

Thaumasite form of sulfate attack on concrete (TSA)

Introduction

From the early 1990's it has been evident that the possibility of a rare form of sulfate attack, the thaumasite form of sulfate attack, or TSA, on concrete in particular soil conditions should be considered for safe durable design. Consideration is particularly important as the TSA deterioration will not be visible in the above-ground parts of the affected structures.

What is TSA and what are its consequences?

TSA is a form of sulfate attack, distinct from the 'conventional/ettringite' form, in that it requires the presence of carbonates in the concrete as well as sulfates in the groundwater. At one time it was thought that the TSA would only form with particular aggregate types but this has been found not to be the case. TSA occurs at low temperatures (below 15°C) and significant damage only occurs in very wet ground, particularly where there is mobile water. The thaumasite mineral which forms gradually replaces the cement paste matrix of the concrete, causing the concrete surface to soften and eventually to disintegrate. TSA can attack concretes containing a wide range of different cements including those that are resistant to the conventional form of sulfate attack. The rate of attack on good quality concrete is relatively slow. Structural failure as a result of TSA is unlikely and would be preceded by early warning signs, such as cracking and deflection.

What is the scale of the problem?

Only about 60 instances of TSA have been uncovered in bridges and other structures, mainly in identifiable high risk areas. Simultaneous occurrence of all the known risk factors will be unusual and the majority of identified cases have been restricted to concrete buried in the Lower Lias or Kimmeridge clays of the West Country. Some cases have also been identified in the North East, where concrete is in contact with pyrite-containing colliery waste ('red shale').

What has been done?

Following the initial identification of TSA in Gloucestershire, Government formed an Expert Group to consider the problem and to produce guidelines for risk analysis, diagnosis, remedial work and new construction. MPA Cement (formerly BCA) was represented on the Expert Group. Industry assisted the BRE in the production of *Special Digest 1, Concrete in aggressive ground*, which still forms the basis of the recommendations intended to reduce the risk of future TSA in the UK. In most cases, carbonate-containing aggregates can still be used in combination with appropriate cement types.

Where can I find out more?

Contact: Dr Chris A Clear at BRMCA, Tel: 07976 546941, chris.clear@mineralproducts.org.
More detailed information can also be found in the following references:

Further reading

Thaumasite Expert Group, *The thaumasite form of sulfate attack: Risks, diagnosis, remedial works and guidance on new construction. DETR 1999*

Building Research Establishment, *Concrete in aggressive ground. Special Digest SD1, Third Edition, 2005*

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