

CLAU SE-BY-CLAU SE COMPANION

IS 456 : 2000

Plain and Reinforced Concrete — Code of Practice
(Fourth Revision) Explained with Sketches

Every section · every clause · Annexes A-H

40+ original drawings · worked examples · exam pointers

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IS 456:2000 Clause-wise Companion — Explained with Sketches

First Edition, 2026

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BEFORE YOU BEGIN

How to Use This Companion

IS 456:2000 — *Plain and Reinforced Concrete: Code of Practice (Fourth Revision)* — is the backbone of every RCC design, estimate, site inspection and competitive examination question in Indian civil engineering. The code itself is written in a compact, legal style: it tells you *what* to do, but rarely *why*, and it has very few pictures. This companion walks through the code **clause by clause, in the same order as the code**, and for each clause gives you:

Element	What it contains
Clause heading (Cl. 26)	The clause number and title exactly as arranged in IS 456, so you can keep the official copy open side-by-side.
Explanation (blue box)	The engineering reason behind the rule, in plain language.
Key values (green box)	Numbers, limits and formulae to memorise.
Exam pointer (orange box)	What is repeatedly asked in WBPSA AE, SSC JE, GATE, ESE and state PSC papers; common traps.
Site practice (grey box)	How the clause is applied on real construction sites and in drawings.
Sketches	Over 40 original drawings: detailing, critical sections, stress blocks, effective lengths, strips, footings and more.
Worked examples	Short numerical illustrations using the clause.

IMPORTANT — READ THIS ONCE

This is an **explanatory companion**, not a copy of the standard. The wording here is our own; clause numbers, tables and numerical limits are cited so that you can locate them in the code. IS 456 is a copyrighted publication of the Bureau of Indian Standards (BIS). For design, tender and legal purposes always refer to the official BIS copy **with all its amendments**, and to the latest versions of the codes it cross-refers to (IS 875, IS 1893, IS 13920, IS 383, IS 10262, IS 516 etc.). Where amendments have changed a value, the note "verify with amended copy" is given.

NOTATION USED THROUGHOUT

f_{ck} = characteristic cube strength of concrete (N/mm²); f_y = characteristic yield / 0.2% proof strength of steel; b = width; D = overall depth; d = effective depth; x_u = depth of neutral axis; A_{st} , A_{sc} = area of tension / compression steel; ϕ = bar diameter; l_{ef} = effective length or span; LSM = Limit State Method; WSM = Working Stress Method; DL, LL, WL, EL = dead, live (imposed), wind and earthquake loads.

Map How IS 456:2000 is organised

The code has five Sections and eight Annexes. Sections 1–2 deal with **materials and construction** (what a site engineer and QC engineer need), Sections 3–4 with **general and member-specific design rules** (what a designer/detailer needs), and Section 5 with the **Limit State Method** of design. Annex B keeps the older Working Stress Method alive for special cases.

