mortar industry association

Learning text part 12

mpa essential materials sustainable solutions

Properties of rendering mortar

Contents

Health and safety

All mortar mixtures, both wet and dry, are abrasive and alkaline. When working with wet mortar, waterproof or other suitable protective clothing should be worn. Guidance on the use of these materials can be found in MIA data sheet No. 20.

Introduction

Rendering mortar is an element of masonry construction and this learning text complements MIA learning text number 6, Masonry Mortar. Content includes how to specify rendering mortar and describes its various properties in the fresh and hardened state. Also included is an overview of rendered finishes, a glossary of terms and a bibliography, with the final section being self-assessment questions and answers.

Render

Render is a mortar consisting basically of cement and fine aggregate, usually together with lime or a plasticizer, applied to a wall surface, generally in two or more coats. When correctly matched with the background, the hardened render provides a durable, weather-resistant finish enhancing the surface of a building.

Rendering is a traditional craft that has evolved over many centuries. Originally wattle and daub was used to fill gaps in walls constructed from wood or stone, to minimise the ingress of wind and rain. A drawback of these early mortars was their inability to prevent water ingress, which was partially compensated for by having roof overhangs and adequate drainage at the base of the wall. The development of Portland cement led to a mixture of cement and sand being applied to the external walls of structures, both for protection and decoration. Historically, in some countries suitable indigenous facing materials have not been available to construct external walls and rendering has been used for this purpose. A walk around some UK towns and villages will provide testimony to the wide range of rendered finishes that may be produced.

Aesthetic fashions in the final coat of a rendering system have changed over the centuries and an examination of buildings with a rendered finish provides an interesting insight into construction history. The outer walls of the Colosseum in Rome were covered with stucco. Stucco or ashlar finishes are often to be found on town houses. Pebbledash and tyrolean finishes are both characteristic of more recently constructed properties, especially semi-detached houses built between 1920-1940.

A satisfactory render depends not only upon a knowledge of the properties of the constituent materials, but also on selecting suitable mix proportions so that the render is compatible with the background to which it is applied.

The two principal reasons for using a rendering mortar are:

- To provide a barrier to prevent rain from penetrating into the background masonry
- To enhance the appearance of a plain masonry structure.

An ideal rendering mortar should generally be slightly weaker than the background to which it is applied. This is also true in a multi-coat rendering system, where each successive coat should be no stronger than the previous coat. In practice this is frequently achieved by maintaining constant mix proportions, but using successively thinner coats. There are some specially formulated rendering mortars available that can be applied in a single coat.

Confusion sometimes arises over the use of the terms rendering and plastering. Rendering mortar is applied to external surfaces, plastering mortar to internal.

Specifying rendering mortar

The principles for specifying a rendering mortar are similar to those for specifying a masonry mortar, which are discussed in greater detail in the MIA learning text 6: Masonry Mortar. The specification of a rendering system should address:

- The nature and condition of the background (i.e., its strength and absorptivity).
- The nature and conditions of exposure
- The functional requirements
- The type of render
- The type of finish/appearance (eg, textured/smooth).

The properties of the background that should be considered include:

- Strength - strong backgrounds generally require relatively strong rendering mixes
- Mechanical key - some backgrounds have an inherently good physical key, others require a key to be provided
- Suction - the degree of suction can be a significant factor in achieving proper adhesion. It may be necessary to adjust this by pre-treatment or the use of admixtures
- Durability - some backgrounds are inherently durable while others such as wood rely on the render to provide the durability
- Resistance to damp penetration - many backgrounds are themselves resistant to moisture penetration while others rely on the render to provide this resistance. Additionally, some backgrounds can themselves be degraded by the effects of saturation.

National annex to BS EN 13914-1, entitled Design, preparation of external rendering and internal plastering - Part 1: External renderings, lists mixes suitable for rendering. Table 1 is based on this.

Table 2 (overleaf) lists recommendations for prescribed render mixes for different applications based on the advice in National Annex to BS EN 13914-1.

