WARRIP

WESTERN AUSTRALIAN ROAD RESEARCH AND INNOVATION PROGRAM

Review of Future Pavement Technologies

Nanotechnology Modified Materials

INVESTIGATION OF NANOTECHNOLOGY USE IN ROAD PAVEMENT APPLICATIONS

AN INITIATIVE BY:

THE GOVERNMENT OF WESTERN AUSTRALIA

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NANOTECHNOLOGY IN ROAD PAVEMENTS

During March - December 2016 WARRIP investigated the use of nanotechnology in road pavement applications. The review included the technical benefits and limitations of using nanotechnology in asphalt and concrete.

Background

In flexible pavement construction, the interconnection of large scale bituminous material components typically relies on material particle on the micro and nanoscale. Therefore, improved nanomaterials may be used to enhance pavement properties.

Approach

- Reviewing current international and national practice
- Identifying products that have been developed and/or are in use
- Evaluating these technologies, particularly regarding likely application into practice
- Conducting an assessment of the relevance of current practice, products and recent research to Main Roads
- Providing recommendations on further investigation of these technologies and what research should be conducted to better inform decisions regarding implementation.

Types of Nanomaterials

There is a significant amount of nanomaterials currently available that may have applications for asphalt and/or concrete pavements. These technologies include:

- nanoclay (NC)
- carbon nanotubes (CNTs)
- titanium dioxide (TiO2)
- shape memory foam (SMF)
- embedded bacteria.

THE NANO SCALE

Carbon nanotube (1 nanometer) | Strand of hair (100 micrometers) | House (10 meters wide)

Source: NNI (n.d.).

Review of Use in Bituminous Materials

Research into the effect nanomaterials have on the performance of asphalt is relatively limited due to the novelty of the technology. However, there have been numerous studies focused on the effect nanomaterials have on the properties of binders.

Research has indicated that NC can be successfully used as a modifier to improve the properties of bitumen. Similarly, studies have indicated that CNT applications of less than 0.1% (by mass of binder) may be able to improve asphalt properties and reduce pavement thicknesses.

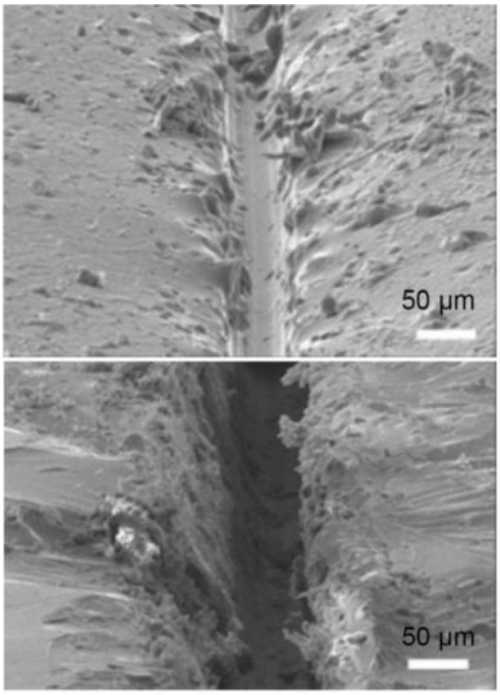
However, it is important to note that the cost of nanomaterials is relatively high and research has primarily been carried out at the nanoscale. Larger-scale investigations and cost-benefit analyses will be required to verify applicability.

Review of Use in Concrete

The application of nanotechnology in concrete engineering has the potential to generate concretes with self-sensing, self-cleaning and notably, self-healing characteristics.

To date, various studies have assessed self-healing using a number of nanomaterials. Findings indicate that these materials have the potential to seal micro-cracks, thus preventing macro-crack propagation.

NANOSCALE PICTURES OF CONCRETE WITH AND WITHOUT SELF-HEALING AGENT



Source: Pianoforte (2013).

Conclusions and Recommendations

- **Nanotechnology can be used in asphalt and concrete pavements**
- **The application of nanomaterials in pavements has yet to be commercialised.**
- **Nanotechnology has the potential to improve the material characteristics, durability and performance of pavements.**
- **Determine the likely practice applications and build a program of research around achieving cost effective applications.**

References

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