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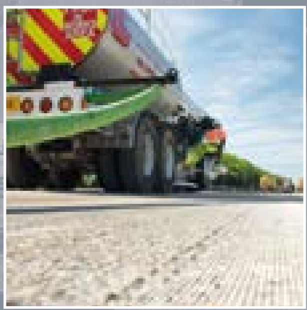
The British Cementitious Paving Association



A GUIDE TO CONCRETE ROAD PAVEMENTS

The British Cementitious Paving Association

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BRITPAVE

Britpave, the British Cementitious Paving Association, promotes the better and greater use of concrete and in-situ cementation infrastructure solutions. Members include major contractors, specialist equipment and material suppliers, consulting engineers and interested trade associations. Together, Britpave provides a single voice for the in-situ cementitious infrastructure sector.

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Concrete road pavements offer a considerable number of long-term benefits. They offer better journey reliability, they need less maintenance interventions resulting in reduced need for road workers to work on live carriageways and less congestion caused by road works, and they offer lower whole life costs and better use of the road network asset. They can also offer significant traffic noise reduction and are well suited to the Smart motorway construction programme.

There is a wide range of concrete road pavements solutions. This new guide covers the main options that are proven, tried and tested and warrant greater use on the UK road network. In addition, there is an overview of future developments that underline the potential of concrete road surfaces to provide a long-lasting road network that has reduced whole life cost, significant environmental benefits and can actually earn its keep.

Joe Quirke, Chairman, Britpave

Introduction

Concrete road pavements offer a wide range of long-term performance and whole life cost benefits for the national and local road networks.

The restructure of the Highways Agency into Highways England, a customer-focused government-owned strategic highways company, underlines the relevance of the benefits of concrete road pavements. Highways England now plans increased capital investment over five year periods in order to offer better long-term funding certainty and programme clarity. To help realise its objectives of better delivery efficiency and improved customer service, Highways England has placed an increased focus on whole life costing, long-term performance, minimum maintenance and interventions and the adoption of a more performance-based approach.

In addition, there are the challenges of operating and maintaining a strategic road network faced with a forecast traffic growth up to 60% by between 2010 to 2040*, the demands to provide a safer environment for road workers and for the road network to reduce its environmental impact.

For the local road network the challenges are also significant. The local road network carries the vast majority of road traffic. Motorway traffic in terms of billion vehicle miles travelled accounts for nearly 21%, over 79% is carried by urban and rural roads**. Budget restrictions means that local authorities need solutions that offer 'more for less'. Concrete roads can do just that.

Meeting these challenges calls for road pavement surfaces that provide long-life and good friction at all traffic speeds, have good longitudinal and transverse profiles, plus low noise and provide a good interface with road markings. They should be durable and resilient, require minimal maintenance and offer sustainable recyclability. Crucially, they should offer good whole life costing and long-term performance that translates into good asset management.

Concrete road pavements offer all of these performance benefits. Furthermore, the cost of concrete pavements compared with cost of bitumen for asphalt roads means that these benefits can be provided 'more-for-less'.

** Department for Transport; Road Traffic Forecast 2015*
*** Department for Transport; Road Traffic Estimates October 2016-September 2017*

1. Concrete Benefits

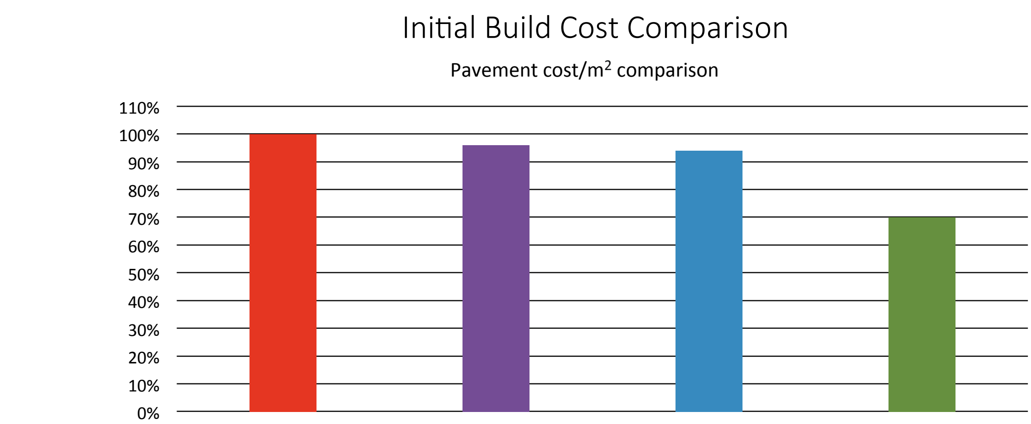
Concrete road pavements offer better journey reliability and they need less maintenance interventions resulting in reduced need for road workers working on live carriageways and less congestion caused by road works.

