Exploration on road maintenance of new infrastructure enabling intelligent expressway

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Abstract: During the 13th Five-Year Plan period, "new infrastructure" was written into the "Outline for the Construction of a Transport Power", and the Ministry of Communications made it clear that intelligent maintenance was the focus of technological innovation. Taking Hangzhou-Shaozhou-Ningbo Expressway as an example, this paper discusses the contents of expressway road maintenance based on new infrastructure construction, and finds the following prominent problems: lack of unified industry standards; there are disadvantages in software assurance; insufficient interaction of elements; the level of regional integration is not high. By establishing the theoretical model of "MADD" and innovating the maintenance mobile terminal platform, the corresponding solutions and strategies are further proposed: strengthening the top-level design and establishing a unified standard; strengthen software matching and promote overall collaboration; strengthen the integration of construction and use, promote the interaction of elements; we will strengthen communication mechanisms and promote regional coordination. The result shows that the road maintenance of new infrastructure enabled expressway is of great significance. The research of this paper has certain reference significance for the further development of highway maintenance and construction in Zhejiang Province in the future.

1. Introduction
In December 2018, the Central Economic Work Conference held by the country first proposed the "new infrastructure construction", which covers seven fields, including 5G base stations and big data centers. This is an unprecedented large-scale economic stimulus plan, is a major opportunity, is the traditional highway to intelligent highway development of an important opportunity. Expressway and new infrastructure have a mutually beneficial integration basis. Expressway can provide broad development space for new infrastructure, and new infrastructure can give new science and technology impetus to expressway development. As an important part of the "smart road", it is of practical significance to plan with the thinking of top design and make innovations in road maintenance of smart expressway with new infrastructure.

To this end, the experts of various countries have been exploring. In view of the disjointed problem of highway maintenance information construction data and application, [1] Enterprise architecture (EA) methodology is proposed to complete the overall architecture design of the platform, and the business management requirements at all levels are supported by application subsystems to realize the centralized storage, centralized management and centralized use of data. In view of the problem that
the maintenance engineering verification and industrialization ability are insufficient. [2] It proposes to set up a system collaborative innovation platform to promote industrial transformation and upgrading through the industrialization demonstration of major technological achievements and the provision of high-quality engineering technical consulting services. For the maintenance construction site supervision and control is not in place. [3] The construction and maintenance of intelligent site, the use of big data for site information management, to achieve the standardization of operation process. In road detection, [4] it indicates the current time-consuming process required to make measurements, record information and process data, and the high labor input required to manually complete field inspections. This method is extremely inefficient, [5] On this basis, two models, single shot multi-box detector (SSD) Inception V2 and detector region-based convolutional neural networks (R-CNN) Inception V2, are proposed to improve the detection accuracy of road damage and the image processing time by increasing the sampling of the image source. [6] Analytic Hierarchy Process (AHP) is used to identify the type and level of road damage and determine the priority of road treatment.

Taking Hangzhou-Shaozhou-Ningbo Expressway as an example, this paper analyzes the contents of road maintenance of empowered expressways such as big data and the Internet. Combined with the status quo at home and abroad, it puts forward the urgent problems to be solved in the current intelligent road maintenance, innovates the theoretical model of "MADD" and the innovative maintenance mobile terminal platform, and puts forward the solutions.

2. Current situation of Zhejiang expressway
In recent years, China has witnessed rapid development of expressways, with the total mileage of expressways in Zhejiang reaching 5,096 km by 2020. With the concept of "new infrastructure construction" put forward, the expressway management department and related enterprises in Zhejiang Province have made a lot of exploration in the intelligent construction of road maintenance. The Hang-Shao-Yong section of Hang-Shao-Yong expressway project in this paper is from the Nanyang Street of Xiaoshan, through Xiaoshan, Dajiang East New Town and Keqiao District of Shaoxing City, Shangyu District, to the Yuyao boundary of Shangyu and Ningbo section of Hang-Shao-Yong expressway, the total length of the route is about 52.7 kilometers. This "Smart Expressway" is oriented by intelligent construction, aiming to build a new type of expressway infrastructure and intelligent cloud control platform covering the integration of "passenger and cargo transportation network", "sensor communication control network" and "green energy network".

3. Enabling and intelligent highway maintenance
Through the example of Hangzhou-Shaozhou-Ningbo Expressway, this chapter will experience how to enable smart expressway maintenance in key new infrastructure fields such as 5G technology, big data and new energy.

3.1. Intelligent high-speed cloud control platform
Hangzhou-Shaozhou-Ningbo Intelligent Expressway uses the high-speed cloud control platform system, which is the basic application of the intelligent comprehensive management system. Based on the multi-dimensional perception system, the system displays various types of data of the current high-speed traffic operation. It mainly covers video monitoring of road network operation, traffic flow monitoring and early warning, fine meteorological monitoring and early warning, traffic emergency monitoring and early warning, health data monitoring and early warning of main structures (such as Bridges and culverts), dynamic monitoring and early warning of key operating vehicles, etc. Based on the collected static data, the corresponding maintenance tasks are formulated, including emergency rescue, preventive maintenance, etc., and the dynamic data (inspection, maintenance dynamics, etc.) are monitored to realize information visualization.

