## Mortar - An Introduction

This Guidance is applicable to all block types from the Lignacite range. The selection of mortar for an application is very important and should take into consideration structural requirements, the type of construction, position in the building and degree of exposure.

## Guidance

Guidance for the specification of mortar for durability can be assessed in accordance with Published Document PD 6697. This provides recommendations for the quality of masonry units and mortar designations for various conditions of use, such as work below or above the external ground level.

Mortars can be specified as design mixes (Strength Performance) or prescribed mixes (Recipe). Mortars can be either factory made or mixed on site. Traditionally, prescribed mixes have been used in the UK and have a proven durability. Design mixes are likely to be increasingly used as a result of designing masonry to the Eurocode.

Where coloured mortars are specified, to avoid inconsistencies, it is advisable to use dry silo mortar or alternatively, retarded ready-to-use mortars.

Eurocode 6 categorises the exposure class by the use of MX numbers. In most cases in the UK the most severe exposure "S" relates to class MX 3.2 - exposure to severe wetting and freeze thaw cycles, but not exposed to external sources or significant levels of sulphates or aggressive chemicals.

Generally the stronger the mortar, the more durable it is. Conversely the weaker the mortar, the greater is its ability to accommodate movement. For the majority of applications a general-purposes mortar will be specified and is defined as a mortar with a thickness greater than 3mm, although 10mm is commonplace. Such mortars are produced using normal-weight aggregates. Mortars should be specified according to their compressive strength. An M4 mortar is 4N/mm$^2$ mortar based on a mean compressive strength at 28 days. Prescribed mortars (described by their constituent materials) are in common use e.g. a 1:1:5 cement: lime: sand mix, and do not have a corresponding 'M' value although they will have strength properties. A comparison of mortar designations from BS 5628 can be compared in compressive strength terms with those described in Eurocode 6, as shown in Table 7.1.

In the selection of mortars, as a general guide, cement:lime:sand mortars give a stronger bond than plasticised mortars of a similar compressive strength. Incorporating lime into the mix is also beneficial in terms of the mortar's ability to accommodate movement.

*Table 7.1 - Equivalent mortar mixes - BS 5628 and BS EN 1996*

| Mortar designation - BS 5628 | Compressive BS EN 1996 |
|---|---|
| (i) | M12 |
| (ii) | M6 |
| (iii) | M4 |
| (iv) | M2 |

Details of the relevant mortar designations are provided in the Table 7.2.

*Table 7.2 - Masonry mortars*

| | Mortar designation - BS 5628 | Compressive BS EN 1996 | Prescribed mortars (proportion or materials by volume) (see notes a and b) | | | | Compressive strength at 28 days (N/mm$^2$) |
|---|---|---|---|---|---|---|---|
| | | | Cement[c] lime: sand with or without air entrainment | Cement[c] sand with or without air entrainment | Masonry cement[d] sand | Masonry cement[e] sand | |
| Increasing ability to accommodate movement, e.g. due to settlement, temperature and moisture changes ↓ | (i) | M12 | 1:0 to ¼:3 | 1:3 | Not suitable | Not suitable | 12 |
| | (ii) | M6 | 1:½:4 to 4½ | 1:3 to 4 | 1:2½ to 3½ | 1:3 | 6 |
| | (iii) | M4 | 1:1:5 to 6 | 1:5 to 6 | 1:4 to 5 | 1:3½ to 4 | 4 |
| | (iv) | M2 | 1:2:8 to 9 | 1:7 to 8 | 1:5½ to 6½ | 1:4½ | 2 |

*Notes*

*a) Proportioning by mass will give more accurate batching than proportioning by volume, provided that the bulk densities of the materials are checked on site.*
*b) When the sand portion is given as, for example, 5 to 6, the lower figure should be used with sands containing a higher portion of fines whilst the higher figure should be used with sands containing a lower proportion of fines.*
*c) Cement conforming to BS EN 197-1 Notation CEM 1(Portland cement). Cement conforming to BS EN 197-1. Notation CEM II/A-S or CEM II B-S (Portland slag cement); or CEM II/A-L or CEM II/A-LL (Portland Limestone cement); or CEM II/B-V (Portland fly ash cement); or a combination, with equivalent proportions and properties to one of these cements:*

- *Combinations prodcued in the mortar mixer from Portland cement CEM 1 conforming to BS EN 197-1 and ground granulated blast furnace slag conforming to BS 6699 where the proportions and properties confirm to CEM II/A-S or CEM II B-S of BS EN 197-1:2000, except Clause 9 of that standard.*
- *Combinations produced in the mortar mixer from Portland cement CEM 1 conforming to BS EN 197-1 and limestone fines conforming to BS 7979 where the proportions and properties conform to CEM II/A-L or CEM II/A-LL of BS EN 197-1:2000, except Clause 9 of that standard.*
- *Combinations produce in the mortar mixer from Portland cement CEM 1 confirming to BS EN 197-1 and pulverized fuel ash conforming to BS 3892-1, or to BS EN 450-1, where the proportions and properties conform to CEM IIA-V or CEM II/B-V or BS EN 197-1:20000 except Clause 9 of that standard.*

