

For discussion
21 June 2013

Legislative Council Panel on Transport

Recycling of Bituminous Pavement Materials in Road Maintenance

PURPOSE

This paper introduces the research studies on the recycling bituminous pavement materials and its applications in road maintenance.

BACKGROUND

2. Bituminous materials have been extensively used in paving roads in Hong Kong. Among the over 2 000 kilometres of road networks in Hong Kong, about three quarters are paved with bituminous materials.

3. In Hong Kong, bituminous pavement generally consists of three layers of different bituminous materials: the top layer “wearing course” (WC) provides an even running surface for vehicles and wearing resistance; the middle layer “base course” (BC) provides a well-prepared and even surface for the laying of WC and helps spread traffic loads to the bottom layer “road base” (RB). The main function of RB is to further distribute loads to the sub-base, which comprises granular materials.

RECYCLING OF BITUMINOUS PAVEMENT MATERIALS

4. To maintain road pavements in a satisfactory condition, the Highways Department (HyD) carries out corresponding repair and rehabilitation works according to the actual extent of deterioration of the pavements.

5 Traditional bituminous pavement maintenance methods deploy machinery to break up and remove the defective pavement materials, followed by laying of new bituminous materials and compaction. Such process inevitably generates a certain amount of bituminous waste, consisting of aggregates of different sizes coated with aged bitumen that has been in use for years. The waste is usually disposed of, causing wastage.

6. To manifest the principle of sustainable development, HyD collaborated with the Hong Kong Polytechnic University (HKPU) to research into the appropriate ratio of bituminous waste used in production of new bituminous materials (hereinafter referred to as "recycled materials"). In addition, HyD conducted local trials on the use of in-situ recycling technology (paragraphs 12 to 15 refer) for small-scale road maintenance works in order to minimise the generation of bituminous waste.

Research and Practice

7. Due to the lack of local experience, in order to examine the effect on the performance of the function and durability of the different layers of bituminous pavement arising from the incorporation of recycled materials, HyD collaborated with HKPU to conduct laboratory tests on the performance of the resultant materials with portions of virgin bituminous materials substituted by recycled materials in WC, BC and RB layers. The research results showed that if the amount of recycled materials was limited to 15% of the total mass of the bituminous materials, the performance would be similar to brand new bituminous materials.

8. With the above research results, HyD encouraged contractors to use bituminous materials incorporated with a maximum allowable amount of 15% recycled materials for laying of WC, BC and RC in maintenance works as trials. Upon accumulating experience and ascertaining the availability of supply in the local market, HyD has stipulated the mandatory use of recycled materials in production of bituminous materials in road maintenance contracts made since 2008.

At the same time, HyD has continued to monitor international development on the use of recycled materials and made reference to other countries' experience in the feasibility of incorporating more recycled materials in bituminous materials.

9. In 2009, HyD collaborated with HKPU to conduct further research on bituminous materials incorporated with a larger amount of recycled materials. The objective was to investigate whether these bituminous materials with a larger amount of recycled materials were suitable for use in the three layers of the bituminous pavement mentioned in paragraph 3 above. The results showed that if the amount of incorporated recycled materials was more than 15% of the total mass of bituminous materials, the fatigue resistance¹ of the bituminous materials would be affected. For bituminous materials incorporated with recycled materials amounting to 30% of the total mass of the bituminous materials, while they were in general comparable with bituminous materials without recycled materials, there was a significant adverse impact on their fatigue resistance.

10. Based on the research results and practical experience, HyD has increased the maximum allowable amount of recycled materials in bituminous materials in the road maintenance contracts since 2012. As the main function of WC and BC is to provide wearing resistance, the performance of fatigue resistance will not affect their overall performance. Therefore, the maximum allowable amount of recycled materials for these two layers has been increased to 30% of the total mass of bituminous materials. However, the performance of fatigue resistance will affect durability and thus the performance of RB. In view of this, the maximum amount of recycled materials allowable in RB has remained at 15% of the total mass of the bituminous materials.

¹ Materials with elastic property will be extended when loading is applied to them. When the loading is removed, they will return to their original state. However, if loading is repeatedly applied and removed up to certain times, the materials will not return to their original state when the loading is removed. This phenomenon is known as "fatigue". "Fatigue resistance" refers to the ability of a material to resist fatigue.

Production Process

11. Production of bituminous materials incorporated with recycled materials is similar to that for brand new bituminous materials. Therefore, the production cost will not be significantly higher. Also, the production rate will not be affected. **Figure 1** shows the production process: through the control of an electronic system, an appropriate amount of recycled materials (see **Figure 2**) and virgin aggregates will be sent to the weigh hopper for mixing. Then, virgin bitumen binder will be added and mixed to produce new bituminous materials for pavement laying.

IN-SITU RECYCLING TECHNOLOGY

12. Traditional bituminous pavement maintenance methods deploy machinery, such as handheld breakers and cold milling machines, to break up and remove defective road materials, followed by laying of new bituminous materials and compaction. Such process will inevitably generate certain construction noise and waste.

13. The basic principle of in-situ recycled technology is to utilise heat radiation to soften defective bituminous pavement, then to compact the scarified surface with an appropriate amount of new bituminous materials to form a uniform and seamless reinstatement. Its advantages include: being able to promote the recycling of existing bituminous materials; and reduction of construction noise (as the mechanical breaking process in traditional method is replaced by heat softening).