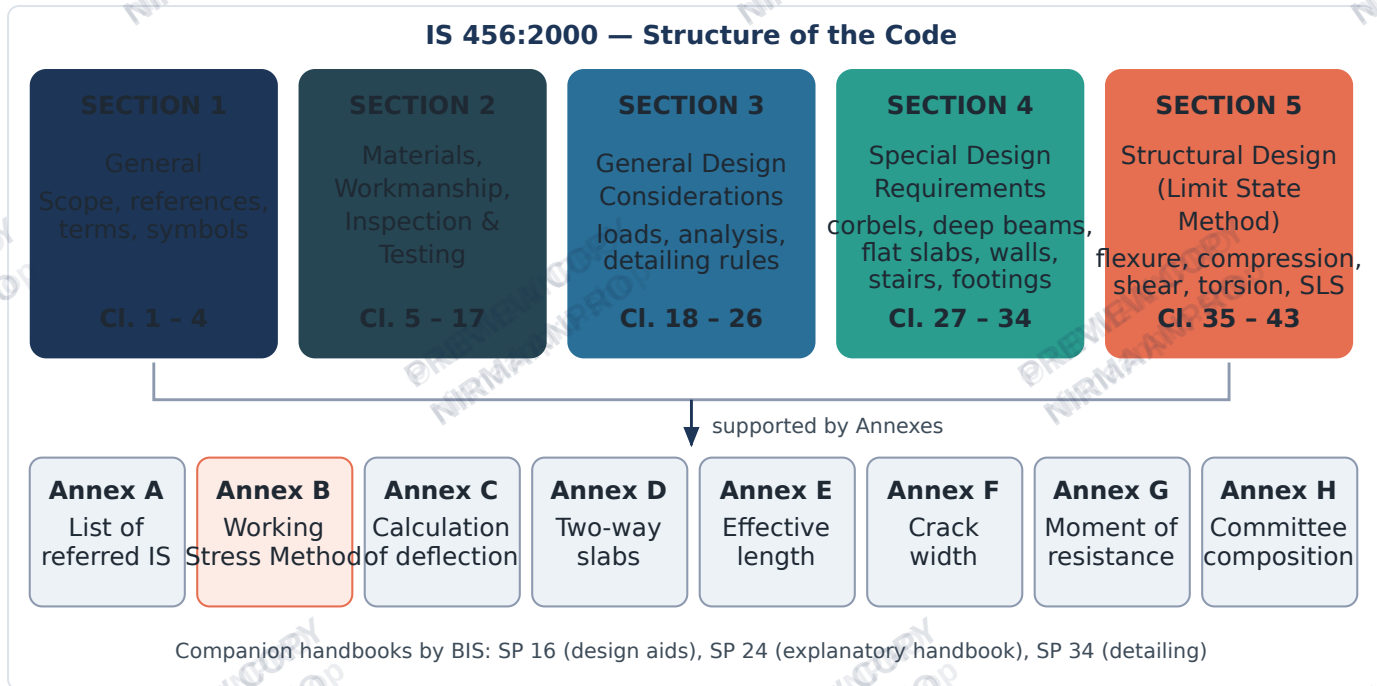


Fig. 0 — The five sections and eight annexes of IS 456:2000

EXAM POINTER

"IS 456:2000 is which revision?" — the **fourth** revision (earlier editions 1953, 1957, 1964, 1978). The 2000 edition made the **Limit State Method the main method**, pushed Working Stress to Annex B, and introduced far stronger **durability** provisions (five exposure classes, higher covers and minimum grades).

SECTION 1 · CLAUSES 1 - 4

General

Cl. 1 Scope

The code lays down the requirements for the **design and construction of plain and reinforced concrete** structures for general use — buildings, water-tank supports, retaining walls, foundations, frames and the like. It covers materials, workmanship, testing, general design considerations, special members and the structural design methods (Limit State in Section 5, Working Stress in Annex B).

It is a *general* code. Structures with special behaviour need additional codes that sit on top of IS 456; IS 456 remains the base document for material and durability requirements even then.

Special case	Companion code to be used with IS 456
Prestressed concrete	IS 1343
Earthquake loads / ductile detailing	IS 1893 (Part 1) / IS 13920
Liquid-retaining structures (tanks)	IS 3370 (Parts 1-4)
Loads (dead, imposed, wind, snow, combinations)	IS 875 (Parts 1-5)
Road bridges	IRC 112 (and other IRC codes)
Chimneys, shells, folded plates, silos	IS 4998, IS 2210, IS 4995 etc.
Detailing of reinforcement	SP 34, IS 2502 (bending of bars)

Cl. 2 References

Clause 2 simply states that the standards listed in **Annex A** are necessary adjuncts. Because referred standards keep getting revised, always use the current edition. Several important references have been revised after 2000 — for example IS 269 (all OPC grades now in one standard), IS 383:2016 (aggregates, now permitting manufactured sand and some recycled aggregate), IS 10262:2019 (mix design) and the IS 516 series (testing of concrete).

Cl. 3 Terminology

Only a few terms are defined in Clause 3, but two of them are the foundation of limit state design.

3.1 Characteristic load

The load that has a **95% probability of not being exceeded** during the life of the structure. Because statistical load data are rarely available, in practice the loads given in IS 875 and IS 1893 are taken as characteristic loads.

3.2 Characteristic strength

The strength of material below which **not more than 5% of test results** are expected to fall. For concrete it is the 28-day cube strength f_{ck} ; for steel it is the minimum yield stress / 0.2% proof stress f_y .

