

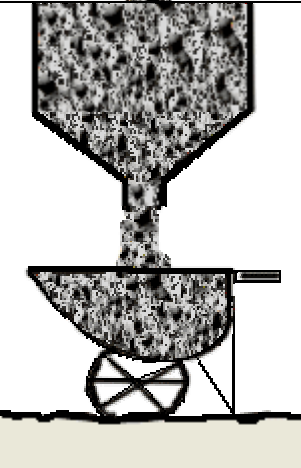
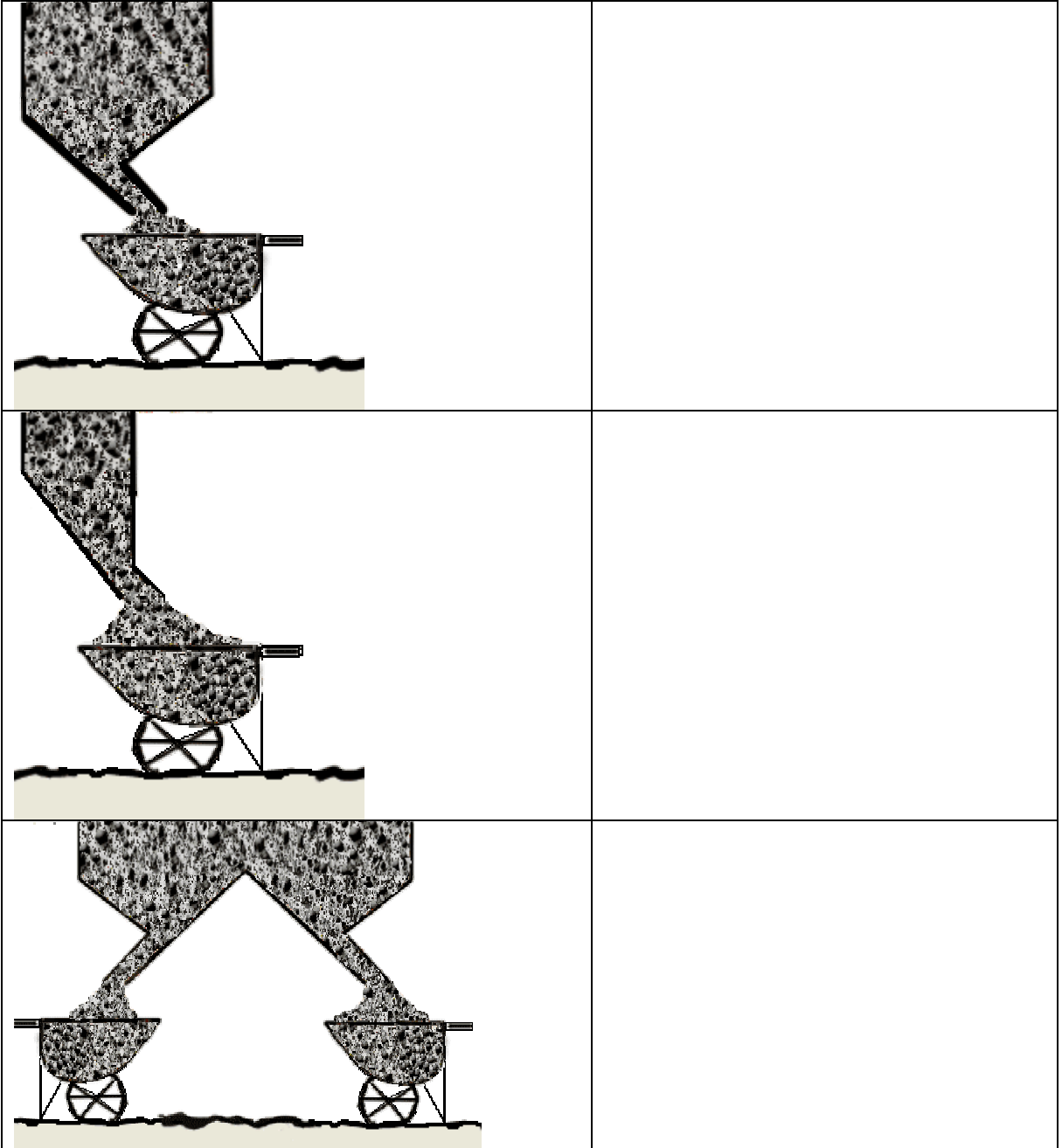
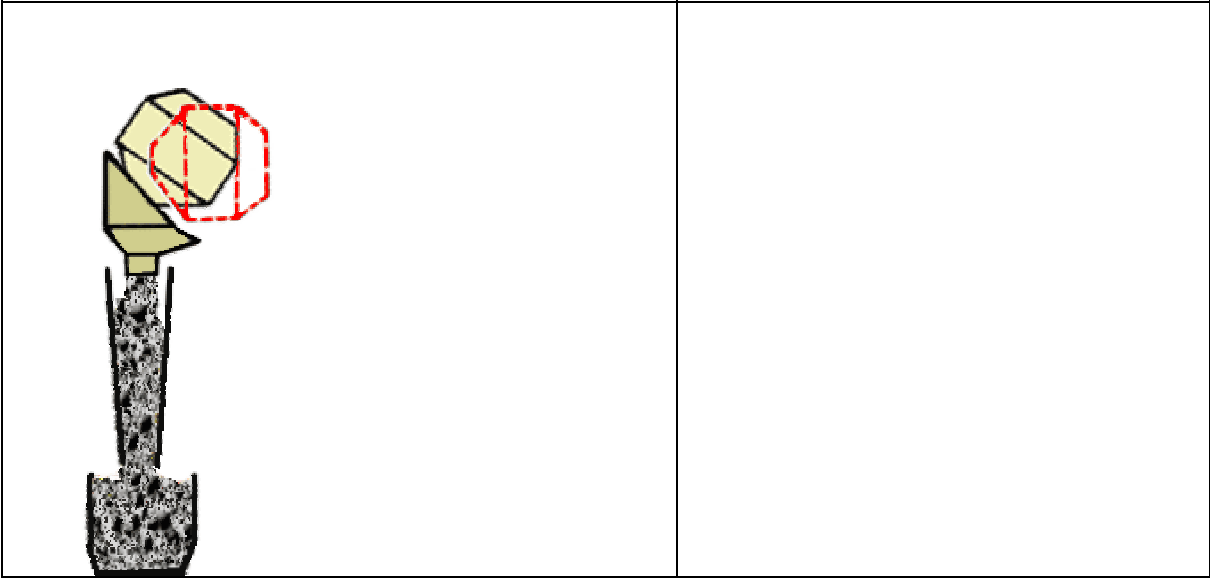
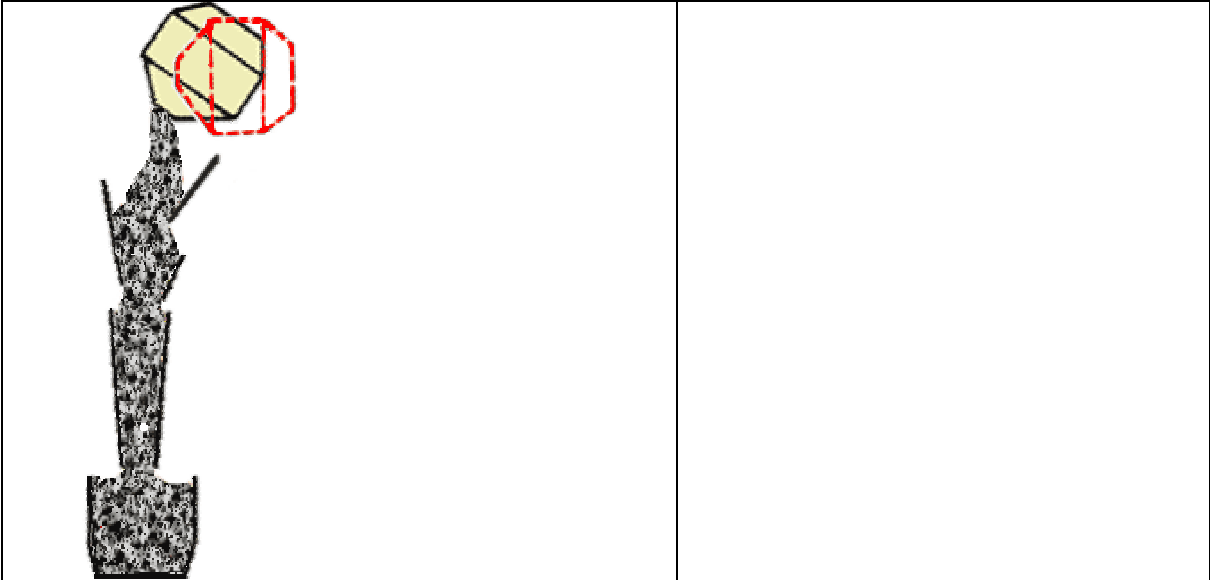