Table 1: ***Composition of rendering mixes***

Mix Designation	Cement: lime: sand	Ready-mixed lime: sand	Cement: ready-mixed material	Cement: sand using plasticiser	Masonry cement sand
i.	1:_:3	1:12	1:3	-	-
ii.	1:_:4 to 4_	1:9	1:4 to 4_	1:3 to 4	1:2_ to 3_
iii.	1:1:5 to 6	1:6	1:5 to 6	1:5 to 6	1:4 to 5
iv.	1:2:8 to 9	1:4	1:8 to 9	1:7 to 8	1:5_ to 6_
v.	1:3:10 to 12	1:4	1:10 to 12	-	-

Table 2: ***Applications of rendering***

Mix Designation	Rendering mix characteristics	Typical Backgrounds
i.	Strong, relatively impervious rendering with high drying shrinkage	Engineering bricks, in situ concrete, dense blocks
ii.	Moderately strong	Calcium silicate bricks, some facing bricks
iii.	Medium strength, greater permeability than Designation i mixes but less likely to crack and craze	Lightweight aggregate blocks, some common bricks
iv.	Moderately low strength	Autoclaved aerated concrete, some softer bricks
v.	Low strength	Weak materials in sheltered locations

Rendering is normally subjected to environmental exposure (eg, frost, wind, sun and rain). The location of the structure to which the rendering has been applied will also affect the ability of the rendering to withstand the environmental conditions. National Annex to BS EN 13914-1 provides details of an exposure classification system. The categories of exposure are based on a driving rain index and cover:

- Sheltered conditions. These are classified as areas of moderately low rainfall in which walls are protected from the weather by overhanging eaves and the close proximity of other buildings. Typical examples are ground and first storey buildings in urban areas
- Moderate conditions. This classification applies to walls partially protected from the weather by overhanging eaves and by adjacent buildings of similar height. Typical examples are to be found in many urban areas
- Severe conditions. This applies to walls, exposed to the weather but not located on hill or coastal sites
- Very severe conditions. Buildings that are exposed to the full force of wind and rain. Examples of this would be buildings on hill sites, near the coast and those projecting above surrounding buildings in built-up areas.

The compilation of a specification for rendering requires a number of factors to be taken into account. These include the characteristics of the substrate or background, the exposure conditions and the type of finish.

Properties of fresh rendering mortar

A fresh rendering mortar must have the ability to adhere to the background to which it is applied.

Workable life

This property is a measure of the length of time after mixing that the mortar remains workable. There are many ways of testing for workable life, but all rely on the assumption that it is taken to have been reached when a certain arbitrary laboratory test value has been attained.

The test procedure given in the BS EN 1015-9, is simple to carry out, although a laboratory facility is generally required. Although the time itself may not match exactly the time that a bricklayer might deem to be appropriate, it is nevertheless a reasonable compromise and represents a good way of comparing different mortars.

Air content

All factory-made mortars and many, but not all, site-made mortars, are air entrained. The use of air entrainment produces mortars that have much improved working properties in addition to being far more durable and resistant to the effects of freezing and thawing. Indeed, it is not recommended to use mortars for rendering that are not air entrained. This situation is reflected in current British and European standardisation.
The topic of air entrainment in mortars is dealt with in MIA learning text 4: Admixtures.

Properties of hardened rendering mortar

The properties required of a hardened rendering mortar are:

- Good adhesion
- Fitness for purpose (i.e. weatherproofing and appearance)
- Durability.

A rendering mortar does not attain its final characteristics until it has hardened after application. As previously stated, different exposure conditions require the use of rendering mortars with different properties and performance levels.

An undercoat must compensate for uneven surfaces of the background, provide uniformly moderate suction and good adhesion for intermediate and/or finishing coats. The final coat must act as the main barrier against rain penetration and provide a visually acceptable surface.

The thickness of an undercoat should be approximately 9-13mm. The final coat should be thinner than the undercoat. Using the same general principle, where three-coat work is undertaken, each successive coat should be no thicker and no stronger than the previous.

Differential drying, moisture and thermal movements greater than those occurring internally, lead to shear and/or tensile stresses between the background and renders or between coats. In persistently wet conditions, sulfates emanating from the masonry units or from the environment may attack Portland cement-based rendering.

