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# Calcined Clays for Sustainable Concrete

Proceedings of the 1st International  
Conference on Calcined Clays for  
Sustainable Concrete



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Editors

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# Preface

The most promising route to improving the sustainability of cement and concrete is to blend Portland cement clinker with substitution materials often referred to as supplementary cementitious materials (SCMs). However, supplies of the most common SCMs, which are slag and fly ash, are quite limited compared to the worldwide production of cement. Calcined clays are the most promising source of additional SCMs which can make a substantial contribution to lowering further the environmental impact of cement and concrete.

The book of proceedings of the international conference on the calcined clay for sustainable concrete contains papers written by practitioners and researchers from all continents. They brought together the advanced studies on the use of calcined clays in concrete. The topics covered are clays geology, hydration of blended cement, performance, alkali-activated binders, economical and ecological impacts and field applications.

The Editors would like to thank the authors for the outstanding contributions which reflect the scientific character of their work.

All papers were published without selection process to permit a full and truly international nature of these proceedings.

Finally, the Editors would like to thank the various organisations for their contribution and help in making these proceedings and conference a success.

Karen Scrivener  
Aur lie Favier

# Contents

## Part I Full Papers

<b>Sulphate and ASR Resistance of Concrete Made with Calcined Clay Blended Cements . . . . .</b>	<b>3</b>
André Trümer and Horst-Michael Ludwig	
<b>The Influence of Metakaolin on Limestone Reactivity in Cementitious Materials . . . . .</b>	<b>11</b>
Guillermo Puerta-Falla, Magdalena Balonis, Gwenn Le Saout, Narayanan Neithalath and Gaurav Sant	
<b>Sustainable Secondary Resources from Brazilian Kaolin Deposits for the Production of Calcined Clays . . . . .</b>	<b>21</b>
H. Pöllmann, M.L. Da Costa and R. Angelica	
<b>Carbonation of Blended Binders Containing Metakaolin . . . . .</b>	<b>27</b>
R. Bucher, M. Cyr and G. Escadeillas	
<b>Service Life and Environmental Impact Due to Repairs by Metakaolin Concrete After Chloride Attack . . . . .</b>	<b>35</b>
Aruz Petcherdchoo	
<b>Properties of Calcined Lias Delta Clay—Technological Effects, Physical Characteristics and Reactivity in Cement . . . . .</b>	<b>43</b>
N. Beuntner and K.Ch. Thienel	
<b>Alternative Binders Based on Lime and Calcined Clay . . . . .</b>	<b>51</b>
Harald Justnes and Tone A. Østnor	

<b>Optimization of Cements with Calcined Clays as Supplementary Cementitious Materials</b> . . . . .	59
Roland Pierkes, Simone E. Schulze and Joerg Rickert	
<b>Feasibility of Calcined Marl as an Alternative Pozzolanic Material</b> . . . . .	67
Tobias Danner, Harald Justnes, Geir Norden and Tone Østnor	
<b>From Ancient to Modern Sustainable Concrete</b> . . . . .	75
A. Tagnit-Hamou, M.T. Tognonvi, T. Davidenko and D.Z. Belkacemi	
<b>Pozzolanicity of Calcined Clay</b> . . . . .	83
Anjan K Chatterjee	
<b>Research on Properties of MK–CFBCA Mineral Admixtures</b> . . . . .	91
Guiming Wang, Ming Bao, Tao Sun, Shuxuan Xing and Kun Li	
<b>Optimization of Alkali Activated Portland Cement—Calcined Clay Blends Based on Phase Assemblage in the <math>\text{Na}_2\text{O}</math>–<math>\text{CaO}</math>–<math>\text{Al}_2\text{O}_3</math>–<math>\text{SiO}_2</math>–<math>\text{H}_2\text{O}</math> System</b> . . . . .	101
Erika Vigna and Jørgen Skibsted	
<b>Phase Assemblages in Hydrated Portland Cement, Calcined Clay and Limestone Blends From Solid-State <math>^{27}\text{Al}</math> and <math>^{29}\text{Si}</math> MAS NMR, XRD, and Thermodynamic Modeling</b> . . . . .	109
Zhuo Dai, Wolfgang Kunther, Sergio Ferreira, Duncan Herfort and Jørgen Skibsted	
<b>Heated Montmorillonite: Structure, Reactivity, and Dissolution</b> . . . . .	117
Nishant Garg and Jørgen Skibsted	
<b>Reactivity of Heated Kaolinite from a Combination of Solid State NMR and Chemical Methods</b> . . . . .	125
Cristina Ruiz-Santaquiteria and Jørgen Skibsted	

