VARIOUS QUALITY CONTROL TESTS

QUALITY CONTROL AND TESTING PROCEDURES

Objectives:

The basic objectives of these guidelines are as under

a) To provide set or working principles to the field engineers
b) To explain the criteria and procedures to be adopted in the implementation of the project.
c) To enumerate the duties, power and responsibilities of the field engineers
d) To provide guidance in assuring and controlling the quality of work.
e) To provide guidance to test the quality of materials and ensure quality.
f) To ensure uniformity and consistency in regulatory, mandatory and routine activities in the project implementation.

IMPORTANT TESTS

Tests on Soil:

1. Determination of Atterberg limits
2. Determination of Proctor Density.
3. Determination of field density of soil (Sand Replacement Method)
4. Determination of field density of soil (Core cutter Method)
5. Determination of CBR of soil in the field (CBR test)
6. Determination of CBR of soil in the laboratory.
7. CBR with Dynamic core penetration method.
8. Nomograph for Computing soaked CBR value from sieve analysis data.

Tests on Coarse Aggregate:

1. Determination of Gradation of Aggregate (Sieve analysis)
2. Determination of Aggregate Impact Value
3. Determination of Flakiness Index
4. Determination of Elongation Index.

Tests on Bituminous Construction :

1. Determination of Binder Content (Bitumen Extraction Test)
2. Determination of Penetration value of Bitumen

Tests on Cement & Concrete:

1. Normal consistency, Initial Setting & Final Setting time of Cement (VICAT's apparatus)
2. Compressive strength of concrete.

Frequency of Testing:

Consolidation:

Determination of Atterberg Limits of Soil

Liquid Limit (LL): It is the water content corresponding to the boundary between liquid and plastic states of soil.

1. Take 120 gms of soil IS 425 micron sieve.

2. Mix it with distilled water from a paste.
3. Place a portion of the paste in the cup of apparatus
4. Level the specimen to half the cup
5. Cut the paste with the standard grooving tool along the centre line.
6. Start rotating the handle at 2 revolutions per second
7. Count number of blows till two parts of sample come into contact at the bottom of the grove (along a distance of 10mm)
8. Record the number of blows and determine the moisture content of the sample taken near the closed groove.
9. Repeat the test by changing the moisture content so that number of blows to close the grove is from 35 to 10
10. Plot a graph between log (no. of blows) and moisture content and fit a straight line.
11. Read the moisture content corresponding to the 25 number of blows from the graph. This gives the liquid limit of the soil.

The limit for the liquid limit for gravel is 25.

Plastic Limit: PL: It is the water content corresponding to the boundary between plastic and semi solid states of soil mass.

1. Take about 30 gms of soil passing IS 425 micron sieve
2. Mix it with distilled water to form a paste.
3. Take about 8 gms of soil from the paste and make a ball.
4. Roll the ball on a glass plate with hand to make a thread.
5. When the diameter of thread reaches 3mm, re-mould the soil again to a ball.
6. Repeat the process of rolling and re-moulding until the thread of soil just starts crumbling at a dia of 3mm.
7. Determine the moisture content of the crumbled threads.
8. Repeat the test two more times with fresh portion of the soil mix.
9. The average of moisture content of the soil in three trials gives the plastic limit of the soil.

The plastic limit for good gravel should be more than 19.

Plasticity Index (P.I):

Plasticity Index is determined by subtracting the value of Plastic Limit from the value of the Liquid Limit.
PI= LL-PL
The Plasticity Index for good gravel should be less than 6.

Liquid Limit

S.No	Determination Number		1	2	3
1	Number of blows				
2	Moisture container number				
3	Weight of the container	W1gm			
4	Weight of the container +Wet soil	W2gm			
5	Weight of container + Dry soil	W3gm			
6	Weigh of the water(Ww)	Ww= (W2-W3)gm			
7	Weight of the Dry soil(Wd)	Wd= (W3-W1)gm			
8	Moisture content (W%)	W%=((Ww)/(Wd))*100			

Liquid Limit= Moisture content at 25 blows (from graph)

Plastic Limit

S.No	Determination Number		1	2	3
1	Moisture container number				
2	Weight of the container	W1gm			
3	Weight of the container +Wet soil	W2gm			
4	Weight of container + Dry soil	W3gm			
5	Weigh of the water (Ww)	Ww= (W2-W3)gm			
6	Weight of the Dry soil (Wd)	Wd= (W3-W1)gm			
7	Moisture content (W%)	W%= ((Ww)/(Wd))*100			

Plastic Limit= Average of three moisture content

Plasticity Index= Liquid Limit – Plastic Limit
=WL- Wp

Determination of Proctor Density (Light Compaction)

1. Weight the mould (W1) to the nearest 1 gm with base plate attached
2. Take 4 Kg of air dried soil passing 20mm IS sieve
3. Add a known percentage of water (moisture content well below the assumed optimum moisture content) by weight of dry soil depending on the expected optimum moisture content.
4. Fix the collar (extension) to the mould.
5. Fill the mould by compacting the specimen in three layers with 2.6 Kgs rammer for light compaction, by giving 25 blows to each layer.
6. Remove the extension and level off carefully to the top of the mould by means of a straight edge.
7. Take the weigh of the mould and the soil (W2)
8. Repeat the same procedure for various percentage of water until the weight of the mould plus soil attains a peak and starts reducing with increase in water content. Ensure that a minimum of 5 points are available to plot the graph of dry density Vs moisture content.
9. Find out the moisture content and tabulate the results in the following table.

By using the graph of dry density Vs moisture content, find out the maximum dry density and the corresponding moisture and report as MDD and OMC respectively.

