APPENDIX NO. XIII

DESTRUCTION OF EXPLOSIVES

1. The destruction of explosives will be carried out only under the supervision of the Sub-Divisional Officer.

2. Gunpowder may be rendered non-explosive by being thrown into water preferably hot which dissolves the saltpetre

3 Cartridges of dynamite should be laid out in a continuous line an inch (25 mm.) between each cartridge of the cartridge wrappers and any other available paper, over a line of shavings or dry straw, soaked in kerosine or similar oil to accelrate combustion. The line of shavings, etc., should be prolonged about 20 feet (6 metres) beyond the dynamite and lit with a short length of safety fuse, the operator quickly retiring to a safe distance. Not more than 50 lbs. (22.5 kg.) of dynamite should be destroyed at a time and a clear space of bare ground about 100 yards (100 metres) all round, must be selected for the purpose.

4. Safety fuse can be destroyed by burning in lengths, in the open under suitable precautions.

5. Detonators should be thrown into deep water two or three at a time, or they can be destroyed by burning, under suitable precautions, after having been soaked for 48 hours in mineral oil.

APPENDIX NO. XIV

PRELIMINARY TEST FOR COMPRESSION STRENGTH OF CONCRETE

1. Scope :

1.1. This method covers compression tests on concrete made in a laboratory where accurate control of quantities of materials and test conditions is possible

2. Test Specimen :

2.1. Test specimens shall be either cubes or cylinders whose sizes shall be as given in Table.

TABLE——SIZES OF TEST SPECIMENS

Maximum size of Coarse Aggregates	Size of specimens					
	Cubes		*Cylinder*			
	cm.	in.	Dia. cm.	in	Height cm.	in.
Not exceeding 3/4 in. (20 mm.)	10×10×10	4×4×4*	15	6	30	12
Greater than 3/4 in. (20 mm.) but not exceeding 1½ in. (38 mm.) ..	15×15×15	6×6×6	15	6	30	12
Greater than 1½ in. (38 mm.) after wet screening or hand picking aggregates greater than 1½ in. (38 mm) ..	15×15×15	6×6×6	15	6	30	12

*The size of the cubic specimen shall be generally 6″×6″×6″ (15 cm. × 15 cm. × 15 cm.) and this size shall be preferred to 4″×4″×4″ (10 cm. × 10 cm. × 10 cm.) Where prior consent of the engineer-in-charge has been obtained, the size of the specimen may be 4″×4″×4″(10 cm. × 10 cm. × 10 cm).

2.2. Moulds for test specimens shall be rigid and of metal, with inner surfaces accurately machined. Each mould shall be provided with a metal base having a smooth machined surface. Means shall be provided for securing the base plate to the mould.

3. **Materials :**

3.1. The materials and proportions used in making the test specimens including the water content shall be similar in all respects to those to be used in the work. The cement on arrival at the laboratory shall be mixed dry either by hand or in a suitable mixer so as to ensure uniformity, care being taken to avoid the intrusion of foreign matter, and then stored in air-tight containers.

3.2. All material shall be brought to a temperature of 81°$\pm$4° F (27°$\pm$2°C) before begining the tests. The aggregate shall be dry.

3.3. The quantities of cement aggregate and water for each batch shall be determined by weight to an accuracy of 1 in 1000.

4. **Preparation of Test Specimen :**

4.1. The concrete shall be mixed by hand or in a small batch mixer in such a manner as to avoid loss of water. If the concrete is mixed by hand, the cement and fine aggretate shall be first mixed dry until the mixture is uniform in colour. The coarse aggregate shall then be added and mixed with the cement and fine aggregate. Water shall then be added and the whole mixed thoroughly until the resulting concrete is uniform in colour, and in no case for less than two minutes. If a batch mixer is used, all materials may be placed together in the mixer and mixed thoroughly until the resulting concrete is uniform in colour, and in no case for less than two minutes.

4.2. The interior surface of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. Test specimens shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved round the top edge of the mould as the concrete slids from it in order to insure symmetrical distribution of concrete within the mould. Each layer shall be rodded 25 times with a $\frac{5}{8}$ in. (16 mm.) rod, 24 in. (.06 metre) in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer The bottom layer shall be rodded throughout its depth. After the top layers has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least $\frac{1}{4}$ in (6 mm.) thick, orwith a machined metal plate, which may be later used in capping the test specimen. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete by the loss of water either by leakage from the bottom or overflowing from the top of the mould.

4. 2.1. Where it is proposed to use mechanical vibrators for compacting the concrete at the site of work and to allow increased stresses in accordance with specification No 10.7 the test specimens may be compacted with a mechanical vibrator.

4.3. **Capping of Cylindrical Test Specimen :**

4. 3.1. Two to four hours after moulding the cylindrical test specimens, if made in metal moulds, may be capped with a thin cap of neat cement paste. The cap shall be formed by means of a piece of plate glass $\frac{1}{4}$ in. (6 mm.) thick, or a machined metal plate $\frac{1}{2}$ in. (13 mm.) thick and of a size 2 to 3 in. (50 to 75 mm.) larger than that of mould. The plate shall be worked on the cement paste until the plate rests on top of the mould. The cement for capping shall be mixed to a stiff paste from about 2 to 4 hours before it is to be used in order to avoid the tendency of the cap to shrink. Adhesion of the concrete to the top and bottom plates may be avoided by coating them with heavy oil or grease.

4. 3.2. If cylindrical specimens are not capped with neat cement paste, they shall be capped before testing in such a manner that the ends are prefectly plane and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that the capping will not flow or fracture under the load.

4. 3.3. It is desirable that the capping material should have a value for modulus of elasticity equal to or greater than that of the concrete under

5. **Curing and Storage of Test Specimen :**

5.1. Immediate the moulding is completed, the moulds, containing the test specimens shall be placed in moist air of at least 90 per cent relative humidity and at a temperature of 81°±4°F (27°±20°C) for 24±$\frac{1}{2}$ hour. After 24 hours, the test specimens shall be removed from the moulds , marked and placed in saturated lime solution at a temperature of 81°±4°F (27°±2°C) until required for test.

