



JOINT APPEARANCE AND MORTAR USE

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Mortar Joints

This paper outlines some of the background, composition and use of masonry mortars, with particular reference to those used for the construction and maintenance of brickwork. The intension of this guide is to enable designers to be aware of the different joint options available with standard mortars.

Mortars are currently required to conform to the requirements of BS EN 998-2 if they are factory made, but if they are site batched they are defined by a design document, BS1996-1-1, Eurocode 6. These standards cover a number of properties, including strength. The published document is PD 6678. There are two alternative methods to specify mortar.

These historically used prescriptive methods shown in the table below which have a ratio of binder to sand of 1 to 3, the binder, either cement and lime or cement only. But with air entrainment to make up the volume, thus filling the voids in the sand to optimise the mortar properties. Mortar mixes are rarely specified and made on a prescribed basis for larger projects. These are normally made as designed mixes, where the strength of the mix is defined and the mix is left open to the manufacturer.

Designed Mortars: Composition and manufacturing method is selected by the producer to choose specified properties. They're classified by their compressive strength.

Prescribed Mortars: Are made in pre-determined proportions, the properties of which are assumed from the stated proportions of the constituents and are classified by designations. It is difficult to state categorically the proportions can be equated to the strength intimated in the table below but it is sufficient as a guide.

Permitted mortar mixes, BS EN 998-2 2013 simplified draft table

Designed Mortars	Mortar Designation	Prescribed mortars (proportions of materials by volume)				Environmental usage condition
		Portland cement or Sulfate resisting Portland cement and lime, with or without air entraining additive	Masonry cement containing Portland cement and lime in approx 1:1 ratio, and air entraining additive	Masonry cement containing Portland cement (min 75%) and inorganic materials other than lime, and air entraining additive.	Portland cement or Sulfate resisting Portland cement and an air entraining additive	
M12	(i)	1:0 to $\frac{1}{4}$:3	-	-	1:3	Severe (S)
M6	(ii)	$1\frac{1}{2}$:4 to $4\frac{1}{2}$	1:3	$1:2\frac{1}{2}$ to 3	1:4	Severe (S)
M4	(iii)	1:1:5 to 6	$1:3\frac{1}{2}$ to 4	1:4 to 5	1:5 to 6	Moderate (M)
M2	(iv)	1:2:8 to 9	$1:4\frac{1}{2}$	$1:5\frac{1}{2}$ to $6\frac{1}{2}$	1:7 to 8	Passive (P)

Lime mortars used prior to the Late 19th Century are becoming popular again and if considered should be specified with the assistance of a specialist mortar supplier.

Pigments

Pigments are frequently used in mortars and often based on metallic oxides, generally of iron. They are chemically stable and will not fade. Visual colour loss may occur if the surface of the joint becomes eroded due to the effects of weathering. Pigments based on carbon are unsuitable for external use as they will fade, although they are low cost.

Coloured mortar has the effect of making the wall more homogeneous and can be a panacea in complex bonding even if the jointing is below the desired standard.

Mix design

The vast majority of prescribed general purpose masonry mortars used in the UK are based on either Portland Cement alone, Portland Cement and air entraining agent, or Portland Cement and hydrated lime, with the latter diminishing. The Table on the previous page, shows these mixes using lime; the lime is often omitted and replaced by air entrainment, so that the mixes consist only of air entrained cement and sand. Hydraulic limes are undergoing something of resurgence, and are available from a number of sources; the manufacturer should be consulted to confirm the best lime mortar.

Mortar production and manufacturing types

Ready mixed lime sand mortar: More correctly described as lime: sand for mortar, or in Germany as lime; sand pre-mortar, this is a factory made mixture of hydrated lime and sand, often with the addition of an air entraining agent and/or a pigment. This mortar type is thus partially factory made, as the cement addition remains to be made on site.

Wet ready-to-use mortar: This material is composed of cement, sand and sometimes lime and/or pigments. It is almost always supplied in bulk, either in tipper vehicles, ready mixed concrete type agitator trucks or specialist vehicles. Because it contains a cement; set retarder it remains workable for a set period of time, usually between 1 and 3 days.