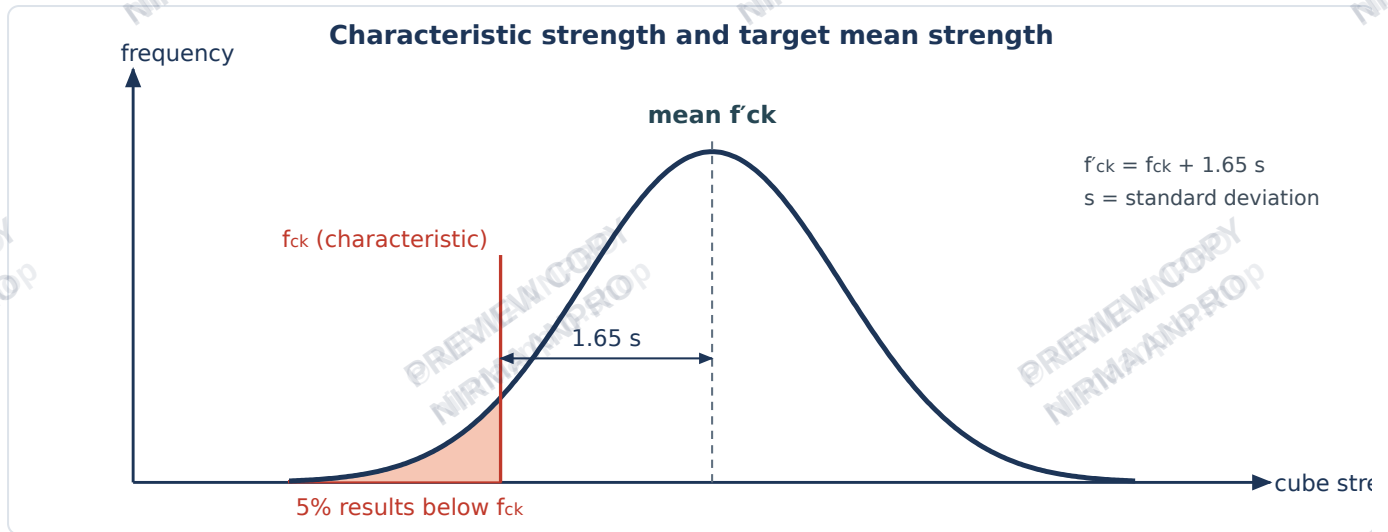


Fig. 1 — Normal distribution of cube strengths; f_{ck} is the 5% fractile

EXPLANATION

If many cubes are cast from the same concrete, their strengths follow approximately a normal (bell-shaped) distribution. The characteristic strength is fixed at the lower 5% point, which lies **1.65 standard deviations** below the mean. That is why a concrete mix is always designed for a **target mean strength** $f'_{ck} = f_{ck} + 1.65 s$ (Cl. 9.2). A site with poor quality control (large s) must aim at a higher mean — i.e. use more cement — to deliver the same characteristic strength.

Other terms used in the code: **chemical admixture** (added in small doses during mixing to modify properties — plasticiser, retarder, accelerator), **mineral admixture** (fine pozzolanic or cementitious material — fly ash, silica fume, GGBS), **durability**, **nominal cover** (defined in 26.4.1), **effective depth**, **effective span** and **effective length** (defined where used).

Cl. 4 Symbols

The code lists symbols in Clause 4; the ones you will use every day are:

Symbol	Meaning	Symbol	Meaning
A_c	Area of concrete	E_c, E_s	Modulus of elasticity of concrete, steel
A_g	Gross area of section	f_{ck}	Characteristic cube strength
A_{st}, A_{sc}	Area of tension / compression steel	f_{cr}	Modulus of rupture (flexural strength)
A_{sv}	Total area of stirrup legs	f_y	Characteristic strength of steel
b, b_w, b_f	Width; web width; flange width	M_u, V_u, P_u, T_u	Factored moment, shear, axial load, torque
D, D_f	Overall depth; flange thickness	s_v	Spacing of stirrups
d, d'	Effective depth; depth of compression steel	x_u	Depth of neutral axis
L_d	Development length	γ_f, γ_m	Partial safety factors (load, material)
l_{ef}, l_{ex}, l_{ey}	Effective length (about x, y axes)	$\tau_v, \tau_c, \tau_{bd}$	Nominal shear, design shear strength, design bond stress

SECTION 2 · CLAUSES 5 - 17

Materials, Workmanship, Inspection and Testing

Section 2 is the "site engineer's section". It controls the quality of what is actually built. A perfectly designed structure fails early if cover is short, w/c ratio is high or curing is skipped — which is why the 2000 revision greatly strengthened this section.

