Chapter 35: Wall Finishes – Plaster: Types, Materials, Durability, Applications

Introduction

Wall finishes play a critical role in civil construction as they provide not only aesthetic enhancement but also protection to building surfaces. Among the various finishing techniques, **plastering** is one of the most commonly adopted methods for internal and external walls. Plaster serves to even out irregular surfaces, cover imperfections, and provide a base for decorative finishes like paint or wallpaper.

In civil engineering, understanding the **types of plaster, materials used, their durability, and applications** is essential to ensure quality, economy, and longevity of constructions. This chapter explores these aspects in technical detail.

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1. Types of Plaster

Plaster can be classified based on the **binder material used**, the **number of coats**, or its **application purpose**. The primary types include:

1.1 Lime Plaster

- **Composition**: Lime plaster is made from **slaked lime ($Ca(OH)_2$)**, **sand**, and **water**.
- **Properties**:
    - Breathable and allows moisture to escape.
    - Offers a traditional finish and is eco-friendly.
- **Applications**:
    - Suitable for heritage buildings and restoration projects.
    - Used in interiors for aesthetic and breathable surfaces.

1.2 Cement Plaster

- **Composition**: Mixture of **Ordinary Portland Cement (OPC)**, **fine aggregates (sand)**, and **water** in a ratio commonly of 1:3 to 1:6 (cement:sand).

- **Properties**:
  - Strong and durable.
  - Hardens quickly and has high resistance to wear.
- **Applications**:
  - Widely used in **modern buildings**, both for **interior and exterior surfaces**.
  - Serves as a base coat for painting or wall cladding.

1.3 Gypsum Plaster

- **Composition**: Processed gypsum (Calcium Sulfate Hemihydrate – $CaSO_4 \cdot \frac{1}{2}H_2O$).
- **Properties**:
  - Quick setting.
  - Smooth surface with good aesthetic appeal.
  - Fire-resistant and lightweight.
- **Applications**:
  - Best for **indoor applications**.
  - Used in **drywall systems**, **false ceilings**, and **internal wall finishes**.

1.4 Mud Plaster

- **Composition**: Natural clay, water, and sometimes reinforced with straw or cow dung.
- **Properties**:
  - Economical and eco-friendly.
  - Low strength and low water resistance.
- **Applications**:
  - **Rural constructions**, temporary structures, and **eco-friendly housing**.

1.5 Special Plasters

- **1.5.1 Waterproof Plaster**: Cement plaster modified with waterproofing additives.
- **1.5.2 Acoustic Plaster**: Contains perlite or vermiculite for sound insulation.

- **1.5.3 Decorative Plaster**: Includes stucco and textured finishes.

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2. Materials Used in Plaster

Each type of plaster requires a combination of **binders**, **aggregates**, and **additives** to achieve desired properties.

2.1 Binders

These act as the primary adhesive materials in plaster:

- **Lime** – White, soft binder used in traditional and breathable finishes.
- **Cement** – Offers strength, used in structural plastering.
- **Gypsum** – Provides a smooth, rapid-setting finish for interiors.

2.2 Aggregates

Aggregates like **sand** are used to reduce shrinkage and provide body to the plaster.

- Must be **clean**, **well-graded**, and **free of organic impurities**.
- Fine aggregates enhance workability and finish quality.

2.3 Water

- Must be **clean**, **potable**, and free of salts or organic matter.
- Water content affects **workability**, **curing**, and **setting time**.

2.4 Additives and Admixtures

Used to modify specific properties of plaster:

- **Plasticizers** – Enhance workability.
- **Waterproofing agents** – Improve resistance to moisture.
- **Retarders/Accelerators** – Control setting time.
- **Fibers** – Reduce cracking and improve tensile strength.

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3. Durability of Plaster

Durability of plaster is influenced by both **material quality** and **execution practices**.

3.1 Factors Affecting Durability

- **Material Proportions**: Improper ratios may lead to weak bonding or shrinkage cracks.
- **Workmanship**: Uneven application, poor curing, or contamination can reduce life.
- **Environmental Exposure**: Direct sunlight, rain, and moisture reduce durability, especially in external plaster.
- **Surface Preparation**: Dirty or unsound surfaces reduce adhesion.

3.2 Common Defects in Plaster

- **Cracks**: Due to thermal movement, shrinkage, or poor mix design.
- **Efflorescence**: White powdery salt deposits due to water movement.
- **Blistering and Peeling**: Caused by moisture trapped beneath the surface.
- **Hollowness or Debonding**: Often due to inadequate surface preparation.

3.3 Enhancing Durability

- Use **curing compounds** or proper water curing for cement plasters.
- Employ **expansion joints** to minimize cracking.
- Apply **primer coats** before finishing.
- Ensure use of **quality materials** and **skilled labour**.

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4. Applications of Plaster

Plaster is used across various **functional and aesthetic purposes** in construction.

