

Status and Development of Road Green Preventive Maintenance Technology under Carbon Neutralization in China

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Abstract. During the 14th five-year Plan period, China made great efforts to develop circular economy, promoted the realization of carbon peak and carbon neutralization goals, and put forward the requirements for the development of road green preventive maintenance. This paper analyzes the current situation of preventive maintenance technology, and combs the conventional and new road preventive maintenance technology in China, as well as the related green new maintenance materials. the working principle, construction process, maintenance characteristics and applicable scope of each technology are summarized, and the new trends and suggestions for the development of road preventive maintenance technology in the future are discussed in order to provide engineers with better technical choices. Provide scientific guidance and suggestions for the development of road pre-maintenance technology in China, and promote the green development of road maintenance industry under the background of carbon neutralization.

Keywords:road maintenance;preventive maintenance; carbon neutralization;new maintenance material

1. Introduction

In recent years, with the increase of population and traffic volume in China, the problem of road diseases has become increasingly prominent, and road maintenance has been paid more and more attention. How to further develop road maintenance has become an issue that we have been paying close attention to. During the 14th five-year Plan period, China will vigorously develop circular economy, promote the conservation and utilization of resources, construct the resource recycling industrial system and waste material recycling system, and promote the realization of the goal of carbon peak and carbon neutralization. In this context, the government proposes to develop road green preventive maintenance to ensure a higher level of road service and to pursue more economical, efficient and green maintenance technology.

At present, the conventional preventive maintenance technologies in China include Synchronous Chip Seal, fog seal, thin overlay, micro-surface technology and so on. These technologies can prolong the service life of the road, flatten the road surface and reduce the pavement disease. With the continuous study of road maintenance technology (Fig 1), researchers began to explore better road maintenance technology: Liu tested the compatibility of color modified emulsified asphalt with bright resin emulsion with different SBS content. The results show that liquid SBS modifier and bright resin emulsion have good compatibility. Song designed the mix ratio of asphalt mastic and carried out laboratory tests. the results show that the performance indexes of asphalt mastic meet the requirements of the specification and have good road performance and application potential. Tian analyzed the anti-dispersion performance of mixture cured by fog seal material, as well as the water seepage and anti-skid performance of original pavement, and finds that this technology has a good effect on the ravelling, and it will not have a serious impact on the drainage effect of the drainage pavement itself. Combined with the comparison of the water mist formed on the conventional road surface and the wear layer on rainy days, Wang found that almost no water mist was formed on the surface of the synchronous thin overlay wear layer, indicating that the synchronous thin overlay cover has the characteristics of strong drainage capacity and reducing water mist . Sun tested and analyzed the mechanism of the micro-surface noise, found that the micro-surfacing mixture tire road noise does

not increase with the increase of use time, noise sound pressure level has always fluctuated around a certain value.

Based on the above research background, this paper summarizes the conventional and new road preventive maintenance technologies in China, as well as the related green new maintenance materials, and summarizes the working principles, steps, applicable scope and advantages of each technology. It also puts forward the new trend and suggestions for the development of road preventive maintenance technology in the future, so as to provide engineers with better technical choices. To provide scientific guidance and suggestions for the development of road pre-maintenance technology in China.