6. **Method of Testing :**

6.1. The tests shall be made at the age of the concrete corresponding to that for which the strengths are specified.

6.2. Compression tests shall be made immediately upon removal of the concrete test specimens from the curing room, i.e., the test specimens shall be loaded in damp condition. The dimensions of the test specimens shall be measured in millimetres accurate to 0.5 mm.

6.3. The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimens shall be placed in the machine in such a manner that the load is applied to the sides of the specimens as cast. An adjustable bearing block shall be used to transmit the olad to the test specimen. The size of the bearing block shall be the same or slightly larger than that of the test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

6. 3.1. The load shall be applied axially without shock at the rate of approximately 2,000 lb./sq. in. (140 kg./sq. cm.) per minute. The total indicated by the testing machine at failure of the test specimen shall be recorded and the unit compressive strength calculated in lb. per sq. in. (kg./sq. cm.) using the area computed from the measured dimension of the test specimen. The type of failure and appearance of the concrete shall be noted.

7. **Standard of Acceptance :**

7.1. Three test specimen shall be made for each age at which tests are required. The average of the strength of the three specimens may be accepted as the compressive strength of concrete provided the difference between the maximum and minimum strength of the three specimens does not exceed 15 per cent of the average strength. If the difference exceeds 15 per cent of average strength, repeat tests shall be made unless the minimum strength is greater than the strength specified in paragraph 3 of Specification No. 10.7.

APPENDIX NO. XV

WORK TEST FOR COMPRESSION STRENGTH OF CONCRETE

1. Scope :

1.1. This method is intended to apply to the moulding, storing and testing of compression test specimens of concrete sampled from concrete being used in construction.

2. Specimen :

2.1. Test specimens shall be either cubes or cylinders whose size shall be as given in Table.

TABLE——SIZES OF TEST SPECIMENS

Maximum size of Coarse Aggregates	Sizes of specimens					
	Cubes		*Cylinders*			
			Dia meter		Height	
	cm.	in.	cm.	in.	cm.	in.
Not exceeding ¾ in. (20 mm.)	10×10×10	4×4×4*	15	6	30	12
Greater than ¾ in. (20 mm.) but not exceeding 1½ in. (38 mm.)	15×15×15	6×6×6	15	6	30	12
Greater than 1½ in. (38 mm.) after hand-picking aggregates than greater 1½ in. (38mm.)	15×15×15	6×6×6	15	6	30	12

2.2. The moulds for test specimens shall be made of non-absorbent material and shall be substantial enough to hold their form during the

*The size of the cubic specimen shall be generally 6″×6″×6″ (15 cm.× 15 cm.×15 cm.) and this size shall be preferred to 4″×4″×4″(10 cm.×10 cm. x 10 cm). Where prior consent of the Engineer-in-charge has been obtained, the size of the specimen may be 4″×4″×4″ (10 cm.×10 cm.×10 cm.).

moulding of the test specimens. They shall not vary from the standard dimensions given under 2.1 by more than one per cent. The moulds shall be so constructed that there will be no leakage of water from the test specimens during moulding.

Note.—Satisfactory moulds can be made from machined iron or steel castings, machined steel water pipe, cold drawn steel tubing, rolled metal plates or galvanised iron.

2. 2.1. Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly with leakage. Glass plate not less than ¼ in. (6mm.) thick, or planed metal not less than ½ in (13 mm.) thick, shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

3. **Sampling of Concrete**

3.1. Samples of concrete for test specimen shall be taken at the mixer, or in the case of ready mixed concrete from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, starting the sampling operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of the specimen and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for future reference. In the case of paving concrete, samples may be taken from the batch immediately after depositing on the sub-grade. At least five samples shall be taken from different portions of the pile and these samples shall be thoroughly mixed before being used to form the test specimen.

4. **Preparation of Test Specimen**:

4.1. The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. From the sample of concrete obtained as described under 3.1, the test specimen shall be immediately moulded by one of the following methods:—

(*a*) When the job concrete is compacted by ordinary methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete with the mould. Each layer shall be rodded 25 times with a ⅝ in. (16 mm.) rod, 24 in. (0.6m.) in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least ¼ in. (6 mm.) thick or a machined metal plate which may be later be used in capping the cylindrical test specimens. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.

(*b*) When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rodding as described under (*a*) above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in the mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, In order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of approp-raite size and shall penetrate only the layer to be compacted. In compacting the first layer the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for the top layer, the mould shall not be filled to the extent that there will be mortar loss during vibration. After vibrating the second layer, enough concrete shall be added to bring the level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified under (*a*) above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cemet ratio of the concrete by loss of water either by leakage from the bottom or overflow from the top of mould.

4.2. Capping of Cylindrical Test Specimen:

4.2.1 Two to four hours after moulding the cylindrical test specimens, if made in metal mould, may be capped with a thin cap of neat cement paste. The cap shall be formed by means of a piece of plate glass ¼ in. (6 mm.) thick, or a machined metal plate ½ in. (13 mm.) thick and of a size 2 to 3 in. (50 to 75 mm.) large than that of mould. The plate shall be worked on the cement paste until the plate rests on top of the mould. The cement for capping shall be mixed to a stiff paste 2 to 4 hours before it is to be used, in order to avoid the tendency of the cap to shrink. Adhesion of the concrete to the top and bottom plates may be avoided by coating them with heavy oil or grease.

4.2.2 If the cylindrical specimens are not capped with neat cement paste, they shall be capped before testing in such a manner that the ends are perfectly plane, and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that it will not flow or fracture under the load.

4.2.3 It is desirable that the capping material should have a value for modulus of elasticity equal to or greater than that of the concrete under test.

