Study of PLC hydration products using different qualities of limestone
François Avet, Karen L. Scrivener

Context
- The use of limestone as clinker substituent is nowadays common in Ordinary Portland Cement (OPC). The two main reasons explaining such replacement are economical and ecological, since it avoids producing higher amounts of clinker.
- The proportion of Portland Limestone Cement (PLC) should potentially increase in Thailand. But this increase requires higher quantity of good quality limestone. Since limestone resources are estimated to be only sufficient for half a century there, it becomes necessary to consider using lower grade limestone in PLC. Thus, impurities present in limestone are focused on in this study. Two main classes of contamination are known and present in limestone sources of Siam Cement Group (SCG): dolomite and quartz/clay.

Aims
The aims of this project are to study changes in hydration products of PLC with limestones containing different impurities, to compare results with high-quality limestone systems, and to study the limitations of using lower grade limestone for PLC production.

Materials

<table>
<thead>
<tr>
<th>Limestone</th>
<th>Calcite</th>
<th>Dolomite</th>
<th>Quartz/Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>99.2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>80.6</td>
<td>18.9</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>57.0</td>
<td>0</td>
<td>43.0</td>
</tr>
</tbody>
</table>

2 replacement rates to OPC: 7.5 and 15%

Compressive strength
High-quality and dolomitic limestone systems at 7.5% of substitution show similar compressive strengths to OPC at 28 days. For quartz/clay system, strength is slightly lower.

At 15% of substitution, strengths are more affected by the clinker content decrease, but are all equal at 28 days whatever the system.

Kinetics
Clinker hydration is enhanced with limestone. Besides, dolomite and quartz/clay do not seem to influence the heat released during hydration for each substitution rate compared to high-quality limestone system.

Porosity evolution
Pore size distribution is affected by limestone. Indeed, even if total porosity appears lower for OPC, there is a refinement of porosity for limestone systems, with a smaller pore threshold diameter.

Dolomitic systems show similar porosity as high-quality limestone systems. Quartz/clay systems might have slightly bigger pores and higher total porosity at 28 days.

Dimension stability
The limit value of shrinkage of 800 µstrain is reached at 15% of substitution for quartz/clay system due to the water adsorption by the clay.

Conclusion
- Dolomite does not significantly impact the hydration of Portland Limestone Cement, as well as the mechanical properties and the porosity. Thus, dolomitic limestone can be used in PLC production.
- Concerning quartz/clay-containing limestone, shrinkage is the main concern. Maximum tolerance is reached at 15% of substitution.

Acknowledgments: Financial support from Siam Cement Group