Learning Text

Part 11

Construction

Contents

Introduction

This learning text considers the subject of good site practice and the factors that need to be considered to ensure that the mortar supplied by MIA member companies is correctly handled and used on the construction site. Recommendations are given for the procedures to be followed for the laying and protection of masonry in adverse weather conditions. It also discusses the practical appreciation and experience of the use of mortars to ensure desirable appearance and performance. This text considers all of these issues and also takes into account some of the important health and safety aspects applicable to the handling, storage and use of mortars on building sites. A glossary of terminology and bibliography are included . The final section of this learning text is self-assessment questions and answers.

Mortar is one of the most basic elements of masonry construction. However, in order to achieve excellent brick and blockwork, a thorough knowledge of good site practices and a trained and skilled workforce is required. The influence of site practice and procedures on the final properties of mortar is profound. The appearance, mechanical properties and even the durability are greatly affected by site operations. Correct practice is needed throughout all of the stages from storage through to use and final protection throughout the construction process. Even when the work is finished the influence of some construction practices may still be considerable.

Learning Text number 5 (Brick and Block Production) deals with the production of the components used in masonry construction.

Site Practices and Requirements

Preparing and Building Reference Panels

Prior to the commencement of a masonry project where final visual appearance of the masonry is important, it is necessary to construct an initial (trial) panel or panels of brickwork or blockwork. This is because the assessment of characteristics using the eye as opposed to using test equipment which yields quantifiable results that can be assessed against an objective measurable specification requirement may be subjective. In order to remove this subjectivity and appraise the work objectively, it is recommended that reference panels be constructed. It is important to realise that, throughout the duration of a contract, minor variations may occur in the consistency of the bricks and mortar with regards to colour and surface texture. The use of reference panels will ensure that variations in appearance are within acceptable limits.

These panels should be built in close proximity, on a level firm base, where they can be viewed for comparison in the same lighting conditions. The distance from which the panels and the subsequently constructed masonry work are to be appraised should be agreed in order that comparison may be made on a like for like basis and to preclude the possibility of excessively close inspection that would not accurately reflect the distance and conditions under which the finished structure is to be viewed.

The panels should also be constructed in an area that is dry, and where they will be protected from damage and saturation for the duration of the contract. At least 100 bricks, that are representative of the average quality of the total order to be supplied, should be used for the panels. These should also incorporate the required joint profiles, mortar designation and colour. Care should be taken to ensure that the quality and standard of workmanship is of a level that may be maintained in practice throughout the duration of the contract.

Handling, Storage and Protection of Bricks and Blocks

Areas should be allocated and prepared for the storage of bricks and blocks by providing a clean, firm, level surface. Immediately on receipt of a consignment, delivery tickets should be checked against site specifications. Where colour is an important requirement packs of bricks and/or blocks should be mixed in usage to ensure that any colour variations are within acceptable limits. In addition, it may be necessary to check for dimensional accuracy and in this respect the reference panels may provide a useful basis for comparison.

Bricks and blocks should be off-loaded onto the hard-standing surface, leaving banding and packaging in place to avoid damage such as chipping, soiling or breakage. Deliveries to site should also be protected from rain and splashing by vehicles.

Transportation of Mortars

The two main types of mortar delivered to sites are "Wet ready-to-use" and "Dry ready-to-use".

Wet ready-to-use mortar is often delivered in truckmixers and requires no further mixing upon arrival on site. The material is discharged from the vehicle into purpose-made mortar tubs. For deliveries, tubs should always be positioned at a level point, which has adequate access for the delivery vehicle and will allow appropriate distribution throughout the site.

Dry ready-to-use mortar is delivered in silos or bulk bags, requiring only the addition of mixing water. The silo (which may be partially filled with dry mortar) complete with integral mixer is delivered to site on purpose built trucks. The producer fills the silo with dried mortar using dedicated vehicles and when power and water supplies are connected, mortar can be produced as required. Once mixed, the material is then discharged into mortar tubs for site distribution.

Where filled tubs are required to be lifted they may have specially designed handles, lugs or other features to facilitate movement by crane, forklift or other mechanical lifting aid. It is important to note that tubs should not be overfilled or used to convey any material other than mortar. Furthermore, transport by cranes or other mechanical lifting devices should not take place without first ensuring that all of the health and safety implications have been properly considered.

Checking Deliveries of Mortars

Immediately on receipt of a consignment of mortar, check the delivery tickets against the site specifications to ensure that the material is of the correct mortar type, colour (if applicable) and quantity.

