



Building Materials & Construction

Detailed notes + compact revision summary

Contents

Part A — Detailed notes (11 chapters, 45 pages)	page 4
Part B — Compact summary notes (10 pages)	page 49

Copyright & licence

© 2026 Nirmaanpro. All rights reserved.

This PDF was bought from nirmaanpro.shop and is licensed to the buyer for personal study only. Copying, printing for others, uploading to any website, app, Telegram or WhatsApp group, or reselling it — in whole or in part — is not permitted.

Every page carries the Nirmaanpro watermark so shared copies can be traced to their source. If you found this file anywhere other than nirmaanpro.shop, please let us know.

The notes are prepared for exam revision. Always check design values against the current IS codes before using them in real work.

More from Nirmaanpro

Free calculators, the Building Frame Designer, Sunday Live Contest, mock tests, free handbooks and job alerts — all at nirmaanpro.shop

Contents

Building Materials & Construction

Part A — Detailed notes	4
01 Building Stones	4
1.1 Classification of rocks	4
1.2 Qualities of a good building stone	4
1.3 Tests on stones	5
1.4 Quarrying, blasting and dressing	7
1.5 Deterioration, preservation, Indian stones and artificial stones	8
02 Bricks and Clay Products	10
2.1 Brick earth — composition and harmful ingredients	10
2.2 Manufacture of bricks	10
2.3 Size, frog and classification of bricks	11
2.4 Tests on bricks (IS 3495 and IS 1077)	13
2.5 Special bricks and defects of bricks	14
2.6 Tiles, terracotta and other clay products	14
03 Lime	16
3.1 Lime — production and chemistry	16
3.2 Fat, poor and hydraulic lime	17
3.3 IS 712 classes, tests and storage	17
3.4 Lime compared with cement	18
04 Cement	19
4.1 Raw materials and manufacture	19
4.2 Composition and Bogue compounds	20
4.3 Types of cement and IS codes	21
4.4 Laboratory tests on cement (IS 4031) and IS limits	22
4.5 Field tests and storage	23
05 Aggregates and Mortar	24
5.1 Classification and grading of aggregates	24
5.2 Physical properties — specific gravity, density, voids, bulking	25
5.3 Mechanical tests and deleterious materials	26
5.4 Mortar	26
06 Concrete Technology I — Fresh and Hardened Concrete	28
6.1 Water and the water-cement ratio	28
6.2 Workability and its measurement	28
6.3 Segregation, bleeding, production and curing	29
6.4 Properties of hardened concrete	30
6.5 Durability of concrete (IS 456)	31
07 Concrete Technology II — Mix Design, Admixtures, Special Concretes an...	32
7.1 Mix design by IS 10262:2019	32
7.2 Nominal mixes	33
7.3 Admixtures	33
7.4 Special concretes	34
7.5 Hot- and cold-weather concreting	35

Contents (continued)

Building Materials & Construction

7.6 Non-destructive testing, sampling and acceptance	35
08 Timber	37
8.1 Classification and structure	37
8.2 Defects in timber	37
8.3 Felling, conversion and seasoning	38
8.4 Preservation and fire-proofing	38
8.5 Timber products and Indian timbers	39
09 Metals	40
9.1 Ferrous metals	40
9.2 Reinforcing and structural steel	41
9.3 Non-ferrous metals and corrosion	42
10 Finishes and Miscellaneous Materials	43
10.1 Paints, varnishes and distempers	43
10.2 Glass and plastics	44
10.3 Gypsum, bitumen and adhesives	44
10.4 Damp-proofing, insulation and geosynthetics	45
11 Building Construction Essentials	46
11.1 Foundations	46
11.2 Brick and stone masonry	46
11.3 Damp-proofing, plastering, pointing and flooring	47
11.4 Stairs, doors, windows, lintels and arches	47
11.5 Roofs, formwork, scaffolding, shoring and underpinning	48
Part B — Compact summary notes (quick revision)	49
Summary notes	50

