Construction Practice of Centralized Maintenance Mode for Asphalt Pavement of Expressway

Wang Hongxiang
Jiangsu Xiandai Road&Bridge Co., Ltd., Hanfu building, 291 Zhongshan East Road, Meiyuan street, Xuanwu District, Nanjing City, Jiangsu Province
331200540@qq.com

Abstract. At present, one of the most prominent problems in Jiangsu Expressway Maintenance Project is the contradiction between maintenance operation and traffic. Based on the centralized maintenance project of Guangjing Xicheng Expressway in Jiangsu Province, this paper analyzes and summarizes the centralized maintenance mode from two aspects: the preparation points and the control in the construction process. The practice of this project shows that the centralized maintenance project needs to focus on the characteristics of multi-dimensional concentration of time, space and material, make targeted preparation from the aspects of organization, human, machine, material, technology and emergency plan, and ensure multi-directional control through summary and improvement, multi-party coordination, dynamic control, construction standardization and a series of measures in the implementation process. Compared with the traditional maintenance mode, the centralized maintenance mode makes the maintenance project better in quality, faster in progress, more controllable in safety and better in benefit. The research results provide important practical experience for similar projects.

1. Preface
Under the traditional maintenance mode, the contradiction between maintenance operation and traffic has a negative impact on maintenance safety, efficiency, quality and benefit. In order to solve the contradiction between highway maintenance and traffic, Japan's Hanshin Expressway Company (here in after referred to as "Hanshin expressway") has successively carried out "highway rejuvenation project" since 1973, and carried out semi closed or fully closed centralized maintenance construction on its many high flow expressways. The practical experience of Japan shows that although the centralized maintenance has caused serious road congestion in some areas, it has obvious advantages: as long as the traffic space is ensured, the construction site can operate freely and shorten the construction period; the construction performance is improved and the construction quality is guaranteed; a variety of maintenance work can be intensive; and the site safety is greatly improved. Benefited from the early fine construction plan and full communication and coordination, the construction period is generally shortened from the original plan of more than 100 days to about 10 days, which has achieved good results and won the praise of the local people and traffic police departments.

In view of this, under the guidance of the "Su-style maintenance" concept, Jiangsu Communications Holding Co., Ltd. is based on the background of the gradual development of "large traffic" expressways in Jiangsu Province, in order to improve the maintenance efficiency and quality of the province's large traffic expressways[1-2], to ensure the safety of construction, learn from the
experience of the Hanshin Expressway centralized maintenance and take the lead in proposing a large-flow expressway centralized maintenance model[3-5], and rely on the Jiangsu Guangjing Xicheng Expressway maintenance project to practice. Jiangsu Xiandai Road&Bridge Co., Ltd. participated in the construction of the project as a construction unit. Based on this project, this article analyzes the practice of centralized maintenance of expressway asphalt pavement from the perspective of construction, in order to provide practical experience for similar centralized maintenance projects.

![Centralized maintenance operations of Guangjing Xicheng Expressway](image)

Fig. 1 Centralized maintenance operations of Guangjing Xicheng Expressway

### 2. Pre-construction preparation

#### 2.1. Equipment preparation

The work area of this centralized maintenance project is large, the process is complicated, and there are dozens of construction machinery and equipment involved. To ensure the normal operation of the machinery and equipment, the following preparatory measures are taken in advance:

1. For the mechanical equipment requirements reported by each project segment, prepare all kinds of mechanical equipment, and conduct preliminary inspections against the list, and screen out the old equipment that has been out of the factory for a long time in advance to ensure that the construction machinery is in good condition;

2. 2 days before the construction operation, check the incoming equipment one by one according to the list of mechanical equipment, and focus on the key parts such as the heating system of the paver and the spraying system of the asphalt distributor;

3. In order to cope with the high-load production of concentrated overhauls, spare parts such as milling cutter heads, rolling sweeps and other vulnerable parts are prepared in advance.

