IS 15917 (2010): Building Design and Erection Using Mixed/Composite Construction - Code of practice [CED 51: Planning, Housing and pre-fabricated construction]

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भारतीय मानक

मिश्रित/संयुक्त निर्माण प्रयुक्त भवन का डिजाइन और स्थापन — रीति संहिता

Indian Standard

BUILDING DESIGN AND ERECTION USING MIXED/ COMPOSITE CONSTRUCTION — CODE OF PRACTICE

ICS 91.040.01

B U R E A U O F I N D I A N S T A N D A R D S
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Planning, Housing and Prefabricated Construction Sectional Committee, CED 51

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Planning, Housing and Prefabricated Construction Sectional Committee had been adopted by the Civil Engineering Division Council.

Systems building and mixed/composite construction is an upcoming field as far as its development and use in the country is concerned. Two aspects specifically to be borne in mind are the system to be adopted for the different categories of buildings and the sizes of their components. Here the principle of modular co-ordination is of value and its use is recommended.

Since the aim of such an approach is to effect economy, improvement in quality and speed in construction, the selection of proper materials for prefabrication is also an important factor in the popularization of this technique. The use of locally available materials with required characteristics and those materials which, due to their innate characteristics like light-weight, easy workability, thermal insulation and non-combustibility, effect economy and improved quality, may be tried.

It is possible to achieve or evolve aesthetically satisfying designs using mixed and composite constructions. A careful and judicious handling of materials and use of finishes on such a building can help the designer a great deal in ensuring that the appearance of the building is aesthetically appealing. The purpose of finishes and architectural treatment is not only to give such buildings an individual character but also to effect better performance and greater user satisfaction.

This standard has been brought out to provide necessary guidance for design and erection of such systems. In this standard, an attempt has been made to prescribe general requirements applicable to all valid existing systems and mixed/composite constructions as also to accommodate any new system introduced in the country in future. The design of such buildings should include provision for all installations of services and their required piping, wiring and accessories to be installed in the buildings.

While this standard covers systems building and mixed/composite construction, for such systems approach using predominantly concrete as material for components, a separate Indian Standard IS 15916 : 2010 'Building design and erection using prefabricated concrete — Code of practice' has been brought out.

The composition of the Committee responsible for the formulation of this standard is given in Annex D.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

BUILDING DESIGN AND ERECTION USING MIXED/ COMPOSITE CONSTRUCTION — CODE OF PRACTICE

1 SCOPE

This standard covers recommendations regarding modular planning, component sizes, joints, manufacture, storage, transport and erection of prefabricated elements for use in buildings and such related requirements for systems building and mixed/ composite construction.

2 REFERENCES

The standards and special publication listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

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

3.1 Authority Having Jurisdiction — The authority which has been created by a statute and which, for the purpose of administering the Code, may authorize a committee or an official or an agency to act on its behalf; hereinafter called the 'Authority'.

3.2 Basic Module — The fundamental module used in modular co-ordination, the size of which is selected for general application to building and its components.

NOTE — The value of the basic module has been chosen as 100 mm for the maximum flexibility and convenience. The symbol for the basic module is *M*.

3.3 Cellular Concrete — The material consisting of an inorganic binder (such as lime or cement or both) in combination with a finely ground material containing siliceous acid (such as sand), gas generating material (for example, aluminium powder), water and harmless additives (optional); and steam cured under pressure in autoclaves.

3.4 Component — A building product formed as a distinct unit having specified sizes in three dimensions.

3.5 Composite/Mixed Construction — Construction involving two or more components such as prefabricated structural units of steel, prestressed concrete or reinforced concrete and cast *in-situ* concrete, ferrocement, timber, masonry in brickwork and blockwork, glass and glazing connected together in such a manner that they act integrally.

3.6 Increments — Difference between two homologous dimensions of components of successive sizes.

3.7 Module — A unit of size used in dimensional co-ordination.

3.8 Modular Co-ordination — Dimensional co-ordination employing the basic module or a multimodule.

NOTE —The purposes of modular co-ordination are:

a) to reduce the variety of component sizes produced; and
b) to allow the building designer greater flexibility in the arrangement of components.