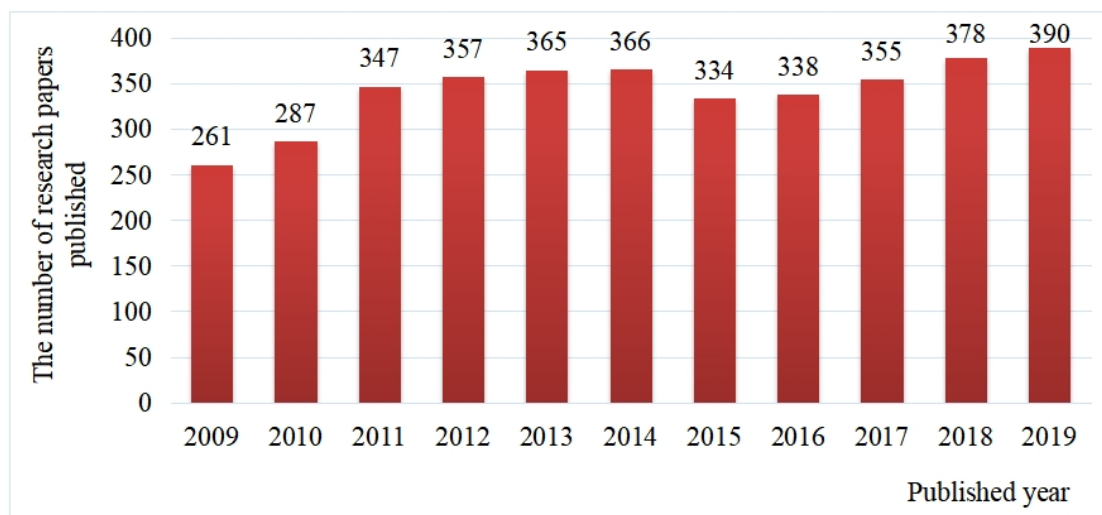


Fig 1 Number of published literature on road preventive maintenance in China in the past decade

2. Development Status of Road Green Preventive Maintenance

2.1 Overview of Road Green Preventive Maintenance

As a high-emission industry in modern society, transport carbon reduction is one of the important links in the process of global carbon neutralization, in which road maintenance has become the focus of attention. The early implementation of China ' s corrective road maintenance technology belongs to the passive road maintenance. When the road deterioration occurs, the road will be uneven, resulting in serious deterioration of traffic road problems that cannot be repaired. The repair project consumes too much funds and takes too long time. Nowadays, China has increasingly stringent requirements for environmental protection, and the awareness of road preventive maintenance is increasing. In order to prolong the service life of roads, save road maintenance funds, and improve the service performance of road surfaces, China's road maintenance technology has begun to change from corrective road maintenance to preventive road maintenance. By 2016, preventive maintenance had been implemented on 8% of high-grade highways in China, of which the proportion of national and provincial highways reached 5%. However, preventive maintenance technology is still in the primary stage of development in China, and there are still some gaps compared with developed countries. Considering the great differences in structural design, traffic characteristics and environmental conditions between China and foreign countries, the study of pre-maintenance technical measures suitable for Chinese road characteristics is a key problem that road maintenance workers need to solve.

2.2 Common Technology of Road Green Maintenance

2.2.1 Synchronous Chip Seal

Synchronous chip seal refers to the use of synchronous chip seal car to spread single-size stone and asphalt cement on the road surface at the same time, and form an asphalt gravel wear layer to protect the original pavement under rubber wheel roller or natural driving compaction. The construction steps are shown in Fig 2. The scope of application of Synchronous chip seal technology includes 1) light traffic highway and rural highway construction; 2) ordinary highway asphalt pavement; 3) new surface wear layer of asphalt pavement. The synchronous chip seal has the advantages of simple construction technology, labor saving and low labor intensity. After rolling, the asphalt is covered with continuous film on the surface of the underlying layer, and there is a good combination between asphalt and aggregate, which can ensure the smoothness of the pavement and have the ability to follow the deformation. In addition, the aggregate of chip seal technology is mainly crushed stone, the material is easy to obtain, low cost, high strength, ensure the anti-compression ability and reduce the repair cost.

