



ARUN SOIL LAB PVT. LTD.

Geotech & Material Consultants

Accredited by - National Accreditation Board for Testing and Calibration Laboratories

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TC-5382

*** QUALITY CONSCIOUSNESS IS OUR CORE CONCEPT**



National Accreditation Board for
Testing and Calibration Laboratories
(A Constituent Board of Quality Council of India)



CERTIFICATE OF ACCREDITATION

ARUN SOIL LAB PVT. LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

**"General Requirements for the Competence of Testing &
Calibration Laboratories"**

for its facilities at

636/110, BUDH VIHAR, LUCKNOW, UTTAR PRADESH, INDIA

in the field of

TESTING

Certificate Number: TC-5382

Issue Date: 13/01/2019

Valid Until: 12/01/2021

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL



Anil Relia
Chief Executive Officer

PROVIDE SERVICES IN -

- Geotech Investigation
- Material Testing
 - Soil
 - Bricks
 - Cement
 - Aggregate
 - Bitumen
 - Reinforcement Bar/Steel/Flats
- Compression Strength Test of Cement
- Concrete Cubes & Paving Blocks
- Plate Load Test
- Modulus of Sub-grade Reaction (K-value)
- Pile Load Test
- Electrical Resistivity Test
- Benkelman Beam Deflection Survey
- Concrete Mix Proportioning
- Bituminous Mix Proportioning
- Topographical Survey
 - By Differential Global Positioning System(DGPS)
 - By Total Station
- Non Destructive Testing
 - Rebound Hammer
 - Pile Integrity
- TRL Dynamic Cone Penetrometer Test
- Traffic Engineering
 - Classified Traffic Volume Count
 - Origin and Destination Survey
 - Intersection Survey
 - Axle Load Survey

FIELD TESTS ON SOIL FOR GEOTECH INVESTIGATION

STANDARD PENETRATION TEST (IS : 2131-1981)

The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil.

| PENETRATION RESISTANCE IS : 2131-1981 | | | |
|--|---------------|-------------------|---------------|
| COHESIVE SOIL | | NON-COHESIVE SOIL | |
| DESCRIPTION | S.P.T. VALUES | DESCRIPTION | S.P.T. VALUES |
| Very Soft | < 2 | Very Loose | < 4 |
| Soft | 2 - 4 | Loose | 4 - 10 |
| Medium | 4 - 8 | Medium | 10 - 30 |
| Stiff | 8 - 16 | Dense | 30 - 50 |
| Very Stiff | 16 - 32 | Very Dense | > 50 |
| Hard | > 32 | | |



SUBSURFACE SOUNDING (IS : 4968 - PART 1 & 2)

Cone penetration testing is a means of testing soil resistance by forcing a rod with a cone-shaped tip into the soil at a measured rate. The extent of penetration at each stage indicates the resistance to shear and the overall ability of the soil to bear a load.

NOTE - However, for the 62.5 mm cone driven dry up to a depth of 9 m (without bentonite slurry) for medium to fine sands, the following relationships have been developed by the Central Building Research Institute, Roorkee. These relationships, when utilized, shall be used with caution.

$$N_{cbr} = 1.5 N \text{ (upto a depth of 4m)}$$

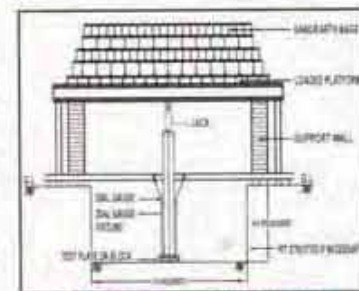
$$N_{cbr} = 1.75 N \text{ (for depths of 4 to 9 m.)}$$

where N_{cbr} = cone resistance obtained with a 62.5 mm cone driven dry (number of blows for 300 mm penetration)

N = resistance to penetration in the standard penetration test, (number of blows for 300 mm penetration)

PLATE LOAD TEST (IS : 1888-1982)

Plate Load Test is a field test for determining the ultimate bearing capacity of soil and the likely settlement under a given load. The Plate Load Test basically consists of loading a steel plate placed at the foundation level and recording the settlements corresponding to each load increment. The test load is gradually increased till the plate starts to sink at a rapid rate. The total value of load on the plate in such a stage divided by the area of the steel plate gives the value of the ultimate bearing capacity of soil. The ultimate bearing capacity of soil is divided by suitable factor of safety to arrive at the value of safe bearing capacity of soil.



TYPICAL SETUP FOR REACTION LOADING PLATFORM

The Settlement of footing can be calculated corresponding to plate settlement from following formula -

$$S_f = S_p \left[\frac{B (B_p + 0.3)}{B_p (B + 0.3)} \right]^2 \text{ Where, } B = \text{the size of footing in meter, } B_p = \text{size of test plate in meter, } S_p = \text{Settlement of test plate in meter}$$

$S_f =$ Settlement of footing in meter

MODULUS OF SUBGRADE REACTION (IS : 9214-1979)

The modulus of sub grade reaction (k) is known as ratio of load per unit area of horizontal surface of a mass of soil to corresponding settlement of the surface. It is determined as the slope of the secant drawn between the point corresponding to zero settlement and the point of 1.25 mm settlement, of a load-settlement curve obtained from a plate load test on a soil using a 75 cm diameter or smaller loading plate with corrections for size of plate used.

$$K = \frac{p}{0.125} \text{ MPa/cm (kgf/cm}^2 \text{ /cm)}$$

where, p = load intensity corresponding to settlement of plate of 1.25 mm.

Alternatively, the K -value may be defined as a pressure of 0.07 MPa (0.70 kgf/cm²) divided by the corresponding settlement. That is, when a standard 75 cm diameter steel bearing plate is subjected to a load 3100 kgf, say

$$K = \frac{0.07}{0.125} \text{ MPa/cm}$$

where, d = settlement in cm.



ELECTRICAL RESISTIVITY TEST (IS : 3043 - 1987)

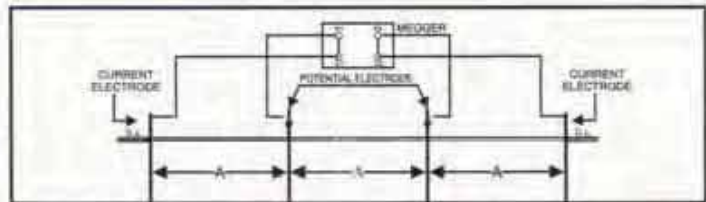
Soil resistivity is a measure of how much the soil resists the flow of electricity. It is a critical factor in design of systems that rely on passing current through the Earth's surface. An understanding of the soil resistivity and how it varies with depth in the soil is necessary to design the grounding system in an electrical substation, or for lightning conductors. It is needed for design of grounding (earthing) electrodes for substations and High-voltage direct current transmission systems. In most substations the earth is used to conduct fault when there are ground faults on system.

