

Research and Practice of Green Maintenance Concept of Highway

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Abstract: The concept of green transportation has evolved and has become an important guide for modern transportation development. However, in China's highway maintenance management, there are several significant problems, including relatively serious pollution of the environment, a large amount of waste of maintenance materials, poor recycling rate of waste materials, and relatively lagging construction technology. In response to these problems, this study discusses in depth the practical techniques of highway pavement and roadbed maintenance and puts forward specific suggestions based on the concept of green maintenance. Through systematic analysis and practical verification, these measures show remarkable effectiveness in improving the quality of highway maintenance and promoting the development of green transportation.

Keywords: Green maintenance; Recycling of waste materials; Sustainable development

Introduction

In the multidimensional structure of the transportation system, highway transportation occupies a pivotal position, and its indispensability is particularly significant in the comprehensive transportation network. Compared with air and sea transportation, road transportation significantly enhances the overall transportation efficiency with its rapid transportation speed and flexible operation mode. With the gradual progress of economic development, the pace of highway construction is also coordinated with it, and its management strategy

has also gone through the process of "reconstruction and light maintenance" to "repair-oriented", and then "maintenance and repair", until nowadays, the maintenance link is highly valued. Until now, the maintenance of the link attaches great importance, this transformation deeply reflects the rising status of highway maintenance in the management of transportation infrastructure^[1]. However, subject to the late start of China's highway research, in China's actual highway maintenance management, the maintenance unit is faced with many problems, such as the lack of maintenance funds and attention, damage to the



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environment, serious waste of maintenance materials, poor recycling rate of pavement waste materials, and the lack of the four new technological innovation and application.

1. Current Situation of Highway Maintenance Management

1.1 Lack of High-Quality Maintenance Team

In the past, highway maintenance work mainly relies on road class, and manpower input dominates. With the economic development and scientific and technological progress, the current maintenance work has been significantly presented information technology, mechanization, and automation. At the same time, the problem of aging and low knowledge level of maintenance workers has made it difficult to meet the needs of modern road maintenance^[2]. In addition, the maintenance work environment is difficult, the wages and benefits are low, the sense of professional identity is not high, resulting in college students are not willing to engage in this industry, resulting in personnel mobility is relatively large, resulting in the maintenance unit is difficult to develop in a healthy and orderly manner.

1.2 Poor Operation of Maintenance System

Highway maintenance units as a public service sector, traditionally used more business unit management system, funding and personnel salaries are fully funded by the state treasury, this system helps to unify planning and leadership. However, in the current market economic environment, the maintenance unit presents the industry monopoly situation, the lack of competitive pressure and cost-saving power, resulting in the organizational structure being bloated, and working without planning. In the long run, the enthusiasm of the maintenance unit gradually weakened, it is difficult to adapt to the needs of economic development, and seriously constrained the professional and technical level of highway maintenance and the innovative development of the management mechanism. Therefore, the maintenance unit urgently needs to be market-oriented and deepen the reform, in order to stimulate internal vitality and enhance the effectiveness of the service.

1.3 Serious Damage and Waste to the Environment and Resources

In the process of maintenance, improper treatment,

such as asphalt, grouting glue and other key materials, disorderly discarded, randomly stacked and improperly stored, has constituted significant damage to the natural environment along the route. These operations not only disturb the ecological balance, but also may lead to long-term environmental degradation^[3]. In addition, the lagging state of technology and equipment has also exacerbated the severity of the problem, as evidenced by the fact that the waste materials generated after pavement milling cannot be effectively recycled. This not only means a waste of resources but also accompanied by a significant increase in maintenance costs.

1.4 Backward Maintenance Technology

The public's perception of highway maintenance engineering is often limited by the stereotypical impression of its low technical content and simple process, thus ignoring the importance of technological enhancement. This results in low mechanization of maintenance equipment, insufficient efficiency, and poor results. At the same time, the introduction of talent channels is limited, and technical theory support is weak, further aggravating the increase in maintenance costs. To improve this situation, it is necessary to improve the understanding of conservation engineering, and strengthen technological innovation and talent training, in order to achieve more efficient and economical conservation management^[4].

2. Measures for Practicing the Concept of Green Conservation

2.1 Promote Environmentally Friendly Maintenance Materials

In the process of highway maintenance, a large amount of greenhouse gases and atmospheric pollutants are inevitably produced, posing a serious threat to the ecological environment^[5]. In the construction and maintenance of asphalt pavements, the greenhouse gases and smoke emitted from the mixing stage of asphalt mixtures are particularly significant. Asphalt fumes released from hot-mix asphalt mixtures are not only genotoxic but may also induce respiratory diseases, highlighting the urgency of environmental and occupational health issues. The significant advantage of warm mix asphalt mixtures over traditional hot mix asphalt mixtures is that the emission of fumes and toxic and harmful gases is much lower

than that of hot mix asphalt, which greatly reduces the negative impact on the environment^[6]. This feature is not only in line with the strategic direction of green development and sustainable development in China but also provides a more environmentally friendly solution for the maintenance of highway pavement. The fast open traffic characteristics of warm mix asphalt mixtures make them particularly suitable for high-speed and national and provincial highway maintenance work with long transportation distances and high requirements for road smoothness. Compared with hot mix asphalt mixtures, warm mix asphalt in the mixing process at lower temperatures, which significantly reduces the degree of aging of asphalt, to ensure the stability and durability of the mixture^[7]. In addition, with warm mix asphalt because of its lower construction temperature requirements, the transportation time and distance are significantly increased, which provides more possibilities for night and long-distance construction and maintenance works. At the same time, the application of warm mix asphalt technology also helps to extend the service life of construction equipment, further reducing maintenance costs.

