

DURABILITY PROPERTIES OF CONCRETE CONTAINING METAKAOLIN

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ABSTRACT

As a means of possible utilization of kaolin clay, metakaolin was incorporated in concrete to enhance its durability properties in terms of concrete penetrability, resistance to carbonation, and mitigation of Alkali Silica Reaction (ASR). The results showed that, with increasing metakaolin content, the transport properties of concrete were improved. Metakaolin also enhanced resistance to carbonation and successfully mitigated ASR. It was concluded that metakaolin has a high potential for improving durability properties of Western Cape concrete.



Fig. 3. Initially kaolin clay was used to make ceramics, porcelains and cosmetics [3]



REFERENCES

- R. Siddique and J. Klaus, "Influence of metakaolin on the properties of mortar and concrete: A review," Appl. Clay Sci., vol. 43, pp. 392–400, 2008.
- D. I. Cole, L. Ngcofe, and K. Halenyane, "Mineral commodities in the Western Cape province, South Africa," Report Number 2014-0012. Western Cape: Council of Geoscience, 2014.
- Google

INTRODUCTION

Environmental impacts associated with cement production as well as deterioration of concrete structures (Fig.1) have led to the adoption of Supplementary Cementitious Materials (SCMs) as partial substitutes for cement. Metakaolin (Fig. 2), as an SCM, has recently been the subject of attention due to its benefits in improving structural and durability properties of concrete.