Ready mixed mortar: As elegantly described in BS EN 998-2, this may be wet, ready-to-use or dry, only requiring the addition of water. Dry mortar may be supplied in one tonne big bags or in 25 kg bags particularly for use on small DIY or congested sites. Dry mortar is also supplied in bulk silos.

Silo mortar: This material is dry, fully mixed, with the exception of the final water addition. The silo in which it is initially delivered may be replenished from a bulk tanker, and contains an integral mixer, with provision for connecting a water feed and a power line, to enable the production of batches of wet, ready-to-use mortar as and when required, usually discharged into a wheelbarrow or similar. Silo mortar is probably the best and most flexible factory made mortar for medium sized and larger sites as it combines a known cement content with virtually

unlimited life prior to mixing, and with the flexibility to produce workability appropriate to the particular units that are to be laid. The latter is a particular advantage where the mortar workability needs to be varied, perhaps because dense bricks and lightweight blocks are being laid at the same general time on the same site, so that the same mortar source is used.

Workmanship and site practice

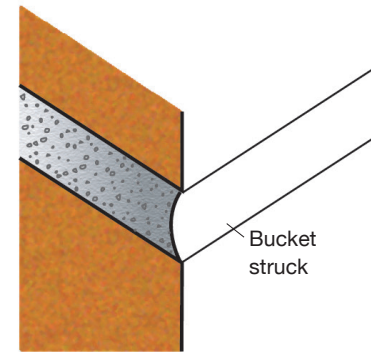
Control of the wet mortar properties, for example the water: cement ratio, is sometimes proposed, but this will be determined by the bricklayer/labourer, who will need to adjust the mix to the correct wetness for laying the particular units in the particular weather conditions with the particular brick. Thus a cold winter day with engineering bricks will require a drier mix than a hot summer, perhaps in full sunlight, with absorptive stock bricks. Both extremes have the potential to produce great masonry, but the final wetness, and thus the workability, of the mortar must be left to the craftsman.

Joints

There are a number of successful joint types available and discussed below: The more complex joints may be traditional but are rarely used today although available if required. The simplest joint is the bucket handled joint, the most complex is tuck pointing.

