



Refurbishment of Brickwork

Cleaning, refurbishment of bricks and joints



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Pre-investigation and planning

- Before any treatment of a facade the masonry and its neighbouring building components are to be investigated concerning damages.
 - Comprehensive ascertainment of the existing building and the weak points
 - Ascertainment of the damages
 - Analysis and appraisal of the damage processes as well as their causes
 - Elaboration of an action plan
 - Selection and assignment of the required experts and authorities

Cleaning: Basics

- Remove biological occurrence or plants
- Clean off dirt (air pollution)
- Remove deposits (salts)
- Re-open shut pores
- Avoid any damages or roughening to the surface
- Methods such as
 - Dry cleaning
 - Wet cleaning (where required chemically or with acid if reconcilable)
 - Steam blasting cleaning
 - Sand blasting (consider risk of damages)
 - Implementation by special experts or companies

Cleaning: Dry cleaning

- Remove loose and rough dirt
 - With spatula in case of smooth surface
 - With wooden boards in case of rough surface
 - With scrubbing brush in any case and especially in case of loose, dry salt deposits

Further cleaning methods are to be carried out by specially qualified companies after consultancy with responsible cultural heritage preservation authority.

Replacement of stones

- Broken stones are re-shaped with appropriate stone substitute mortar.
- Missing stones are replaced by new appropriate material.

Refurbishment of cracks in stones: Overview

- Analyse the cause of cracks and eliminate it
- Methods of cracks treatment:
 - Tensional grouting with epoxide resin
 - Non-tensional crack sealing against moisture
 - Sealing of cracks with elastic sealant
 - Crack-bridging coating (not in case of facing masonry)
 - Crack-bridging with special mash (not in case of facing masonry)

Refurbishment of cracks in brickwork: Elastic sealing

- Joints and cracks that are influenced by continuous movement:
 - Scrap out joint mortar ca. 2cm deep
 - Prepare cracks in stones carefully with angular grinder
 - Install plastoelastic joint / stone sealing with acryl-sealant ca. 1cm deep to protect from moisture
 - Close remaining groove of 1cm with restoration mortar to protect the underneath lying sealant from UV radiation (risk of brittleness)

Refurbishment of broken joints

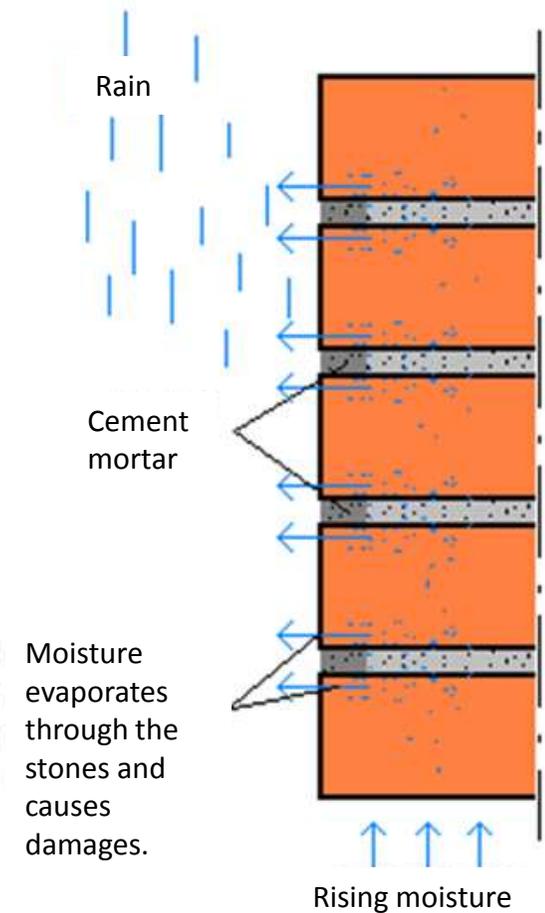
- Remove joint mortar mechanically with
 - Hammer and chisel
 - Air driven hammer
 - Cut beforehand in the middle of the joint with a fine angular cutter advisable to lower the tension while chiselling out
 - Angular grinder as tool to remove the joint mortar are improper for the stone sides will be teared open (> increased absorption of moisture)
 - Clean brickwork from dust and make it wet