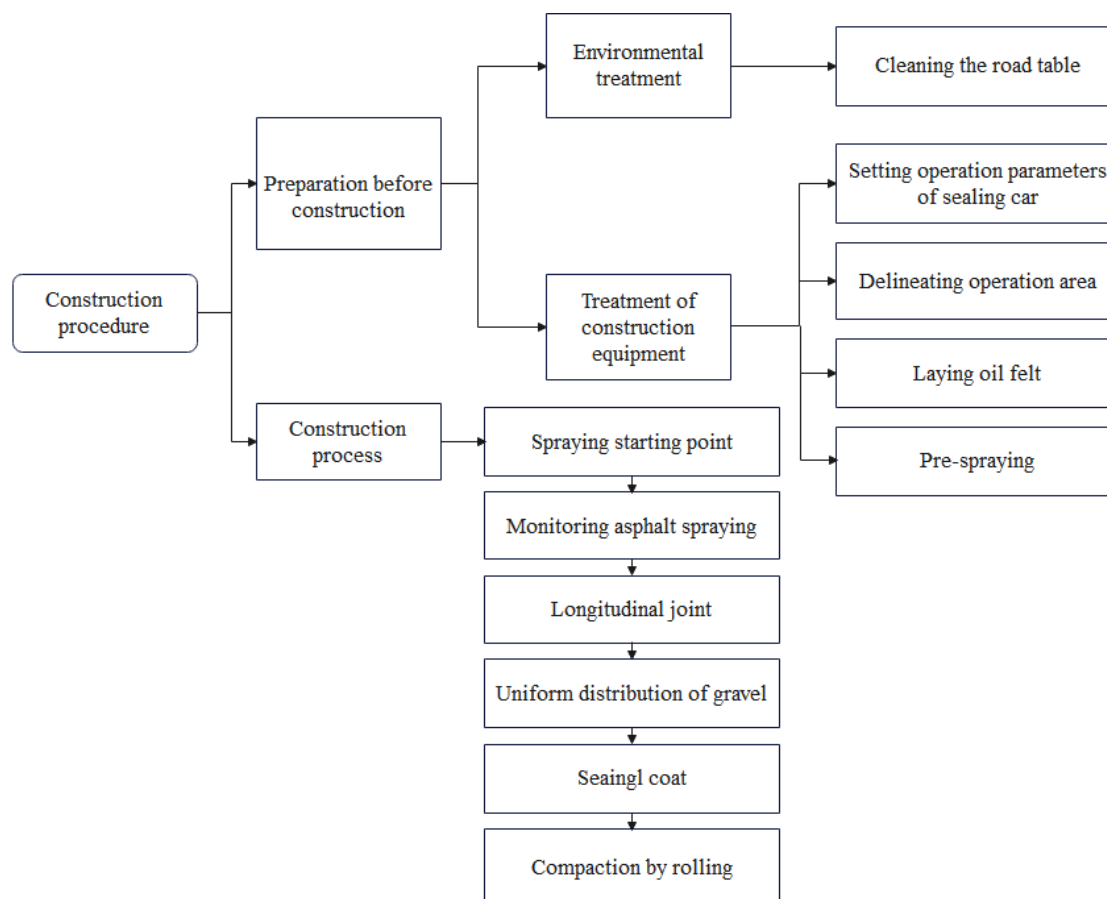


Fig 2 Construction steps of Synchronous chip seal technology

2.2.2 Fog seal technology

The fog seal is mainly composed of emulsified asphalt, modified emulsified asphalt and other curing agent materials, which are evenly sprayed to the pavement that needs maintenance by special construction equipment during road maintenance. add a layer of "film" on the original road surface through the principle of similar miscibility. The fog seal can fill the road surface gap and stabilize the road surface loose aggregate, and the fog seal made of reducing agent can repair the aging asphalt pavement. The scope of application of fog seal technology includes 1) small cracks, or the treated pavement with mesh crack and crack disease; 2) the road with loose spalling, asphalt aging and hemp

disease but not endangering the pavement structure; 3) the road with water damage but not endangering the pavement structure. The construction process of the fog seal is shown in Fig 3.

