The development trend of new pavement materials

Haining Ying¹, Yuhong Du²,³*, Jie Ren⁴, Kang Li² and Jing Chen¹,²
¹Nanjing Vocational Institute of Transport Technology, Nanjing, Jiangsu, 211188, China
²Jiangsu Province Transportation Energy Conservation And Emission Reduction Engineering Technology Research Center, Nanjing, Jiangsu, 211188, China
³Hohai University, Nanjing, Jiangsu, 210098, China
⁴Jinan North Traffic Engineering Consulting and Supervision Co., Ltd, Jinan, Shandong, 250023, China
*Corresponding author’s e-mail: du_yh97@163.com

Abstract. Economic development cannot be separated from the development of traffic. With the continuous increase of traffic volume, the construction of road surface infrastructure must keep pace with the needs of social development. Based on the analysis of the current research status of road materials, this paper looks forward to the development direction of new road materials in the future.

1. Introduction
The rapid economic development needs the support of strong infrastructure construction. China has 9.6 million square kilometers of land, covering a variety of landforms and climatic types. Therefore, the climatic and geographical conditions that need to be adapted to are various.

The choice of materials in road construction has a great impact on road construction technology, maintenance and cost. The problems after laying the pavement material are as follows: 1. The pavement bears the weight of the vehicle and produces deformation or even damage; 2. Pavement strength reduction and damage caused by special natural environment; 3. Rutting is the pit left by the sudden stop or quick turn of the vehicle, which directly affects the smoothness of the road surface; 4. Dust on the road pollutes the environment and blocks the line of sight. [1]

In view of the above mentioned pavement problems, we have higher and higher requirements for various performance indexes of pavement materials, so we need to study new pavement materials to satisfy the use requirement. This paper summarizes the current pavement materials, and puts forward the prospect of the future development of new pavement materials.

2. Development status of pavement materials

2.1. Earth and stone pavement
Earth and stone are the most traditional pavement materials. With the development of society, this kind of pavement is generally abandoned in urban roads. At present, it exists in relatively backward rural areas, mountainous areas and temporary roads on construction sites. Earth and stone road surface has very good plasticity, simple laying and low cost. Among the three types of pavement materials, the
stability and flatness of earth and stone pavement are the worst, so it is less and less used for road laying.

2.2. Cement concrete pavement
Cement concrete pavement is widely used in the construction of urban roads and squares. It is composed of cement, aggregate and admixture in a certain ratio and then cooled and solidified by pouring and rolling. The strength, flatness and stability of cement concrete pavement are good, the disadvantages are that the friction is small and easy to produce shrinkage joints and stress joints. The generation of cracks is equivalent to direct damage to concrete.

2.3. Asphalt concrete pavement
Asphalt concrete pavement is mainly used in the construction of expressways and urban roads, which is composed of asphalt, aggregate and mineral powder according to a certain proportion. The advantages of asphalt concrete pavement are good continuity, high flatness, good adhesion in fine and rainy weather, good toughness and deformation performance, as well as sound absorption and shock absorption function. The biggest problems of this road surface are the deformation of high temperature softening, thermal shrinkage cracks, fatigue cracking and ruts at low temperature. [2]

3. Development trend of new pavement materials

3.1. Functional pavement materials

3.1.1. Rutting resistant pavement materials
Rutting is mainly caused by shear strain of pavement stress. Therefore, all materials that hinder the shear strain of pavement materials have an impact on the performance of rutting. The results show that choosing appropriate geogrid can effectively improve the strength and stiffness of asphalt concrete, reduce the shear strain, and reduce the depth of rutting. In addition, geogrid with small aperture or the use of steel bars will have a better effect on anti-rutting. [3]

Li Can [4] used dynamic stability to characterize the anti rut performance when studying the anti rut function of semi-flexible materials. Under the condition that the cement paste remains unchanged, the dynamic stability of the material increases with the increase of the voidage of the parent asphalt, and the rutting resistance also increases accordingly. Under the same porosity of parent asphalt, the different admixtures affect the rutting resistance of the material.

Zhao Guoqiang [5] and others obtained the data shown in Table 1 when studying the influence of asphalt type on the performance of large gap asphalt pavement. Comparing the influence of common asphalt, rubber asphalt, modified asphalt and high viscosity modified asphalt on the performance of semi flexible pavement materials, high viscosity modified asphalt has the best effect on improving the rutting resistance of pavement materials, and can also improve the low-temperature cracking resistance.

| Asphalt type         | Voidage(%) | Rut depth (mm) | Flying loss (%) | Marshall stability (kN) |
|----------------------|------------|----------------|-----------------|-------------------------|
| Common asphalt       | 25.8       | 31             | 48              | 2.4                     |
| Rubber asphalt       | 26.2       | 24             | 38.4            | 2.7                     |
| Modified asphalt     | 25.9       | 21             | 32.5            | 3.0                     |
| High viscosity       | 26.0       | 15             | 19.5            | 3.6                     |
| modified asphalt     |            |                |                 |                         |

3.1.2. Permeable pavement materials
The permeable road can allow the water on the yield surface to infiltrate into the ground, which helps the road drainage. On the one hand, it can reduce the potential danger brought by road surface water to driving safety; on the other hand, it can prevent the
occurrence of urban waterlogging.
Jiang Wei[6] and others conducted a series of experiments on surface runoff respectively. They compared the water quality changes before and after the water sample passes through the permeable pavement. The infiltration experiment of surface runoff has achieved good results, and the water quality of initial infiltration water sample has obviously improved.