All of the above can be provided with lower initial build costs and lower whole life costs.

1.1 Initial build costs

Concrete pavements can be up to 30% cheaper to build than a fully flexible pavement option.

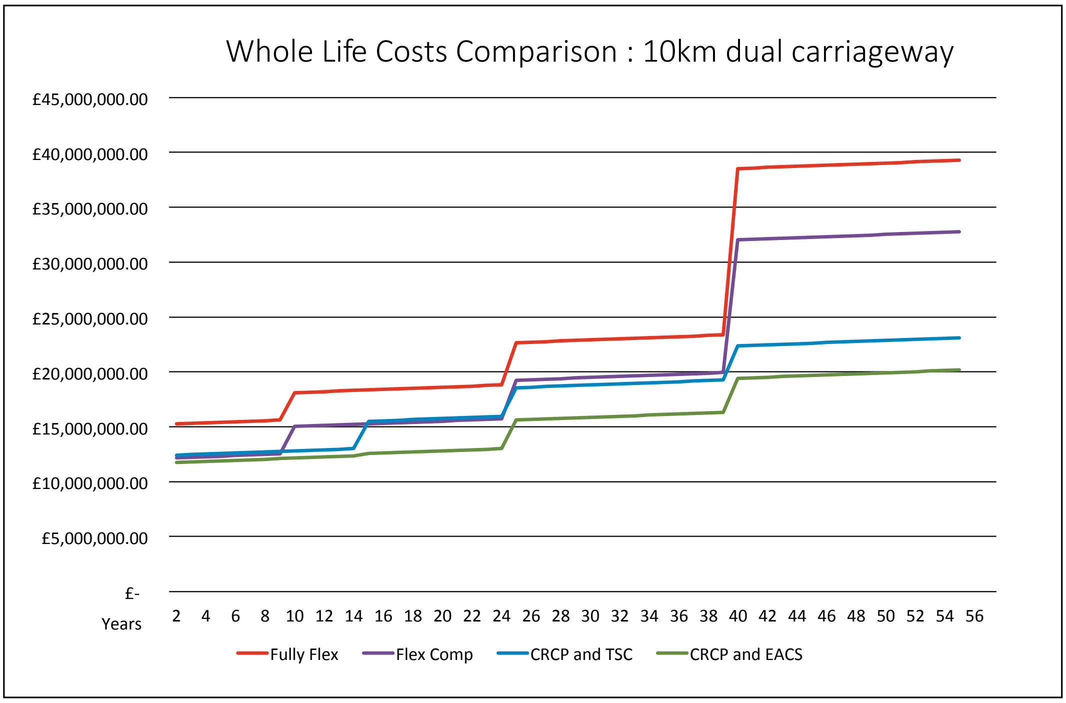
This is underlined by an analysis of DMRB HD26/06 pavement options for a heavily trafficked >80msa built on a greenfield site or substantial reconstruction on Class 3 foundations. The analysis is explained by the table below:



Traffic Loading Pavement Type:	>80msa Fully Flexible HDM/DBM 50	>80msa Flexible Composite HBM Cat D. C16/20	100-400msa CRCP+TSC ff=4.5-6.0MPa	100-400msa EACS ff=4.5 – 6.0Mpa
Pavement Thickness:	Surface course 35mm	Surface course 35mm	Surface Course 30mm	EACS
	Binder course 60mm	Binder course 60mm	CRCP	CRCP
	Upper base 80mm	Upper base 80mm	200mm	200mm
	Lower base 140mm	Lower base 150mm		

1.2 Whole life costs

The Design Manual for Roads and Bridges HD26/06 describes whole life costing as examining “the costs of a project from inception to disposal, including the direct costs of constructing and maintaining a highway and the indirect costs imposed on society and the environment by its use and operation (e.g. traffic delay, accidents at roadworks, skidding accidents, fuel consumption and tyre wear)”. Concrete pavements offer long-term solutions that fully meet the criteria of that description.