<b>Durability of Portland Cement Blends Including Calcined Clay and Limestone: Interactions with Sulfate, Chloride and Carbonate Ions . . . . .</b>	<b>133</b>
Zhenguo Shi, Mette R. Geiker, Klaartje De Weerd, Barbara Lothenbach, Josef Kaufmann, Wolfgang Kunther, Sergio Ferreira, Duncan Herfort and Jørgen Skibsted	
<b>Thermodynamic Modeling of Portland Cement—Metakaolin—Limestone Blends . . . . .</b>	<b>143</b>
Wolfgang Kunther, Zhuo Dai and Jørgen Skibsted	
<b>Comparison of the Pozzolanic Reactivity for Flash and Soak Calcined Clays in Portland Cement Blends . . . . .</b>	<b>151</b>
Kasper E. Rasmussen, Mette Moesgaard, Lea L. Køhler, Thuan T. Tran and Jørgen Skibsted	
<b>The Impact of VMA on the Rheology, Thixotropy and Robustness of Self-compacting Mortars . . . . .</b>	<b>159</b>
Farid Van Der Vurst, Steffen Grünewald and Geert De Schutter	
<b>Calcined Coal Gangue and Clay Shale for Cementitious Materials Without Clinker . . . . .</b>	<b>169</b>
Huiwen Wan and Zhifei Gao	
<b>Red Ceramic Wastes: A Calcined Clay Pozzolan . . . . .</b>	<b>179</b>
Viviana Rahhal, Zbyšek Pavlík, Monica Trezza, Cristina Castellano, Alejandra Tironi, Tereza Kulovaná, Jaroslav Pokorný, Robert Černý and Edgardo F. Irassar	
<b>Assessment of Sustainability of Low Carbon Cement in Cuba. Cement Pilot Production and Prospective Case . . . . .</b>	<b>189</b>
Sofía Sánchez Berriel, Yudiesky Cancio Díaz, José Fernando Martirena Hernández and Guillaume Habert	
<b>Ternary Blended Cement with Limestone Filler and Kaolinitic Calcined Clay . . . . .</b>	<b>195</b>
Alejandra Tironi, Alberto N. Scian and Edgardo F. Irassar	
<b>Blended Cements with Kaolinitic Calcined Clays: Study of the Immobilization of Cr(VI) . . . . .</b>	<b>203</b>
Mónica A. Trezza, Alejandra Tironi, Edgardo F. Irassar and Alberto N. Scian	

<b>The Efficacy of Calcined Clays on Mitigating Alkali-Silica Reaction (ASR) in Mortar and Its Influence on Microstructure . . . . .</b>	<b>211</b>
Chang Li, Jason H. Ideker and Thanos Drimalas	
<b>Influence of MK-Based Admixtures on the Early Hydration, Pore Structure and Compressive Strength of Steam Curing Mortars . . . . .</b>	<b>219</b>
Jinlong Han, Zhonghe Shui, Guiming Wang, Jiancong Shao and Yun Huang	
<b>Design and Preparation of Metakaolin-Based Mineral Admixture and its Effects on the Durability of Concrete . . . . .</b>	<b>229</b>
Zhonghe Shui, Kai Yuan, Tao Sun, Qiu Li and Weineng Zeng	
<b>Reactivity and Microstructure of Calcined Marl as Supplementary Cementitious Material . . . . .</b>	<b>237</b>
Tone Østnor, Harald Justnes and Tobias Danner	
<b>Assessing the Synergistic Effect of Limestone and Metakaolin . . . . .</b>	<b>245</b>
D. Nied, C. Stabler and M. Zajac	
<b>Study on Influence of Limestone Powder on the Fresh and Hardened Properties of Early Age Metakaolin Based Geopolymer. . . . .</b>	<b>253</b>
Jiang Qian and Mu Song	
<b>Evaluation of the Permeation Properties of Concrete Added with a Petrochemical Industry Waste . . . . .</b>	<b>261</b>
Nancy Torres Castellanos, Janneth Torres Agredo and Ruby Mejía de Gutiérrez	
<b>Calcined Illitic Clays as Portland Cement Replacements . . . . .</b>	<b>269</b>
Roxana Lemma, Edgardo F. Irassar and Viviana Rahhal	
<b>Low Carbon Cement: Durability Performance Assessment with Laboratory and Site Tests . . . . .</b>	<b>277</b>
Ernesto Díaz, Fernando Martirena, Adrian Alujas and Roberto Torrent	
<b>Influence of the Manufacturing Process on the Performance of Low Clinker, Calcined Clay-Limestone Portland Cement . . . . .</b>	<b>283</b>
A. Perez, A. Favier, F. Martirena and K. Scrivener	