5. Curing and Storage of Test Specimen:

5.1 In order to afford reasonably uniform temperature moist conditions during the first 24 hours for curing the specimens and to protect them from damage, the moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept in such a position on the work that its air temperature when containing concrete specimens shall remain between 72° to 91° F (22° to 33° C) Other suitable means which provide such temperature and moisture conditions may be used.

Note.—It is suggested that the storage box be made of 1 in. (25 mm) dressed tongued and grooved timber, wall braced, with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimens shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within the range of 76° to 86° F (24° to 30° C) until the time of test. If storage in water is desired, a saturated lime solution shall be used.

6. Method of Testing:

The specimens shall be tested in accordance with procedure described in paragraph 6 of Appendix.

7. Standard of Acceptance:

The standard of acceptance shall be the same as described in paragraph 7 of Appendix XIV.

APPENDIX NO. XVI

DETERMINATION OF CONSISTENCY OF CONCRETE BY SLUMP TEST

1. Scope:

1·1 This method covers test for determining the consistency of concrete samples from concrete being used in construction.

2. Specimen :

2·1 The test specimen shall be formed in a mould in the form of the frustum of a cone with internal dimensions as follows:—

(*a*) Bottom diameter 8 inches (20 cm.),

(*b*) Top diameter 4 inches (10 cm.), and

(*c*) Height 12 inches (30 cm.)

The bottom and the top shall be open, parallel to each other, and at right angles to the axis of the cone. The mould shall be provided with suitable foot pieces and handles. The internal surface shall be smooth.

2·2 Care shall be taken to ensure that a representative sample is taken.

3. Sampling of Concrete:

3·1 Samples of concrete for test specimens shall be taken at the mixer, or in the case of ready-mixed concrete, from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, starting the sampling operation of the beginning of discharge and repeating the operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of the specimen, and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for future reference. In the case of paving concrete, samples may be taken from the batch immediately after depositing on the sub-grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen.

4. Moulds:

4·1 The internal surface of the mould shall be thoroughly clean, dry and free from set cement before commencing the test.

5. Procedure:

5·1 The mould shall be placed on a smooth, flat, non-absorbent surface. The operator should hold the mould firmly in place, while it is being filled, by standing on the foot-pieces. The mould shall be filled to about one-fourth of its hieght with the concrete which shall then be tamped, using 25 strokes of a ⅝ inch (16mm.) diameter steel rod, 2 feet (0·6 m.) long and bullet pointed at the lower end. The filling shall be completed in successive layers similar to the first, and the top struck off so that the mould is exactly filled. The mould shall then be removed by raising vertically immediately after filling. The moulded concrete shall then be allowed to subside, and the height of the specimen measured after coming to rest.

5·2 The consistency shall be recorded in terms of inches (millimetres) of subsidence of the specimen during the test, which is known as the slump.

APPENDIX NO. XVII

DETERMINATION OF CONSISTENCY OF CONCRETE BY VEE-BEE CONSISTOMETER METHOD

1. Scope:

1·1 This appendix deals with the determination of consistency of concrete using a Vee-Bee Consistometer, which determines the time required for transforming, by vibration, a concrete specimen in the shape of a conical frustum into a cylinder.

2. Apparatus:

2·1 The Vee-Bee Consistometer (see Fig. on page 878) consists of:—

(*a*) A vibrator table resting upon elastic support.

(*b*) A metal pot.

(*c*) A sheet metal cone, open at both ends; and

(*d*) A standard iron rod.

2·2. The vibrator table (G) is 380 mm. long and 260 mm. wide and is supported on rubber shock absorbers at a hieght of about 305 mm. above floor level. The table is mounted on a base (K) which rests on three rubber feet, and is equipped with an electrically operated vibrometer mounted under it operating on either 65 volts or 220 volts, three phase, 50 cycles alternating current. A sheet metal cone (B) open at both ends is placed in the metal pot (A) and the metal pot is fixed on to the vibrator table by means of two wing nuts. (H). The sheet cone is 30 cm. high and its bottom diameter is 20 cm. and top diameter 10 cm. A swivel arm holder (M) is fixed to the base and into this is telescoped another swivel arm (N) with funnel (D) and guide sleeve (E). The swivel arm can be readily detached from the vibrating table. The graduated rod (J) is fixed on the swivel arm and at the end of the graudated arm a glass disc (C) is screwed. The graduation of the scale on the rod records the slumps of the concrete cone in centimetres and the volume of concrete after vibration of the cone in the pot. The standard iron rod is 20 mm. in diameter and 500 mm. in length. The electrical equipment mounted on the base of the consistometer consists of a fixed plug and connector for the electric supply cable, plug and socket contacts for the detachable cable connected to the vibrometer and a control switch.

3. Procedure:

3·1. A slump test as described in Appendix XVI is performed in the sheet metal cylinderical pot of consistcmeter. The glass disc attached to the swivel arm is moved and is placed juts on tp of the slump cone

