Abstract A brief overview is given of performance requirements for bedding mortars for historic masonry.

1 Introduction

This paper highlights aspects of the chapter on performance requirements for bedding mortars to be included in the forthcoming RILEM TC 203-RHM guide on repair mortars for historic masonry. Existing information on bedding is also available [e.g. 1].

A bedding mortar provides an even bed and bonding for masonry units to ensure stability and an even transfer of load. The mortar also provides resistance to moisture and air penetration (weather-tight). It should also be durable. The bedding mortar may be exposed on the exterior surface or recessed for later pointing.

Bedding mortars for historic masonry are composed of a binder such as lime, an aggregate such as sand, and water which gives them initial plasticity. Additives or pigments may also be present.
There are five levels of restoration to consider: do nothing, stabilize, repair, restore, and/or replace [3]. Before deciding on any work, carry out a building condition assessment which should include a thorough survey of the composition of the existing masonry and its condition (see workshop paper ‘Repair mortars for historic masonry. From problem to intervention: a decision process’). The cause of material deterioration should be determined and any repair work to reduce the risk of mortar deterioration should be addressed prior to repair. On bigger projects, it can be worthwhile to do a small initial project to obtain an idea of likely costs and unforeseen factors.

2 Design and construction issues

Performance requirements for mortars vary depending on the needs. They may also conflict with each other, and therefore the designer will have to decide on the priorities and make compromises. Furthermore there can be varying opinions on appropriate requirements. Requirements to consider for bedding mortars include:

Conservation issues

• Historic authenticity/compatibility
  - repair mortar to be compatible with the existing masonry units and mortar, and/or with the original mortar.
  - where required for historic authenticity, the mortar ingredients should be matched to the original where possible. This may not be easy to do because the original ingredients may no longer be available, the original mortar may have insufficient durability, or the original ingredients may be difficult to determine. Chemical reactions with other materials in the mortar or the environment, as well as deterioration processes, may significantly change the original composition over the years.

• Able to remove the mortar without damage to the masonry units in future repair (reversibility)
  - mortar should not be stronger than needed for the structural and durability requirements. This will reduce the chance of damage to the masonry units in future repairs. In the case of demolition, it may be possible to use the masonry units in other locations in the same structure or in other structures if the mortar is easy to remove.

Aesthetic issues

• Visual appearance of the mortar if bedding mortar is carried to the face of the joint.
  - assess colour, texture and surface profile (e.g. the particle grading and colour of the aggregate are factors of importance for the appearance).
• **Mortar should not cause staining on the surface**
  - low risk of efflorescence or lime leaching.
  - no mortar stains on the masonry units resulting from the application of the mortar.

**Structural issues**

• *Withstand imposed permanent and transient loads*
  - Gain strength sufficiently early to resist short-term applied loads.
  - Develop enough strength to resist permanent loads, and transient loads such as wind and earthquake. Pure lime (non-hydraulic) bedding mortars can take a long time to gain strength (fully carbonate). They need access to atmospheric carbon dioxide and a minimum humidity. Within thick masonry walls or damp walls it may take a very long time to fully carbonate if at all (especially walls with dense masonry units). Their use in such walls is therefore discouraged. A pozzolan or a small amount of cement should be added to ensure a more even and rapid gain in strength, or another possible alternative is an hydraulic lime mortar.

• *Withstand structural effects of short and long-term movements*
  - Assess loads induced by temperature and moisture movement (e.g. thermal movement in parapets can lead to cracks in mortar joints).
  - Assess effects due to shrinkage and creep.

**Weather-tightness**

• *Resist moisture ingress and airflow through the joint, and not restrict drying*
  The mortar should resist water penetration through the masonry. Most water infiltration through a masonry wall occurs at the interface of the mortar and the masonry unit, and voids in the mortar joints. Relatively little is transmitted through the mortar itself.
  - where exposed, the mortar joint should have an appropriate finish (profile) to encourage the shedding of water.
  - low risk of cracks developing. This means low shrinkage, compatible thermal and moisture expansion properties, adequate deformation under load (elastic modulus), and adequate bond with the masonry units.
  - mortar in the joints should have negligible voids, and full contact with the masonry units. Good mortar workability will increase the likelihood of full contact.
  - there should be good drying capability through the mortar joint should the masonry become wet. This is especially important in masonry with dense masonry units (the mortar will allow the masonry to ‘breathe’).

**Service life**

Service life not only depends on the mortar mix but also on how it is installed (workmanship) and cured, on the compatibility between the masonry unit and mortar, and on the severity of the environmental exposure, which in turn depends on weather, design, construction practice, operation, and maintenance.
Adequate service life of the mortar itself
- Resistance to expected environmental loads (e.g. freeze-thaw cycles, salts, wind erosion, acid rain & biological elements).

The risk of damage to the existing masonry not to be increased by the new repair mortar
- no damaging salts within the mortar.
- mortar bond strength lower than the tensile strength of the masonry unit.
- promote drying; the mortar should have adequate moisture and soluble salt transfer properties.

Construction (execution) to ensure good performance and service life.

In the elder days of art, builders wrought with greatest care each minute and unseen part; for the gods see everywhere [3]. This may not be an accurate reflection of past construction procedures, but it is something to aim for in the conservation of historic buildings.

- Use a contractor experienced in the conservation of older masonry.
- Repair mortars should be practical in application to encourage good workmanship.
  - Mortar should have a sufficient usable life before setting. Some mortars set very quickly (e.g. a natural cement mortar sets within half an hour).
  - Mortar holds together (cohesive) to reduce excessive flow and risk of staining masonry.
  - Spreads easily over the masonry unit, is plastic long enough after laying to allow placing of the next masonry unit, and stiffens rapidly enough so several courses can be laid without mortar squeezing out or deforming.

Careful execution of the work including adequate curing conditions. The designer should talk to the masons and mortar mixer beforehand. Only one person should be assigned to mixing the mortar.

Supervision and quality control are important! Low-strength repair mortars, often used for older masonry, are less forgiving of errors.

Maintenance is an important factor in service life.

- For larger projects develop a maintenance guide documenting the evaluation of the masonry before the work started, the materials used for the work, and the installation practice. Recommendations on regular visual inspection for signs of deterioration should be provided, ideally in a checklist format.

- Ensure prompt repair of water shedding elements (e.g. gutters, downspouts, flashings).

Performance requirements can be assessed with the help of tests (see the paper on testing of repair mortars for historic masonry):

- Performance of the mortar as part of the masonry is most important (e.g. flexural bond test). Performance of mortar specimens cast separately is useful for comparative testing and quality control.
3 References

2. Cooke J (2008) Comment during presentation by John Cooke at a TC203-RHM meeting, Toronto, Canada
3. Longfellow HW (1850) From his poem The Builders