

PBMC Training for CAREC

PBMC and Case Study in China

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I. Introduction of Road Maintenance

- ◆ **Road maintenance is the work to maintain the road in good status, prevent the quality worsening and provide good service to the users.**
- ◆ **After open to traffic, due to the wearing and impact from vehicle wheels and erosion and weathering from storm, flood, wind, ice, snow and sun, etc., and due to outside damages and some construction defects, quality of roads will degrade gradually. Necessary maintenance measures should be adopted and improved during the service of the roads.**

I. Introduction of Road Maintenance



Traffic jam

Disaster from snow and ice



I. Introduction of Road Maintenance

1. Targets of Road Maintenance

- ◆ **Maintain the good technical condition of the highway and its facilities, detect and eliminate the hidden dangers in time, ensure safe and comfortable driving, and improve the economic and social benefit of transportation.**
- ◆ **Adopt the correct technical and management measures, to improve the levels of maintenance management, effectively prolong the service life of road, reduce the life cycle cost of the facilities, and improve the utilization benefit of maintenance funds.**

I. Introduction of Road Maintenance

1. Targets of Road Maintenance

- ◆ In combination of prevention and treatment, deal with the existing diseases and hidden troubles of road, and improve the anti-disaster capability.
- ◆ Improve and rebuild the original road, structures and facilities with low technical standards, and gradually promote the service quality

I. Introduction of Road Maintenance

2. Characteristics of Road Maintenance

- ◆ **Mandatory of maintenance work.**
- ◆ **Universality and comprehensiveness of the maintenance objects.**
- ◆ **Pertinence, maneuverability and timeliness of maintenance measures.**
- ◆ **Profession and complexity of maintenance technology.**
- ◆ **Big maintenance cost and high quality requirements for maintenance staff.**

I. Introduction of Road Maintenance

3. Classification of Road Maintenance

China:

- ◆ **Routine maintenance;**
- ◆ **Minor repairs and maintenance;**
- ◆ **Medium maintenance;**
- ◆ **Overhaul and improvement.**

Japan:

- ◆ **Maintenance;**
- ◆ **Repair.**

I. Introduction of Road Maintenance

3. Classification of Road Maintenance

Russia:

- ◆ Maintenance;
- ◆ Minor repairs;
- ◆ Medium maintenance;
- ◆ Overhaul.

Britain and USA:

- ◆ Specific maintenance;
- ◆ Traffic services.