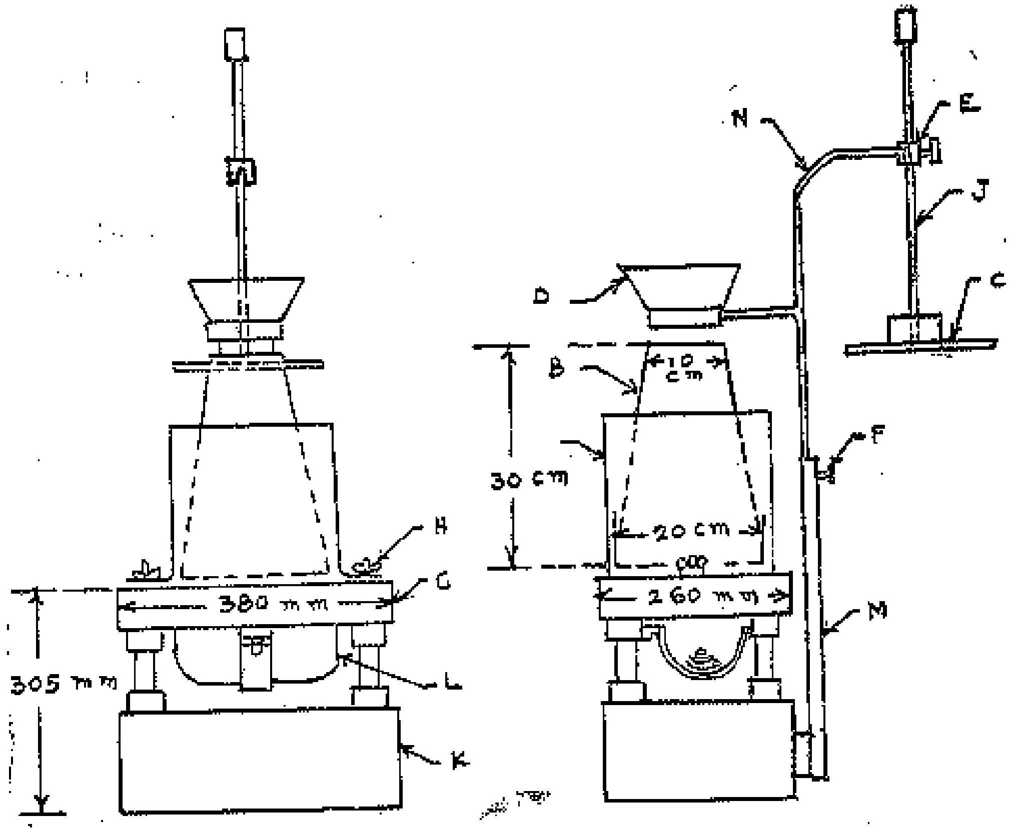


FIG: 1 VEE-BEE CONSISTOMETER, TYPE VBR

in the pot and before the cone is lifted up the position of the concrete cone is noted by adjusting the glass disc attached to the swivel arm. The cone is then lifted up and the slump is noted on the graduated rod by lowering the glass disc on top of the concrete cone. The electrical vibrator is then switched on and the concrete is allowed to spread out in the pot. The vibration is continued until the whole concrete surface uniformly adheres to the glass disc as indicated in figure and the time taken for this to be attained is noted with a stop-watch. The time is recorded in seconds.

4. Result: —

4.1. The consistency of the concrete is expressed in Viee-Bee degrees which are equal to the time in seconds under 3.1.

4.2. The required slump is obtained on the basis of the consistency scale given in Table below.

4.2.1 The curve in Fig. 2 indicates the relationship between slump in cm. and the degrees covered by the consistency scale given in Table below.

Consistency	Number of Vee-Bee Degrees	Characteristics.
Moist Earth	.. 40 to 25 to 20	Particles of coarse aggregate in the concrete are adhesive but concrete does not clot. Risk of segregation.
Very dry	.. 20 to 15 to 10	Concrete has the consistency very stiff porridge, forms a stiff mound when dumped, and barely tends to shake or roll itself to form an almost horizontal surface when conveyed for a long time in, say, a wheel barrow.
Dry	.. 10 to 7 to 5	Concrete has the consistency of stiff porridge, forms a mound when dumped, and shakes or rolls iteslf to form a horizontal surface when conveyed for a long time in, say, a wheel barrow.
Plastic	.. 5 to 4 to 3	Concrete can be shaped into a ball between the palms of the hands and adheres to the skin.
Semi-fluid	.. 3 to 2 to 1	Concrete cannot be rolled into a ball between the palms of the hands, but spreads out even though slowly, and without affecting the cohesion of the constituents so that segregation does not occur.
Fluid	.. More fluid than 1	Concrete spreads out repidly and segregation takes place.

APPENDIX NO. XVIII

UNTESTED STEEL FOR REINFORCED CONCRETE WORK

1. Untested steel obtained through reliable agents in sealed bundles may be used without test only in case of petty works and village road bridges or culverts up to 12.0, span. Safe tensile strength of this steel should not be taken in excess of 16000 per sq. inch (1120 kg./sq. cm.).

2. Untested steel may be used in case of V. R. bridges upto 20 ft. (6 metres) span subject to the following conditions:—

(*i*) Safe tensile strength of steel should not be taken to be in excess of 16000 lb./sq. inch (1120 kg./sq. cm.) or that determined by a yield point test allowing a factor of safety of 2.2 as described in para 5.

(*ii*) The bars should be capable of bent double when cold without fracture to a radius not greater than 1½ times in diameter of the bars over 1 inch (25 mm.) dia. or a radius equal to one diameter if 1 inch (25 mm.) or less.

3. In case of important works, class A, class AA and higher loading Road Bridges, and for all spans larger than 20 ft. (6 metres) the untested steel should be subjected to the following tests before it is used:—

(*a*) Tensile test.

(*b*) Cold bend test.

Tensile tests shall be carried out in accordance with Indian Standard : 1608 in a laboratory where adequate arrangements exist for testing steel. Safe tensile strength of steel shall be taken as ½ of a ultimate tensile strength subject to a maximum of 16000 lb/sq. inch (1120 kg./sq. cm.). Cold bend test as described below shall be carried out personally by engineer-in-charge:—

The test piece shall withstand, without fracture being doubled over either by pressure or by steady blows from a hammer until the two sides of the piece are parallel and, in the case of bars above 1 inch (25 mm.) in diameter, the internal radius is not greater than 1½ times the diameter of the bar, and in the case of bars of 1 inch (25 mm.) and under in diameter, the internal radius of the bond is not greater than the diameter of the bar.

4. **Number of tensile and cold bend test.**—One test in either case shall be made from every 10 or part of 10 bundles in any consignment of untested bars.

5. Determining yield point of steel bars at site.—

(*i*) A segment of a circle of given radius is cut out exactly in wood and if used frequently should be lined with steel.

