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# Indian Standard

# CODE OF PRACTICE FOR USE OF IMMERSION VIBRATORS FOR CONSOLIDATING CONCRETE

## *( First Revision )*

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## ( First Revision )

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# *Indian Standard*

# CODE OF PRACTICE FOR USE OF IMMERSION VIBRATORS FOR CONSOLIDATING CONCRETE

## *( First Revision )*

## 0. FOREWORD

**0.1** This Indian Standard ( First Revision ) was adopted by the Indian Standards Institution on 24 February 1983, after the draft finalized by the Construction Plant and Machinery Sectional Committee had been approved by the Civil Engineering Division Council.

**0.2** Consolidation of concrete by vibration has almost completely revolutionized the concept of concrete technology, making possible the use of low slump stiff mixes for economic production of high quality concrete with required strength and impermeability. The use of vibration may be essential for the production of all good concretes particularly where the reinforcement is congested or where to produce quality concrete. Vibration is often adopted to improve the compaction and strength of concrete. In this way vibration can, under suitable conditions, produce better quality concrete than by hand compaction, or by permitting lower cement content and lower water/cement ratio, produce equally strong concrete more economically than by hand compaction.

**0.2.1** While vibration properly applied is a great step forward in the production of quality concrete, it is also employed as a method of placing ordinary concrete more easily than as a method of obtaining high grade concrete at an economical cost. All the potential advantages of vibration can be fully realised only if proper control is exercised in the design and manufacture of concrete and certain rules are observed regarding proper use of different types of vibrators. This code covers the use of immersion type concrete vibrators and is intended to give guidance in obtaining maximum benefit from the technique of vibration with immersion vibrators.

**0.3** This standard was first published in 1966. Based on the work done at Central Building Research Institute, Roorkee the frequency of vibration has been redefined and a service log book for flexible shaft vibrators has been included. Also, the maximum thickness of concrete layer, that can be compacted, and vibration time for optimum compaction has been specified in this revision.

**0.3.1** Essential requirements regarding the quality and manufacture of concrete suitable for vibration have been covered but detailed methods for the actual design of concrete mixes have not been included, these being beyond the scope of this code.

**0.4** In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

**0.5** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## 1. SCOPE

**1.1** This code deals with the use of immersion vibrators for the consolidation of concrete, the maintenance of the immersion vibrators in proper running order, besides giving recommendations regarding placing of concrete and its consolidation by vibration.

## 2. TERMINOLOGY

**2.0** For the purpose of this code, the definition as given in IS : 2505-1980† and the following shall apply.

**2.1 Frequency of Vibration** — Number of complete cycles of vibration per second ( Hz ) of the vibrating needle.

## 3. GENERAL CONSIDERATIONS

### 3.1 Suitability of Immersion Vibrators

**3.1.1** Immersion vibrators can be satisfactorily used for consolidation of plain as well as reinforced concrete. To ensure their proper use, the concrete mix shall be properly designed ( *see* **6** ) and filling of concrete

*Rules for rounding off numerical values ( *revised* ).

†General requirements for concrete vibrators, immersion type ( *second revision* ).

shall be deep enough to allow the vibrating needle to be adequately dipped either perpendicularly or at an angle ( *see* Note ). To be fully effective, the needle of immersion vibrator shall be completely immersed in concrete. As a general rule, the depth of concrete layer to be vibrated should be in the range of 2/3 '*l*' to '*l*' where '*l*' is length of vibrating needle. It has been found that with immersion vibrator, a greater density of the concrete is obtained at the bottom of the layer then at the top due to compacting effect of the weight of concrete above and rebound from bottom. Therefore, it is in general not advisable to have layer thickness greater than 600 mm. The flexible shaft should always be kept clear to prevent damage to it. Immersion vibrators shall not be used where the thickness of the concrete is less than 100 mm.

NOTE — The vibrating needle should perferably be inserted vertically. The insertion at an angle, in thick layers, may leave concrete unconsolidated without any indication at the surface.

**3.1.2** Immersion vibrators to be used for consolidation of concrete may be either flexible shaft driven or motor-in-head type. Flexible shaft drive may be either compressed-air or motor or petrol or diesel engine driven. Motor-in-head type are operated electrically or pneumatically. Motor-in-head eliminates the limitations of flexible shaft drive as the maintenance of driving shafts is a problem because their life and resistance to wear is a function of the relative speed to which they are subjected.