Strengthen the management of the use of machinery and equipment, do a good job in the registration of the use of accounts, and implement both parties' signatures on the fuel consumption management of all types of machinery and equipment. The fueler uses a metered fuel dispenser to fill the equipment fuel tanks. After the filling is completed, both parties sign and refuel. And mark the working hours of the equipment. The maintenance manager uses the refueling amount and working hours to calculate the fuel consumption of a single engine, and analyzes the reasons for deviations from the normal worth of vehicles and equipment. For some outsourcing vehicle equipment fuel tanks, the on-coming fuel volume is equal to the running fuel volume.

#### 2.2. Material preparation

This centralized maintenance project has a large volume and a large amount of construction materials. The modified asphalt, non-sticky wheel emulsified asphalt, EME high modulus additives, self-
modified asphalt is the key supply material. At the peak of construction, there are 4 asphalt mixture mixing stations to supply materials at the same time. The asphalt supply is made in advance according to the mixing plan and tank capacity every day, and the overall arrangement and reasonable scheduling are carried out. Calculate the amount of asphalt storage on the day of the end of construction, try to keep the asphalt storage capacity full, and ensure that it is required for continuous production for 24 hours. In order to strengthen the connection between asphalt quality control and production, the asphalt supply of this project adopts the whole process control including the whole process supervision of on-site production, positioning supervision of transportation process, on-site acceptance and other links, so as to ensure the controllable quality and timely supply, and effectively guarantee the on-site production.

2.3. Technical preparation
In the preparation stage for the implementation of the centralized maintenance project, a number of design and technical service briefings were organized, and the technical briefing training content was made into relevant training manuals and distributed to every frontline staff. After the training, all relevant personnel who participated in the training were assessed by a written examination, the relevant technical personnel who passed the written examination were adopted, and the relevant technical personnel who failed the written examination were replaced. Ensure that the relevant management personnel and front-line operators on site construction are effectively trained to ensure the smooth implementation of this centralized maintenance project.

2.4. Emergency plan preparation
After fully considering various emergencies that may occur during project implementation, the project team has prepared various emergency plans in advance, which are mainly reflected in the following aspects:

(1) Mechanical equipment
Require large-scale equipment such as milling machines and pavers in each project to prepare spare equipment to prevent the construction from being affected by failures, stock the vulnerable parts of the mixing plant, and repair them in time.

(2) Construction team
The project is implemented in two phases. In the first phase, during the construction of the first division of the project, the second and third divisions are required as backup teams, and during the second phase of construction, the road maintenance department is required to be the third division as the backup teams.

(3) Mixing station
There are Jingjiang Junhao, Wuxi Jiaoqiong and Wuxi Wanchang mixing stations. At the same time, they have reached an agreement with Wuxi Huihai and Jingjiang Runhua, requiring these two mixing stations to be used as standby mixing stations, with complete materials, equipment and teams, and ready to start at any time.

(4) Transportation route
In order to ensure the construction of the surface paving, when the transportation plan was formulated, the transportation route was investigated in consideration of traffic jams and other issues, and two lines were reserved. Once traffic jams occur, the second set of alternate routes is activated to ensure that the surface paving is not Intermittently, for the section K1049+880-K1053+620 in the
direction of Xiguang, the conventional way is to enter the expressway from the Jingjiang South toll station, but if the place encounters traffic jams, you can change the route to enter the expressway from the Jingjiang toll station.

3. Construction process control

3.1. Project quality control

3.1.1. Early guarantee
Participating units prepared project work instructions, drawn 8 process flow diagrams, and conducted design and technical clarification meetings before the start of construction. The meeting was divided into three agenda items. First, the technical service unit held a design briefing meeting, then after the meeting a technical briefing meeting was held, and finally the participants were assessed for construction.