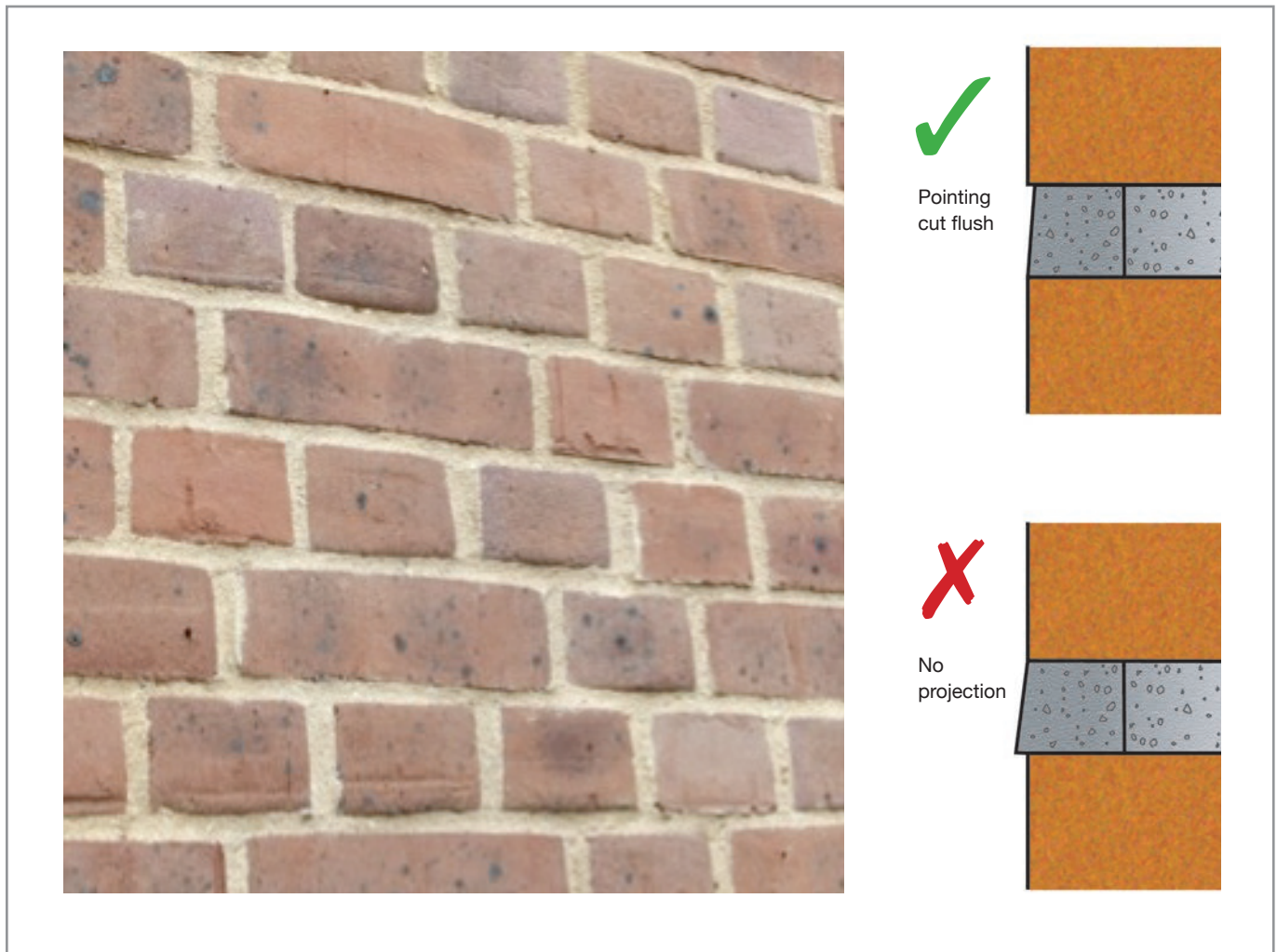


Bucket handled or Curved Recessed: This joint gives good weather resistance. The cement is brought to the surface by working the joint for improved weather resistance. The joint is both economical and the most commonly chosen joint. Owing to the compressing of the joint and the superior bond, it has good weather resistance and is suitable for all grades of exposure. It is normally a one operation finish not relying on a follow on pointing operation.