3.9 Modular Grid — A rectangular coordinate reference system in which the distance between consecutive lines is the basic module or a multimodule. This multimodule may differ for each of the three orthogonal dimensions of the grid, two in plan and one in vertical direction.

3.10 Multimodule — A module whose size is a selected multiple of the basic module.

3.11 Prefabricate — Fabrication of components or assembled units prior to erection or installation in a building.

3.12 Prefabricated Building — The partly/fully assembled and erected building, of which the structural parts consist of prefabricated individual units or assemblies using ordinary or controlled materials, including service facilities; and in which the service equipment may be either prefabricated or constructed *in-situ*.

3.13 Sandwich Panels — Panels made by sandwiching a layer of insulation material between two outer layers of hard durable materials like steel, dense concrete, plastic, cement based sheet, ceramic, etc. The hard coverings on two outer faces may be of same or different materials; the three layers being bonded with each other to behave as a composite panel.

3.14 Self-compacting Concrete — Concrete that is able to flow under its own weight and completely fill the voids with in the formwork, even in the presence of dense reinforcement without any vibration, whilst maintaining homogeneity without segregation.

3.15 Shear Connectors — Structural elements, such as anchors, studs, channels and spirals, intended to transmit the shear between the prefabricated member and the cast *in-situ* concrete and also to prevent separation at the interface.

3.16 System — The method of construction of buildings with certain order and discipline and repetitive operations using the prefabricated components, tunnel form or engineered shuttering, where the work is organized and follows a defined procedure.

3.17 Unit — Building material formed as a simple article with all three dimensions specified, complete in itself but intended to be part of a compound unit or complete building. Examples are brick, block, tile, etc.

4 MATERIALS, PLANS AND SPECIFICATIONS

4.1 Materials

4.1.1 The materials used shall conform to relevant Indian Standards.

4.1.2 The materials used in prefabricated components may be many and the modern trend is to use concrete, ferrocement, steel, treated timber, aluminium, cellular concrete, light weight concrete, ceramic products, etc. However, this standard pertains to mixed/composite construction using such materials.

4.2 Plans and Specifications

This shall be in accordance with IS 15916.

5 MODULAR CO-ORDINATION, ARCHITECTURAL TREATMENT AND FINISHES

5.1 Modular Co-ordination

This shall be in accordance with IS 15916.

5.2 Architectural Treatment and Finishes

This shall be in accordance with IS 15916.

6 COMPONENTS

6.1 The preferred dimensions of precast concrete elements used and their casting tolerances shall be in accordance with IS 15916.

6.2 The permissible tolerances of timber used shall be in accordance SP 7 (Part 6/Sec 3A).

6.3 For permissible tolerances of steel and masonry, reference may be made to relevant Indian Standards.

7 FORMWORK SYSTEMS

The formwork systems which are utilized in buildings shall be as given in **7.1** to **7.5**.

7.1 Tunnel Form

This is a system which casts walls and slab together like a portal in a single pour of concrete. Facade walls are precast or of block masonry to enable removal of tunnel form. All components are made up of steel. This produces very rapid construction. Accelerated curing, if required is possible enabling early stripping of formwork.

7.2 Slipform

Slipform is a continuously moving form at such a speed that the concrete when exposed has already achieved enough strength to support the vertical pressure from concrete still in the form as well as to withstand nominal lateral forces. Slipform may be classified as straight slipform, tapering slipform and slipform for special applications. Construction of lift cores and stairwell using slipform technique comes under special applications because of their complex sizes, shapes and loads to be lifted along with the slipform like walkway truss, etc, which is essential for construction. This system uses hydraulic jacks avoiding crane for lifting of assembly during construction operation. This system facilitates rapid construction and continual casting, creating a monolithic structure thereby avoiding construction joints.

7.3 Aluminium Formwork

This system of formwork uses aluminium, which is light and rust free material, in both sheathing and framework. It may be used for a broad range of applications from wall to slab construction panels to more complicated structures involving bay windows, stairs and hoods. Every component is light enough to be handled easily thereby minimizing the need for heavy lifting equipment.