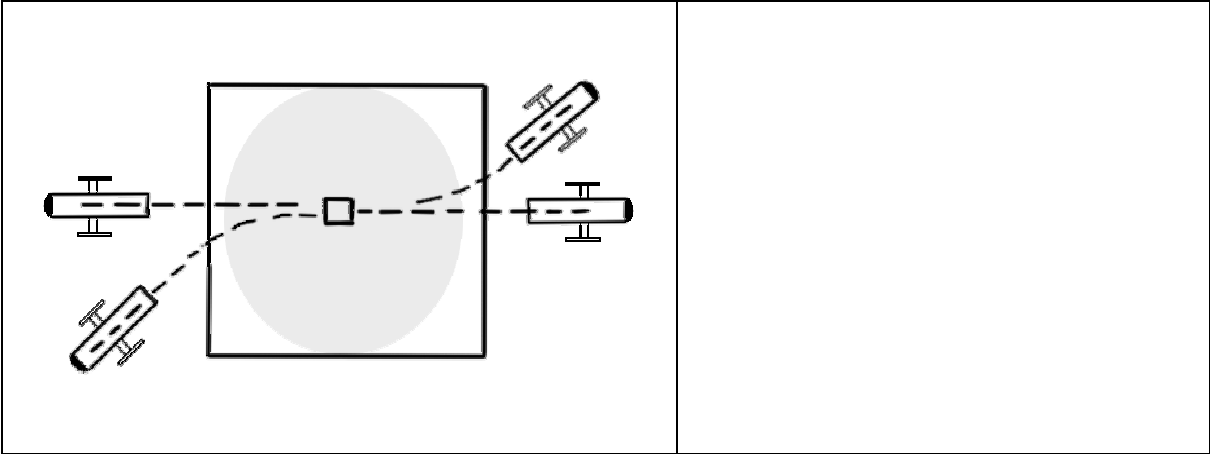
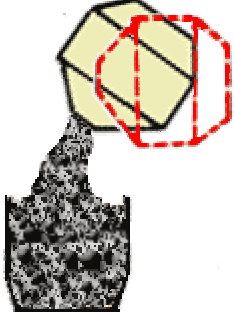
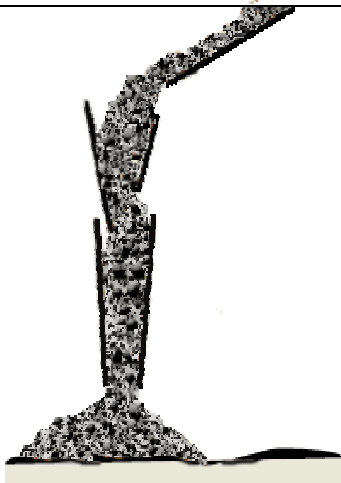
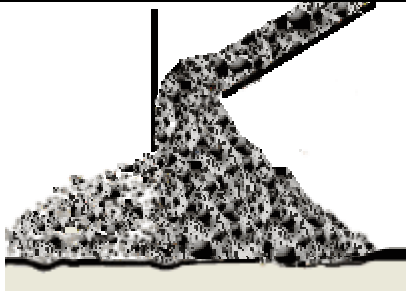



