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RECOMMENDATIONS FOR USE OF TABLE VIBRATORS FOR CONSOLIDATING CONCRETE

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Indian Standard

RECOMMENDATIONS FOR USE OF TABLE VIBRATORS FOR CONSOLIDATING CONCRETE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 21 February 1974, after the draft finalized by the Construction Plant and Machinery Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Vibrating tables are widely employed in the production of precast concrete building units and possess the unique advantage of imparting uniform energy for consolidation. 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 vibrators. This code covers the use of concrete vibrating tables and is intended to give guidance in obtaining maximum benefits from the technique of vibration with table vibrators.

0.2.1 Essential requirements regarding the quality and manufacture of concrete suitable for table 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 standard.

0.2.2 Indian Standard specification for concrete vibrating tables (IS : 2514-1963) is a necessary adjunct to this standard.

0.3 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, 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.

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1. SCOPE

1.1 This standard deals with the use of vibrating tables for the consolidation of concrete and gives recommendations regarding placing of concrete and its consolidation by vibration.

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

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Amplitude of Vibration — The maximum displacement of the table top from its mean position during vibration. It is usually expressed as half of the total displacement.

2.2 Frequency of Vibration — Number of complete cycles of vibration per minute of the vibrating table.

2.3 Vibration Acceleration — The maximum acceleration per cycle of vibration. It is usually expressed as a multiple of *g*, the acceleration due to gravity.

2.4 Vibrating tables shall include all appliances creating rapidly alternating horizontal, vertical or circular vibration and capable of transmitting these to moulds filled with concrete and placed or clamped on the table top. The vibrating tables do not include shock tables which pulsate at low frequency and operate on the principle of gravity fall with the help of rotating cams.

3. GENERAL CONSIDERATIONS

3.1 Suitability of Table Vibrators

3.1.1 Vibrating tables are used for the consolidation of concrete in moulds for the manufacture of plain and reinforced concrete or prestressed concrete elements.

3.1.2 In the case of lightweight concrete prepared from admixtures and lightweight aggregates, the degree of vibration shall be suitably controlled since excessive or over vibration may lead to floating of aggregates to the surface where thorough consolidation is not desirable, table vibrators may be used for improving the cohesion among the grains of concrete.

3.1.3 With the table vibrators, the vibration of concrete can start from the moment the concrete is placed on the base of the mould, so that the expulsion of air is facilitated and compaction continues steadily with the addition of each batch of concrete in the mould.

3.2 Power Unit

3.2.1 The vibrating tables are operated either through an eccentric rotor driven by a prime mover such as electric motor, internal combustion engine, pneumatic power; or directly by electromagnetic pulsators.

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

3.2.3 *Rating of the Power Unit* — The power required to operate the vibrator depends upon the characteristics of the vibrator and varies with the power unit employed to drive the vibrator. The output rating of the power unit is related to the capacity of the vibrating table and it should be sufficient to prevent the reduction in amplitude from no load to full load by more than 25 percent. Type of power unit and its rating shall be as specified by the manufacturer of the vibrator. Very large or long table vibrators should be fitted with several vibrating units which shall be synchronized. Such tables shall be regularly checked for synchronization and vibration characteristics as specified in IS : 2514-1963*.

The power absorbed by the table and consequently the running cost is considerably reduced by running the vibrating table at resonance, that is, operating at its natural frequency. Some tables provide adjustment of the springs to achieve resonance in spite of varying loads.

4. HANDLING THE VIBRATING TABLE

4.1 The vibrators operate under heavy stress and therefore, require regular maintenance to keep them under proper working conditions. After use, the components of the vibrator shall be thoroughly cleaned. All repairs shall be carried out under careful supervision and according to manufacturer's instruction.

4.2 In mechanical vibrators, the full force required to accelerate the table and concrete is applied through the bearing of the rotating shaft.

These bearings may give trouble if they are not designed to withstand very large variable loads. There is a tendency for the bearings to wear out and those should be checked regularly. Worn out parts should be replaced in time to avoid premature damage to the whole machine.

4.2.1 The sizes and capacities of vibrating tables are indicated in IS : 2514-1963*. The manufacturer shall indicate the capacity of the vibrating tables in terms of the total load of the mould and the concrete which can be vibrated to achieve optimum results without adversely affecting the life of the vibrating table.

4.3 Rigidity of the table top should be regularly checked and ensured during service. If the table top is insufficiently rigid to vibrate evenly all over, nodes and antinodes will occur in different places on the surface of the table thus affecting the efficiency of compaction.

4.4 Electrical Protective Devices

4.4.1 If the vibrator is worked by an electrical motor, special precautions shall be taken to protect the operator from shock. Special protective means

*Specification for concrete vibrating tables.

against too high a contact voltage shall be provided by an authorized installation company in accordance with the requirements of IS : 1356-1964* 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 cable or a similar wire shall be used.

4.2.2 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.

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

5. PERFORMANCE AND SIZE OF VIBRATORS

5.1 Vibrator tables conforming to IS : 2514-1963† shall be used. The capacity size, vibration characteristics and the number of vibrating tables depends on the characteristics of concrete and the weight and size of the job. The vibration characteristics for different sizes of vibrating tables have been specified in IS : 2514-1963†.

