Concrete:-

(I) Workability:- (i) Property by which Ease of mixing, trasported, placed, compacted and finish.

(ii) It is also may also be defined as amount of useful internal work reqd to be done by concrete in order to achieve full compaction.

(iii) Workability of concrete is dependent upon following factors:-

(1) Water Content.
(2) Mix Proportion.
(3) Shape of Aggregates.
(4) Size
(5) Texture
(6) Grading of Concrete.
(7) Use of Admixture.

(1) Water Content:- More addition of water in concrete doesn't have any effect over it's workability. However it reduces it's strength due to increase in w/c ratio hence in order to increase the workability, cement content is also increase in proportion with water content such that w/c ratio remains constant.

(2.) Mix Proportion:- (Ratio of Agg. to Cement)
In lean concrete having higher aggregate/cement Ratio workability is comparitively less than in rich concrete in which Ag/Ce ratio is comparatively less as same qt quantity of cement paste has

to lubricate higher area.

Agg. / Cement ; Agg ↑↑ → A/c ↑↑ i.e. ↓↓ workable

(3) Shape of Aggregates :- Bigger size aggregates results in higher workable conc. as smaller area is to be lubricated in this case.

(Size, Texture)

Engg. Mthd.

(4) Grade of Concrete :- Well graded Conc. offers lower Volm of voids hence availability of cement paste to carryout the lubrication in this case is more compairitively. That results in highly workable Concrete.

Measurement of Workability :- It can be measured by any of the following test :-

- Slump test
- Compaction Factor test
- Flow table Test
- Vee - Bee Consistometer Test.

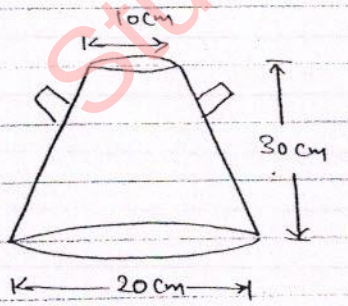
(A) Slump Test :- It is the commanmost test that is used for measurement of workabⁱᵗʸ of Conc.

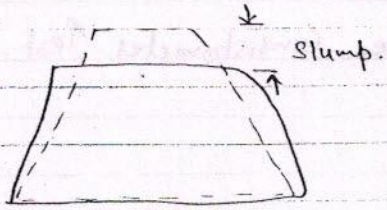
(i) It consist of a mould that is in a form of frustrum having the top diameter of 10cm and bottom of dia 20cm. and height of 30cm.

(ii) Concrete to be tested is filled in this mould in 4 layers where each layer is compacted 25 times with a rod. After the mould is completely filled is lifted immedeatly in upward direct^{n} which causes the concrete to subside and this subsidence of concrete is reffered as "Slump" which may also be defined as diff^{ce} in level of height of mould and the highest point of subsided concrete.

(iii) This slumps of the concrete represents it's workability as higher is the value of slump, higher is it's workability.

(iv) This test is not suitable for concrete that is either possesing very high workability or very low workability.





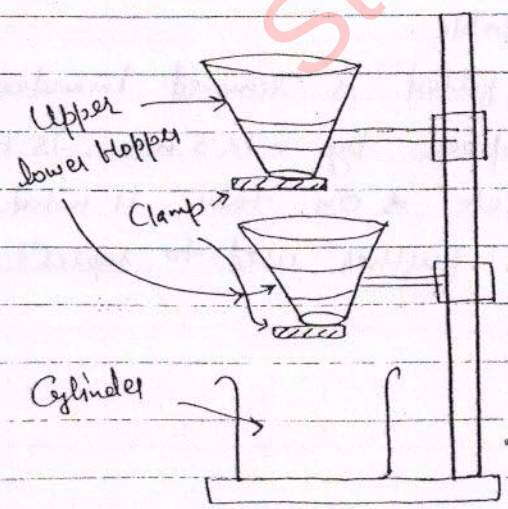
(B) Compaction Factor Test :- This test is used to find the workabil of concrete for which it's value is compairitively low and slump test is not suitable.

(i) The principle of this test is based upon determining the degree of compaction achieved by amount of workdone by allowing the concrete to fall through Std. height.

(ii) The degree of compact^{n} is represt^{d} in terms of Compaction factor that represents density ratio i.e. the ratio of density achieved during the test to the density of the fully compacted concrete.

