Raw material mapping for use in LCC

Selected areas of Rajasthan and West Bengal

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WORLD CEMENT PRODUCTION BY REGION EVOLUTION 2001-2013

Index 2001 = 100

Source: CemBureau 2013
Cement Demand of India 2006-2015E (MT)

Source: World Press 2014
LC³ – a new blend
LC³ – a new blend

Do we have enough China clay?
Raw materials required for production of LC³

- Clinker
- Calcined kaolinitic clays
- Limestone
- Gypsum

Availability in India

- China clay
  - 2,705 million tonnes (ceramic grade)
- Limestone
  - 184,935 million tonnes (all grades)
- Gypsum
  - 1,286 million tonnes (mineral grade)

Source: Indian Minerals Yearbook 2011, Govt. of India,
China clay deposits of India

Leading producers of china clay:

- Gujarat 49%
- Kerala 27%
- Rajasthan 16%
- Jharkhand 4%
- West Bengal 3%
- Andhra Pradesh
- Karnataka
- Madhya Pradesh
- Odisha

China clay – found in 22 states

Source: Indian Minerals Yearbook 2011, Govt. of India,
Sourcing of china clay in Rajasthan

Geologic formation and sample collection areas:

- Bhilwara
- Merta
- Bikaner
Raw material quality – China clay

Tests conducted

- Phase analysis
  - X-ray diffraction
- Chemical analysis
  - X-ray fluorescence
- Thermo gravimetric analysis
  - Thermal analyzer
- Differential thermal analysis
  - Thermal analyzer

<table>
<thead>
<tr>
<th>Sample</th>
<th>Weight loss% (400-600°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>9.78</td>
</tr>
<tr>
<td>K2</td>
<td>10.46</td>
</tr>
<tr>
<td>K3</td>
<td>9.34</td>
</tr>
<tr>
<td>K4</td>
<td>9.78</td>
</tr>
<tr>
<td>K5</td>
<td>9.22</td>
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<tr>
<td>K6</td>
<td>7.64</td>
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<tr>
<td>K7</td>
<td>9.10</td>
</tr>
<tr>
<td>K8</td>
<td>5.07</td>
</tr>
</tbody>
</table>

60% kaolin

40% kaolin

All tests done by Aditya Birla Science and Technology Centre, Taloja, Mumbai
Analysis of West Bengal china clay

- 2 clays found and tested for:
  - Weight-loss
  - Chemical composition
  - Pozzolanicity
- Procurement cost from Rs. 300 to 3000 per tonne (CHF 4 to CHF 40)
- First clay commercially produced
- Second clay overburden (waste)

Tests done by Conmat Technologies, Kolkata
A typical china clay mines
### Analysis of West Bengal china clay

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Clay 1</th>
<th>Clay 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>43.30</td>
<td>55.78</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>36.35</td>
<td>17.46</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>2.56</td>
<td>8.89</td>
</tr>
<tr>
<td>TiO₂</td>
<td>2.56</td>
<td>0.46</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.076</td>
<td>1.93</td>
</tr>
<tr>
<td>MgO</td>
<td>0.27</td>
<td>0.59</td>
</tr>
<tr>
<td>CaO</td>
<td>0.46</td>
<td>4.84</td>
</tr>
<tr>
<td>LOI</td>
<td>13.94</td>
<td>9.49</td>
</tr>
<tr>
<td>Colour</td>
<td>White</td>
<td>Red</td>
</tr>
<tr>
<td>Max Kaolinite</td>
<td>79.10</td>
<td>28.00</td>
</tr>
</tbody>
</table>

Tests done by Calcutta University, Kolkata
West Bengal china clay calcination results

- Firing temperature of at least 800°C required for proper calcination
  - No formation of mullite

- Packing density of materials has an important role in calcination

- Good calcination achieved under static conditions after few trials

Tests done by Calcutta University, Kolkata
LCC blends prepared

Composition

- 50% clinker (CL)
- 15% limestone (LS)
- 30% calcined clay (CC)
- 5% gypsum (G)

Blends

- OPC
- LCC A: CC1 + LSA + CL + G
- LCC B: CC1 + LSB + CL + G
- LCC C: CC3 + LSA + CL + G
- LCC D: CC3 + LSB + CL + G
Pilot grinding of LCC blends
Mortar strength results

- OPC and PPC prepared from the same clinker

- Blends with high kaolinite content (80%) show better strength than OPC/PPC

- Very low grade waste overburden clay with low kaolinite content show acceptable strength than PPC/OPC
Conclusions

- Good quality china clay are available in both the states of Rajasthan and West Bengal

- Generally the china clay quality of Rajasthan is average compared to the high quality in West Bengal

- Poor quality china clay found as overburden is also available in large quantities

- It is possible to produce a general purpose cement with a substitution of
  - 15% clinker by crushed limestone
  - 30% calcined china clay of various grades
Acknowledgement

- Swiss Agency for Development and Cooperation
  - Cooperation support

- EPFL, Switzerland
  - Technical and Research guidance

- Aditya Birla Science and Technology Centre, Mumbai, India
  - Sample testing and analysis support

- Conmat Technologies, Kolkata, India
  - Sample testing and analysis support

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