



Job Report Hot Recycling

Remixer 4500: Different hot in place recycling applications in China



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Introduction

In 2002 Wirtgen introduced a new application for repairing damaged road pavements in China – hot in place recycling. Now, three years later, the application is completely accepted in road rehabilitation, with well over three million square metres of road pavement repaired in China using Wirtgen's hot in place recycling process.

Before the hot in place recycling process was introduced, routine maintenance was normally carried out by patching the damaged areas. In some cases, where the problems were more widespread, damaged sections of the asphalt were milled out and overlaid with a new asphalt wearing course.

The increased popularity of the Wirtgen hot in place recycling process can be easily explained. Hot in place recycling offers a more effective means of repairing damaged road pavements, its main advantages being that the asphalt in the damaged pavement is reused, thus substantially reducing the amount of new asphalt that has to be produced and hauled to the jobsite.

This significantly reduces the cost of the repair work compared to the old mill-and-patch methods of repair. It also results in considerable environmental benefits, as less crushed stone has to be mined and crushed, and much less asphalt has to be transported to the jobsite, thus reducing damage to the road network caused by heavy vehicles



Wirtgen hot in place recycling on the Jing-Jin-Tang expressway between Beijing and Tianjin.



The Wirtgen HM 4500 Preheater heats the asphalt ahead of the remixer.

transporting the asphalt. In order to give the reader a better understanding of the applications and advantages of the Wirtgen hot in place recycling process, this report covers some of the projects that have been successfully completed in China over the past three years.

Hot in place recycling on the Jing-Jin-Tang expressway

The Jing-Jin-Tang expressway is one of China's busiest, stretching from the Tang Gu district, near the port city of Tianjin, to China's capital city, Beijing. Of the 35,000 vehicles that use the expressway every day, well over 10 % consist of heavies.

History was made on this expressway – this was where the first hot in place recycling project was carried out in China, in 2002. Since this time the expressway owners have carried out two other projects using this process.

The first project was carried out on the 22.5 kilometre section between Tang Du and Dong Li. This section had been hastily completed in 1990 to open in time for the Beijing Asian Games, without a wearing course. With traffic running on the asphalt binder course for around 12 years, the surface, particularly in the slow lane, had become severely cracked. Based on significant cost savings in comparison to mill-and-patch rehabilitation, a decision was taken by the expressway owners to carry out hot in-place recycling of the



New asphalt mix being tipped into the Wirtgen Remixer RX 4500.

slow lane, and then to pave the full width of the carriageway with a new wearing course.

The Wirtgen hot recycling train owned by Huayu R&B Maintenance New-Tech Ltd, consisting of the HM 4500 Preheater and the RX 4500 Remixer, started work at the end of April 2002. Both machines were easily adjusted to the required recycling width of 4.0 metres, and the existing asphalt in the slow lane was recycled to a depth of 5 cm.

The process starts with the Wirtgen Preheater HM 4500; infrared heater banks using gas stored in the onboard tank heat and soften the in situ asphalt. The remixer, which is equipped with additional heater banks, increases the asphalt's temperature. The scarifier unit on the Wirtgen Remixer 4500, with variable width from 3.0 metres to 4.5 metres, scarifies and windrows the heated asphalt to the required depth and transfers the material into the onboard pugmill. During this project the aggregate grading of existing asphalt was improved by adding 10 % of new wearing course asphalt mix, while the properties of the bitumen were enhanced by the addition of an emulsified rejuvenating agent. The rejuvenator improves the penetration and softening point of the aged bitumen in the old asphalt.

From time to time new asphalt mix is delivered by tip trucks that fill the Remixer's feed hopper. The microprocessor con-

trolled system enables a precise volume of asphalt mix to be conveyed to the onboard pugmill where it is thoroughly mixed together with the reclaimed asphalt.

Rejuvenating agent, or additional bitumen, is added by spraying it onto the scarified asphalt just before it is transferred into the pugmill. Here again, the control system enables the volume of additive to be precisely metered. The additive tank is heated, enabling the use of penetration grade bitumen, if the addition of bitumen is found necessary during the investigation stage. On this particular project between 0.3 % and 0.4 % by mass of rejuvenator was added during the remixing process.

After being thoroughly mixed together in the pugmill, the recycled asphalt mixture is paved using the integrated paving screed, which is equipped with tamping and vibration systems. The working speed on this project varied between 1.6 and 2.5 metres per minute.