(iii) The results obtained from Compaction factor test are more uniform than those obtained from "Slump" test.

$$\text{Compaction Factor} = \frac{\text{Mass of Concrete in cylinder during test}}{\text{Mass of full Comptacted Concrete}}$$



Workability ↑↑ , More the concrete will fall

$$C.F. = \frac{\text{Mass } \uparrow\uparrow}{\text{Mass Constant}} = \uparrow\uparrow \text{ more Value}$$

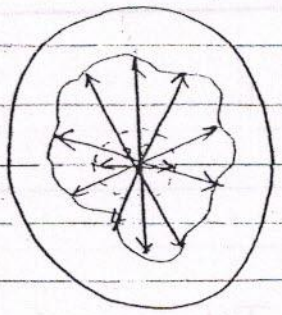
↑ more Value → ↑↑ workability

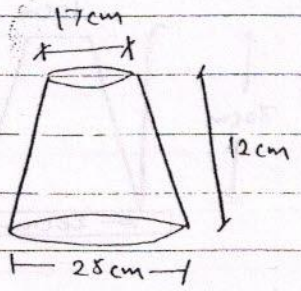
Workability	Slump	Compaction Factor	Use of Construct^n	Remarks.
Very low	–	0.78 - .80	Road construct^n	Compact^n factor test is used
low	25-75	0.85 - 0.87	Light Reinf^{cd} struct^n	
Medium	50-100	0.92 - 0.93	Normal Reinf^{cd} Struct^n	
High	100-150	0.95 - 0.96	Highly Reinf^n -/—	
Very high	—	–	Concreting Tremie (Pipe ~~Casting~~ transporting.	Flow table test used.

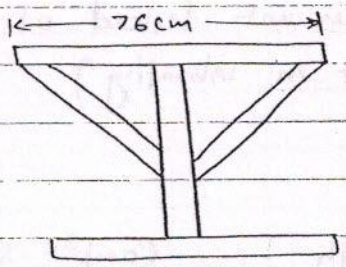
(c) Flow table test :- This test is performed for the concrete which posses Very high workability.

(i) It consist of a circular table 76 cm in diameter and a mould that is in form of a frustum having the top diameter of 17 cm, bottom dia, 25 cm and 12 cm height

(ii) Concrete to be tested is filled in the mould in two layer that is placed over the flow table. When the mould is completely filled is removed immediatly. and the table is raised and dropped by 12.5 mm, 15 times in 15 sec^{nds}. The spread of concrete is on table is noted in ~~all~~ atleast 6 direct^n that is further used to repres^t it's workability.







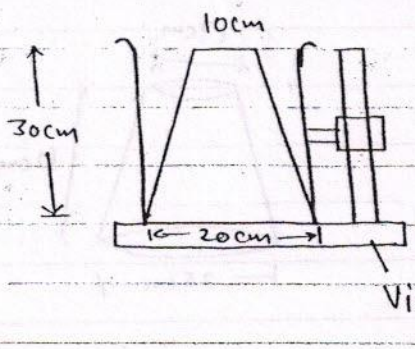
$$\text{Flow Percent} = \frac{\text{Spread of Cone} - 25}{25} \times 100$$

(0 to 150 %)

(D) Vee bee Consistometer Test :- This test is used to find the workability of the concrete for which slump is less than 50mm.

(i) It consist of a mould in form of a frustumn that is placed inside the cylinder which is further placed over the vibrating table.

Concrete to be tested is filled in the mould which is raised immedeatly and cylinder is subjected to vibration the time req^{d} by the concrete to assume the cylindrical shape is noted that is reffered as "Vee-bee degrees." and is further used to represent the workability of Concrete.



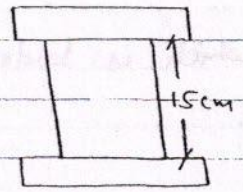
(Higher Workable Concrete is not tested as water will come out on vibrating)

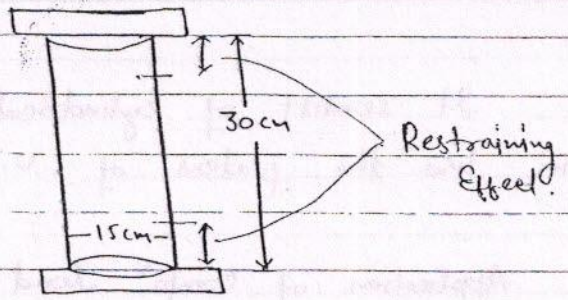
(II) Strength :- (A) Compressive Strength :- Comp^{sv} str. of concrete is measured in U.T.Machine using mould that may be of Cubical, prismoidal, Trapozoidal, cylindrical in shape. Generally cubical moulds of 150mm are used. for max^{in} nominal size of aggregates 20mm. and if less than 20 mm mould of size 100mm can also be used.