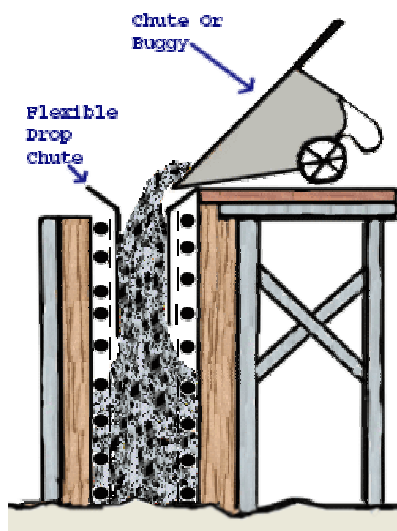
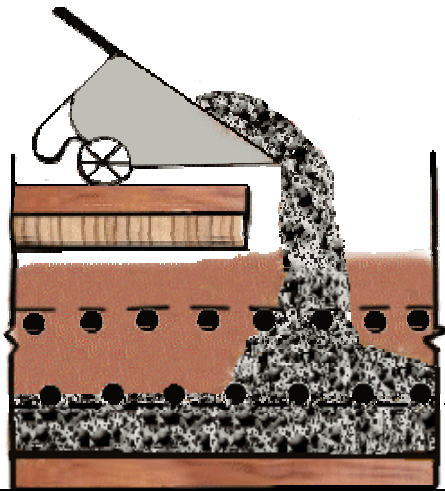
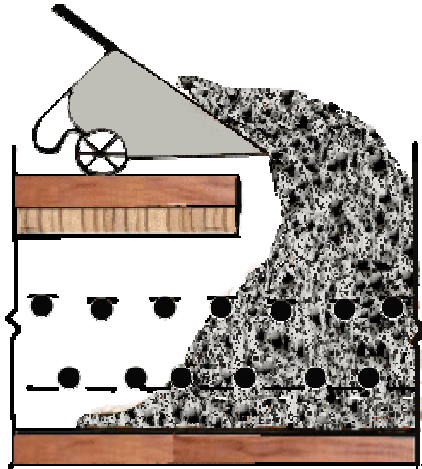
Concreting (UNDER CONSTRUCTION)