4.1 Functional Applications

- **Surface Levelling**: Provides a smooth and even base.
- **Protection**: Shields structural members from weathering and moisture.
- **Sound Insulation**: Specialized acoustic plasters help in noise control.
- **Fire Protection**: Gypsum-based plasters resist high temperatures.

4.2 Aesthetic Applications

- **Decorative Moulding**: Used in cornices, ceiling roses, and panel designs.
- **Textured Finishes**: Trowel or brush techniques for architectural expression.
- **False Ceilings and Drywalls**: Pre-fabricated gypsum plasterboards.

4.3 Use in Different Building Types

- **Residential Buildings**: For both structural protection and interior beauty.
- **Commercial Complexes**: High-quality finishes with quick turnaround (e.g., gypsum plaster).
- **Heritage Structures**: Lime-based plasters for preservation.
- **Industrial Buildings**: Cement-based plasters with waterproofing for durability.

4.4 Application Techniques of Plaster

Correct application techniques are vital to ensure durability and appearance of plastered surfaces.

4.4.1 Surface Preparation

- Clean the surface of **dust, oil, and loose particles**.
- Moisten the surface before plastering to avoid absorption of water from the plaster.
- For **smooth concrete**, roughening or hacking may be needed for proper bonding.

4.4.2 Mixing of Plaster

- Use **mechanical mixers** for uniformity in large-scale works.
- Mixing ratio depends on plaster type:
  - Cement:Sand – commonly 1:4 or 1:6.
  - Gypsum plaster – mixed with water only.
- Mix only as much as can be applied within the setting time.

4.4.3 Application Process

- **Dashing Coat**: For rough surfaces, a slurry of cement is dashed on to improve bond.
- **First Coat (Scratch Coat)**:
  - 10–12 mm thick.
  - Scored with horizontal lines for better adhesion.
- **Second Coat (Brown Coat)**:

    - 5–8 mm thick.
    - Applied after initial coat sets; levels and flattens the surface.
- **Final Coat (Finishing Coat)**:
    - 2–3 mm.
    - Applied for aesthetics and smoothness.

4.4.4 Curing

- Essential for cement-based plasters.
- Curing should continue for **at least 7 days** to avoid shrinkage cracks.
- Gypsum plaster does not require curing.

4.5 Quality Control in Plastering Works

Ensuring quality during plastering is vital for performance and appearance.

4.5.1 Material Inspection

- **Cement** should be fresh (less than 3 months old).
- **Sand** must be free from clay, silt, and organic matter.
- **Water** must meet IS 456 standards for construction.

4.5.2 Field Quality Checks

- **Plaster thickness**: Measured using gauges or straightedges.
- **Surface flatness**: Checked with a straightedge and spirit level.
- **Plumb and alignment**: Verified using plumb bob and levels.
- **Bond Test**: Tap the surface; hollow sound indicates poor adhesion.

4.6 Testing of Plaster Materials and Work

Various **laboratory and field tests** are performed to ensure performance:

4.6.1 Laboratory Tests

Test	Purpose	Applicable To
Fineness Test	Determines fineness of binder	Cement, Lime, Gypsum
Initial and Final Setting Time	Evaluates setting characteristics	Cement, Gypsum

Test	Purpose	Applicable To
Compressive Strength	Strength of hardened plaster	Cement Plaster Cubes
Soundness Test	Ensures volume stability	Cement, Lime
Bulk Density	Measures material density	Aggregates

4.6.2 Field Tests

- **Ball Test for Gypsum**: A ball of gypsum plaster should hold shape and not disintegrate quickly.
- **Workability Test**: Ensures ease of application and finish.
- **Crack Monitoring**: Done visually after drying.

4.7 Comparison of Plaster Types

Property	Lime Plaster	Cement Plaster	Gypsum Plaster
Setting Time	Slow	Moderate	Fast
Strength	Moderate	High	Moderate
Curing Required	Yes	Yes	No
Crack Resistance	High	Low (if not cured)	High
Surface Finish	Good	Moderate	Excellent
Fire Resistance	Moderate	High	Very High
Cost	Low	Moderate	Slightly High
Best Use	Heritage works	Exterior walls	Interior walls & ceilings

4.8 Modern Innovations in Plastering

Civil engineering has witnessed modern advancements in plaster materials and application technologies:

4.8.1 Ready-Mix Plaster

- Factory-mixed dry powder available in bags.
- Ensures consistency, reduces on-site labour.
- Just add water and apply.
- Often contains polymers for added strength and flexibility.

4.8.2 Polymer-Modified Plaster

- Contains polymer emulsions.
- Offers higher **flexibility**, **adhesion**, and **crack resistance**.
- Suitable for renovation works and masonry repairs.

4.8.3 Machine Plastering

- Plastering machines spray a uniform layer on large wall areas.
- Enhances **speed** and **uniformity** of application.
- Reduces **labour dependency** and improves quality control.