<b>Development of Room Temperature Curing Geopolymer from Calcined Water-Treatment-Sludge and Rice Husk Ash . . . . .</b>	<b>291</b>
Anurat Poowancum, Ekkasit Nimwinya and Suksun Horpibulsuk	
<b>Characterising the Reaction of Metakaolin in an Alkaline Environment by XPS, and Time- and Spatially-Resolved FTIR Spectroscopy . . . . .</b>	<b>299</b>
John L. Provis, Syet Li Yong and Jannie S.J. van Deventer	
<b>From a View of Alkali Solution: Alkali Concentration to Determine Hydration Process of Alkali Activating Metakaolin . . . . .</b>	<b>305</b>
Mu Song, Jiang Qian, Liu J. Zhong and Shi Liang	
<b>What Happens to 5 Year Old Metakaolin Geopolymers' the Effect of Alkali Cation . . . . .</b>	<b>315</b>
Susan A. Bernal, Jannie S.J. van Deventer and John L. Provis	
<b>Development and Introduction of a Low Clinker, Low Carbon, Ternary Blend Cement in Cuba . . . . .</b>	<b>323</b>
Jose Fernando Martirena Hernandez and Karen Scrivener	
<b>Influence of Calcination Temperature in the Pozzolanic Reactivity of a Low Grade Kaolinitic Clay . . . . .</b>	<b>331</b>
Adrián Alujas and J. Fernando Martirena	
<b>Pozzolanic Reactivity of Low Grade Kaolinitic Clays: Influence of Mineralogical Composition . . . . .</b>	<b>339</b>
Adrián Alujas, Roger S. Almenares, Sergio Betancourt and Carlos Leyva	
<b>Industrial Manufacture of a Low-Clinker Blended Cement Using Low-Grade Calcined Clays and Limestone as SCM: The Cuban Experience . . . . .</b>	<b>347</b>
L. Vizcaino, M. Antoni, A. Alujas, F. Martirena and K. Scrivener	
<b>Development of Low Cost Geopolymer from Calcined Sedimentary Clay . . . . .</b>	<b>359</b>
Anurat Poowancum and Suksun Horpibulsuk	
<b>Hydrothermal Synthesis Products of CaO Metakaolin H<sub>2</sub>O System at 90 °C. . . . .</b>	<b>365</b>
Mian Sun, Tao Sun, Weiwei Han, Guiming Wang and Mingjun Mei	

<b>Reactivity of Calcined Clay in Alite-Calcium Sulfoaluminate Cement Hydration</b> . . . . .	373
Natechanok Chitvoranund, Barbara Lothenbach, Sakprayut Sinthupinyo and Frank Winnefeld	
<b>Primary Kaolin Waste as Pozzolan Material in Dry Concrete: Mechanical Properties and Resistance to Attack by Sulphates</b> . . . . .	381
M.L.S. Rezende, J.W.B. Nascimento, G.A. Neves and H.C. Ferreira	
<b>The Influence of Cavitation Treatment on Amorphization of Kaolinite in the Dispersion of the “Kaolin—<math>\text{Na}_2\text{O} \cdot n\text{SiO}_2 \cdot m\text{H}_2\text{O}</math>—<math>\text{NaOH}</math>—<math>\text{H}_2\text{O}</math>” Composition</b> . . . . .	387
P. Krivenko, S. Guziy and J. Abdullah Al Musa	
<b>Role of Metakaolin on Lowering pH of the Alkali Activated Cement Concrete in Barrier Application</b> . . . . .	395
P. Krivenko, O. Petropavlovsky and E. Kavalerova	
<b>Protocol for Prediction of Durability of New Cements: Application to <math>\text{LC}^3</math></b> . . . . .	403
Aneeta Mary Joseph, Vineet Shah and Shashank Bishnoi	
<b>The Role of Calcined Clay Cement vis a vis Construction Practices in India and Their Effects on Sustainability</b> . . . . .	411
Arun C. Emmanuel, Anuj Parashar and Shashank Bishnoi	
<b>Testing of Suitability of Supplementary Materials Mixed in Ternary Cements</b> . . . . .	419
Anuj Parashar, Sreejith Krishnan and Shashank Bishnoi	
<b>Compatibility of Superplasticizers with Limestone-Metakaolin Blended Cementitious System</b> . . . . .	427
Behnaz H. Zaribaf, Burak Uzal and Kimberley Kurtis	
<b>Field Application of Limestone-Calcined Clay Cement in India</b> . . . . .	435
Soumen Maity, Shashank Bishnoi and Arun Kumar	
<b>Raw Material Mapping in Selected Areas of Rajasthan and West Bengal and Their Suitability for Use in Low Carbon Cement Production</b> . . . . .	443
Soumen Maity and Shashank Bishnoi	