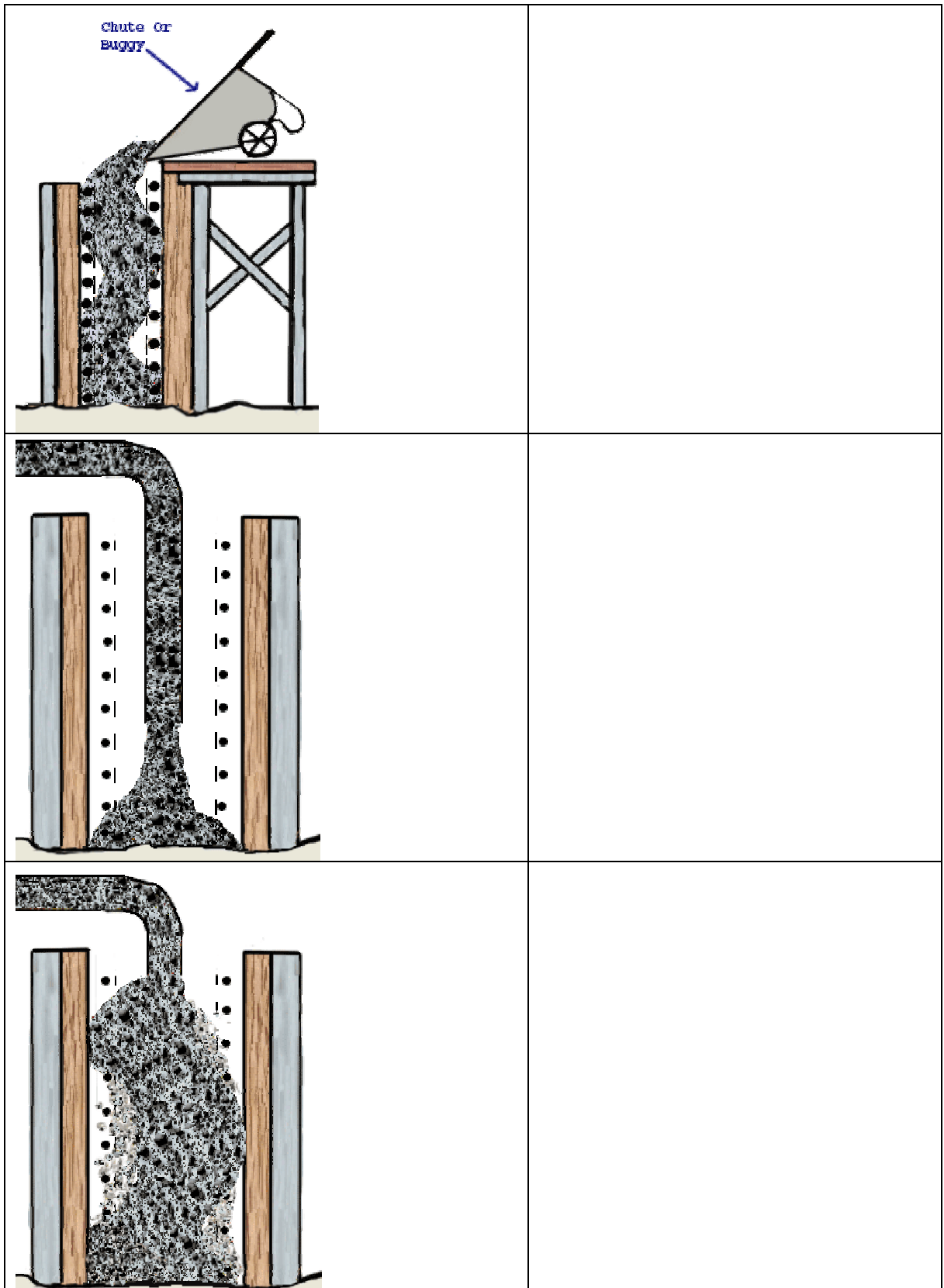
	
	
	

