Repointing of Historic Masonry

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Mortar Components

- Portland Cement
- Lime
- Sand
Historical Background

• Early mortar formulations were primarily lime putty (slaked lime) and sand mixed in a ratio of 1 part lime putty and 3 parts sand by volume.

• Other ingredients could include crushed marine shells, brick dust, and animal hair were also added.

• This basic formulation for mortar remained mostly unchanged for centuries until the creation of portland cement.
Historical Background

• Portland cement was patented in Great Britain in 1824 and was imported until it was first manufactured in the U.S. in 1872.
• Portland cement was not widely used throughout the country until the early 20th century.
• Early use of portland cement was as a minor ingredient to accelerate mortar set time.
• By the 1930’s most masons used a 1:1 ratio of portland cement and lime putty. Therefore, mortar mixes found in masonry structures built between 1873 and the 1930’s can differ greatly.
# Mortar Types

## Mortar Recipe

<table>
<thead>
<tr>
<th>Type</th>
<th>Cement</th>
<th>Lime</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>1</td>
<td>¼</td>
<td>3 to 3-3/4</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>½</td>
<td>4 to 4-1/2</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>1</td>
<td>5 to 6</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
<td>2</td>
<td>8 to 9</td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td>3</td>
<td>10 to 12</td>
</tr>
<tr>
<td>L</td>
<td>0</td>
<td>1</td>
<td>2-1/4 to 3</td>
</tr>
</tbody>
</table>
## Suggested Mortar Types

<table>
<thead>
<tr>
<th>Masonry Material</th>
<th>Sheltered</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Durable: Granite, etc.</td>
<td>O</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>Moderately Durable: Limestone</td>
<td>K</td>
<td>O</td>
<td>N</td>
</tr>
<tr>
<td>Molded Brick, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimally Durable: Soft hand</td>
<td>L</td>
<td>K</td>
<td>O</td>
</tr>
<tr>
<td>made brick</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Function of Mortar

• As a structural binder for the masonry units
• To bed the bricks neatly accounting for differences in size and shape
• To be the weak link in the natural aging and weathering of the wall system
• To enhance the visual characteristics of the building
• To weatherproof the bricks while allowing the free evaporation of moisture “breathing”
Importance of “Breathability”
Mortar Matching

• Partial repointing or 100%
  – Partial repointing: match existing mortar to remain if appropriate type for masonry
  – 100% repointing: research to find original samples and joint profiles if possible

• Analysis of historic mortar
  – To most accurately duplicate the original formulation consider a mortar analysis service

• If unable to determine original mortar formulation use the suggested mortar type for your masonry type and exposure

• Lime inclusions and pigments
Removal of Mortar

- Preferred tools for removal
  - Hammer and chisel or pneumatic chisels
  - Center cut removal method
  - Arbortech tool (soft mortars only)
No Grinders in Inexperienced Hands!
Removal of Mortar

• Old mortar should be removed carefully as to not damage the surrounding masonry

• Center cut method is best for removal of hard mortars
  – Cut a relief joint down the middle of the mortar joint with either a swept tooth chisel or grinder (yes I said grinder)

• Remove mortar to a MINIMUM depth of 2 to 2-1/2 times the width of the joint
  – Critical for adequate bond and to prevent “popouts”
Conventional Mortar Preparation

• Thoroughly blend dry ingredients first before addition of water
  – Sand should be added in a damp loose condition
• Pre-hydrate the mortar with just enough water to make it hold together and mix for approximately 5 minutes
• Remaining water can be added until a workable mortar is achieved
  – A workable mortar is one that is moist enough to hold together, but not so moist that it leaves wet mortar smears all over the masonry
Lime Putty Mortar Preparation

• Mix with sand by VOLUME not weight
• Proportion and place the damp loose sand into a mortar tub
• Then follow by placing lime putty onto sand
• Begin blending materials with a mortar hoe
• Finish blending with a large wooden mallet or dowel by ramming the material, interspersed by chopping with the mortar hoe
• Do not attempt mixing this type of mortar with a mortar or cement mixer
• If portland cement is required to create the specified mix always make a portland/water slurry and then add to the mix. Adding dry will make the portland “ball up”
Mortar mixing tub

Mock up in progress
Joint Preparation for Mortar

• Clean joints with compressed air and a light water rinse being careful not to flood the wall cavity with water
• When joints greater than 1” are present it is recommended that these deeper areas be filled first to create a continuously even depth for pointing
• Build out the joints in ¼” to ½” lifts at a time
• Additional layers can be added when the previous lift is thumbprint hard
• Once the final layer is applied it can be tooled to match the historic joint
• In hot or extremely dry climates routine light water misting is preferred during the first 24 to 48 hours of curing
Tooling Profiles

- Concave
- Vee
- Weathered
- Raked
- Beaded
- Struck
- Flush
- Grapevine
- Extruded
Carbonation

• Carbonation is the “curing” process of a high lime mortar
• Carbon molecules are taken from the atmosphere and incorporated back into the lime creating a durable and breathable joint
• Once pointing is complete a stippling process with an English churn brush can open the exterior pore structure aiding the carbonation
Field Experience
Conclusion

• Take extreme care when removing mortar
• Utilize the original mortar formulation when possible
• Breathability is paramount
• Produce mock up samples before embarking on a full scale repointing project
• Only contract with qualified historic restoration masons
• When in doubt remember the preservationists motto, “do no harm”