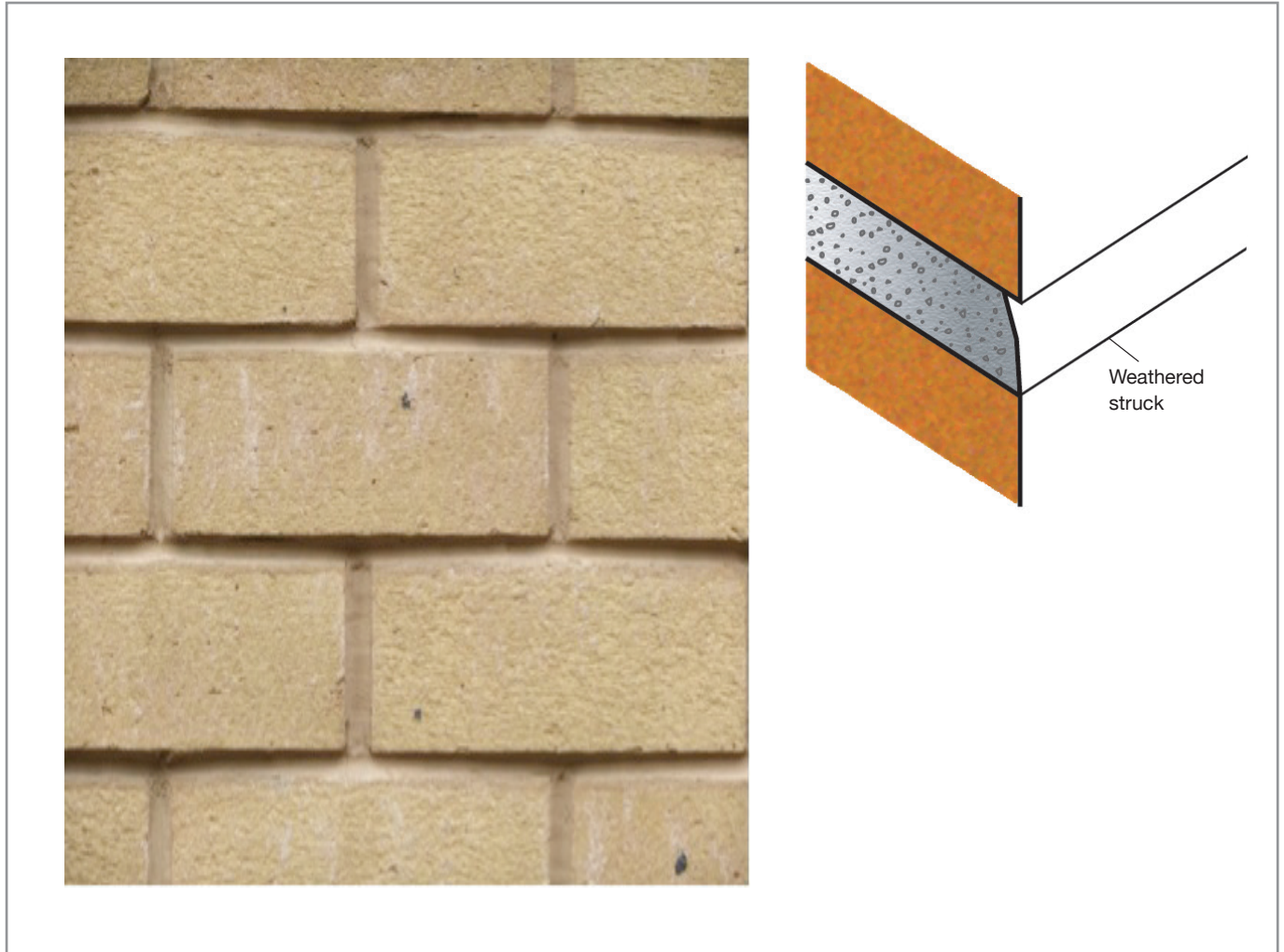


Struck flush: This gives maximum bearing area and is often favoured when coarse textured bricks are used. With some brick types the finish may appear a little irregular. Suitable for moderate and sheltered exposures as the mortar joint has not been compressed by the finishing tool. It is preferred to over point the joint and compress the mortar. After an initial set has been achieved the brushing can occur which should be diagonally applied. Both a wood dowel or brush can be used. A brush will expose the aggregate giving a texture to the joint.