5.1.1 The effectiveness of vibration is generally proportional to the acceleration up to 4 to 5 *g* after which the rate of increase in effectiveness becomes less. An acceleration of 4 to 7 *g* is generally desirable in the frequency range of 3 000 to 6 000 cycles per minute.

5.1.2 *Rotational Versus Directional Vibration* — A vibrating table having only a single eccentric, gives a rotational vibration effect which generates a sympathetic movement in concrete mix and a resultant tendency to a sloping top surface which in many cases has to be levelled by hand floating. This disadvantage is largely eliminated by the use of directional vibration in which case the vibrator unit consist of two eccentrics, synchronized by rotating in opposite direction, so that the table is given a simple harmonic vertical motion (*see* Fig. 1).

5.2 Testing of Vibrating Tables — The action of various types of vibrating tables can be assessed by comparison of the time required for consolidation or by comparing the degree of consolidation achieved after the same period of vibration with the same sample of concrete. The indication of the vibrating time or the degree of consolidation of concrete as a measure of the

*General requirements for electrical equipment of machine tools.

†Specification for concrete vibrating tables.

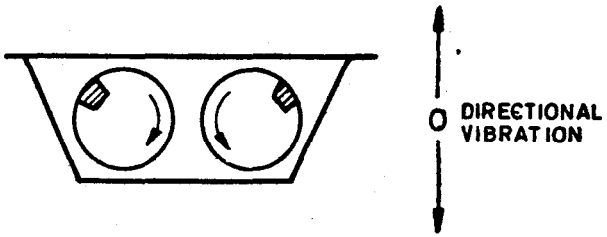

FIG. 1 PRINCIPLE OF DIRECTIONAL VIBRATION

performance of the vibrating table will be objective only under identical conditions in regard to the constituents of the concrete, mixture, properties of the raw materials, consistency of the fresh concrete size of aggregates and age and storage of concrete.

5.2.1 The vibration characteristics and other requirements of vibrating tables may be tested according to the relevant requirements of IS : 2514-1963*.

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 workability of concrete should be suitably low, provided the fine mortar in concrete shows at least a greasy wet appearance on the surface of concrete after normal time of vibration. The most suitable workability is dependent on the capacity of the vibrator. If the concrete is highly workable (say as workable as that used for hand consolidation or compaction), little or no advantage is gained by vibration and the elements cannot be demoulded immediately after vibration. Besides, the chances of segregation will be more in such cases. If the concrete is too stiff that is of very low workability, complete compaction or consolidation can be achieved only after a long period of vibration. Table vibrators are most successfully used with earth moist mixes having a consistency of about 4° Vee-Bee or a compacting factor of 0.78. It is often possible to strip the forms immediately after vibration with such mixes.

7. DESIGN OF FORM WORK

7.1 The moulds or formwork should be as light as possible but should be of rigid construction, so that the sides do not vibrate or flutter as this gives a pumping action which entraps air and leads to defective moulded surfaces.

*Specification for concrete vibrating tables.

The moulds should preferably be of metal. Timber moulds dampen the vibrations and thus reduce the effect of vibration.

8. RECOMMENDED PRACTICE FOR VIBRATION OF CONCRETE

8.1 Placing Moulds on the Vibrating Table — The moulds may be rigidly clamped to the vibrating table in such a manner that they have contact with the support in as many and in the most suitable places possible, so that the vibration amplitude is fairly uniform over the whole range of the support and the moulds. With the rigid and uniform clamping of the moulds the frequency and amplitude of vibration of the table are uniformly transmitted to the mould as well as the fresh concrete. For smaller units when the moulds are not rigidly clamped on the table, they are repeatedly thrown into the air in a haphazard manner owing to the vibration acceleration of the tables, which is generally considerably greater than the acceleration due to gravity. During this process the concrete may be subjected to impacts with quite high acceleration but there may be considerable loss of energy transmitted to the concrete and there may be damage to the concrete, moulds and table.

8.2 Pouring Concrete — The concrete should be filled in the moulds in continuous shallow lifts, with the vibrating table already in vibration. This helps in the escape of air from the filled concrete and consequent greater compaction. The lifts should be of as uniform depth as possible, so that no cones or slopes are formed. Slopes cause segregation of coarse particles from the fine mortar and this leads to non-uniform texture and formation of honey-combing packets.

8.3 Period of Vibration — The period of vibration depends on the efficiency of the vibrating table, the consistency of fresh concrete and the height of the filled concrete. The appropriate vibration time will have to be determined in each case. The vibrating time is considered adequate when the laitenace layer is about to form at the top surface. The adequacy of compaction due to vibration is also indicated by the movement of the whole mass in the form while the top surface of concrete is pressed strongly by hand and moved. On adequate compaction, there is cessation of escape of air bubbles and the top surface of concrete appears smooth with greasy wet appearance.

8.4 Vibration Under Pressure — Table vibration can often be combined with pressure on the top surface of the concrete. Such ' vibration under pressure ' helps in achieving increased density and strength of concrete, especially when very thin layers, thick layers of heavy concrete, or the final layer of concrete in a form, are to be compacted. The top layer, especially of a dry mix, in many cases needs such simultaneous pressure in order to achieve satisfactory density and smooth surface.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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