In-situ road recycling

Howard Robinson from the Road Surface Treatments Association (RSTA) discusses in-situ road recycling

In-situ road recycling is not only an economical solution to road pavements in need of reconstruction but is also well suited to the rehabilitation of pavements that are contaminated with ‘tar’. Tar is derived from the distillation of coal in the production of domestic ‘town’ gas and was widely used in UK road building from the mid 1800s. ‘Tar’ is a possible carcinogen and is therefore considered hazardous.

In-situ recycling is acknowledged as being the preferred method of dealing with ‘tar’ residues in road construction in that the resultant recycled mix encapsulates the hazardous contaminants, rendering them harmless to the environment and avoids the need to treat tar as hazardous waste.

The structural maintenance options available to the highway engineer will vary depending on the amount of funding available and the physical constraints of the site. Some sites may have structurally deteriorated to a ‘critical’ condition so that full depth reconstruction is considered the only option available whereas others may be deemed to be less serious and may therefore be strengthened by the provision of a substantial overlay or inlay.

The purpose of in-situ recycling is to effectively restore a failed road pavement by recycling and reusing the existing construction materials to construct a new pavement with strength and life expectancy that is equal to that of a traditionally designed and reconstructed pavement. The need to dispose of huge volumes of waste materials, import processed virgin aggregates and hot bituminous bound material is greatly reduced resulting in a lower carbon footprint overall.

Structural road recycling can often be a cheaper and more effective solution in both the urban and rural situation by virtually eliminating accommodation works and by providing a 20 to 40 year design life with a construction which is non-frost susceptible regardless of site conditions or constraints.

Depending on the design traffic predictions for the pavement and the severity and nature of the structural failure a recycling solution may require recycling thicknesses ranging from 125 to 325mm with additional overlay requirements of between 45 and 160mm. The structural design of a recycled pavement can be adjusted in accordance with TRL Report 386.

To ensure quality assurance contractors operate to BS EN ISO 9001 Quality Management Systems.

Site suitability

It is essential to prove the strength capability of the processed material and to demonstrate its suitability for the application proposed.

There are four main elements that determine site suitability:

- Cause of failure of an existing road pavement
- Proposed design traffic in Million Standard Axles (MSA)
- Suitability of the existing pavement materials
- Underground utilities

TRL 611 or TRL 386 states that recycled roads can be expected to carry up to 80 million standard axles (MSA).

The specialist plant needed can process widths from one metre to full carriageway whilst the machines themselves vary in overall width between 1.6 to 3.1m.

Road recycling can be carried out under a range of different traffic management options including full road closure (generally considered the safest, quickest and cheapest) or half width working under temporary traffic control or ‘one way’ system configuration.

Ex-situ recycling requires a mobile plant to be installed near to the site therefore it is important to identify a suitable compound (often a field or car park) typically 2,000 m² in area with safe access for HGVs.

The process requires large volumes of water to hydrate the hydraulic binder in the mixture and also to control moisture content in the mixed material. Up to 60,000 litres of water may be required to complete each day’s work so local water supplies need to be identified prior to tendering to avoid increased costs from importing water long distances by road.

Statutory undertaker’s appliances within the proposed recycling layer may prevent the process from being used particularly on urban sites. It is important a ground radar survey is carried out at an early stage so any offending apparatus can be located and a judgement made.

Drainage improvements may need to be carried out prior to the recycling works commencing in order to ensure that the life expectancy of the repaired pavement lives up to the theoretical design life. The set-up costs are relatively high in comparison to traditional reconstruction as the process requires specialist plant and a highly trained labour force. Only a small number of contractors have the necessary specialist plant and expertise to carry out these projects. Larger schemes of a 3,000 m² will show the greatest cost savings and environmental benefit.
Site investigation

All sites to be considered for treatment should be properly investigated and the materials recovered and tested in accordance with TRL guidelines prior to acceptance for treatment.

Most materials found in UK roads are suitable for treatment including successive layers of asphalt and bituminous bound macadam, tar bound macadam or granular materials contaminated with tar, granular sub-base, burnt colliery shale, quarried scalplings (maximum size 100mm), soft sandstone pitching and brick hardcore. There are however some materials that cannot be treated including oversized hard stone rock including granite sets, large pitching/capping rocks, pavement quality concrete, organic peat and some clay deposits.