I. Introduction of Road Maintenance

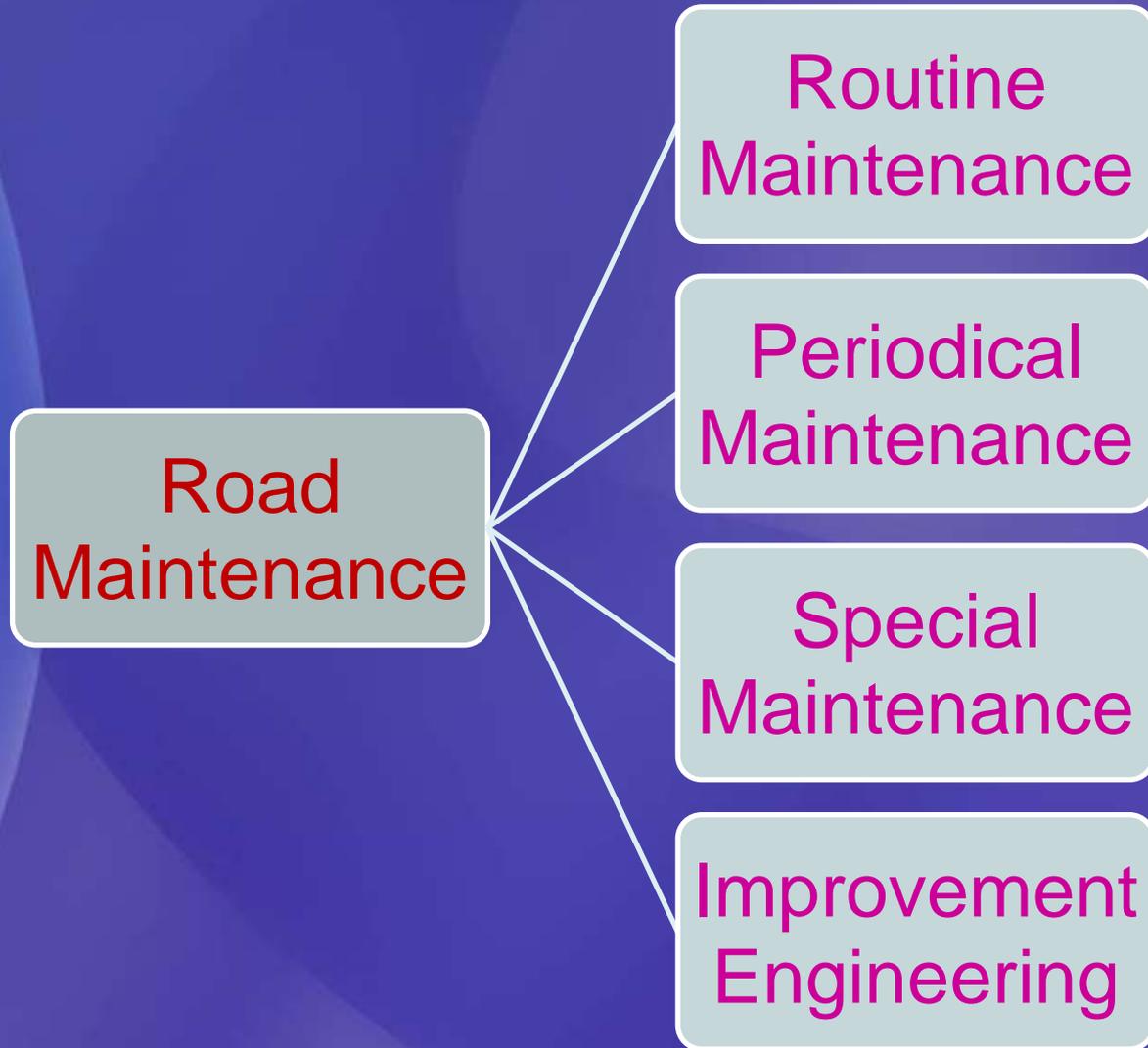
3. Classification of Road Maintenance

Association of International Road Conference:

- ◆ Routine maintenance;**
- ◆ Periodical maintenance;**
- ◆ Special maintenance;**
- ◆ Improvement engineering.**

I. Introduction of Road Maintenance

3. Classification of Road Maintenance



- ◆ Hold the principle of **prevention first**. Take efforts to eliminate the factors that lead to highway damage, enhance the durability of facilities, and improve the ability to resist natural disasters.
- ◆ Pay great attention to **routine inspection, periodical inspection and special inspection**, accumulate the technical information, strengthen the scientific analysis, and take correct and effective technical measures.

- ◆ **Fully exploit the potential of the original engineering facilities according to real conditions to achieve the purpose of applicability and economy.**
- ◆ **Use the advanced scientific and technological achievements, implement the scientific management methods, pay effort to information collection and analysis, and timely treat the problems occurred.**
- ◆ **Improve the machinery equipments, operation methods and labor organizations.**

◆ Quality assessment of road maintenance generally adopts the method of **periodical inspection of the road service performance**, including:

- Damage rate
- Roughness
- Sliding resistance
- Whole strength
- Other technical indicators