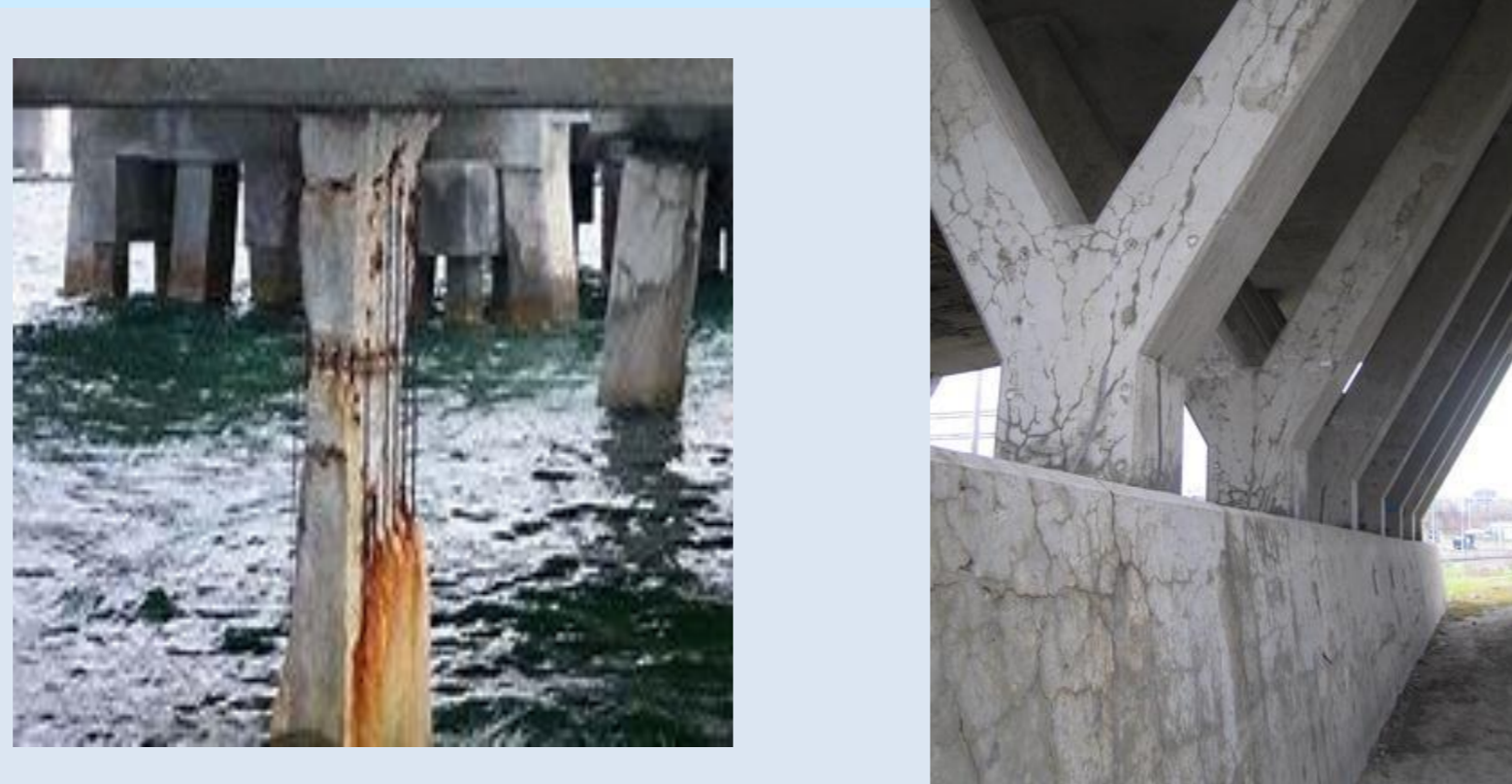


Fig. 1. Chloride and ASR attacks on the concrete structures [3]

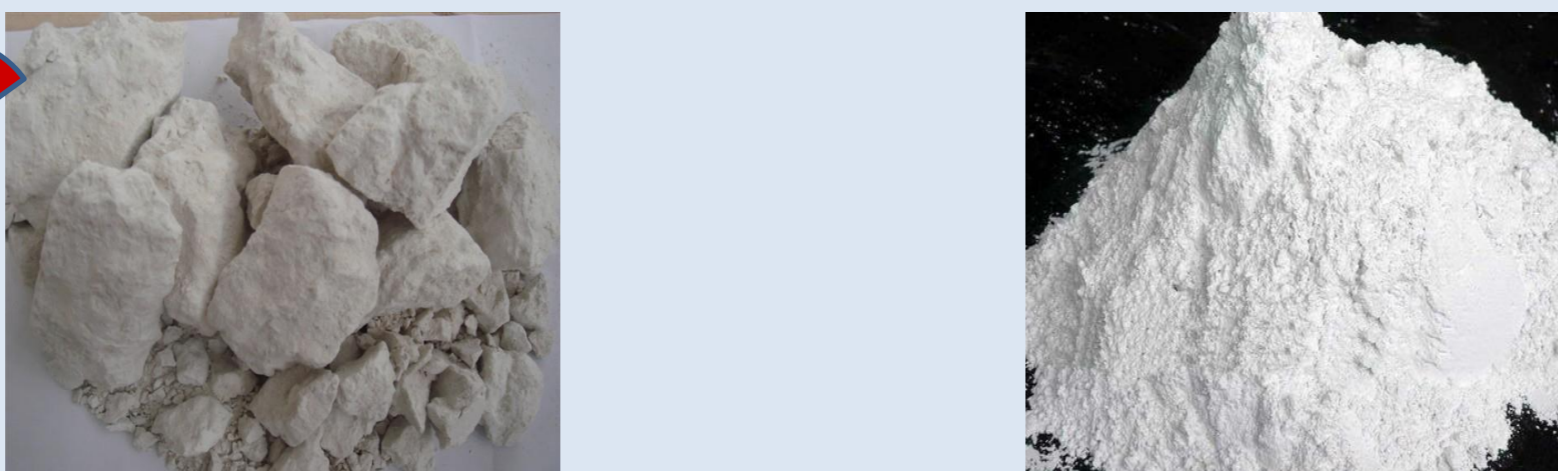
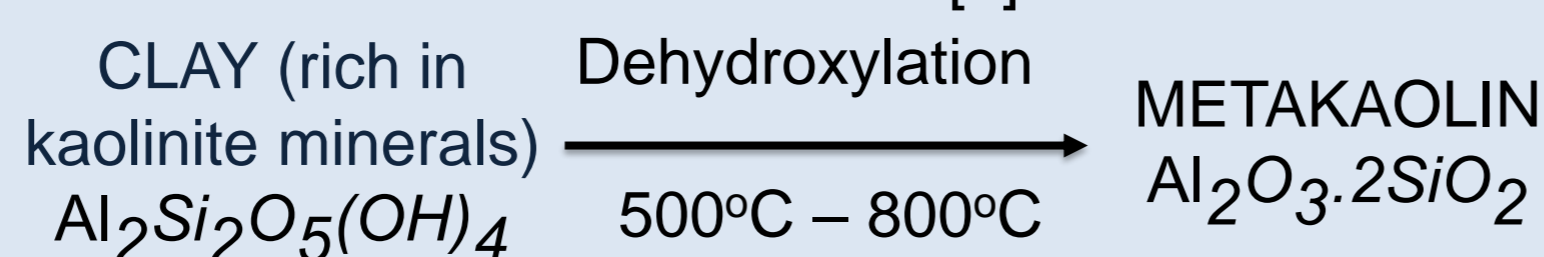