**3.2 Power Unit**

**3.2.1** The immersion vibrator may be powered by any of the following power units:

a) Electric motors either driving the vibrator through flexible shaft or situated at the head of the vibrator,

b) Internal combustion engine ( petrol or diesel engine ) driving the vibrator needle through flexible shaft, and

c) Compressed-air motor situated near the head of the vibrator.

**3.2.2** Where reliable supplies of electricity are available the electric motor is generally the most satisfactory and economical power unit. The speed is relatively constant, cables supplying current are light and easily handled as the motor itself.

**3.2.3** Internal combustion engines are often convenient source of power. Small petrol engines sometimes give trouble at starting and are more easily put out of action by site conditions compared to electric or compressed-air motors. They should be located conveniently near the work to be vibrated and should be properly secured to their base.

**3.2.4** Compressed-air motors are generally suitable but their vibrators are sometimes difficult to manipulate where the compressor cannot be placed adjacent to the work in hand such as on high scaffoldings or at depths below ground level due to heavy weight of air hoses. These compressed-air vibrators occasionally give trouble, especially in cold weather, by freezing at exhaust unless alcohol is trickled into the air line or dry air is used. Glycol type antifreeze agents tend to cause gumming of the vibrator valves. There is also a tendency for moisture to collect in the motor and care should be taken to remove the moisture to prevent possible damage.

**3.2.5** The speed of both the petrol and compressed-air motors tend to vary giving rise to variation in the compacting effect of the vibrator.

**3.2.6** *Rating of the Power Unit* — The power required to operate vibrators, depends upon the characteristics of the vibrator and varies with the power unit employed to drive the vibrator. The type of power unit and its rating shall be as specified by the manufacturer of the vibrator. The following power ratings have generally been found adequate:

| *Power Unit* | *Power Rating* kW |
|---|---|
| Petrol engines | 1·5 to 3·5 |
| Diesel engines | Up to 3·3 |
| Electrical motor | 0·75 to 2·5 |
| Compressed air operation | 7·5 |

## 4. HANDLING THE IMMERSION VIBRATOR

**4.1** The vibrators operate under heavy stress and therefore, require regular maintenance to keep them in proper working order. After use the vibrators shall be thoroughly cleaned and stored in clean dry place. All repairs shall be carried out under careful supervision and as per manufacturer's instruction. Sufficient stand-by equipment shall also be provided to keep placement of concrete fully operative when vibrators are undergoing repairs. Provisions shall be made for replacement of vibrators that have to be taken out of service for maintenance and repair. Where a number of vibrators are being operated by a contractor or department, it is recommended that service log book should be maintained as given in Appendix A. The manufacturer should specify type of lubricant for flexible shaft and the repair instructions.

**4.1.1** The vibrator head is liable to wear off in the course of usage due to frictional contact with sharp edged stone aggregate of concrete. There is also a tendency for the bearings to wear out because of centrifugal force and the resultant impact. Worn-out parts should be replaced in time to avoid premature damage to the whole machine.

**4.1.2** Care shall be taken that the vibrating head does not come into contact with hard objects like hardened concrete, steel and wood, as otherwise the impact may damage the bearings. The power unit should, as far as possible, be started only when the head is raised or resting on soft support. Similar precautions shall be observed while introducing or withdrawing the vibrator in the fresh concrete to be consolidated; when the space for introduction is narrow, the vibrator should be switched on only after the vibrator head has been introduced into the concrete. A bend with a radius less than 500 mm not only reduces the torque capacity of the flexible shaft drive, but may also lead to earlier failure. Unnecessary sharp bends in the flexible shaft drive shall therefore, be avoided.

**4.2 Overloading of Driving Motor** — When the concrete is very stiff or rough grained, the vibrator will usually be overloaded and the electric motor may get excessively heated. In such cases, unless the motor is provided with an automatic cut-off device, it should be switched off and the overload remedied.

**4.3 Electrical Protective Devices**

**4.3.1** If the vibrator is worked by an electric motor, special precautions shall be taken to protect the operator from shocks. Special protective measures against too high contact voltage shall be incorporated by an authorized installation company in accordance with the requirements of IS : 1356 ( Part I )-1972* and other relevant Indian Standards, current Indian Electricity Rules and any other regulations in force in the particular area. The vibrator shall be adequately earthed to prevent shock to the operator. The safety lead shall be carried over the connection; for this purpose four-core rubber-sheathed cable or a similar wire shall be used.

**4.3.2** The safety device shall always be kept in good working order so as to effectively protect the operator from danger which can be fatal. The protective device shall be checked every day before the vibrator is used.