Compaction Test

S.No	Determination Number		1	2	3
1	Weight of the mould	Wm gm			
2	Weight of Mould + Compacted soil	W gm			
3	Volume of Mould	Vm cc			
4	Wet Density	Yw= (W-Wm)/Vm gm/cc			
5	Weight of the moisture container	W1 gm			
6	Wright of the container + Wet soil	W2 gm			
7	Weight of the container + Dry soil	W3 gm			
8	Moisture content (W%)	W%=(W2- W3)/ (W3-W1) * 100			
9	Dry Density (Yd)	Yd= (Yw)/ (1+w/100) gm/cc			

Determination of Field Density of Soil

(Sand Replacement Method)

1. The pouring cylinder shall be filled so that the level of the sand in the cylinder is within about10mm of the top. Its total initial weight (W1) shall be found and shall be maintained constant throughout the tests for which the calibration is used. Volume of sand equivalent to that of the excavated hole in the soil (or equal to that of the calibration container) shall be allowed to run out of the cylinder. The shutter on the pouring cylinder shall then be closed and the cylinder placed on a plane surface such as the glass plate.
2. The shutter on the pouring cylinder shall be opened and sand allowed to run out. When no further movement of sand takes place in the cylinder, the shutter shall be closed and the cylinder moved carefully.
3. The sand that has filled the cone of the pouring cylinder (that is the sand that is left on the plane surface) shall be collected and weighed to the nearest gram repeated at least three times and the mean weight (W2) taken.
4. The internal volume (V) in cc of the calibrating container may be calculated from its internal dimensions.
5. The pouring cylinder shall be placed concentrically on the top of the calibrating container after being filled to the constant weight (W1). The shutters on the pouring cylinder shall be closed during this operation. The shutters shall be opened and sand allowed to run out. When no further movement of sand takes place , the shutter shall be closed. The pouring cylinder shall be removed and weighted to the nearest gram.
6. These measurements shall be repeated at least three times and the mean weight (W3) taken.
7. A flat area approximately 45cm square of the soil to be tested shall be exposed and trimmed down to a level surface, preferably with the aid of the scraper tool.
8. A round hole approximately 10cm dia and the depth of the layer to be tested upto a maximum of 10 cm depth shall be excavated in the soil. No loose material shall be left in the hole. The metal tray with a central hole shall be laid on the prepared surface of the soil with the hole over the portion of the soil to be tested – the hole in the soil shall be then be excavated using the hole in the tray as a patter. This tray shall be removed before the pouring cylinder is placed in a position over the excavated hole. The excavated soil shall be carefully collected and weighed to the nearest gram.
9. The moisture content of (W) of the excavated soil shall be determined by taking representative sample of soil. Alternatively, the whole of the excavated soil may be dried and weighted(Wd)
10. The pouring cylinder filled to the constant weigh (W1) shall be placed so that the base of the cylinder covers the hole concentrically, the shutters on the pouring cylinder shall be closed during this operation. The shutter shall then be opened and sand allowed to run out into the hole.
11. The pouring cylinder and surrounding area shall not be vibrated during this period. When no further movement of sand takes place, the shutter shall be closed. The cylinder shall be removed and weighed to the nearest gram(W4)
    Note: It is necessary to make a number of repeated determinations say 4 to 5 and to average the results, since the dry density of the soil varies appreciably from point to point.
12. The weight of sand (Wa) in gm required to fill the calibrating container shall be calculated from the following formula
    Wa= W1-W2-W3 where
    W1= Weight of pouring cylinder and sand before pouring into calibrating cylinder in gms
    W2= Mean weight of sand in cone in gm.
    W3= Mean weight of cylinder with residual sand after pouring into calibrating cylinder and cone in gms.

13. The bulk density of the sand Ys in (gm/cc) shall be calculated from the formula: Ys= Wa/V, where V= Volume of calibrating cylinder in cc
14. The weight of sand (Wb) in gm required to fill the excavated hole shall be calculated from the following formula:
    Wb= W1-W4-W2, Where
    W1= Weight of cylinder and sand before pouring into the hole in gm
    W2= Mean weight of sand in cone in gm.
    W4= Weight of cylinder and sand after pouring into hole and cone in gm
15. The bulk density of the soil Yb shall be calculated from the following formula
    Yb= (Ww/Wb)* Ys gm/cc, where
    Ww= Weight of natural soil excavated in gm.
    Wb= Weight of sand required to fill the hole in gm.
    Ys= Bulk density of sand.
16. The density of the dry soil Yb shall be calculated from the formula
    Yd= (Ww/Wb) * Ys gm/cc Or (100/(100+W)) * Yb gm/cc, where
    W= Moisture content of the soil in percent.
    Wd= Weight of dry soil from the hole in gm and
    Wb= Weight of sand required to fill the hole in gm
17. The following values shall be replaced
    a) Dry density of soil in gm/cc
    b) Moisture content of the soil in percent.

The permissible limit of the field density of observed sample should be 95% of the field density in the case of embankments and 97% in the case of sub-grade.

Field Density of Soil
(Sand Replacement Method)

Name of the work:

A **Calibration**

1	Weight of sand pouring cylinder and full of sand	W1gm	:			
2	Weigh of sand in cone	W2 gm	:			
3	Volume of calibrating container	Va cum	:			
4	Weight of cylinder and sand filling the calibrating container	W3g	:			
5	Weight of sand filling calibrating container and cone Wa	Wa= (W1-W3-W2)	:			
6	Bulk density of sand	Ys= (Wa/Va) g/cum	:			

B **Field Density Test**

7	Weight of sand pouring cylinder and full of sand	W1gm	:			
8	Weight of moist soil / material from excavated hole	W gm	:			
9	Weight of cylinder and sand after filling the excavated hole	W4 gm	:			
10	Weight of sand in the excavated hole (Wb)	Wb= (W1-W4-W2) gm	:			
11	Volume of sand filling the excavated hole (V)	V = Wb/Ys)cum	:			
12	In situ bulk density of wet excavated soil (Y)	Y=(W/V) gm/cum	:			
13	Weight of soil samples for moisture content determination					
	Wet weight		:			
	Dry weight		:			
	Weight of soil material excavated from the hole after dry	Wd gm	:			
14	Moisture content of excavated soil (W%)	W%= (Wm-Wd)/Wd	:			
15	In situ bulk density of dry soil Yd	Yd= (100y)/(100+w)	:			

		gm/cum				
	Or					
	In situ bulk density of dry soil (Yd)	Yd = ((Wd y)/(W)) gm/cum	:			