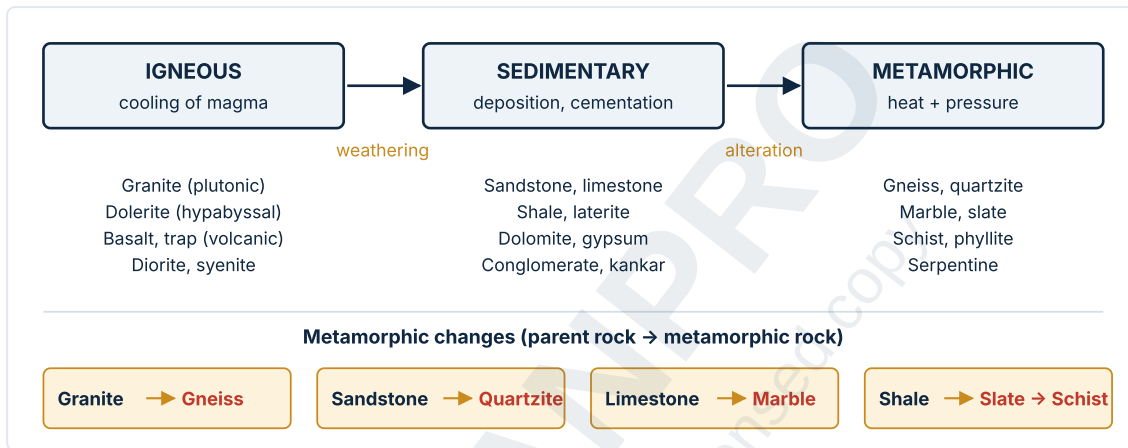
CHAPTER 01

Building Stones

Classification of rocks, qualities and tests of stones, quarrying and dressing, preservation, Indian stones and artificial stones.

1.1 Classification of rocks

A **rock** is an aggregate of minerals; a **stone** is a piece of rock that has been quarried and shaped for use. Building stones are classified in three ways — by geological origin, by physical structure and by chemical composition. All three are asked in exams, usually as "match the stone with its class".



Geological families of rocks with examples and the common metamorphic changes

Physical and chemical classification

Basis	Class	Meaning	Examples
Physical	Stratified	Layered (bedding planes); split easily along beds	Sandstone, limestone, shale
Physical	Unstratified	No layers; compact crystalline mass	Granite, trap, basalt, marble
Physical	Foliated	Split in one direction only (foliation, slaty cleavage)	Gneiss, schist, slate
Chemical	Siliceous	Silica (SiO ₂) is the main constituent; hard, durable	Granite, quartzite, trap, gneiss
Chemical	Argillaceous	Clay (alumina) is the main constituent; dense, brittle	Slate, laterite, shale
Chemical	Calcareous	Calcium carbonate is the main constituent; affected by acids	Limestone, marble, dolomite

- Igneous** rocks: *plutonic* (deep-seated, slow cooling, coarse crystals — granite), *hypabyssal* (shallow — dolerite) and *volcanic* (surface flows, fine grained — basalt, trap).
- Sedimentary** rocks form from deposition of weathered particles and are cemented by silica, lime, iron oxide or clay; the cementing material governs durability (siliceous cement best).
- Metamorphic** rocks are earlier rocks altered by heat and/or pressure; they are usually harder and denser than the parent rock.
- Laterite** is a porous, iron-rich (red-brown) sedimentary rock that is soft when quarried and hardens on exposure to air — cut directly into building blocks in Kerala, Konkan and Odisha.

Exam trap: Marble is *calcareous* (chemical class) but *metamorphic* (geological class); slate is *argillaceous* and *foliated*. Read which classification the question asks for.