7.4 Large Panel Shuttering System

This is a system, which gives an advantage of combining speed and quality of construction. The vertical load carrying members are made of steel whereas the horizontal members are of plywood inserted into two wooden beams thereby forming a web flange. All the formwork and support systems shall be designed for the loads coming during the actual execution stage.

7.5 Other/New Systems

Any other/new system may be used for systems building after due examination and approval by the Authority.

8 SYSTEM AND STRUCTURAL SCHEMES

8.1 Several schemes are possible, with certain constraints, using the same set of components. The degree of flexibility varies from system to system. However, in all the systems there is a certain order and discipline.

8.2 The following aspects, among others, are to be considered in devising a system:

a) Effective utilization of spaces;
b) Straight and simple walling scheme;
c) Limited sizes and numbers of components;
d) Limited opening in bearing walls;
e) Regulated locations of partitions;
f) Standardized service and stair units;
g) Limited sizes of doors and windows with regulated positions;
h) Structural clarity and efficiency;
j) Suitability for adoption in low and high rise building;
k) Ease of manufacturing, storing and transporting;
m) Speed and ease of erection; and
n) Simple jointing system.

8.3 Systems for Mixed/Composite Construction

The system of mixed/composite construction depends on the extent of the use of prefabricated components, their materials, sizes and the technique adopted for their manufacture and use in building.

8.3.1 *Combinations of System Components for Mixed/ Composite Construction*

The following combinations may be used in mixed/ composite construction:

a) Structural steel work and timber roofs on precast frames;
b) Precast floors onto steel and concrete beams, and masonry walls;
c) Profiled metal decking on precast beams;
d) Precast frames onto cast *in-situ* foundations, retaining walls, etc;
e) Precast frames stabilized by masonry walls, steel bracing, etc;
f) Precast cladding in steel or cast *in-situ* frames and *vice-versa*;
g) Glass curtain walling, stone cladding or metal sheeting onto precast concrete frames, etc; and
h) Reinforced concrete and structural steel as composite columns and beams.

8.3.1.1 Precast concrete may be combined with cast *in-situ* concrete, often termed hybrid construction. Cast *in-situ* is mostly used to form homogenous connections between precast elements and provide a structural topping for horizontal diaphragm action. In other cases it is used to form the foundations and sub-structure to the building.

8.3.1.2 Structural steel-work is largely used in long span prestressed concrete floors supported on rolled and prefabricated steel beams and also as steel roof trusses supported on concrete columns.

8.3.1.3 Timber may be used as long span glue-laminated beams and rafters, with precast concrete. Precast floors may be used in timber frame construction. Similarly, timber frames with precast elements shall be used as a building system.

8.3.1.4 Brick and block masonry may be combined with precast concrete structures and floors. The most common combinations is to use prestressed floors on load bearing walls.

9 DESIGN CONSIDERATIONS

The mixed/composite structures shall be analyzed appropriately and the joints in them designed to take the forces of an equivalent discrete system. Resistance to horizontal loading shall be provided by placing beams, walls and bracings in two directions at right angles or otherwise. The individual components shall be designed, taking into consideration appropriate end conditions and loads at various stages of construction. The components of the structure shall be designed for loads in accordance with IS 875 (Parts 1 to 5) and IS 1893 (Part 1). In addition members shall be designed for handling, erection and impact loads that might be expected during handling and erection.

9.1 For mixed and composite construction the following points shall be considered:

a) *Positions of stability cores, walls, bracing, etc* — In high rise buildings the most popular method is a cast *in-situ* core constructed several storeys ahead of the framework. In medium height buildings this may be precast concrete or brick infill, steel cross bracing or precast concrete diagonal bracing.
b) *Maturity of connections* — This may be decisive for or alter planned site progress unless it is properly managed. Cast *in-situ* grouted joints need a few days of temporary propping unless combined mechanical connections are also used.
c) As a consequence of the above, the need to design some of the key components to achieve temporary stability.
d) *Availability and/or positioning of equipments to transport and erect components* — The size and weight of the various components shall be organized to make optimum use of crane

capacity, for example, the lightest units farthest from the operating zone.

e) *Erection safety and speed of construction, with attention to cast in-situ concreting sequences* — This is particularly important where fixing gangs are unaccustomed to working with different materials.

f) *Tolerances for economical construction* — This is particularly important where different manufacturers are producing components in different materials.