I. Introduction of Road Maintenance

5. Quality Assessment Criteria of Road Maintenance

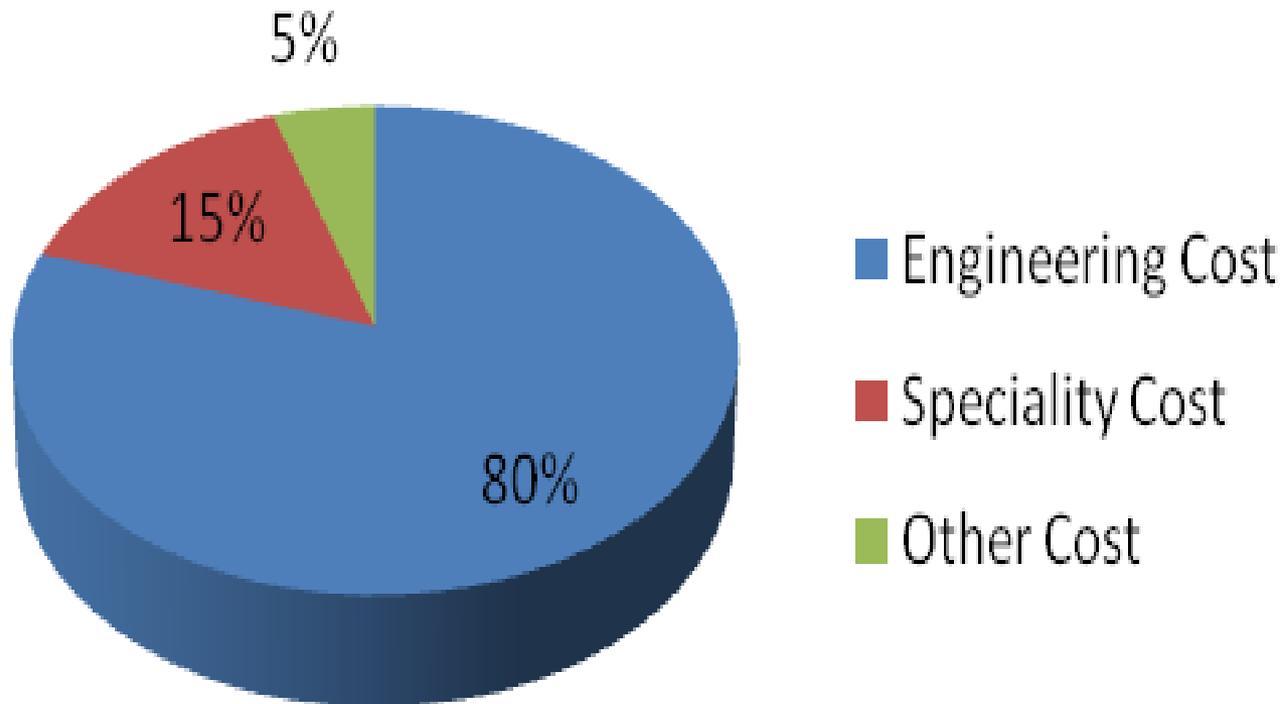
- ◆ In china, 5 indicators for pavement, subgrade, bridges and culverts, signs and markings, and greening of every kilometer road are checked and assessed per month. Quality point of each part is: pavement 50 points, subgrade 20 points, and other three parts 10 points respectively.
- ◆ Road condition is divided into four categories: **excellent, good, inferior, and poor**. The percentage of excellent and good road sections (good road rate) is taken as the main indicator for the quality assessment of maintenance work.

- ◆ **Fund of road maintenance is from highway funds in most countries.**
- ◆ **Proportion of maintenance fund in the total investment of road construction is generally from 30% to 50%.
The highest proportion is over 60% (such as in Sweden), and the lowest proportion is about 20% (such as in Japan).**

◆ Composition of road maintenance fund:

➤ **Engineering cost:** including the minor repairs and maintenance, medium maintenance, overhaul, improvement engineering, water damage restoration, road building and the ferry, greening, etc., accounting for about 80% of the total maintenance cost;

- **Speciality cost:** including the purchase of machinery and equipment, small plant and field construction, scientific research, training, the station building and administrative management, accounting for about 15% of the total maintenance cost;
- **Other cost:** accounting for about 5% of the total maintenance cost.



(1) Crack seal coat of pavement

- ◆ **Crack filling:** mainly for active cracks;
- ◆ **Crack sealing:** mainly for inactive cracks, slots are not needed.