**4.3.3** Special attention shall be paid to the connections at the vibrator and to the plug, since inappropriate installation and handling may lead to breakage of wire thus causing interruption of the safety lead or

*Specification for electrical equipment of machine tools: Part I Electrical equipment of machines for general use ( *second revision* ).

dangerous contact voltage in the casing. All cord inlets shall be provided with suitable anti-tension devices.

## 5. PERFORMANCE AND SIZE OF VIBRATOR

**5.1** Virbrators conforming to the requirements of IS : 2505-1980* shall be used. The size and characteristics of the vibrator suitable for a particular job vary with the mix preparation, quality and workability of concrete, placing conditions, size and shape of the member and shall be selected by the engineer-in-charge depending upon various requirements. Guidance regarding selection of a suitable vibrator may be obtained from Table 1.

**TABLE 1 APPLICATIONS OF IMMERSION VIBRATORS**

| Sl No. | Diameter of the Vibrating Needle | Applications |
|---|---|---|
| i) | 25 and 35 | Plastic ( workable ) concrete in very thin members and confined places and for fabrication of laboratory test specimens. Suitable as auxiliary to larger vibrators in prestressed work where cables and ducts cause congestion in the forms. Auxiliary vibrations adjacent to forms of the pavements. |
| ii) | 40 and 50 | Plastic ( workable ) concrete in thin walls, columns, beams, precast piles, light floors, light bridge decks and along construction joints. Auxiliary vibrations adjacent to forms of the pavements. |
| iii) | 60 | Plastic (workable) concrete in general construction such as walls, columns; beams, precast piles, heavy floors: bridge deck and roof slabs. Auxiliary vibration adjacent to forms of mass concrete and pavements. |
| iv) | 75 | Mass and structural concrete deposited in increments up to 2 $m^3$ heavy construction in relatively open forms, in power houses, heavy bridge piers and foundations, and for auxiliary vibration in dam construction near forms and around embedded items and reinforcing steel. |
| v) | 90 | Mass concrete containing 150 mm aggregate deposited in increments up to 8 $m^3$, in gravity dams, large piers, massive walls, etc. Two or more vibrators will be required to operate simultaneously to spread and consolidate increments of concrete of 4 $m^3$ or greater volume deposited at one time in the form. |

*General requirements for concrete vibrators, immersion type ( *second revision* )

## 6. CONCRETE MIX

**6.1** Correct design of concrete mix and an effective control in the manufacture of concrete, right from the selection of constituent materials through its correct proportioning to its placing, is essential to obtain maximum benefits of vibration. For best results, the concrete to be vibrated shall be of stiffest possible consistency, generally within a range of 0·75 to 0·85 compacting factor, provided the fine mortar in concrete shows at least a greasy wet appearance when the vibrator is slowly withdrawn ( *see* **8.5** ) from the concrete and the material closes over the space occupied by the vibrator needle leaving no pronounced hole. The vibration of concrete of very high workability will not increase its strength; it may on the contrary, cause segregation. Similarly, excessive vibrations may also lead to segregation of concrete constituents. Formation of watery laitance on the surface of concrete due to vibration is an indication that the concrete possesses high to very high workability and unsuitable for vibration; such laitance may also be noticed when excessive vibration is applied to concrete of otherwise appropriate workability. A close textured layer of viscous grout may, however, be allowed.

**6.1.1** On the other hand, the mix shall not be so stiff that it is incompatible with the particular virbrator in use. As a general guide, a mix will be compatible with a particular vibrator if the hole formed in the concrete by the vibrator head closes completely as the vibrator is slowly withdrawn without leaving a cavity. This property is largely independent of the speed of removal of the vibrator beyond the practical range of mixes; but within the practical range, the occurrence of a hole can be avoided by a gradual removal.

**6.1.2** It has been proved conclusively that the best compaction is achieved at the resonant conditions. In other words, one should try to match the frequency of vibration with aggregate size in the concrete mix. In general, higher aggregate sizes require lower frequency of vibration and *vice versa*. Normally, frequencies of 100Hz, 150 Hz and 200 Hz are best suited to the aggregate sizes of 40, 20 and 10 mm.

## 7. DESIGN OF FORMWORK

**7.1** For vibrated concrete, the formwork shall be strong and great care shall be exercised in its assembly. It shall be designed to take up increased pressure of concrete and the pressure variations caused in the neighbourhood of vibrating head which may result in excessive local stress on the formwork. More exact details on the possible pressures are not available, and much depends upon the experience and judgement and the character of work. The joints of the formwork shall be made and maintained tight and close enough to prevent the squeezing out of grout or sucking in of air during vibration. Absence of this precaution may cause honeycombing in concrete or form rock pockets or gravel streaks along the cracks impairing the appearance and also weakening the structure.