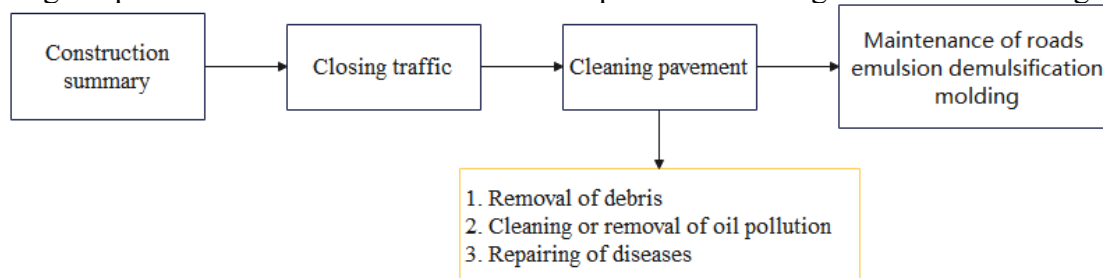


Fig 3 Construction process diagram of fog seal

Through the comparison of the performance of six road projects before and after the construction and maintenance of fog seal technology (Fig 4), it is found that the crack depth is reduced, the anti-skid ability is improved and the seepage is reduced after the technical treatment, indicating that the fog seal technology can effectively reduce the pavement crack gap and improve the road surface structure.

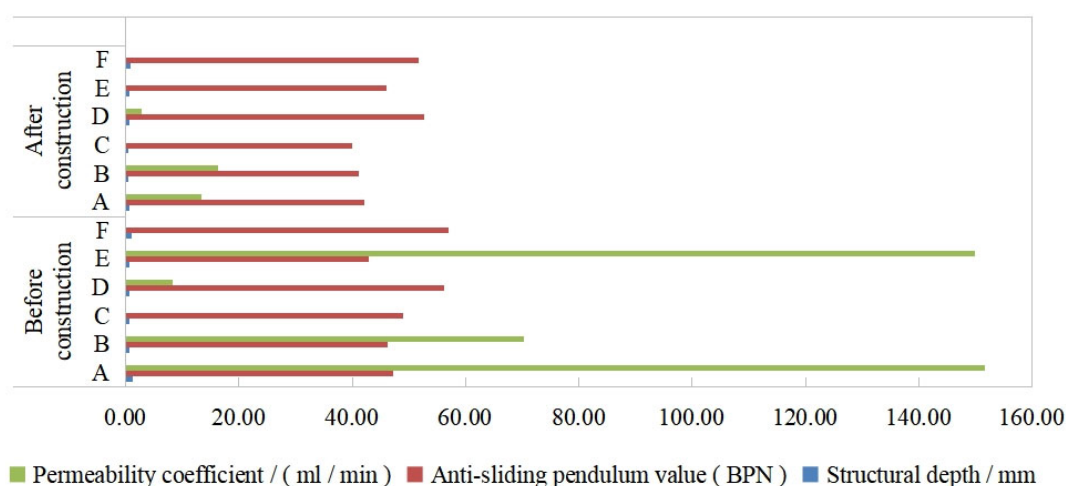


Fig 4 Comparison of performance before and after construction and maintenance of road engineering with fog seal technology

A. Shandong Jingfu Expressway; **B.** Highway in Guangzhou
C. Pingwei Road, Guigang City ; **D.** Xi ' an West Pacific Highway
E. Jiepuhui Expressway in Guangdong Province; **F.** Fuzhou-yinchuan Expressway Wensha section

2.2.3 Thin overlay technology

Thin overlay generally refers to the asphalt mixture cover with thin thickness, which is a single layer hot mix asphalt mixture paved with pavers and rolled with rollers. The structure of thin layer cover can be divided into surface wear layer and bonded waterproof layer. The anti-skid wear layer on the surface can provide a safe, comfortable and durable driving surface, restore the surface function of the pavement, improve the skid resistance of the pavement and improve the smoothness of the pavement; the bonded waterproof layer can ensure the close combination of the thin overlay and the original pavement, prevent rain water from seeping, and appropriately delay the reflection cracks of the old asphalt pavement. The scope of application of thin layer cover technology includes 1) high-grade pavement maintenance, corrective maintenance of mild or moderate diseases, and 2) new road pavement wear layer construction projects that require rapid opening of traffic. The thin overlay has excellent road performance, and its construction process is shown in Fig 5.