For Gravel Sub base, Earth work Yd>=1.65 gm/cc

Field density of soil
(Core Cutter Method)

1	Volume of Core cutter	V cc	:	997.86	
2	Weight of empty core cutter	W g	:		
3	Weight of core cutter and wet soil	W1 g	:		
4	Weight of wet soil	(W1-W) g	:		
5	Bulk density yb	yb= (W1-W)/V gm/cc	:		
6	Container No.		:		
7	Weight of container and soil sample	W2			
8	Weight of container and dry soil sample	W3	:		
9	Moisture content	(W2-W3) gm	:		
10	Weight of empty container	W4 gm	:		
11	Weight of dry soil	(W3-W4) gm	:		
12	Percentage of moisture content	(W2-W3)/ (W3-W4) *100	:		
13	Dry density (yd)	yd= (100/(100+m)) yb gm/cc			

For Gravel Sub base, Earth work >=1.65 gm/cc

Determination of CBR of Soil in the Field
Field CBR Test (IS 2720)

Procedure:

The general surface area to be tested should be exposed, cleaned of all loose and dried material and leveled. Extreme care shall be taken not to disturb the test surface. A circular area of about 30cm in diameter is trimmed. Particular care should be taken at the center where the plunger is to be seated. The surcharge load of 15kg (including annular weight) is placed on this surface and the plunger is seated properly. The dial gauge to measure the penetration is attached to the plunger from an independent datum frame. A seating load of 4kg is applied and the load and penetration dials are set to zero.

The load is applied to the plunger by means of jack such that the rate penetration is approximately 1.25 mm/ minute. The load readings noted for at penetration 0.0,0.5,0.2,0,0.25,3.0,4.0,5.0,7.5,10.0,12.5mm. The load is released and moisture content specimen is taken from underneath plunger.

Calculation:

The load penetration curve is plotted, and the CBR value is calculated. The correction is applied where necessary i.e., in the case of load- penetration curves which are concave upwards.
Three in place CBR test shall performed at each elevation to be tested and the average value is adopted. However if the three tests in any group do not show reasonable agreement (tolerance of 3 for CBR values upto 10%, 5 for value 10 to 30%, 10 for 30 to 60% and 25 for values greater than 60%. Three additional tests shall be made and the average of six tests is adopted

Bearing Ratio:

Corresponding to the penetration value at which the bearing ratio is desired, corrected load values shall be taken from the load penetration curve and bearing ratio calculated as follows

$$\text{Bearing Ratio} = \frac{Pt*100}{Ps}$$

Where
Pt= Corrected unit (or total) test load corresponding to the chosen penetration value read from the load penetrate curve in kg/cm^2.
Ps= Unit (or total) standard for the same depth of penetration as per Pt taken from the table given below in kg/cm^2 (from Lab test)

Determination of CBR of Soil in the Field Laboratory (IS :2720)

To determine the CBR value of a given soil sample

CBR is ratio of load carries by soil samples at defined penetration level to load carried by standard stone at the above penetration level. The CBR is measure of sharing resistance of the material under controlled density and moisture conditions considering limitations of CBR test, it is stated that the test procedure should be strictly adhered if high degree of reproducibility is desired. The CBR test is conducted in the moulded specimen in the laboratory. Many methods exist today which utilize mainly CBR strength value for pavement structure. The test is simple and extensively investigated for field correlations.

The test consists of causing a cylindrical plunger of 50 mm diameter to penetrate a pavement component material at 1.25mm/ minute. The load for 2.5mm and 5mm are recorded. The load is expressed as a percentage of standard load of values were obtained from the average of a large number of tests on different stones.

Standard load values on crushed stones for different penetration value

Penetration	Standard load	Unit Standard load kg/cm^2
2.5	1370	70
5.0	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

Procedure:

1. 45 Kgs of material is dried and sieved through 20mm sieve.
2. Determine the optimum moisture content and maximum dry density of the given soil sample.
3. Batch of soil (atleast 5.5 Kg for granular soil and 4.5 to 5Kg for grained soil) is mixed with water up to the optimum content.
4. The spacer disc is placed at the bottom of the mould and a filter paper placed over it, the processed soil sample is placed over this.
5. The soil is compacted by dynamic compaction with 56 bowls per layer in three layers with compacted thickness about 50mm each.
6. The color is removed and the excess soil at the top of the third layer is struck of using a straight edge.

7. Such three CBR test specimens are prepared from each mould soil samples are collected for moisture content determination.
8. The filter paper is now placed on the base plate and the mould is turned upside down.
9. The filter paper is placed over the sample top along with the performed plate with adjustable stem over this surcharge weight 5 to 75kg is placed. Soaking is done for 4 days.
10. The sample is allowed to drain off water in a ventricle position for 15 minutes. The sample along with mould is again weighed to calculate the percentage of water absorbed.
11. The surcharge weight is again provided and the assembly with the base plate is placed in the compressive machine. The plunger is brought in contact with the top surface of the sample. A seating load of 4 kg is applied. The dial is attached for measuring the penetration and is set to zero.
12. The load is applied smoothly at the rate of 1.25mm/minute. Load readings are recorded at penetration 0,0.5,1.0,1.5,2.0,2.5,3.0,4.0,5.0,7.5,10.0 and 12.5. The load is released and the mould is removed from the loading machine.
13. A soil sample from the top 3 cm layer is collected and weighed for moisture content determination.
14. Plot graph between penetration (on X-axis) and load on (Y-axis)

Calculation:

CBR penetration= Load carried by soil sample at defined penetration level * 100
Load carried by the standard crushed stones at the above penetration

Observation Sheet:

California Bearing Ratio Test

Compaction moisture content
Dry density

1	2	3	4	5	6

Condition of test specimen: Soaked/ Un soaked

Moisture content: a) at top 3mm layer after soaking=
b) average after soaking=

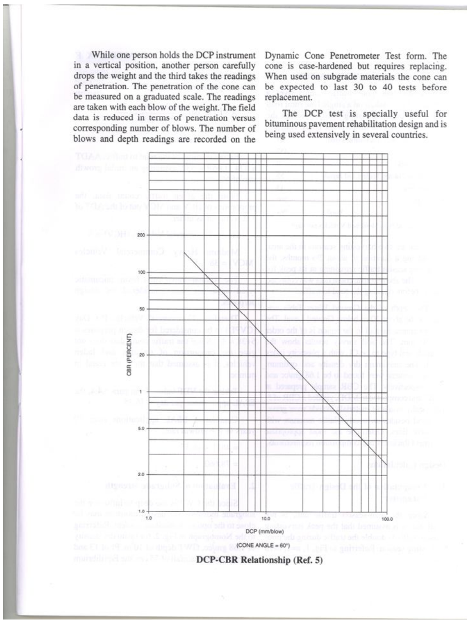
Providing ring calibration factor=
Surcharge weight= Period of soaking expansion ration=

Sample Number	Penetration mm	Providing dial reading	Load on plunger, Kg	Corrected load Kg	Unit/ Kg^2 Cm^2
	0.0				
	0.5				
	1.0				
	1.5				
	2.0				
	2.5				
	3.0				
	4.0				
	5.0				
	7.5				
	10.0				
	12.5				
CBR at 2.5mm			CBR at 5.0mm		
1	2	3	4	5	6

CBR at 2.5mm…………………………… CBR at 5.0m………………………………

Average CBR value at penetration mm= %

CBR with dynamic core penetration method

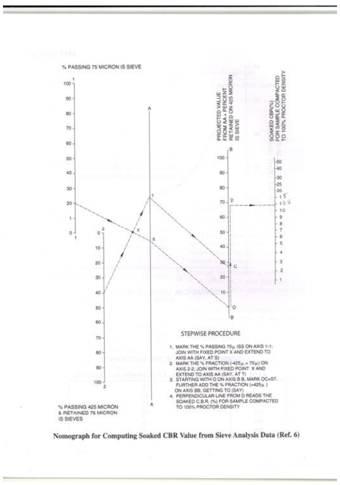


While one person holds the DCP instrument in a vertical position, another person carefully drops the weight and the third takes the readings of penetration. The penetration of the cone can be measured on a graduated scale. The readings are taken with each blow of the weight. The field data is reduced in terms of penetration versus corresponding number of blows. The number of blows and depth readings are recorded on the Dynamic Cone Penetrometer Test form. The cone is case-hardened but requires replacing. When used on subgrade materials the cone can be expected to last 30 to 40 tests before replacement.

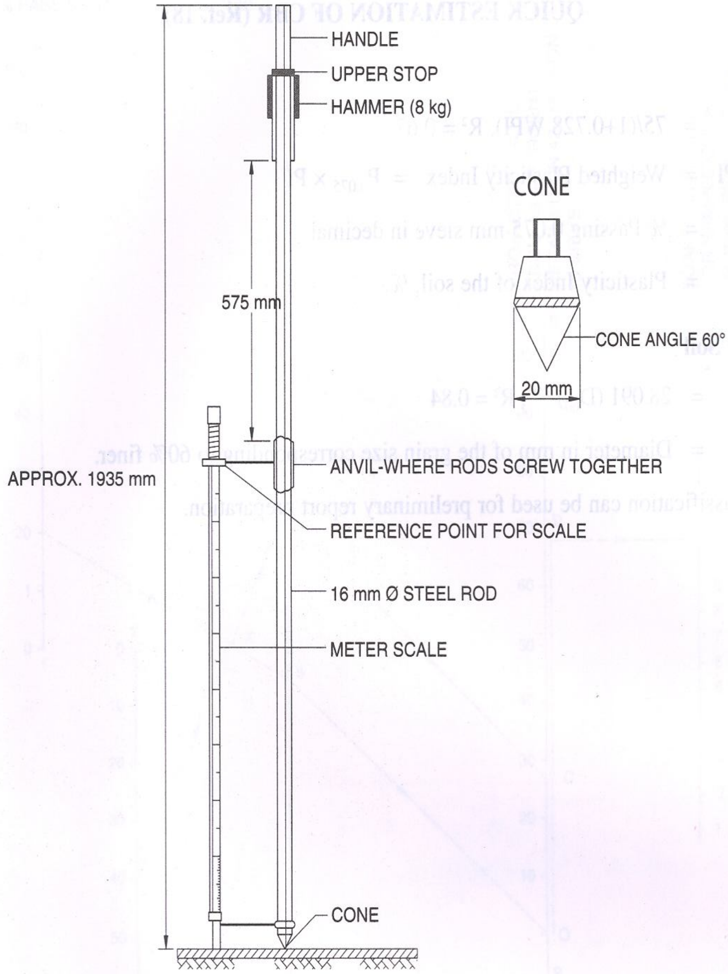
The DCP test is specially useful for bituminous pavement rehabilitation design and is being used extensively in several countries.

DCP-CBR Relationship (Ref. 5)

Nomograph for computing soaked CBR value from sieve analysis data



Nomograph for Computing Soaked CBR Value from Sieve Analysis Data (Ref. 6)



A Typical Dynamic Cone Penetrometer (DCP)

SALIENT FEATURES OF DCP TEST

The Dynamic Cone Penetrometer is a simple device developed in UK for rapid in situ strength evaluation of subgrade and other unbound pavement layers. Essentially, a DCP measures the penetration of a standard cone when driven by a standard force, the reported DCP value being in terms of the penetration of the standard cone, in mm per blow of the standard hammer. The figure above shows a typical DCP. The standard steel cone with an angle of 60° has a diameter of 20 mm. The standard 8 kg drop hammer slides over a 16 mm dia steel rod with a fall height of 575 mm.