9.2 Other design considerations and safety requirements against progressive collapse shall be in accordance with IS 15916.

10 JOINTS

Design of joints shall be in accordance with IS 15916.

11 TESTS FOR COMPONENTS/ STRUCTURES

Sampling procedure, testing on individual components and load testing of structure shall be in accordance with IS 15916.

12 ERECTION

12.1 Manufacture, Storage, Transport and Erection

The requirements relating to manufacture, storage, transport and erection of precast concrete elements shall be in accordance with IS 15916 including the requirements applicable to mixed/composite constructions given therein.

12.2 Decking

Constructional practices relating to decking shall be as given in Annex B.

12.3 Concreting on Decking

Concreting on decking shall be carried out in accordance with Annex C.

12.4 For the design and construction of composite structures made up of prefabricated structural units and cast *in-situ* concrete, reference may be made to IS 3935.

For design and construction of precast reinforced and prestressed concrete triangulated trusses reference may be made to IS 3201.

For design and construction of floors and roofs using various precast units, reference may be made to IS 6332, IS 10297, IS 10505, IS 13994, IS 14142, IS 14215 and IS 14242.

For construction with large panel prefabricates, reference may be made to IS 11447.

For construction of floors and roofs with joists and filler blocks reference may be made to IS 6061 (Parts 1 and 2).

13 EQUIPMENT

The requirements relating to equipment used in the precast concrete construction shall be in accordance with IS 15916.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
875	Code of practice for design loads (other than earthquake) for buildings and structures:
(Part 1) : 1987	Dead loads — Unit weights of building materials and stored materials (*second revision*)
(Part 2) : 1987	Imposed loads (*second revision*)
(Part 3) : 1987	Wind loads (*second revision*)
(Part 4) : 1987	Snow loads (*second revision*)
(Part 5) : 1987	Special loads and load combinations (*second revision*)
1893 (Part 1) : 2002	Criteria for earthquake resistant design of structures: Part 1 General provisions and buildings (*fifth revision*)
3201 : 1988	Criteria for design and construction of precast trusses and purlins (*first revision*)
3935 : 1966	Code of practice for composite construction
6061	Code of practice for construction of floor and roof with joists and filler blocks:
(Part 1) : 1971	With hollow concrete filler blocks
(Part 2) : 1981	With hollow clay filler blocks (*first revision*)

IS No.	Title
6332 : 1984	Code of practice for construction of floor and roofs using precast doubly-curved shell units (*first revision*)
10297 : 1982	Code of practice for design and construction of floors and roofs using precast reinforced/ prestressed concrete ribbed or cored slab units
10505 : 1983	Code of practice for construction of floors and roofs using precast concrete waffle units
11447 : 1985	Code of practice for construction with large panel prefabricates
13994 : 1994	Code of practice for design and construction of floor and roof with precast reinforced concrete planks and RC joists
14142 : 1994	Code of practice for design and construction of floors and roofs with prefabricated brick panel
14215 : 1994	Code of practice for design and construction of floors and roofs with precast reinforced concrete channel units
14242 : 1994	Code of practice for design and construction of roof with L-panel units
15916 : 2010	Building design and erection using prefabricated concrete — Code of practice
SP 7 (Part 6/ Sec 3A) : 2005	National Building Code of India 2005: Part 6 Structural design, Section 3A Timber

ANNEX B

(*Clause* 12.2)

CONSTRUCTION PRACTICE FOR DECKING

B-1 RECEIVING, STORING AND LIFTING THE DECKING

B-1.1 Receiving Decking

Decking is packed by the manufacturer into bundles of up to 24 sheets, and the sheets are normally secured with metal banding. Each bundle may be up to 1 m wide (the width of a single sheet) by 750 mm deep, and may weigh up to 2.5 t, depending on sheet length. Loads are normally delivered by articulated vehicles approximately 16 m long with a maximum gross mass of up to 40 t, and a turning circle of approximately 19 m. It shall be ensured that there is suitable access and appropriate standing and off-loading areas.