Storage of Mortar

Space on construction sites is often limited, especially in urban areas. Therefore it is important to allocate and prepare areas for the storage of mortar as described in the following section: Wet ready-to-use mortar normally contains a set-retarding admixture, which results in the mortar remaining fully useable for a specified period, generally two or three working days. In order to avoid any contamination and resultant loss of retardation it is essential that tubs are completely emptied, thoroughly cleaned and lined with polythene (where provided) before fresh mortar is delivered. The 'topping up' of tubs should not be allowed.

Wet ready-to-use mortars should be stored on level, dry areas at a safe distance from other trades and site traffic. When not in use the material should be kept in covered tubs to prevent:

- Saturation caused by rain.
- Excessive drying out during warm weather.
- Freezing during frosty weather.

Retarded ready-to-use mortars should not be stored for longer than the manufacturer's quoted period of retardation.

The silos for the storage and mixing of the dry ready-to-use mortar should be located on a firm level base, constructed preferably of concrete or a well-compacted hard standing. Access should be allowed around the silo for the removal of mixed mortar. When a delivery is expected, clear unobstructed access is required. Furthermore, the positioning of the silo and the 'top up' delivery point should be located as close together as possible. This will minimise the delivery time and maximise the mixer output. Silo systems make it possible to store products vertically on a limited area of ground with protection of the product against the weather.

With regard to current health and safety guidance as discussed on page 10 concerning the occurrence of allergic contact dermatitis a reducing agent is added to cement at the grinding stage, this chemical has a limited period of effectiveness therefore it is important that any material containing cement is used within the stated use by date.

Summer and Winter Working

The ability to continue masonry construction in both hot and cold weather conditions requires consideration as to how these conditions may affect the quality of the finished masonry. In some cases, extreme weather conditions may warrant the use of special construction techniques or protective measures to ensure that the masonry work is not adversely affected.

Summer Working

Laying masonry units

The primary concern to the masonry contractor during hot weather is the evaporation of water from the mortar. If sufficient water is not present, the bond between the mortar and masonry unit may be reduced. However, the effects of high temperatures are not as damaging to the

performance of the masonry as those of low temperatures. The increased rate of hydration of the cement and favourable curing conditions in warm, humid weather will help develop masonry strength if sufficient water is present at the time of construction.

Masonry units-good practice

The bricks and blocks that are used in masonry construction are generally affected little by hot weather. However, the interaction between these materials and the mortar is critical, as warmer bricks and blocks will generally absorb more water from the mortar. Therefore, during periods of hot weather, the temperature of the materials should be controlled for best results. Storing bricks and blocks in the shade or under cover will help control heat gain. Furthermore, reducing the suction rate of bricks and blocks by spraying or docking with potable water may be necessary in extremely hot and drying conditions, but care should be taken to avoid excessive wetting and the manufacturer's advice should first be sought. The effect of windy drying conditions may also have to be considered.

Lower bond strength may potentially result if there is an incorrect amount of water present in the mortar when the units are laid. Excessively wet or excessively dry extremes are undesirable. Furthermore excessive water loss shortly after laying should be avoided. This may potentially occur when there are hot drying weather conditions or when the units being laid have a high suction rate.

Mortar-good practice

In hot weather mortar will tend to lose its plasticity more rapidly due to evaporation of the water from the mix and the increased rate of hydration of the cement. Mortar mixed at high temperatures may have a higher water content, a lower air content, and a shorter board life than those mixed at normal temperatures, unless compensatory measures are taken. Therefore, mortar with a high lime content and high water retention characteristics is sometimes considered for use in these conditions.

In hot summer conditions, materials and mixing equipment should be shaded from direct sunlight prior to use. Mortar tubs and mortar boards should be rinsed with cool water before they come into contact with mortar.

Protection of masonry

Under hot, dry and windy conditions, bricks and blocks should be laid more rapidly after placing the mortar. Following final tooling it may be necessary to protect newly erected masonry against excessively rapid drying by the provision of protection, sheeting, shading or similar.

Winter Working

Laying masonry units

Hydration and strength development in mortar generally occurs at temperatures of greater than about 4°C. This means that when the temperature at the time of laying is less than about 4°C, the characteristics of the mortar may be affected. Consequently, masonry construction should

be discontinued when the air temperature falls below 3°C, unless the mortar temperature can be maintained at a minimum of 4°C until it has hardened; this may necessitate working in heated enclosures. If suspended laying may be resumed when the air temperature rises to 1°C and is expected to continue rising to above 3°C over the bricklaying period.