Behind the remixer, compaction was carried out using two rollers, a 10 ton vibrating roller and a 20 ton rubber tyred roller. The contractor was well satisfied with the performance of the Wirtgen HM 4500 Preheater and RX 4500 Remixer. An average production rate of over 3,000 square metres per day was achieved, even though work could only start at 9 o'clock in the morning and had to end at 4 o'clock in the afternoon due to restrictions imposed by the traffic authorities on this busy expressway. The owner of the



Remixing being carried out on the slow lane.

expressway was also impressed by the fact that the hot in place recycling could be carried out during the day with only the slow lane having to be closed while the fast lane would be left open to traffic. At night, and during times of peak traffic, in the mornings and evenings, the equipment was taken off the road and both lanes were opened to traffic. As part of the ongoing maintenance programme on the Jing-Jin-Tang expressway between Beijing and Tianjin, hot in place recycling of another section of 30 kilometres, between Dayangfang and Caiyu, was carried out, commencing in July 2002.

On this project the requirement was to carry out remixing of the existing asphalt wearing course in the slow lanes only. This was done to eliminate cracks and slight rutting that had taken place since the road was constructed in 1990. In this case the existing asphalt wearing course along the slow lanes on both carriageways was remixed to a depth of 4 cm. Recycling width varied from 3.8 m to 4.0 m.

As a means of improving the properties of the aged bitumen in the original asphalt wearing course, as well as to level off the ruts, 8 % to 10 % of the additional new wearing course asphalt mix, as well as 0.4 % to 0.6 % of rejuvenating agent, was added during the remixing process. The working speed on this project varied from 1.6 m to 2.2 m per minute. Two rollers were used behind the Wirtgen RX 4500 Remixer to compact the recycled asphalt; a 12 ton vibrating roller and a 20 ton rubber tyred roller.



Showing the advantage of using hot in place recycling to recycle only the damaged slow lane.



Hot in place recycling using the Wirtgen Remix-plus process on the Jing-Jin-Tang expressway.

A very important feature of this project was that the Wirtgen hot in place recycling process enabled only the damaged slow lane to be targeted for maintenance. On most multi-lane expressways and highways, the slow lane, which carries by far the heaviest traffic, becomes damaged much sooner than the middle and fast lanes. Using conventional construction equipment it would be necessary to pave an asphalt overlay over the full width of the carriageway. Otherwise, if a milling machine is available, the slow lane could be milled out and an asphalt inlay could be undertaken to replace the damaged asphalt that had been removed by milling.

Both these methods imply additional costs, whereas Wirtgen hot in place recycling offers a practical and substantially less expensive solution; only the slow lane is recycled, while the profile between the slow lane and the adjacent lane is maintained without a change in level. In the year 2005, due to the success of the previous projects, the Jing-Jin-Tang expressway owners commissioned two contractors to carry out further hot in place recycling on sections of the expressway between Tang Gu and Beijing. Two sets of Wirtgen hot recyclers were used, the one owned by Shanghai Pudong R&B and the other by Hebei Runze Company. Approximately 540,000 m³ of pavement was recycled between 10th April and 12th June 2005 by the two recycling trains, a clear indication of the good production



Wirtgen Remix-plus - showing the two paving screeds.

rate that can be expected from the Wirtgen hot in place recycling process!

In this case the Remix-plus process was selected, where the existing asphalt is remixed to the prescribed depth and a layer of new asphalt wearing course is simultaneously paved over it. Two paving screeds are used, the first to level the remixed material and the second to pave the new wearing course.

A distinct advantage of Wirtgen Remix-Plus is that the process ensures excellent hot-to-hot bonds between the underlying and the remixed asphalt, as well as between the remixed asphalt and the new wearing course layer. Sound hot-on-hot longitudinal joints are also achieved between each paving pass. There are thus significant cost savings in terms of eliminating the need for bitumen tack-coat, as well as the labour needed to apply it.

On this project the old pavement was recycled to a depth of 4 cm and the 3 cm wearing course was paved simultaneously on top of the recycled layer. Two lanes were recycled, with widths varying from 3.8 m to 4.1 m. In order to improve the properties of the aged bitumen in the old pavement, between 0.4 litres and 1.0 litres per m³ of rejuvenating agent were added during the recycling process. The working speed obtained on this project averaged 2.5 m per minute. Compaction



Hot in place recycling on the Cheng-Yu expressway, showing the preheater heating the old pavement as well as the newly paved asphalt behind the remixer.

of the asphalt behind the remixer was achieved using two rollers, a 12 ton vibrating roller and a 20 ton rubber tyred roller.