Compressive strength

BS EN 998-1 lists four categories of compressive strength:

Table3: ***Compressive strength categories (BS EN 998-1)***

Category	Strength range N/mm²
CS i	0.4 - 2.5
CS ii	1.5 - 5
CS iii	3.5 - 7.5
CS iv	≥6

Compressive strength is determined in accordance with BS EN 1015-11. The stronger a rendering mortar is:

- The more impervious it is
- The more susceptible it is to cracking
- The greater its drying shrinkage

Rendering mixes with a lower strength are less liable to cracking and crazing.

Durability
To ensure a durable render, a number of factors have to be considered in its specification:

- The penetration of rain and rising damp
- Problems associated with soluble salts
- The corrosion of embedded metal
- Damage from abrasion and impact
- Crazing and cracking.

One of the principal functions of a render is to assist in the exclusion of water. If a render becomes cracked, rainwater can penetrate into the rendering system and may freeze during periods of cold weather causing partial disintegration. In addition, rain penetration may lead to adhesive failure between the render and the substrate. Render should not be applied to saturated walls as there is a high risk that it will become detached.

Capillary water absorption
A render should restrict the penetration of rain into the fabric of the building. Water ingress can be a serious problem because if the water freezes loss of adhesion to the substrate may develop. In sheltered and moderate exposure conditions a render conforming to the requirements of BS EN 998-1 with a capillary water absorption of Class W/1 or W/0 should be used. Where severe conditions of exposure exist, a render conforming to the requirements of BS EN 998-1 with a capillary water absorption Class W/2 should be used.

Water vapour permeability
BS EN 998-1 specifies that the water vapour permeability shall be determined for mortar used in external situations. The test is undertaken in accordance with the requirements of BS EN 1015-19 and determines the passage of water vapour through a specimen under standard conditions.

Thermal conductivity
The majority of rendering mortars have little direct effect upon the thermal transmittance of an external wall. This is due to the fact that only a thin coat of material is applied and the conductivity of the rendering mortar is relatively high.

However, it is possible to obtain thermal insulating mortars that have enhanced properties. BS EN 998-1 has created a category of designed mortar entitled thermal insulating mortar. This material is further classified into two classes T/1 and T/2 based on their thermal conductivity. Thermal insulating render may be applied in thicker coats than normal renders.

Fire resistance and combustibility
Cementitious external rendering is classified as non-combustible when the organic material content is less than 1%. Where the organic material is greater than that, the render should be tested and classified in accordance with BS EN 13501-1. A render contributes to the fire resistance of a wall, but generally no separate values are calculated for the rendering system.

Rendered finishes

Many types of finish can be produced, some of which are smooth while others are textured or mixed with coarse aggregate. The decision on the type of finish is generally based on serviceability and aesthetic merit. Local custom or tradition may favour a particular finish, but in some locations the degree of exposure or the type of background may restrict the choice. Due to the fact that rendering has evolved as a craft over hundreds of years, there are a wide variety of terms applied to finishes that can be produced. Some renders textbooks and guides classify rendered finishes into four types:

- Those applied with a trowel directly by hand
- Those thrown onto the wall and left in this state
- Those applied with a trowel and subsequently tooled or imprinted
- Those applied by machine.

However, this learning text discusses rendered finishes under six main headings:

- Smooth
- Scraped
- Textured
- Tooled
- Thrown
- Special ornamental

Smooth finishes
The final coat is smoothed by using a float. It should be remembered that a smooth finish may become somewhat drab as time progresses. A variation on this type of finish is to remove the surface matrix to expose the fine aggregate. Traditionally, some plain finishes were described as stucco finishes, which were generally painted.

Scraped finish
The aggregate is selected for its colour and grading and the render allowed to harden for a few hours. The surface is then scraped, sometimes with a float faced with a piece of expanded metal. This process removes some of the cement-rich surface and drags some of the coarser sand particles out of the matrix, whilst exposing others.

Textured finish
A plain, smooth finish can also be textured with a criss-cross pattern by scoring through the finished mortar using a straightedge, trowel or hacksaw blade. An alternative finish is to score the render to produce a stone block effect (ashlar finish). A stiff bristle brush can also be used to give a textured finish.