I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance



Crack seal coat of pavement

Slot



I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance



Pump Slurry

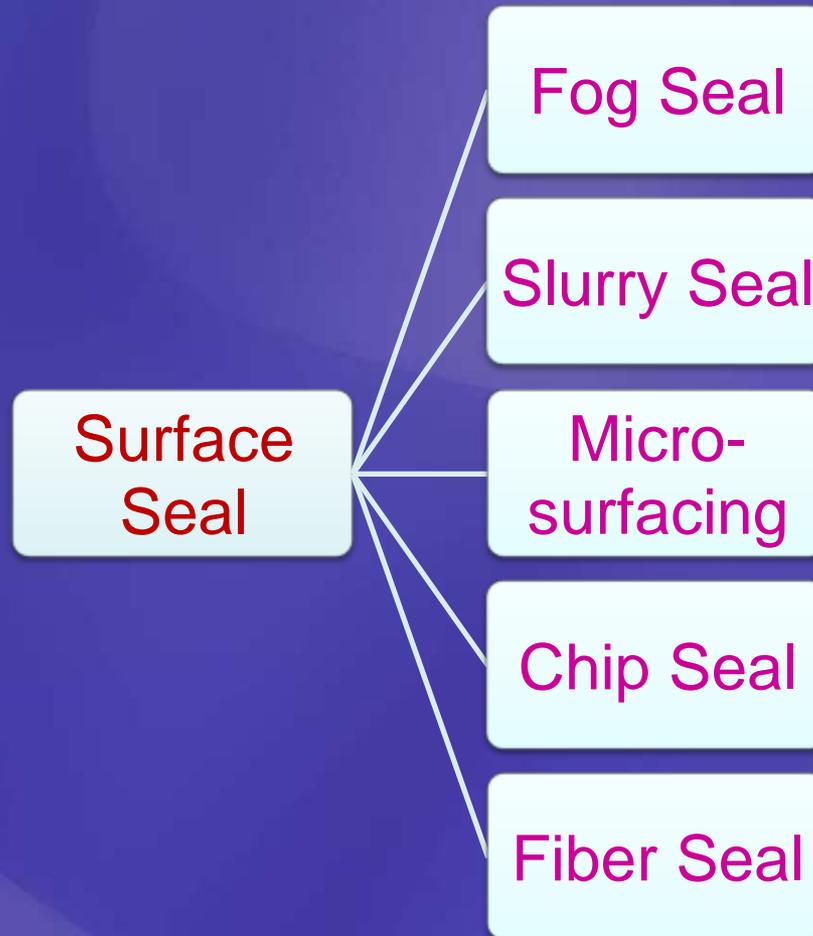
Lay Seam Belt



(2) Surface seal of pavement

- ◆ Surface sealing technology is to lay the protective layer on the road to protect the original pavement and to dispose the diseases of pavement.**

- ◆ According to the materials used, surface seal can be divided:



I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance

◆ Fog seal:

- **Good waterproof;**
- **Good permeability, can fill the fine cracks and surface voids of the pavement;**
- **Blacken the pavement, can increase color contrast of the pavement, enhancing the visual comfort of the drivers;**
- **Self heal the cracks with width less than 0.3mm;**
- **Greatly improve the service life of the road and reduce the maintenance cost. Generally, it can delay the disease from 2 to 4 years, and improve the service life of the road.**

I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance



Comparison before and after fog seal construction

I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance

◆ Slurry seal:

- Effectively improve the antisliding ability of pavement;
- Improve the durability of pavement;
- Can open traffic with 1 hour.

Comparison before
and after slurry seal
construction



◆ **Micro-surfacing:**

- **Effectively improve the antisliding ability of pavement;**
- **Prevent water infiltration, prevent aging and loose of pavement, thus effectively prolong the service life of pavement;**
- **Can open traffic with 1 hour;**
- **Service life is usually 5 to 6 years, long up to 8 years.**

I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance

Comparison before and after micro-surfacing



◆ **Chip seal:**

- **improve the waterproof performance of road;**
- **Improve the antisliding ability;**
- **eliminate the road diseases, enhance the traffic comfort on the road;**
- **Prolong the service life.**

I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance

Construction effect
of chip seal



I. Introduction of Road Maintenance

7. Basic Technologies of Road Maintenance

◆ Fiber seal:

- Prevent reflective cracks, blocking the diseases between subgrade and surface layer;
- Improve the waterproof performance of road;
- Good effect on stress absorption and dispersion.