Basically, the penetration (in mm) per blow is inversely proportional to the strength of the material. Thus, higher the CBR value of a material being tested, lower will be the DCP value in mm/blow. Besides the measurement of subgrade strength, the DCP tests can be conducted to determine the boundaries between pavement layers with different strengths and their thicknesses. The measurements can be taken upto 1.2 m depth with an extension rod.

While one person holds the DCP instrument in a vertical position, another person carefully drops the weight and the third takes the readings of penetration. The penetration of the cone can be measured on a graduated scale. The readings are taken with each blow of the weight. The field data is reduced in terms of penetration versus corresponding number of blows. The number of blows and depth readings are recorded on the Dynamic Cone Penetrometer Test form. The cone is case-hardened but requires replacing. When used on subgrade materials the cone can be expected to last 30 to 40 tests before replacement.

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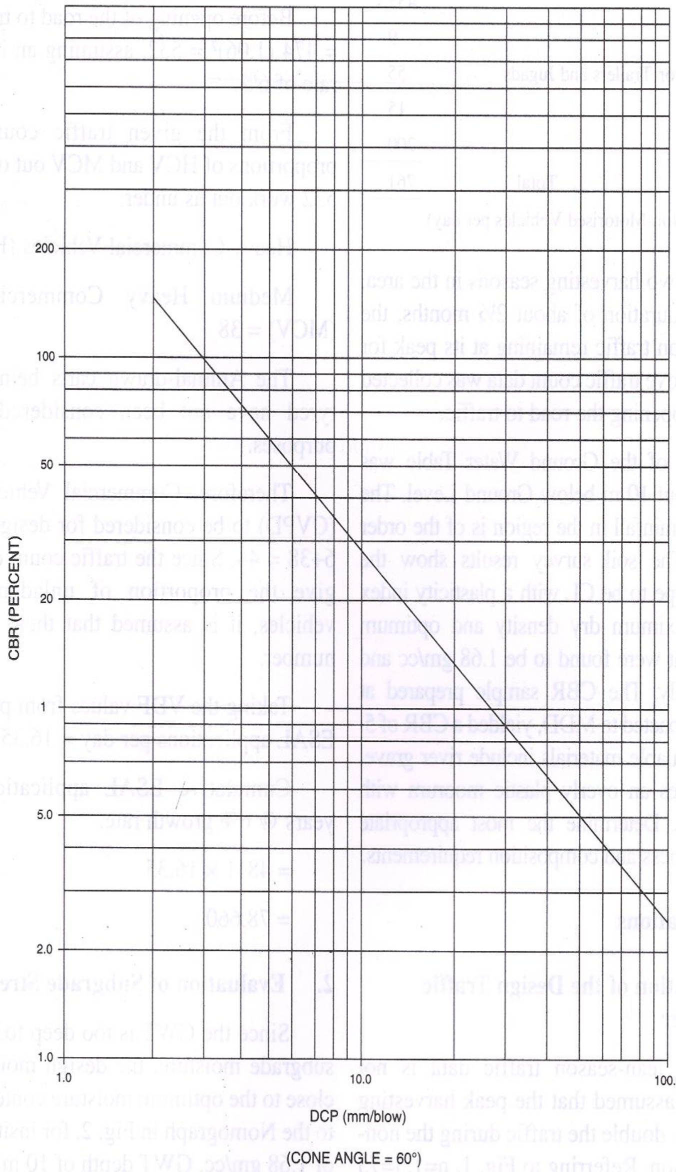
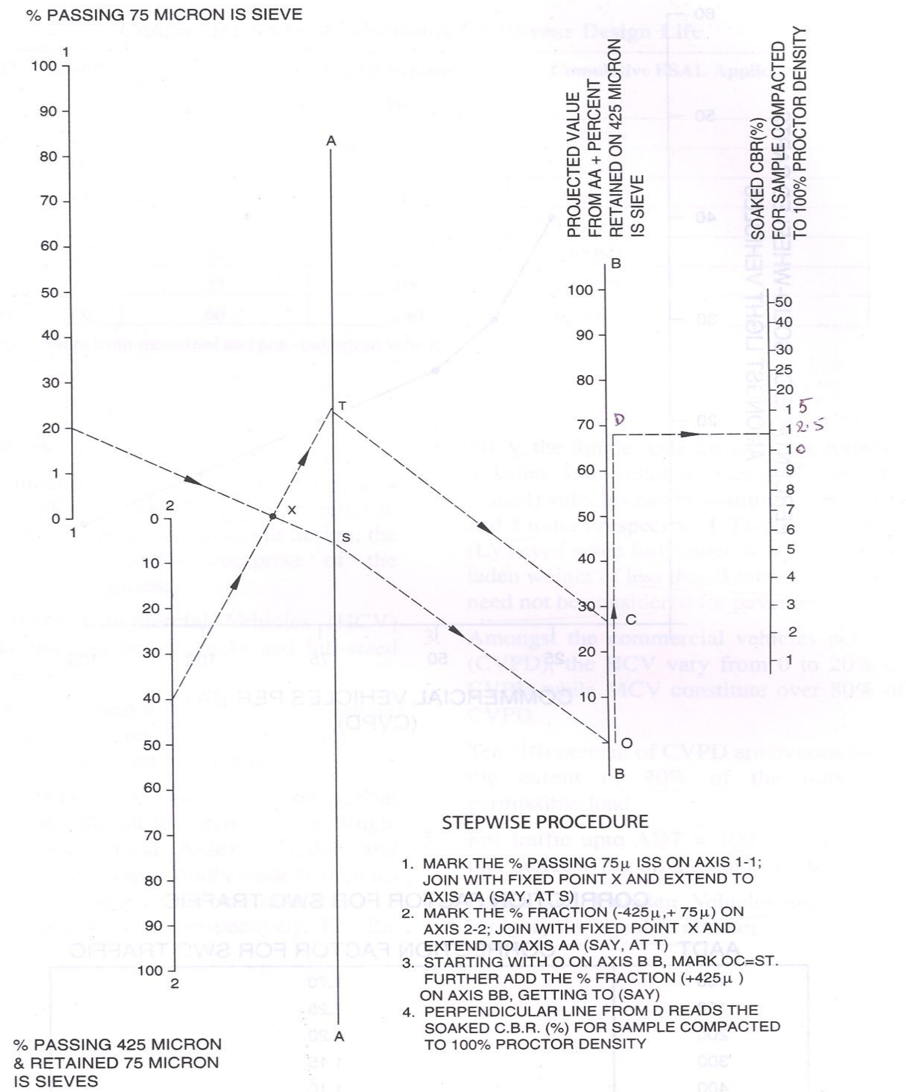