<b>Suitability of Raw Materials in Gujarat for Production of Low Carbon Cement . . . . .</b>	<b>451</b>
Palas K. Haldar and Soumen Maity	
<b>Effects of Metakaolin on Nanomechanical Properties of Cement Paste . . . . .</b>	<b>459</b>
Salim Barbhuiya and PengLoy Chow	
<b>Meta-Kaolin for High Performance Concrete . . . . .</b>	<b>467</b>
Sui Tongbo, Wang Bin, Zhang Lijun and Cheng Zhifeng	
<b>Clay Activation and Color Modification in Reducing Calcination Process: Development in Lab and Industrial Scale . . . . .</b>	<b>479</b>
Fabiano F. Chotoli, Valdecir A. Quarcioni, Sérgio S. Lima, Joaquim C. Ferreira and Guilherme M. Ferreira	
<b>Experimental Study on Evolution of Pore Structure of Cementitious Pastes Using Different Techniques . . . . .</b>	<b>487</b>
D. Yuvaraj and Manu Santhanam	
<b>Various Durability Aspects of Calcined Kaolin-Blended Portland Cement Pastes and Concretes . . . . .</b>	<b>491</b>
M. Saillio, V. Baroghel-Bouny and S. Pradelle	
<b>Economic Implications of Limestone Clinker Calcined Clay Cement (LC<sup>3</sup>) in India . . . . .</b>	<b>501</b>
Shiju Joseph, Aneeta Mary Joseph and Shashank Bishnoi	
<b>Fresh and Mechanical Properties of High Strength Self Compacting Concrete Using Metakaolin . . . . .</b>	<b>509</b>
S.N. Manu and P. Dinakar	
<b>Effective Clinker Replacement Using SCM in Low Clinker Cements . . . . .</b>	<b>517</b>
Sreejith Krishnan, Arun C. Emmanuel and Shashank Bishnoi	
<b>Durability Characteristics of Sustainable Low Clinker Cements: A Review . . . . .</b>	<b>523</b>
Vineet Shah, Aneeta Mary Joseph and Shashank Bishnoi	

<b>Calcined Shale as Low Cost Supplementary Cementitious Material</b> .....	531
Saamiya Seraj, Rachel Cano, Raissa P. Ferron and Maria C.G. Juenger	
<b>Development of a New Rapid, Relevant and Reliable (R<sup>3</sup>) Testing Method to Evaluate the Pozzolanic Reactivity of Calcined Clays</b> .....	539
F. Avet, R. Snellings, A. Alujas and K. Scrivener	
<b>Investigation of Ternary Mixes Made of Clinker Limestone and Slag or Metakaolin: Importance of Reactive Alumina and Silica Content</b> .....	545
M. Antoni, L. Baquerizo and T. Matschei	
<b>Using of Libyan Calcined Clay in Concrete</b> .....	555
Abdelsalam M. Akasha	
 <b>Part II Abstracts</b>	
<b>Physical, Mineralogical and Chemical Characterization of Venezuelan Kaolins for Use as Calcined Clays in Cement and Concrete</b> .....	565
Fuentes Irania, Martínez Francis, Reátegui Katya and Bastos Vannesa	
<b>Pozzolanic Potential of the Calcined Clay-Lime System</b> .....	567
Sofie Hollanders, Özlem Cizer and Jan Elsen	
<b>Effect of Metakaolin on the Drying Shrinkage Behaviour of Portland Cement Pastes</b> .....	569
Duyou Lu, Jingwang Luo and Zhongzi Xu	
<b>BIND-AMOR: Reuse of Dredged Sediments as Supplementary Cementitious Materials</b> .....	571
Liesbeth Horckmans, Ruben Snellings, Peter Nielsen, Philippe Dierckx, Joris Dockx, Jos Vandekeybus, Özlem Cizer, Lucie Vandewalle, Koen Van Balen and Lea Lindequist Kohler	
<b>Influence of Mineral Impurities on the Pozzolanic Reactivity of Metakoalin</b> .....	573
Sofie Hollanders, Özlem Cizer and Jan Elsen	