(*ii*) A straight untested bar is bent down over the curve and released. The bar will strengthen out in part. The remaining curvature is measure to calculate the yield point. In Fig. 1 is shown the bar before and after bending :

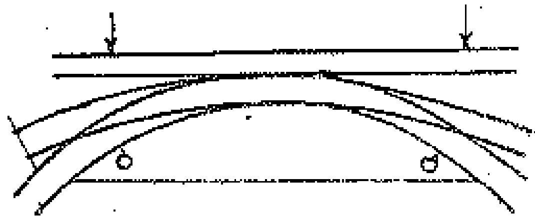


FIG : 1

(*iii*) r_2 the radius of curvature of the bar after its release can be determined as follows :—

Fix two nails at a distance S inches apart and draw a line to join them as shown in **Fig. 2.** Bring the curved bar into contact with both nails on the same side and measure **h** the height of the arc.

$$\text{Then } r_2 = \frac{S_2}{8h} + \frac{h}{2}$$

If QY is the stress at yield point.

$$QY = \frac{ED}{2\, r_1} \cos\phi$$

Where E is the modulus or elasticity and is equal to 30×106 lbs./sq. in.

D=dia of bar, r_1=Radius of curve over which bar is bent. ϕ can be calculated from the relation.

$$n = \frac{II}{4} \frac{(1-10\dagger)}{r^2} = \frac{II}{4} - \frac{II}{360^0}\phi + \frac{5}{6}\sin\phi \cos.\phi$$

$$+ \text{Cos}^2\phi \sin\phi - \frac{4}{3} \cos.\phi \tan\phi.$$

If n has been calculated, cos ϕ be obtained from Fig. 3.

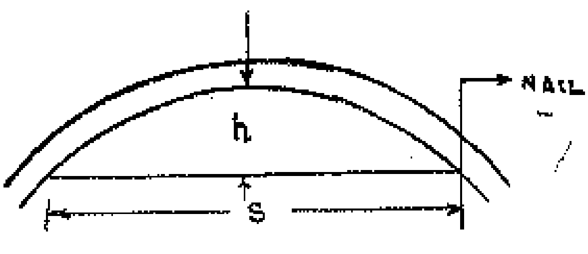


FIG : 2

APPENDIX NO. XIX

METHODS FOR SUPERELEVATING THE ROAD SURFACE AT CURVES

The superelevation is built into a road in two stages. In the first stage the camber is neuteralised gradually till the road has one straight line slope from the inner to the outer edge. In the second stage, the straight line slop is gradually increased till the designed superelevation is attained.

The change from a cambered section to a straight line cross slope is effected by progressively decreasing the inclination of outer slope tangential to the curved crown until it reaches the horizontal and then progressively increasing it until it conincides with the inclination of the inner slope (*See* figure 1 and 2). This method is open to the objection that difficulties with surface drainage are introduced unless the

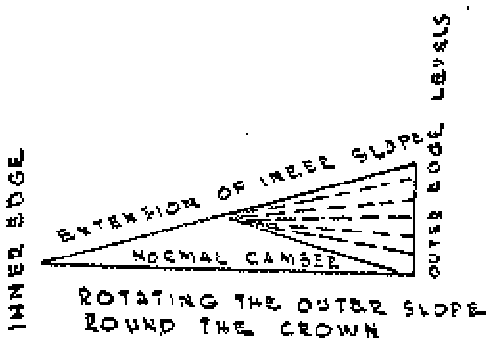


FIG: 1

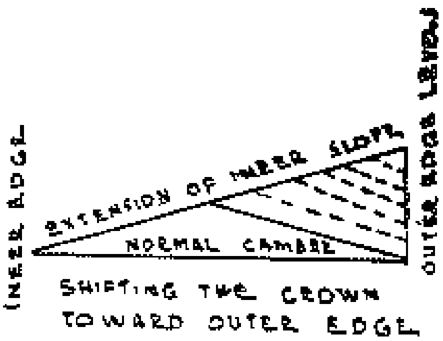


FIG: 2

road has a good longitudinal fall. It has, however, the following advantages:—

(*i*) The outer half of the curve can be brought to level before the start of the curve, so that no point in the curve will the surface have a negative superelevation.

(*ii*) It does not call for the use of special templates and point of elevation of the outer edge can be easily calculated.

Another method known as the diagonal crown method which consists in progressively shifting the crown towards the outer edge and extension of the inner slope until the crown is completely run of the width of the pavement. Adoption of this method necessitates the starting of the shift after the start of curve and is not recommended.

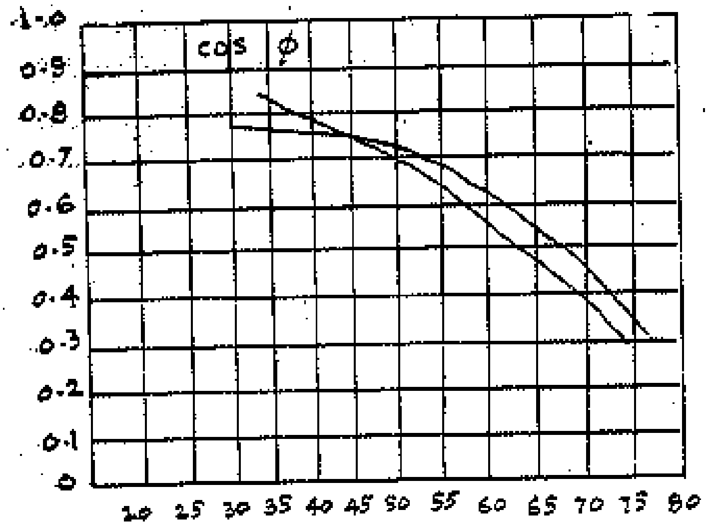


FIG: 3

(*iv*) To obtain reasonable results following figures form r_1 may be used in case of round mild steel bars:—

Dia of bar		Radious of curavture (r_1) over which the bar should be bent.
inch	mm	inch
$\frac{3}{8}$ to $\frac{1}{2}$	10 to 12	24
$\frac{5}{8}$	16	40
$\frac{3}{4}$ to $\frac{7}{8}$	20 to 22	55
1 to 1 $1\frac{1}{8}$	25 to 28	80
		100

(*v*) The permanent height of the arc should be about half of the original curve.