*d) Masonry cement conforming to BS EN 413-1, Class MC 12.5 (inorganic filler other than lime), not less than 65% by mass of Portland Cement clinker as defined in BS EN 197-1.*
*e) Masonry cement confirming to BS EN 413-1, Class MC 12.5 (lime), not less than 65% by mass of Portland cement clinker as defined in BS EN 197-1.*
*f) Table 7.2 is based on data from EC6 and the National Annex.*

# Mortar

When selecting the mortar strength Class/Designation, the following guidance may assist designers:

| | |
|---|---|
| Above ground - Loadbearing and non-loadbearing walls (of moderate compressive strength). | Compressive strength class - BS EN 1996 |
| Above ground - High strength blockwork >10.4N/mm$^2$ | In most cases a mortar strength Class M4 will be sufficient. Although the maximum permissible stresses in a wall will be gained using a stronger mortar this will need to be balanced with a decreasing ability of the wall to accommodate movement. Loadbearing walls are rarely loaded to their ultimate safe working limit, therefore only in exceptional cases will it be necessary to use a stronger mortar. |
| Below ground - Blockwork used with a high risk of saturation with freezing | A mortar strength Class M6 will normally be specified. |
| Reinforced blockwork e.g. Hollow blockwork with vertical reinforcement. | A mortar strength Class M12 or M6 will normally be specified. |

Further information on the use of mortar may be found in the following publications:

- Published Document PD 6697 'Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2'
- BS EN 1996-2:2006 Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry.
- BS EN 1996-2:2006 Eurocode 6. Design of masonry structures. Design considerations, selection of materials and execution of masonry.

The Mortar Products Association provides a range of informative resources, including Data Sheets, on mortar mixes and applications. https://www.mortar.org.uk/technical_information/data_sheets.php

## Bedding and jointing

Solid, cellular or hollow units should be laid on a full bed of mortar. Cellular units should be laid with the closed end uppermost to allow for a full bed of mortar to be applied. All perpend joints should be solidly filled with mortar to maintain the built strength, weather resistance and airtightness of the structure.

Correctly filled and tooled joints enhance the masonry's appearance and has a considerable effect upon the durability and weather resistance of the blockwork. Tooling of the joints involves forming a suitable joint profile e.g. concave joint, using a jointing tool while the mortar is still green. In addition to improving the durability of the mortar joint, tooling will improve the walls' resistance to air and sound leakage. The joint profile should be specified, taking into account the appearance required and the degree of exposure. Tooled and non-recessed joints provide the greatest resistance to rain penetration. Recessed joints should not generally be specified to exposed walls.

Flush jointing is not normally recommended for fair face blockwork, as a quality finish is difficult to achieve, especially with textured blocks and can result in mortar smears to the block face.

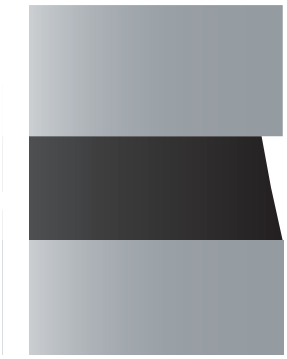
Mortar joints should be of uniform thickness and it is generally accepted that a nominal 10 mm joint be used in order to ensure optimum performance. After placing the blocks on a bed of mortar, the optimum length of time should be established between laying the units and finishing the joints - for example, 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.

### Concave (bucket handle)

This joint usually provides an improved appearance over a flush joint. It is comparatively easy to achieve and is recommended for both internal and external fair face blockwork. Owing to the compressing of the joint and the improved bond, it has good weather resistance and is suitable for all grades of exposure.

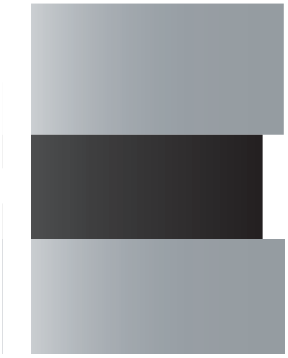
### Struck or weathered

Weathered bed joints produce an interplay of light and shadow on the blockwork. Such joints when correctly made have excellent strength and weather resistance.



### Square recessed

This joint when used with durable masonry units, can produce a very pleasing effect, but its weather resistance and strength will be considerably less than struck, flush or curved recess joints. Recommended in sheltered exposure conditions. The recess should not exceed 3-4mm and is not recommended with full fill cavity insulation.



### Flush or bagged joint

This finish can provide the greatest loadbearing area. However flush jointing is not normally recommended for fair face work as a good quality finish is difficult to achieve and can often result in mortar smears to the block face.