Each bundle will be given an identification tag by the manufacturer. The information on each tag shall be checked immediately upon arrival, to prevent incorrect sheets being used, or unnecessary delays, if changes are necessary. In particular, the stated sheet thickness shall be checked against the requirement specified on the drawings, and a visual inspection shall be made to ensure that there is no damage.

The bundles shall be lifted from the vehicle. Bundles shall never be off-loaded by tipping, dragging, dropping or other improvised means.

B-1.2 Storing of Decking

The decking shall not be delivered more than one month before its anticipated use, as it may be vulnerable to abuse and damage, if stored for longer periods on site. If it is not for immediate use, the decking shall be stored on the steel frame. If this is not possible, it shall be located in an area where it will not be contaminated by site traffic, and placed on bearers, which provide a gentle slope to the bundle. This will allow any condensation or rain to drain and a free flow of air around the bundle. Bundles shall not be stacked more than 4 m high, and no other materials shall be stored on top of them. Bearers shall be placed between bundles, and positioned to prevent bending of the sheets.

B-1.3 Lifting and Positioning the Decking

The support steel-work shall be prepared to receive the decking before lifting the bundles onto it. The top surface of the underlying beams shall be reasonably clean. When through-deck welding of shear studs is specified, the tops of the flanges shall be free of primer, paint and galvanizing.

The identification tags shall be used to ensure that bundles are positioned on the frame at the correct floor level, and in the nominated bay shown on the deck layout drawing. The bundles shall be positioned such that the interlocking side laps are on the same side. This will enable the decking to be laid progressively without the need to turn the sheets. The bundles shall also be positioned in the correct span orientation, and not at 90° to it. Care shall be taken to ensure that the bundles are not upside down, particularly with trapezoidal profiles. For most trapezoidal decking profiles, the embossments shall be oriented so that they project upwards.

Care is needed when lifting the decking bundles; protected chain slings are recommended for the same. Unprotected chain slings can damage the bundle during lifting. When synthetic slings are used there is a risk of the severing them on the edges of the decking sheets.

If timber packers are used, they shall be secured to the bundle before lifting so that when the slings are released they do not fall to the ground (with potentially disastrous results). Bundles shall never be lifted using metal banding.

B-2 DECK INSTALLATION

B-2.1 Placement of Decking

Breaking open the bundles and installing the decking shall be done only when all the sheets can be positioned and secured. The decking layout drawing shall also be checked to ensure that any temporary support that need to be in position prior to deck laying, is in place.

Access for installation may normally be achieved using ladders connected to the steel frame. Once the laying out the sheets is started by erectors, they shall create working platform by securely fixing the decking as they progress.

The laying of sheets shall begin at the locations indicated on the decking layout drawings. These would normally be at the corner of the building at each level, to reduce the number of leading edges, that is unprotected edges where the decking is being laid. When the bundles have been properly positioned, as provided above, there shall be no need to turn the sheets manually, and there shall be no doubt which way up the sheet shall be fixed.

Individual sheets shall be slid into place and, where possible, fixed to the steelwork before moving onto the next sheet. This will minimize the risk of an accident occurring as a result of movement of a sheet when it is being used as a platform. However, for setting-out purposes, it may be necessary to lay out an entire bay using a minimum number of temporary fixings before fully securing the sheets later.

Sheets shall be positioned to provide a minimum bearing of 50 mm on the steel support beams. The ends of adjacent sheets shall be butted together. A gap of up to 5 mm is generally considered not to allow excessive seepage, but, if necessary, the ends of the sheets may be taped together. When end gaps are greater than 5 mm, it is normally sufficient to seal them with an expanding foam filler. The longitudinal edges shall be overlapped, to minimize concrete seepage along the seams. Although not normally required, seam fixings may be necessary in some circumstances. Sheets projecting freely more than 600 mm shall be avoided.

If necessary, sheets shall be cut using a grinder or a nibbler. However, field cutting shall be kept to a minimum and shall only be necessary where a column or other obstruction interrupts the decking. Gaps adjacent to the webs of columns shall be filled in with off-cuts or thin strips of steel. Decking sheets shown as continuous on the decking layout drawing shall never be cut into more than one length. Also, sheets shall never be severed at the location of a temporary support, and the decking shall never be fastened to a temporary support.