DCP-CBR Relationship (Ref. 5)

Nomograph for computing soaked CBR value from sieve analysis Data



Nomograph for Computing Soaked CBR Value from Sieve Analysis Data (Ref. 6)

Determination of Gradation of Aggregates

(Sieve Analysis)

There are two types of metals that are being used for road construction in PRED

- Normal Size metal
- Graded metal

The following procedure will be adopted for Gradation of metal used for road construction.

Normal size metal:

- 75mm metal is to be tested to pass 100% through 90mm sieve & 100% retain on 65mm sieve.
- 65mm metal is to be tested to pass 100% through 80mm sieve & 100% retain on 50mm sieve.
- 40mm metal is to be tested to pass 100% through 50mm sieve & 100% retain on 25mm sieve.

Graded metal: For Graded metal the sieve sizes specified are

For Grade I

60-65mm metal size	Sieve size	% of passing
	125mm sieve	100
	90mm	90-100
	63mm	25-60
	45mm	0-15
	22.40mm	0-5

For Grade II

50-55mm metal size	Sieve size	% of passing
	90mm	100
	63mm	90-100
	53mm	25-75
	45mm	0-15
	22.40mm	0-5

For Grade III

40-45mm metal size	Sieve size	% of passing
	63mm	100
	53mm	95-100
	45mm	65-90
	22.40mm	0-10
	11.20mm	0-5

Recovery Procedure for oversize metal observed in WBM layers
(vide Cir. Memo No: 711/QC/D3/99, Dt. 02.03.84 of ENC, R&B, Hyderabad.)

Oversize 0%-20% - Recovery at the rate of 25% of difference of rate with the higher size metal.

Oversize 20%-30% - Recovery at the rate of 50% of difference of rate with the higher size metal.

Oversize 30%-40% - Recovery at the rate of 100% of difference of rate with the higher size metal.

Oversize >40% - The layer for that reach is rejected.

Sieve Analysis of Grade III Metal

Name of the work:

Weight of sample : kgs
Location :
Thickness : mm

S.No	IS sieve designation on mm	Wt. of sample retained	Cumulative Wt. retained	% of Wt. of the metal retained	% of Wt. of metal passing observed	% of Wt. of metal passing specified	% of Wt. of metal oversize/ undersize
1	2	3	4	5	6	7	8
1	63					100	
2	53					95-100	
3	45					65-90	
4	22.4					0-10	
5	11.2					0-5	

Sieve Analysis of Grade II Metal

Name of the work:

Weight of sample: kgs Location
Thickness mm

S.No	IS sieve designation on mm	Wt. of sample retained	Cumulative Wt. retained	% of Wt. of the metal retained	% of Wt. of metal passing observed	% of Wt. of metal passing specified	% of Wt. of metal oversize/ undersize
1	2	3	4	5	6	7	8
1	90					100	
2	63					90-100	
3	53					25-75	
4	45					0-15	
5	22.4					0-5	

Determination of Aggregate Impact Value

1. Aggregate passing through 12.5mm IS sieve and retained on 10mm sieve is filled in the cylindrical measure in 3 layers by tamping each layer by 25 blows. Determine the net weight of aggregate in the measure (W1)
2. Transfer the sample from the measure to the cup of the aggregate impact testing machine and compact it by tamping 25 times.
3. The hammer is raised to height of 38cm above the upper surface of the aggregate in the cup and is allowed to fall freely on the specimen.
4. After subjecting the test specimen to 15 blows, the crushed aggregate is sieved on IS 2.36mm sieve.
5. Weight the fraction passing through IS 2.36mm sieve (W2)
6. Aggregate impact value= W2/W1 * 100

The permissible limits for the hard granite sample for road construction

0-10% Exceptionally strong
10-20% Strong
20-30% Satisfactory
>30% Rejected.

Aggregate Impact Value

Name of the work:

S.No	Observations	Test Nos			Average
		1	2	3	4
1	Empty weight of the mould				
2	Weight of the mould filled with the aggregate sample				
3	Weight of the aggregate sample filling in cylinder W1 gms				
4	Weight of the aggregate passing 2.36mm sieve after test W2				
	A.I.V= (W2/W1)				

Avg. Aggregate Impact Value: (%)

Allowable limit:
1. 0-10% Exceptionally strong
2. 10-20% Strong
3. 20-30% Satisfactory
4. Above 30% Rejected.

Determination of Flakiness Index

The sub base metal used for construction of pavements shall be in cubical shape with sharp edges to have better interlocking and good strength. If the sub base metal has any flakiness or elongation it shall be within tolerable limits.

1. The sample is sieved through IS sieve 63,50,40,31.5,25,20,16,12.5,10 and 6.3mm
2. Minimum 200 pieces of each fraction to be tested are taken and weighed (W gm)
3. Separate the flaky material by using the standard flakiness gauge.
4. Take the weight of the flaky material which passes through standard gauge (W gm)
5. Flakiness Index (FI)= $\frac{\text{Weight of material passing the gauge}}{\text{Total weight of sample}}$ *100

For hard Granite material the Flakiness Index is allowable upto 15%.

