New Generation Geopolymeric Bricks

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PADRA CO.
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Padra Incubator Research areas of expertise:

- Waste management and construction materials
- Environment
- New generation bricks using waste-Derived aluminosilicate
Silico-aluminates based for bricks

\[
\begin{align*}
\text{Si:Al} &= 1 \\
\text{#1} &\text{ ortho-sialate} \\
\text{Si:Al} &= 2 \\
\text{#2} &\text{ ortho(sialate-siloxo)} \\
\text{#3} &\text{ ortho(sialate-siloxo)}
\end{align*}
\]
Raw materials:

1- Kaoline: the Kaoline based bricks were made with local kaoline from Esfahan

**Chemical composition of kaolin**

<table>
<thead>
<tr>
<th>component</th>
<th>SiO$_2$</th>
<th>Al$_2$O$_3$</th>
<th>Fe$_2$O$_3$</th>
<th>SO$_3$</th>
<th>MgO</th>
<th>CaO</th>
<th>Na$_2$O</th>
<th>K$_2$O</th>
<th>TiO$_2$</th>
<th>L.O.I</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>62.7</td>
<td>28.9</td>
<td>0.12</td>
<td>0.09</td>
<td>0.13</td>
<td>0.84</td>
<td>0.18</td>
<td>0.06</td>
<td>1.15</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Si:Al = 1.8-2  Kaolin% = 5.7:14 = 40-41% weight

2- Alkaline based reagents

3- Local Shale of Esfahan

**Chemical composition of shale**

<table>
<thead>
<tr>
<th>component</th>
<th>SiO$_2$</th>
<th>Al$_2$O$_3$</th>
<th>Fe$_2$O$_3$</th>
<th>SO$_3$</th>
<th>MgO</th>
<th>CaO</th>
<th>Na$_2$O</th>
<th>K$_2$O</th>
<th>L.O.I</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>40.83</td>
<td>22.66</td>
<td>19.25</td>
<td>0.13</td>
<td>0.46</td>
<td>1.43</td>
<td>0.69</td>
<td>0.96</td>
<td>9.43</td>
</tr>
</tbody>
</table>
Mixing

- Raw materials will be weighted accordingly based on the mixed design
- Materials will put into crusher respectively
- The water in the alkaline solution provides a reaction medium and assures the workability of the mixture during mixing and handling
Pressing

Hydraulic 300tons press machine with different molds sizes
Ordinary brick’s firing:

- Old dome type
- Gas consumption: 160-200 cubic meter per ton bricks.
- Process duration: 24-48 h +12 h drying=36-60 h

Geopolymeric brick’s firing:

- Old dome kiln
- Gas consumption: 50-60 cubic meter per ton bricks
- Process duration: 10-15 h (the whole process)
Old dome kiln

Tunnel kiln
# Standard parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>individual</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength MPa</td>
<td>11 (min)</td>
<td>14 (min)</td>
</tr>
<tr>
<td>Boiling water absorption(%)</td>
<td>*8-20</td>
<td>8-18</td>
</tr>
<tr>
<td>Active soluble salts%</td>
<td>-</td>
<td>0.6(max)</td>
</tr>
<tr>
<td>Freeze/thaw Resistance(weight loss %)</td>
<td>-</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Modulus of rupture(kg/cm²)</td>
<td>35(min)</td>
<td>40(min)</td>
</tr>
</tbody>
</table>

**M = Modulus Of Rupture**  
**P = Breaking Load**  
**L = Distance Between Knife Edges on which the Sample is Supported**  
**b = Average Specimen Breadth**  
**d = Average Specimen Depth**
# Standard test report

<table>
<thead>
<tr>
<th></th>
<th>individual</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength (MPa)</td>
<td>24.5</td>
<td>27.6</td>
</tr>
<tr>
<td>Boiling water absorption(%)</td>
<td>*8.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Active soluble salts%</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Freeze/thaw Resistance(weight loss%)</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td>Modulus of rupture(kg/cm²)</td>
<td>48</td>
<td>53</td>
</tr>
</tbody>
</table>

*water absorption could be less but in case of bricks we needed at least 8%
Benefits of geopolymeric bricks

- High Energy efficiency
- High Compressive strength
- High Modules of rupture
- Low shrinkage
- Fast setting
- Acid resistance
- Fire resistance
- Low thermal conductivity