Repointing of joints: Working steps

- Cleaned brickwork must be wet
- Repoint the joints with mortar that suits to the existing (historic) one respectively to the strength of the stones, first the butt joints, then the bed joints (for optical reasons)
- Attention: Preceding analysis of the existing mortar urgently advisable; the mortar should be a bit more diffusion open than the stone
- Take care of sufficient compression
- Sweep the brickwork with a soft broom and make it wet again

Repointing of joints: Mortar composition and mistakes

- Historic joint mortar mixtures consist mostly of lime, sand and water
- Portland cement is too strong and too water impermeable for soft historic stones
 - Cement joints give too much pressure on soft stones while hardening
 - Moisture cannot emit through the joints any longer and searches for a new way through the stones >Frost effect can blast off the outer stone layers



Composition of historic mortar: Lime and cement

- Lime (calcium hydroxide) derives from calcium carbonate at high temperatures at which carbon dioxide exhausts.
 - For new jointing should be used unslaked lime, hydrated lime or lime filler.
- Portland cement has been used since the beginning of the 20. century.
 - Extremely strong and shrinks while hardening
 - As aggregation to lime-bonding mortar it increases the workability and malleability, early rigidity and quick hardening (but not for hand-formed bricks)

Composition of historic mortar: Sand

- Sand is the major component of mortar. It determines the colour, the structure and the rigidity.
- Natural sand (beach, river bed, gravel extraction plant) has got round grains
- Mechanically produced sand is sharp with edged grains
- Natural sand is suitable for the restoration of brickwork because it was used in the past as well. It suits optically better to historic mortar.
- Possible mixing ratio for mortar (cement/lime/sand according to ratio)

Brick type	Stress type (weathering)		
	protected	normal	extrem
Hard brick	1 / 2 / 8-9	1 / 2 / 5-6	1 / 1.5 / 4-4.5
Shaped bricks	1 / 3 / 10-12	1 / 2 / 10-12	1 / 1 / 5-6
Hand-formed bricks	0 / 1 / 2.25-3	1 / 3 / 10-12	1 / 2 / 8-9

1. Bond: The mortar

Hydrating process to produce the bonding agent lime

>> Reaction of quicklime to hydrated lime while adding water

Wet hydration	<ul style="list-style-type: none">• Quicklime is mixed with water with spillover• It comes to a lime mush, the so-called ‘sump lime’• The longer it is stored, the smoother it gets• The storage duration in water can last for years• Disadvantage: Works only with very pure lime
Dry hydration	<ul style="list-style-type: none">• Quicklime is covered in one layer or in several layers with wet sand and kept constantly wet• Advantage: Short handling and not pure limes can be taken

Restoration of masonry: Anchorage bond of facing masonry I

- Stability of the facing masonry of cavity masonry is challenged because of missing or corroded wire ties
- Supplementary installation of wire ties that are specially made for restoration, use expansion pegs (in case of massive bricks)
 - According to static calculation and manufacture's instructions
 - Control the spread of the anchor with a torsional moment wrench

Restoration of masonry: Anchorage bond of facing masonry II

- Supplementary anchoring of the facing masonry to the backing masonry through injection anchors (in case of hollow bricks) according to static calculation and manufacture's instructions
- Boring through the crossing point of the bed and the butt joint of the facing masonry as well as into the backing masonry
- Clean the borehole, insert a suitable screen case into the backing masonry (anchorage ground) and fill with injection mortar
- Insert anchor bars with thread into the filled up screen cases to achieve a tensional connection between the facing masonry and the backing masonry
- Grouting of the anchor points in the joint net