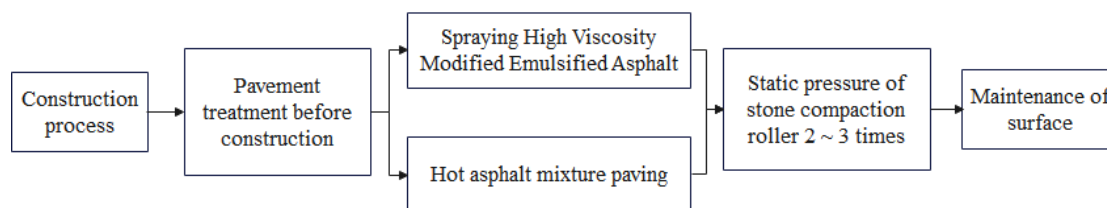


Fig 5 Construction process of thin overlay technology

2.2.4 Micro-surface technology

Micro-surfacing is a preventive maintenance technical measure developed on the basis of slurry seal, which is mixed by polymer modified emulsified asphalt, filling, aggregate, water and admixture according to a certain proportion and spread to the pavement through special equipment. And the rapid opening of the traffic of the thin layer structure, mainly used for roadbed pavement structure strength is sufficient, but only the appearance of surface function attenuation, slight rutting and uneven road conditions. Through the performance comparison of Jilin Changying highway construction project before and after micro-surface construction (Fig 6), it is found that the parameters such as structural depth, anti-sliding swing value and water seepage coefficient have been improved. it shows that the micro-surface technology has the advantages of fast construction speed, energy saving and environmental protection, low cost, good performance, high economic benefit and so on.

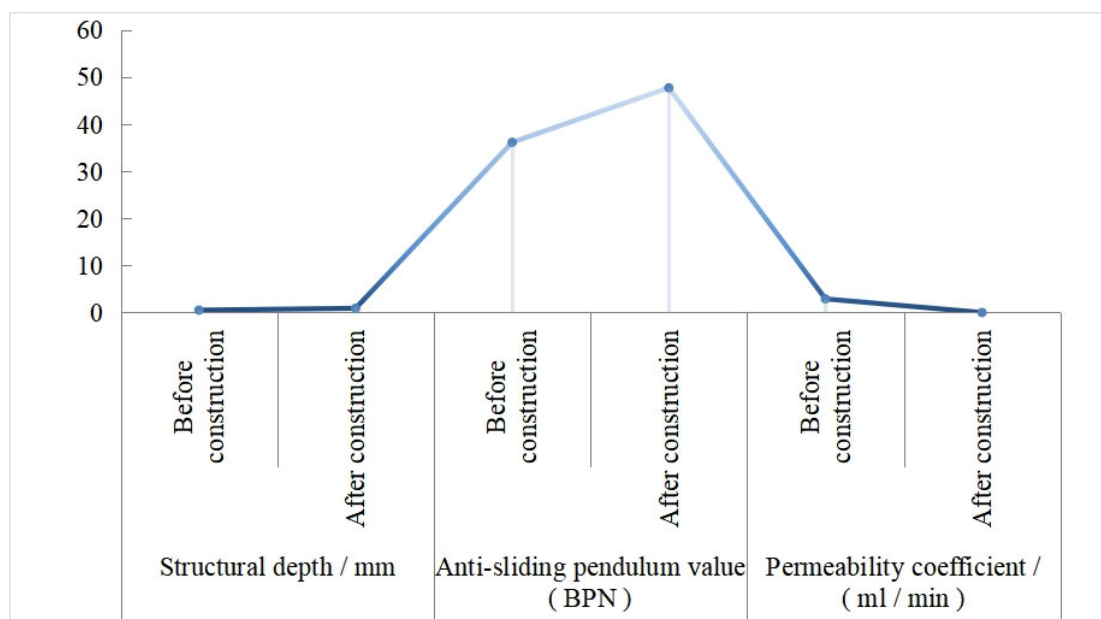


Fig 6 Performance comparison of micro-surfacing before and after construction in Jilin Changying highway construction project

2.3 New green road maintenance technology

2.3.1 TIT embedded sealing technology

TIT embedded anti-skid sealing technology uses high performance nano thermosetting special materials as the core raw materials, together with a certain proportion of emulsified asphalt and certain graded wear-resistant fine aggregate, through the fully automated TIT fixed-table car synchronously sprays all over the binder and anti-skid materials on the road surface, sealing pavement micro-cracks and filling surface gaps, in order to achieve the effect of waterproof and anti-seepage, at the same time, improve the skid resistance of the pavement and prolong the service life of the pavement. The applicable scope of TIT embedded anti-skid sealing technology is as follows: 1) overall preventive maintenance of newly-built pavement; 2) cement concrete pavement; 3) construction in non-rainy days. TIT embedded anti-skid sealing technology has the advantages of

strong anti-skid resistance, strong permeability reinforcement, waterproof, anti-corrosion, anti-ultraviolet aging, strong durability and so on. The construction principle is shown in Fig 7.

