Imperial College London

INFLUENCE OF SUPPLEMENTARY CEMENTITIOUS MATERIALS ON PORE STRUCTURE AND TRANSPORT PROPERTIES OF CEMENT PASTES

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INTRODUCTION

In order to reduce the carbon footprint in cement production, secondary cementitous materials (SCMs) are implemented. This project focuses on the understanding the influence of pore structure and transport properties with the addition of different SCMs.

BACKSCATTERED ELECTRON MICROSCOPY

The microstructures of the samples were acquired by using the CamScan Apollo 300 scanning electron microscope. Capturing the 2D images, the pore structures can be characterised by the porosity and the specific surface. The degree of hydration of cement can also be obtained from the images.

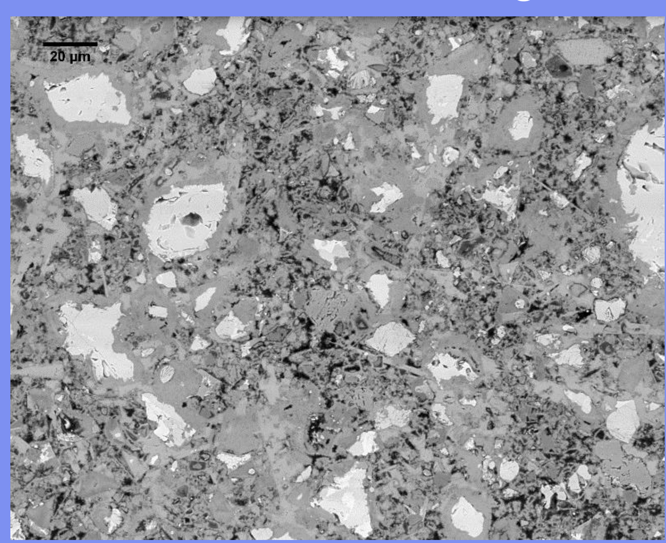
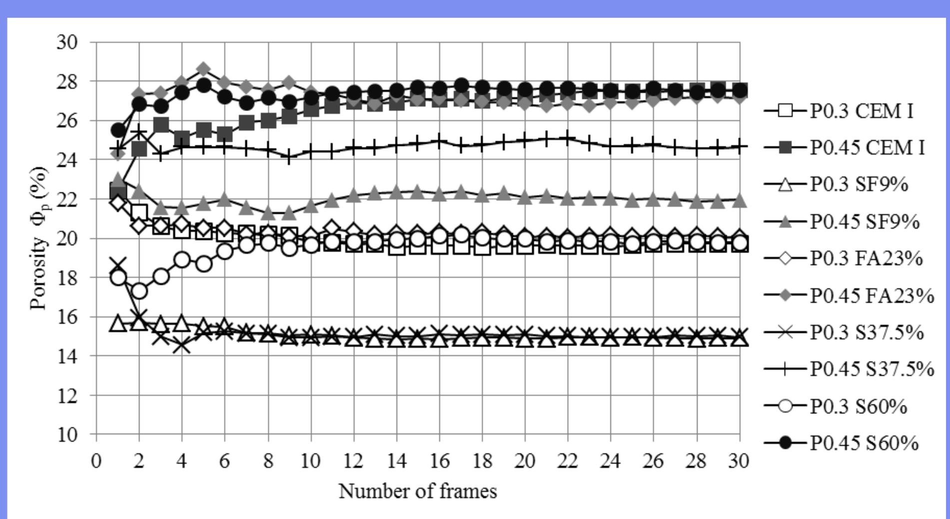
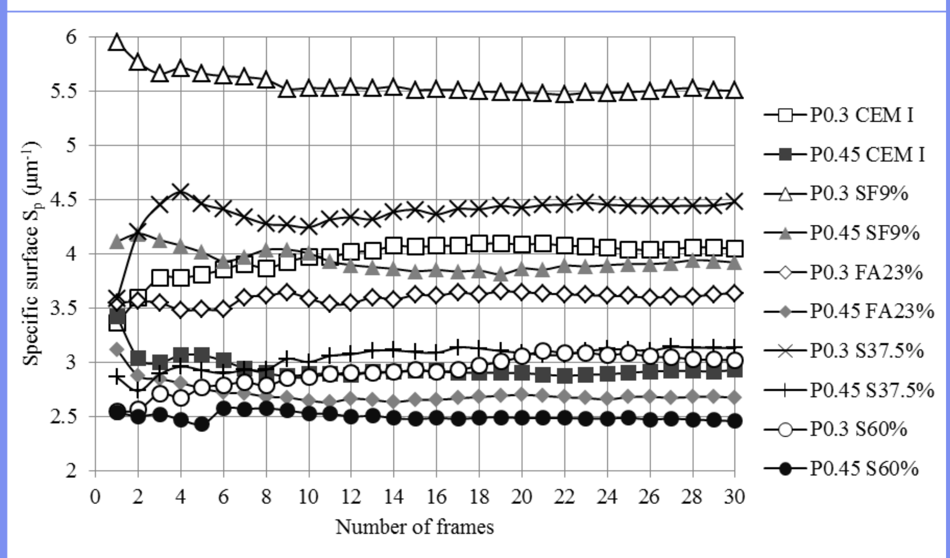