(i) If cylindrical mould is used "Height to Dia" Ratio is kept to be 2:1 (Generally Height → 30cm ; Dia → 15cm is used for testing)

(ii) The results obtained from cylindrical Mould are more closer value to actual value ~~to~~ in comparision to those obtained from cubical mould.

(iii) Results obtained from cylindrical mould is App^{rtly} 0.8 times the Results obtained by cubical moulds.
As the restraining affects of ~~plastering~~ the plates of U.T.M. is found for the intire height for cubical mould.





for Aggᵗ dia < 20mm
Cube of 100mm.

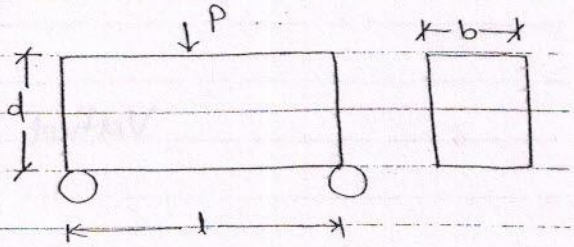
(iv) At perticular age of testing 3 moulds are used to find the strength of the concrete. Variation of which should not be greater than ±15%.

(B) Tensile strength test :- Tensile strength of the concrete is tested indirectly by finding the modulus of rupture for which mould of size 15cm x 15cm x 70cm is prepared if maxᵐ nominal size of Aggᵗ is > 20mm. And of size 10x10x50cm is prepared if maxᵐ nominal size of Aggᵗ is ≤ 20mm.

(i) The mould is then placed over simple supports and it is loaded upto it's failure.

(ii) The tensile strength of concrete is further represented in terms of it's modulus of rupture

$$f_b = \frac{Pl}{bd^2}$$



(iii) Tensile str. of conc. can also be tested using splitting cylinder test.

It consist of cylindrical mould which is loaded horizontally in b/w the platens of U.T.M Machine.

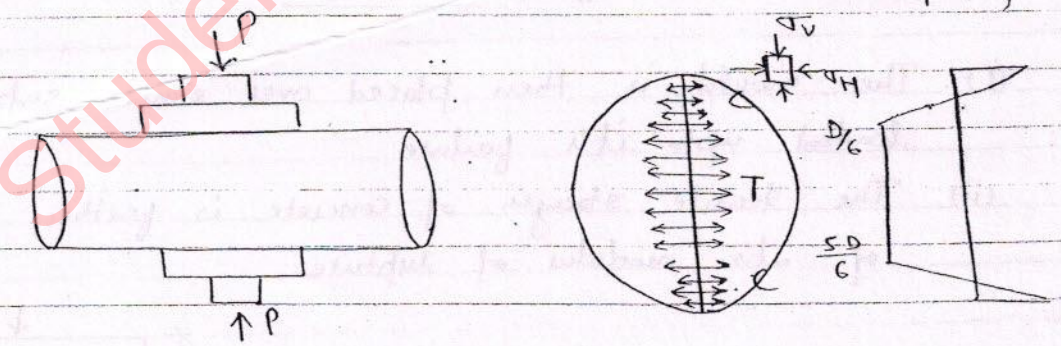
(iv) Application of comps^{v} load over the specimen leads to the developm^{t} of comp^{sv} stresses upto the depth of $P/6$ from top and bottom but tensile stresses are developed for the remaining depth of "$\frac{5}{6}D$" of section.

(v) The failure of specimen takes place under these tensile stresses only that represents it's tensile strength.

(vi) The results obtained by this test are more precise then any other test available. Moreover the Results are approx^{ly} 8–12 % higher than the actual.

(vii) The main advantage of this test is that same specimen can be used to find the comps^{v} and tensile strength of concrete. (as well as)