3.2. Vehicle GPS monitoring and operation process monitoring
The special vehicle for maintenance is equipped with GPS monitoring system to monitor the location,
driving path and driving speed of the vehicle in real time. It can command and dispatch at any time when performing tasks, and can effectively control the behaviors such as overrunning the range and over-speeding in daily maintenance operations. Real-time monitoring of maintenance operation process ensures that the platform can acquire maintenance progress in time, maintenance operation data and image collection quickly, and provides users at different levels with operation application services such as data comprehensive summary analysis, query statistics and other data from different perspectives.

3.3. Intelligent road maintenance auxiliary decision system
Using big data algorithm model, dynamic curing divided into sections, through the whole road network coverage of the video monitoring and traffic monitoring to analyze road freight volume, super limited trajectory, and freight information according to the operation of the road surface disease (pit slot, subsidence, fracture, etc.) of data, statistical lorry overrun behavior degree of the damage to the road life, according to the pavement performance decay model, combination of accumulated time and pavement performance indexes, summed up the benefit cost ratio of the highest maintenance plan, to get the most out of the road transportation function and the economic and social benefits.

3.4. Intelligent maintenance materials
Hangzhou-Shaozhou-Ningbo Intelligent Expressway adopts photovoltaic pavement, which is divided into three layers. The surface layer is light-transmitting concrete pavement layer, which has two characteristics of high strength and high light transmittance. The middle layer is photovoltaic panel, photoelectric conversion, using the idle time of the road to absorb sunlight to generate electricity; The third layer is the insulation layer, which not only provides physical protection to the photovoltaic panel, but also waterproof and moisture-proof. At the same time, the road surface is also reserved under the electromagnetic induction magnetic ring. In the future, through the integration of transportation network, information network and energy network, and the supporting of electric vehicle wireless technology, the functional demand of electric vehicle charging while running in this road section can be realized. The move could lead to the development of new road materials, such as porous, low-pollution, quiet pavement materials that can be converted into heat.

3.5. Intelligent integrated maintenance
To control the pavement disease, improve the road performance, at the same time, with the intelligent road facilities, to achieve the "intelligent road". Integrate road maintenance and intelligent transportation to achieve the purpose of cost reduction and efficiency increase. For example, in the road section with high accident rate, the road section easy to violate rules and regulations or the road section with intensive electronic monitoring, color road materials or signs should be used to play the role of auxiliary reminding. In the maintenance of the road surface, intelligent sensors are embedded to strengthen the management of vehicle violations, strengthen the ability of fine intelligent perception of the road, and ensure road traffic safety

4. Prominent problems to be solved
Under the promotion of the new infrastructure policy, the traditional expressway road maintenance has encountered some outstanding problems to be solved on the road of intelligent and efficient development.

4.1. Lack of uniform industry standards
Regional maintenance information system construction, basic it independently by the provincial or municipal units to carry out, according to the characteristics of highway maintenance management national or local unified specification has not been introduced, and the conservation of quota and each region has the problem of insufficient communication identity, lack of uniform standards, relatively independent information system, data cannot be Shared, in information system transplant and
promotion is difficult, to reach the objective requirement of the highway comprehensive maintenance.

4.2. Shortcomings in software assurance
Restricted by capital, technology and other conditions, the problem of software guarantee is not in place is more prominent. Has both the problem of insufficient software and software, software and hardware mismatch between, between incompatible problems, including software shortage problem, especially in the traditional curing system fixed to the computer using method and maintenance personnel specific hand-held input data, limiting the usage scenario, unable to meet the "increases with the increasing to check for" goal, affect the efficiency of maintenance.

4.3. Insufficient interaction of elements
Disconnect because of the information system construction and the working process, construction and maintenance, the different levels lead to APP terminal is not practical, workers do not love, not deep, do not close interaction between the operating elements, system data maintenance in time, limiting the highway intelligent maintenance of large data quantity, quality and efficiency improvement.

4.4. The development of regional integration is not high
The same highway should not only form contact in maintenance and construction, operation, management, law enforcement, emergency management, but also keep close contact with expressways of surrounding provinces and cities. The low level of regional integration will lead to information fault, which is not conducive to the coordinated development of the entire regional expressway industry.

5. Further improve the ideas and strategies of road maintenance of intelligent expressway
Through the analysis of the outstanding problems to be solved, combined with new infrastructure, especially big data and 5G technology and other fields, the corresponding ideas and strategies are proposed.

5.1. Strengthen top-level design and establish unified standards
In order to solve the problem of lack of unified standards in the industry, we deepened scientific decision-making, formulated the development and implementation plan of expressway informatization in the next five years, studied and established a complete set of maintenance informatization construction data standards, and then matched the expressway maintenance standards, regulations and technical guidelines. In the process of data standardization construction, on the one hand, enterprise data categories are analyzed from top to bottom to form planning paths; on the other hand, with the help of system planning and business process optimization, basic data can be extracted from bottom to top, and then databases, data categories and data elements can be extracted and identified, data models can be established, and the standardization and comprehensive coverage of the information system can be finally realized.