Construction
effect of fiber seal



II. Administration System of RM in the world

1. USA

- ◆ **Interstate highway and national highway in U.S. is planned by the Federal Highway Administration. States are responsible for the project implementation and operations management in accordance with the AASHTO maintenance manual.**
- ◆ **Road administration agency are in charge of the management of plan, technique, finance, quality and environment. Maintenance work is contracted to the private maintenance companies, and maintenance contracting market is established. Road management and maintenance are separate. As the owner, administration is responsible for the contract negotiations and overseeing the implementation and acceptance of the contract.**

II. Administration System of RM in the world

1. USA

- ◆ **Maintenance company is fully market-oriented. It can trans-regionally contract all kinds of roads maintenance tasks. The road maintenance market is mature, the industry assessment qualification is unified, and technical specifications are reasonable. Check and assessment of maintenance results are fair and impartial.**

◆ Characteristics:

- (1) Management agency is compact, saving personnel and money input.
- (2) Maintenance work can be completed with high quality and efficiency. Federal government gets out from the growing investment in road maintenance. Maintenance investment is more reasonable.
- (3) Traffic condition is well guaranteed during maintenance contracting period.

◆ Problems:

- (1) Reduce the regulation ability of the government in the contracting period;
- (2) Considering the efficiency and cost, private contractor is probably reluctant to adopt new methods, new materials and new technologies.
- (3) Once the private contractor evacuate midway because of bad mismanagement, the government needs to re-select the contractor. Maintenance work gets discontinuous.

II. Administration System of RM in the world

2. Canada

- ◆ Canadian federal government is responsible for the maintenance of special roads, such as the National Garden Road, military road, etc. Maintenance of other roads is responsible by provincial government.
- ◆ Road maintenance is generally contracted to private companies.
- ◆ Taking British Columbia as an example. The road maintenance in British Columbia general takes 5 years as the contract period. Total maintenance price of the first year, rather than unit-price, is provided in the contract. One year later, the government may regulate the total price according to the price growth index.
- ◆ In road maintenance cost, routine maintenance accounts for 65%, and prevention maintenance accounts for 35%.

II. Administration System of RM in the world

2. Canada

- ◆ The main content of maintenance contract includes maintenance quality, schedule and risk, and the contractor should be responsible for the public complaints, meaning that the contractor will assume full responsibility in road maintenance and management. The responsibility of government is only to ensure the implementation of the contract and only emphasize the final maintenance results.
- ◆ Maintenance guarantee system includes two parts: contractor's quality control, and government's quality assurance. The government prescribed comprehensive quality assurance plans. Maintenance work is ensured to meet the requirements via planned inspection system (including status inspection, in-process inspection and completion inspection).

◆ Characteristics:

- (1) The contract uses the total price. The contractor takes all responsibility of road maintenance and management, and is supervised by road users and public opinion, which force the contractor to improve the regular maintenance quality and provide the best service.
- (2) The government only emphasizes final maintenance results, thus having more time to take macro management for road.

◆ Problems:

(1) It's hard to determine total maintenance contract price.

Scientific evaluation system, accumulated experience and perfect quality assurance system of road and bridge are required.

(2) Maintenance in every districts may have no uniform standards.

- ◆ Road administration agency in France is in charge of the investment and management of road network, and developing traffic regulations.
- ◆ Government fund used in road construction is mainly from fuel tax, vehicle purchase tax and vehicle use tax.
- ◆ Road maintenance adopts enterprise management mode. Professional companies are chosen by bidding. Maintenance fund is from the government budget.