(*vi*) Safe tensile stress should have a factor of safety of 2.2 over yield point stress.

(*vii*) *Examples.*—A $\frac{3}{8}$ inch (10 mm.) diameter round bar was bent with r_1=48". Measured value of h=0.65 in. and of

S=39.4 in.

$$r_2 = \frac{39.4^2}{8\times 0.65} + \frac{0.65}{2} = 300 \text{ in.}$$

$$n = \frac{II}{4} \; \frac{(I-48)}{300} = 0.661$$

From Fig. (3) cos ϕ = .60

$$\text{therefore } QY = \frac{30\times 106\times 3}{2\times 48\times 48} \; 0.06 = \text{Say } 7{,}0000 \text{ lb/sq. inch}$$

After the profile of the pavement has been brought to a straight line slope, the designed superelevation could be obtained either by:—

(1) Progressively revolving the slope about the centre line, thus simultaneously depressing the inner edge and elevating the outer edge.

OR

(2) Progressively revolving the slope about the inner edge raising both the centre and the outer edge simultaneously.

Method (1) maintains the grade of the centre line without inducing bumps in the longitudinal section and therefore is preferable Method (2) is suitable for flat location to prevent drainage difficulties, in cuts, and in approaches to bridges on trestles.

(Taken from Chief Engineer's Technical memo No. 5 on "Road Curves").

APPENDIX XX

Sampling aggregate for Laboratory Testing

1. The procedure outlined herein should be followed to obtain samples of both coarse and fine aggregates for laboratory tests. The task of obtaining a truly representative sample of aggregate is considerably camplicated because of the segregation that takes place when the eggregate is hand led or moved. General.

2. Sampling from sand stock piles should start at equally spaced points along the bottom of the pile and proceed upwards, at equal intervals, over the sides and top, thuscovering the entire heap. If only part of the pile is to be used for a portion of the job, just the part to be used should be sampled. Sampling from stock piles.

Where practicable, gravel samples from stock plies should be taken with a specified tube sampler. Generally samples consisting of material from well beneath the surface obtained with a shovel, shall be considered satisfactory. By holding a short peace of board against the pile just above the point of sampiing, the inclusion of unwanted surface material can be avoided.

3. Samples from railway wagons should, preferably; be taken at points equally spaced on straight lines along the sides and centre of the wagon. The size of the samples will depend on the size of the wagon, the number of points from which samples are taken, and the maximum size of aggregate particles. Sampling from railway wagons.

A standard tube sampler should be used for sand, and when possible, for coarse aggregate. The tube sampler is a steel pipe about 2 inches in diameter and 6 feet long pointed at the lower end and having a handle at the top. A series of openings is punched along the pipe in such a way that a line of "ears" projects from one side of the openings. The sampler tube is forced into theaggregate as ar as possible; turned until the ears, have scooped sufficent material into the tube for a sample; and then withdrawn, keeping the openings on top.

Usually it may more convenient to take representative samples when the material is being loaded into or unloaded from a wagon. If loading or unloading is done by hand, a fairly representative sample may be obtained by taking a shovelful at regular intervals; provided care is taken that the larger pieces do not roll off the shoval. If wagons are mechanically loaded or unloaded, sanples should be taken at regular intervals.

4. To secure representative samples of aggregate from a conveyor belt, sampling should be done over the complete cross-section of supply stream in a short period. Samples should be taken at regular intervals until the whole supply has been sampled. The number and size of such sample will depent on the quantity and uniformity of the aggregate. Sampling from conveyor belts

Reduction to test sample.

5. The sample obtained from aggregate supply should be reduced to test sample by quartering or splitting as described below —

(a) *Guartering method.*—Place the sample on a hard, clean surface where there will be neither loss of material nor addition of foregin matter. Mix the sample thoroughly by turning the entire lot over three times with a shovel. With the third or last turning, the entire sample should be shovelled into a conical pile by depositing each shovelful on top of the preceding one. The conical pile should be then flattened to a uniform thickness and diameter, so that after the pile has been quartered, each quarter will contain the material originally in it. The flatened mass should be then marked into quarters by two lines that inter-sect at right angles at the centre of the pile. Remove two diagonally opposite quarters and brush the cleared spaces clean. The remaining material should be mixed and quartered successively unit the sample is reduced to 50 pounds or less. The sample should be furt er reduced to the desired size by passing it through a sample splitter, one-half being discarded and the other half spilt again.

(b) *Sample splitting.*—The entire sample should be passed through a sheet metal sample splitter. One-half of the split sample shaold be set aside and the other half split again. This procedure should be repeated until the sample is reduced to the desired size.

Details of the standard sample splitter are shown in figure below :—

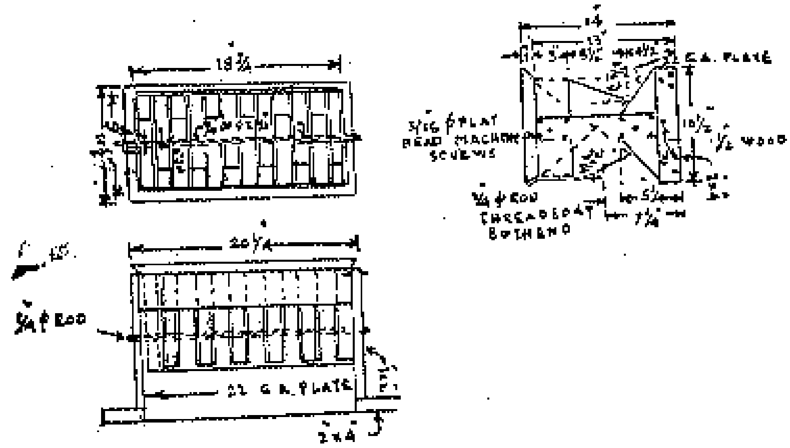


FIG: SAMPLE SPLITTER

Coarse aggregate samples should be reduced to test specimen size by the quartering method only. With aggregate larger then 2 inch size, it may be more convenient and desirable to hand-pick the sample. In such a case care shoul dbe taken to obtain a representative sample. Samples of sand should be reduced to test size by the quartering method or use of a sample splitter.