Fig 2. Derivation of metakaolin from clay with kaolinite minerals[3]

OBJECTIVE AND METHODS

To investigate durability performance of Concrete with metakaolin

Penetrability; Durability Index tests

Carbonation; Accelerated carbonation test

Alkali Silica Reaction (ASR); Accelerated Mortar bar test

MATERIALS AND MIX DESIGN

Table 1. Materials and concrete mix design

Variable	kg/m ³			METAKAOLIN (mk) rates;
w/b	0.4	0.5	0.6	
CEM II A/L 52.5 N	463	370	308	• 0% mk
Water	185	185	185	(Control)
Greywacke aggregates	1000	1000	1000	• 10% mk
Dune Sand	544	597	633	• 15% mk
Crusher sand	305	335	355	• 20% mk
Total	2497	2487	2481	

RESULTS AND DISCUSSION

Durability Index (DI) results (SANS 3001-CO3-1&2)

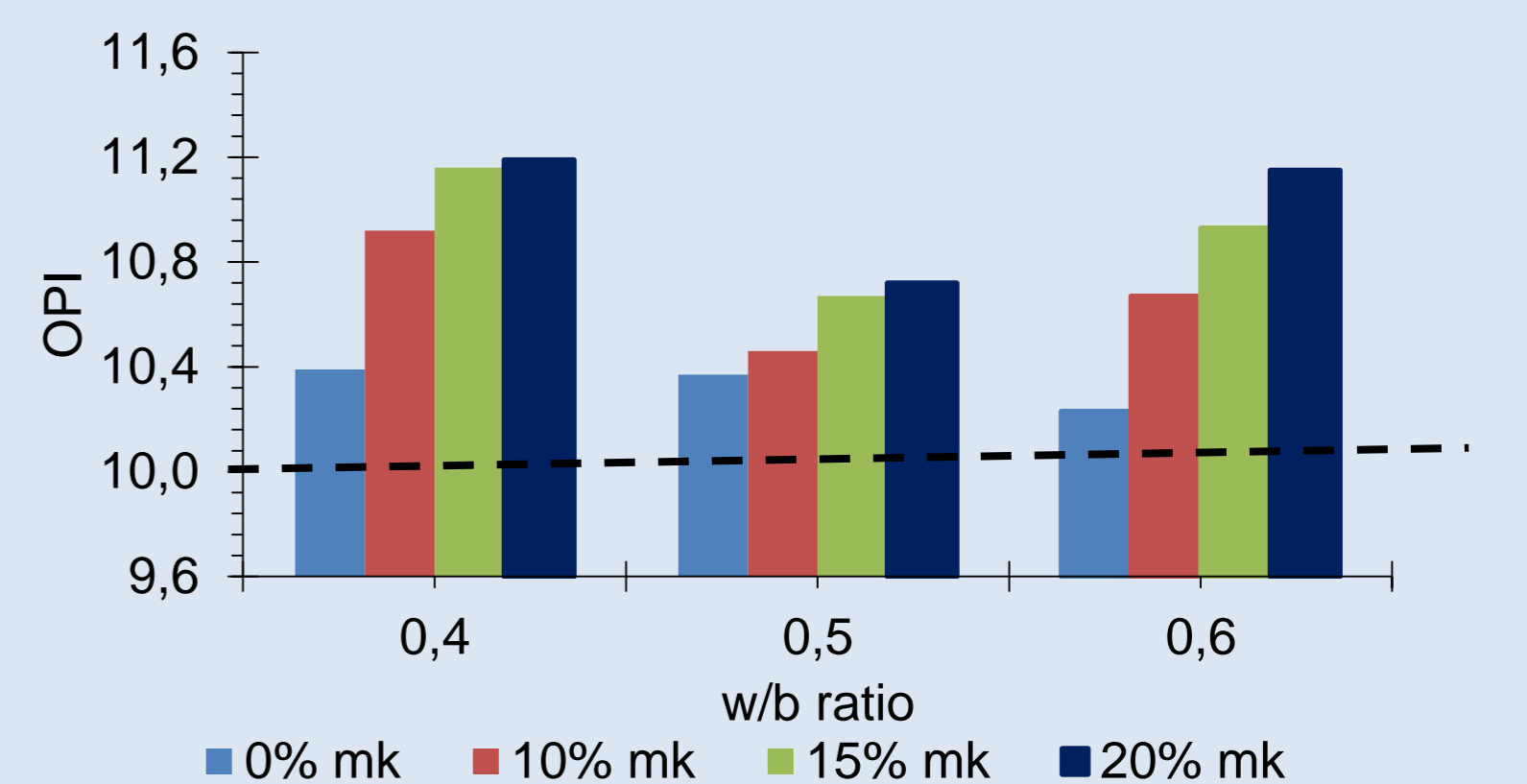


Fig. 4. Oxygen Permeability Index (OPI) test results

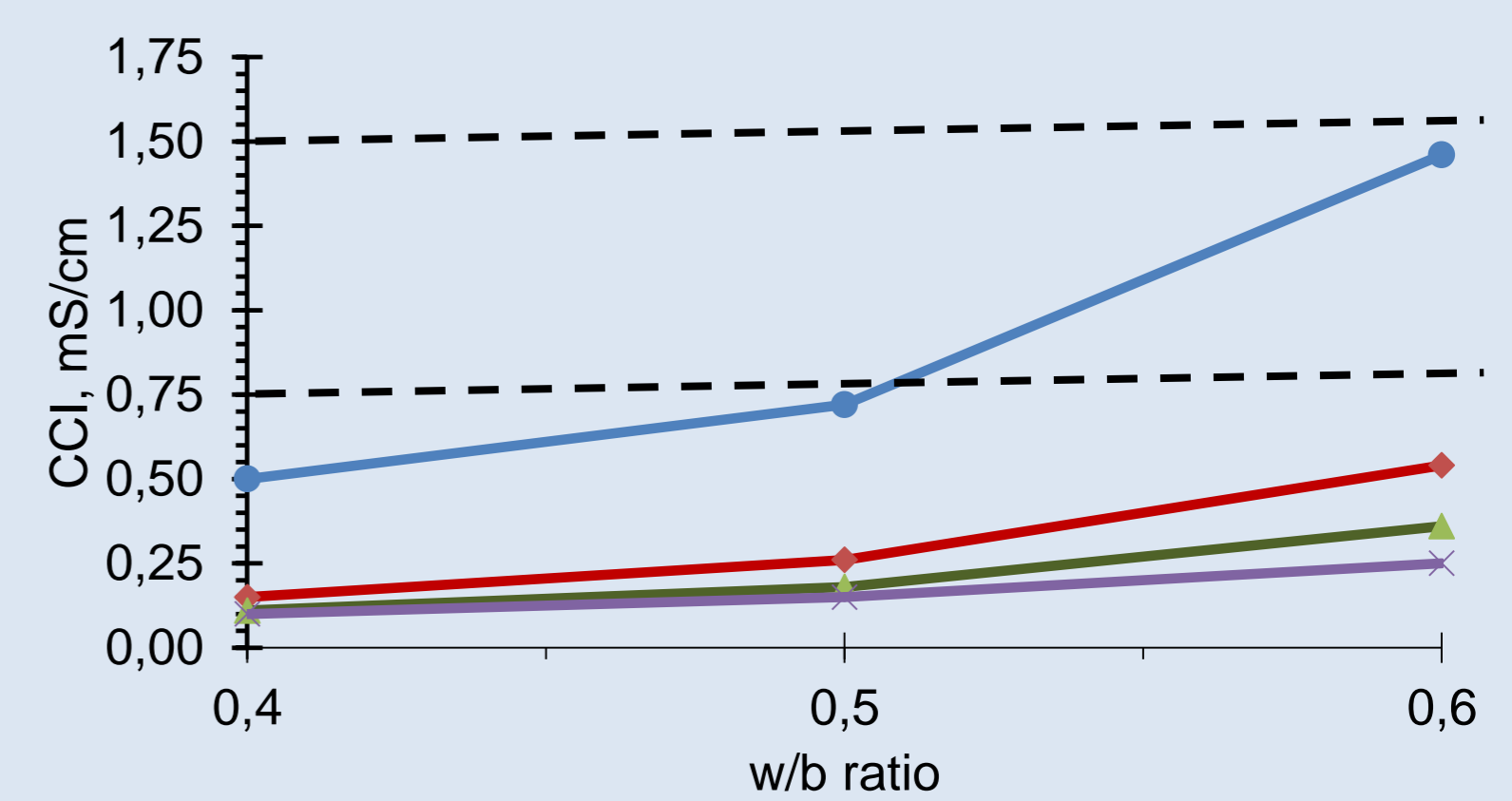


Fig. 5. Chloride Conductivity Index (CCI) test results

Accelerated Carbonation test results (RILEM CPC-18)

