CASE STUDY

Conventional Deep In-Situ Recycling

'The project ultimately delivered 31,500m² of recycled reconstruction over four weekends and four night shifts on the Mondays that followed'

Scheme:	**A1066, Thetford Road, Brettenham**
Authority:	**Norfolk County Council**
Client:	**Tarmac for Norfolk County Council**
Date:	**October 2020**
Area:	**31,500m²**
In-Situ Process:	**Conventional Deep In-Situ Recycling**
Surface:	**Asphalt 30mm (10mm SMA) 50mm (20mm SMA) 40mm Surface Course**
CO_2 Saving:	**711 tonnes**

The recently completed £3.4m scheme on the A1066 near Thetford saw a section of road surface replaced between Thetford and Diss. Routine monitoring showed a rapid deterioration of the surface following the hot summers of 2018 and 2019 which left the busy route very uneven in places.

The road runs through rural land and forest with long stretches of straight single lane carriageway with speed limits set at 60mph.

SPL were brought in by contractors Tarmac to deliver a recycling treatment that was identified as suitable on this route.

As part of the design assessment, extensive investigation and testing was undertaken by Norfolk Partnership Laboratory (NPL) – part of the Norse Group – on behalf of Norfolk County Council.

A 4.7Km section was identified for a recycling treatment, NPL removed bound construction materials with 350mm diamond tipped core barrels. NPL then measured 'stiffness modulus' (Sm) of the material directly beneath the core before using hand tools to remove bulk samples of unbound sub-base and the sub grade where possible.

Ironstone House, High Street, Scaldwell, Northampton, NN6 9JS
T. 01604 882955 E. info@stabilisedpavements.co.uk

www.roadrecycling.co.uk

Once the bound material had been removed, further values of Sm were measured with a light weight deflectometer (LWD), directly below where possible bulk samples were taken. A Dynamic Cone Penetrometer (DCP) was also used to profile the pavement foundation to determine if there were variable or weak layers beneath the pavement.

Bound samples were then brought back to NPL's laboratory, in Norwich. The samples were largely intact asphalt, sub-base and sub-grade which comprised of a Type 2 (sand and gravel) material and the sub-grade chalk material.

The in-situ recycling process generally mixes up to a depth of 300mm in one lift, although it can be carried out to a greater depth with the correct compaction equipment. The asphalt course and sub-base layers were crushed using a Wirtgen 380CRi machine to create a stable foundation.

NPL crushed the samples of the bound asphalt material and unbound materials to 20mm then the samples were mixed thoroughly to provide a homogenous sample for subsequent laboratory tests. These were then tested for particle size distribution (PSD) using sieve analysis to EN933 and using (Transport Research Laboratory) TRL 611 envelope graphs. Moisture content of the material, with differentiating cement contents, was also sampled during the cube making process. Water was added during the mixing until the material could be formed into a ball within the hand.

A hydraulic binder provided by Cemex was used with a mix proportion of 70% ordinary Portland Cement (OPC) and 30% Pulverised Fly Ash (PFA) (CEM2), this was added at dose rates of 3.0%, 4.0% and 5.0%, calculated by percentage of dry mass to create a hydraulically bound material (HBM).

Samples were formed from the amalgamated trial pits and used for:

- Strength testing in cubes
- Modulus of elasticity in compression
- Resistance to water – strength after emersion

A review of Modulus of Elasticity (MPa) and Compressive Strengths at 28 days indicated an optimal CEM 2 Binder addition of 4.0% within the recycled HBM.

In order to minimise disruption on the key local route all on site work took place under overnight and weekend road closures. The road remained open as usual at all other times, but for safety reasons a 20mph speed restriction was in place while the road did not have its upper surface course.