Wenner's four electrode method is recommended for these types of field investigation. In this method four electrodes are driven into the earth along a straight line at equal intervals and electric field is produced by passing a DC current of known magnitude between the outer two electrodes and the potential drop for surface current flow is measured by means of the inner electrodes.

EARTH TESTER - The earth tester used the four terminal megger as shown in the enclosed figure . The resistivity is evaluated by the formula given below -

where
$$\rho = 2 \pi A R$$

ρ = resistivity of soil in ohm-meter
 A = distance between two successive electrodes in meter
 R = megger reading in ohms



IN-SITU DENSITY

Whenever soil is placed as an engineering fill, it is usually compacted to a dense state, to obtain satisfactory engineering properties. Compaction on site is usually effected by mechanical means such as rolling, ramming or vibrating. Control of compaction is necessary to achieve a satisfactory result at a reasonable cost. Laboratory compaction tests provide the basis for control procedures used on site. There are two methods for obtaining insitu density as follows -

- Sand Replacement method as per (IS-2720-PART-28) - 1975
- Core Cutter method as per IS: 2720 (Part 29) - 1975

COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE

| Sl. No. | Type of Work / Material | Relative compaction as percentage of maximum laboratory dry density as per IS:2720 (Part 8) |
|---------|--|---|
| 1 | Subgrade and earthen shoulders | Not less than 97 |
| 2 | Embankment | Not less than 95 |
| 3 | Expansive Clays | |
| | a) Subgrade and 500 mm portion just below the subgrade | Not allowed |
| | b) Remaining portion of embankment | Not less than 90 |

IN-SITU CALIFORNIA BEARING RATIO (IS : 2720-PART 31-1969)

The Ratio of the force per unit area to penetrate a soil mass with Circular Piston of 50 mm dia @ of 1.25 mm/min to that for corresponding penetration of a standard material.

Where,
$$CBR = (Pt/Ps)$$

P_t = Corrected Test Load Corresponding chosen Penetration
 P_s = Unit Standard Load for the same depth of Penetration

| PENETRATION DEPTH (mm) | UNIT STANDARD LOAD (kgf/cm ²) | TOTAL STANDARD LOAD (kgf) |
|------------------------|---|---------------------------|
| 2.5 | 70 | 1370 |
| 5.0 | 105 | 2055 |
| 7.5 | 134 | 2630 |
| 10.0 | 162 | 3180 |
| 12.5 | 183 | 3600 |

TRL DYNAMIC CONE PENETROMETER TEST (IRC : SP-72 -2007)

The Dynamic Cone Penetrometer Test provides a measure of a material's in-situ resistance to penetration. The test is performed by driving a metal cone into the ground by repeated striking it with a 8 Kg weight dropped from a distance of 575 mm. The penetration of the cone is measured after each blow and is recorded to provide a continuous measure of shearing resistance up to 1200 mm below the ground surface. Test results can be correlated to California Bearing Ratios.

BENKELMAN BEAM DEFLECTION TEST (IRC : 81-1997)

Basic Principles of Deflection Method Performance of flexible pavements is closely related to the elastic deflection of pavement under the wheel loads. The deformation or elastic deflection under a given load depends upon subgrade soil type, its moisture content and compaction, the thickness and quality of the pavement courses, drainage conditions, pavement surface temperature etc

$D_c = \bar{X} + \sigma \cdot 2$ (for NH and SH)
 $D_c = \bar{X} + \sigma$ (for all other roads)

Where, D_c = Characteristic Deflection, \bar{X} = Mean Deflection, σ = Standard Deviation



LAB TESTS FOR GEOTECH INVESTIGATION

ACCORDING TO IS : 2720

PREPARATION OF DRY SOIL SAMPLE (PART 1-1983)

Soil sample as received from the field shall be dried in the air or in sun. In wet weather a drying apparatus may be used in which case the temperature of the sample should not exceed 60°C. The clods may be broken with a wooden mallet to hasten drying. The organic matter, like tree roots and pieces of bark should be removed from the matter other than soil, like shells should also be sample. Similarly, separated from the main soil mass. A noting shall be made of such removals and their percentage of the total soil sample noted.

WATER CONTENT (PART 2-1973)

In almost all soil tests natural moisture content of the soil is to be determined. The knowledge of the natural moisture content is essential in all studies of soil mechanics. To sight a few, natural moisture content is used in determining the bearing capacity and settlement. The natural moisture content will give an idea of the state of soil in the field.

SPECIFIC GRAVITY (PART 3-1973)

Specific gravity is the ratio of the weight in air of a given volume of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature.

GRAIN SIZE ANALYSIS (PART 4-1985)

The grain size analysis is widely used in classification of soils. The data obtained from grain size distribution curves is used in the design of filters for earth dams and to determine suitability of soil for road construction, air field etc. Information obtained from grain size analysis can be used to predict soil water movement although permeability

ATTERBERG LIMIT (PART 5-1985)

The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil, such as its shrinkage limit, plastic limit, and liquid limit. As a dry, clayey soil takes on increasing amounts of water, it undergoes dramatic and distinct changes in behavior and consistency. Depending on the water content of the soil, it may appear in four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil is different and consequently so are its engineering properties.

SHRINKAGE FACTORS (PART 6-1972)

The soil shrinkage is defined as the specific volume change of soil relative to its water content and is mainly due to clay swelling properties



COMPACTION OF SOIL (PART 7-1980 & PART 8-1983)

Soil compaction is defined as the method of mechanically increasing the density of soil. In construction, this is a significant part of the building process. If performed improperly, settlement of the soil could occur and result in unnecessary maintenance costs or structure failure. Almost all types of building sites and construction projects utilize mechanical compaction techniques.

DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS

| Sl. No. | Type of Work | Maximum laboratory dry unit weight when tested as per IS:2722 (Part II) |
|---------|---|---|
| 1 | Embankments up to 3 metres height, not subjected to extensive flooding | Not less than 15.20 Kn/cu.m. |
| 2 | Embankments exceeding 3 metres height or embankments of any height subject to long periods of inundation. | Not less than 16.00 Kn/cu.m. |
| 3 | Subgrade and earthen shoulders/verges/backfill. | Not less than 17.30 Kn/cu.m. |

SPECIFICATION OF MOULD ACCORDING TO PARTICLE SIZE

| MATERIAL PASSING | TYPE OF MOULD | NO. OF BLOWS | INSIDE DIA (mm) | HEIGHT (mm) | VOLUME (cc) |
|------------------|---------------|--------------|-----------------|-------------|-------------|
| 19mm | 1 | 25 | 100±0.4 | 127.3±0.2 | 1000cc |
| 37.5mm | 2 | 55 | 150±0.4 | 127.3±0.2 | 2250cc |

SPECIFICATION OF RAMMERS

| | STANDARD PROCTOR TEST | MODIFIED PROCTOR TEST |
|------------------|-----------------------|-----------------------|
| Weight of Rammer | 2.60 Kg. | 4.90 Kg |
| Fall of Rammer | 310 mm | 450 mm |
| No. of Layers | 3 Nos. | 5 Nos. |

UNCONFINED COMPRESSIVE STRENGTH TEST (PART 10-1973)

The unconfined compressive strength (UCS) is the maximum axial compressive stress that a right-cylindrical sample of material can withstand under unconfined conditions-the confining stress is zero. It is also known as the uniaxial compressive strength of a material because the application of compressive stress is only along one axis-the longitudinal axis-of the sample.





