Final Report

Investigating the potential for reactive 'glowing' roads as an initiative on the Scottish road network

Prepared for

Scottish Road Research Board

March 2014

CH2MHILL®

City Park 368 Alexandra Parade
Glasgow, G31 3AU
GB

This report has been prepared in accordance with the instructions of the client, Transport Scotland, for the client's sole and specific use.
Any other persons who use any information contained herein do so at their own risk.

This document has been issued and amended as follows:

Version	Date	Description	Created By	Verified by	Approved by
1	14/03/14	Working Draft	K Turnpenny	K Turnpenny	E Crawford
1.1	26/03/14	Final	K Turnpenny	K Turnpenny	E Crawford

Contents

SECTION 1

Introduction and Objectives

1.1 Introduction

Dutch artist, Daan Roosegaarde, has partnered with construction and infrastructure company Heijmans Infrastructure to develop a road marking product that "glows in the dark". The innovation behind the product combines photoluminescence and a responsive paint that charges up during daylight hours emitting eight to ten hours of glow at night during the hours of darkness.

The photo-luminescent properties may also present an opportunity to display different graphics under certain climatic or meteorological conditions. With a temperature sensitive paint mixture the Dutch have proposed the possibility of creating snowflake shaped warning signs that would glow on the road. The patterns change from being transparent to colour when sections of the road become cold, warning that they could be slippery due to the presence of ice.

The potential for such innovation would be the provision of luminous driver information in areas where electric power is unavailable and to provide user information in terms of driving conditions on a locus-specific basis.

The ratio of daylight hours to darkness in Scotland differs from mainland Europe during a large part of the year. It is at these times of darkness that such markings would be of most value. The primary aspect of the proposed research is to investigate the use of such coatings given the possible charging/ discharging cycle under all-year Scottish climatic conditions.

1.2 Objectives

CH2M HILL understands the objective of the project is to deliver a wide-based information-gathering report detailing the viability of the various strands of this technology focused on potential use on the Scottish road network.

At the outset of the study, CH2M HILL believed that the considerations of this project should include but not be limited to:

- The charging and discharging cycles against Scottish daylight hour;
- State of development of the product including chemical content;
- The maintenance and durability of the material; and
- Driver interaction with this type of information.

However, as the following sections detail, it quickly became obvious that the technology is not sufficiently developed to address the first, third and fourth objectives noted above. Instead, the study focuses on the second objective, with recommendations for further work to develop the concept.

SECTION 2

Research Methodology

2.1 Introduction

The scope of the research work was to look at the issues around the innovation of glowing road markings from the Dutch and compare the state of development undertaken elsewhere in the UK and internationally.

2.2 Methodology

CH2M HILL conducted the following key project stages:

a) Scoping meeting with Transport Scotland – during the meeting the scope of the project was discussed and an appropriate contact list was agreed

b) Information collation – through desk based research and targeted telephone calls information and data was collated in order to assess the development of glowing road markings in the UK market as well as overseas.

c) Assessment of testing requirements for road marking paints – data and information was interrogated and collated for the British and European specific criteria to determine the performance and durability requirements for roadmarkings and signage in the UK.

d) Reporting and presentation – an information gathering report and accompanying data interrogation will be submitted to the Scottish Road Research Board.

A key risk for the project is considered to be the availability of data specifically relating to charging and discharging cycles and tested durability of the road markings. We will undertake an analysis of collated data and knowledge to identify gaps.

SECTION 3

Summary of Research

3.1 Findings

After extensive research using the internet, the only product listed as a glow-in-the-dark road marking paint was the Dutch innovation. It was not apparent from the research that other road marking companies were developing a glow-in-the-dark road marking product.

Latest findings on the Dutch glowing paint road markings suggests that it is currently being tested in laboratory conditions and the intention was that it would be road tested in Brabant, Holland in mid-2013. A later article suggested however that this date had been extended until mid-2014.

The glow-in-the-dark paint uses strontium aluminate pigments that can glow throughout the night on a single charge. The resulting paint discharges eight to ten hours' of glow. The charging of the paint occurs during the daytime. The idea is therefore to provide the road marking in areas where there is no public lighting. It is considered to be a simple, cost effective measure compared to using a combination of existing road markings and street lighting. A particular benefit is expressed by the Dutch because of its approach to sustainability, where lighting is shut down at night to save money.

The initial cost of putting the glowing road marking paints onto urban roads would of course be very high but the Dutch expect that long term savings could be found through the removal of road signs and markings that require costly electric powered lighting to be visible at night. The interest of such road marking paints in countries where electricity fails regularly such as India and Africa has increased.

The laboratory work is assessing aspects such as skid resistance and its ability to withstand salt ingress.

3.2 Limitations

Using modern grade strontium aluminate pigments may allow the glow to be bright enough for the first two or three hours. However, once the daylight fails, discharging will begin and therefore by the time the sun fully sets the glow-in-the-dark road marking paint may actually only glow for an hour or so.

Furthermore, the headlights from cars may recharge the paint but the headlights themselves will also put out an ambient light that is likely to overpower the glow. The Dutch considered that the road marking paint might be an alternative to cat's eyes. However, the length of discharge from the glow would have to be proven to provide sufficient light throughout the hours of darkness.