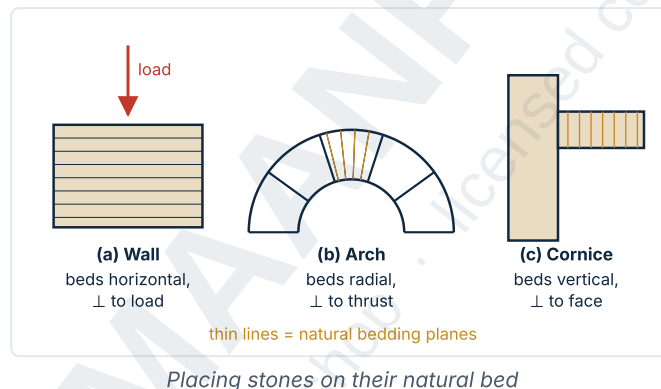
1.2 Qualities of a good building stone

The choice of stone depends on the structure, the exposure and the cost. A good building stone is strong, dense, durable and easy enough to work. The commonly accepted limits are given below.

Requirements of a good building stone

Property	Requirement / typical value
Crushing strength	> 100 N/mm ² for building stone
Water absorption (24 h)	< 5 % by weight (good stone); > 10 % generally rejected
Specific gravity	> 2.7 for a good, heavy stone (dense = strong, less porous)
Hardness (Dorry)	Coefficient of hardness > 17 for road work
Toughness (impact)	Toughness index > 19 for road work
Appearance	Uniform colour, free from clay holes, spots, cracks and soft patches
Seasoning	Quarry sap removed by drying for 6–12 months before use

- **Durability** depends on density, mineral composition and resistance to weathering (rain, frost, wind, temperature change, chemicals, plants).
- **Fire resistance:** argillaceous stones (and sandstone) resist fire well; **granite** cracks in fire because quartz expands suddenly; limestone and marble calcine to lime.
- **Dressing:** soft stones dress easily; granite is hard to dress but takes a high polish.
- **Natural bed:** the plane along which a sedimentary stone was deposited. A stone is strongest when the load acts perpendicular to its bedding planes.



Exam tip: Natural bed rules: walls — beds horizontal; arches — beds radial (perpendicular to the line of thrust); cornices, string courses and projecting stones — beds vertical and perpendicular to the face.

1.3 Tests on stones

Laboratory and field tests check strength, durability, hardness and wear resistance. Specimens are usually tested dry and saturated; a large drop in strength on saturation indicates a poor stone.

Water absorption

$$w_a = \frac{W_2 - W_1}{W_1} \times 100 \%$$

W_1 = oven-dry weight; W_2 = weight after 24 h immersion

Crushing strength

$$f_c = \frac{P}{A}$$

P = load at failure (N); A = loaded area (mm²)

Coefficient of hardness (Dorry)

$$C_h = 20 - \frac{W}{3}$$

W = loss of weight (g) after 1000 revolutions on the abrasion disc

Attrition (Deval) — percentage wear

$$\text{Wear} = \frac{W_{\text{loss}}}{W_{\text{initial}}} \times 100 \%$$

W_{loss} = material passing 1.7 mm sieve after the test

Tests on stones — purpose and procedure

Test	Measures	Key points
Crushing test	Compressive strength	Cube/cylinder specimens, loaded to failure; dry and saturated
Water absorption	Porosity, durability	24 h immersion; < 5 % for good stone
Attrition (Deval)	Resistance to wear by rubbing	Cylinders inclined at 30° to the axis of rotation; 10,000 revolutions at 30–33 rpm
Impact (Page) test	Toughness	25 mm × 25 mm cylinder; 2 kg hammer; first drop 1 cm, raised 1 cm each blow; blow number at failure = toughness index
Hardness (Dorry)	Abrasion hardness	25 mm cylinder pressed on a rotating disc with sand; 1000 revolutions
Acid test	Resistance to acids/ smoke	Sample kept in about 1 % HCl for 7 days; edges should remain sharp
Smith's test	Soluble earthy matter	Chips shaken in clear water; turbid water ⇒ clay/earthy matter present
Crystallisation test	Weathering durability	Repeated soaking in sodium sulphate solution and drying; loss of weight recorded
Freezing–thawing	Frost resistance	Saturated specimens frozen and thawed repeatedly; check for flaking, weight loss
Microscopic test	Mineral composition, texture	Thin sections examined under a microscope