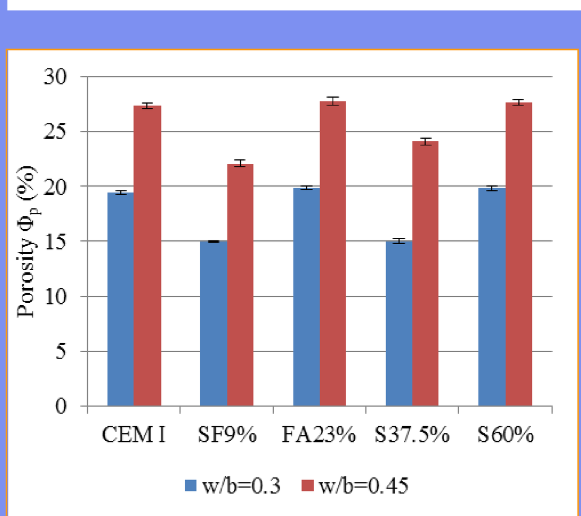
IMAGE ANALYSIS

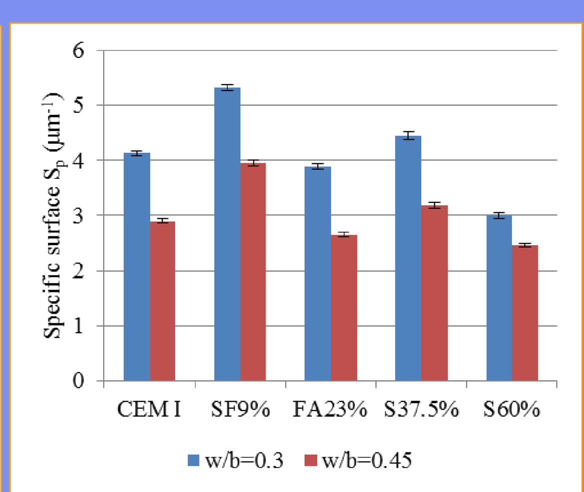


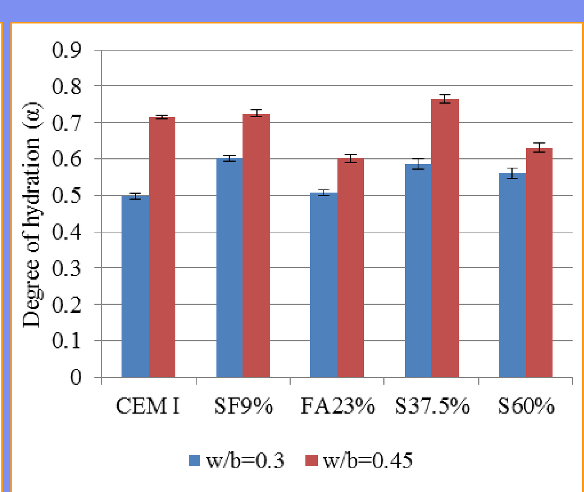


The porosity and specific surface reached a steady value after analysing thirty images. This indicates that the measurements are accurate and increases in the number of frames with the same resolution will not improve the measurements significantly.

Image analysis results show that samples with 0.3 water/binder ratio have a denser pore structure than those with 0.45. Among different SCMs, samples with silica fume resulted in the best pore refinement.







