Study of limestone at Khor Eit-North of Port Sudan as building materials and in the productions of lime mortars

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Introduction

Lime stone at Khor Eit North of Port Sudan as building material and the results of characterization tests were used for production of new compatible mortars, which would then be used for the buildings. The binder aggregate ratio of mortar samples were in the range of 1:2 Lime with metakaolin aggregate ratios.
The ratio of the mortars lime blended with cement (70%, 60% and 50% lime, and cement 30%, 40%, and 50% of respectively) and of ratio 1:3. Lime to Sand, moreover the Standard sand size was used in the aggregate. The pozzolanic additive calcined kaolin which was calcined between (750-850°C). It was found that the addition of Pozzolana improved the compressive strengths of the mortars and the high lime ratio blended with cement i.e. (70%:30%) revealed high long term strength.
Location of the Area of Study

Khor Eit has been selected for the targeted Locality of the material studied lies at 45 Kilometer north of the city at longitudes 36° 30-37° 20 East, and latitudes 22° - 22° 30 North. It is exactly located in the east central region of Sudan, surrounded by a number of states, in the eastern side bounded by the Red Sea, and in the North and western part is bounded with Red Sea Mountains Chain. Khor Eit is bounded south with Port Sudan city.
Previous study:

*The limestones was studied by GRAs for evaluations and estimations for cement industries during the 1974 by M.Mus. followed by the Adli Abdel majeed 1981 for evaluations of raw materials for Sharf Cement Co.LTd. The drilling were carried out at West Eit Village for reserve estimations, and the laboratory testing result for quality of the limestone chemical contents as well as Clay for cement uses recommended that the good quality cement

*Elfateh Abadal1999 has a short report on lime in chemical industry as a product of the calcined limestone for GRAS mission, his work concerned specifications of the lime, quantity, quality as a hydrated lime used in industry to compensate for the imported lime in Sudan, their investigations were taken at wade Kurmut (Bayuda Desert) and Atbara region, and also Nyfer-Erugiq Quarry Rabak Area. Where the resulting chemical analysis test give arrange of CaO 93.25-98 %.

*Ariab Mining company 1992 work in the study of the lime in the mining activity through Chemestar company. They developed a new lime–based agglomeration product designed to decrease leaching times and increase recovery rate of gold from ores for example heap leaching process. The product is a combination of inorganic minerals that when agglomerated with fine particles create, dendrite crystalline structures allowing greater contact of oxygen and cyanide with ore and give PH range content necessary
Geology:

The regional geology of the coastal area north of Port Sudan was comprehensively studied for the potentiality of the formation. The basement complex rocks forming the hilly region to the west, comprises metamorphosed and repeated deformed rocks as well as relatively younger intrusive and extrusive rocks. The basement complex rocks are overlain unconformably by tertiary sequence comprising a series of conglomerate, clay, and marl magnesian lime stones, sandstone, shaly limestone and older coral reefs. This succession followed by gypsiferous clay and marl and a thick layer of gypsum horizon.

Eit succession includes lithology different in age, from Lower –Middle Miocene and extends to post Middle Miocene.

The distinguishable baking effect of the Basalt extrusion was clearly observed on Eit-Mohamed goal road and north of Eit village at J, Tabonam. Moreover the Iron and magnesium from Basalt characterized the color of the sediments contact by yellow, pinkish and tint.
The Geology of the Shallow shelf carbonates:

The lithostratigraphic boundary between the clastics and carbonates has no regional or local Biostratigraphically significances as the carbonates are dischronous. Their deposition began in various portion at Sudanese coastal plain at different times. Even on a given platform, carbonate sedimentation did not begin simultaneously solely in all part for example, at jebel abu imama in carbonates developed first, probably in warm phase (Read, 1985) while the platform of khor Eit rim developed later. The onset carbonate deposition on isolated platforms also at khor Eit indicates favorable local conditions. In the regional transgressive episode, these conditions possibly include the existence of inherited relief, and reduction in clastices in put the latter ecological permitted or increase growth of organisms and sediment logically prevent carbonates for being deposited or produced or diluted by clastics components. Shallow shelf deposition represented by tilt blocks, reflects similar sets of conditions privilege over layer area. It also appears that carbonates deposition ended at various times before and during the one set of evaporates deposition. The evaporate subjected to later erosion and their record was largely destroyed.
Methods:

1-the limestones calcined and slaked for the production of calcium hydroxide which has been blended with cement in different ratios and the results obtained Presented at table (2), moreover the kaolin calcined at((750-850°C) to metakaolin and mixed with lime at 1:1 ratio and the blended mixture with sand at 1:3 ratio. The result represented at the graph (1,2)

2-Hardening of the mortars was studied using standard mortar (50×50mm)) which were prepared in accordance with (the American standard testing methods]. Mortars were cured at the standard laboratory conditions (30 °C humid.) for 90 days. The progress of hardening was studied by means of mechanical strength test

3-Mechanical strength tests were carried out by unconfined compressive strength test using the standard mortar at 3, 7, 28, 60, 90 days of hardening.

4-The Scanning Electron Microscopes tested the some mortars and the results presented at graph (3)
The Geotechnical laboratory methods of limestones:

The geotechnical testing were carried out on the collected samples which prepared in cubic (5*5 according to ASTM) the Unconfined compressive strength and the Brazilians test which revealed the strength ranges from medium to low and other physical properties such as Bluck and dry density (range between 2.89-2.95) and water absorption were measured.

According to the geotechnical properties of the collected samples the water absorption, the Bulk specific gravity, and the strength are corresponding with the requirements of the dimensions stone used in building industry.
Three types of mortars were prepared as lime-cement mortars, and lime-calcinced kaolin mortar, the former with blend cement mortar of different blend ratio, but the later of lime to metakaolin ratio 1:1, the compressive strength was measured (Table 1). The mortars were prepared using standard quartz sand with maximum grain size of 2 mm [EN 196-1]. Binder/sand ratio of these mortars was kept 1:3 by weight. Concerning the former, lime was replaced at 30%-wt, 50%-wt and 70%-wt. with cement (Table 2). Two types of ternary blended mortars composed cement and lime, lime and metakaolin were prepared. The ratio of the kaolin was kept 50%-wt. for both compositions with varying Binder/sand ratio 1:3 (Table 2). Due to the higher porosity and specific Surface area of the metakaolin and lime than the cement, they have higher water absorption. This led to the use of much more water for the blended mortars to reach similar workability with the lime-cement mortars, resulting in different water/binder ratio.

Mortar compositions
Progress of hardening of the mortars was measured by the compressive strength in)
Progress of compressive strength of lime-cement mortar and lime- Meta kaolin-mortars is given in fig (2). While the lime- Meta kaolin mortar yielded the highest compressive strength values at all stages, these values became lower as lime was partially replaced with cement at 60%, 50% and 70%-wt. respectively. Whoever Lim-C.7-3 and lime-C6-4 mortars yielded an increasing compressive strength development until 90 days whereas lime 5-c5 revealed high strength at the 3,7,14,28 but no strength increase was recorded for the lime-C.5-5 mortar after 90 days or in long term strength.
Table (1) shows the mortar type, binder ratio and the compressive strength in accordance (ASTM, 1989).

<table>
<thead>
<tr>
<th>Mortar Type</th>
<th>W/binder</th>
<th>Binder Ratio</th>
<th>Binder</th>
<th>3 Days UCS (Mpa)</th>
<th>7 Days UCS (Mpa)</th>
<th>14 Days UCS</th>
<th>28 Days UCS</th>
<th>45 Days UCS</th>
<th>60 Days UCS</th>
<th>90 Days UCS</th>
<th>120 Days UCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime-Cement</td>
<td>0.65</td>
<td>60%-40%</td>
<td>L6-C4</td>
<td>2.6</td>
<td>2.73</td>
<td>2.85</td>
<td>2.9</td>
<td>4.1</td>
<td>4.8</td>
<td>5.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Lime-Cement</td>
<td>0.65</td>
<td>70%-30%</td>
<td>L7-C3</td>
<td>2.5</td>
<td>2.7</td>
<td>2.8</td>
<td>3.2</td>
<td>4.5</td>
<td>4.9</td>
<td>5.7</td>
<td>6</td>
</tr>
<tr>
<td>Lime-Cement</td>
<td>0.65</td>
<td>50%-50%</td>
<td>L5-C5</td>
<td>2.7</td>
<td>2.87</td>
<td>3.5</td>
<td>3.6</td>
<td>3.7</td>
<td>4.01</td>
<td>4.09</td>
<td>4.1</td>
</tr>
<tr>
<td>Lime-Metakaolin</td>
<td>0.71</td>
<td>50%-50%</td>
<td>L5-Ka5</td>
<td>2.78</td>
<td>3.1</td>
<td>3.98</td>
<td>4.2</td>
<td>4.6</td>
<td>5.2</td>
<td>5.9</td>
<td>6.5</td>
</tr>
</tbody>
</table>
RESULTS