Toughness index and coefficient of hardness — interpretation

Rating	Toughness index (impact)	Coefficient of hardness (Dorry)
Poor / not tough	< 13	< 14 (not for road work)
Moderate / medium	13–19	14–17
High / hard	> 19	> 17

Mohs scale of hardness

Hardness	Mineral	Hardness	Mineral
1	Talc (softest)	6	Orthoclase (feldspar)
2	Gypsum	7	Quartz
3	Calcite	8	Topaz
4	Fluorite	9	Corundum
5	Apatite	10	Diamond (hardest)

- Field scratch test: a fingernail scratches up to hardness ≈ 2.5 (gypsum); a steel knife scratches up to ≈ 5.5; quartz (7) scratches glass.
- Brard's test** is the older laboratory test for frost resistance using boiling sodium sulphate solution (crystal growth imitates ice formation).

Worked example — Water absorption

A dry stone specimen weighs 2.50 kg. After 24 h immersion it weighs 2.58 kg. Find the water absorption and comment.

1. $w_a = (2.58 - 2.50)/2.50 \times 100 = 3.2 \%$

2. $3.2 \% < 5 \% \rightarrow$ acceptable for building work

Answer: Water absorption = 3.2 % — good stone

CHAPTER 06

Concrete Technology I — Fresh and Hardened Concrete

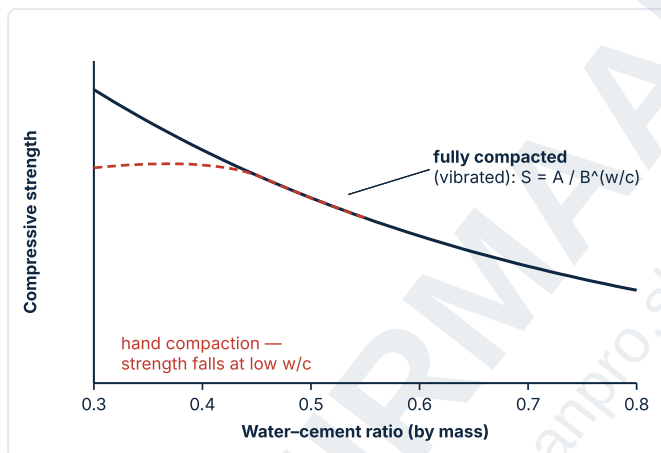
Water for concrete, w/c ratio laws, workability and its tests, segregation and bleeding, production and curing, strength and elastic properties, creep, shrinkage and durability (IS 456).

6.1 Water and the water–cement ratio

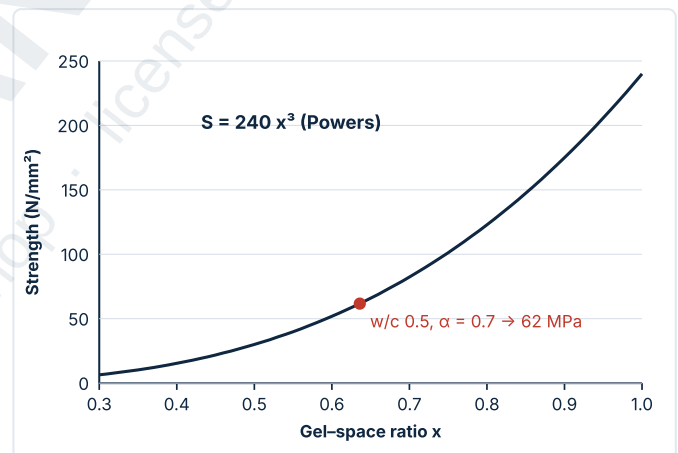
Water used for mixing and curing must be clean and free from harmful amounts of oils, acids, alkalis, salts, sugar and organic matter; **potable water is generally satisfactory** (IS 456 cl 5.4). Sea water must not be used for RCC or prestressed concrete.