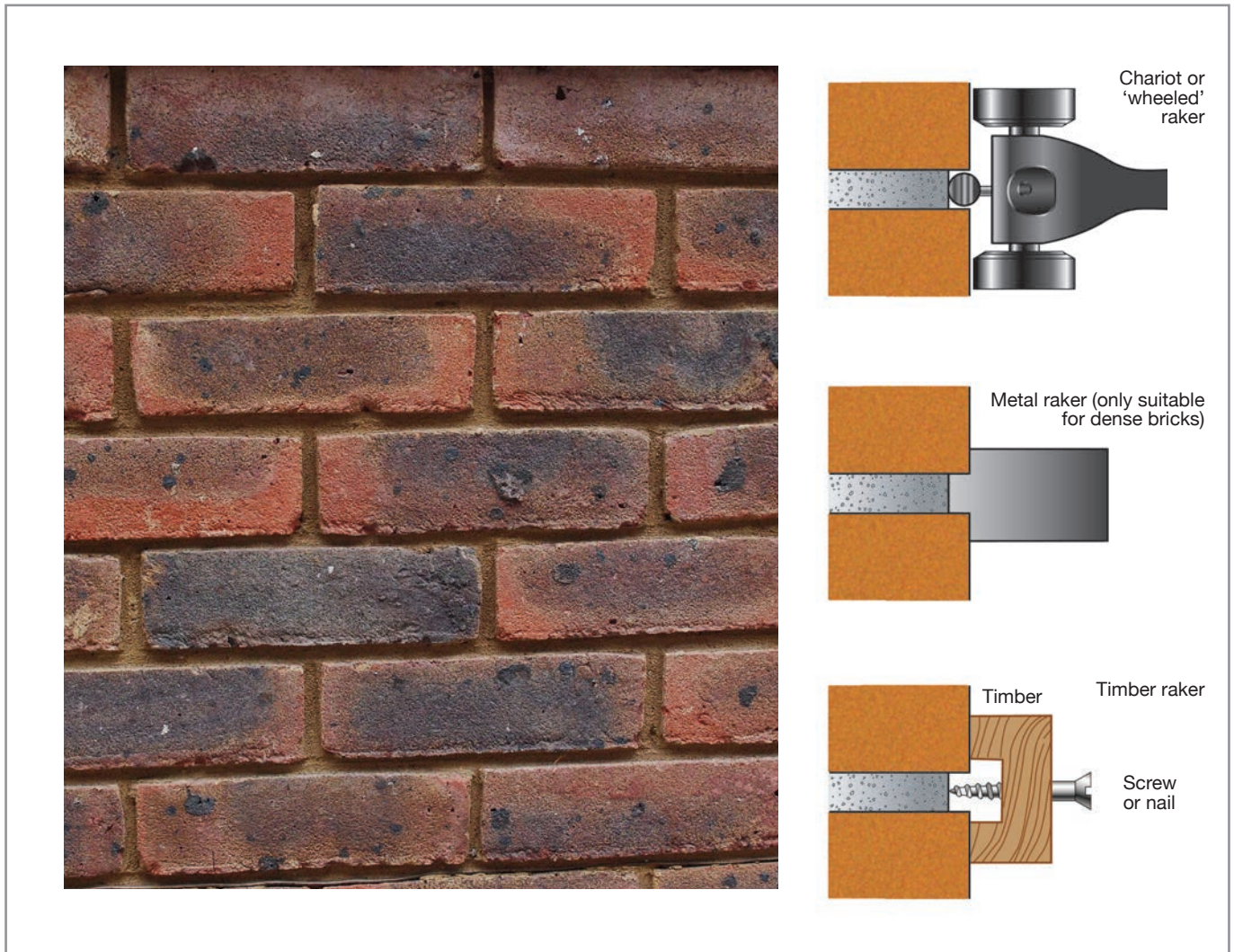
If a matching mortar is used the wall can have a monolithic appearance which can be desirable.



Weather struck: This produces a contrasting effect of light and shade on the brickwork. Such joints, when correctly formed, have excellent strength and weather resistance and are suitable for all grades of exposure. Perpendents should all be angled left or right hand throughout the building.