Cl. 5 Materials

5.1 Cement

Any of the standard Indian cements may be used, chosen to suit the job and exposure. The choice affects early strength (and therefore stripping time and curing period), heat of hydration and chemical resistance.

Cement	Standard	Typical application / remark
Ordinary Portland Cement 33, 43, 53 grade	IS 269	General construction; 53 grade for high-strength and precast work
Portland Pozzolana Cement (fly ash based)	IS 1489 (Part 1)	General work, mass concrete, marine; lower heat, better long-term durability, slower early strength
Portland Slag Cement	IS 455	Marine and sulphate-prone works, mass concrete
Rapid Hardening Portland Cement	IS 8041	Early stripping, repairs, cold weather
Sulphate Resisting Portland Cement	IS 12330	Foundations in sulphate-bearing soil / groundwater (low C_3A)
Low Heat Portland Cement	IS 12600	Dams, thick rafts — controls thermal cracking
White / Hydrophobic / Super-sulphated / High-alumina	IS 8042 / 8043 / 6909 / 6452	Architectural / storage in humid areas / aggressive chemicals / special refractory uses (high-alumina not for general structural work)

EXAM POINTER

Sulphate attack → use **SRC (low C_3A)** or PSC; mass concrete → **low heat**; early formwork removal → **rapid hardening**. Blended cements (PPC/PSC) need **longer curing** (Cl. 13.5.1).

5.2 Mineral admixtures

Fly ash (IS 3812), silica fume (IS 15388), rice husk ash, metakaoline and ground granulated blast-furnace slag (GGBS) may be used as part-replacement of cement when their uniform blending is ensured. They react with the $Ca(OH)_2$ released by cement hydration to form additional C-S-H gel, making concrete denser and less permeable. **Silica fume** is extremely fine (about 100 times finer than cement) and is used for high-strength and low-permeability concrete.

5.3 Aggregates

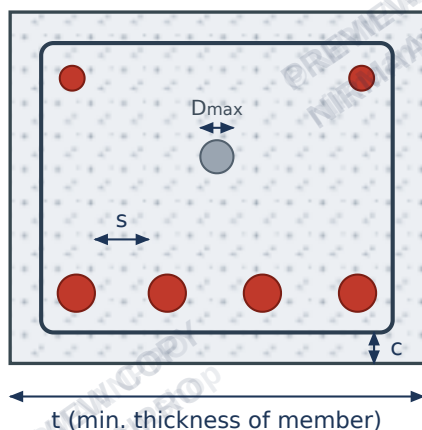
Aggregates must comply with IS 383. They must be hard, strong, durable, clean, and free from harmful materials (clay lumps, organic matter, alkali-reactive silica, excess chlorides/sulphates).

5.3.3 Size of aggregate. The nominal maximum size of coarse aggregate should be as large as possible (less cement paste needed), but limited by the member size and the gaps between bars so that concrete can flow around reinforcement:

- not more than **one-fourth of the minimum thickness** of the member;

- for heavily reinforced members, **5 mm less than the minimum clear distance between bars or the minimum cover**, whichever is smaller;
- **20 mm** is generally adequate for most RCC work; 40 mm or larger may be used for mass/plain concrete where there is no restriction; plums (large stones above 160 mm) up to 20% by volume may be permitted in plain mass concrete by the engineer-in-charge.

Limit on nominal maximum size of coarse aggregate (Cl. 5.3.3)



Nominal max. aggregate size $D_{max} \leq$

- (i) $t / 4$
- (ii) (smaller of s and c) – 5 mm
- (iii) usually 20 mm for RCC

s = min. clear gap between bars, c = min. cover

Fig. 2 — The aggregate must pass between bars and into the cover zone

5.4 Water

Water used for mixing and curing must be clean and free from oils, acids, alkalis, salts, sugar and organic matter. **Potable water is generally satisfactory.** The pH should not be less than 6. The code also gives two performance checks: cubes made with the water should reach at least **90%** of the 28-day strength of cubes made with distilled water, and the initial setting time should not be less than 30 minutes nor differ by more than ± 30 minutes from the control.