**7.1.1** The amount of mortar leakage or the permissible gap between sheathing boards will depend on the desired final appearance of the work but normally gaps larger than 1·5 mm between the boards shall not be permitted. Sometimes even narrower joints may be objectionable from consideration of their effect on the surface appearance of certain structures. The number of joints shall be made as low as possible by making the shutter sections large. Applications on the inside of formwork to prevent the adhesion of concrete should be very thin as otherwise they may mix with the concrete under the effect of vibration.

## 8. VIBRATION OF CONCRETE, RECOMMENDED PRACTICES

**8.1** The vibrator may be used vertically, horizontally or at an angle depending upon the nature of the job ( *see* **3.1.1** ). The concrete to be vibrated shall be placed in position in level layers of suitable thickness not greater than the effective length of the vibrator needle ( *see* **8.2** ). The concrete at the surface shall be distributed as horizontally as possible since the concrete may flow in slopes while being vibrated and may segregate, particularly when concrete possesses high workability. The concrete shall, therefore, be of low workability where it is required to be vibrated on slopes.

**8.1.1** The internal vibrator shall not be used to spread the concrete from the location of a deposition as this can cause considerable segregation of concrete. It is advisable to deposit concrete well in advance at the point of vibration. This prevents the concrete from subsiding non-uniformly and thus prevents the formation of incipient plastic cracks. When the concrete is being continuously deposited to a uniform depth along a member, vibrator shall not be operated too near the free end of the advancing concrete, usually not within one metre of it. Every effort shall be made to keep the surface of the previously placed layer of concrete alive so that the succeeding layer can be amalgamated with it by the vibration process. However, if due to unforeseen circumstances the concrete in underlying layer has hardened to such an extent that it cannot be penetrated by the vibrator but is still fresh (that is, just after initial set ), unimposed bond can be achieved between the top and underlying layer by first sacrifying the lower layer before the new concrete is placed followed by systematically and thoroughly vibrating the new concrete.

**8.2 Height of Concrete Layer** — The concrete shall be placed in shallow layers consistent with the method being used to place and vibrate the concrete. Usually concrete shall be placed in thickness not more than 600 mm, and on initial placing in thickness not more than 150 mm. The figure of 600 mm will be lower for concrete with low workability. The superimposed load increasing with the height of the layer will favour action of vibrator, but as it is also the path of air forced upwards, it may trap air rising up by vibration. Very deep layers ( more than 600 mm ) should, therefore, be avoided as far as possible.

**8.3 Depth of Immersion of Vibrator** — To be fully effective the active part of the vibrator shall be completely immersed in the concrete ( *see* **3.1.1** ). Its compacting action can be usually assisted by maintaining a head of concrete above the active part of vibrator, the primary object of which is to press down upon and confine the concrete in the zone of influence of the vibrator. The vibrator head shall be dipped through the concrete filling to be consolidated to a further depth of 100 to 200 mm in the already consolidated lower layer for effective homogenuity and bound between layers.

**8.4 Spacing and Number of Insertion Positions** — The points of insertion of vibrator in the concrete shall be so spaced that the range of action overlap to some extent and the freshly filled concrete is sufficiently consolidated at all locations. The range of action varies with the characteristics of vibrator and the composition and workability of concrete. The range of action and the degree of consolidation can be recognized from the rising air bubbles and the formation of a smooth close textured surface around the vibrating head. The range of action can be more accurately determined by the method described in IS: 2505-1980*. With concrete of workability of 0·75 to 0·85 compacting factor, the vibrator shall generally be operated at points 350 to 900 mm apart depending on the rated capacity of the vibrator. The specified spacing between the dipping positions shall be maintained uniformly throughout the surface of concrete so that the concrete is uniformly vibrated.

**8.5 Speed of Insertion and Withdrawal of the Vibrating Head** — The vibrating head shall be regularly and uniformly inserted in the concrete so that it penetrates of its own accord and shall be withdrawn quite slowly whilst running so as to allow redistribution of concrete in its wake and allow the concrete to flow back into the hole behind the vibrator. The rate of withdrawal is determined by the rate at which the compaction in the active zone is completed. Usually a speed of 20 - 30 mm/s gives sufficient consolidation without undue strain on the operator. The speed of withdrawal is lower in case of low workability concrete. Further concrete shall be added as the vibrators are withdrawn

*General requirements for concrete vibrators, immersion type ( *second revision* ).

so as to maintain the head of the concrete until the lift of the concrete is completed.