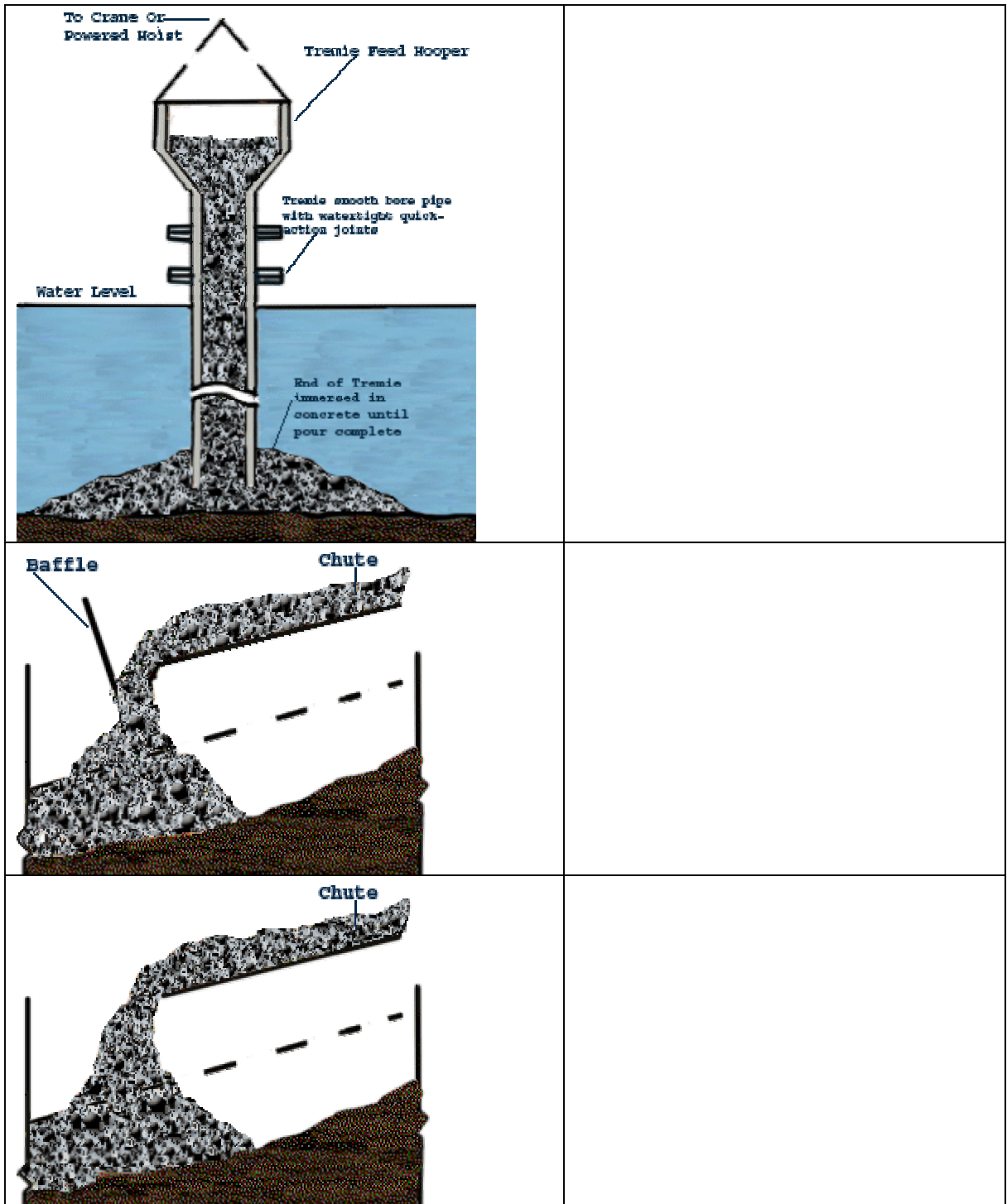


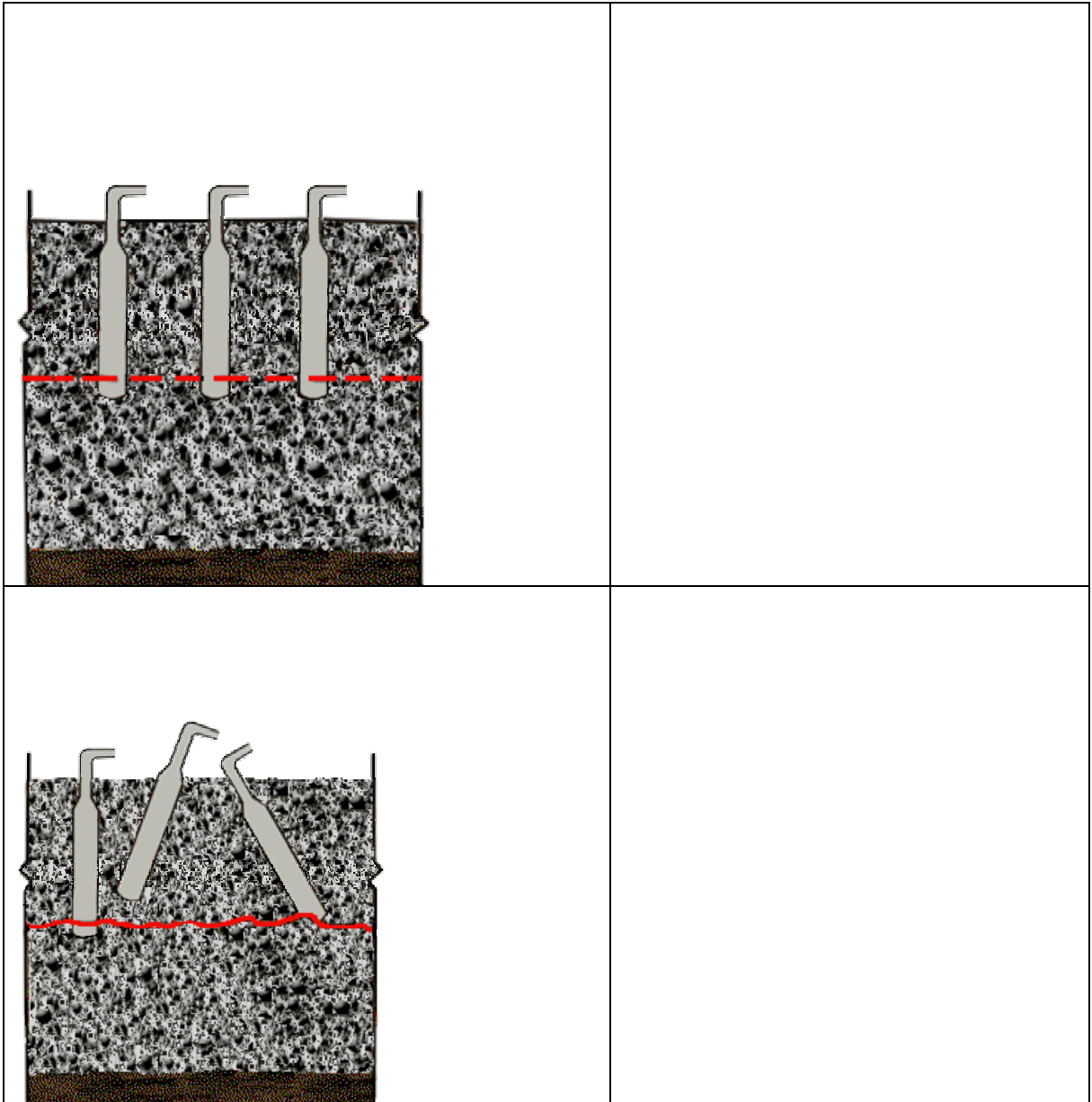










Clauses From IS 456

10.2 Batching

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixes on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be measured in volume or mass; water shall be weighed or measured by volume in a calibrated tank (see *also* IS 4925).

Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926).

10.2.1 Except where it can be shown to the satisfaction of the engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock-piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the engineer-in-charge to ensure that the specified grading is maintained.

10.2.2 The accuracy of the measuring equipment shall be within ± 2 percent of the quantity of cement being measured and within ± 3 percent of the quantity of aggregate, admixtures and water being measured.

10.2.3 Proportion/Type and grading of aggregates shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

10.2.4 Volume batching may be allowed only where weigh-batching is not practical and provided accurate bulk densities of materials to be actually-used in concrete have earlier been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by engineer-in-charge to ensure that the specified grading is maintained.

10.2.5 It is important to maintain the water-cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the engineer-in-charge according to weather conditions. The amount-of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of -exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 10.

Table 10 Surface Water Carried by Aggregate

Sl. No.	Aggregate	Approximate Quantity of Surface Water	
		Percent by Mass	1/m ³
(1)	(2)	(3)	(4)
i)	Very wet sand	7.5	120
ii)	Moderately wet sand	5.0	80
iii)	Moist sand	2.5	40
iv)	Moist gravel or crushed rock	1.25-2.5	20-40

10.2.6 No substitutions in materials used on the work or alterations in the established proportions, except as permitted in 10.2.4 and 10.2.5 shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

10.3 Mixing

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS 1791 and IS 12119. The mixers shall be fitted with water measuring (metering) devices. The mixing shall be continued until there is a uniform distribution of the materials and the mass is a uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed.

10.3.1 For guidance, the mixing time shall be at least 2 min. For other types of more efficient mixers, manufacturers recommendations shall be followed; for hydrophobic cement it may be decided by the engineer-in-charge.

10.3.2 Workability should be checked at frequent intervals (see IS 1199).

10.3.3 Dosages of retarders, plasticisers and superplasticisers shall be restricted to 0.5, 1.0 and 2.0 percent respectively by weight of cementitious materials and unless a higher value is agreed upon between the manufacturer and the constructor based on performance test.

11 FORMWORK

11.1 General

The formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete, and shall be such as to prevent loss of slurry from the concrete. For further details regarding design, detailing, etc. reference may be made to IS 14687. The tolerances on the shapes, lines and dimensions shown in the drawing shall be within the limits given below:

a) Deviation from specified dimensions of cross-section of columns and beams		+12 mm -6
b) Deviation from dimensions of footings		
	1) Dimensions in plan	+50 mm -12
	2) Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50mm
	3) Thickness	± 0.05 times the specified thickness

These tolerances apply to concrete dimensions only, and not to positioning of vertical reinforcing steel or dowels.

11.2 Cleaning and Treatment of Formwork

All rubbish, particularly, chippings, shavings and sawdust shall be removed from the interior of the forms before the concrete is placed. The face of formwork in contact with the concrete shall be cleaned and treated with form release agent. Release agents should be applied so as to provide a thin uniform coating to the forms without coating the reinforcement.

11.3 Stripping Time

Forms shall not be released until the concrete has achieved a strength of at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates and

admixture, if any, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work.

11.3.1 - While the above criteria of strength shall be the guiding factor for removal of formwork, in normal circumstances where ambient temperature does not fall below 15°C and where ordinary Portland cement is used and adequate curing is done, following striking period may deem to satisfy the guideline given in 11.3:

<i>Type of Framework</i>	<i>Minimum Period Before Striking Formwork</i>
a) Vertical formwork to columns	16-24h
b) Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)	3 days
c) Soffit formwork to beams (Props to be refixed immediately after removal of form work)	7 days
d) Props to slabs: 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	7 days 14 days
e) Props to beams and arches: 1) Spanning up to 6 m 2) Spanning over 6 m	14 days 21 days

For other cements and lower temperature, the stripping time recommended above may be suitably modified.

11.3.2 The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

11.3.3 Where the shape of the element is such that the formwork has re-entrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

12 ASSEMBLY OF REINFORCEMENT

12.1 Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502. The high strength deformed steel bars should not be re-bent 25 IS 456 : 2000 or straightened without the approval of engineer-incharge.

Bar bending schedules shall be prepared for all reinforcement work.

12.2 All reinforcement shall be placed and maintained in the position shown in the drawings by providing proper cover blocks, spacers, supporting bars, etc.

12.2.1 Crossing bars should not be tack-welded for assembly of reinforcement unless permitted by engineer-in-charge.

12.3 Placing of Reinforcement

Rough handling, shock loading (prior to embedment) and the dropping of reinforcement from a height should be avoided. Reinforcement should be secured against displacement outside the specified limits.