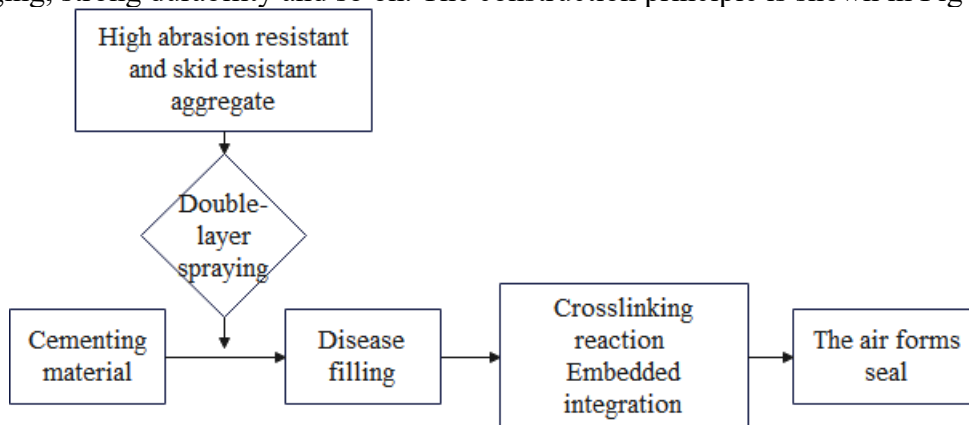


Fig 7 Construction principle of TIT embedded sealing technology

2.4 New road prevention materials

2.4.1 Color emulsified asphalt

As a special asphalt material, color emulsified asphalt is gradually used in road engineering because of many advantages, such as multi-color, good waterproof impermeability and wear resistance, room temperature construction and simple construction technology. According to the different materials and construction methods, color emulsified asphalt is usually divided into color asphalt pavement, warm mix color asphalt pavement, color micro-surface and color asphalt indentation pavement. These pavements are mainly used for traffic instructions of urban highways, crosswalks, bicycle lanes, bridge surfaces, platform surfaces, car parks and the division of industrial production areas. The preparation process of color emulsified asphalt is shown in Fig 8.

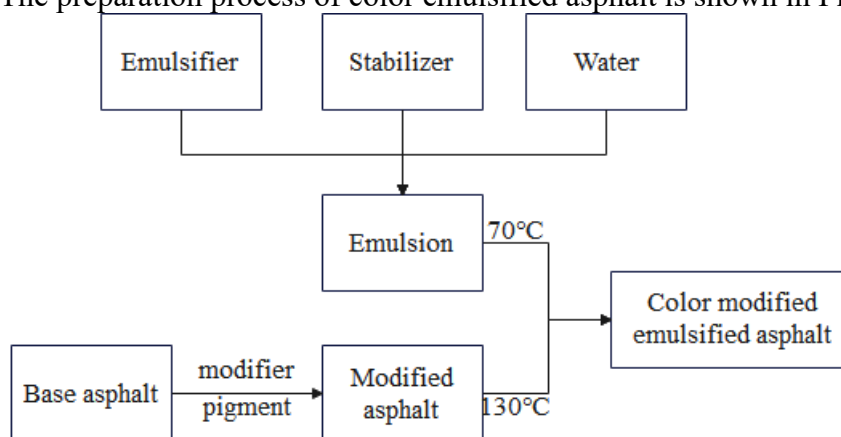


Fig 8 Preparation process of color emulsified asphalt

2.4.2 UV-curable adhesive

UV-curable adhesive is a kind of new material which uses photoinitiator to initiate chemical reactions such as polymerization, grafting and cross-linking of unsaturated organic monomers under UV irradiation to achieve rapid curing. It is accepted by people because of its low energy consumption, no pollution and high quality. At the same time, UV curing adhesive has good optical properties, good weather resistance, short curing time almost completely cured, high energy utilization rate, low curing temperature, room temperature can be cured, and environmental protection, using low volatile raw materials, no solvent. The preparation of UV-curable adhesive is shown in Fig 9.