APPENDIX XXI

Abstract of regulations for the electrical eqhipment of buildings of the Institution of Electrical Engineers, London referred to in the specification no. 31.1 (clause 2)

DEFINITIONS

1. **Consumer's Terminals.**—The pression "consumer's terminals" means the ends of the electric conductors situated upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service lines.

2. **Medium Pressure.**—The expression 'medium pressure' means a pressure between conductors normally exceeding 250 volts, but not exceeding 650 volts at the point at which the supply is delivered.

3. **Low Pressure.**—The expression 'low pressure' means a pressure between conductors normally exceeding 30 volts in the case of alternating current and 100 volts in the case of direct current, but not exceeding 250 volts in either case at be point at which the supply is delivered.

4. **Extra Low Pressure.**—The expression 'extra pressure' means a pressure between conductors normally not exceeding 30 volts in the case of alternating current, and 100 volts in the case of direct current, at the point at which the supply is delivered.

Note :—**Pressure and Frequencies**:—The British Standard frequency for alternating current systems is 50 periods per second. Standard pressures will be found in British Standard Specification No. 77.

5. **Live (Alive).**—An object is said to be 'live' when a difference of potential exists between it and earth.

Note.—All metal connected to the neutral conductor of the supply system, even if such neutral be earthed at the source of supply, shall be deemed to be alive for the purposes of these Regulations.

6. **Earthed.**—The expression 'earthed ' means connected to the general mass of earth in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

7. **Earthing Lead.**—The 'earthing lead' is the conductor connecting the earthing system to the metal sheathing or apparatus required to be earthed.

8. **Uninsulated Conductor.**—An uninsulated conductor is one in which no provision is made for its insulation from earth.

9. **Bare Coductor.**—A bare conductor in one not covered with insulating material.

10. **Dielectric.**—The term 'dielectric' denotes that portion of a core or cable which is relied upon to insulate the conductor.

11. **Core (of a cable).**—The core of a cable is the conductor with its insulation or dielectric, but does not include the mechanical protective covering. Two, three or more cores may be laid up together to form a twin, threecore or multicore cable.

12. **Cable.**—The term 'cable' denotes one or more conductors with insulating covering and with or without protecting coverings.

Note:—Where the term 'cable' is used in these Regulations it shall be deemed to include a wire.

13. **Flexible Cable.**—A flexible cable is one in which the conductor (or conductors) exceeds 0.007 square inch in cross-section and comprises a number of wires, the diameter of the wires and the material of the dielectric being such as to ensure flexibility.

14. **Flexible cord.**—A flexible cord is a flexible cable of cross-section not exceeding 0.007 square inch.

15. **Armoured cable.**—An armoured cable is one provided with a protective metallic covering of wires or tapes, usually of iron and steel.

16. **Double insulation.**—A conductor is said to have double insulation when it is provided with insulating material between the conductor and its surrounding envelope or immediate support as well as between this and earth.

17. **Bunched cable.**—Cables are said to be bunched when more than one is contained within a single duct or groove, or when unenclosed cables are not separated from each other.

18. **Fitting.**—A fitting is an appliance for supporting or containing a lamp together with its holder and shade or reflector; for example, a bracket, pendant and ceiling rose, electrolier or portable standard.

19. **Accessory.**—An accessory is an appliance other than a fitting, associated with the wiring, fittings and consuming devices ; for example, a small switch, cutout, plug, sockets or similar device.

20. **Domestic appliance.**—A domestic appliance is a current consuming device, other than an electric lamp, which is normally installed in a dwelling house and in which the electrical energy is converted into heat or drives a small electric motor forming an integral part of the device.

21. **Point.**—See special definition in clause 2 of 8-9 specification No. 31.1.

22. **Weather proof.**—Fittings, accessories and consuming devices are said to be weather proof if they are so constructed that when installed, rain, snow and splashings are excluded.

23. **Switchgear.**—The term 'switchgear' denotes apparatus for controlling the distribution of electrical energy, or for controlling or protecting electrical circuits, machines transformers or other apparatus.

24. **Switchboard.**—The 'switchboard' denotes and assemblage of switchgear, with or without instruments, but does not apply to a group of local switches on a final subcircuit (See definition 35), where each switch has its own insulating base and protective covering.

Notes—In the Home Office Regulations for factories and workshops the term 'switchboard' includes the distribution board.

25. **Singe switch.**—A single pole switch is a switch suitable for making or breaking a circuit on one pole (or phase) only.

26. **Double-pole switch.**—A double pole switch is a switch suitable for making or breaking a circuit on two poles (or phases) simultaneously or for making or breaking two separate circuit simultaneously.

27. **Triple-pole switch.**—A triple-pole switch is a switch suitable for making or breaking a circuit on three ples (or phases) simultaneously, or for making or breaking three separate circuits simultaneously.

28. **Four-pole switch.**—A four-pole switch is a switch suitable for making or breaking a circuit on four poples (or phases) simultaneously or for making or breaking four separate circuits simultaneously.

29. **Linked switches.**—Linked switches are switches linked together mechanically so as to operate simultaneously or in definite sequence.