TRIAXIAL SHEAR TEST (PART 11 & 12 -1986)

In a triaxial shear test, stress is applied to a sample of the material being tested in a way which results in stresses along one axis being different from the stresses in perpendicular directions. This is typically achieved by placing the sample between two parallel platens which apply stress in one direction, and applying fluid pressure to the specimen to apply stress in the perpendicular directions. The triaxial test is carried out in a cell on a cylindrical soil sample having a length to diameter ratio of 2. The usual sizes are 76 mm x 38 mm and 100 mm x 50 mm. Three principal stresses are applied to the soil sample, out of which two are applied water pressure inside the confining cell and are equal. The third principal stress is applied by a loading ram through the top of the cell and is different to the other two principal stresses. The soil sample is placed inside a rubber sheath which is sealed to a top cap and bottom pedestal by rubber O-rings. For tests with pore pressure measurement, porous discs are placed at the bottom, and sometimes at the top of the specimen. Filter paper drains may be provided around the outside of the specimen in order to speed up the consolidation process. Pore pressure generated inside the specimen during testing can be measured by means of pressure transducers.

DIRECT SHEAR TEST (PART 13 -1986)

The concept of direct shear is simple and mostly recommended for granular soils, sometimes on soils containing some cohesive soil content. The cohesive soils have issues regarding controlling the strain rates to drained or undrained loading. In granular soils, loading can always assumed to be drained. A schematic diagram of shear box shows that soil sample is placed in a square box which is split into upper and lower halves. Lower section is fixed and upper section is pushed or pulled horizontally relative to other section; thus forcing the soil sample to shear/fail along the horizontal plane separating two halves. Under a specific Normal force, the Shear force is increased from zero until the sample is fully sheared. The relationship of Normal stress and Shear stress at failure gives the failure envelope of the soil and provide the shear strength parameters (cohesion and internal friction angle).



CONSOLIDATION TEST (PART 15 -1986)

This test is performed to determine the magnitude and rate of volume decrease that a laterally confined soil specimen undergoes when subjected to different vertical pressures. From the measured data, the consolidation curve (pressure-void ratio relationship) can be plotted. This data is useful in determining the compression index, the recompression index and the preconsolidation pressure (or maximum past pressure) of the soil. In addition, the data obtained can also be used to determine the coefficient of consolidation and the coefficient of secondary compression of the soil.

The height of the ring shall not be less than 20mm with a diameter to height ratio of about 3 and further the specimen height shall not be less than 10 time of maximum particle size.

CALIFORNIA BEARING RATIO TEST (PART 16 -1979)

The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.



PERMEABILITY OF SOIL (PART 17 -1986)

The soil permeability is a measure indicating the capacity of the soil or rock to allow fluids to pass through it. The permeability coefficient can be determined in the laboratory using falling head permeability test, and constant head permeability test. The knowledge of this property is much useful in solving problems involving yield of water bearing strata, seepage through earthen dams, stability of earthen dams, and embankments of canal bank affected by seepage, settlement etc.

FREE SWELL INDEX (PART 40 -1977)

The clay and specially the black cotton soils have a tendency to swell in small or more proportion when submerged in water. Free swell or differential free swell also termed as free swell index, is the increase in volume of soil with out any external constraint when subjected to submergence in water.



SWELLING PRESSURE OF SOIL (PART 41 -1977)

The one-dimensional consolidometer is widely used for the measurement of swelling characteristics of expansive soils. The swelling pressure in the consolidometer test has been defined as the pressure which prevents the specimen from swelling or the pressure which is required to return a swelled specimen back to its original state (void ratio, height) prior to swelling.



NON-DESTRUCTIVE TESTS

PILE INTEGRITY TEST (IS : 14893 - 2001)

INTEGRITY TESTING OF PILES BY PILE INTEGRITY TESTER

Pile Integrity Testing (P.I.T), a low strain method for integrity testing of driven piles and drilled shafts, uses a variety of techniques for the interpretation of force and velocity records taken under the impact of a light hammer blow. This is a system of assessing the integrity of piles by the use of low stress wave imparted to the pile shaft and is also known as Sonic Integrity or Sonic echo method.

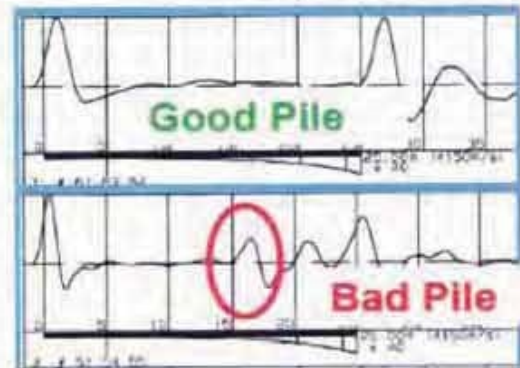
PEM IMPLEMENTATION

A small impact is administered to the pile's surface, generally using a special hand-held hammer, and an acoustic wave from the impact propagates down through the pile. Variations in the shape and material quality of the pile produce reflections of the wave, which are observed as they return to the surface. Surface vibrations are recorded until all primary reflections have been observed. Reflections are then interpreted, considering their nature and times of observation, to assess pile integrity.

It is very important to first grind the top surface to create level and smooth zones for placing the accelerometer and applying the blows. Pile top preparation is a key to good data, which is fundamental for a better interpretation.

INTERPRETATION OF RESULTS

The interpretation of results consists of evaluation of data based on the reflections recorded during testing as described above. Reflections are produced by variation in shape, materials, Soil resistance changes, joints etc. The integrity of the pile thus tested is based on such reflections and detected changes in impedance (EA/c) along the pile length when subjected to an impact blow. Here E is the elastic modulus of the pile material, A is cross-sectional area of the pile and c is the wave speed. Impedance variation usually refers to cross-sectional change.