12.3.1 Tolerances on Placing of Reinforcement

Unless otherwise specified by engineer-in-charge, the reinforcement shall be placed within the following tolerances:

a) for effective depth 200 mm or less	$\pm 10 \text{ mm}$
b) for effective depth more than 200 mm	$\pm 15 \text{ mm}$

12.3.2 Tolerance for Cover

Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover

By $+10 \text{ mm}$
0

Nominal cover as given in 26.4.1 should be specified to all steel reinforcement including links. Spacers between the links (or the bars where no links exist) and the formwork should be of the same nominal size as the nominal cover.

Spacers, chairs and other supports detailed on drawings, together with such other supports as may be necessary, should be used to maintain the specified nominal cover to the steel reinforcement. Spacers or chairs should be placed at a maximum spacing of 1 m and closer spacing may sometimes be necessary.

Spacers, cover blocks should be of concrete of same strength or PVC.

12.4 Welded Joints or Mechanical Connections

Welded joints or mechanical connections in reinforcement may be used but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars connected. Welding of reinforcements shall be done in accordance with the recommendations of IS 275 1 and IS 9417.

12.5 Where reinforcement bars up to 12 mm for high strength deformed steel bars and up to 16 mm for mild steel bars are bent aside at construction joints and afterwards bent back into their original positions, care should be taken to ensure that at no time is the radius of the bend less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars, to ensure that the concrete around the bar is not damaged beyond the band.

12.6 Reinforcement should be placed and tied in such a way that concrete placement be possible without segregation of the mix. Reinforcement placing should allow compaction by immersion vibrator. Within the concrete mass, different types of metal in contact should be avoided to ensure that bimetal corrosion does not take place.

13 TRANSPORTING, PLACING,

COMPACTION AND CURING

13.1 Transporting and Handling

After mixing, concrete shall be transported to the formwork as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients or ingress of foreign matter or water and maintaining the required workability.

13.1.1 During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

13.2 Placing

The concrete shall be deposited as nearly as practicable in its final position to avoid re handling. The concrete shall be placed and compacted before initial setting of concrete commences and should not be subsequently disturbed. Methods of placing should be such as to preclude segregation. Care should be taken to avoid displacement of reinforcement or movement of formwork. As a general guidance, the maximum permissible free fall of concrete may be taken as 1.5 m.

13.3 Compaction

Concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into corners of the formwork.

13.3.1 Concrete shall be compacted using mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656. Over vibration and under vibration of concrete are harmful and should be avoided. Vibration of very wet mixes should also be avoided. Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators should receive special consideration to ensure efficient compaction and to avoid surface blemishes.

13.4 Construction Joints and Cold Joints

Joints are a common source of weakness and, therefore, it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be indicated by the designer. Construction joints should comply with IS 11817.

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/uneven surface. It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean out the same immediately thereafter. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it. In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining a rough surface for the previously poured concrete is to expose the aggregate with a high pressure water jet or any other appropriate means.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be provided.

Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

13.5 Curing

Curing is the process of preventing the loss of moisture from the concrete whilst maintaining a satisfactory temperature regime. The prevention of moisture loss from the concrete is particularly important if the water cement ratio is low, if the cement has a high rate of strength development, if the concrete contains granulated blast furnace slag or pulverised fuel ash. The curing regime should also prevent the development of high temperature gradients within the concrete.

The rate of strength development at early ages of concrete made with supersulphated cement is significantly reduced at lower temperatures. Supersulphated cement concrete is seriously affected by inadequate curing and the surface has to be kept moist for at least seven days.

13.5.1 Moist Curing

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least seven days from the date of placing concrete in case of ordinary Portland Cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

13.5.2 Membrane Curing

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer-in charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membranes such as polyethylene sheeting covering closely the concrete surface may also be used to provide effective barrier against evaporation.

13.5.3 For the concrete containing Portland pozzolana cement, Portland slag cement or mineral admixture, period of curing may be increased.

13.6 Supervision

It is exceedingly difficult and costly to alter concrete once placed. Hence, constant and strict supervision of all the items of the construction is necessary during the progress of the work, including the proportioning and mixing of the concrete. Supervision is also of extreme importance to check the reinforcement and its placing before being covered.

13.6.1 Before any important operation, such as concreting or stripping of the formwork is started, adequate notice shall be given to the construction supervisor.

14 CONCRETING UNDER SPECIAL CONDITIONS

14.1 Work in Extreme Weather Conditions

During hot or cold weather, the concreting should be done as per the procedure set out in IS 7861 (Part 1) or IS 7861 (Part 2).

14.2 Under-Water Concreting

14.2.1 When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the engineer-in-charge before the work is started.

14.2.2 Under-water concrete should have a slump recommended in 7.1. The water-cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be at least 350 kg/m³ of concrete.

14.2.3 Cofferdams or forms shall be sufficiently tight to ensure still water if practicable, and in any case to reduce the flow of water to less than 3 m/min through the space into which concrete is to be deposited. Cofferdams or forms in still water shall be sufficiently tight to prevent loss of mortar through the walls. De-watering by pumping shall not be done while concrete is being placed or until 24 h thereafter.