As the work progresses, scraps and off-cuts shall be disposed off in a skip placed alongside the appropriate level of working. The skip shall be positioned carefully over a support beam to avoid overloading the decking. If a skip is not available, scraps shall be gathered for collection as soon as possible. Partially used bundles shall be secured, to avoid individual sheets moving in strong winds.

B-2.2 Fixing of Decking

Decking sheets shall be fixed to the top of the supporting structure. All fixings shall be made through the troughs in the decking. Fixings shall be at approximately 300 mm centres (or in every trough) along the end supports, and at 600 mm centres (or in alternate troughs) along the internal supports. As an absolute minimum, each sheet shall be connected at least twice to each permanent support. The number and placement of fasteners will normally be given on the decking layout drawing. Fixings shall not be made to temporary supports.

The fixings, together with through-deck welded studs (if present) normally provide lateral restraint to the beams during the construction stages.

ANNEX C

(*Clause* 12.3)

CONSTRUCTION PRACTICE FOR CONCRETING ON DECKING

C-1 PLACING CONCRETE

C-1.1 Preparation

Prior to beginning work on the decking, guardrails shall be in position at all perimeters, internal edges and voids. The positions of any props (and back props) shall be checked against the details shown on the decking layout drawings to ensure that adequate support has been provided.

C-1.2 Cleaning the Decking

The surface of the decking shall be reasonably free of dirt, oil, etc, prior to concreting.

C-1.3 Construction Joints

Although there is no technical limitation to the area that may be concreted, the usual pour area is up to 1 000 m^2/day. Where the limits of the pour do not coincide with permanent slab edges, construction joints are used to define the extent of the pour.

The locations and details of the construction joints may have an effect on the cracking. The layout and details of the joints shall be determined by the structural designer. For example, when brittle bonded finishes are used, the relationship between the joints in the concrete and the joints in the finishes shall be considered at the outset, to reduce the risk of cracking in undesirable locations.

Where possible, the construction joints shall be located close to butt joints in the decking. Where shear connectors are used, it is preferable to create the joint to one side of the line of the shear connectors, to ensure sound concrete around the studs. If the construction joint cannot be made near a butt joint, it is suggested that no more than one-third of the decking span from a butt joint shall be left unpoured. Concreting shall not be stopped within a sheet length, because excessive deflections may occur when the loads on a continuous decking sheet are not balanced on either side of the intermediate support beam.

Stop ends, usually in the form of timber or plastic inserts, are used to create the construction joints. As with all the joints and ends of the decking, they shall be checked for potential grout loss.

C-1.4 Reinforcement

All reinforcement shall be properly supported so that it does not get displaced during concreting. Plastic stools, loops or preformed mesh may be used as chairs, but not plastic channels, which can induce cracking. Chairs shall be robust. In particular, the handling and movement of concrete carrying pipes during pumping can cause significant local impacts on the reinforcement.

The reinforcement that has been fixed shall be checked. Particular attention shall be given to checking any additional bar reinforcement, such as may be needed around openings.

C-1.5 Grout Loss

The decking joints shall be closely butted and exposed ends shall be stopped with proprietary filler pieces to avoid grout loss. Gaps greater than 5 mm shall be sealed.

C-2 PLACEMENT

C-2.1 Concrete shall be placed in a way that minimizes the permanent deformation of the decking. This is particularly important for spans greater than 3 m. When concreting is progressed in the same direction as the span of the decking (that is parallel to the decking ribs), it shall be placed first over supports where the decking is continuous, followed by the mid-span region and finally the areas above the end supports. When concreting is progressed in a direction perpendicular to the decking span (that is transverse to the decking ribs), it shall be placed first at the edge where a decking sheet is supported by the underlap of an adjacent sheet. This helps to ensure that longitudinal seams between panels remain closed.

The concrete shall be well compacted, particularly near and around any shear connectors. This may be done using a vibrating beam, which may require adequate supports at either ends, or an immersion needle vibrator. Hand tamping is not recommended as a way of compacting the concrete. For slim floors with deep decking, or for other partially encased beams, a needle vibrator is needed to ensure proper concrete flow around the beams, beyond the ends of the decking.