LIMITATIONS OF TEST SYSTEM

1. The test method can generally evaluate for piles upto an L/D ratio of 45 to 60.
2. For piles with greatly varying cross-sectional area especially in layered soils, it may be difficult to distinguish relevant reflections due to construction method and those due to localized discontinuities.
3. Cannot locate defect in cross-section.
4. Although the test system can be used to evaluate length of piles, the determination of pile length is approximate within a range of $\pm 5 - 10\%$ due to variation in concrete density. This implies that the method cannot evaluate defects that could be present in the bottom 5% - 10% of the pile shaft.

TESTING OF CONCRETE BY REBOUND HAMMER (IS : 13311 - Part 2 - 1992)

The concrete test hammer is a mechanical device used for performing rapid, non destructive quality testing on materials in accordance with the customer's specifications; in most cases, however, the material involved is concrete.

The device is to be used exclusively on the surfaces to be tested and on the testing anvil. The device measures the rebound value R . There is a specific relationship between this value and the hardness and strength of the concrete. It is done to assess the compressive strength, quality of concrete in relation to standard requirements.

The factors that are taken into account while ascertaining rebound values R are Impact direction: horizontal, vertically upwards or downwards, age of concrete, size and shape of the comparison sample (cube cylinder), Concrete 100 mm or more in thickness with a maximum particle size 32mm



TOPOGAPHICAL SURVEY

BY TOTAL STATION

A total station or TST (total station theodolite) is an electronic/optical instrument used in modern surveying and building construction. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to readslope distances from the instrument to a particular point.



APPLICATION

- Angle measurement
- Distance measurement
- Coordinate measurement
- Data processing

ADVANTAGE OF USING TOTAL STATIONS

The following are some of the major advantages of using total station over the conventional surveying instruments:

1. Field work is carried out very fast.
2. Accuracy of measurement is high.
3. Manual errors involved in reading and recording are eliminated.
4. Calculation of coordinates is very fast and accurate. Even corrections for temperature and pressure are automatically made.
5. Computers can be employed for map making and plotting contour and cross-sections. Contour intervals and scales can be changed in no time.

BY DIFFERENTIAL GLOBAL POSITIONING SYSTEM

DGPS receiver is the most advanced instrument to determine geographical position by receiving signals from geo-positioning satellite network. There are various categories or types of DGPS receiver available. The field of application of a DGPS receiver depends on its category. The GPS receivers those gives high degree of positional accuracy are generally used for control work. Lower precision DGPS receivers are used for simple verification, navigation purpose etc. Post-processing is used in Differential GPS to obtain precise positions of unknown points by relating them to known points such as survey markers.

The GPS measurements are usually stored in computer memory in the GPS receivers, and are subsequently transferred to a computer running the GPS post-processing software. The software computes baselines using simultaneous measurement data from two or more GPS receivers.

The baselines represent a three-dimensional line drawn between the two points occupied by each pair of GPS antennas. The post-processed measurements allow more precise positioning, because most GPS errors affect each receiver nearly equally, and therefore can be cancelled out in the calculations.

Differential GPS measurements can also be computed in real-time by some GPS receivers if they receive a correction signal using a separate radio receiver, for example in Real Time Kinematic (RTK) surveying or navigation.

The improvement of GPS positioning doesn't require simultaneous measurements of two or more receivers in any case, but can also be done by special use of a single device. In the 1990s when even handheld receivers were quite expensive, some methods of quasi-differential GPS were developed, using the receiver by quick turns of positions or loops of 3-10 survey points



TESTS ON CEMENT

ACCORDING TO IS : 4031-1988

CONSISTENCY - (PART 4)

The basic aim is to find out the water content required to produce a cement paste of standard consistency. The principle is that standard consistency of cement is that consistency at which the Vicat plunger penetrates to a point 5-7mm from the bottom of Vicat mould.

INITIAL & FINAL SETTING TIME - (PART 5)

Initial setting time is that time period between the time water is added to cement and time at which 1.13 mm diameter needle fails to penetrate the cement paste, placed in the Vicat's mould beyond 5 mm \pm 0.5 mm from the bottom of the mould.

Final setting time is that time period between the time water is added to cement and the time at which 5 mm circular cutting edge makes an impression on the paste in the mould but 5 mm attachment does not make any impression.

COMPRESSIVE STRENGTH - (PART 6)

Compressive strength of cement is determined by compressive strength test on mortar cubes compacted by means of a standard vibration machine. Standard sand (IS:650) is used for the preparation of cement mortar.

The specimen is in the form of cubes 70.6mm X 70.6mm X 70.6mm.

FINENESS BY DRY SIEVING - (PART 1)

This experiment is carried out to check the proper grinding of cement. The cement which is produced by an industry is checked for its quality, that either it is good for certain type of construction or it doesn't possess that much strength. If the cement is fine then greater is its cohesiveness, which is the property, required in the concrete because it gives compactness to the concrete. Usually cement loses 10% of its strength within one month of its manufacturing.

FINENESS BY BLAINE AIR PERMEABILITY - (PART 2)

This test method covers determination of the fineness of hydraulic cement, using the Blaine air permeability apparatus, in terms of the specific surface expressed as total surface area in square centimeters per gram, or square meters per kilogram, of cement.



SOUNDNESS BY LE-CHATELIER / AUTOCLAVE - (PART 3)

In the soundness test a specimen of hardened cement paste is boiled for a fixed time so that any tendency to expand is speeded up and can be detected. Soundness means the ability to resist volume expansion.

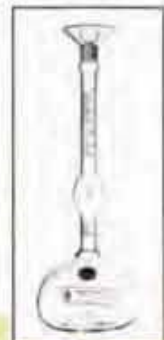
It is very essential that the cement after setting shall not undergo any appreciable change in volume, because change in volume after setting of cement causes

- * Cracks,
- * Undue expansion, and as a result
- * Disintegration of concrete.

SPECIFIC GRAVITY OF CEMENT - (PART 11)

Specific gravity of the cement is the ratio of the mass of a given volume of the cement to that of an equal volume of water at the same condition of temperature. Cement will absorb water, so to prevent this reaction kerosene should be used instead of water to be mixed with cement.

For determining the specific gravity of hydraulic cement, dust, sand and other fine materials. The body holds approximately 250ml. The oval bulb in the neck holds 17ml. Volume below the bulb is graduated from 0 to 1.0ml in 0.1ml subdivisions, with an additional 0.1 subdivision below the 0 and above the 1.0ml mark. The neck is graduated from 18 to 24ml in 0.1ml subdivisions above the bulb (white graduations).



LAB TESTS FOR COARSE & FINE AGGREGATE

ACCORDING TO IS : 2386 -1963

SIEVE ANALYSIS - (PART 1)

Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates. This is done by sieving the aggregates. In this we use different sieves as standardized by the IS code and then pass aggregates through them and thus collect different sized particles left over different sieves.