- **IS 456 limits for mixing water:** pH ≥ 6 ; organic solids ≤ 200 mg/L, inorganic ≤ 3000 mg/L; sulphates (SO_3) ≤ 400 mg/L; chlorides (Cl) ≤ 2000 mg/L for PCC and ≤ 500 mg/L for RCC; suspended matter ≤ 2000 mg/L. Neutralising 100 mL of sample needs ≤ 5 mL of 0.02 N NaOH and ≤ 25 mL of 0.02 N H_2SO_4 .
- **Test with doubtful water:** 28-day cube strength ≥ 90 % of cubes made with distilled water, and initial setting time not to differ by more than 30 min.

Abrams' law: for fully compacted concrete made with given materials, strength depends only on the **water–cement ratio** — the lower the w/c, the higher the strength, provided the mix can still be fully compacted. **Powers' gel-space ratio** explains why: strength depends on how much of the space available is filled by cement gel.



Abrams' law — strength vs w/c ratio



Strength vs gel-space ratio

Abrams' law

$$S = \frac{A}{B^{w/c}}$$

A, B = empirical constants

Gel-space ratio (Powers)

$$x = \frac{0.657 \alpha}{0.319 \alpha + w/c}$$

α = degree of hydration (0–1)

Strength from gel-space ratio

$$S = 240 x^3 \text{ N/mm}^2$$

Cylinder vs cube strength

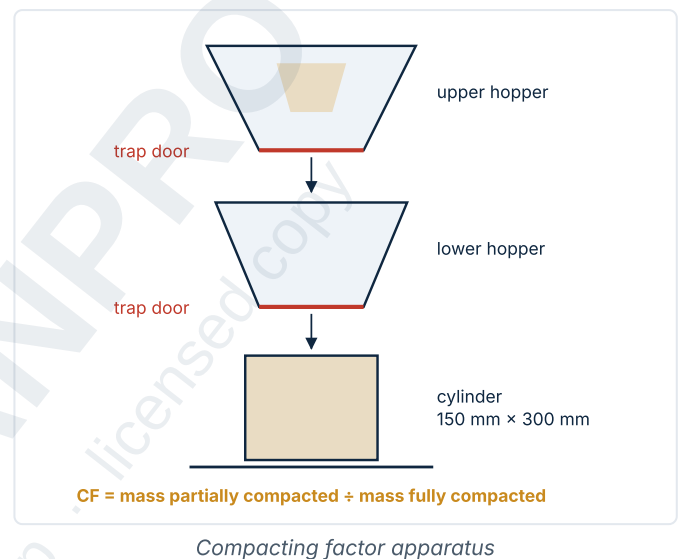
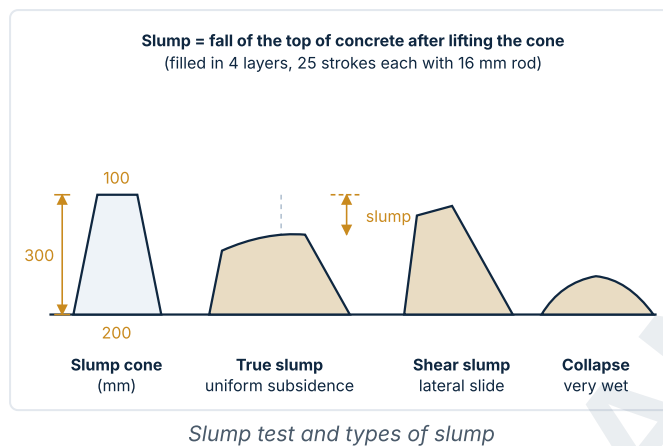
$$f_{cyl} \approx 0.8 f_{cube}$$

6.2 Workability and its measurement

Workability is the ease with which concrete can be mixed, transported, placed and fully compacted without segregation. It increases with water content, use of plasticisers, rounded and well-graded aggregate and higher paste content; it decreases with angular, flaky or porous aggregate, more fines, high temperature and time.