In the UK there are a number of specific documents which govern the use and performance of road markings. These are related to luminance, reflection under vehicle headlight, colour, skid resistance and functional life. The durability of road marking materials depends upon three factors: traffic volume, materials used and thickness. Standards and specifications restrict the thickness and width of road markings so manufacturers produce materials to meet traffic volumes and standards/specifications.

Following the strict guidelines for testing, a road test certificate for each product is required and road tests need to be carried out.

The road markings standards and maintenance requirements in the UK have consistently remained lower than those accepted in Europe and the US for some years (Ref: Road Markings, Road Safety and Efficient Road Utilisation in 21st Century Britain, Road Safety Markings Association, 2007). If new products come to the fore whilst experiencing the current increased traffic levels, a change to road markings to a higher standard may take some time but nevertheless innovative products such as glowing road markings could be considered a sustainable option with a low carbon footprint once they had been tested and providing they can meet strict performance criteria set out in the standards/specification.

The study has shown the potential for glow-in-the-dark paint for road markings. However, this research concludes that they are very much in the early stages of development and it is not yet clear if trials have

been carried out with which to gauge their success. The information available to date has been very limited and UK road marking paint manufacturers do not seem to have expressed an interest to date.

3.3 Other Developments

The research showed that in the UK, "Starpath" is a glow in the dark quick drying, spray applied elastomeric coating manufactured, supplied and traded by PRO-TEQ. The coating can be combined with stone to create a non-slip pathway, or with rubber crumbs to re-surface a playground. A meeting was held at the PRO-TEQ offices on 7th February 2014 to discuss the concept of glowing road markings and the "Starpath" product. PRO-TEQ are the sole suppliers, contractors and traders of their product. It uses a mixture of a photo luminescent powder with a stone or rubber aggregate which is placed on to a polyurethane layer. It is finished with a clear polyaspartic sealant topcoat. The aggregates can be varied in size and colour. Total thickness of the system is 4-5mm. "Starpath" can be placed over concrete (sealed), cardboard, metal and wood. It is non-reflective, waterproof and anti-slip. PRO-TEQ claim at least 16 hours of discharge because it absorbs UV light rather than direct sunlight. The photo-luminescence adjusts to the natural light. Therefore if it is pitch black then "Starpath" will be brighter. If the sky or lighting conditions are lighter, then the luminsence will not be as intense. PRO-TEQ claim that it is environmentally friendly.

"Starpath" was spray applied with specially designed spraying equipment on 1,600ft2 of existing tarmac footpaths at Christ's Pieces Park in Cambridge in 2013. The spray application operation took 4 hours and was ready to open to the public after 30 minutes of the work finishing (Ref: www.independent.co.uk/life-style/gadgets-and-tech/news/starpath). It has anti-slip properties and is non-reflective.

PRO-TEQ believe that it could be applied to tarmac on roads. A fine white aggregate is available if it was to be developed for use in road markings.

PRO-TEQ claim that tests in NAMAS accredited laboratories are complete. It was considered at the time that further testing would be required to investigate skid resistance, salt ingress, maintenance, temperature sensitivity, wear and abrasion etc. However, if these tests have already been successfully completed, then it adds credibility to the products viability as a photo luminescent footpath/surfacing product and demonstrates that there may be potential in supporting further development of the technology as a road marking product.

SECTION 4

Summary, Considerations and Next Steps

4.1 Summary

Currently, the innovation of glowing road markings is not as developed as first envisaged. There is no historical background data available of the trial set with the road users' organisation along a short stretch of provincial road in Brabant, the Netherlands, originally planned for November 2013. A recent search suggests that this has been put back to mid-2014.

In the UK, a glowing footpath/surfacing product, "Starpath", manufactured, supplied and contracted by PRO-TEQ, has been put down on a number of cycle ways and footpaths from 2013 and is seeing a rise in publicity and potential applications. "Starpath" is not a road marking paint. It is an aggregate-powder mixture which has a sealant topcoat. However, there is clearly potential for the development of a road marking product using similar technology.

4.2 Considerations

For a road marking product to be considered, it would have to be developed, and tested to prove that it meets all European and British Standards. As such, the product would have to demonstrate performance and durability against all of the following criteria:

a) Standards

- In particular, BS EN 1436 which is based on functional life, luminance in daylight, luminance in dry, reflection under vehicle headlight, colour and skid resistance,
- TD 26/05 is also important in terms of setting out the minimum maintenance requirements for retro-reflectivity, luminance, skid resistance and wear.

b) Performance

- Skid resistance,
- Luminance,
- Reflection under vehicle headlights,
- Charging/discharging cycles vs full range of daylight hours under Scottish conditions.

c) Durability

- Minimal maintenance requirements,
- Durability with respect to traffic volumes.

d) Sustainability

- Materials and carbon footprint.

e) Economics

- Whole life costing.

4.3 Next Steps

As a generic concept, "Starpath" could potentially be developed for use as a road marking product. The next step will be assessing its potential application to tarmac on roads and the consequent testing (both laboratory and trial sections of road) to determine if it meets the required British and European Standards.

SRRB and Transport Scotland should consider options for providing further support to the development of this emerging technology. Whilst the product development is likely to require to be led by the private sector, there is an opportunity for support to be provided in terms of further material research and laboratory testing. CH2M HILL, with its close links to academia through the Universities of Glasgow and Dundee (and their extensive lab testing facilities) would be happy to discuss such provision of services under the Transport Research framework.