At 40 years, the Fully Flexible Pavement option will be almost 2.5 times more expensive than the Exposed Aggregate Concrete Surface.

This is based on the following maintenance invention assumptions:

- For the Fully Flexible and Flexible composite:
  Resurface at year 10
  Resurface with 30% of Lane 1 reconstructed at year 25
  Fully reconstructed at year 40
- For the CRCP with TWC:
  Resurface at year 15
  Resurface with 10% of lane 1 reconstructed at year 25
  Resurface with 20% of lane 1 reconstructed at year 40
- For the EACS:
  Reseal /minor repairs at year 15
  Reconstruct 10% and provide a TWC (or groove and grind) at year 25
  Reconstruct 20% and replace the TWC at year 40

1.3. Noise reduction

A major issue is the level of road surface noise. In the UK, the favoured option to overcome this has been to apply a thin asphalt surface course. However, thin asphalt layers soon need replacing and, therefore, do not offer long-term performance. An asphalt layer may only last 7-15 years compared to 15-40 years for concrete road pavements.

A number of concrete solutions for quieter roads have been developed. These offer the necessary surface texture for both noise reduction and wet/dry skid resistance.

Exposed Aggregate Concrete Surface (EACS) is a type of Continuously Reinforced Concrete Pavement (CRCP) with a specific noise reducing texture. It has already been successfully tested and proven on a number of UK roads built some fifteen years ago including the M18 in Yorkshire, the M23 near Gatwick, the A50 in Derbyshire, the A13 in Essex and the A449 in Wales. EACS differs from conventional concrete road surfaces in that the aggregate at the surface is left exposed. This results in random contact between tyre treads and the exposed concrete which results in reduced noise of up to three dBA. This is equivalent to halving the traffic flow. In Europe, EACS has been adopted as standard practice for quiet concrete road surfaces.

Significant noise reduction has been reported on those sections of the A12 Chelmsford Bypass, Essex, and the A14 in Suffolk that have been treated to another option: concrete grinding and grooving. It involves plant equipped with closely-spaced diamond-tipped saw blades that cut drainage and traction grooves into the existing concrete road surface. Successfully used for many years in the United States, the process restores the surface performance of existing concrete roads, at less than half the cost of overlaying the concrete with asphalt. On the sections treated 54% improvement in skid resistance and a noise reduction of 4 – 6 dBA with traffic flowing at 50mph has been reported. At higher vehicle speeds the noise reduction is even more apparent.

The resultant closely spaced grooves left after grinding provide a high level of texture and skid resistance. Experience in California, where the use of grind and groove is widespread, has found that whilst asphalt overlays typically last 8 – 12 years, the average life span of a diamond ground concrete surface is 17 years. Furthermore, a concrete road can be ground up to three separate times without significantly affecting its structural performance. Such is the success of the approach that in the USA, black top is being stripped to reveal the concrete structural base layer which is then subject to grind and groove. The Americans are referring to subsequent revealed hard wearing, low noise concrete surface as ‘buried treasure’.

A third option for quiet concrete roads is overlaid Continuously Reinforced Concrete Pavement (CRCP) which has no joints but is constructed with continuous longitudinal reinforcement. This eliminates the need for transverse joints (other than at bridges and other structures) and provides a smooth riding, jointless surface that is virtually maintenance-free. In the UK, CRCP is usually used as the structural base for a road because of its robust, maintenance-free performance. A thin surfacing of asphalt is then overlayed on top. There is evidence that this asphalt layer has a longer service life when placed on top of CRCP due to the improved stiffness. Using EACS or grinding and grooving to the concrete surface would eliminate the need for an additional asphalt layer as the concrete surface itself would then provide the required skid resistance and noise reduction.