Workability for placing conditions (IS 456 cl 7)

Placing condition	Degree	Slump (mm)
Blinding concrete; shallow sections; pavements laid by pavers	Very low	See note (CF 0.75–0.80)
Mass concrete; lightly reinforced slabs, beams, walls, columns; floors; hand-placed pavements; canal lining; strip footings	Low	25–75
Heavily reinforced slabs, beams, walls, columns	Medium	50–100
Slipform work; pumped concrete	Medium	75–100
Trench fill; in-situ piling	High	100–150
Tremie concrete	Very high	Flow test (cl 71.2)



- **Slump test** (IS 1199): frustum 300 mm high, 200 mm bottom and 100 mm top diameter; for medium–high workability. A *shear* slump means lack of cohesion — repeat the test.
- **Compacting factor test**: concrete falls through two hoppers into a cylinder; suitable for low workability. CF ≈ 0.78 very low, 0.85 low, 0.92 medium, 0.95 high.
- **Vee-Bee consistometer**: time (s) to remould a slump cone of concrete into a cylinder by vibration — for very dry (very low workability) mixes; the *higher* the time, the *lower* the workability.
- **Flow table test** (spread after 15 jolts) for high-workability mixes; **Kelly ball** penetration as a quick field test.

Compacting factor

$$CF = \frac{W_p}{W_f}$$

W_p = partially compacted mass, W_f = fully compacted mass in the cylinder

6.3 Segregation, bleeding, production and curing

- **Segregation**: separation of coarse aggregate from mortar (or water from the mix). Causes: excess water, poor grading, dropping from height, over-vibration, long transport on rough roads. **Bleeding**: water rising to the surface after placing, leaving a weak, porous **laitance** layer and channels; reduced by finer cement, air entrainment, pozzolanas and proper grading.
- **Batching**: weigh batching (accurate, IS 456 recommends) or volume batching (allowance for bulking). **Mixing** in a mechanical mixer until uniform — generally at least 2 minutes.
- **Transport**: pans, wheelbarrows, chutes, buckets, transit mixers, pumps, conveyors — without segregation or loss of slump. **Placing** as near its final position as possible, in layers, without large free fall.

PART B

Compact Summary Notes

Building Materials & Construction

Illustrated one-page-per-topic revision sheets — read these in the last days before the exam, after studying the detailed notes in Part A.

Summary notes

page 50

10 pages of summary notes



Brick



Cement

BUILDING MATERIALS – Handwritten Revision Notes



Timber



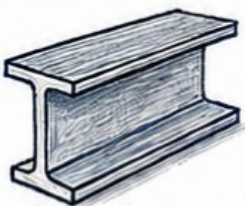
Stone

Properties • Manufacture • Classification • Tests • Key IS Values

Exam-ready compact notes

— CONTENTS (21 TOPICS) —

- | | |
|------------------------------------|-------------------------------|
| ① Properties of Building Materials | ⑫ Building Mortars |
| ② Structural Clay Products | ⑬ Ferrous Metals |
| ③ Rocks & Stones | ⑭ Non-Ferrous Metals |
| ④ Wood & Wood Products | ⑮ Ceramic Materials |
| ⑤ Cement | ⑯ Polymeric Materials |
| ⑥ Aggregates | ⑰ Paints, Enamels & Varnishes |
| ⑦ Water for Concrete | ⑱ Tar, Bitumen & Asphalt |
| ⑧ Lime | ⑲ Gypsum |
| ⑨ Pozzolanas | ⑳ Special Cements & Concretes |
| ⑩ Concrete | ㉑ Miscellaneous Materials |
| ⑪ Concrete Mix Design | |



Steel Section



Paint Brush



Concrete Cube



Aggregate



Bitumen

HOW TO USE THESE NOTES

- ★ Revise **headings** first to build overall understanding of each topic.
- ★ Remember important **formulas**, definitions and key **IS limits**.
- ★ Study **sketches, diagrams** and **manufacturing processes** carefully.
- ★ Use **quick-hit values** and tables for fast exam revision.