- ◆ Road maintenance mode is mainly determined by car flow. In the early stage of construction, maintenance modes are analyzed and classified into two kinds. One mode is to use routine repair and maintenance mode, and the other mode is to adopt periodic maintenance according to the pavement life.
- ◆ Maintenance and quality standards are set by the government:
 - (1) If pavement friction coefficient does not meet the requirements, new pavement is needed;
 - (2) If structure layer is damaged, new pavement is added after analyzing the reasons and damages are treated.

◆ Characteristics:

- (1) National highway agency is in charge of the management of highway.
- (2) Construction and maintenance contractors are chosen by bidding.
- (3) Independent to highway management and maintenance agencies, machinery companies serving for road maintenance are set. Maintenance equipments are rented from the companies, favoring the specialization, mechanization and commercialization of road maintenance.

- ◆ **According to the road grade and different functions, road maintenance is responsible by state transport department and local governments. Transport department is mainly responsible for the maintenance of expressway and trunk road, and local governments are responsible for the work of other roads.**
- ◆ **Road maintenance funds are from the budget of central government and local governments.**

- ◆ **Government transport agencies are mainly in charge of the management of technology, finance and contract in road maintenance. All maintenance works and special traffic inspection are commissioned to technical contractors.**
- ◆ **In order to simplify the bidding work and contract management, the transport department prescribed sample contract document for road construction and maintenance.**

◆ Characteristics:

(1) Management level is clear, and responsibility is explicit. Inspection and assessment function of the government is stressed.

(2) By introducing competition mechanism, overhaul and medium-sized repair adopt bidding system to choose contractor.

◆ Problems:

- (1) Maintenance plans and technical standards in different regions are not uniform.
- (2) It is difficult to investigate the relationship between maintenance agent and contractor.

II. Administration System of RM in the world

5. Germany

- ◆ As a country with the most highways in European countries, maintenance of expressway and ordinary road adopts different modes.
- ◆ For expressways, maintenance is funded by federal government and managed by state government. A maintenance management station is set every 50~60km, equipped with a variety of repair and maintenance mechanical equipments, responsible for all the maintenance work. This is a kind of vertical and professional maintenance and management system, suitable for formal and professional maintenance and management, meeting the requirements of expressway with heavy traffic, fast running speed, high efficiency and safety.
- ◆ For ordinary roads, contractors are chosen and responsible for the maintenance work.

- ◆ In the past, the State Highway Bureau (Swedish National Road Administration) was responsible for the construction and maintenance in the past, leading to the huge institution of maintenance agency, low efficiency and high running cost.
- ◆ In 1992, the system was changed. Separation system between management and maintenance agencies are adopted, and competition mechanism was introduced. The owner was responsible for the macro management, and the maintenance work was contracted to commercial contractor.

- ◆ Maintenance contractor is chosen by bidding.
- ◆ Ordinary maintenance and periodic maintenance are divided in maintenance work. Contracting period of ordinary maintenance is generally 5 years, such as 3+2 years or 4+1 years. Contract of 3 or 4 years is signed with the contractor. Then whether to continue or to change the contract will be decided after synthetic assessment of the contractor's situation, condition change and work performance.

- ◆ **Most of the road maintenance is in marketing mode. Professional contractors are commissioned to carry out the maintenance work via bidding.**
- ◆ **Road owner is in charge of the supervision and assessment of the road maintenance result. It has no maintenance agency, staff and equipments.**

II. Administration System of RM in the world

8. Japan

- ◆ Vertical management system is adopted in Japan, i.e. transport ministry, highway bureau and road corporation

Under the road corporation, regional management bureau is set to be responsible for the road management and maintenance.

- ◆ Road maintenance is divided into routine maintenance and periodic maintenance. Large amount of work, such as toll, maintenance, overhaul, reconstruction, etc., are commissioned to professional contractors.

- ◆ Maintenance fund is planned by road corporation and executed after approval by transport minister. In the total highway maintenance cost, maintenance and management fee accounts for 42%, engineering improvement fee accounts for 55%, and countermeasure of disaster fee accounts for 2.6%.

◆ Characteristics:

- (1) Adopting vertical management system, maintenance mode is united and management level is clear and complete.
- (2) Management and quality supervision functions of maintenance agency are highlighted. It belongs to technology intensive management.
- (3) Maintenance construction is highly socialized. Maintenance engineering is contracted. Management agency has no its own maintenance organization and equipments.