FLAKINESS & ELONGATION INDEX - (PART 1)

This test is used to determine the particle shape of the aggregate and each particle shape being preferred under specific conditions.

The significance of flakiness & elongation index is as follows;

- ★ The degree of packing of the particles of one size depends upon their shape.
- ★ Due to high surface area to volume ratio, the flaky and elongated particles lower the workability of concrete mixes.



DELETERIOUS MATERIALS - (PART 2)

Aggregates Quality should consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. They should be hard, strong, dense, durable, clear and free from veins and adherent coating, and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky, scoriaceous and elongated pieces, pieces are avoided. Visual inspection of gravel and natural sand is necessary for presence of clay lumps, clay coating, silt, grading and shape, while for crushed aggregates and sand inspection is necessary for stone dust, flaky shape and grading. If clay dust silt or mud is present and not removed/reduce through washing, it may produce lower strength concrete.

The presence of mica should be investigate in fine aggregate and should also make suitable allowances for the possible reduction in the strength of concrete or mortar. The aggregate should not contain harmful organic impurities, excess to the limit specified.

LIMITS OF DELETERIOUS MATERIALS (AS PER IS : 383-1970)

| Sl. No | DELETERIOUS SUBSTANCES | FINE AGGREGATE PERCENTAGE BY WEIGHT, MAX | | COARSE AGGREGATE PERCENTAGE BY WEIGHT, MAX | |
|--------|---|--|---------|--|---------|
| | | UNCRUNCHED | CRUSHED | UNCRUNCHED | CRUSHED |
| 1 | 2 | 3 | 4 | 5 | 6 |
| i | Coal and lignite | 1.00 | 1.00 | 1.00 | 1.00 |
| ii | Clay Lumps | 1.00 | 1.00 | 1.00 | 1.00 |
| iii | Material finer than 75 | 3.00 | 15.00 | 3.00 | 3.00 |
| iv | IS Sieve Soft fragments | - | - | 3.00 | - |
| v | Shale | 1.00 | - | - | - |
| vi | Total of percentages of all deleterious materials (except mica) including Sl No. (i) to (v) for col 3, 5 and 6 and Sl No. (i) and (ii) for col 4 only | 5.00 | 2.00 | 5.00 | 5.00 |



SPECIFIC GRAVITY AND WATER ABSORPTION - (PART 3)

Specific gravity, a low specified gravity indicates to high porosity, which results in poor durability and low strength. The concrete density is greatly depending on the specific gravity. A porous should not be permitted, unless specified.



BULK DENSITY & VOIDS - (PART 3)

Bulk density of aggregates is the mass of aggregates required to fill the container of a unit volume after aggregates are batched based on volume.

It depends on the packing of aggregate i.e. Either loosely packed aggregates or well dense compacted aggregates. In case, if the specific gravity of material is known, then it depends on the shape and size of particles. It is because, if all the particles are of same size than packing can be done up to a very limited extent. If the addition of smaller particles is possible within the voids of larger particles than these smaller particles enhance the bulk density of the packed material. Shape of the particles also influence very widely, because closeness particles depends on the shape of aggregates.



BULKING OF FINE AGGREGATE - (PART 3)

The volume increase of fine aggregate due to presence of moisture content is known as bulking. Fine sand bulks more as compared to coarse sand. Extremely fine sand particularly the manufactured fine aggregate bulks as much as about 40%. The moisture present in aggregate forms a film around each particle. These films of moisture exert a force, known as surface tension, on each particle. Due to this surface tension each particles gets away from each other. Because of this no direct contact is possible among individual particles and this causes bulking of the volume.

AGGREGATE CRUSHING VALUE - (PART 4)

Aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. The aggregate crushing value should not exceed 45% for aggregate used for concrete other than for wearing surfaces, and 30 % for concrete for wearing surfaces, such as runways, roads for pavements.



AGGREGATE IMPACT VALUE - (PART 4)

Aggregate impact value gives a relative measure of the resistance of an aggregate to sudden shock or impact. As an alternative to crushing value, the aggregate impact value should not exceed 45% by weight for aggregates used for concrete other than for wearing surfaces and 30% by weight for concrete for wearing surfaces, such as runways, roads for pavements.



LOS ANGELES ABRASION TEST - (PART 4)

The Los Angeles (L.A.) abrasion test is a common test method used to indicate aggregate toughness and abrasion characteristics. Aggregate abrasion characteristics are important because the constituent aggregate in HMA must resist crushing, degradation and disintegration in order to produce a high quality HMA.



LIMITS OF PHYSICAL PROPERTIES OF AGGREGATE

| | CONCRETE FOR WEARING SURFACE | CONCRETE FOR OTHER THAN WEARING SURFACE |
|----------------|------------------------------|---|
| Crushing Value | 30% | 45% |
| Impact Value | 30% | 45% |
| Abrasion Value | 30% | 50% |

10% FINE VALUE - (PART 4)

Ten percent fines value is a measure of the resistance of aggregate crushing subjected to loading and it is applicable to both weak and strong aggregate.

This test is very similar to Aggregate Crushing Test in which a standard force 400kN is applied and fines material expressed as a percentage of the original mass is the aggregate crushing value.

$$\text{Load Required for 10\% fines} = 14 \times X / (y+4)$$

Where X=Load in tonnes, y = Mean percentage fines from two tests at X tonnes load.

SOUNDNESS TEST OF AGGREGATE - (PART 5)

The soundness test repeatedly submerges an aggregate sample in a sodium sulfate or magnesium sulfate solution. This process causes salt crystals to form in the aggregate's water permeable pores. The formation of these crystals creates internal forces that apply pressure on aggregate pores and tend to break the aggregate. After a specified number of submerging and drying repetitions, the aggregate is sieved to determine the percent loss of material.

LIMITS OF SOUNDNESS OF MATERIALS AFTER FIVE CYCLES

| SOUNDNESS WITH | COARSE AGGREGATE | FINES AGGREGATE |
|--------------------|------------------|-----------------|
| Sodium Sulphate | 12% | 10% |
| Magnesium Sulphate | 18% | 15% |



CONCRETE MIX PROPORTIONING

ACCORDING TO IS : 10262-2009

MATERIALS

CEMENT

Any of the following shall be used with prior approval of the competent authority :

- Ordinary Portland Cement conforming to IS : 269
- Portland slag cement conforming to IS : 455 but with not more than 50 percent slag content
- Rapid hardening Portland cement conforming to IS : 8041
- High strength Portland cement conforming to IS : 8112

COARSE AGGREGATE :

Coarse aggregate shall consist of clean, hard, strong, dense non porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination therefore other approved inert material. It shall not contain pieces of disintegrated stones, soft, flaky elongated particles, salt alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength or durability of the concrete, or to attack the embedded steel. It shall comply with IS : 383.