Highways England noise classification is now performance not material based. Concrete road surfaces offer a range of low noise, long term solutions. The establishment of first cost comparables between concrete and asphalt means that these solutions should be examined on merit and not only cost.

1.4 Further Benefits of concrete pavement

In addition to cost and noise reduction benefits concrete pavements offer:

- **Minimum maintenance and increased safety**
  Live carriageways are potentially dangerous working environments. Highways England is committed to reducing the number of road workers harmed whilst carrying out their jobs and has managed to eliminate the need for road workers to cross live carriageways by removing the need for signs in the central reserve for roadworks. This has saved an estimated 3.7 million live lane crossings.

  Similarly, concrete pavements require fewer and less-frequent maintenance interventions. This reduces the number of occasions of placing road workers on live carriageways undertaking unplanned maintenance.

The concrete pavement supply team are fully ready to work with highway authorities to further improve standards, develop new ways of working and share best practice as part of their commitment to health and safety.

- **Long-term performance**
  The maximum service life an asphalt service course is 20 years (MPA/ADEPT; The service life of asphalt materials for asset management purposes; 2015) compared with 30 to 50 years for concrete road surfaces. Indeed, subject to cost parameters a concrete road can be designed for however long it is required.

- **Environmental**
  Concrete road surfaces make use of by-products as part of the cement in the mix plus it can be 100% recycled at the end of life. Concrete roads can better withstand extreme weather conditions, for example they do not melt during periods of high summer temperatures. In addition, there is the increasingly attractive environmental benefit of reducing fuel consumption.

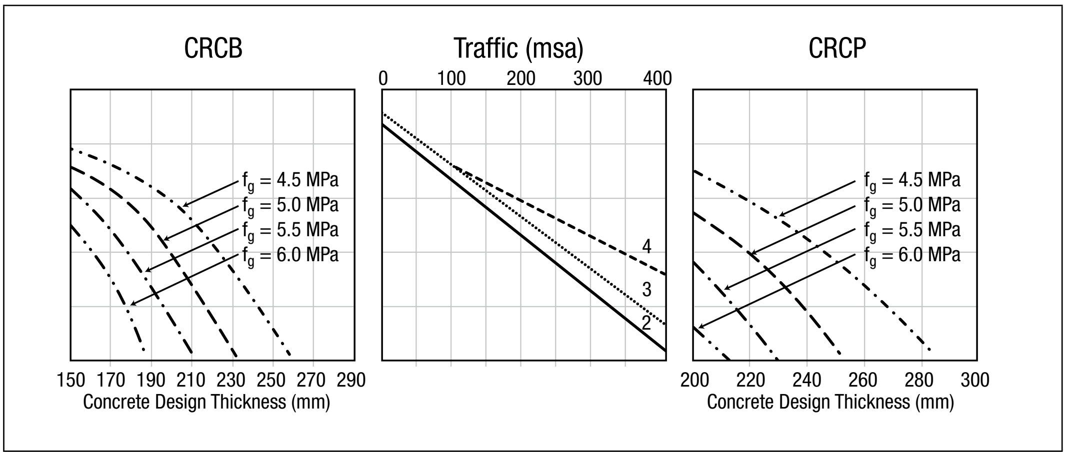
2. Concrete Road Surface Solutions

Concrete road pavement solutions include rigid concrete options for inlays to flexible pavements, lane replacement and hard shoulder upgrade for all-lane running, Continuously Reinforced Concrete Pavements (CRCP), Exposed Aggregate Concrete Surface (EACS), Roller Compacted Concrete (RCC) Groove and Grind, and Whitetopping. These solutions have been widely used overseas where they have proven construction with high tolerances for smoothness and modern methods of texturing that provide long-term skid resistance and acceptable noise levels.

2.1 Concrete pavement design procedures

Concrete pavement design follows conventional design procedures that are generic to all concrete road pavement types. These include:

- Foundations are designed based on the subgrade strength
- Traffic frequency and type are analysed to provide total number of axles during the design life
- These values are plotted onto nomographs and the resultant thicknesses are read off
- Concrete thicknesses can be reduced by taking advantage of increases in flexural strengths
- Joint and joint patterns are designed based on various factors such as aggregate type, reinforcement density and pavement depths
- Good detailing is required to keep joints away from wheel tracks and heavily loaded areas.