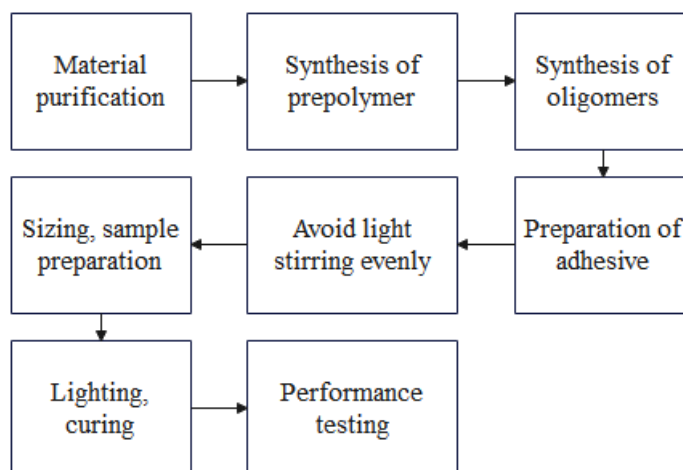


Fig 9 Preparation process of UV-curable adhesive

3. Summary and outlook

Aiming at the road pre-maintenance technology in China, this paper makes a detailed technical analysis from two aspects of conventional technology and new technology, expounds the construction principles and steps of each technology, and summarizes its applicable scope and advantages. to provide reference and reference for the selection of road pre-maintenance technology in China.

In this paper, through the summary and comparison of various technologies, it is found that the preventive maintenance technology applicable to roads in different periods is different. Synchronous chip seal can repair mild cracks, loose, slow down the peeling of road surface particles, and is often used in medium-term preventive maintenance work; fog seal can deal with diseases such as loose surface, hemp surface or slight cracks, and is often used in early preventive maintenance work; thin overlay can repair general cracks and ruts, which is generally used in later preventive maintenance work. The micro-surface can repair mild or moderate cracks, loose surface, mild rutting, and is usually used for medium-term preventive maintenance. In addition, different technologies for the treatment of diseases are also very different, such as fog seal technology is not suitable for road surface polishing, oil. In the construction, the staff need to be carefully screened and selected.

In addition, the main problem of domestic conventional preventive maintenance technology is that it is unable to recycle materials, noise pollution is easy to occur in the construction process, and the stacking of construction waste can not be cleaned up completely. However, the new technology is more environmentally friendly and energy-saving, but the material preparation process is complex, the preparation cost is high, and there are some problems such as insufficient monitoring of road surface conditions and non-standard and immature construction technology. therefore, according to the research status and existing problems of preventive maintenance sealing technology, it is suggested that the key work of preventive maintenance technology in the future is as follows:

(1) Grasping the future development trend of road preventive maintenance: economically applicable while pursuing "green environmental protection". Dig and introduce recyclable, green environmental protection materials, reuse, reduce costs, and achieve zero damage and pollution to the surrounding environment and facilities as far as possible.

(2) Strictly control the construction personnel, do not waste, do not reduce materials, reduce unnecessary losses, and ensure the integrity of construction technology.

(3) Formulating perfect technical norms for road maintenance to ensure the standardized development of road preventive maintenance.

(4) Strictly monitor the damage on the road surface, excavate the root causes of the problems, and deal with them in a timely manner, so as to put an end to the development of small problems into major diseases.

(5) According to the domestic actual situation, actively introduce and learn from foreign advanced technology, so as to make the preparation of the required materials simple and easy to obtain, and ensure that there is no noise in the construction process.

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