Trial pits should be excavated at a maximum frequency of one trial hole per 800–1,000 m² providing that materials and depth of construction found are broadly similar.

Specification

Road recycling is covered in the Specification for Highway Works clause’s 947 and 948 and in TRL 386 or TRL 611 and referred to as cold recycled bound material (CRBM).

Which binder to use depends on many factors including funding restraints, environmental considerations, traffic usage, sub-grade CBR and any other underlying ground conditions. The application of lime may also be required initially in order to modify cohesive sub-grade soils that will be incorporated within the recycled roadbase/binder course layer in order to satisfy the structural design requirements of the site.

TRL 386 contains a useful flow chart which helps the engineer decide whether road recycling is a viable option for a site under consideration and which binder option to use.

Most in-situ road recycling schemes have used either quick hydraulic (QH), medium hydraulic (MH) binders or quick visco elastic (QVE) foamed bitumen binders.

Schemes are usually designed by the recycling contractor then approved and adopted by the engineer in charge of the works. The guarantee period is usually 12 months from completion.

Road preparation

It can be necessary to pre-plane the road in advance of the works in order to maintain levels and thresholds.

All recycling schemes require the application of at least a new surface course and this together with a degree of bulking caused by the recycling process will mean that if thresholds are to be maintained then some material will have to be taken away from the site.

Installation

It is a requirement of the specification that a UKAS accredited laboratory technician attends the site throughout each stage of the process fully briefed as to the sampling and testing regime required.

With urban sites all ironwork within the pavement to be treated should be lowered to a level at least 100mm below the proposed treatment depth wherever possible.

With rural sites it is important that the drainage is improved in advance of the works where practical to help achieve the expected service life of the road pavement.

It is essential that after the pulverisation stage but prior to the mixing stage the granulated material is levelled and graded back to a similar shape and level to the original road surface. This is necessary to ensure that the correct depth of treatment is achieved and the correct amount of binder is added throughout the course of the works.

The moisture content of the pulverised material should be measured and recorded immediately prior to stabilisation and any necessary adjustments made to achieve + or – 2% of optimum either prior to treatment by aeration or during mixing by the addition of additional water through a computer controlled pump and spray bar on the recycling machine.

The addition of both bituminous and hydraulic binders demands great care to make sure that the resultant mixture compares favourably with the job standard mixture.

Once grading is complete final rolling can take place, usually involving two or three passes of the roller in vibration mode.

Following compaction the treated surface is sealed with a K1-40 bituminous emulsion. A lightly coated bituminous grit should then be applied immediately on to the bituminous tack coat layer at a rate of 5.5 – 7.0 kg/m² to provide a non-stick surface for public vehicles, pedestrians and construction traffic and to facilitate the curing of the recycled layer.

Road recycling should only be carried out when the air temperature is ≥ 3°C and rising.

Binders

There are five main binder categories used in road recycling:

QH – Quick hydraulic
Portland cement (PC) as the main hydraulic component.

SH – Slow hydraulic
Binders such as pulverised fuel ash (PFA)/lime or granulated blast furnace slag/lime but excluding bituminous binders and PC.

MH
A medium strength gain hydraulic binder containing both PC and PFA thereby offering the advantages of both QH and SH binder categories.

QVE – Quick visco-elastic
Bituminous binder as the main component but also including PC.

SVE – Slow visco-elastic
Bituminous binder as the main component but excluding PC.
Aggregates and fillers
It is rare that additional aggregate or fillers are required. PFA on occasion is used as a filler to correct inadequacies in material grading.

Compaction
Compaction should be carried out with a twin drum vibrating roller with a minimum dead weight of 10 tonnes. Vibration mode should be used at all times. Each pass of the roller should be overlapped by at least 100mm and a defined rolling pattern should be adhered to.

Aftercare
The treated area can usually be trafficked two hours after completion and straight line trafficking is often encouraged. This usually applies to all binder categories except SVE which normally requires a 24 hour period for curing.

Compacting to achieve a minimum 95% of refusal density

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