Highways feel the heat

USING SPECIAL EQUIPMENT TO HEAT AND REHABILITATE ROADS IS SAID, AMONG OTHER THINGS, TO OFFER COST AND ENVIRONMENTAL BENEFITS

While cold recycling improves the bearing capacity of a pavement structure, another way of processing asphalt highways is by using hot recycling.

The system uses special units to heat the surface to the required temperature and soften it so that a recycling machine can scarify, remove, recycle and replace it.

According to Wirtgen, hot recycling is used for the rehabilitation of damaged asphalt surfaces, so an intact pavement structure is of vital importance. The layers underlying the surface must fulfill all the requirements with regard to bearing capacity and resistance to frost.

Hot recycling often involves the recycling or reprocessing of reclaimed asphalt pavement (RAP) materials into hot mix asphalt in a central plant while hot in-place recycling (HIR) is an on site, in-place method that rehabilitates deteriorated bituminous pavements and minimises the use of new materials. A special train is used for the process, and these have been developed by a number of companies including Wirtgen, FAYAT Group, Socotherm, Martec and Green ARM.

Asphalt pavement is arguably the most recycled product in the United States [automobiles also claim that status] with ten of millions of tonnes reclaimed each year. So as stocks of raw materials become scarcer, and more costly, its reuse becomes more important.

According to the Asphalt Recycling and Reclaiming Association (ARRA) the proven technology of hot recycling provides a timely answer to the nation's road maintenance and rehabilitation problems.

Reclaimed aggregates and asphaltic cements are broken down to their original state and reused to produce high quality asphaltic concrete, the performance of which has been proven to equal that of conventional mixes.

"Hot recycling can transform old, deficient pavements into good functional roadways. Problems associated with deterioration of asphalt and gradation can be corrected with aggregates and asphalt added to the new mix. Hot recycling can also help correct and maintain vertical and horizontal geometrics. Where curb and bridge clearances are affected, old overlays can be milled and recycled in a cost effective rehabilitation alternative," says ARRA.

Hot recycling eliminates the disposal problems inherent in conventional methods; requires only minor modifications to existing equipment; can be performed in compliance with existing air pollution control standards; and can be done repeatedly, using the same materials.

"Equipment now available offers a cost effective enhancement and allows conventional asphalt plants, which were not originally designed for using recycled materials, to be modified and fitted with recycling equipment," says ARRA.

Indeed as one observer noted in a paper on the subject: "The technology and equipment necessary to do recycling is developed and available. What makes hot recycling seem complicated sometimes is the seemingly infinite number of ways to go about it."

The HIR process may be performed as either a single pass (one phase) operation that monolithically recombines the restored pavement with virgin material, or as a two pass procedure, wherein the restored material is recompacted and the application of the new wearing surface then follows a prescribed interim period that separates the process into two distinct phases, says ARRA.

"It provides a very low cost maintenance strategy that enables the public works official to effectively reuse existing materials. This process demonstrates that asphalt is a rather unique construction material in that it can be effectively and economically restored. Rather than bury the deteriorated pavement with inordinate depths of new material conventionally applied, or lose it to the grinder, proponents of HIR encourage restoration."

Many advantages are claimed for the process, and says ARRA, it effectively addresses the classic symptoms of deteriorated pavement including cracks are interrupted and filled; aggregate stripped of the bitumen is remixed and recoated; ruts and holes are filled, shoves and bumps are levelled, drainage and crowns are re-established; flexibility is restored by chemically rejuvenating the aged and brittle pavement; aggregate gradation and asphalt content may be modified by some variations of this process,

Green ARM's HITONE system at work on No 36 national road in Sapporo, Japan

and highway safety is enhanced through improved skid resistance.

"In a period of rapidly increasing costs and limited funding, HIR presents the opportunity to spread available dollars over a much greater area. Roadway deterioration can be suspended, pavements preserved and upgraded, and costly reconstruction avoided," adds ARRA.

Porous transformation

A system that can transform or regenerate existing in situ dense asphalt pavement into porous asphalt pavement has been highlighted by Japanese company Green ARM.

The company says the HIT (hot in-place transforming technology) construction method, known as HITONE, has advanced since experimental demonstration work was carried out on 680m of Highway 77 in Okinawa Perfecture, Japan, in 2005.

With HITONE the construction work using a special train is divided into four processes: pre-heating, milling, separating and paving, and the self-propelled machines (preheater, heater miller, separator and mixer paver) having specific functions drive on the road and carry out their own functions.

The concept and design for the advanced technology for asphalt transforming in a single pass process was developed through a collaboration of Green ARM, Sumitomo, Showa, Shell, Hikari Kogyo, all of Japan, and the machine is manufactured by Hitachi and Sumitomo.