Applications in Local Road Maintenance

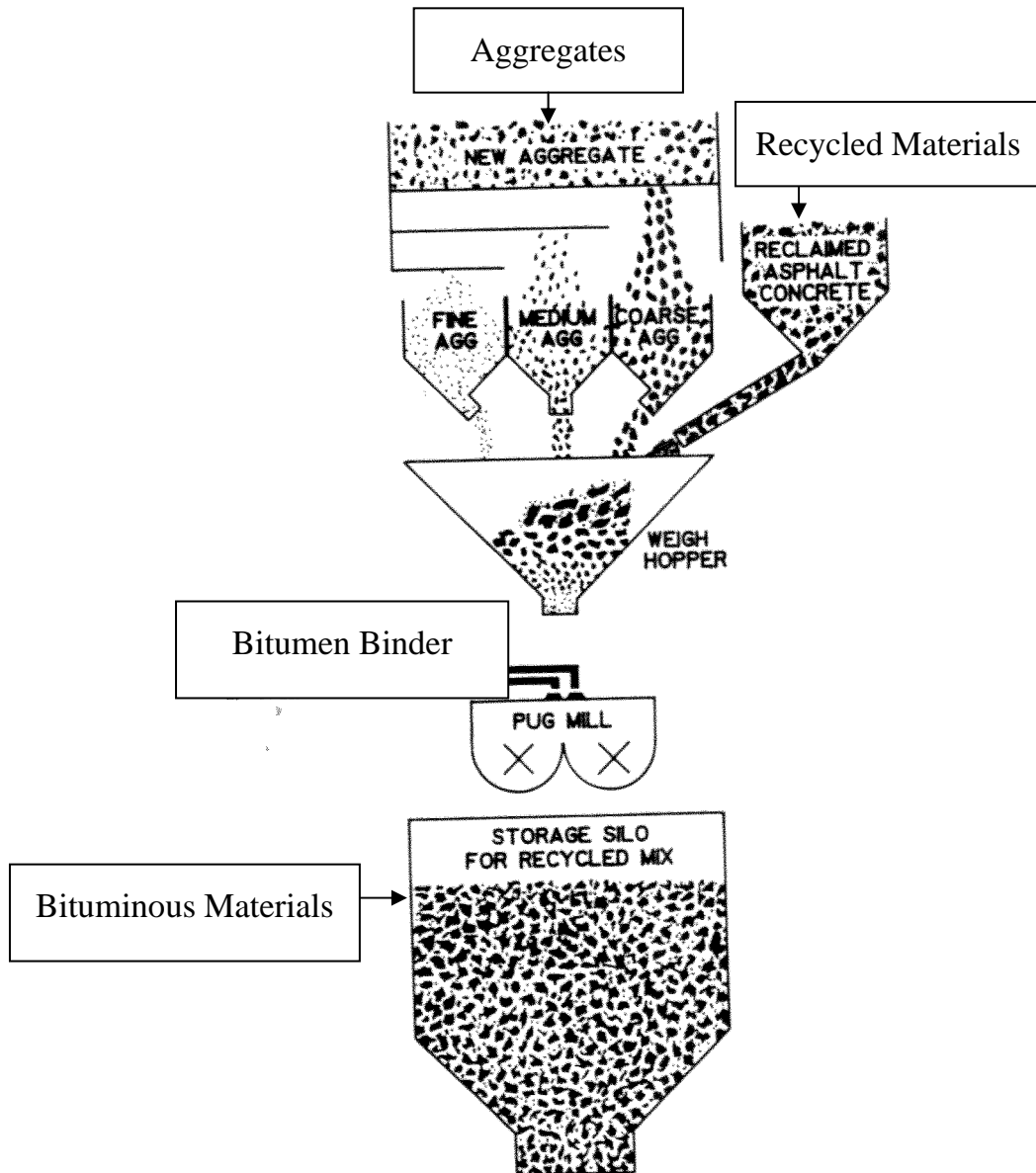
14. Similar road maintenance technology has been used by different places around the world. A few years ago, HyD conducted local trials on the application of thermal patchers as alternative options for pothole repair and small scale resurfacing of bituminous pavements.

15. After accumulating experience and ascertaining the availability of supply in the local market, HyD has included the use of in-situ recycling technology in road maintenance contracts since 2009. Under normal circumstances, contractors are required to accord priority in using thermal patchers to perform minor bituminous pavement repair up to an area not exceeding 2.5 m². For road maintenance contracts made since 2011, HyD has further incorporated provisions on the application of thermal patchers (see **Figure 3**). Contractors are allowed to use thermal patchers for small scale resurfacing of bituminous pavements (area not exceeding 100 m²) along road sections subjecting to stringent environmental and traffic constraints.

WAY FORWARD

16. To cope with the ever-increasing demand on road maintenance works and to minimise bituminous waste generation from these works, HyD will keep abreast of international development in bituminous pavement recycling technologies. Moreover, subject to local conditions, HyD will continue to conduct research with the objective to extend the use of recycled materials in Hong Kong.

Highways Department
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[Figure 1] Schematic Plan – Production of bituminous materials incorporated with recycled materials



[Figure 2] Recycled materials stored in production plant



[Figure 3] Small-scale pavement resurfacing by thermal patcher