14.2.4 Concrete cast under water should not fall freely through the water. Otherwise it may be leached and become segregated. Concrete shall be deposited, continuously until it is brought to the required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of seams avoided. The methods to be used for depositing concrete under water shall be one of the following:

a) Tremie-

The concrete is placed through vertical pipes the lower end of which is always inserted sufficiently deep into the concrete which has been placed ~previously but has not set. The concrete emerging from the pipe pushes the material that has already been placed to the side and upwards and thus does not come into direct contact with water. When concrete is to be deposited under water by means of tremie, the top section of the tremie shall be a hopper large enough to hold one entire batch of the mix or the entire contents the transporting bucket, if any. The tremie pipe shall be not less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job should be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of the gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie in order to cause a uniform flow of the concrete, but the tremie shall not be emptied so that water enters the pipe. At all times after the placing of concrete is started and until all the concrete is placed, the lower end of the tremie pipe shall be below the top surface of the plastic concrete. This will cause the concrete to build up from below instead of flowing out over the surface, and thus avoid formation of laitance layers. If the charge in the tremie is lost while depositing, the

tremie shall be raised above the concrete surface, and unless sealed by a check valve, it shall be re-plugged at the top end, as at the beginning, before refilling for depositing concrete.

b) *Direct placement with pumps-*

As in the case of the tremie method, the vertical end piece of the pipe line is always inserted sufficiently deep into the previously cast concrete and should not move to the side during pumping.

c) *Drop bottom bucket -*

The top of the bucket shall be covered with a canvas flap. The bottom doors shall open freely downward and outward when tripped. The bucket shall be filled completely and lowered slowly to avoid backwash. The bottom doors shall not be opened until the bucket rests on the surface upon which the concrete is to be deposited and when discharged, shall be withdrawn slowly until well above the concrete.

d) *Bags -*

Bags of at least 0.028 m³ capacity of jute or other coarse cloth shall be filled about two-thirds full of concrete, the spare end turned under so that bag is square ended and securely tied. They shall be placed carefully in header and stretcher courses so that the whole mass is interlocked. Bags used for this purpose shall be free from deleterious materials.

e) *Grouting-*

A series of round cages made from 50 mm mesh of 6 mm steel and extending over the full height to be concreted shall be prepared and laid vertically over the area to be concreted so that the distance between centres of the cages and also to the faces of the concrete shall not exceed one metre. Stone aggregate of not less than 50 mm nor more than 200 mm size shall be deposited outside the steel cages over the full area and height to be concreted with due care to prevent displacement of the cages.

A stable 1:2 cement-sand grout with a water cement ratio of not less than 0.6 and not more than 0.8 shall be prepared in a mechanical mixer and sent down under pressure (about 0.2 N/mm²) through 38 to 50 mm diameter pipes terminating into steel cages, about 50 mm above the bottom of the concrete. As the grouting proceeds, the pipe shall be raised gradually up to a height of not more than 6 000 mm above its starting level after which it may be withdrawn and placed into the next cage for further grouting by the same procedure.

After grouting the whole area for a height of about 600 mm, the same operation shall be repeated, if necessary, for the next layer of 600 mm and so on. The amount of grout to be sent down shall be sufficient to fill all the voids which may be either ascertained or assumed as 55 percent of the volume to be concreted.

14.2.5 To minimize the formulation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

15 SAMPLING AND STRENGTH OF DESIGNED CONCRETE MIX

15.1 General

Samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

15.1.1 In order to get a relatively quicker idea of the quality of concrete, optional tests on beams for modulus of rupture at 72 + 2 h or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the values should be arrived at based on actual testing. In all cases, the 28 days compressive strength specified in Table 2 shall alone be the criterion for acceptance or rejection of the concrete.

15.2 Frequency of Sampling

15.2.1 Sampling Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested that is, the sampling should be spread over the entire period of concreting and cover all mixing units.

15.2.2 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

<i>Quantity of Concrete in the work, m³</i>	<i>Number of Samples</i>
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50m ³ or part thereof

NOTE-At least one sample shall be taken from each Shift. Where concrete is produced at continuous production unit, such as ready-mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.

15.3 Test Specimen

Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.

15.4 Test Results of Sample

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ± 15 percent of the average. If more, the test results of the sample are invalid.

16 ACCEPTANCE CRITERIA

16.1 Compressive Strength

The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

- a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 11.
- b) Any individual test result complies with the appropriate limits in col 3 of Table 11.

16.2 Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

- a) The mean strength determined from any group of four consecutive test results exceeds the

specified characteristic strength by at least 0.3 N/mm^2 .

b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2 .

16.3 Quantity of Concrete Represented by Strength Test Results

The quantity of concrete represented by a group of four consecutive test-results shall include the batches from which the first and last samples were taken together with all intervening batches. For the individual test result requirements given in col 2 of Table 11 or in item (b) of 16.2, only the particular batch from which the sample was taken shall be at risk. Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m^3 .

16.4 If the concrete is deemed not to comply pursuant to 16.3, the structural adequacy of the parts affected shall be investigated (see 17) and any consequential action as needed shall be taken.