1. PROPERTIES OF BUILDING MATERIALS

- (1) **Bulk density (P_b)**: Mass of material / Total volume (including voids).

$$P_b = \frac{\text{Mass}}{V} \quad (\text{kg/m}^3)$$

- (2) **Density (Specific Gravity)**: Ratio of mass of material to mass of equal volume of water (at 4°C).

$$\text{Specific gravity} = G = \frac{M_m}{M_w} \quad (\text{dimensionless})$$

- (3) **Porosity (n)**: Percentage of voids in the material.

$$n = \left(\frac{V_v}{V} \right) \times 100 \quad \% \quad \begin{matrix} V_v = \text{volume of voids} \\ V = \text{total volume} \end{matrix}$$

- (4) **Density index (DI)**: Ratio of solid volume to total.

$$DI = 1 - \frac{n}{100} = \left(\frac{V_s}{V} \right) \times 100 \quad \%$$

- (5) **Water absorption**: Increase in mass due to water absorbed, expressed as % of dry mass.

$$\text{Water absorption (\%)} = \frac{M_{\text{wet}} - M_{\text{dry}}}{M_{\text{dry}}} \times 100$$

- (6) **Thermal conductivity (k)**: Ability to conduct heat. Low $k \rightarrow$ good insulator; High $k \rightarrow$ good conductor.

- (7) **Fire resistance**: Ability to withstand fire without losing strength or integrity.

- (8) **Weathering resistance**: Ability to resist action of sun, rain, wind, frost, chemicals etc.

- (9) **Strength**: Ability to resist applied loads without failure.

- (10) **Elasticity**: Ability to regain original shape after removal of load.

- (11) **Plasticity**: Ability of material to undergo permanent deformation without cracking.

- (12) **Ductility**: Ability to undergo large plastic deformation in tension before fracture.

- (13) **Brittleness**: Tendency to break suddenly with little or no plastic deformation.

- (14) **Hardness**: Resistance to scratching, abrasion or indentation.

- (15) **Toughness**: Ability to absorb energy upto fracture without breaking.

$\rightarrow$ Toughness = area under full stress-strain curve up to fracture.

- (16) **Resilience**: Ability to absorb energy within elastic limit and release it on unloading.

$\rightarrow$ Resilience = area under curve up to elastic limit only.

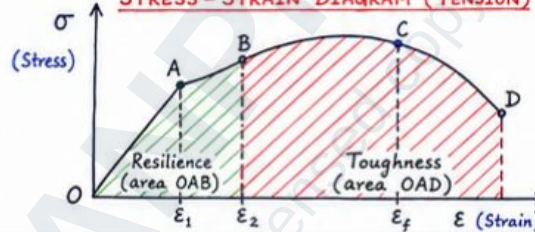
- (17) **Fatigue**: Failure under repeated or fluctuating loads which are less than ultimate strength.

- (18) **Creep**: Slow, progressive deformation under sustained load with time.

IMPORTANT FORMULAS (TENSION/COMPRESSION)

- Stress, $\sigma = \frac{P}{A}$ (Pa or N/m²) $\left\{ \begin{array}{l} P = \text{load (N)} \\ A = \text{cross-sectional area (m}^2\text{)} \end{array} \right.$
- Strain, $\epsilon = \frac{\delta L}{L}$ (dimensionless) $\left\{ \begin{array}{l} \delta L = \text{change in length (m)} \\ L = \text{original length (m)} \end{array} \right.$
- Elastic modulus (Young's modulus), $E = \frac{\sigma}{\epsilon}$ (Pa)
Higher $E \rightarrow$ stiffer material.

STRESS-STRAIN DIAGRAM (TENSION)



OA : Proportional limit
A : Proportional limit
B : Elastic limit
B-C : Strain hardening
C : Ultimate strength
C-D : Necking
D : Fracture point

ϵ_f = strain at fracture

2. STRUCTURAL CLAY PRODUCTS

A. CONSTITUENTS OF BRICK EARTH & THEIR FUNCTIONS

- Alumina (Al_2O_3) $\rightarrow$ Gives plasticity and strength.
- Silica (SiO_2) $\rightarrow$ Provides body; reduces shrinkage.
- Lime (CaO) $\rightarrow$ Acts as flux; aids burning but excess causes warping.
- Iron oxide (Fe_2O_3) $\rightarrow$ Gives red colour; acts as flux.
- Magnesia (MgO) $\rightarrow$ Improves vitrification and strength.