Flakiness Index Value

Name of the work:

Size Aggregate		Weight of the fraction consisting of at least 200 pieces gm(W)	Thickness gauge size (0.6 times the mean sieve) mm	Weight of the aggregate in each fraction passing thickness gauge gm (W)
Passing through IS sieve mm	Retain on IS sieve mm			
63	50		33.9	
50	40		27	
40	31.5		21.45	
31.5	25		16.95	
25	20		13.5	

20	16		10.8	
16	12.5		8.55	
12.5	10		6.75	
10	6.3		4.879	
Total				

Flakiness Index: w/W*100

Determination of Elongation Index

1. The sample is sieved through IS sieve 63,53,40,31.5,25,20,16,12.5,10 and 6.3mm
2 Minimum 200 pieces if each fraction to be tested are taken and weighed (W gm)
3. Separate the elongated material by using the standard elongation gauge by passing each pieces of aggregates from each fraction in lengthwise .
4. Take the weight of the elongated material which retained on gauge (W gm)
5. Elongation Index (EI)= $\frac{\text{Weight of material retained on gauge}}{\text{Total weight of sample}}$ *100

For hard Granite material the Elongation Index is allowed upto 15%.

Elongation Index Value

Name of the work:

Size Aggregate		Weight of the fraction consisting of at least 200 pieces gm(W)	Thickness gauge size (1.8 times the mean sieve) mm	Weight of the aggregate in each fraction not passing through the gauge gm (W)
Passing through IS sieve mm	Retain on IS sieve mm			
63	50		101.7	
50	40		81	
40	31.5		64.35	
31.5	25		50.85	
25	20		40.5	
20	16		32.4	
16	12.5		25.65	
12.5	10		20.25	
10	6.3		14.67	
Total				

Elogation Index: w/W*100

Determination of Binder Content

1. A representative sample of 150mm*150mm BT flake is to be exactly weighed and placed in the bowl of the extraction apparatus.
2. Cover the sample with commercial grade benzene.
3. The mixture is allowed to stand for about one hour before starting the centrifugal machine.
4. The dried filtering is weighed and then fitted around edge of the bowl and the cover of the bowl is clamped tightly.
5. A beaker is placed under the drain to collect the extract.
6. The machine is revolved and the speed is maintained till the solvent ceases to flow from the drain.
7. The machine is allowed to stop and 200ml of benzene is added to the bowl and the procedure is repeated.
8. The filter ring is removed , the residual material is dried first in air and then in oven at constant temperature of 110^0 C $\pm$ 5^0 C till constant weight is obtained.
9. Filter the extract through a filter paper.

10. Dry the filter paper in the oven and determined the weight of fines in the extract.

% weight of BT content= $\frac{\text{Weight of sample – Weight of metal}}{\text{Weight of sample}}$ * 100

Recovery procedure for deficiency in BT content of Bituminous layer

0-10%- Recovery @ agreement rates
10-15%- Recovery @ 1.50 times agt. Rates.
>15%- Rejection of layer for the reach.

Determination of Penetration Value of Bitumen (IS 1203)

Object:

To determine the penetration of asphaltic bitumen and fluxed native asphalt and the blown type bitumen.

Penetration:

The penetration of a bituminous material is the distance in tenths of millimeter that a standard needle will penetrate vertically in to a sample of the material under standard conditions of temperature, load and time.

Apparatus:

Container
A metal or glass cylindrical, flat bottom container of essentially the following dimensions shall be used.

For penetration below	225
Diameter, mm	55
Internal depth, mm	55
For penetration between	225 to 350
Diameter, mm	70
Internal depth, mm	45

Needle
A straight, highly polished, cylindrical, hard steel road.

Water Bath:
A water bath preferably with the most maintained at 2.5$\pm$0.1 degrees containing not less than 10 liters of water, the sample being immersed to a depth of not less than 100mm from the top and supported on a perforated shelf not less than 50m from the bottom of the bath.

Transfer Dish:

A small dish tray, provided with some means which ensure a firm bearing and prevent the rocking of the container and of such capacity as will ensure complete immersion of the container during the test.

Penetration Apparatus:

Any apparatus which allow the needle to penetrate without appreciable friction, and which is accurately calibrated to yield results in tenths of millimeter shall be adopted.

Thermometer:

It shall be conform the following requirements

Characteristic	Requirement
Range	0 to 44^0C
Gradations	0.2^C
Immersion	65mm
Overall length	340±10mm
Stem Diameter	5.5 to 8.0mm
Bulb length	10 to 16mm
Bulb Diameter	Not longer than stem diameter
Length of graduated portion	150 to 190mm
Longer lines at each	1^0 C and 5^c
Figured at each	5^C
Scale	± 0.2^0

Procedure:

Soften the material to a pouring consistently at a temperature not more than 60^0C and pitches and not more than 90^0C for bitumens above the respective approximate softening and stir it thoroughly until it is homogeneous and is free from air bubbles add water. Pour the melt into the container to a depth atleast 10mm in excess of the expected penetration. Protect the sample from dust and allow it to cool in an atmosphere at a temperature between 15 to 30^0C for 1 ½ to 2 hours for 45mm deep container and 1 to 11/2 hours when the container of 35mm depth is used. Then place it along with the transfer dish in the water bath at 25.0± 0.0^)C and allow it to remain for 1 to 11/2 to 2 in the case of cutback bitumen and Digiboi type cutback bitumen reside left over distillation shall be used for the test.