5.2. Strengthen software matching and promote overall collaboration
Focusing on solving the shortcomings of software support, the company selects capable personnel, invites experts in the industry, and sets up an information-based development team. By introducing 5G technology, it develops a maintenance mobile terminal platform, establishes real-time information interaction between the platform and maintenance personnel, and solves the drawbacks of the fixed terminal of the maintenance system computer. It is planned to integrate the intelligent integrated platform of "intelligent maintenance" from the five aspects of "current pile number, workbench, team tracking, information inquiry and me", as shown in Figure 1. In addition, by increasing the investment in hardware, configuring more enterprise-class servers and hardware such as GPS positioning system for working vehicles, it can better cooperate with the intelligent development of the platform. This can effectively solve the problem of hardware constraints, maximizing the compatibility between hardware
and hardware, hardware and software, enhance the overall synergy.

![Figure 1 maintenance mobile terminal platform components](image)

5.3. Strengthen the integration of construction and use and promote the interaction of elements

Elements interact enough eyes to solve the problem, firmly establish a "built in one" concept, change the previous technical guidance to practical guidance, avoid don't have to waste phenomenon, after the completion of the system in the construction of informatization system depth fusion, pay attention to and the working process and combining actual work, strengthen the system construction of practicability, interactivity, effectiveness.

(1) Build an "Internet + high-speed" emergency management platform to achieve scientific and efficient emergency response

The Internet, automatic control and 5G technologies will be used to establish machinery management, emergency management system for flood control and early warning system for snow and ice. Flood prevention and emergency management system to achieve automatic control of equipment, data statistics and analysis, scientific and accurate drainage scheduling, improve management quality and efficiency. The snow and ice warning system monitors the snow and ice through sensors on the road or bridge deck, transmits the data to the server for analysis, and gives feedback on the ice and snow on the road in the next few hours, so that the snow removal can be carried out reasonably and quickly to ensure the smooth and safe road.

(2) The "MADD" theoretical model was innovatively put forward to promote intelligent conservation

The "big data" technology is introduced, and the "MADD" theoretical process is innovatively proposed in the direction of intelligent road maintenance. The process includes four links, including "Manufacture, Analysis, Data Driven and Decide", so as to give full play to the efficiency of "big data" and continuously improve the effect of intelligent maintenance.

Data production: collect front-end data by using high-speed toll collection system, traffic data system, daily road patrol system, road measurement and perception system, and meteorological data system, and initially excavate the extensive value of data.

Data analysis: Strengthen data supervision and data utilization, carry out data fusion analysis through artificial intelligence and big data, and establish an intelligent evaluation model of road state based on the static road history model.
Data driven: through the system and mechanism of data empowerment, ignition drive, so that the data reaction and management, for the management of power, summarized in the wisdom of high-speed integrated management system, improve efficiency.

Decision-making: Artificial decision-making and system deviation correction are combined to form an intelligent maintenance strategy, and an intelligent maintenance planning model is established to realize intelligent maintenance and maintenance information visualization.

Fig. 2 Theoretical flow chart of MADD 2

5.4. Strengthen communication mechanisms and promote regional coordination
Establish communication and coordination mechanisms with neighboring provinces and cities. Under the guidance of the goal of seeking common ground while reserving differences and coordinated development, a set of communication and coordination mechanism suitable for the development of expressways in the whole region should be established. Strengthen communication, sum up experience, strengthen regional expressway information exchange in real time, make up the short board. For example, in the process of compiling special highway plans, the focus should be on interprovincial road connectivity, and technical standards such as road construction, maintenance and management should be taken into overall consideration to avoid the formation of a "dead end road".

6. Conclusion
(1) This paper analyze the Hang-Shao-Yong expressway, based on the new construction of seven important areas, especially in big data, 5G technology and new energy can assign the main content of highway road maintenance, mainly includes the following five: wisdom high-speed cloud platform, GPS vehicle monitoring control and operation process monitoring, the wisdom road maintenance auxiliary decision system, intelligent maintenance materials, intelligent integration of maintenance.

(2) The paper analyzes the following problems that need to be solved in the development of intelligent road from traditional road maintenance: lack of unified industry standard; hardware support has shortcomings; insufficient interaction of elements; the level of regional integration is not high.

(3) According to the existing problems, put forward the maintenance mobile terminal platform and
the theoretical model of "MADD" innovatively, and put forward the corresponding decision: strengthen the top-level design; establish unified standard and strengthen software matching; promote the overall collaboration, strengthen the integration of construction and use; promote the interaction of elements; we will strengthen communication mechanisms and promote regional coordination. And to draw up the maintenance mobile terminal platform model and the maintenance platform and other data system integration, to develop a more reasonable and efficient maintenance strategy.

(4) It is concluded that the importance of intelligent maintenance of new infrastructure enabled expressway roads: the need to carry out the major strategic decision of building a transportation power; the need to conform to the development trend of smart roads; the need to accelerate the regional integration construction of the Yangtze River Delta; the need to maximize industrial benefits.

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