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Historical Mortar of the Kölner Dom foundation

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In 2008 a tunnel of 2.40 meter height and 2.80 meter wide and 11 meters in length was drilled through the historical foundation of the southern tower of the Kölner Dom to have an alternative access to the south tower. This part of the basement was build in the middle of the 14th century. It consists of natural dark basalt pillars, small gray tuff stones and white lime. During the drilling of the tunnel a considerably high compressive strength of the foundation was detected. For a better understanding of this observation, mortar analysis were performed on mortar samples taken from a separated drill core of the southern tower foundation.

The composition of mortar and aggregate samples was determined by chemical analysis and X-ray diffraction (Siemens D5000). For structural investigations polished thin-sections were prepared and analysed by microscopy with an Olympus BH-2 microscope. The compressive strange of samples was analysed. To describe the binder-aggregate-ratio mortar analyses were performed by acid dissolution and binder separation from aggregates. The chemical composition of the acid-soluble binder was determined for soluble silica. Wet chemical analyses were performed on the acid filtrate for the characterisation of soluble $Me2O_3$, CaO, MgO and SO_3-ions. The carbonate amount was determined by volumetric method.

The typical historic lime-binder does show a remarkably high hydraulic composition detectable by the high contents of HCl-soluble SiO_2. The content of soluble silica relates to hydrated calcium silicates in the binder and thus the hydraulicity of the binder. There were no sulphate-compounds but a minor MgO-content detected. The composition of historical mortar shows a binder-to-aggregate relation of 1:2 wt-%. The particle size distributions of the sand was determined by sieve analysis. The sample shows a gravel sand of a grain size between 0.0-32.0 mm. The aggregates consist of Rhine sand and tuff stone material. The X-ray diffraction analysis on separated binder shows calcite and quartz phases and a significant amorphous composition.
The microscopy investigations of polished sections show a binder - aggregate-matrix of mainly white quartz, rock fragments and light brown tuff aggregates. The grain shape is rounded to rounded at the edges. The mortar is heterogenic and shows a clear binder-aggregate-contact. The polished section shows well distributed and small sized tuff components. Those highly puzzolanic reactive tuff components act like a modern trass lime binder. They are responsible for the high compressive strength. The analysed samples of the historic mortar from the 14th century show the compressive strength compareable to the recent definition of the German mortar group classification II to III.