2.2 Continuously reinforced concrete pavement

Developed over 75 years ago, Continuously Reinforced Concrete Pavement (CRCP) is constructed in a longitudinal direction with steel reinforcing bars placed within the concrete along the entire length of the pavement. The concept of CRCP is to allow cracks to occur at intervals of between 1.5 and 2.5 metres in order to release pavement stresses. The reinforcing bars control the width of the transverse cracks that form and hold them closed. The transverse cracks do not impair the structural integrity of the pavement. Design considerations include: proposed traffic use; foundation and climate parameters; hard shoulder requirements: pavement slab width and thickness; longitudinal reinforcement.

Due to there being no transverse joints, CRCP provides a continuous, smooth-riding surface capable of withstanding the heaviest traffic loads and the most adverse environmental conditions. Because of its greater durability, longer life expectancy, and minimal maintenance requirements, CRCP can provide the best long-term value of any pavement type and can have a service life 50 - 60 years with minimum or no maintenance requirements. These benefits all combine to prove CRCP with significant whole life cost reductions over its initial construction costs.

2.3 Roller compacted concrete

Roller compacted concrete (RCC) pavements offer a competitive and long-lasting solution. Despite this, and the fact that it has been used in the States since the 1930's, RCC has yet to gain mainstream recognition in the UK. The inclusion of RCC in the Design Manual for Roads and Bridges (DMRB) could change that.

RCC takes its name from the construction method used – it is placed by modified asphalt paving equipment, but it is stiff enough to be compacted by vibratory rollers. RCC has the same constituents as conventional concrete – cement, water and aggregates, and requires no formwork or reinforcement. The surface texture is smooth and suitable for parking, materials handling and road pavements where the traffic speeds are relatively low (< 60km/hour). For higher speed highway and airfield pavements it is necessary to provide the RCC with an asphalt surface in order to meet skid resistance and surface regularity requirements. Alternatively, the RCC surface may be treated by grooving and grinding to gain the required surface parameters.

RCC combines the strength, long-term performance and minimal maintenance of conventional pavement quality concrete (PQC) with the simplicity of asphalt. For roads, RCC offers further advantages that include minimal rutting, it can span localised soft subgrades and will not deform under heavy concentrated loads. In addition, at end-of-life it can be crushed and recycled for a new pavement. The economic benefits of RCC are of interest to Highways England who are increasingly focussed on efficiency and the resultant cost savings. Here, RCC offers cheaper material costs than fully flexible paving solutions, it is stronger than flexible solutions and can be thinner for similar traffic loading.

The economy of RCC is in its simple application. Large-capacity mixers continually blend the RCC which is transported to site and discharged into an asphalt paver. This places the materials in layers up to 250mm thick and 13m wide. Compaction starts immediately after placement and continues until the pavement meets density requirements. Curing ensures a strong and durable pavement. Where appearance is important, joints can be saw cut into the RCC to control crack location.

A well-designed RCC mixture, because of its grading and crushed aggregate, will be mechanically stable and have a very high Immediate Bearing Index (IBI). This allows a subsequent layer such as a bituminous surfacing to be load immediately on completion of compaction of the RCC and so permit early opening of pavements to light traffic. Heavy loadings should not be imposed until the material has gain sufficient strength – the threshold for general traffic is an in-situ strength of 20MPa.

RCC has significant potential for the UK road network and is increasingly being considered for truck lanes and motorway widening projects. This potential could be realised following the completion of a joint Highways England/Britpave/MPA project to include RCC in the Design Manual for Roads and Bridges (DMRB) HD26 and in the updates in the Specification for Highway Works and Notes for Guidance Series 1000.

2.4 Exposed aggregate concrete surface

Exposed aggregate concrete surface (EACS) does exactly what is says: the surface is brushed to expose the aggregate to provide a surface that significantly reduces traffic tyre noise. With EACS, after paving the concrete surface is finished with a longitudinal finisher and sprayed with a combined retarder and curing agent. Approximately 24 hours after paving, the surface is brushed to expose the aggregate at a depth of 15.mm. The exposed textured surface is then again sprayed with a curing agent. The exposed texture results in random contact between tyre treads and the road surface which reduces traffic noise by up to 3dBA – this is equivalent to halving the traffic flow. In addition, to noise reduction, EACS offers a high level of skid resistance and minimum long-term maintenance.