FINE AGGREGATE :

Fine aggregates shall consist of hard, strong, durable, clean particles of natural sand, crushed stone or crushed gravel or suitable combination of natural sand and crushed stone or gravel. They shall not contain dust, lumps, soft or flaky materials, mica and other deleterious materials in such quantities as would reduce the strength or durability of concrete or attack the embedded steel. Fine aggregates shall conform to IS : 383

WATER:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentrations represent the maximum permissible values :

- To neutralize 100 ml sample of water using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH.
- To neutralize 100 ml sample of water using methylorange as an indicator, it should not require more than 25 ml of 0.02 normal H_2SO_4 .

ADMIXTURE

Accelerator / Water Reducing / Superplasticizer / Air Entraining Admixture may be provided in conformity with IS : 9103.

CONCRETE MIX DESIGN

The determinations of the proportion of cement, aggregates and water to attain required strengths shall be made by designing the concrete mix. Such concrete shall be called only "Design Mix Concrete". For prestressed concrete construction only "Design Mix Concrete" shall be used. The concrete mix shall be designed as per IS:10262 (Recommended Guidelines for Concrete Mix Design) to have a target mean strength defined as $f_{ck} + 1.65 \times SD$. Maximum quantity of cement shall not be more than 540 Kg/cum of concrete.

CALCULATION OF AGGREGATE CONTENT

With the quantities of water and cement calculate the weight of coarse and fine aggregate from the following equations:

Weight of coarse aggregate =

$$\left[\frac{1 - (W / S_w \times 1000) - (C / S_c \times 1000)}{S_a} \right] \times \text{Specific Gravity of coarse aggregate} \times \text{Volume of coarse aggregate} \times 1000$$

where,

W = Weight of water (Kg)

S_w = Specific Gravity of water

C = Weight of cement (Kg)

S_c = Specific Gravity of cement

Weight of fine aggregate =

$$\left[\frac{1 - (W / S_w \times 1000) - (C / S_c \times 1000)}{S_f} \right] \times \text{Specific Gravity of fine aggregate} \times \text{Volume of fine aggregate} \times 1000$$



BITUMINOUS MIX PROPORTIONING

Suitably designed bituminous mix is able to withstand heavy traffic loads under adverse climatic conditions and also fulfill the requirement of structural and pavement surface characteristics. The stability of the compacted bituminous mix mainly depends on the gradation of the aggregate mix used; the type, grade and percentage of bituminous binder in the mix also contributes towards the stability of the mix.

REQUIREMENTS OF DESIGN - MIX

The bituminous mix is designed in the laboratory considering the following requirements as per Table 500 - 11 of Section 500 of Specifications for Road and Bridge Works of Ministry of Road Transport and Highways :

- (a) The stability of the mix corresponding to the design-binder content need be more than minimum specified value.
- (b) Flexibility or deformation at failure is to be within the specified range.
- (c) Void content of the design mix is to be within the specified range.

GENERAL APPROACH FOR DESIGN OF BITUMINOUS MIXES

(1) **GRADATION OF AGGREGATE** : Gradation of aggregate is one of the most important factors for the design of mixture. The gradation of final mix after blending of the aggregates and filler should be within the specified range as per the specifications of either the Indian Road Congress (IRC) or the Ministry of Road Transport and Highways (MORTH), Government of India.

(2) **VOLUMETRIC PROPERTIES** : Fundamentally, mix design is meant to determine the volume of bitumen binder and aggregates necessary to produce a mixture with the desired properties. The properties that are to be considered, include the theoretical maximum specific gravity G_{mm} , the bulk specific gravity of the mix G_{mb} , percentage air voids V_A , percentage volume of bitumen V_b , percentage void in mineral aggregate VMA and percentage voids filled with bitumen VFB .

REQUIREMENTS FOR THE FINAL MIX OF DENSE BITUMINOUS MACADAM & BITUMINOUS CONCRETE Section 500 (Table 500 - 11)

| PROPERTIES | VISCOSITY GRADE PAVING BITUMEN | MODIFIED BITUMEN | | TEST METHOD |
|------------------------------------|---------------------------------------|------------------|--------------|---------------------|
| | | HOT CLIMATE | COLD CLIMATE | |
| Compaction Level | 75 blows on each face of the specimen | | | ASTM D1559 |
| Minimum Stability in kN (at 60°C) | 9.0 | 12.0 | 10.0 | AASTHO T245 |
| Marshall Flow (mm) | 2 - 4 | 2.5 - 4 | 3.5 - 5 | AASTHO T245 |
| Marshall Quotient (Stability/Flow) | 2 - 5 | 2.5 - 5 | | MS-2 and ASTM D2041 |
| % Air Voids | 3 - 5 | | | |
| % Voids filled with Bitumen (VFB) | 65 - 75 | | | |
| Coating of aggregate particle | 95% minimum | | | IS 6241 |
| Tensile Strength Ratio | 80% minimum | | | AASTHO T 283 |

| NOMINAL MAXIMUM PARTICLE SIZE | MINIMUM VMA PERCENT RELATED TO DESIGN PERCENTAGE AIR VOIDS | | |
|----------------------------------|--|----|----|
| | 3 | 4 | 5 |
| 26.5 | 11 | 12 | 13 |
| 37.5 | 10 | 11 | 12 |

MIX DESIGN

Marshall stability of the bituminous mix design used in the laboratory has been specified by IRC and MoRTH Specifications for use in India.

Marshall Stability test is conducted on compacted 3 to 4 cylindrical specimens of bituminous mix of diameter 101.6 mm and thickness 63.5 mm. The load is applied perpendicular to the axis of the cylindrical specimen through a testing head consisting of a pair of cylindrical segments, at a constant rate of deformation of 51 mm per minute at the standard test temperature of 60°C.

The 'Flow Value' is the total deformation that the Marshall test specimen undergoes at the maximum load, expressed in mm units. The Marshall Stability value of a compacted specimen of bituminous mix indicates its resistance to deformation under applied incremental load and the flow value indicates the extent of deformation it undergoes due to loading or its 'flexibility'.



PAVING BLOCK

ACCORDING TO IS : 15658-2006

METHOD FOR DETERMINATION OF COMPRESSIVE STRENGTH

Dimensions and plan areas of the specimens shall be determined as described in Annex B. The blocks shall be stored for at least 24 hours in water at a temperature of $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates.