3.1.2. Process guarantee
On the basis of the preliminary guarantee, the construction quality of the first stage was summarized in time during the project implementation process[6-7], and 28 summary materials of problems and solutions were formed. For the problems in each process, the specific aspects are as follows improve quality:

(1) Adjustment process: In order to ensure the compaction of the edge of the road surface and reduce pollution, firstly lay the guardrail sheet pile, then roll the road surface, and finally hang the guardrail board; stop with emulsified asphalt lagging spreading, provide construction vehicles with driving channels and reduce pollution, ensure the quality of the sticky layer; dry milling at the start and end points of milling and planing to improve cleaning quality and efficiency.

(2) Optimized parameters: the transition section of the bridge head is grid lined in meters, and the milling depth is adjusted by 1 mm/m to improve the flatness of the bridge head; the hole is filled with hot material within 2 hours after the core is taken to ensure the upper layer paving needs; keep the distance between the front and rear pavers within the range of 10-15 m to ensure sufficient working space while reducing the joint time and improving the night joint effect; adjust the width of the paver to ensure that the upper and lower layers of longitudinal thermal joints are staggered less than 20 cm; reduce the concrete slump to ensure a 5% slope of the shoulder when pouring.

(3) Strengthen management: strengthen the supervision of the thermal insulation measures of the material truck, and complete the paving within 4 hours of discharging; establish a punishment mechanism for on-site pollution; temporarily park at the emergency parking zone at least 400 m away from the paving operation area; Follow the milling process inspection to prevent interlayer.

3.2. Project progress control

3.2.1. Early guarantee
(1) Scientific selection of construction period: considering that the construction area (Wuxi) from June to July is the rainy season, this paper makes a statistical analysis of the weather conditions of the construction section in April and may in recent five years, scientifically selects the construction period, and reduces the impact of weather factors on the construction progress.

(2) Wall chart operations: prior to the project construction, ergonomic verification of key processes such as milling and cleaning, slope adjustment, sticky layer oil spreading, and guardrail board removal and installation was carried out; on the basis of ergonomics verification, a detailed and reliable construction process schedule was prepared Figures, 8 total crossroad maps and 64 daily crossroad maps were made; the daily construction progress was fine to the meter and the required working hours were accurate to the hour as the basis for schedule control.
In addition, the project also shortened the construction period in terms of personnel, equipment, material preparation, new technology application, and time schedule. Specifically, the project included four project divisions with more than 1,400 people, more than 130 sets of large machinery, 5 mixing plants were put into construction; all the aggregates used in the material aspect were produced in advance, and the asphalt was inspected in the plant and used directly at the mixing station; the new technology applied super fast hard concrete repair king, non-stick wheel emulsified asphalt, light weight New technologies such as foam concrete; time arrangement is "5+2", "white plus black", two shifts work, 24 hours of fighting.

3.2.2. Process guarantee

Although a series of schedule guarantee measures were specifically put forward during the construction preparation period, unexpected conditions such as rain and mechanical failure were encountered during the project implementation. In order to ensure the total construction period, the following measures were taken during the project implementation process:

1. Adjust process: from thin layer milling and then lane repair and crack treatment to lane repair, crack treatment and then thin layer milling; due to rain delays, it is adjusted from two-layer continuous paving to the whole layer. Paving.

2. Adjust the construction plan: the guardrail is removed and adjusted from the forward construction to the two-end construction; the guardrail and pavement construction plan is adjusted.

3. Activate emergency plan for overlay paving: increase overlay construction teams and mixing buildings, increase paving teams, and "back-to-back" construction.

3.3. Project safety control

3.3.1. Early guarantee

In view of the characteristics of centralized maintenance, this project implements the following specific plans to deal with the hidden dangers of multi-point crossover operations. In the preparation stage, the traffic organization design plan is refined, the traffic organization implementation plan is drawn, the layout control map of the forced diversion point is drawn, and all projects are issued For vehicles in the operation management area, all vehicles must have a permit to enter the construction area.