Masonry units-good practice

All stocks of bricks and blocks should be adequately covered to provide protection against rain, frost and snow. Bricks or blocks that are saturated should not be laid, nor should they be when there is a danger of freezing.

Mortar-good practice

Mortar stored in containers should be adequately covered to provide protection against rain, frost and snow. During prolonged periods of very cold weather, it is best practice to protect containers storing mortar.

If mortar freezes during storage, remove and discard any frozen material prior to use of the remainder. Do not use mortar that contains ice particles or lay mortar on frozen surfaces. The inclusion of anti-freeze agents for masonry mortars is not generally recommended, as these admixtures are not recognised in any British or European Standard.

Masonry-good practice

As mortar hardens and develops strength more slowly in cold weather, all newly erected masonry, and masonry under construction, should be covered to provide protection against rain, frost and snow. Unless the work is protected there is always the risk that the water in the mortar and masonry units will freeze with the consequent possibility of damage to the masonry such as loss of bond or joint spalling and disintegration.

Newly erected brick and block masonry should be covered to protect it from extremes of weather, and at all times when work is not proceeding. If there is any danger of the work being frozen, then consideration should be given to the use of insulating covers. Furthermore, ensure that any insulating layer, e.g. hessian or quilting, is kept dry by covering with plastic sheeting or other waterproof material. Position protective covers away from masonry facework to avoid "sweating" and consequent staining. Secure the covers to prevent them from being dislodged by wind on exposed sites, and allow the masonry to dry out before removing the covers.

Workmanship

Basic Laying Techniques

The correct mortar mix should be used at the right consistence and the material applied with a bricklayer's trowel. The brick or block should be placed as accurately as possible into its final position, but may need to be adjusted very slightly by light tapping to achieve the accurate final line and level. Unless otherwise specified, bricks and blocks should be laid on a full bed of mortar and cross-joints should be filled. Horizontal joints should be kept level, and to a uniform thickness, perpendicular joints should line up vertically. Alignments both horizontal, vertical and ranging should be checked using a spirit level.

After the unit is positioned the excess mortar should be struck off with the trowel leaving the joints flush and laying then continued. Once the bricks or blocks are in place, and the mortar has begun to stiffen, the units should not be adjusted further as the adhesion of the mortar may be impaired and the rain resistance and stability of the wall affected.

Where final appearance is important care should be taken to avoid getting mortar on the outer face of the wall. Where fresh mortar splashes do occur, it is best to allow these to dry off before brushing. Furthermore, in order to achieve a uniform appearance throughout the building, and to avoid the possibility of patches or bands of differing shades, bricks should generally be used from a minimum of three packs at the same time. The placing of bricks from one pack, in one section of the wall only, should be avoided.

Jointing

Correctly filled and tooled joints enhance the appearance of masonry and have a considerable effect upon the durability and weather resistance of walls. Mortar joints should therefore be of uniform thickness, and it is generally accepted that a nominal 10 mm joint be used in order to ensure optimum performance.

After placing bricks and blocks on a bed of mortar, the optimum length of time should be established between laying the units and finishing the joints; for example, until such time as the mortar has stiffened to the point of resisting an "easy thumbprint". If joints are tooled too soon, or too late, bond strength may be compromised and the subsequent appearance made more variable.

Tooling of the joints tends to assist in bringing the mortar and units into close contact. The four principle joint profiles generally used for brick and block masonry are:

Flush: This profile is suitable for moderate and sheltered exposure. No attempt is made to iron the joint surface, resulting in an open texture. The bond between the mortar and units is dependent upon the skill used during the unit laying. This type of joint has the potential to produce a uniformly coloured and textured appearance.

Struck or Weathered: When used with the appropriate mortar this profile is suitable for every degree of exposure. The surface of the mortar is closed by ironing and inclined to the lower edge to shed off water. The ironing produces a good bond between the mortar and units. Masonry constructed with this joint type requires good workmanship to obtain a uniform colour and texture.

Bucket Handle: This profile is also potentially suitable for every degree of exposure. The surface of the mortar is closed by ironing and the curved profile tends to allow water to run from the face. The ironing produces a good bond between the mortar and units. The use of this joint type requires good workmanship to obtain a uniform colour and texture.

Recessed: This profile is only suitable for sheltered, and moderate exposure. A tool should be used to rake the joint to a consistent depth. Deep raking should be avoided and should never be more than half way between the face of a unit and its perforations. Consideration should be given prior to using recessed joints in applications where durability is critical, such as exposed

and costal environments. This type of joint has the potential to produce excellent uniformity of colour and shade.