A texture that is popular in some areas is the so-called "English cottage" finish, which is achieved by hand texturing and produces a random rugged effect which looks old fashioned, hence the name. This type of finish may be seen in many English villages and contributes to the quintessential charm of the surroundings. The workmanship in producing this finish is unique in that application of the render begins at the bottom of the wall, while all the other types start at the top and continue downwards.

"Travertine" finish is achieved by incorporating rounded particles of approximately 5mm in size, which move under the wooden float to

produce a dragged or torn surface, said to resemble marble.

A textured finish gives greater protection against rain penetration and is less prone to cracking.

Tooled finishes
The hardened render can be tooled with a needle gun or by abrasive blasting to expose the aggregate.

Thrown finishes
Thrown finishes can be sub-divided into wet-dash and dry-dash.

A wet-dash finish is achieved by incorporating 6-14mm coarse aggregate in the final coat, with the mortar being thrown onto the wall and left untrowelled. The coarseness of the texture depends on the aggregate size and shape. This type of finish is known as roughcast in some parts of the country although traditionally in Scotland it is known as harling.

A dry-dash finish is where dry aggregates in the size range 6-14mm are thrown onto a freshly applied coat of mortar (often called a butter coat) and left exposed. The aggregate can be selected in combination with a pigmented mortar to give a range of colours. In some areas this type of finish is referred to as pebble- or spar-dash (dependent on particle characteristics).

Special ornamental finishes
Although most renders are to some extent ornamental, special techniques or materials may be used to accentuate visual features.

A variety of impressions can be made in freshly applied rendering using profiled tools or the base of bottles. This type of finish is called pargeting in some areas, the word being derived from medieval English and meaning "ornamental plasterwork".

A "Tyrolean" finish is a proprietary finish, which is supplied in a number of colours and applied as thrown material, where a machine is used instead of hand application. This type of finish cab be sanded down with a carborundum stone to produce a rubbed "Tyrolean" finish. Render may also be applied by spraying. The texture obtained will depend primarily upon the render material used and the type and size of spray nozzle.

General

Metal lathing and expanded metal
When applying rendering to steel- or timber-framed structures or to other surfaces which provide an unsatisfactory bond/key (eg, friable masonry or unsound renderings), support can be provided by metal lathing. To minimise the risk of corrosion, the lathing may be initially coated with a workable cement rich mix, although a preferable alternative is to use stainless or zinc-coated steel.

Curing
In common with all cementitious materials, adequate curing is essential to allow the strength of the render to develop. Fresh rendering should be protected from the effects of drying winds and wind funnelling and from direct sunlight.

Fibres
Many ancient rendering mortars incorporated animal hair. The inclusion of fibres in a mix improves toughness and impact resistance.

Polymers
Polymer dispersions may be incorporated in rendering mixes to improve bond strength, resistance to rain penetration and durability. Care should be taken to utilise only those polymers that are known to be suitable for external use.

New developments

Organic binders
BS EN 15824 is the standard applicable to factory-made rendering/plastering products based on organic polymer binders. These products are classified according to:

- The chemical nature of the principal active binder
- The type of finish obtained
- The properties and/or use.

Organic binders can be applied by brush, roller, trowel, spray machine or other special tools.

External thermal insulation composite systems (ETICS)
External thermal insulation composite systems (ETICS) are popular in some parts of continental Europe. The system consists of prefabricated insulation products, which are bonded and/or mechanically fixed onto external walls. The insulation is faced with a rendering of one or more layers, one of which contains reinforcement, The rendering is applied to the insulating panels without any air gap. ETICS are designed to give walls superior thermal insulation.

Glossary of Terms

Adhesive strength (bond strength)
The maximum adhesive strength of a mortar applied onto a substrate, which can be determined by a shear or tensile strength test.

Ashlar finish
A plain rendered finish scored to simulate stone blocks.

Butter coat
The soft final coat to which the aggregate is applied in dry-dashing.

Crazing
Cracking of the surface layer into small irregular shaped contiguous areas.

Final coat
Ultimate coat of a multicoat rendering system.