3.3.2. Process guarantee

In the project implementation stage, construction safety is guaranteed by establishing safety networks, conducting safety education and training, and strengthening on-site safety supervision. Specific construction safety measures include: ① Each operation site has independent closed traffic control at both ends; ② Closed area Speed limit and stipulate the driving route of vehicles in the construction area; ③ Adjust the crack treatment process to reduce cross-operations and reduce safety hazards; ④ Increase the safety inspection of the diversion points, induction points, construction areas and other nodes; ⑤ Increase investment in safety production and increase anti-collision and lighting equipment; ⑥ Establish a four-party linkage mechanism for traffic police, road companies, traffic law enforcement, and construction units to ensure timely handling of safety incidents.

In addition, a safety management team has been established to elaborate safety plans, set up full-time safety management personnel, and implement a three-shift 24-hour inspection system; uniformly purchase 1,500 reflective vests and 1,500 helmets to achieve full coverage of safety equipment.

4. Implementation Effect

Through the reality of this centralized maintenance model, compared with traditional maintenance, it fully reflects its advantages in quality, progress, safety and benefits[8-9]. In order to reflect the actual effect of the centralized maintenance mode compared with the traditional maintenance mode, the actual effects of the traditional maintenance mode of Guangjing Xicheng Expressway in 2018 and the
actual effect of the centralized maintenance mode of Guangxi and Jiangyin Bridges in 2019 are compared and analyzed. The advantages are mainly reflected in the following Aspects:

4.1. Good quality

Through the preparation of project operation instructions and process flow diagrams; strengthen the training and assessment of technicians and quality inspectors (preparation stage); grasp the material barrier; increase the inspection of the asphalt mixture backyard and on-site; the first stage of construction. The quality problems are summarized and analyzed and solutions (project implementation stage) are proposed for a series of key measures to achieve good quality of centralized maintenance. The comparison results with the traditional maintenance mode in 2018 are as follows:

| Maintenance mode          | Compactness (%) | Surface Roughness | Permeability coefficient (ml/min) | Coefficient of friction (BPN) | Structural depth (mm) |
|---------------------------|-----------------|-------------------|-----------------------------------|-------------------------------|-----------------------|
| 2019 centralized maintenance | 99.1 (457 points) | σ=0.59 mm         | 9.1 (785 points)                 | 63.0 (301 points)            | 0.90 (301 points)     |
| 2018 traditional maintenance | 98.9 (263 points) | σ=0.80 mm         | 16.0 (82 points)                 | 60.0 (135 points)            | 0.90 (135 points)     |

From the comparison data in the table, it can be seen that the detection indicators of the centralized maintenance mode road surface have been significantly improved compared with the traditional maintenance mode, especially the international roughness index: the international roughness index IRI measured by the automatic inspection vehicle for centralized maintenance in 2019 is 0.98 m/km, relative to the standard deviation σ=0.59 mm, which is significantly greater than the roughness of the asphalt pavement of the traditional maintenance mode in 2018, and meets the roughness requirement of the newly-built asphalt pavement of Jiangsu expressway (σ≥0.8 mm).

4.2. Fast progress

By analyzing the weather conditions in the past 5 years, select the optimal construction period; compile a detailed construction process schedule plan; team, machinery, materials, technology, and time guarantee (preparation stage); adjust the process; adjust the construction plan; start the cover stall A series of key measures such as laying emergency plans; starting a standby mixing plant; increasing the team (in the project implementation phase) have been realized: centralized maintenance completed the traditional maintenance 131 effective working days in 15 effective working days; average daily milling The volume reaches 68,100 m³/day; the average daily paving volume reaches 106,500 m³/day; the average daily output value exceeds 8 million yuan/day. The comparison results with the traditional maintenance mode in 2018 are as follows:

| Maintenance mode          | Construction period (day) | Effective working day (day) | Average daily paving volume (m³/day) | Total output value (ten thousand yuan) | Average daily output value (Ten thousand yuan/day) |
|---------------------------|----------------------------|-----------------------------|-------------------------------------|----------------------------------------|-----------------------------------------------|
| 2019 centralized maintenance | 5.10-5.29                 | 15                          | 1352.6                              | 13000                                  | 866.7                                         |
| 2018 traditional maintenance | 4.17-6.13                 | 30                          | 127.8                               | 1514                                   | 50.5                                          |
Tab. 3 Comparison of main engineering quantities between centralized maintenance and traditional maintenance mode

| Maintenance mode     | Milling and resurfacing mixture (m³) | Adhesive layer and sealing layer (m²) | Crack pretreatment (m²) | Shoulder hardening (m) | Guardrail (m) | Expansion joint repair (m) |
|----------------------|--------------------------------------|--------------------------------------|-------------------------|------------------------|--------------|---------------------------|
| 2019 centralized maintenance | 20289                                | 265921                               | 2310                    | 13436                  | 14076        | 161.9                     |
| 2018 traditional maintenance | 3834                                 | 44331                                | 0                       | 0                      | 0            | 0                         |

From the comparative data in the table, it can be seen that the centralized maintenance mode has faster work efficiency than the traditional maintenance mode. Among them, the average daily paving volume exceeds 10 times of the unified maintenance mode, and the average daily output value exceeds 16 times that of the traditional maintenance mode, which fully reflects the preparation phase of this centralized maintenance project was fully considered, and the implementation phase responded promptly, which ensured the construction progress and successfully completed the scheduled construction period target.

4.3. Safe and controllable

By compiling a traffic organization implementation plan and drawing a layout control map of mandatory diversion points (preparation phase); passes for all vehicle operation management areas; each operation point has independent closed traffic control at both ends; speed limits in closed areas and vehicle driving in the construction area route; adjust procedures; increase safety inspection; increase investment in safety production; establish a four-party linkage mechanism for traffic police, road companies, traffic law enforcement, and construction units (project implementation stage). A series of key measures have been achieved: zero accidents in production safety\[10\].

4.4. Significant benefits

According to the internationally accepted formula for calculating the congestion loss of centralized maintenance, it has been estimated that compared with traditional maintenance, it has saved about 265 million yuan in construction congestion loss.

5. Conclusion

On May 29, 2019, the Guangxi and Jiangyin Bridges' centralized maintenance projects were fully completed. During the implementation of this project, Jiangsu Xiandai Road&Bridge Co., Ltd., under the unified leadership of Jiangsu Communications Holding Co., Ltd., took the initiative to plan systematically, integrate resources, and reform and innovate. With the most efficient organization and preparation, the most advanced construction technology, and the shortest construction period, the centralized maintenance project was successfully completed, and the construction tasks and safety goals during the centralized maintenance period were fully realized 3 effective working days earlier than the original plan. Relying on the implementation of this project, combined with the construction characteristics of the centralized maintenance project, the key points of the centralized maintenance project in the project organization and implementation stage can be summarized as follows:

1. Preliminary preparation: Fully integrate available social resources, establish a reasonable organization; standardize construction operation methods, strengthen technical training and assessment of construction personnel; reasonably decompose engineering projects, and accurately arrange daily construction cross-sectional drawings; consider crossing Operation characteristics, preparation of the implementation plan for the transportation organization of the construction operation area;
comprehensive consideration of weather, large equipment and other emergency situations, and formulate feasible emergency plans.

(2) Construction process management and control: timely summarize and improve the problems that occurred during the project implementation phase; establish a multi-party linkage mechanism for traffic police, road companies, traffic law enforcement, construction units, etc.; dynamic control: in case of rain, large equipment failures, etc. Circumstances, it is necessary to ensure construction progress by adjusting procedures and increasing investment; promote construction standardization to ensure construction quality.

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