30. **Fusible cut-out.**—(abbreviation 'cut-out'). A fusible cut-out compries all the separate parts' e.g. fuse carrier, fuse contacts, fuse

extension and circuit contacts which together with their mountings and base, form the complete protecting device.

31. **Fuse.**—A fuse is the actual wire or strip of metal in a cut-out the function of which is to be fused by an excessive current.

32. **Circuit Breaker.** A circuit breaker is a switch for opening automatically unless otherwise specified, a circuit under abnormal conditions such as those of overload.

33. **Fuse switch.**—A fuse-switch is a switch the moving part of which carries one or more fuses.

Note.—In every case in which a separate fuse and-switch or separate fuses and linked switches are required by these Regulations, they may replaced by a fuse-switch or linked fuse-switches, as the case may be.

34. **Section or distribution board.**—A section or distribution board is an accessory comprising fusible cut-out with or without switches and arranged for the distribution to, and protection and control of, branch circuits fed from a main circuit.

35. **Sub-Circuit.**—A sub-circuit is a branch circuit connected to a distribution board fed from a main circuit and may either feed a further distribution board or be a final sub-circuit. A final sub-circuit is a sub-circuit which does not feed a distribution board and to which lamps and/or other current-consuming devices are connected.

36. **Systems of wiring (distribution)** A—Two **wire.**—A two-wire system of writing is one comprising two conductors between which the load may be connected, the wiring being effected by either of the following methods :—

(*a*) **Two-Conductor, insulated.**—Conductors insulated throughout are provided for all connections to both poles of the supply, the conductors being separate, twin, or concentric.

(*b*) **Two-conductor, earthed.**—Conductors are provided throughout for all connections to both poles of the supply, those connected to one pole being insulated througout, and those connected to the other being uninsulated throuhgout and efficienlty earthed. The uninsulated conductor, know as the 'external' conductor, completely surrounds the whole length of the other, known as the 'internal' conductor.

Note.—Except with the consent of the Electricity Commissioners no conductor directly connected to the public supply system may be earthed.

B.—**Three-wire.**—A three wire system of wiring is one comprising three conductors, one of which, known as the 'neutral' or 'middle' is maintained at a potential midway between the potentials of the other two, referred to as the 'outer' conductor. Part of the load may be connected directly between the outer conductor and the remainder divided as evenly as possible into two parts connected respectively between the middle and each outer conductor.

C.—**Two-phase three-wire.** A two phase three-wire system of wiring is one comprising three conductors between one of which, is known as the 'common return' and the other two are maintained respectively alternating differences of potential displaced in phase by one-quarter of a period.

D.—**Three-phase three-wire.**—A three-phase three-wire system of wiring is one comprising three conductors, between successive pairs. of which are maintained alternating differences of potential successively displaced in phase by one-third of a period.

E.—**Two-phase four-wire.**—A gwo phase four-wire system of wiring is one comprising four conductors divided into two pairs which have maintained between their conductors alternating differences of potential displaced in phase by one-quarter of a period.

F—**Three-phase four-wire.**—A three-phase four-wire system of wiring is one comprising four conductors, three of which are connected as in a three-phase three-wire system the fourth being connected to the neutral point of the supply.

37.—**Balanced.**—A three-wire system of generation or supply is said to be 'balanced' when :—

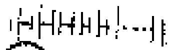
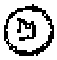
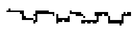
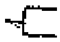
(*a*) In the case of direct-current or single-phase alternating-current systems of generation or supply, the loads connected between the 'middle' and each of the outer conductors are equal.

(*b*) In the case of a three-phase system of generation of supply, the load carried by an combination of two conductors is equal to the load carried by any other combination of two conductors.

Note :—In the case of a three-phase four-wire system of generation of supply in addition to condition 'b' above, the load connected between the middle and each of the outer or 'phase' conductors are also equal.

APPENDIX XXII

TABLE OF CONVENTIONAL SYMBOLS

NAME OF APPARATUS	SYMBOL
1 BATTERY	
2 DIRECT CURRENT GENERATOR	
3 DIRECT CURRENT MOTOR	
4 ALTERNATOR	
5 ALTERNATING CURRENT MOTOR	
6 TRANSFORMER	
7 MOTOR STARTER	
8 INDUCTIVE COIL	
9 NON-INDUCTIVE RESISTANCE	
10 CONDENSOR	
11 POST FOR OVERHEAD WIRES (POLE)	
12 SERVICE BRACKET	
13 METER BOARD	
14 MAIN DISTRIBUTION BOARD	
15 BRANCH DISTRIBUTION BOARD	
16 CIRCUIT FUSES ON BOARDS	
17 LIGHTNING ARRESTER	
18 EARTH PLATE OR PIPE	
19 MAINS	— — — — — — —
20 SUB-MAINS	—— · —— · —— · ——
21 UNDERGROUND CABLE	- - - - - - - - - - - -

	NAME OF APPARATUS	SYMBOL
22	AERIAL LINE	————————
23	CIRCUITS	— — — — — — —
24	CEILING FAN OR CLAMP	
25	CEILING FAN ON STRUT BETWEEN BEAMS	
26	FAN REGULATOR	R
27	DESK OR BRACKET FAN	
28	VENTILATOR FAN (PRESSURE OR Exhaust)	
29	SWITCH (TUMBLER)	S.P D.P T.P
30	SWITCH (IRON CLAD)	
31	SWITCH (AIR-BREAK)	
32	SINGLE PENDANT LIGHT	O
33	COUNTER WEIGHT PENDANT LIGHT.	O C.W.
34	ROD PENDANT LIGHT	O R
35	SPECIAL LIGHT FITTING	O
36	SINGLE BRACKET LIGHT.	—O
37	TWO LIGHT BRACKET.	
38	BATTEN LAMP HOLDER	O B.H
39	WATER TIGHT FITTING.	O W.T.
40	LIGHT PLUG	H
41	HEATER PLUG.	
42	CALL BELL	