Testing:

1. Unless otherwise specified, testing shall be carried out at 25.0± 0.1^0 C.
2. Fill the transfer dish with water from the water bath to a depth sufficient to cover the container completely, place the sample in it and put in upon the stand of the penetration apparatus. Adjust the needle (previously washed clean with benzene, carefully dried and loaded with the specified weight) to make contract with the surface of the sample.
3. This may be accomplished by placing the needle point in contact wit its image reflected by the surface of the material from a suitably placed source of light.
4. Unless otherwise specified, load the needle holder with the weight required to make a total moving weight (that is the sum of the weight of the needle, carrier and superimposed weights) of 100 ± 0.25g.
5. Note the reading of the dial or bring the pointer to zero. Release the needle and adjust the points. If necessary to measure the distance penetrated. Make atleast three determinations at points on the surface of the sample not less than 10mm from the side of the dish. After each test, return the sample and transfer dish to the water bath, and wash the needle clean with benzene and dry. In the case of material of penetration greater than 225, three determinations on each of two identical specimens using a separate needle for each determination to avoid disturbance of the specimen.

Reporting of Results:

1. Express the depth of penetration of the needle in tenths of millimeter.
2. The value of penetration reported shall be mean of not less than three determinations whose values do not differ by more than amount given below

Penetration	Maximum Difference
0 to 40	2
5 to 149	4
150 to 249	6
25 and above	8

Compressive Strength of Concrete

1. Fill the mould with freshly mixed concrete in 3 equal layers, compact it with tamping bar giving 35 bowls in each layer uniformly and finally level off with the trowel. Mark the date of casting cube and the identification of member.
2. Keep the specimen in moist air of atleast 90% relative humidity and at a temp. of 27 plus or minus 2 degree Celsius for 24 hours. Alternatively, cover the moulds with wet gunny bags.
3. After specified time period is over remove the specimen from the mould and submerge it in clean fresh water, maintained at a temp. of 27 $\pm$ 2 ^{0} Celsius till the cube is ready for test.
4. Take out the cube after for 3,7,14,24,28 days as required and wipe off the surface water with cloth.
5. Note down the dimensions and weigh the cube and then place it in the compression testing machine. Such that the four corners are enclosed with the circle of the rim.
6. Apply the load on the cube at the rate of 130 to 140 kg/sq.cm/Min. till it fails record the maximum load applied.
7. The compressive strength is calculated in N/ sq. mm by dividing maximum low takes in Newtons by the cross sectional area of the cube calculated from the mean dimension of the section.
8. Inspect the type of failure and record it.

Initial & Final Setting Of Cement
(Vicat apparatus IS:5513-1969)

1. Take 350 gms of cement, mix with 0.85 times of water to give a standard consistency.
2. Start a stop watch at the instant when the water is added to the cement.
3. Fill the standard mould with the cement paste completely and level the top surface with a trowel.
4. The cement block thus prepared is the test block.

Initial Setting time:

5. Place the test block confined in the mould under the rod bearing initial setting needle. Lower the needle gently in contact with the surface of the test block and quickly release allowing it to penetrate into the test block.
6. Repeat this procedure until the needle fails to pierce the block for 5$\pm$ 0.5mm measured from the bottom of the mould.
7. The total time elapsed shall be initial setting time._

Final Setting time:

8. Replace the needle of the vicats apparatus with an annular ring.
9. Repeat the procedure of lowering the needle and the annular ring into the test block to penetrate.
10. After some time the needle makes an impression on the surface of the test block but the ring fails to do so.
11. The time elapsed from the time of adding water to the cement till the above state shall be the final setting time.

Initial Setting time (minimum) : 30 minutes
Final Setting time (maximum): 600 minutes

Frequency of Testing:

SNo	Type of construction	Test	Test Method	Desirable frequency
1	Earth work	Moisture content prior to compaction	IS 2720 part III	2-3 tests per 250 cum loose soil
		Dry density of compacted layer	IS 2720 part XXVIII	One test per 1000cum
		CBR (for material to be placed in sub-grade		As required
2	Granular and mechanically stabilized sub base	Gradation	IS 2720 part IV	One test per 200cum
		Atterberg limits	IS 2720 part V	One test per 200 cum
		Moisture content prior to compaction	IS 2720 part III	One test per 250 cum
		Dry density of compacted layer	IS 2720 part XXVIII	One test per 500 cum
3	Water bound macadam	Aggregate impact value	IS 2386 part IV	One test per 200 cum
		Grading of aggregates and screenings	IS 2386 pat I	One test per 100 cum
		Flakiness index of aggregates	IS 2386 part I	Same as the aggregate impact value
		Camber, thickness of layer and grading, width of metal layer		Regularly
4	Bituminous works	Temperature of binder in boiler and at application		At closed intervals
		Aggregate impact value test	IS 2389 part IV	One test 50 cum of aggregate
		Grading of aggregates	IS 2386 part I	One test per 25 cum
		Rate of spread of bitumen/ aggregate/mix		One test per 500 sqm
		Binder content		Two tests/ day
		Quality content		As required.
		Stripping value of aggregates		One set of 3 representative specimens of each sources of supply
		Camber, thickness, width of BT layer		

Consolidation:

A) WBM Surface, Earth Work and Murram Gravel compaction

a) WBM Surface – 10 Sqm.:

i) 100 mm thick compacted - 490 Sqm. Per day of 8 Hrs.
ii) 75 mm thick compacted - 560 Sqm. Per day of 8 Hrs.
iii) 50 mm thick compacted - 650 Sqm. Per day of 8 Hrs.
iv) 40 mm thick compacted - 740 Sqm. Per day of 8 Hrs.

Consolidation for WBM Roads is to be carried out from edge to centre with 30% overlap with power roller

b) Earth Work and Murram Gravel compacted - 425 Cum per day of 8 Hrs.

B) B.T. Work and Bituminous surface 10 Sqm.

i) Surface dressing of wearing coat	-	465 Sqm. Per day of 8 Hrs.
ii) Bitumen macadam / built in spray grout 50 mm thick compacted	-	280 Sqm. Per day of 8 Hrs.
iii) Seal coat	-	930 Sqm. Per day of 8 Hrs.
iv) Asphaltic concrete 40 mm thick	-	125 Sqm. Per day of 8 Hrs.
v) 75 mm thick compacted at Bituminous macadem	-	200 Sqm. Per day of 8 Hrs.

Power roller rolling for B.T. Work is to be done from centre to edge with 30% overlap.