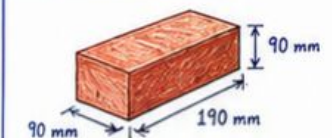
B. HARMFUL IMPURITIES

- Kankar / Lime lumps $\rightarrow$ Cause disintegration, cracks.
- Pebbles & gravel $\rightarrow$ Prevent proper moulding; cause breaks.
- Organic matter $\rightarrow$ Causes cracks, honeycombing, efflorescence.
- Iron pyrites (FeS_2) $\rightarrow$ Causes expansion and discolouration.

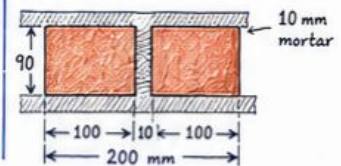
C. MANUFACTURE OF BRICKS (GENERAL)



E. BRICK (STANDARD)



- Standard modular size in India = 190 × 90 × 90 mm
- Nominal size with 10 mm mortar = 200 × 100 × 100 mm



D. KILNS (BURNING)

1. Clamp / Bhatta (Temporary)



- Cheapest method.
- Bricks stacked in open ground and covered.
- Poor control of temp. and quality.

2. Intermittent Kiln (Periodic)



- Bricks stacked in chamber.
- Fired batch by batch.
- More control; better quality than clamp.

3. Continuous Kiln (Continuous firing)

(a) Bull's Trench



(b) Hoffman Kiln



- Continuous supply & discharge.
- Fuel economy.
- High output & uniform quality.

F. PROPERTIES / TESTS OF GOOD BRICKS

- Compressive strength: ≥ 3.5 MPa
- Water absorption: $\leq 20\%$ by weight after 24 h immersion (First class bricks $\leq 15\%$)
- Efflorescence: Nil to moderate.
- Warpage: ≤ 3 mm in first class bricks.
- Hardness: No impression by fingernail.
- Soundness: Clear ringing sound when two bricks are struck.
- Structure: Homogeneous and compact; free from cracks and lime lumps.

G. OTHER CLAY PRODUCTS

- Terracotta**: Plain burnt clay products (tiles, pipes, jalis, plaques); porous; used in roofing, flooring, decoration.
- Earthenware**: Low-fired; porous; used for pottery, flower pots, water jars.
- Stoneware**: Higher fired; dense, strong, less porous; used for pipes, chemical jars, glazed ware.
- Porcelain**: Very high fired; dense, white, non-porous, translucent; used for sanitary ware, electrical insulators, tableware.

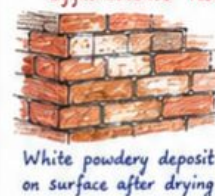
H. FIRE-CLAY BRICKS

- Made from fire-clay (high Al_2O_3).
- Refractories; withstand high temp. (1200–1600°C).
- Used in furnaces, chimneys, kilns, boiler settings, fireplace linings.



TESTS (QUICK CHECKS)

Efflorescence Test



White powdery deposit on surface after drying.

Ring Test



Clear metallic ringing sound $\rightarrow$ good brick.



End of the free preview

Building Materials & Construction

The full PDF has 59 pages:

Part A — detailed typed notes: 11 chapters, 45 pages

Part B — handwritten compact summary: 10 pages

Chapters in the full notes

- 01 Building Stones
- 02 Bricks and Clay Products
- 03 Lime
- 04 Cement
- 05 Aggregates and Mortar
- 06 Concrete Technology I — Fresh and Hardened Concrete
- 07 Concrete Technology II — Mix Design, Admixtures, Special Concretes and Quality Cont
- 08 Timber
- 09 Metals
- 10 Finishes and Miscellaneous Materials
- 11 Building Construction Essentials

Formula boxes with every symbol explained · IS / IRC code values in tables · labelled sketches
Worked examples step by step · exam tips & traps · quick revision points after every chapter

Get the full notes at nirmaanpro.shop

Shop → Notes & ebooks. Pay once, download instantly — no sign-up needed.