary thickness of granular backfill or subgrade modification needed to withstand construction activities (Figure 3). Additionally, the user can plot a graph of IBV versus depth from the subgrade surface to help identify changes in material strengths and potentially weak areas that need to be removed (Figure 4). Finally, IBV values from DCP testing can be used as subgrade inputs in most IDOT flexible pavement design procedures for local roads.

## SPECIAL CONSIDERATIONS

DCP testing can be performed directly through thin flexible pavements with uncemented aggregate sublayers, such as many "oil and chip" pavements. The DCP can also be used to test directly through lightly cemented materials having unconfined compressive strengths of less than 3000 kPa (440 psi); otherwise, DCP testing can be performed only after a core containing pavement and other materials exceeding that strength are removed.

DCP tests of highly moisture sensitive soils (especially silty soils) can sometimes yield inaccurate results. Proof rolling is recommended immediately prior to DCP testing to identify silty ("pumpy") soils. Proof rolling softens the soil by drawing moisture to the surface and breaking thin surface crusts. The process involves driving a loaded truck or heavy equipment repeatedly over the subgrade to simulate construction activity.

## CONTACT INFORMATION

If you have any questions, or to request more information about any of the material herein, please contact:

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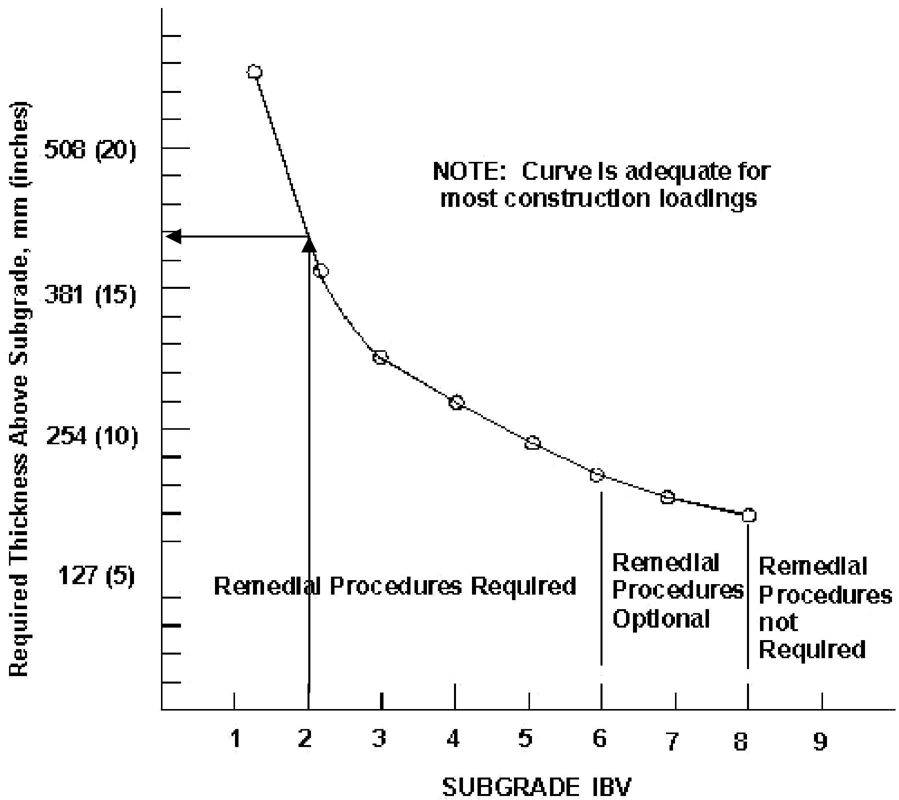


**Figure 3: IBV-Based Thickness Design for Granular Backfill and Subgrade Modification**

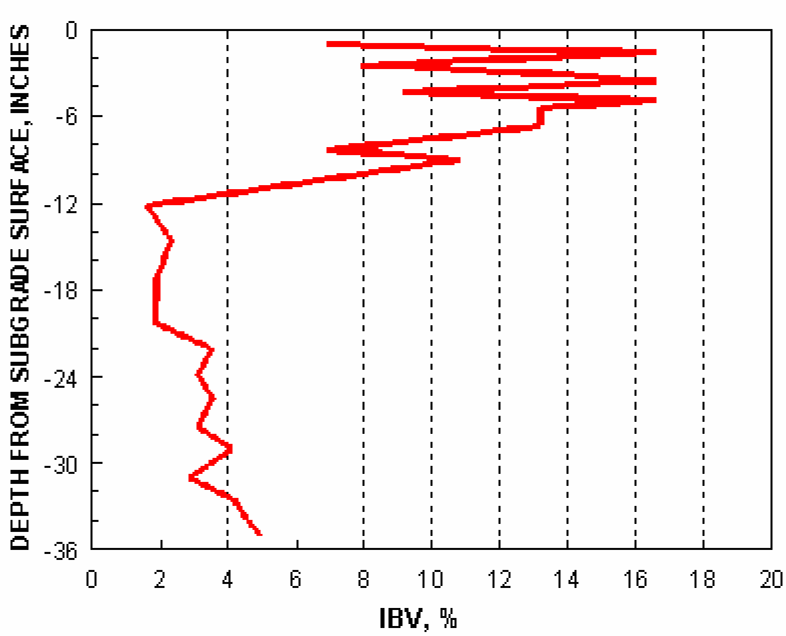


**Figure 4: IBV versus Depth from Subgrade Surface**