"With a newly developed screening device, milled asphalt mixture collected from the road surface is screened in-place while the train is advancing, to be eventually converted to porous top layer and dense bottom layer," says the company.

"Separated asphalt fraction to be used for the upper layer is mixed in a pugmill installed in the separator and the rest to be transferred to the mixer which follows, where mixing process for the lower layer takes place. This technology allows simultaneous placement of the two differently graded fractions of asphalt for the different layers.

"Utilisation of the above characteristics provides the HIT construction method with very different processes in paving compared to the conventional construction method."

Green ARM says that by using its process the removal of milled asphalt; surface treatment after removal; and recycling of asphalt mixture removed from the job site become unnecessary, and the volume of new porous asphalt mixture brought in from an outside asphalt plant is reduced to the minimum necessary.

"The asphalt transforming project executed in Okinawa in September, 2005 shows that, with the HIT construction method, it successfully reduced the total energy consumption by about 34% compared to that of the conventional construction method and also realised a reduction in the dump truck requirements by 72% in that 18 trucks were required in comparison to the 64 trucks otherwise needed using the conventional method."

As reconstructed roads have been transformed to porous asphalt pavement, they can effectively control such phenomena as hydro-plane and water-spray, points out Green ARM.

Tomoyuki Wada, Green ARM's general manager for administration and sales, said that since last year the HITONE technology had achieved some major developments.

In August 2007, four nights of public construction works on No 36 National Road in Sapporo (under the administration of the Hokkaido Development Bureau of the Ministry of Land, Infrastructure and Transport) were successfully completed.

In October last year a patent for the heating process and apparatus of HITONE

The Wirtgen train rehabilitates a section of the Jingjintang Expressway in China

was granted in Japan, and in April this year, Caltrans (the California Department of Transportation) in the US "appreciated HITONE and issued an official spec for HITONE for California's state highways. A tender document was issued for public bidding."

Tomoyuki Wada said: "In May 2008, a process patent was granted in Korea and we expect it to be granted in the US in the near future.

"Based on the above official specs, two pilot projects to construct porous asphalt pavement out of the existing dense graded asphalt will be undertaken over 40km of California state highway in August and September."

Jingjintang Expressway

In 2002 German company Wirtgen introduced HIR, a new application for repairing damaged road pavements in China, and since then its equipment has rehabilitated millions of square metres of road.

One such project was on the Jingjintang Expressway, which links the port of Tianjin with the capital, Beijing. When repaired, some 35,000 vehicles/day, including 10% of heavy traffic, put a much higher strain on the road than originally planned. The heavy traffic had caused, in particular, the right-hand lane to literally fall apart.

The motorway owners decided to hot recycle several sections of the 143km long road.

According to Wirtgen, one of the benefits of this method was that instead of placing a new surface course across the full road width, rehabilitation was restricted to the damaged slow lane. The option of replacing the entire pavement would also have been much more expensive.

One section chosen for hot recycling was a 30km stretch between Caiyu and Dayafang.

The hot recycling method was put to the test at a recycling depth of 4cm and a working width of between 3.8m and 4m, says Wirtgen.

The heating units of the Wirtgen Remixer 4500 followed in the wake of a Wirtgen HM 4500 preheater.

The remixer then scarified the heated asphalt pavement material and conveyed it to the integrated twin-shaft mixer, where the existing material was thoroughly mixed with 8% to 10% of new mix and in addition sprayed 0.4 - 0.6litres m^2 of bitumen into the mix to be paved.

The recycled surfacing course material was then placed by the machine's integrated paving screed. The recycling train worked at an advance speed of between 1.6 to 2.2m/min, and a few hours after compaction the road was opened, and was being used by heavy traffic.

PAVIREC for A22

Italian motorway operator Autostrada del Brennero is using an innovative hot recycling system to carry out repairs to a 2km section of the A22 motorway.

Celebrating its 50th birthday next year, the company is said to have used 'thermal regeneration' on the route as part of the "huge project carried out by the company in order to keep high levels of quality, respecting the environment."

The PAVIREC system uses the advanced technology of hot in-place recycling for deteriorated asphalt surfaces, and has been developed by the Socotherm Group, whose activities relating to infra-structures and rehabilitation are carried out by Socotherm Infraviab.

The A22 runs southwards for 314km from Brennero in northern Italy to near Modena. With the expansion of tourism and its related activities in the Trentino-Alto Adige region in the 1950s, problems arose due to deficiencies of the existing road structures, which were inadequate to deal with the increase in traffic, especially in the summer season. It became evident that a new multi-lane motorway had to be constructed.

Autostrada del Brennero was founded on 20 February, 1959 on the direct initiative of the local authorities convinced of the importance of the new road link. In 1961 the company was granted permission to construct and manage the A22 motorway.