CALCULATION

The apparent compressive strength of individual specimen shall be calculated by dividing the maximum load (in N) by the plan area (in mm^2). The Corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor from Table given and below. The strength shall be expressed to the nearest $0.10\text{N}/\text{mm}^2$

| PAVER BLOCK THICKNESS mm | CORRECTION FACTOR FOR | |
|-----------------------------|-----------------------|---------------------------|
| | PLAIN BLOCK | ARRISED / CHAMFERED BLOCK |
| 50 | 0.96 | 1.03 |
| 60 | 1.00 | 1.06 |
| 80 | 1.12 | 1.18 |
| 100 | 1.18 | 1.24 |
| 120 | 1.28 | 1.34 |

For other thickness of paver blocks between 50 mm and 120 mm, linear extrapolation of concrete factor shall be made.

RECOMMENDED GRADES OF PAVER BLOCKS FOR DIFFERENT TRAFFIC CATEGORIES

| Grade Designation of Paver Blocks | Specified Compressive Strength of Paver Blocks at 28 Days (N/mm^2) | Traffic Category | Recommended Minimum Paver Block Thickness (mm) | Traffic Examples of Application |
|-----------------------------------|--|--------------------|--|--|
| M-30 | 30 | Non-traffic | 50 | Building premises, monument premises, landscapes, public paths and patios, embankment slopes, sand stabilization area, etc. |
| M-35 | 35 | Light-traffic | 60 | Pedestrian plazas, shopping complexes ramps, car parks, office driveways, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads, etc. |
| M-40 | 40 | Medium-traffic | 80 | City streets, small and medium market roads, low volume roads, utility cuts on arterial roads, etc. |
| M-50 | 50 | Heavy-traffic | 100 | Bus terminal, industrial complexes, mandi houses, roads on expansive soils, factory floor, service stations, industrial pavements, etc. |
| M-55 | 55 | Very heavy-traffic | 120 | Container terminals, ports, docks yards, mine access roads, bulk cargo handling areas, airport pavements, etc. |

ABRASION RESISTANCE (IS : 15658-2006)

Square shaped specimens measuring 71.0 ± 0.5 mm shall be cut from the block (specimen selected) and testing surface of the specimen shall be centrally loaded with 294.3N on grinding disc. Disc shall be stopped after one cycle of 22 revolutions at a speed of 30 rpm. the specimen turned 90 in clockwise direction and repeat the test for 16 cycle.

The abrasive wear of the specimen calculated as mean loss in specimen volume V form the equation

$$V = \Delta m / PR$$

where,

V = loss in volume in mm^3

Δm = loss in mass in gms.

PR = density of the specimen.



ABRASION MACHINE

FLEXURAL STRENGTH / BREAKING LOAD

(IS : 15658 - 2006)

The Flexural strength of the specimen shall be calculated as

$$F_b = 3pl / 2bd^2$$

F_b = Flexural Strength, in N/mm^2 ;

p = Maximum Load, in N;

l = Distance between central lines of the supporting rollers, in mm;

b = Average width of block, in mm

d = Average thickness, in mm

The maximum load p shall be reported as the breaking load, nearest to 1 N



FLEXURAL STRENGTH



ARUN SOIL LAB PVT. LTD.

TESTS ON BURNT CLAY AND FLYASH BRICKS

COMPRESSIVE STRENGTH (IS : 3495 - PART 1 - 1992)

PRECONDITIONING - Remove unevenness observed in the bed faces to provide two smooth and parallel faces by grinding. Immerse in water at room temperature for 21 hours. Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog (where provided) and all voids in the bed face flush with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). Store under the damp jute bags for 24 hours followed by immersion in clean water for 3 days. Remove, and wipe out any traces of moisture.

PROCEDURE - Place the specimen with flat faces horizontal, and mortar filled face facing upwards between two 3-ply plywood sheets each of 3 mm thickness and carefully centered between plates of the testing machine. Apply load axially at a uniform rate of 1.4 N/mm^2 (1.40 kgf/cm^2) per minute till

failure occurs and note the maximum load at failure. The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

NOTE - In place of plywood sheets plaster of Paris may be used to ensure a uniform surface for application of load.

CALCULATION - The report shall be as given below:

$$\text{Compressive strength in N/mm}^2 \text{ (kgf,cm}^2 \text{)} = \frac{\text{Maximum load at failure in N(kgf)}}{\text{Average area of the bed faces in mm}^2 \text{ (cm}^2 \text{)}}$$

WATER ABSORPTION (IS : 3495 - PART 2 - 1992)

PRECONDITIONING - Dry the specimen in a ventilated oven at a temperature of 105 to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (M_1). Specimen warm to touch shall not be used for the purpose.

PROCEDURE - Immerse completely dried specimen in clean water at a temperature of $27^\circ\text{C} \pm 2^\circ\text{C}$ for 24 hours.

Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen.

Complete the weighing 3 minutes after the specimen has been removed from water (M_2).

Water absorption, percent by mass, after 24-hour immersion in cold water is given by the following formula:

$$\text{Water Absorption (\%)} = \frac{M_2 - M_1}{M_1} \times 100$$

EFFLORESCENCE (IS : 3495 - PART 3 - 1992)

PROCEDURE - Place the end of the bricks in the dish, the depth of immersion in water being 25 mm. Place the whole arrangement in a warm (for example, 20 to 30°C) well ventilated room until all the water in the dish is absorbed by the specimens, and the surplus water evaporates. Cover the dish containing the brick with suitable glass cylinder so that excessive evaporation from the dish may not occur. When the water has been absorbed and bricks appear to be dry, place a similar quantity of water in the dish and allow it to evaporate as before. Examine the bricks for efflorescence after the second evaporation and report the results.

INTERPRETATION - The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious' in accordance with the following definitions:

NIL - When there is no perceptible deposit of efflorescence.

SLIGHT - When not more than 10 percent of the exposed area of the brick is covered with a thin deposit of salts.

MODERATE - When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

HEAVY - When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

SERIOUS - When there is a heavy deposit of salts accompanied by powdering and/or flaking of the exposed surfaces.

WARPAGE (IS : 3495 - PART 4 - 1992)

PRECONDITIONING - Remove any dirt adhering to the surface of brick.

TESTING PROCEDURE

For Concave Warpage

Place the flat surface along the surface to be measured selecting the location that gives the greatest departure from straightness. Measure the greatest distance of the brick surface from the edge of straightness by a steel rule or wedge.

For Convex Warpage

Place the brick on the flat surface with the convex surface in contact with the flat surface. Measure the distance from flat surface to the four corners of the brick, and take the maximum of four measurements.

INTERPRETATION - The higher of the distance measured shall be reported as warpage.