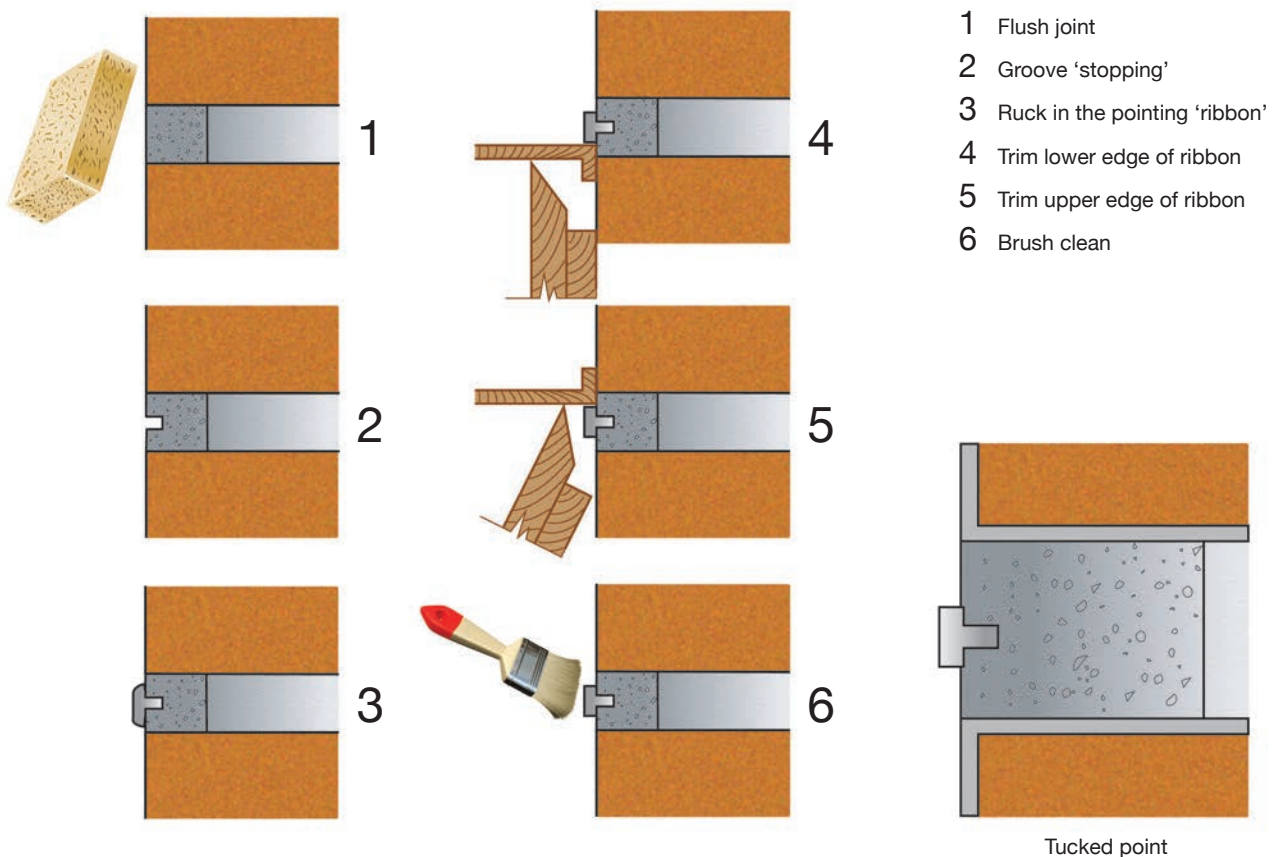


Square recessed: The joint producing the most uniform appearance, and inducing a sharp well defined edge to the brick coursing. Care should be taken when used in exposed conditions with units that are not of good durability. It should not be deeper than 3mm.



Tuck pointing: The most difficult process of jointing is shown below and is extremely labour intensive and laborious and is only practised by specialists. A diagram is shown below indicating the process. The technique was popularised in the 17th Century to give the handmade soft mud bricks an appearance of regularity which they do not possess. The cross joints are actually planted on. The photograph below shows a repointed detail with the original wash on the wall starting to flake off.

The illustration also shows how difficult it can be to repoint a Tuck pointed wall successfully.