EACS has been successfully used and proven on a number of UK roads including the M18 is Yorkshire, the M23 near Gatwick, the A50 in Derbyshire, the A13 in Essex and then A449 in Wales. The A449 Coldra to

Usk scheme in Wales involved for the first time in the UK the overlay of a life expired rigid carriageway with a continuously reinforced concrete pavement (CRCP) that featured a two-layer exposed aggregate surface. Completed in 1999, the surface noise and skid resistance was assessed by TRL in 2015 to determine the long-term performance of EACS. Tests found that the road surface continues to offer good noise reduction compared with equivalent asphalt surfaces and has skidding resistance SCRIM levels that are considerable above intervention point with the possibility of 10 to 15 years further service life. This evidence points towards a 30 year maintenance free life service for EACS.

(For further information see *Section 1.3 Noise reduction*)

2.5 Grind and groove

Diamond grinding, a process used in the United States since 1965, offers a cost effective way to restore the skid resistance and noise reduction of concrete roads. Tests in the US have demonstrated that the longevity of a diamond ground surface are between 11 years to 17 years. Tests undertaken in the UK have also shown positive results.

Grinding involves diamond blades removing and retexturing the surface of concrete roads. Up to 250 diamond tipped lades of 400 to 450mm diameter are used to remove 3 to 8mm of worn surface to provide a renewed surface finish of longitudinal grooves. As only 3 – 8mm of road surface is removed the grinding process can be stopped at any time and the road reopened to traffic thereby allowing grinding to be carried out during off-peak hours or with short-term mobile lane closures. No remedial work to drains, crash barriers or clearance heights for bridges is required unlike with the use of asphalt overlays.

In 2009, a 500m section of the A12 Chelmsford bypass at Boreham was treated using longitudinal diamond grinding. The same treatment was applied on a section of the A12 at Kelverdon. During 2010, a 6km four-lane section of the A14 Whitehouse to Copdock was treated.

Road noise is not resultant from the material used but from the surface texture. 70% of road noise from passenger vehicles is created when air is compressed between the road surface and the tyre. UK concrete roads generally have a tined surface that is transverse across the carriageway. This improves the level of friction but also creates an undesirable tonal noise of 1000 hertz. Grinding imparts a surface roughness that is longitudinal rather than traverse this and the higher surface roughness allows the air between road surface and tyre to more readily escape significantly reducing traffic noise levels. Following grinding, the sections of road trialled demonstrated a reduction s noise levels of between 4 – 6dBA at speeds of 50 – 80 kph. This is the equivalent of halving the traffic density.

Skid resistance is related to surface roughness and over time worn road surfaces result in decreased skid resistance. Following diamond grinding on the A12 and A14 sections their low speed skid resistance improved considerably rising from 0.29 to 0.36 to 0.49 to 0.57. The test sites were monitored for 3 years and the improvement was found to have remained at an average rate of 54%.

The trials and subsequent monitoring proved that diamond grinding is a sustainable repair option for the renovation of worn, polished concrete roads. The result is quieter roads with improved skid resistance. Whilst the trails did not evaluate costs, evidence from the US shows that if the road surface is structural sound then the grinding process can be used at least three times without significant loss to load carrying ability. With each treatment lasting at least ten years, this would mean an extension to road life of 30 years.

As a result of the trials, the Highways England has adopted the diamond grinding process for use of roads with flint aggregates without the need for departures.

2.6 Whitetopping

Used extensively in the USA, whitetopping offers the beleaguered UK road network a fast, economic, sustainable and long-term reconstruction solution.

Whitetopping refers to the use of a concrete overlay to resurface an existing distressed pavement surface. The technique has a long history with the first thin white topping overlay being placed in Indiana, USA, in 1918. However, it is only over the last ten years as a result of new technology that use of the technique has significantly increased as hard-pressed national and local road authorities recognise its potential of as a long-term maintenance and reconstruction solution for their crumbling road networks.

