Technical Note No: 13 14

Sub: APRRP-Roads –Compaction of Shoulders – Testing Procedure-Guidelines – Communicating - Reg.

Ref: 1) Inspection of APRRP works by Project Director and Project Advisor (PMC) in different districts.

2) Review of IQM reports by PMC Team.

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Background:

During the review of IQM reports by PMC Team it was observed that some of the IQMS are conducting field density of shoulders to assess the compaction by means of Core cutter method which may not give accurate results since the material used in the shoulders are non-cohesive in nature. Hence there is a need to streamline the process of testing field density of soil used in the shoulders based on the relevant codes and specifications.

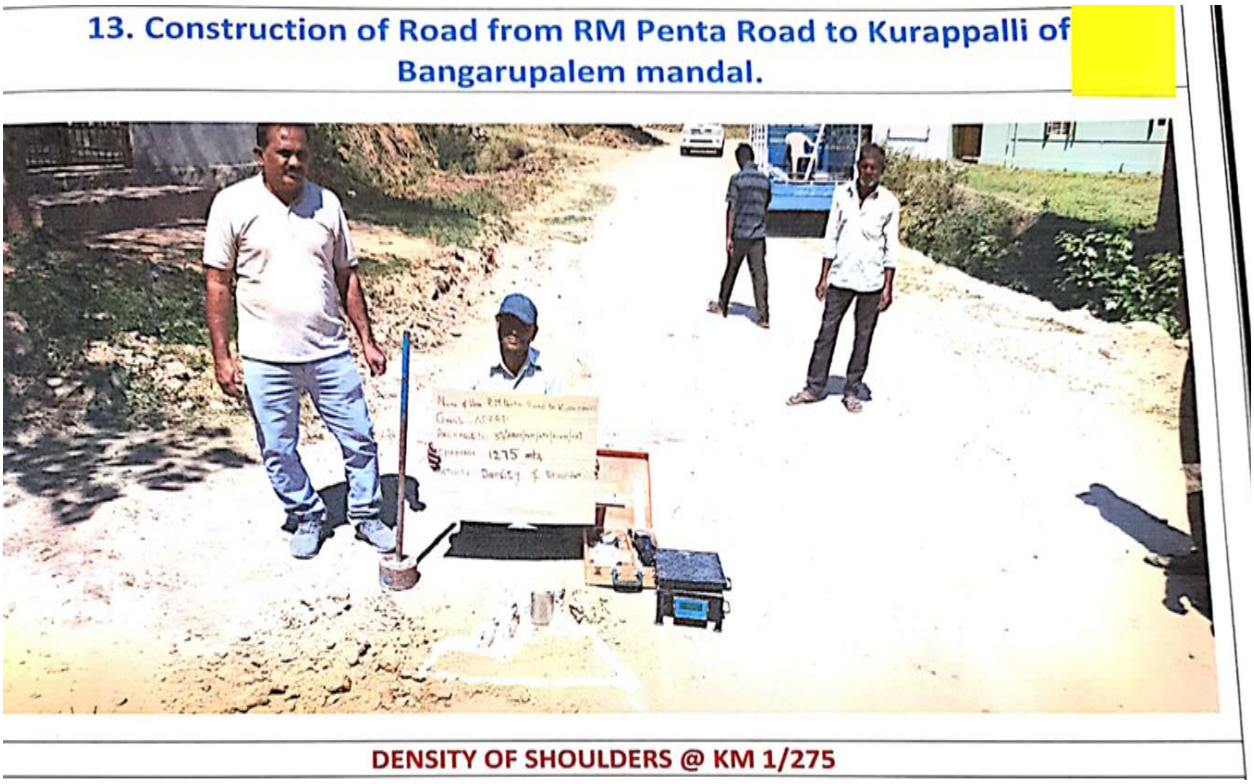

Fig: Density of Shoulders with Core Cutter (Extract from the IQM report)

Procedure to be adopted to determine the field density of soils:

There are two conventional methods to determine the field density of soils- Sand replacement method and Core cutter method.

These methods are used to study the in-situ density of soils to understand the soil bearing capacity, stability, and to determine the degree of compaction of the fills.

There are certain limitations for each and every test method.

Core Cutter Method: is used to determine the field density of fine-grained soils like clay soils or other cohesive soils free from aggregates as stipulated in IS: 2720 -Part 29 which are placed as fills. This method cannot be used for coarse grained soils since the core cutter does not penetrate through them due to high resistance at the tip of the instrument.