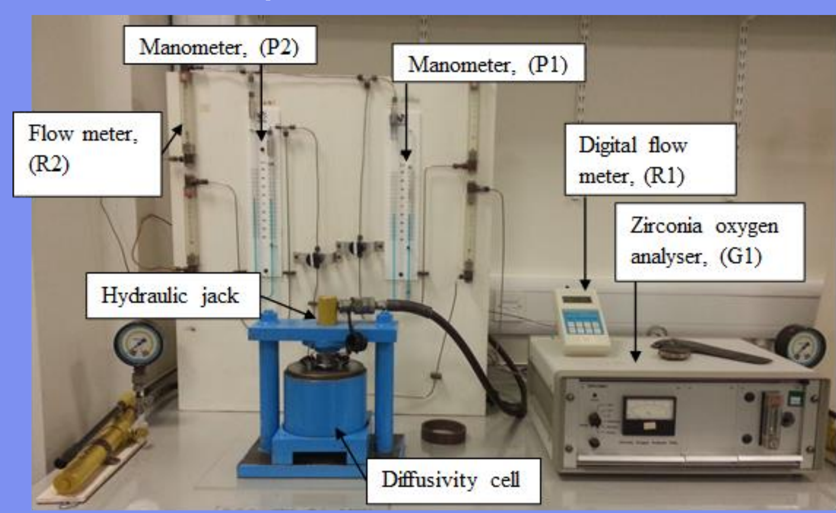
SAMPLE PREPARATION

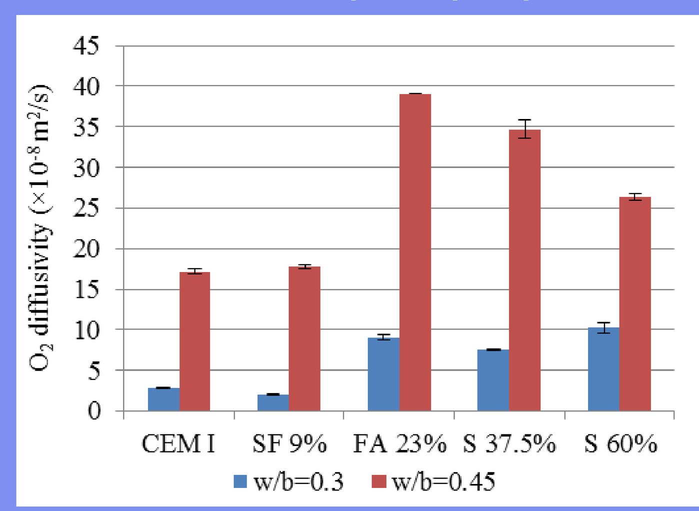
Sample type	Paste				
Water/ Binder ratio	0.3/0.45				
Binder system	CEM I	CEM I + 9% SF	CEM I + 23% FA	CEM I + 37.5% GGBS	CEM I + 60% GGBS
Curing	Cure in fog room with 100% RH for 7 days				

Samples were prepared with different water/binder ratio, types of SCMs and SCM ratio in order to investigate the different resulting pore structures and transport properties.

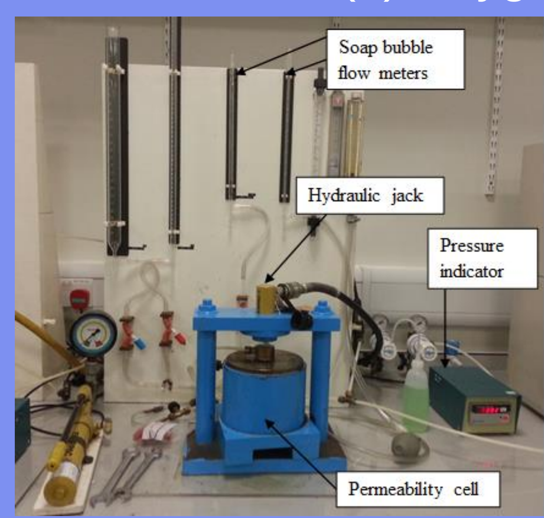
TRANSPORT PROPERTIES

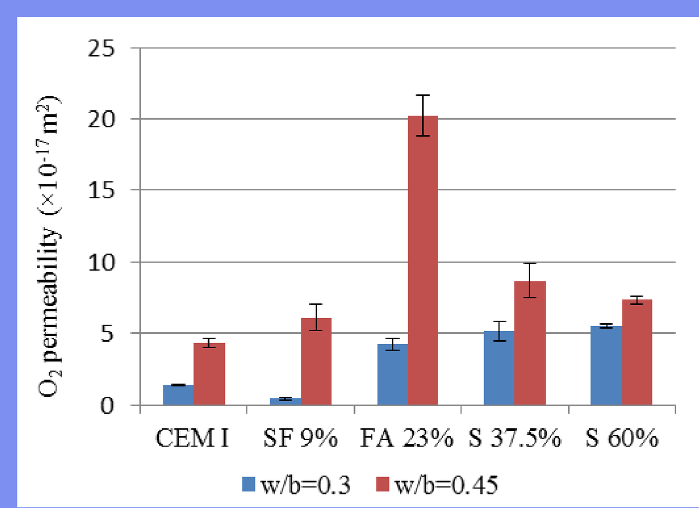
The samples were conditioned to constant mass. Then the mass transport tests were carried out in the sequence of oxygen diffusion, oxygen permeation, water absorption and electrical conduction in order to obtain the transport coefficients that characterise the transport properties.