The resurfacing technique involves bonding a new concrete overlay onto the existing road. In contrast to other repair and reconstruction methods, if the sub-structure foundation is still sound then no part of the existing road has to be removed. Deformations in the existing surface are milled level and the surface cleaned ready for the new concrete overlay. Not having to dig up the top layer of an asphalt road surface provides substantial time and cost savings. These savings are increasingly attractive to cash-strapped road authorities and to public/private partnership infrastructure models which have a focus on long-term life-cycle costs and performance.

There are two types of whitetopping:

- Ultrathin whitetopping (UTW) with a concrete surface thickness ranging from 50 to 100mm
- Thin whitetopping (TWT) with a concrete surfaced thickness ranging from 100 – 150mm

Thin whitetopping is used where greater strength is required particularly for heavily trafficked roads. Ultrathin whitetopping is designed to renew the surface of worn roads but not to increase structural capacity. Both types offer cost, safety, performance and environmental benefits.

At current prices, concrete often costs less than asphalt. In addition to first cost savings, concrete offers better whole life cost as it requires less maintenance expenditure and provides greater long-term performance. Indeed, whitetopping can extend the life of a road by up to 30 years.

By renewing the road surface, whitetopping improves safety. Not only does it eliminate the rutting and rippling hazards of a deteriorating asphalt road surface, whitetopping provides a much lighter road surface that reflects up to three times more light than asphalt. This not only improves road safety but can also be used to reduce street lighting costs. It has been estimated that in cities whitetopping could reduce the level of street lighting by up to 24%.

Whitetopping is not new. Indeed, it has been around for nearly 100 years. What is new is the growing recognition of the advantages that this road reconstruction techniques offers.

3. Concrete Innovation and Future Possibilities

In the future, roads will no longer be a medium used to go from one place to another. Instead of being inanimate, they will have a number of active infrastructure roles. There are a number of research and development projects that could forward new future benefits of concrete road surfaces.

3.1 Vehicle charging and connectivity

It is predicted that roads will play a far more active role in the future. This could be especially so with the provision of integrated solutions for vehicle connectivity, autonomy and electrical charging. It is envisaged that transmitters embedded into pavement would allow wireless connection to the internet and provide real-time information on traffic, accidents and road conditions. Sensors in the road could record the weights and velocity of every vehicle on the road thereby proving valuable traffic and usage data. Metal slot tracks could enable continual charging of electric vehicles' batteries.

The future may not be that far away. Sweden has opened its first stretch of electrified road that allow lorries to charge themselves as they drive along it. The aim is to have a fuel-free freight fleet by 2030. In the UK, Highways England is undertaking trials into dynamic wireless power transfer technologies to charge ultra-low emission vehicles. Highways England is also committed to installing plug-in charging points every 20 miles on the motorway network as part of the government's Road Investment Strategy.

Future roads would actively allow vehicles to communicate and share information with each other via sensors, wireless systems and the internet. Such connectivity is essential for the operation of autonomous self-driving vehicles. The success of this will be based on the provision of durable and predictable road surfaces. Particularly as all vehicles will use the same connected carriageway track. This will call for road pavements that can offer more resistance to rutting resulting from freight traffic. Concrete pavements can provide roads that meet all of these requirements.

3.2 Saving fuel

There is a growing appreciation of the potential fuel and CO_2 savings to be gained from driving on concrete roads. A Eupave report, 'Concrete Pavements Contribute to Decarbonising of Transport', pulls together the findings of a number of independent international research studies. These have compared the fuel consumption of heavy good vehicles using concrete and asphalt road surfaces and examined the impact of a number of factors particularly that of rolling resistance which has a direct influence on tyre-pavement interaction and, therefore, fuel consumption and CO_2 emissions.

The studies found that the stiff and rigid pavements of concrete roads significantly reduced the fuel consumption of heavy goods vehicles compared with the flexible pavements of asphalt roads. The reduction is due to the decreased rolling resistance between a vehicle's wheels and the rigid road surface. The deflection of a flexible asphalt pavement increases the rolling resistance and, therefore, the fuel consumption.