Sand Replacement Method: As Per IS:2720- Part 28: Method suitable for fine, medium, and coarse-grained soils to determine the dry density of natural or compacted soil containing stones. In this method small pit is made and the soil is that extracted is weighed. The pit is replaced with sand, whose density has been measured. The volume of the pit is calculated by knowing the weight and density of the sand that is required to fill the pit. The weight of the soil that is excavated from the pit and the volume of the pit is calculated to determine the density of the soil.

Specification of material used in Shoulders in APRRP Estimates:

"Construction of Shoulders by providing selected earth having MDD not less than 1.85 g/cc with LL & PI not more than 40% and 20 respectively and spreading in uniform layers with tractor grader on prepared surface and compacted at OMC with vibratory roller 80-100 kN to meet requirement as per Technical Specification Clause 303 & 407 MORD, by using machinery including contractors profit & Overhead charges, but excluding GST and seigniorage etc., complete."

As seen from the above specification the type of soil used in the shoulders falls in the category of "Sandy Clay" or "Sand" as per classification of soil shown in the Table below since the required MDD is more than 1.85g/cc.

Table 301.3.1 Typical Values of Maximum Dry Density and Optimum Water Content

	Light Compaction test		Heavy Compaction test	
Type of Soil	Max.dry density (kN/m3)	Optimum water content (%)	Max.dry density (kN/m3)	Optimum water content (%)
Clay	15.2	28	18.2	18
Silty Clay	16.3	21	19.1	12
Sandy Clay	18.1	14	20.4	11
Sand	19.0	11	20.6	9
Gravel-sand-clay-mixture	20.0	9	22.0	8

Reference: IS : 2720 (Part 7)

Some common types of soils that may have MDD values greater than 1.85 g/cc include:

1. **Well-graded and uniform sands**: Soils composed of well-graded and uniform sands with minimal fines tend to have higher MDD values. These types of sands have a relatively low void ratio and can be compacted efficiently to achieve high dry densities.
2. **Silty sands**: Soils that contain a significant amount of silt in the sand matrix can also exhibit high MDD values. Silty sands have the potential for good compaction, especially when the fines are well-dispersed within the sand particles.
3. **Gravels**: Coarse-grained soils like gravels can have relatively high MDD values, especially when they are well-graded and contain limited fines. Gravels can be challenging to compact uniformly due to their particle size, but proper compaction efforts can lead to dense structures.
4. **Sandy gravels**: Soils composed of a mixture of sand and gravel can often achieve high MDD values, particularly if the mix is well-graded and contains limited fines.

The core cutter method is commonly used to determine the in-situ density of soils, including gravel soils. However, when applied to gravel soils, the core cutter method may have some disadvantages and limitations. Here are the main disadvantages of using the core cutter method in gravel soils.

1. **Particle Size**: Gravel soils typically consist of coarse particles with sizes ranging from 2 mm to 75 mm or more. The core cutter method is better suited for fine-grained soils and may encounter challenges when trying to extract intact cores from gravel soils due to the large particle sizes. The core cutter may not penetrate the gravel effectively, leading to difficulties in obtaining a representative sample.
2. **Disturbance**: In gravel soils, the core cutter may cause significant disturbance to the surrounding soil particles during insertion and extraction. The disturbance can alter the natural state of the soil and affect its density, leading to inaccurate density measurements.
3. **Sample Representation**: Due to the heterogeneity of gravel soils, extracting a small core sample may not provide a representative representation of the entire soil stratum. The variation in gravel particle sizes and arrangement within the soil can lead to inconsistencies in the density measurements obtained from the core cutter method.
4. **Incomplete Core Recovery**: The core cutter method relies on the ability to extract a full and intact cylindrical sample from the ground. However, in gravel soils, the core may not be completely recovered due to difficulties in obtaining a clean cut or getting the gravel particles to stick together during the extraction process.
5. **Equipment Limitations**: The core cutter apparatus may not be designed or suitable for gravel soils. The large and irregular particles in gravel can pose challenges for the cutting edge and result in increased wear on the equipment.

Given these limitations, alternative methods such as the sand replacement method or nuclear density gauges (e.g., the Troxler gauge) may be more suitable for determining the in-situ density of gravel soils. These

methods are better equipped to handle the challenges posed by coarse-grained soils and can provide more reliable density measurements for engineering and construction purposes.

Hence as seen from the above soil properties whose MDD is greater than 1.85g/cc, it is better to conduct compaction test for shoulders with Sand replacement method as against Core cutter by all inspecting agencies to have accurate results of dry density at site.

References:

1. IS:2720(Part XXIX)-1975- Determination of Dry Density of Soils in Place by the Core-Cutter Method.
2. IS:2720(Part XXVIII)-1974- Determination of Dry Density of Soils in-Place by the Sand Replacement Method.

Project Advisor. APRRP
Vijayawada.