P_6 → {Top + Bottom Comp^{sv}}



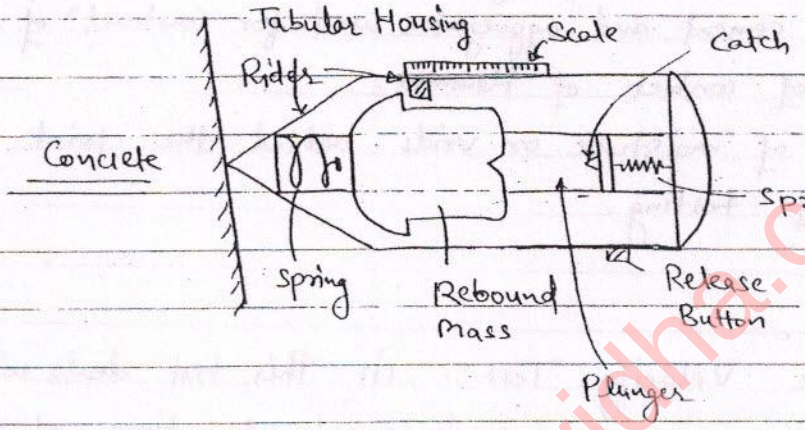
$$\text{Vertical stress} = \frac{2P}{\pi DL}\left[\frac{D^2}{3(D-3)} - 1\right]$$

$$\text{Horizontal stress} = \frac{2P}{\pi DL}$$

(C) Non- Distructive Test :- These tests are used to ascertain the Quality of hardened concrete.

Generally Following Test falls in the catagory :-

(1) Schmidt Rebound Hammer Test :-



Rebound Hammer

In This test quality of hardened Conc. is analysed with help of Rebound Hammer which consist of spring controlled rebound mass which slides over the plunger in tubular housing.

(i) In order to anaylyse the quality Rebound Hammer is pressed against the surface of structure and "Release Button" is pressed that carries the rebound mass to strike against the surface which rebacks due to spring force and carries the "Rider" along with in backward direct".

Displacement of which is noted over upon the scale and referred as Rebound Number that is further Related to the quality of concrete Structure.

(ii) Higher is the value of the rebound no. better is the quality of the structure and vice-versa.

(iii) The results obtained from this test depends upon the following factors.

(a) smoothness of the surface
(b) shape, size and rigidity of structure
(c) Type of cement and aggregates used for Construct^{n} of struct^{g}.
(d) Angle of contact of Hammer.
(e) Presence of moisture or voids behind the point of contact.
(f) Age of testing.

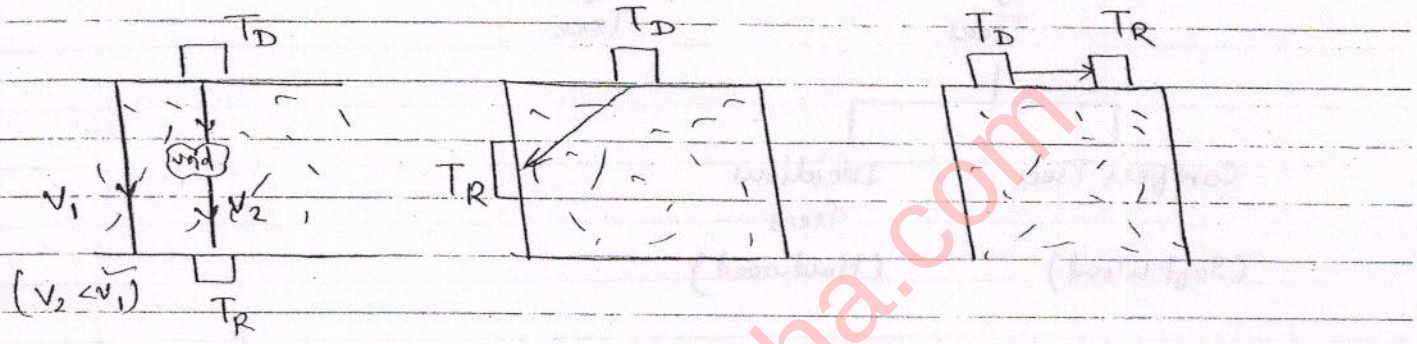
(2) Ultrasonic Pulse Velocity Test:- (i) This test deals with the measurement of time of travel of electronically generated mechanical pulse through the struct^{t}. That is further used to find the velocity of the pulse that represents the quality of the structure to be tested.

(ii) In this test the mechanical pulse is generated with the help of electro-acoustic transducer and is detected with help of transmitter. The time is noted b/w the formation of the pulse and it's detection through a known distance from the structure.

(iii) Generally 3-types of arrangements are used for the placement of transducer and transmitter

→ Direct
→ Semi Direct } Transmission.
→ Surface

Velocity of Pulse (km/sec)	Quality
> 4.5	Excellent
3.5 ~ 4.5	Very Good
3 - 3.5	Good
< 3	Doubt full



Direct Transmission

Semi Direct Transmission

Surface Transmission.

(iv) Quality of the concrete is related with the velocity of the pulse through the structure as above table.