

# Lime Mortar for the Conservation of the Timur Shah Mausoleum in Kabul, Afghanistan

## Building History

- Built in 1816 for the Afghan king Timur Shah (1773-1793) in the center of Kabul, Afghanistan
- Damaged during the first Anglo-Afghan war (1839-42); afterwards repair of the dome
- Collapse of the repaired part in the early 20th century, probably due to an earthquake
- Construction of a roof of metal sheeting on a wooden support in 1936/37
- Reconstruction of the dome in 2003-2005

The Timur Shah mausoleum during the reconstruction in 2003. The damage extended almost to one third of the dome surface (inset image).



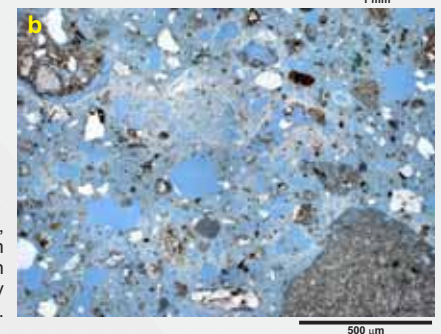
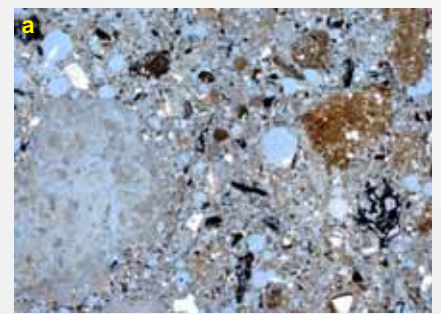
## Material Related Tasks for the Reconstruction

- Analysis of existing building materials, i.e. mortars and bricks, with the main focus on composition, micro texture and physical parameters - mechanical parameters could not be determined due to a limited amount of sample material
- Establishment of criteria for the development of compatible repair mortars and the manufacture of bricks
- Recommendations for preparing and processing the bedding mortar on-site

## Original Building Materials

- **Bricks:** Two different raw materials - one with higher carbonate content, the other with higher content of organic matter; all bricks were hand crafted and fired at low temperatures; brick size 20 x 20 x 4 cm<sup>3</sup>
- **Bedding mortar:** Consisted of a weak hydraulic lime binder with a high amount of fine aggregate; a higher amount of charcoal reduced the density to < 1150 kg/m<sup>3</sup>; high content of chlorides up to 2.8 mass-%; low mechanical strength; many inclusions of lime lumps indicated use of quicklime or insufficient homogenization
- **Plaster:** Consisted of a very porous gypsum-lime plaster

a. Photo micrograph of the bedding mortar with lime lumps, charcoal and clay/silt fragments. b. Micro texture of the gypsum lime plaster with a high binder content. Both materials show a high porosity (thin sections, transmitted light, pore space indicated by blue dyed resin).



## Restoration Materials

- **Bricks:** Were taken from a local brickworks, which was able to produce low fired hand made bricks of the required size and properties
- **Bedding mortar:** As a binder an aged lime putty with the addition of some brick dust and char coal was used; aged lime putty was prepared by slaking quicklime from the brickworks and storing it for at least 6 weeks in barrels; as aggregate washed river sand was used similar in grain size distribution as in the original mortar
- **On-site processing of mortar:** Guidelines were given in how to process the lime mortar on site; a small training program was developed in order to familiarize the local craftsmen in processing lime mortar



a. Local brickworks, the source of quicklime and bricks near Kabul. b. Barrels where slaked lime was stored. c. Local craftsmen preparing lime mortar during the reconstruction. d. The first brick layers closing the hole in the dome. e. The Timur Shah Mausoleum after the reconstruction in early 2005. The metal sheeting rests on a wooden support structure on top of the reconstructed dome.

Contact: BAM Division VII.1 - Building Materials  
Dr. Urs Mueller,  
Phone: +49 30 8104 1712  
Email: urs.mueller@bam.de