4.8.4 Self-Healing Plaster

- Contains **microbial agents or encapsulated materials** that activate upon cracking.
- Still under research but shows promise for sustainable, low-maintenance structures.

4.9 Sustainable and Green Practices in Plastering

Sustainability in construction demands eco-friendly plastering techniques:

4.9.1 Low-Carbon Plasters

- **Lime plasters** absorb CO_2 during carbonation.
- Use of **fly ash** or **slag-based binders** reduces cement usage.

4.9.2 Waste Utilization

- Use of **recycled aggregates** from demolition waste.
- **Natural additives** (e.g., cow dung, jute fibers) in rural housing.

4.9.3 Energy-Efficient Alternatives

- **Clay plasters** reduce embodied energy.
- Use of **local materials** minimizes transport impact.

4.10 Case Studies on Plaster Applications

Case Study 1: Use of Gypsum Plaster in High-Rise Residential Complex – Mumbai

Project Overview:

- 35-storey residential tower in Andheri East, Mumbai.
- Objective: Reduce construction time and enhance interior finish quality.

Challenges Faced:

- Delays in conventional plastering due to curing time.
- Labour inefficiencies and inconsistency in manual application.

Solution Implemented:

- Switched to **gypsum plaster** for all internal walls and ceilings.
- Adopted **ready-mix gypsum plaster** with no requirement of sand or curing.

Outcome:

- **30% reduction in finishing time**.
- Superior finish achieved with less effort.
- Improved worksite cleanliness and safety due to dry application.

Case Study 2: Lime Plaster for Heritage Restoration – Jaipur Palace

Project Overview:

- Restoration of a 200-year-old palace facade in Jaipur.
- Requirement: Preserve architectural authenticity with breathable materials.

Challenges Faced:

- Cement plaster caused dampness and damaged old lime substrates.
- Need for material compatible with traditional construction techniques.

Solution Implemented:

- Removed cement coatings and reapplied **lime-sand plaster**.
- Employed artisans skilled in lime plastering.

Outcome:

- Heritage aesthetics preserved.
- Breathable lime plaster prevented moisture entrapment.
- Increased longevity of facade without further cracking.

Case Study 3: Cement Plaster with Waterproofing Additives – Coastal Housing Scheme, Kerala

Project Overview:

- Government low-cost housing near coastal areas of Kollam.
- Frequent rain and high humidity posed durability issues.

Challenges Faced:

- Early peeling of paint and dampness.
- Capillary water rise from foundations.

Solution Implemented:

- Used **cement plaster with waterproofing admixtures** on both sides of walls.
- Applied a **polymer-modified slurry** coat as a base.

Outcome:

- Walls showed **no efflorescence or flaking** after monsoon.
- Increased lifespan of interior paint and finishes.
- Reduced maintenance needs by over 50%.

4.11 Relevant IS Codes and Specifications

Understanding and applying relevant Indian Standards (IS) is essential for quality assurance in plastering works.

IS Code	Title / Use
IS 1661:1972	Code of practice for application of cement and cement-lime plaster finishes
IS 1542:1992	Specification for sand for plaster

IS Code	Title / Use
IS 712:1984	Specification for building limes
IS 2250:1981	Code of practice for preparation and use of masonry mortars
IS 9103:1999	Specification for admixtures for concrete (applies to plastering as well)
IS 2645:2003	Specification for integral waterproofing compounds
IS 2542 (Part 1 & 2):1978	Methods of test for gypsum plaster, concrete, and products

These codes guide **mix design**, **execution standards**, **material specifications**, and **testing procedures**.

4.12 Challenges and Limitations in Modern Plastering

Even with modern methods, plastering faces technical and operational constraints:

- **Shortage of Skilled Labour**: Inconsistent workmanship impacts surface quality.
- **Material Availability**: Good quality river sand is becoming scarce.
- **Environmental Regulations**: Restriction on wet curing in certain green projects.
- **Cost Escalation**: Polymer-based or machine-applied plasters can increase upfront costs.
- **Compatibility Issues**: Mixing different types (e.g., gypsum over cement) can cause debonding or cracks.

Mitigating these challenges requires **engineer supervision**, **site testing**, and use of **locally optimized solutions**.

4.13 Emerging Trends in Wall Plastering

Keeping pace with technology, the plastering industry is evolving through:

- **3D Printing in Plaster Application**: For artistic and automated wall textures.
- **Smart Plasterboards**: Embedded with sensors for temperature and humidity.
- **Nano-Modified Plasters**: Enhanced with nanoparticles for self-cleaning and antimicrobial surfaces.
- **Digital Quality Control**: Using **laser levels**, **drones**, and **AI-based surface scanners** to assess plaster finish and thickness.

These innovations promise **greater speed**, **precision**, and **sustainability** for future constructions.