The following illustrate the types of profiles discussed:

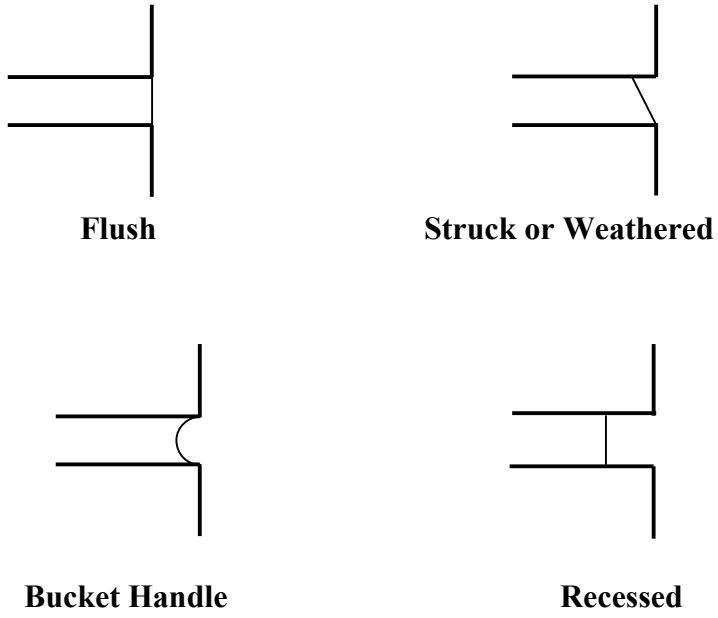

Figure 1: Joint types

Protection of Newly Constructed Masonry

Suitable protection is desirable to protect newly erected masonry against extremes of weather, both in winter and summer conditions, which can affect the appearance and sometimes even the integrity of the mortar. Generally adequate curing is achieved without recourse to special measures, although in very hot and/or drying conditions some protection may be necessary to provide protection against premature drying (as discussed earlier). Covering the masonry with polyethylene may be desirable in some circumstances and where adopted this protective measure will prevent damage to freshly completed masonry from:

- Frost damage.
- Excessive evaporation of moisture.
- Fine particles of cement, lime or pigment being washed out during periods of rain.

The polyethylene should remain in place until the mortar has fully hardened. Any damaged polyethylene should however be removed and replaced as soon as possible.

Health and Safety on Site

Mortar is a potential hazard on construction sites. Dry mortar dust, both airborne and in contact with the skin, can present a health hazard, as can mortar in a wet state. With sensitive skins, burning can take place very quickly and all users should be fully aware of the hazards and of the precautions necessary. A particular danger is trapping of dust or splashes, e.g.

around the top of boots, where injury is exacerbated by abrasion and rubbing.

When the cement in mortar is mixed with water an alkaline solution is produced. If this comes into contact with the eyes or skin it may cause burns and ulceration. The eyes are particularly vulnerable and the degree of damage will increase with contact time.

Strong alkaline solutions in contact with the skin tend to damage the nerve endings first before damaging the skin; therefore chemical burns can develop without pain being felt at the time. Mortar mixes may, until set, cause both irritant and allergic contact dermatitis:

- Irritant contact dermatitis is due to a combination of the wetness, alkalinity and abrasiveness of the constituent materials.

- Allergic contact dermatitis is caused mainly by the sensitivity of an individual's skin to hexavalent chromium salts.

First Aid Measures

Eye contact

Wash eyes immediately with plenty of clean water for at least 15 minutes and seek medical advice without delay.

Skin contact

Wash the affected area thoroughly with soap and water before continuing. If irritation, pain or other skin trouble occurs, seek medical advice. Clothing contaminated by wet mortar should be removed and washed thoroughly before use.

Ingestion

Do not induce vomiting. Wash out mouth with water and give plenty of water to drink.

Dust inhalation

If irritation occurs, move to fresh air. If nose or airways become inflamed seek medical advice.

Cleaning Procedures in the Event of Spillage

Recover the spillage in a dry state if possible. Minimise generation of airborne dust. The product can be made into slurry by the addition of water but will subsequently set as a hard material.

Storage and Handling

Storage

Mortar containers and silos should be stored in a safe and stable manner.

Handling

When handling mortar due regard should be paid to the risks. Direct contact with the skin and eyes should be avoided and the appropriate personal protective clothing used.