Graph (1) shows the mortar with metakaolin in scanning electron microscope.
RESULTS

Graph (2) shows the mortar with metakaolin in scanning electron microscope.
Discussion:

Blended binders composed of lime-cement, and metakaolin-lime revealed different hardening reactions, strength development. Compressive strength results studied indicated that while hardening of the Lime c5-5 mortar was governed by the cement hydration, that of lime cement mortars occurred as a result of early-stage cement hydration combined with pozzolanic reaction and carbonation at later stage (Figure 5, 6, 7). Decrease in the calcium hydroxide content in the lime-cement mortars upon hardening gives evidence to its consumption by the pozzolanic reaction and carbonation. The carbonation reaction is much more pronounced with decreasing cement content and increasing porosity which favors the diffusion of the carbon dioxide into the core where calcium hydroxide is still present to carbonate [Van Balen and Van Gemert 1994]. The reaction started to appear much more after 60 days for lime-C.7-3 and after 28 days for lime-C.6-4. It is not that clear exactly when the pozzolanic reaction has started but it has probably started before 7 days and contributed to the formation of hydrated phases upon hardening as metakaolin is quite reactive.
Metakaolin-cement mortars

Metakaoline-cement mortars reached high strength values at 7 days, confirming that early-stage strength gain was mainly controlled by the rapid hydration of cement as well as pozzolanic reaction. Contribution of the pozzolanic reaction and carbonation to the strength development of these mortars is also evident as the strength values increased gradually until 60 days while no considerable increase was recorded in the strength of the lime cement mortar after 28 days (Figure 9). lime-C.7-3 and lime-C.5-5 mortars yielded an increasing long-term strength development whereas no strength increase was recorded for the lime-C.7-3 mortar after 90 days as it contained lower amounts of cement (30%-wt.) than the other blended mortars. All the lime cement mortars indicated a long-term strength development even though their strength values were increased gradually.
CONCLUSIONS & Recommendation

Hardening of cement in combination with metakaolin and lime occurs as a result of combined cement hydration, pozzolanic reaction and carbonation. Moreover Lime cement blended in different ratio the hardening occurs as a result of cement hydration and carbonation.

Limestone and dolomitic limestone, used either directly as crushed stone Lime stone at Khor Eit North of Port Sudan as building material as Dimention Stones and the results of characterization tests were used for production of new compatible mortars
REFERENCE


This standard is issued under the fixed designation C 911
7- Designation C-5-79 (1998), Standard Specifications of Quick Lime for Structural Purposes
10-Designation: C 305 – 99 Standard Practice for AMERICAN SOCIETY FOR TESTING AND MATERIALS-100 Barr Harbor Dr., West Conshohocken, PA 19428
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11- Designation: C 778 – 00 Standard Specification AMERICAN SOCIETY FOR TESTING AND MATERIALS-100 Barr Harbor Dr., West Conshohocken, PA 19428
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THE MOST IMPORTANT PROPERTY OF CEMENT-LIME MORTAR IN MASONRY CONSTRUCTION IS.


Thanks
Introduction

Lime-based mortars have been used in building construction for thousands of years. In the 1800s, the development of natural and portland cements provided architects and contractors a range of new properties with which to work. Cement provided the early hardness to speed masonry projects. By varying the level of cement and lime, the workability and strength of mortars could be modified. This paper describes the rational basis for the use of cement-lime mortars in masonry applications today. First, a description will be provided of cement-lime mortars and how they are specified. Key properties of cement-lime mortar will then be discussed. Research used to identify these properties will also be identified and discussed.