



**LOCATING, DRILLING & EVALUATING
PORTLAND CEMENT CONCRETE PAVEMENT CORES**

SCOPE

Cores shall be taken from Portland Cement Concrete (PCC) pavement, to determine the pavement thickness and the thickness index for each section. These cores will also be used to provide data for strength, air content of the hardened concrete and correct steel placement. Refer to Specification Article 2301.34.

The District Materials Engineer will determine identification of the limits of each lot and the random location of each core. The engineer will determine and record the core lengths and calculate the thickness index to determine payment to the contractor from the Payment Schedule. The cores shall be 4 in. (101.6 mm) in diameter. A core drill bit with a 4 1/4 in. (108 mm) outside diameter usually has an inside diameter of 4 in. (101.6 mm). The engineer will witness core drilling.

DEFINITIONS

Section: All Portland Cement Concrete in a project of the same bid item. Irregular areas, as defined herein, of the same bid item shall form a separate section.

Lot: A portion of a section normally not more than 2000 sq. yd. (1700 m²). Each lot is represented by a randomly located core as part of the set of cores that will represent the section.

Segments: A portion of a lot. Lots are divided both longitudinally and transversely into segments. A segment of the lot is chosen at random and the core is taken from that segment.

Set of Cores: A minimum of ten randomly located cores that represent a pavement section. The engineer determines the location of each core.

See Figure 1 in Appendix A for an illustration of the elements described above. See Article 2301.34 of the Standard Specifications regarding coring of sections less than 5000 sq. yd. (4200 m²).

PROCEDURES

A. Core Location – Regular Areas

Regular area pavement sections are defined as follows:

- All mainline pavement for normal travel lanes. Includes middle (both direction) turn lanes
- Paved shoulder – if same thickness as pavement and part of pavement bid item include with pavement. If separate bid item, treat as separate section.
- Paved median - if same thickness as pavement and part of pavement bid item, and longer than 300 feet (90 m), include with pavement.
- Auxiliary lanes of full width longer than longer than 300 feet (90 m).
- Widening greater than six feet (1.8 m).

1. Lots. Divide the section longitudinally into 2000 sq. yd. (1700 m²) lots. If the last lot of the pavement section is less than 1000 sq. yd. (850 m²) group this lot with the last full 2000 sq. yd. (1700 m²) lot, otherwise treat lots greater than 1000 sq. yd. (850 m²) as a lot by themselves. A minimum of ten cores is required. Sections less than 20,000 sq. yd. (17,000 m²) will be divided longitudinally into ten lots approximately equal in size. The width of the section shall be the pavement design width, regardless of placement width.
2. Segments. Divide the lots into six approximately equal segments, both longitudinally and transversely. Assign a number one through six to each longitudinal and each transverse segment.
3. Core Location. Select the segment to be cored within each lot separately, by rolling the die or other random selection method. Locate the core at the approximate midpoint transversely and longitudinally of the selected segment. No core shall be taken within 18 in. (450 mm) of a transverse joint. If any of the random core locations are placed in an area that is unable to be cored, such as a bridge deck, approach, etc., relocate the core one full station forward or backwards from the original random location.
4. Shoulders. Divide the section into 2000 sq. yd (1700 m²) lots. Divide each lot into six segments. Core a random segment at approximately mid point longitudinally and transversely.

B. Irregular Areas

Irregular areas are defined as follows:

- Widening less than six feet (1.8 m).
- Side street connections.
- Ramps, including gore areas, and collector distributor roads.
- Deceleration and acceleration lanes.
- Turn lanes, including taper sections.
- Tapers.
- Radiuses.
- Median crossovers.

1. Sections. All irregular areas of the same design thickness shall be grouped together for determining number of lots. The engineer may waive sections of the same design thickness that total less than 5,000 square yards.
2. Core Location. Irregular areas to be cored will be determined by random selection of all irregular areas larger than 100 sq. yd. (85 m²). One core will be randomly located in each selected irregular area, unless one or more of the areas are significantly larger than the others, then more than one core may be located in the large area. A minimum of ten cores is required to represent each section of irregular areas.

C. Records

The Project Engineer will determine and record the locations daily. This information will be

furnished to the Contractor daily for use in locating and cutting cores. The Project Engineer will monitor the cutting of the cores.

D. Section Evaluation

1. Use the following formula to determine the mean core length for the section:

$$\bar{X} = \frac{\sum X}{n}$$

Round the mean core length to two decimal places.

Where : \bar{X} = mean length for the section

$\sum X$ = sum of core lengths for the section

n = number of cores taken within the section

2. Use the following formula to determine the sample standard deviation of the core lengths of the section:

Where:
$$S = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

S = core length standard deviation for the section.

\bar{X} = mean core length for the section

X = individual core length values for the section.

n = number of cores representing the section.

\sum = sign indicating the sum of all values of $(X - \bar{X})^2$

Round the sample standard deviation to two decimal places.

NOTE: Calculations of the standard deviation are best made with an electronic calculator with standard deviation capability that uses the formula containing the quantity (n-1).

3. Use the following formula to determine the thickness index for the section of pavement thickness.

$$TI = (\bar{X} - S) - T$$

Where:

TI = thickness index for the section

\bar{X} = mean core length for the section

- T = design thickness
S = core length standard deviation (of the sample) for the section

Round the thickness index to two decimal places.

NOTE: If the mean core length minus the standard deviation is less than the design thickness of the section, the thickness index will be a negative number.

4. Basis of Payment. Payment for the quantities of pavement in square yards (square meters) in each section will be as shown in Article 2301.35 and based on the thickness index as determined in accordance with these instructions.

E. Deficient Areas

1. Deficient areas, represented by cores deficient in length by 1 in. (25 mm) or more from design thickness, are to be replaced. These areas will be determined by drilling a core 60 ft. (18 m) in each direction longitudinally at the same transverse location from the deficient core. Drilling will be continued at 60 ft. (18 m) intervals until a core is obtained which is not deficient by 1 in. (25 mm) or more from design thickness. Interpolate between this core and the adjacent core to determine the limits of the deficient area. This is the area to be removed and replaced at contractor's expense. These additional cores are to be used to define the deficient area and will not be used in the thickness index calculation. When an obstruction, such as a bridge, intersection, previous work, etc., prevents drilling a core at the required 60 ft. (18m) interval in either direction longitudinally, continue the balance of the distance on the other side of the obstruction.
2. To replace the original core taken from the deficient area, randomly select a core location in the remaining area of the original lot. This core length will be used for calculating the thickness index. If the remainder of the original lot is less than 1000 sq. yd. (850 m²), include this remaining area with the next full lot.

F. Core Numbers

The engineer will assign all cores a number. The core numbers shall consist of the District number and a consecutive number beginning with 0001 and terminating at 9999. (For example, 10385 would be the 385th core recorded District 1 Materials Office.)

In the Remarks section, as shown in Appendix B of this IM, mark cores as D for deficient or R if a replacement core has been added.

G. Reporting

The engineer will report the results of the core measurements in the following manner:

1. The core lengths and associated information will be reported on Form #130.
2. The distance from centerline and roadway width should be measured to the nearest 0.1 in. (25 mm). The contractor shall deliver the cores to the designated laboratory.

3. The nine point measurements should be reported on Form #130.
4. The nine-point assurance measurement will be determined and reported by the District Materials Engineer.
5. Report #130 will accompany the cores when delivered to the District Materials Laboratory
Distribution of Form #130 will be made after assurance measurements are added to the form.