**8.6 Duration of Vibration** — Newly deposited concrete shall be vibrated while it is still plastic, preferably immediately after placing. The next adjacent concrete shall be placed before the initial setting occurs. The duration of vibration in each position of insertion is dependent upon the height of layer, the size and characteristics of vibrator, and the composition and workability of the concrete mix. It is better to insert the vibrating head at a number of places than to leave it for a long time in one place as in the latter case there is a tendency for formation of mortar pocket at the point of insertion of vibrator.

**8.6.1** The vibrator head shall be kept in one position till the concrete within its influence is completely consolidated which will be indicated by formation at the surface of circular shaped laitance of cement mortar, showing of flattened glistening surface and cessation of the rise of entrapped air. Vibration shall be discontinued immediately thereafter. Vibration shall be continued until the coarse aggregate particles have blended into the surface but have not disappeared.

**8.6.2** Time required to effect complete consolidation is readily judged by the experienced vibrator operator through the feel of the vibrator due to resumption of frequency of vibration after the short period of dropping in the frequency when the vibrator is first inserted. Doubt about the adequacy of vibration should always be resolved by further vibration; well proportioned concrete of the correct consistency is not readily susceptible to over vibration. For optimum compaction, a minimum time of vibration is 90 seconds for mixes with a compacting factor of 0·78 (stiff mixes). This time may be reduced if more workable mixes are used.

**8.7 Vibrating Concrete at Junctions with Hardened Concrete** — In cases where concrete has to be joined with rock or hardened concrete, the defects can occur owing to the layers nearest to the hardened concrete not being sufficiently vibrated. In such cases the procedure given in **8.7.1** shall be followed.

**8.7.1** The hardened concrete surface shall be prepared by hacking or roughening and removing laitance, greasy matter and loose particles. The cleaned surface shall be wetted. A cement-sand grout of proportion 1:1 and of creamy consistency shall then be applied to the wet surface of old concrete and fresh concrete vibrated against it.

**8.8 Vibrating the Reinforced Concrete** — The reinforcement shall be designed to leave sufficient space for the vibrating head. The reinforcement or group of reinforcement should be so placed that a space of 75 mm exists between the bars or groups of bars to allow the vibrator to pass freely. The space between the bars in any group may be reduced to two-thirds of the nominal size of coarse aggregate, where needed. The total width of each group shall not exceed 250 mm.

**8.8.1** When the reinforcement lie very close to each other, greater care shall be taken in vibrating so that no pockets or collections of the grout are formed. Except where some of the concrete has already set and provided that the reinforcement is adequately supported and secured, the vibrator may be pressed against the reinforcement under exceptional circumstances.

**8.9 Vibrating Near the Formwork** — For obtaining a smooth close textured external surface the concrete shall have sufficient content of low bleeding grout of thick consistency. The vibrator head shall not be brought very near the formwork as this may cause formation of water whirle (stagnations), especially if the concrete contains too little of fine aggregate. On the other hand, a close textured surface may not be obtained, if the positions of insertion are too far away from the formwork. The most suitable distance of the vibrator from the formwork is from 100 to 200 mm. With the vibration done at the correct depth and with sufficient grout rising up at the formwork, the outside surface will generally have a closed textured appearance. In the positions of formwork difficult to reach and in concrete walls less than 300 mm thick it is preferable to use vibrators of small size which can be brought to the required place and which will not excessively strain the formwork. Alternate form of vibrator such as formwork vibrator may also be considered in such cases.

**8.10 Vibrating High Walls and Columns** — While designing the formwork, reinforcement as well as the division of layers for high walls and columns, it should be kept in mind that with the usual driving shaft lengths it is not possible to penetrate the vibrating head more than three metres in the formwork. In the case of higher walls and columns it is recommended to introduce the shaft driven vibrating needle through a side opening into the formwork. A suitable guiding device with gutter like features can be used as a guide for movement near the reinforcement. For use with high walls and columns, the flexible driving shaft can be brought to a length of six to eight metres or even more by using adopter pieces. The motor-in-head type vibrators are more useful for the purpose in which case a very long current cable can be used for sinking the vibrator to a greater depth. In fact, for walls less than 300 mm thick, it is preferable to supplement with the formwork vibrator especially to avoid seggregation in deep wall due to drop of concrete.