Lathing
Mesh which when fixed to a background provides a key for rendering and in some cases support and stability.

Rendering coat
A layer applied in one or more operations or passes with the same mix, with the previous pass not being allowed to set before the next one is made.

Rendering mortar
Mortar, which is applied in the fresh state to an external wall or other surface and which hardens after application.

Rendering system
A sequence of coats applied to a background which can be used in conjunction with a support and/or reinforcement and/or a preparatory treatment.

Renovation render
Designed render for use on moist backgrounds containing water soluble salts.

Stucco
A smooth external rendering with a painted finish.
Surface coat
See Final coat

Thermal conductivity
A measure of the rate of heat transfer through unit thickness and area of material and from face to face. The thermal conductivity (k) of a material is technically defined as the quantity of heat that passes through $1m^2$ of the material of 1m thickness for 1^oC difference in temperature of the inner and outer surface. The units used to measure thermal conductivity are W/mK where W represents Watts and K represents Kelvin.

Thermal insulating mortar
A designed mortar with specific thermal insulating properties.

Thermal resistivity
The resistivity of a material is a measure of resistance to heat flow through unit thickness and is the reciprocal of the conductivity value (i.e. 1/conductivity).

Thermal transmittance
Thermal transmittance (U value) is the rate of heat transfer through a construction from air to air and is the reciprocal of the sum of all the thermal resistances offered by a construction (i.e. all the components).

Undercoat
Bottom layer or layers of a render system

Bibliography

BS EN 13501-1:2007 Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests, excluding ventilation services.

BS EN 13914-1:2005 Design, preparation and application of external rendering and plastering - Part 1: External rendering.

BS EN 15824Specifications for external renders and internal plasters based on organic binders

Good Concrete Guide 3: Rendering A practical handbook (Bill Monks published by the Concrete Society).

BRE Digest 410 Cementitious renders for external walls.

Self-assessment questions

1 What standard is applicable to rendering mortar?

A _____

_____

2 What type of finish is a stucco finish?

A _____

3 What is the principal difference between a dry-dash and a wet-dash finish?

A _____

_____

4 What are the principal functions of a rendering mortar?

A _____

5 Complete the following:
i) A plastering mortar is applied to _____

_____

ii) A rendering mortar is applied to _____

_____

6 What is English cottage?

A _____

7 Above what level of organic content does a mortar have to be tested for reaction to fire?

A _____

8 In a two-coat rendering system what should be the approximate thickness of each coat?

A _____

9 What are the two main properties measured in a rendering mortar?

A _____

10 What parameters are exposure classes based on?

_____

Answers to self-assessment questions

1 BS EN 998-1 (Specification for mortar for masonry - Part 1: Rendering and plastering mortar).
2 A plain rendered finish, which is generally painted.
3 In a wet-dash finish the aggregates are part of the mix, in a dry-dash the aggregates are applied while the final coat is still plastic (fresh).
4 To provide a barrier to the ingress of water and wind. To provide a decorative surface.
5 i) A plastering mortar is applied to an internal wall or other surface.
ii) A rendering mortar is applied to an external wall or other surface.
6 A textured rendered finish, in which the render is applied to the walling from the bottom upwards.
7 1% organic content. Undercoat 9 - 13mm.
8 Final coat Less than the above.
9 Workable life and air content.
10 Driving rain index.

MIA Learning Texts include:

1 Introduction to modern mortars
2 Cementitious materials
3 Aggregates
4 Admixtures, additives and water
5 Brick and block production
6 Properties of masonry mortar
7 Production, delivery and storage of mortar
8 Mortar testing
9 Specifications
10 Quality assurance
11 Construction
12 Properties of rendering mortar
13 Best practice - potential site problems

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The Mortar Industry Association is part of the Mineral Products association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries

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There is a real danger of contact dermatitis or serious burns if skin comes into contact with wet mortar. Wear suitable protective clothing and eye protection. Where skin contact occurs either directly or through saturated clothing was immediately with soap and water. For eye contact immediately wash out eyes thoroughly with clean water. If swallowed wash out mouth and drink plenty of water.

The relevant codes of practice, standards and statutory regulations must always be observed.