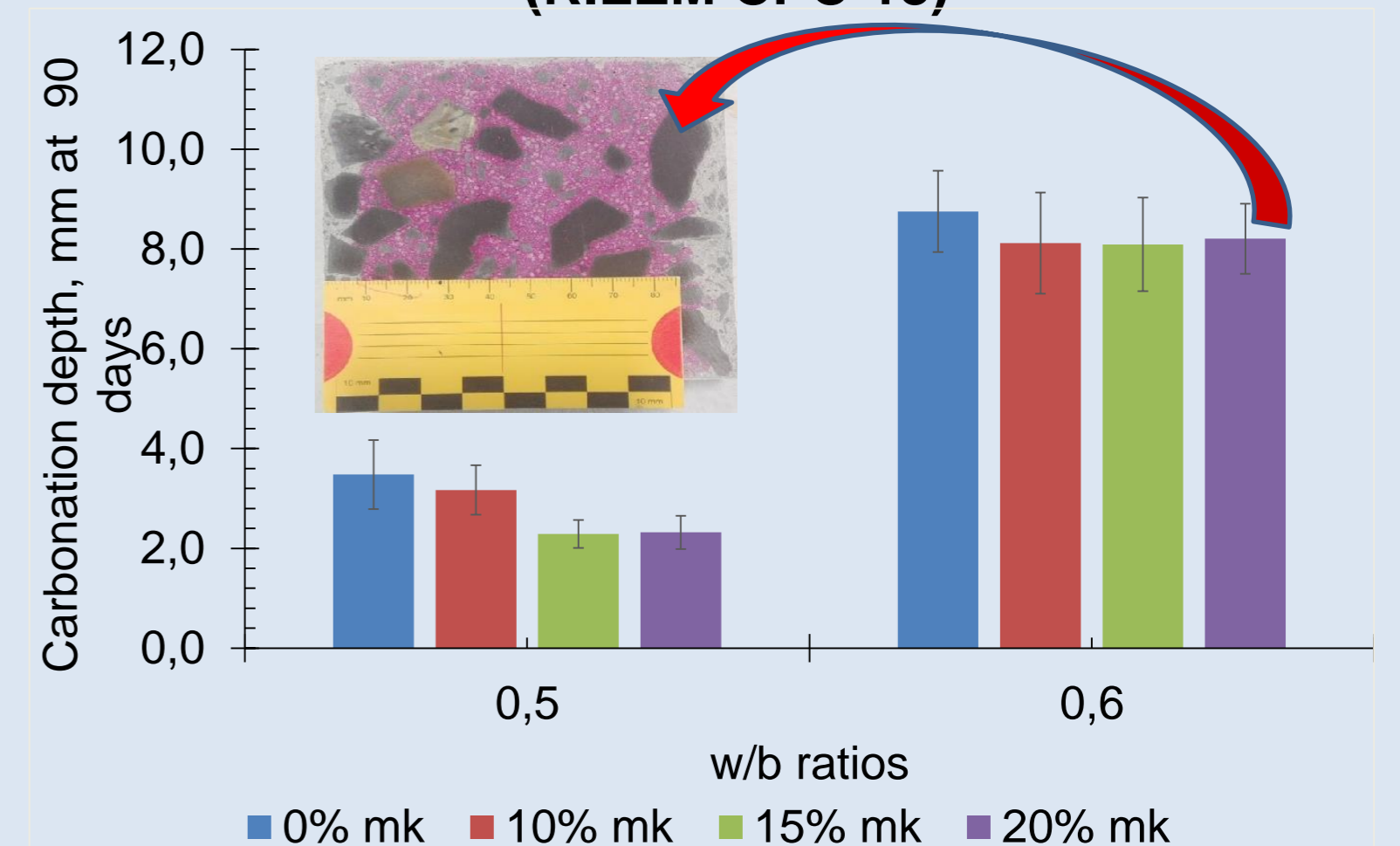


Fig. 6. Accelerated carbonation test results of concrete with metakaolin

Accelerated Mortar bar test results (ASTM C 1567)