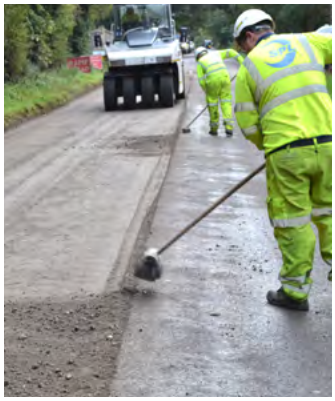
In order to achieve the high output targets, SPL deployed the Wirtgen W380CRi, the very latest in recycling technology. It is the only third generation recycling machine of its kind currently operating in the UK, and only 1 of 26 units operating worldwide.

Conventional Deep In-Situ Recycling

The key differences between this and the widely used W2000 machines are:

- The 380 has an operating width of 3.5m rather than 2m
- The machine's toothed drum operates in "downcut" mode whereby the drum rotates in the direction of travel. This means the first penetration into the existing carriageway is through the surface, improving the gradings produced
- Recycled material is fed via conveyor to a paver and placed to levels as a one pass operation and then rolled to final level ready to receive dressing
- Moving at between 4m and 5m per minute, the recycling train SPL were recycling an unprecedented volume of material enabling the placement of a recycled HBM of 4000m^2 per shift at a depth of 270mm

In preparation prior to mixing, CEM2 was spread onto the existing carriageway and a 1m planer run near the centre line (approximately 4.2m from the road's edge) providing the additional width required for the works to be carried out in a lane width. This meant that the planed material deposited on the CEM2 was picked up and mixed with the existing carriageway before being fed to the paver and laid to the 4.2m width.



Since the mixed material is placed through the paver levels are set and, following compaction, falls ensure cambers remove water from the carriageway. In this case 2.5% from the centre line to the side of the road.

During the works, as part of SPL's quality assurance procedure, a proportion of the site testing was undertaken to determine compliance with the project's mix design.

Cement spread rate was tested using a collecting mat or tray, one every 500m^2, as well as in situ sampling to confirm Particle Size Distribution (PSD) involving one test every 1,000m^2, or sooner if any notable change in composition was found.

For client information only, and in support of the LWD testing to be undertaken once compaction had taken place, compressive strength and elastic modulus under compression testing was also undertaken by NPL.

Conventional Deep In-Situ Recycling

This involved three no. 150mm cubes from each 1,000m^2 of material laid, compacted and cured in accordance with Clause 1040. The cubes from each batch tested should have a target mean strength of4.0N/mm^2. A set of five cylinders was also undertaken daily to compare the elastic modulus in compression of the material compared with that of the mix design at7 and 28 days.

Post-production once works to a particular section of the scheme was complete surface stiffness was measured by NPL using a Light Weight Deflection (LWD) Plate - three tests every 50m across the lane width of laying. Typically, targets are set at 50MPa single point value, with a mean value of 50MPa at 2 hours and 100MPa after 24 and 72 hours.

The project ultimately delivered 31,500m^2 of recycled reconstruction over four weekends and four night shifts on the Mondays that followed. Maximum outputs utilising the latest technology, collaborative planning and teamwork resulted in minimising the disruption on this busy route. In addition to the reduced disruption, carbon saving can be demonstrated of over 700 tonnes over a conventional asphalt solution. As a guide, this equates to CO_2 emissions from 257,408 litres of diesel consumed, or approximately 90 million smart phones charged.

In line with the Government's environmental and efficiency targets and aspirations SPL alongside our partners are proud to be able to provide a sustainable process more quickly than ever before, meaning less disruption as well as improving even further the low carbon figures associated with in situ recycling.

Councillor Martin Wilby, Norfolk County Council's cabinet member for highways, infrastructure and transport, said: *"We were pleased to secure £2.539m from the Department for Transport's Challenge Fund to enable this important scheme to go ahead. It's vital we have a reliable transport network, and this is a key local route. I'm pleased how our team and all the companies involved have been able to accomplish this major improvement with minimal disruption."*

The final scheme cost includes Norfolk's contribution to the Challenge fund bid, together the additional Transport Infrastructure Investment Fund (Pothole & Challenge Fund) funds received in-year. They were also able to extend the length of the site taking advantage of the traffic management arrangements.