◆ With the social and economic development, road maintenance and management modes in China can be divided into 3 stages:

Stage 1: 1949 ~1978, system establishment stage. “Unified leading, and leveled management” mode for road maintenance was formed.

Stage 2: 1979 ~1997, system adjustment stage. A professional maintenance mode was formed; and in pace with the diversity trend in road construction and management, maintenance market mechanism was introduced.

Stage 3: since 1999, system reform stage. Road maintenance and management system was deeply reformed in the target of “separation of management and maintenance, and separation of institution and enterprise”. Maintenance enterprises were almost marketed.

III. Existing RM Modes in China

- ◆ At present, due to the difference of road investor, economic development level and commercialization degree, a variety of road management and maintenance modes exist at the same time in China.
- ◆ The existing maintenance modes mainly includes:
 - Self-operated maintenance mode
 - Outside contracting maintenance mode

According to the marketing degree:

Outside contracting mode in specific repair and overhaul

Completely marketing maintenance mode

According to different assessment methods:

Input-based maintenance mode

Performance-based maintenance mode

III. Existing RM Modes in China

1. Self-operated Maintenance Mode

- ◆ **Road management agency has its own maintenance team (generally as maintenance center). It completed the maintenance task in most of the time.**
- ◆ **The mode is the product of construction agency and maintenance agency with the same superior. After the road construction, the construction agency transfers to management agency, and construction agency transfers to maintenance agency.**

III. Existing RM Modes in China

1. Self-operated Maintenance Mode

- ◆ **Zhejiang Shanghai-Hangzhou-Ningbo Expressway Maintenance Center was established in 1997, accompanied with the completion of the expressway, and under the leadership of Zhejiang Shanghai-Hangzhou-Ningbo Expressway Company, Ltd.**
- ◆ **Now, the maintenance center is in charge of the routine maintenance and special project for Shanghai-Hangzhou-Ningbo Expressway and Shang-San Expressway. Only in the case of the maintenance center cannot finish or there is overhaul or emergency events will the center hire outside maintenance companies.**