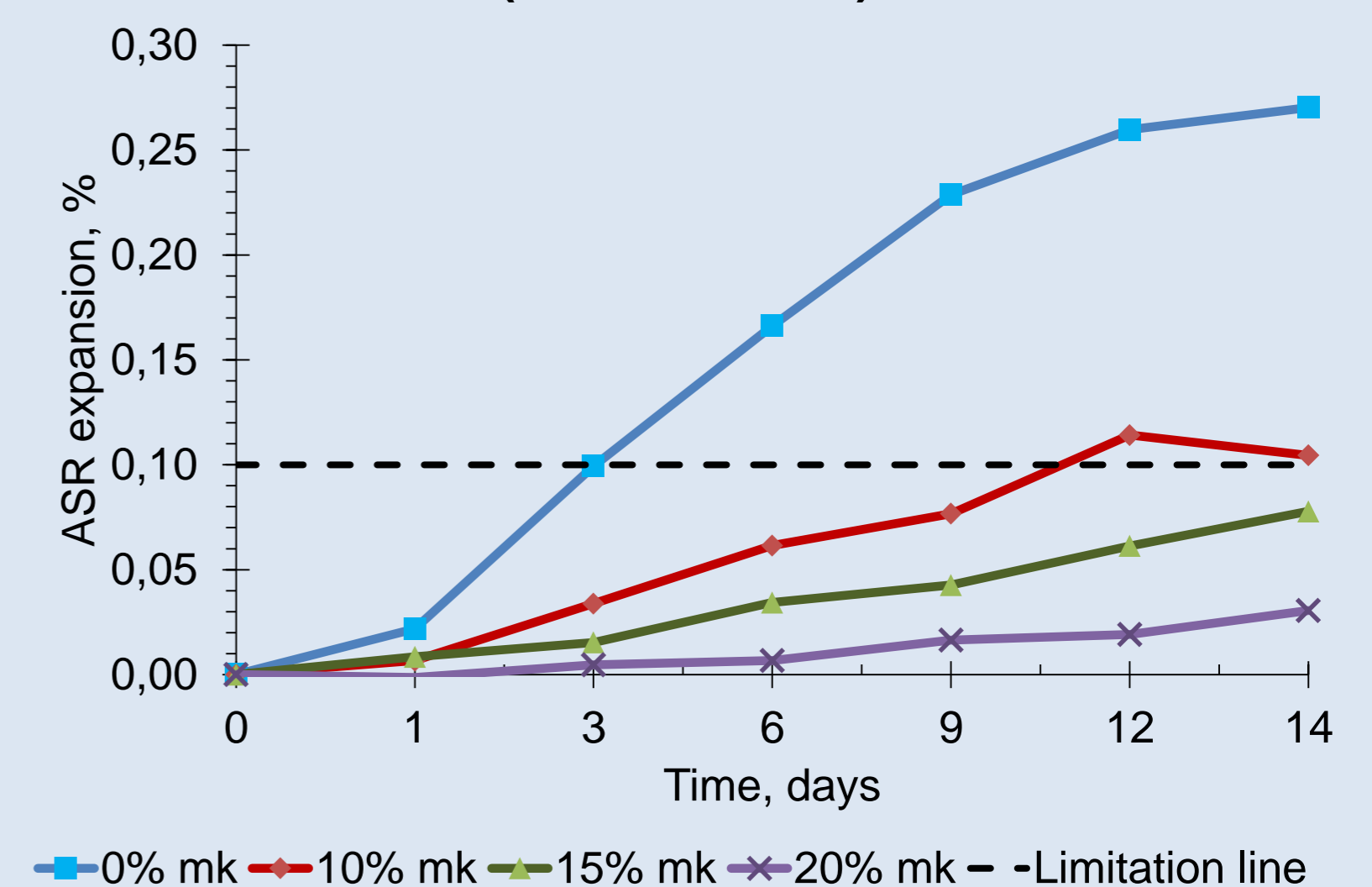


Fig. 7. ASR expansion of mortar bars with different levels of metakaolin

CONCLUSIONS

Metakaolin reduces concrete penetrability as per DI test results, Its potential for resisting carbonation depends on water/ binder ratios. Its potential for mitigating ASR in concrete increases with its content. Finally, metakaolin improves the durability properties of concrete.