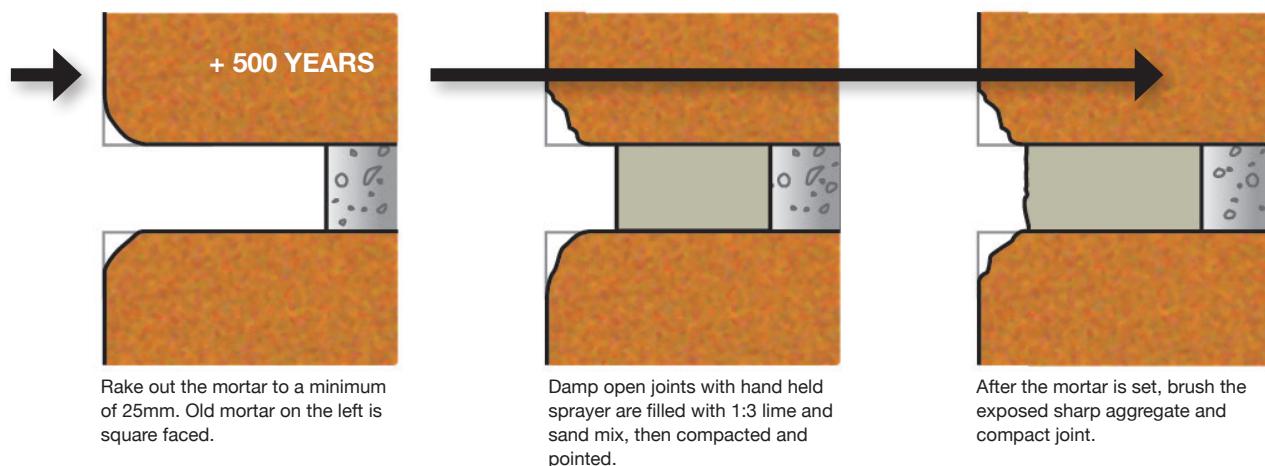


Repointing: Repoint to match the original mortar. If the building is old, commonly prior to 1890, lime mortar may have been used. **Do Not** repoint with a modern cement mix.

Lime mortar mix for repointing does not normally use pozzolanic additives as the joints are not deep, so will set with exposure to air. Sand was originally found locally and the colour of the sand used should try to match the original. Of course the original sand would not be pure and may well have been mixed with other materials present when dug. The mix would be about 1 of lime putty to 3 of sand. The sand would generally be sharp with larger aggregate which increases strength.

Lime mortar mix for bed joints may include pozzolanic materials. The mix might be 1 part brick dust to 20 parts of mortar. Of course this mix must be discarded if not used and cannot be added back to the mix if unused.

If the edge of the bricks is sharp, the pointing should be flush pointed and brushed when green to expose the aggregate. In general although there are exceptions, modern pointing techniques may not be suitable. If the bricks have rounded edges the pointing should be recessed, otherwise the joints are too wide and the wall is visually spoilt.



Routine testing

If routine testing is undertaken, care should be paramount for compressive strength. If the mortar is a prescribed mix, the testing will provide a guide of variability, but the absolute value should not be used as a criterion of pass/fail acceptability as a prescribed mix is based on proportion, not strength. Where strength is tested for 150 mm cubes, it will give poor results, and even 100 mm cubes are not a preferred size, which is 40 mm x 40 mm x 160 mm.

Specification

It is recommended that specification be to BS EN 998-2 and/or to the Eurocode 6, BS 1996-1-1, or to the old British Standard Code of Practice BS 5628 which is still widely used and which contains much useful information.

Relevant British Standards

1. BS EN 771-1:2011 Specification for masonry units part 1: Clay Masonry Units
2. PD 6697:2010 Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2
3. BS 8221-1:2012 Code of practice for cleaning and surface repair of buildings
4. BS 7533-9:2010 Pavements constructed with Clay natural stone or concrete pavers
5. PAS 70:2003 HD clay bricks guide to appearance and site measured dimensions and tolerance
6. BS EN 15804:2012 Sustainability of construction works
7. BS 8103-2:2012 Structural design of low rise buildings
8. BS 8000-3:2008 Workmanship on building sites
9. BS EN 1344:2003 Clay pavers – requirements and test methods
10. National Federation of Demolition Contractors: (NFDC), Demolition of refurbishment information data sheet 13. nfdc-drlds.com/sheet13
11. BS EN 772-3:1998 Methods of test for masonry units determination of net volume
12. BS EN 772-1:2011 Methods of test determination of compressive strength
13. BS EN 1998-1.1:2005 and A1 2012: Design of masonry structures
14. BS EN 998-2:2010 Specification for mortar and masonry
15. BS EN 772-5:2001 Methods of test for masonry units' determination of the active soluble salts
16. BS EN 772-7:1998 Methods of test of masonry units. Determination of water absorption of clay masonry damp proof courses



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