<b>Fresh Properties of Limestone Calcined Clay Cement (LC<sup>3</sup>)</b>	
<b>Pastes</b> . . . . .	575
Sendhil Vigneshwar and Prakash Nanthagopalan	
<b>Alkali Silica Reaction Mitigating Properties of Ternary Blended Cement with Calcined Clay and Limestone</b> . . . . .	577
Aur�lie R. Favier, Cyrille F. Dunant and Karen L. Scrivener	
<b>Autogenous Shrinkage of Limestone and Calcined Clay Cements</b> . . . . .	579
J. Ston and K. Scrivener	
<b>Sustainable Benefits of a Low Carbon Cement Based Building</b> . . . . .	581
Kriti Nagrath and Soumen Maity	
<b>CO<sub>2</sub> Abatement During Production of Low Carbon Cement</b> . . . . .	583
Bhaskar Dutta and Soumen Maity	
<b>Role of Blended Cement in Reducing Energy Consumption</b> . . . . .	585
Bhaskar Dutta and Soumen Maity	
<b>Investigation of Sulphate Attack on Limestone-Calcined Clay Cement Mortars</b> . . . . .	587
Fathima Suma and Manu Santhanam	
<b>Experimental Study of the Flow Behaviour of Superplasticized Pastes with Cement-Calcined Clay-Limestone Blends</b> . . . . .	589
B. Karmugil and Ravindra Gettu	
<b>Hydration Properties of Cement Pastes with Recycled Demolition Waste from Clay Bricks and Concrete</b> . . . . .	591
Thiago Melo Grabo�s, Guilherme Chagas Cordeiro and Romildo Dias Toledo Filho	
<b>Calcined Natural Clays: Performance Evaluation as Cementitious Material</b> . . . . .	593
Nikola Mikanovic, Michael Hoffs�ns, Diego Rosani and Inga Hauschildt	

<b>Rheology of Limestone Calcined Clays Cement Pastes. A Comparative Approach with Pure Portland Cement Pastes . . . . .</b>	<b>595</b>
Lukas Gebbard, Blandine Feneuil, Marta Palacios and Nicolas Roussel	
<b>Chloride-Induced Corrosion Rates of Steel Embedded in Mortar with Ordinary Portland and Limestone Calcined Clay Cements (OPC and LC3) . . . . .</b>	<b>597</b>
Sripriya Rengaraju and Radhakrishna G. Pillai	

**Part I**  
**Full Papers**





# Sulphate and ASR Resistance of Concrete Made with Calcined Clay Blended Cements

André Trümer and Horst-Michael Ludwig

**Abstract** This paper presents the results of several investigations concerning the durability of mortar and concrete with higher proportion of calcined clays in the cement part. For this purpose, different clays based on kaolinite, montmorillonite and illite were fired at optimum temperatures according to the strength contribution in cement. The raw materials were analyzed chemically (XRF) and mineralogically (XRD). The pore size distribution of the mortars was measured by mercury intrusion porosimetry. Cement pastes were produced in order to calculate the phase composition by XRD/Rietveld and to estimate the microstructure with SEM. The performance tests comprised investigations of the long-term behaviour in case of sulphate attack and alkali silica reaction respectively. The results show that the addition of the calcined clays are able to improve the concrete resistance against these exposures or at least doesn't affect it negatively compared to the control. It can be followed that the application of cements with higher percentage of calcined clays substituting clinker is not restricted to only slightly loaded concrete constructions.

## 1 Introduction

A lot of work has been spent on the activation of raw clays by means of firing. Several authors could show that this treatment is suitable for producing supplementary cementitious materials (SCM) [1–6], which are intended to substitute bigger amounts of clinker in cement in order to save energy, CO<sub>2</sub> and finally costs. These studies predominantly focus on the pozzolanic activities of the fired clays in the binding material resulting in an optimum strength of the composite cement. But only little effort has been spent to investigate the effects on the concrete durability. Concerning this aspect, only data for highly reactive metakaolin exist [7–10], which is not a suitable material for normal concrete due to its price. In most applications, the

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