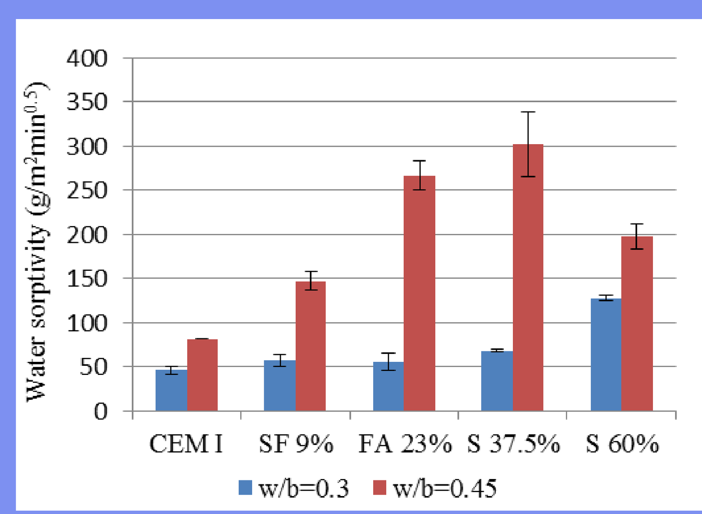


(a) Oxygen diffusion.

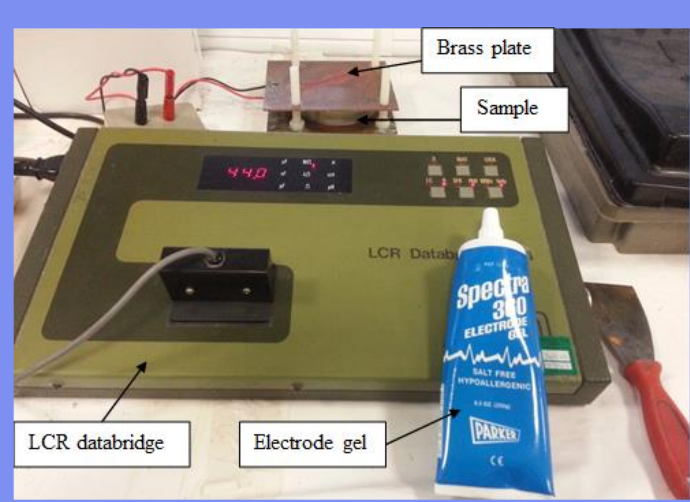


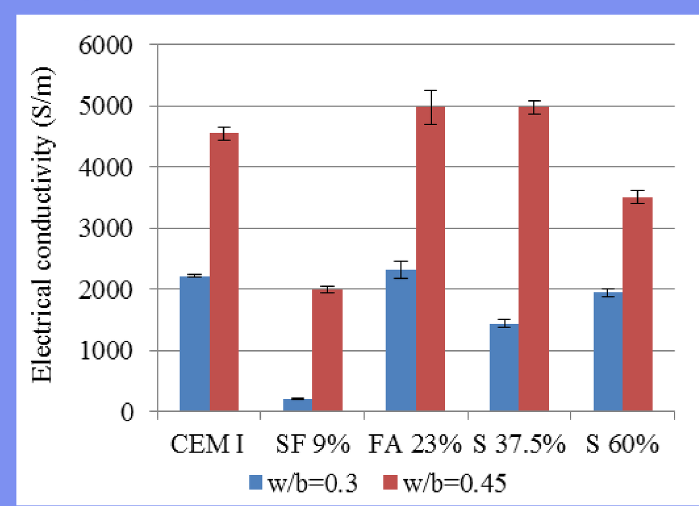


(b) Oxygen permeation.



(c) Water absorption.





(d) Electrical conduction.

CONCLUSION

Although the effect of SCMs were not appreciated in the early age, samples with 9% silica fume gave the most remarkable positive effect in transport properties and pore refinement as it can serve as pore filler due to small particle size. On the other hand, samples with 60% slag (w/b=0.3) and 23% fly ash (w/b=0.45) performed the worst in pore refinement and transport properties due to slow pozzolanic reaction and poor pore filling effect.

ACKNOWLEDGEMENTS

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REFERENCES

Wong, H. S., Buenfeld, N. R. & Head, M. K. (2006) Estimating transport properties of mortars using image analysis on backscattered electron images. *Cement and Concrete Research*, 36 (8), 1556-66.