The research reported savings of up to 6.7%. This not only offers significant financial savings but given that road haulage in Europe produces some 40% percent of transport CO_2 emissions there is a significant environmental benefit too.

The Eupave report examined the research carried out by the National Research Council in Canada, the Transport Research Laboratory in the UK, the Swedish National Road and Transport Institute and Lund University and the Nippon Expressway Institute in Japan. Research carried out by the Massachusetts Institute of Technology in the USA determined that asphalt pavements would need to be 25 to 60% thicker to provide the same level of fuel savings as concrete pavements.

Collating the research findings, Eupave concluded that a 100km concrete road with a daily traffic flow of 5,000 to 15,000 heavy goods vehicles would, over a 30 year period, save up to 400,000 tonnes of CO_2.

3.3 Self-healing concrete roads

Researchers at the University of Bath, Cardiff University and the University of Cambridge are working on a self-healing concrete that uses bacteria to seal cracks that can lead to decay and collapse. The aim is to create a concrete blend containing bacteria in microcapsules that will germinate if water seeps through a crack. The bacteria will produce limestone as they multiply, sealing the crack before the water can cause structural damage. Self-healing concrete could vastly increase the life of concrete structures, remove the need for repairs, and reduce the lifetime cost of a structure by up to 50%.

3.4 Self-heating concrete roads

The University of Houston, Texas, are working on a design to incorporate heating elements into the concrete roads to reduce ice and snow build-up. They first tried using fly ash, a by-product of coal power plants, and then tried steel shavings. The idea is to use an element that resists electricity, thus producing heat. Both ideas worked, but the best ideas involve carbon nanofibres which heat the road much faster. The nanofibres are stacked like cups on a paper sheet and were able to heat a slab of concrete 10 centimetres thick and 25 centimetres in area from -10 degrees C to 0 degrees C in two hours using 6 watts of power.

3.5 Power generating concrete roads

In 2015, the Netherlands last year built the world's first solar road - an energy-harvesting bike path paved with glass-coated solar panels. Engineers have reported that the system is working even better than expected, with the 70-metre test bike path generating 3,000 kWh, or enough electricity to power a small household for a year.

The solar panels used on the Dutch bike path are sandwiched between glass, silicon rubber and concrete, and are strong enough to support 12-tonne fire trucks without any damage. Each individual panel connects to smart metres, which optimise their output and feed their electricity straight into street lighting, or the grid. More than 150,000 cyclists rode over the solar panels during the initial 6 month trial, and so far they have only noticed one fault – a small section of a coating, which provided grip to the surface, has become delaminated due to temperature fluctuations. The team at SolaRoad is now working to improve this coating.

3.6 Albedo Value

Compared with black asphalt, light concrete road surfaces have a high albedo value – the ratio of surface reflected solar radiation. For a new concrete road surface the albedo value is 0.35 – 0.4 compared to 0.05 – 0.1 for new asphalt. By reflecting more solar radiation, a concrete road surface helps to minimise the formation of urban heat islands thereby reducing the energy demands for cooling and air-conditioning. With summer temperatures predicted to rise as a result of climate change the beneficial albedo effect of concrete road surfaces could become more recognised.

3.7 Pollutant absorbing concrete roads

New developments in concrete technology offer a further exciting environmental benefit: the ability to absorb air pollutants. Vehicle exhaust includes a high level of nitrogen oxide air pollutant. However, the addition of titanium dioxide to the concrete means that it actually eats these pollutants. Titanium dioxide (TiO2) is a photocatalytic material that reacts in sunlight to absorb nitrogen oxides and convert them into harmless nitrates that are washed away by the rain. Scientists at Eindhoven University of Technology in the Netherlands have found nitrogen oxide reductions of 35 – 40% in areas paved with concrete featuring TiO2. Researchers at the Public University of Navarre, Spain, are developing a nonoparticle coating for concrete that uses photocatalytic reaction to disintegrate certain pollutants. They report that the coating can reduce 90% of nitrogen oxides, 80% of hydrocarbons and 75% of carbon monoxides. The use of such treated concrete road surfaces, particularly in urban areas, offer the prospect of roads eating the pollutants from the very vehicles that use them.

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