Personal Protective Equipment

Hand and skin protection

Protective clothing should be worn which ensures that dry or wet mortar does not come into contact with the skin. Particular care should be taken to ensure that wet mortar does not enter the boots and individuals do not kneel on the wet mortar so as to bring the material into contact with unprotected skin. Should wet mortar get inside boots, gloves or other protective clothing then this protective clothing should be immediately removed and the skin thoroughly washed as well as the protective clothing/footwear.

Eye protection

Protective dust-proof goggles should be worn wherever there is a risk of dry or wet mortar entering the eye.

Short-term effects

Eye contact

Mortar is a severe eye irritant. Mild exposures can cause soreness. Gross exposures or untreated mild exposures can lead to chemical burning and ulceration of the eye.

Skin

Mortar may cause irritant contact dermatitis, allergic (chromium) dermatitis, and/or burns.

Ingestion

The swallowing of small amounts of mortar is unlikely to cause any significant reaction. Larger doses may result in irritation to the gastro-intestinal tract.

Inhalation

Dry mortar powder may cause inflammation of mucous membranes.

Glossary of Terms

For the purpose of this learning text, the following terms and definitions apply:

Admixture	Material added in small quantities during the mixing process to modify the properties of the mortar in the fresh and/or hardened state.
Air content	The quantity of air contained in a mortar.
Bond	Adhesion between masonry unit and mortar.
Course	Single layer of masonry units in uniform height, including the bed joint.
Docking	The practice of briefly immersing bricks in water prior to laying. This practice both removes adhering material (dust) from the brick and reduces absorption.
Dry mortar	Material produced in a factory and delivered to site in silos or bags and requiring only the addition of water.
Durability	The resistance of a mortar to adverse chemical, mechanical and climatic conditions.
Hexavalent Chromium	Chromium (VI) is the water soluble chrome ion that is produced during the processing of raw materials and manufacture of Portland cements.
Ironing	An alternative name used in some parts of the country for rounded or tooled pointing. This type of pointing has the advantage of the mortar being well pressed into the joint making it denser.
Jointing iron	A tool usually made from an old bucket handle or other suitable material.
Masonry	Construction of bricks or blocks.
Masonry unit	Brick or Block.
Mortar	Mix of one or more inorganic binders, aggregates, water, and sometimes additives and/or admixtures.
Mortar joint	Joint between masonry units filled with mortar.
Perforation	Void that passes through a masonry unit.
Plasticity	The cohesiveness and ease of spreading of a mortar.

Construction

Reference panel	Panel of masonry erected and retained on a building site, used to establish the visual acceptability of materials and workmanship to be maintained during construction.
Retarded mortar	Wet ready to use mortar containing a cement set retarder.
Set	The stiffening of a mix caused by the hydration of cement.
Spalling	Separation of a fragment from a surface.
Suction	The property of a substrate, which influences its rate of absorption of water.
Unit absorption	The amount of water a brick or block absorbs.
Water retention	The ability of a fresh mortar to retain its mixing water when exposed to substrate suction.
Workability	The overall properties of a fresh mortar which influence its suitability for a particular application e.g. consistence, cohesion.

Bibliography

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Self-assessment Questions

1	What is the reason for constructing Reference Panels on site?
2	When placing bricks, why is it important to use a minimum of three packs at the same time?
3	Name the four principle joint profiles generally used for brick and block masonry.
4	Above what temperatures does hydration and strength development in mortar generally occur?
5	Name the skin condition that can be caused by contact with fresh mortar mixes.
6	Why is it important to protect freshly completed masonry?
7	Mortars mixed at high temperatures may display what three characteristics when compared to mortar mixed at normal temperatures?
8	When the cement in mortar is mixed with water, what sort of solution is produced and what effect can it cause when in contact with the skin and eyes.
9	Why is it important to check deliveries of mortar against site specifications?
10	What three methods are used to transport mortars to site?

Answers to Self-assessment Questions

1	Reference Panels are constructed to establish the visual acceptability of materials and workmanship to be maintained during construction.
2	To avoid the possibility of patches or bands of differing shades.
3	Struck or Weathered, Bucket Handle, Flush and Recessed.
4	Hydration and strength development in mortar generally occurs at temperatures above 4°C.
5	Irritant and allergic contact dermatitis.
6	This protects masonry from, frost damage, excessive evaporation of moisture, cycles of wetting and drying and particle wash out.
7	Higher water contents, lower air contents and a reduced board life.
8	A strong alkaline solution that may cause serious burns and ulcerations.
9	To ensure that the mortar is of the correct mix type, colour and quantity.
10	Truckmixers, silos and bulk bags.