**8.11 Over-Vibration** — There is a possibility of over-vibration while trying to achieve thorough vibration, but it is exceedingly unlikely in well proportioned mixes containing normal weight aggregates. Generally, with properly designed mixes, extended vibration will be only waste of effort without any particular advantage to the concrete. However, where the workability of concrete is high for the conditions of placing, or where the quantity of mortar is in excess of the volume of voids in the coarse aggregate, or where the grading of the aggregate is unsatisfactory, over-vibration will encourage segregation bleeding or both causing the migration to the surface of the lighter and smaller constituents of the mix and thus producing a layer of mortar or laitance on the surface, and leakage of mortar through defective joints in the formwork. This may produce concrete with poor resistance to abrasion and attack by various agencies, such as frost, or may result in planes of weakness where successive lifts are being placed. If over-vibration occurs it will be immediately evident to an experienced vibrator operator or supervisor by a forthy appearance due to the accumulation of many small air bubbles and the settlement of coarse aggregates beneath the surface. These results are more liable to occur when the concrete is highly workable and the proper correction will be to reduce the workability ( not the vibration ), until evidence of over-vibration disappears during the period of vibration considered necessary for consolidating the concrete and eliminating air bubble blemishes.

**8.12 Re-vibration** — Re-vibration is delayed vibration of concrete that has already been placed and consolidated. It may occur while placing succeessive layers of concrete, when vibrations in the upper layer of fresh concrete are transmitted to the underlying layer which has partially hardened or may be done intentionally to achieve certain advantages ( *see* **8.12.1** )

**8.12.1** Except in the case of exposed concrete ( *see* **8.12.3** ) and provided the concrete becomes again plastic under vibration, re-vibration is not harmful and may be beneficial. By repeated vibration over a long period ( repetition of vibration earliest after one hour from the time of initial vibration ), the quality of concrete may improve because it rearranges the aggregate particles and eliminates entrapped water from under the aggregate and reinforcing steel, with the consequent full contact between mortar and coarse aggregate or between steel and mortar and thus produces stronger and watertight concrete. Cracks due to setting as well as other disturbances like hollow space below the reinforcement bars and below coarse aggregates, may thereby be closed again provided the concrete becomes plastic again when the vibrator head is introduced. Controlled re-vibration of conrete may result in improved compressive and bond strength, reduction of honey-comb, release of water trapped under horizontal reinforcing bars and removal of air and water pockets.

**8.12.2** Re-vibration is most effective at the lapse of maximum time after the initial vibration, provided the concrete is sufficiently plastic to allow the vibrator to sink of its own weight into the concrete and make it again plastic.

**8.12.3** On exposed concrete work where appearance is important, care shall be taken to avoid inserting internal vibrators through the fresh concrete into a layer of partially hardened concrete below, as this may result in the appearance of a wavy line of demarcation between the layers on the surface. This would be objectionable from considerations of surface appearance though the quality of concrete may not be impaired.

**8.12.4** However, re-vibration shall be done with prior approval of the engineer-in-charge only since the state of concrete at the time of re-vibration is very acute. Re-vibration of concrete which does not get again plastic under re-vibration is definitely harmful leading to formation of cracks, non-closure of gaps formed by the insertion of vibrators, etc.

**8.13 Lightweight-Concrete** — In general, principles and recommended practices for consolidation of concrete of normal weight hold good for concrete made with lightweight aggregates, provided certain precautions are observed.

**8.13.1** There is always a tendency for lightweight pieces of aggregates to rise to the surface of fresh concrete, particularly under action of over vibration; and a fairly stiff mix with the minimum amount of vibration necessary to consolidate the concrete in the forms without honey-comb is the best insurance against undesirable segregation. The rise of lightweight coarse aggregate particles to the surface, caused by 'over vibration' resulting from too wet a mix, makes finishing difficult if not impossible.

# APPENDIX A

( *Clause* 4.1 )

## SERVICE LOG BOOK FOR FLEXIBLE SHAFT VIBRATORS

Name of manufacturer ______________________________

Model ______________________ Serial No. ______________

Date of purchase ______________________________

| Item | Frequency of Preventive Maintenance | | |
|---|---|---|---|
| | Cleaning & Inspection | Lubrication | Replacement |
| | *Flexible Shaft* | | |
| Shaft | | | |
| Bearings | | | |
| | *Vibrator Needle* | | |
| Seals | | | |
| Bearings | | | |
| Oil charges | | | |

( *Continued from page* 2 )

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