Beijing: Connection road between 3rd and 4th ring roads
Another project that used Remix-plus was carried out on the busy 2.6 km dual carriageway connecting Beijing's 3rd and 4th ring roads. The connecting road was constructed in 1993, and since then the asphalt wearing course had aged, exhibiting both longitudinal and transverse cracks, as well as isolated areas of crocodile cracking. A depth of 4 cm of the existing asphalt was remixed, and a layer of 3 cm of wearing course was paved over it.

The work started on 27 June 2002 and Remix-Plus on the 6 lanes was completed on 20 July. A working speed of approximately 2 metres per minute was achieved and a total of 170 hours was clocked on the remixer. Emulsified rejuvenating agent was used to improve the aged properties of the bitumen in the existing asphalt, using 0.3 % by mass. Two rollers, a 12 ton vibrating roller and a 20 ton rubber tyred roller, were used to compact the asphalt layers.

Hot in place recycling on the Cheng-Yu expressway
Two projects using the Wirtgen hot in place recycling process have been undertaken on this expressway, between Chengdu and Chongqing. This expressway, which was constructed in 1993, was showing damage and needed strengthening in order to carry the increasing volume of heavy traffic that uses this route.



The first project was awarded to Shanghai Pudong R&B and started in May 2004. By mid-September, at the end of the project, a length of 20.75 km of the expressway had been completed, resulting in a total recycled area of around 300,000 m³.

Both lanes and shoulders were recycled to a depth of 4 cm, and 4 cm of type AC13-C wearing course was simultaneously added to strengthen the pavement using the Remix-plus process.

The quantity of rejuvenating agent added to the aged asphalt varied on this project, from zero to 0.8 litres per m³, depending on the properties of the original asphalt in the old pavement. A production rate of around 2 m per minute was achieved. Behind the Wirtgen RX 4500 Remixer, the asphalt was compacted using two rollers; a Hamm HD 130 vibrating roller and a 20 ton rubber tyred roller. The second project on this expressway commenced on 15th April 2005, as an extension to the first project. This clearly shows the confidence of the expressway owners in the Wirtgen hot in place recycling process!

Hot in place recycling of modified asphalt on the Hu-Rong expressway
Another interesting project was undertaken in 2004, on a section of the Hu-Rong expressway, the aim being to assess whether the Wirtgen process was suitable for recycling the polymer modified wearing course.



Second hot in place recycling project, on the Cheng-Yu expressway showing the compaction of the recycled asphalt layer using a Hamm HD 130 vibrating roller, as well as a view of the completed pavement.

In order to judge the effectiveness of the recycling process, the following parameters were set by the Hubei Xiao-Xiang Expressway Investment Company:

- ▶ The depth of recycling shall be between 3 cm and 4 cm
- ▶ The forward speed of the recycler shall be 1 m to 2 m per minute
- ▶ The minimum temperature inside the recycled layer, when measured immediately behind the remixer's paving screed, shall be 120 °C
- ▶ The density of the recycled layer shall not be less than 95 % of the Marshall density of the recycled mix

The quality of compaction was checked by Hubei Transportation Engineering Inspection Centre. During the project, all these requirements were met, and the conclusion was reached that the Wirtgen RX 4500 and HM 4500 recycling train is fully capable of recycling pavements where the asphalt in the wearing course has been modified using SBS.

Conclusions

Hot in place recycling has been carried out in many countries across the world. Notably in the USA, the Wirtgen hot in place recycling process was introduced way back in 1983, and has been used in 11 states, with well over 7 million m³ having been completed. There has therefore been sufficient time for the performance of hot in place recycling to be properly evaluated, and the process has been fully proven. For instance, in a well researched project carried

out by the US Department of Transportation Federal Highway Administration (Report No. FHWA/MS-DOT-RD-99-102), the following conclusions were reached:

“The reuse of the existing asphaltic pavement can often be very desirable, because of the decrease in the new asphalt needed and as a safety factor because the finished grade is essentially the same elevation as the original pavement. The hot in-place recycling project also produced savings over the conventional design. There are no major differences in the hot in place recycled projects and the overlay projects in properties, which include viscosity, penetration, percent voids, specific gravity, aggregate gradations, and resilient modulus.”

In China, the Wirtgen hot in place recycling process was introduced in 2002; much later than in the USA. Nevertheless it is rapidly gaining in popularity, as illustrated by the fact that already more than 3 million m³ of hot in place recycling using the Wirtgen process has been completed.

As described in this report, the Wirtgen process can be used in a variety of ways; to recycle only one lane, or the full carriageway width, to recycle the old pavement and pave a new wearing course simultaneously using Remix-plus, as well as to recycle polymer modified wearing courses. There is no doubt that more and more use will be made of the well proven Wirtgen hot in place recycling process for repairing and strengthening road pavements throughout China!



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