C-2.2 Concrete Pumping

Pumping may be adopted for both normal and light-weight concrete mixes. Flow rates in the order of 0.5 m^3 to 1 m^3 of concrete per minute may be achieved, although, clearly, the longer the pump lines and the higher the concrete is to be pumped, the slower the operation. A pump may normally lift the concrete up to 30 m. Secondary pumps, placed at intermediate levels, may be necessary for higher lifts.

Pumplines are normally 150 mm in diameter and are assembled in segments. As the force exerted at bends may be significant, straight line pumping is preferred. The lines shall be supported on timber blocks at intervals of 2 m to 3 m. Resetting of pumplines is required at frequent intervals as the pour progresses. This means that the outlet pipe shall be moved frequently and carefully so that concrete heaping is minimized. A minimum of two operators are necessary for this operation, one to hold and manoeuvre the outlet pipe, the other to shovel away excess concrete. No more than 4 workmen shall be present around the pipe outlet during pumping, because of the potential for overloading the decking. The concrete shall not be dropped from the outlet pipe onto the decking from a height of more than about 1 m.

C-2.3 Skip and Barrow

Placing concrete from a skip hung from a crane may be difficult because of obstructions from beams and decking at higher floor levels. However, despite being time consuming, it is sometimes efficient to use the skip and barrow technique for small infill bays.

Skips shall have a means of controlling the rate of discharge, and shall not be discharged from more than 0.5 m above the decking or barrow. When discharging into a barrow, the barrow shall be supported by thick (about 30 mm) boards covering a 2 m × 2 m area, or by a finished part of the slab. Either provision limits impact loads. Barrows shall be run over thick boards placed on the mesh, which shall be supported locally.

C-3 FINISHING, CURING AND DRYING

If power floating is to be carried out, this shall be done within 2 h to 3 h of casting. This allows time for the concrete to harden sufficiently.

As the concrete is only exposed on one surface of a composite floor, it can take longer than a traditional reinforced concrete slab to dry out.

ANNEX D
(*Foreword*)

COMMITTEE COMPOSITION

Planning, Housing and Prefabricated Construction Sectional Committee, CED 51

Organization	*Representative(s)*
In personal capacity (*Apartment No. 3203, Verona, Cliff Avenue, Hiranandani Gardens, Powai, Mumbai*)	Shri V. Suresh (***Chairman***)
A. P. State Housing Corporation Limited, Hyderabad	Shri Ch. Mallikarjuna Rao Shri P. Sri Ramulu (*Alternate*)
Army Welfare Housing Organization, New Delhi	Brig M. Gandhi Col N. Bhushan (*Alternate*)
B. G. Shirke Construction Technology Limited, Pune	Shri V. G. Jana Shri Yogesh P. Kajale (*Alternate*)
Bhardwaj Bhardwaj & Associates (P) Ltd, New Delhi	Shri A. Bhardwaj
Builders' Association of India, Mumbai	Shri S. K. Choudhury Shri N. Krishnaraj (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Dr Shailesh Kumar Agrawal
Central Building Research Institute (CSIR), Roorkee	Shri Ashok Kumar Shri S. K. Negi (*Alternate*)
Central Government Employees Welfare Housing Organization, New Delhi	Shri A. K. Rajput Shri M. Narayanan (*Alternate*)
Central Public Works Department, New Delhi	Shri T. K. Sinha Shri R. Kakkar (*Alternate*)
City and Industrial Development Corporation of Maharashtra Limited, Navi Mumbai	Shri S. C. Deshpande Shri K. Y. Joshi (*Alternate*)
Council for Advancement of People's Action and Rural Technology, New Delhi	Shri C. S. Pandey (Civil Engg) Shri S. H. Indurkar (*Alternate*)
Delhi Development Authority, New Delhi	Engineer Member Commissioner (Planning) (*Alternate*)
Development Alternatives, New Delhi	Ms Zeenat Niazi Ms Mona Anand Chhabra (*Alternate*)
Directorate General Border Roads, New Delhi	Shri P. D. Arora
Engineering Consultants (India) Ltd, New Delhi	Shri S. S. Mann Shri Aditya Sharma (*Alternate*)
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