3.1.3. Noise reduction pavement materials. The road texture is the key factor to reduce the traffic noise. To achieve the effect of the noise reduction, it is necessary to balance the road surface texture and roughness to ensure the reduction of noise under the condition of safe driving. Rubber modified asphalt has excellent crack resistance, durability and noise reduction performance. The high viscoelasticity and damping properties of rubber make the sound wave attenuating continuously to reduce the noise. Making rubber asphalt mixture pavement into skeleton dense structure and porous structure can effectively reduce the noise.[7]

3.1.4. Frost resistant pavement materials. In the snowfall area in winter, in order to prevent the potential safety problems of the road surface from over sliding, it is necessary to deice and snow the road surface. The use of deicing salt accelerates the destruction of the concrete road surface and seriously affects the service life of the road surface. The research on the frost resistant road materials can be started from two aspects: one is the research on the salt frost resistant road materials; the other is the anti-icing road materials.

Through the experimental study, Wang Qi concluded that adding air-entrainer and reducing water-cement ratio could both improve the salt-freezing resistance of concrete, and the type and amount of mineral admixtures also had a great impact on the salt-freezing resistance.[8] The salt frost resistance of concrete is measured by the amount of salt frost denudation of concrete after a certain number of freeze-thaw cycles. The calculation formula of the amount of salt frost denudation is as follows:

$$m_n = \frac{\sum \mu_s}{A}$$

Where: $m_n$—the amount of salt frost denudation per unit area of the sample(kg/m); $\sum \mu_s$—the amount of salt frost denudation(kg); $A$—the test area of the sample(m$^2$);

Wright et al. mixed sodium formate and sodium silicate with asphalt respectively as part of the filler.[9] Research shows that certain low surface energy materials can be added to the pavement surface layer to reduce the adhesion between the ice and the pavement, so that the ice can be easily removed.

3.2. Environment-friendly pavement materials
The environmental protection function and the above various functional pavement materials have different degrees of crossing: anti-rutting pavement and anti-freezing pavement both extend the service life of the pavement and reduce the cost of infrastructure construction; antifreeze pavement also reduces the use of deicing salts; water pollution and noise pollution are reduced to some extent by permeable pavement and noise reduction pavement.[10,11]

Jiang Wei et al. applied the composite structure of natural sand and geotextile in permeable pavement materials research, found that the composite structure has a good filtering effect on heavy metals and organic pollutants.[12]

Hu Liqun et al. applied porous cement concrete to the degradation of NO, one of the main components of automobile exhaust, and coated TiO2 on the surface of porous cement concrete. The porosity ensured the coating amount of TiO2 and reduced the loss of TiO2 during the use of cement concrete.[13]
In order to improve the reuse rate of pavement materials, reduce the cost of road construction and save resources, recycled asphalt is added to asphalt concrete in the form of aggregate, in which the aging asphalt binder and aggregate have an impact on the new asphalt concrete pavement. The new asphalt concrete shows better high-temperature fatigue resistance, but has a negative impact on the fatigue life at low temperature.[14,15]

3.3. **Self-healing technology**

In order to extend the service life of cement concrete, the emergence of self-healing technology provides a method. Microbial self-healing technology is produced by microbial metabolism of calcium carbonate components to repair the concrete crack. However, the kinds of microorganism, the survival rate and void produced by microbial death limit the development and application of microbial self-healing technology, thus further research is needed. [16]

In the method of microcapsule, the repairing agent is coated into the microcapsule and mixed in the concrete. The stress at the crack tip leads to the destruction of the microcapsule, and the repairing agent is released to achieve the repairing effect. The method of microcapsule repair is rapid and the healing effect is good, but this method is one-time, and it is difficult to ensure that the microcapsule does not break during mixing.[17]

4. **Conclusion**

At present, the research of new pavement materials tends to the functional characteristics that traditional pavement materials do not have, and the functional characteristics of the materials are relatively single. In the future, new pavement materials can be studied from the following aspects:

- Conduct further research on functional materials with excellent functional characteristics but unable to be put into use due to other factors, so as to overcome the obstacles restricting their practical application;
- Combined with a variety of functional characteristics and environmental properties, the research on multi-functional new pavement materials can be conducted, especially environmental properties. For the sustainable development of society and energy conservation and emission reduction, the study of multi-functional pavement materials can meet the needs of many aspects;
- The functions endowed to pavement materials do not necessarily need to be used for pavement, but can also be other functions beneficial to society, such as the research on power generation pavement materials.

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