TESTS ON BITUMEN

SPECIFIC GRAVITY (IS : 1202-1978)

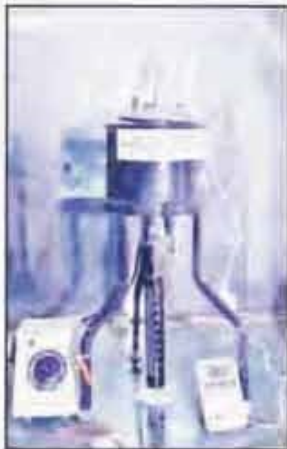
This test is done to determine the specific gravity of semi-solid bitumen road tars etc. The principle is that it is the ratio of mass of a given volume of bitumen to the mass of an equal volume of water, both taken at a recorded/specified temperature.

PENETRATION (IS : 1203-1978)

Penetration value is a measure of hardness or consistency of bituminous material. It is the vertical distance traversed or penetrated by the point of a standard needle in to the bituminous material under specific conditions of load, time and temperature. This distance is measured in one tenths of a millimeter. This test is used for evaluating consistency of bitumen. It is not regarded as suitable for use in connection with the testing of road tar because of the high surface tension exhibited by these materials.

SOFTENING POINT (IS : 1205-1978)

The Softening Point of bitumen or tar is the temperature at which the substance attains particular degree of softening. It is the temperature in °C at which a standard ball passes through a sample of bitumen in a ring and falls through a height of 2.5 cm, when heated under water or glycerine at specified conditions of test. The binder should have sufficient fluidity before its applications in road uses. The determination of softening point helps to know the temperature up to which a bituminous binder should be heated for various road use applications. Softening point is determined by ring and ball apparatus.



INDUSTRIAL VISCOSITY (IS : 1206 -PART 1 - 1978)

Viscosity denotes the fluid property of bituminous material and it is a measure of resistance to flow. At the application temperature, this characteristic greatly influences the strength of resulting paving mixes. Low or high viscosity during compaction or mixing has been observed to result in lower stability values. At high viscosity, it resists the compactive effort and thereby resulting mix is heterogeneous, hence low stability values. And at low viscosity instead of providing a uniform film over aggregates, it will lubricate the aggregate particles. Orifice type viscometers are used to indirectly find the viscosity of liquid binders like cutbacks and emulsions. The viscosity expressed in seconds is the time taken by the 50 ml bitumen material to pass through the orifice of a cup, under standard test conditions and specified temperature.

ABSOLUTE VISCOSITY (IS : 1206-PART 2 - 1978)

The basic absolute viscosity test measures the time it takes for a fixed volume of asphalt binder to be drawn up through a capillary tube by means of vacuum, under closely controlled conditions of vacuum and temperature. Although absolute viscosity is an improvement over the penetration test, it still only measures viscosity at one temperature and thus does not fully characterize an asphalt binder's consistency over the expected range of construction and service conditions.

KINEMATIC VISCOSITY (IS : 1206-PART 3-1978)

The kinematic viscosity of a liquid is the absolute (or dynamic) viscosity divided by the density of the liquid at the same temperature of measurement. The 135° C measurement temperature was chosen to simulate the mixing and lay down temperatures typically encountered in pavement construction.

The basic kinematic viscosity test measures the time it takes for a fixed volume of asphalt binder to flow through a capillary viscometer under closely controlled conditions of head and temperature.



DUCTILITY (IS : 1208-1978)

Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking. Dimension of the briquette thus formed

is exactly 1 cm square. The bitumen sample is heated and poured in the mould assembly placed on a plate. These samples with moulds are cooled in the air and then in water bath at 27 °C temperature. The excess bitumen is cut and the surface is leveled using a hot knife. Then the mould with assembly containing sample is kept in water bath of the ductility machine for about 90 minutes. The sides of the moulds are removed, the clips are hooked on the machine and the machine is operated. The distance up to the point of breaking of thread is the ductility value which is reported in cm. The test should be conducted at a temperature of 25 °C ± 0.5 °C at a rate of pull of 50.0 ± 2.5mm./min. The ductility value gets affected by factors such as pouring temperature, test temperature, rate of pulling etc



FLASH & FIRE POINT (IS : 1209-1978)

This test is done to determine the flash point and the fire point of asphaltic bitumen and fluxed native asphalt, cutback bitumen and blown type.

Flash Point - The flash point of a material is the lowest temperature at which the application of test flame causes the vapours from the material to momentarily catch fire in the form of a flash under specified conditions of the test.

Fire Point - The fire point is the lowest temperature at which the application of test flame causes the material to ignite and burn at least for 5 seconds under specified conditions of the test.

LOSS ON HEATING (IS : 1212-1978)

Loss on heating test determines the effect on asphaltic materials of heating in an oven under prescribed conditions. The results are reported in terms of change in sample mass and/or changes in selected properties such as viscosity, penetration and ductility as evidenced by test data taken before and after the oven cycle.

SOLUBILITY IN TRICHLOROETHYLENE (IS : 1216-1978)

This method covers the procedure for determining the degree of solubility in trichloroethylene of bituminous materials containing little or no mineral matter. The sample is dissolved in trichloroethylene and filtered through whatman filter paper number five. The insoluble material is washed, dried and weighed.

ELASTIC RECOVERY (IRC : SP 53-2010)

The elastic recovery of a polymer modified asphalt cement is evaluated by the percentage of recoverable strain measured after elongation upto 10 cm. during a conventional ductility test. Unless otherwise specified, the test shall be made at the temperature of 25°C ± 0.5°C and with a speed of 50 mm/min. ± 2.5 mm/min.

REQUIREMENTS FOR PAVING BITUMEN (AS PER IRC : 73-2013)

| CHARACTERISTICS | PAVING GRADES | | | |
|---|---------------|---------|---------|---------|
| | VG 10 | VG 20 | VG 30 | VG 40 |
| Penetration at 25°C, 100 g, 5 s, 0.1 mm, Min | 80 - 100 | 60 - 80 | 50 - 70 | 40 - 60 |
| Absolute Viscosity at 60°C, Poises | 800 | 1600 | 2400 | 3200 |
| Kinematic Viscosity at 135°C, cSt, Min | 250 | 300 | 350 | 400 |
| Flash point (Cleveland open cup), °C, Min | 220 | 220 | 220 | 220 |
| Solubility in trichloroethylene, percent, Min | 99 | 99 | 99 | 99 |
| Softening point (R&B), °C, Min | 40 | 45 | 47 | 50 |
| Tests on residue from rolling thin film oven test : | | | | |
| a) Viscosity ratio at 60°C, Max | 4.0 | 4.0 | 4.0 | 4.0 |
| b) Ductility at 25°C, cm, Min | 75 | 50 | 40 | 25 |



Recently Added Instruments



Computerised Universal Testing Machine
(Capacity 1000 kN)



Computerised Compression Testing Machine
with controlled stress rate
(Capacity 2000 kN & 500 kN)



Pile Integrity Tester

**Also Accredited in Non-Destructive Testing Field By
National Accreditation Board for Testing and Calibration Laboratories**



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