The first 50km section of the motorway running through the Adige Valley from Bolzano to Trento, opened in December, 1968, and from July, 1972 the motorway could be travelled on without interruption from Brenner to Chiusa (54km) and from Bolzano to Modena (228km), "representing an important link in

Left: A PAVIREC machine at work on A22 Highway, and right: a detail of the machine at work

the European road network." In April, 1974 the last section, from Chiusa to Bolzano South, was inaugurated.

Autostrada del Brennero is the first Italian motorway operator to achieve the integrated certification Quality and Environment ISO 9001/14001 fro the A22.

The work carried out for Autostrada del Brennero using the 62m long PAVIREC train was on the A22's porous asphalt pavement, and the working speed was 2.5-3.5/min with daily production of 6,800m² over the working width of 3-4m.

The regeneration depth varied from 2-5cm, with thermal regeneration, a non-destroying process, used to remove and mix the old draining pavement with added materials.

According to Socotherm, the technique solves completely the problem of the disposal of products from the milling of pavements because it uses 100% of the existing materials, offering cost savings and environmental benefits.

On site thermal regeneration transforms the milled material into a product, not into a waste, and reduces the withdrawal of materials from quarries, energy consumption and transportation costs. The company says that a comparison with the traditional replacement systems shows the PAVIREC recycling process requires approximately 33% lower energy consumption.

PAVIREC recycles in situ all the asphalt components in a system of melting the deteriorated asphalt by irradiation and remixing it directly over the ground with a vertical mixer, avoiding the breaking of aggregates and the chemical binding substances.

Socotherm says that PAVIREC recycling requires only a short length of site, and compared to some recycling systems, involves no removing, transportation or disposal of old materials; no surface cleaning and laying of the tack coat layer (the old one remains in place and an effective hot bonding is realised); an 80-90% reduction in new aggregates added; 75-80% reduction of the new bitumen added, and a proportional reduction of the materials-related transportation.

The work is carried out in a single operation, 100% on site, using a mobile plant consisting of equipment to remove the old asphalt using heat; add the new materials; regenerate and apply the asphalt concrete mix, and finally compaction. The road is then opened to traffic.

Voyager's travels

The FAYAT Group is highlighting its Marini Voyager HIR machine, which it says now takes full advantage of new technologies.

A descendant of the ART 220, a mobile hot mix asphalt (HMA) plant built by Marini, with 40 machines being sold worldwide (some are still in use in Venezuela, Romania, Finland and Italy), the Voyager is a traditional parallel flow machine. It is a self-propelled travelling plant that is automated in all areas, drying and then heating the recycled materials to a temperature of approximately 150°C, which is compatible with good compaction.

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Wirtgen
www.wirtgen.de

Green ARM
www.green-arm.com

ARRA
www.arra.org

FAYAT Group
www.fayat-group.com

Socotherm Infravib
www.socotherm.com

Martec
www.martec.ca

The system it calls thermo-regeneration (also known as thermo-shaping or thermo-surfacing) involves only the first few centimetres of carriageway: it can never become a suitable solution for structural recycling, says the company.

However, FAYAT says that the operational economies made with in-place recycling are estimated at more than 50% in comparison to traditional recycling solutions.

It also points out that the Voyager can take advantage of the appearance of new low-energy technologies, such as half warm and warm solutions.

"The two major disadvantages relating to the hot recycling process (at 150°C) are now dispensed with: elimination of pollutant emissions such as dust, with stoppage of drying, and increased output to 200tonnes/hr in situ, instead of 100tonnes/hr," says FAYAT, whose Voyager technique takes full advantage of the boom in half-warm emulsions and foam bitumen.

Indeed, FAYAT says the Voyager utilises the advantages of HIR, among which are dehydration of the recycled materials and perfect coating with new bitumen; it is possible to add 20% virgin materials; milling is independent and the depth of cut can be controlled; it is possible to bring into operation immediately; application of a tack coat after brushing, and the quality is equivalent to that of a traditional hot mix plant.

FAYAT says that while traditional binders are usually bitumen, with regenerating agents, new technologies have opened up possibilities that are routine for stationary plants but remain new territory for mobile plants. These include foam bitumens, emulsions, modified bitumens and sequential coating techniques.

One solution suggested is half warm emulsions, a process that involves coating asphalt aggregates and/or aggregates heated to 90°C with high-performance emulsions. All of these solutions seek to make the viscosity of low-temperature binders compatible with coating.

FAYAT says that the production of asphalt mixes can be schematically subdivided into four temperature ranges, and temperature variations in the mixing phase have been proved to greatly influence the final characteristics of the product.

Accurate studies and tests have been carried out on the benefits that can be obtained by increasing the aggregate temperature over ambient temperature, before mixing with foam-bitumen, or with bitumen emulsion. ■