Globally, warm mix asphalt technology is recognized as a revolutionary breakthrough in asphalt technology. It is in line with the development trend of low-carbon economy and helps promote the green transformation of the transportation industry. With the continuous maturity of the technology and the wide promotion of its application, warm-mix asphalt mixtures will play a more important role in the future of high-speed maintenance.

2.2 Promote Pavement Waste Material Recycling Technology

Asphalt pavement performance decay after long-term use, smoothness reduction, need to carry out maintenance or major repair. In this process, a large number of waste materials will be generated. The core of pavement waste material recycling technology lies in the recovery and reprocessing of these materials as new pavement materials. This technology has been gradually popularized and applied in China, and its environmental protection and economic benefits are becoming more and more prominent. For example, China's highway surface layer is generally selected

as high-quality basalt aggregate. If in the process of maintenance project implementation, the surface layer milling after the waste material is directly discarded without recycling is undoubtedly a huge waste. Therefore, the recycling technology of asphalt pavement materials is not only the reuse of waste asphalt materials, but also the effective protection of valuable natural resources, but also the vivid embodiment of China's sustainable development and circular economy concept. The pavement recycling technology has attracted the attention of scholars at home and abroad because of its significant resource-saving and environmental protection advantages. Currently, the research of domestic recycled asphalt pavement material focuses on the fields of high dosage asphalt hot recycling technology, warm mix asphalt recycling technology and cold recycled asphalt technology optimization. These technologies can be selected flexibly according to the actual project, effectively realizing the regeneration and re-use of asphalt pavement materials, and promoting the green development of the transportation industry.

(1) As an efficient way of recycling resources, the technology of asphalt pavement with central plant hot recycling of surface material plays a key role in modern road engineering. Through the recycling of waste asphalt materials, the technology realizes the recycling of materials through high temperature heating and precise matching of professional equipment, which not only reduces the environmental load, but also significantly improves the performance and durability of the pavement.

(2) Hot-in-place recycling of asphalt pavement in the surface layer. It is an advanced highway maintenance technology that works directly on the original pavement without large-scale excavation and removal of old materials. The technology utilizes special hot-in-place recycling equipment to heat and loosen the pavement, then add the appropriate amount of new asphalt, regeneration agent and the necessary aggregates, and complete the regeneration and repair of the old asphalt pavement in one go through the processes of on-site mixing, paving and compaction. The hot-in-place recycling technology not only improves the efficiency and quality of highway maintenance, but also significantly reduces the generation of waste materials and transportation costs, which is of

great significance to environmental protection and resource conservation. In addition, this technology can improve the smoothness and skid resistance of the road surface, and improve the safety and service life of the road. Therefore, the hot-in-place recycling of asphalt pavement of surface layer has a wide range of application prospects in modern road engineering.

(3) The cold-in-place recycling technology of asphalt pavement surface layer, grass-roots level and its composite materials is to mill and crush the old pavement under normal temperature condition by special machinery for cold recycling, and add recycled materials, aggregate, emulsified asphalt or foam asphalt bonding material, water-hardened active filler and water, etc., for in-situ mixing to form a new structural layer of the pavement. This technology can make full use of the old road materials and improve the utilization of resources, while reducing the environmental pressure caused by the mining of new materials and the waste of old materials. Compared with the traditional method, cold-in-place recycling technology has the advantages of simple construction, energy saving and environmental protection, low cost, etc. It is especially suitable for the large and medium repair projects of national and provincial trunk roads.

(4) The cold-in-place recycling technology of asphalt pavement surface layer, grass-roots level and its composite materials is a green and efficient means of road repair and transformation. This technology does not require heating, and works directly on the old pavement, through the cold regeneration machinery and equipment to complete a series of continuous processes such as milling, crushing, adding recycled materials, mixing, paving and rolling. This process makes full use of the old pavement materials, significantly reduces the consumption of new materials, and realizes the recycling of resources. Cold-in-place recycling technology can not only effectively repair pavement damage, but also adjust the material ratio according to the actual demand, optimize the pavement structure, and improve the overall performance of the road. At the same time, the technology simplifies the construction process, shortens the construction period, reduces the interference with traffic, and has significant economic and social benefits. In terms of protecting the environment and saving resources, the cold-in-place recycling technology of asphalt pavement surface layer,

base layer and its composite materials shows great potential.

Conclusion

After in-depth research and analysis, this paper draws the following conclusions:

First of all, the core of highway green maintenance technology lies in ecological environmental protection and material recycling. This technology not only brings significant social and environmental benefits to the field of highway maintenance but also shows good economic benefits. By reducing waste emissions and improving resource utilization, the technology effectively promotes the win-win situation of environmental protection and economic and social development, which is of great significance for realizing sustainable development.

Secondly, highway green maintenance technology significantly reflects the concept of environmental protection and resource conservation. Among them, warm mix asphalt technology reduces the mixing temperature of asphalt mixture, significantly reducing energy consumption and harmful gas emissions; pavement regeneration technology through the recycling of old pavement materials, effectively saves raw materials and reduces the burden of waste on the environment. These two technologies together contribute to the sustainable development of the road maintenance industry. The combined application of these two technologies not only realizes the recycling of resources but also significantly protects the ecological environment, which is highly compatible with the strategic direction of China's sustainable development and circular economy.

Finally, highway green maintenance measures need to be based on the actual situation and realistic conditions, and the appropriate methods should be selected according to the road policy. For example, in road sections with heavy traffic and heavy vehicles, more durable maintenance materials can be used; in environmentally sensitive areas, priority should be given to the use of maintenance techniques that have little impact on the environment. Through scientific planning and reasonable layout, we can realize the best maintenance effect and contribute to the sustainable development of highway transportation.

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