Constituent (Cl. 5.4)	Permissible limit (max.)
Organic solids	200 mg/l
Inorganic solids	3000 mg/l
Sulphates (as SO_3)	400 mg/l
Chlorides (as Cl) — plain concrete / reinforced concrete	2000 mg/l / 500 mg/l
Suspended matter	2000 mg/l

SITE PRACTICE

Sea water must **not** be used for mixing or curing RCC — chlorides corrode reinforcement. Water for curing should be of the same quality; water that stains the surface (iron, tannic acid) should be avoided for exposed faces.

5.5 Admixtures

Chemical admixtures must comply with IS 9103 (accelerators, retarders, water-reducers/plasticisers, superplasticisers, air-entrainers). Their effect must be established by trial mixes, and their chloride and sulphate contribution counted towards the total limits of Cl. 8.2.5. **Calcium chloride based accelerators should not be used in RCC or prestressed work** because of corrosion risk.

5.6 Reinforcement

Type	Standard	f_y (N/mm ²)	Remarks
Mild steel plain bars (Grade I)	IS 432 (Part 1)	250	Fe 250; ductile; hooks needed for anchorage
High Yield Strength Deformed (HYSD/TMT) bars	IS 1786	415, 500, 550, 600	Fe 415, Fe 500 most common; "D" grades have higher ductility
Hard-drawn steel wire fabric	IS 1566	480 (0.2% proof)	Welded mesh for slabs, walls
Structural steel	IS 2062	250 +	Composite / embedded sections

For all steels the **modulus of elasticity** $E_s = 2 \times 10^5$ N/mm². All reinforcement must be free from loose mill scale, loose rust, oil, mud and paint that would reduce bond. A thin firm layer of rust is not harmful.

5.7 Storage of materials

Storage should follow IS 4082: cement on raised platforms in weather-proof sheds, stacked not more than 10 bags high and used on "first-in first-out" basis; aggregates on hard clean surfaces with separate heaps for each size; steel above ground on supports, protected from moisture.

Cl. 6 Concrete

6.1 Grades of concrete (Table 2)

Group	Grades	Remark
Ordinary concrete	M10, M15, M20	M = mix, number = f_{ck} in N/mm ² (150 mm cube, 28 days)
Standard concrete	M25, M30, M35, M40, M45, M50, M55	Design mix mandatory for M25 and above in practice
High strength concrete	M60, M65, M70, M75, M80	Special design, testing and quality control

KEY VALUES

Minimum grade for **RCC** = **M20** (mild exposure); for **PCC** = **M15** (moderate exposure) — see Table 5. Grades below M20 are not permitted for reinforced concrete.

6.2 Properties of concrete

Property (clause)	Value / rule	M20 example
Increase of strength with age (6.2.1)	Concrete keeps gaining strength after 28 days, but design is based on the 28-day characteristic strength unless an age allowance is specifically justified	—
Flexural tensile strength (6.2.2)	$f_{cr} = 0.7 \sqrt{f_{ck}}$	3.13 N/mm ²
Short-term modulus of elasticity (6.2.3.1)	$E_c = 5000 \sqrt{f_{ck}}$ (actual may vary $\pm 20\%$)	22 360 N/mm ²
Shrinkage (6.2.4)	Total shrinkage depends on constituents, member size and humidity; in absence of data, ultimate shrinkage strain = 0.0003	0.3 mm per metre
Creep (6.2.5)	Creep coefficient θ (ultimate creep strain / elastic strain) depends on age at loading: 2.2 at 7 days, 1.6 at 28 days, 1.1 at 1 year	$E_{ce} = E_c / (1 + \theta)$
Thermal expansion (6.2.6)	Depends on aggregate type (quartzite ≈ 1.2 – 1.3 , sandstone 0.9 – 1.2 , granite 0.7 – 0.95 , basalt 0.8 – 0.95 , limestone 0.6 – 0.9 , all $\times 10^{-5}$ per $^{\circ}\text{C}$)	$\approx 1 \times 10^{-5} / ^{\circ}\text{C}$

You've reached the end of the preview

This sample covers the first 11 of 55 pages: the copyright page, table of contents, the code map, Clauses 1-4 (Scope, References, Terminology, Symbols), and the start of Materials (Clause 5).

The full edition continues through Section 2 (Cl. 6-17), Sections 3-5 (Cl. 18-43), Annexes A-H, 40+ original sketches, worked examples, exam pointers for every section, the Quick Reference sheet, and 20 self-test questions with answers.

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