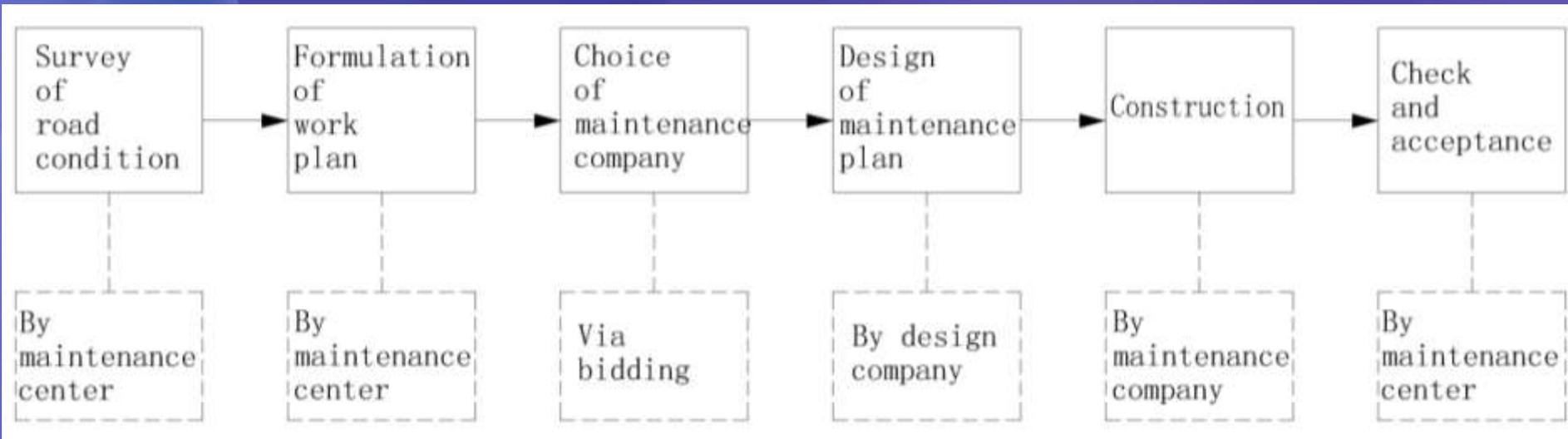
III. Existing RM Modes in China

2. Outside contracting mode in specific repair and overhaul

- ◆ **In 2001, Anhui Expressway Authority established maintenance center after He-Ning Expressway completed. Routine maintenance was responsible by the management office, and the rest work was responsible by maintenance center, who chooses the maintenance team via bidding.**
- ◆ **In 2004, Wantong expressway company maintenance center was established, which was responsible for maintenance management and composition of maintenance plan. Maintenance construction is commissioned to professional companies by social bidding.**

III. Existing RM Modes in China

2. Outside contracting mode in specific repair and overhaul



Maintenance and management flow of Wantong xpressway

III. Existing RM Modes in China

3. Completely marketing maintenance mode

- ◆ **Completely marketing maintenance mode refers to that the road maintenance task is to be completely carried out by the professional maintenance companies which are chosen in the maintenance market.**
- ◆ **Road maintenance includes greening, daily minor maintenance, special engineering, overhaul. Big differences exist in technical and equipment requirements. Several maintenance teams are needed to jointly finish the maintenance work. It is difficult to find a single company to finish all the work. Thus such a maintenance mode is rarely adopted at present. The maintenance modes of Changzhou section of Shanghai-Nanjing expressway and Anhui section of Lian-Huo expressway are closer to the mode.**

III. Existing RM Modes in China

3. Completely marketing maintenance mode

- ◆ **The maintenance work of Changzhou section of Shanghai-Nanjing expressway includes two part. Some minor works, e.g. greening, the daily repair and maintenance, restoration of safety protection facilities, are finished by the relatively fixed professional companies; Special projects and overhaul engineering are bidden publicly to choose qualified companies to finish.**
- ◆ **For Lian-Huo expressway, the daily maintenance work of asphalt pavement is commissioned to a maintenance company in a fixed total cost. The owner is only in charge of the supervision in technology, quality, time and cost, and does not involved in the maintenance construction. With the maintenance mode, daily maintenance cost of the expressway are greatly saved (about 100 ~ 150 million yuans one year).**

III. Existing RM Modes in China

4. Input-based maintenance mode

- ◆ **Input-based maintenance mode refers to that the final maintenance payment is based on the maintenance quota or pre-specified prices in the contract and actually finished maintenance quantity by the contractor.**
- ◆ **Theoretically, it is the most reasonable and fair to the owners and the contractor to adopt measurement and quota to determine the final maintenance cost or maintenance price. Firstly, in engineering measurement, theory is relatively mature and easy to operate, and it has the national and local quota as the guidance and reference. Secondly, in terms of price calculation, there is national and local quota. Big difference will not occur between two sides.**

III. Existing RM Modes in China

4. Input-based maintenance mode

◆ **But in the actual operation, due to various reasons, some problems are met:**

(1) Motivated by economic interest, maintenance company will prefer to big maintenance work. Using the same vehicles, equipment and personnel as well as safety measures, it is better to repair more damages and have bigger profits, leading to repair delay of minor damages, not to mention prevention maintenance. It is far away with the real objectives of road maintenance.

(2) Management difficulty increases, and correspondingly increases the management expense.

III. Existing RM Modes in China

5. Performance-based maintenance mode

- ◆ **Performance-based maintenance contracting mode (i.e. PBMC mode), is also named as output-based maintenance contracting mode.**
- ◆ **In PBMC mode, the owner and the maintenance company signs the maintenance contract, specifying the maintenance scope, items and assessment criteria. The maintenance work is contracted to the maintenance company as a total cost, which will remain unchanged unless the owner has special requirements. Road standards, performance evaluation and assessment standard are specified in the contract, and the evaluation result is the payment basis to the maintenance companies.**

III. Existing RM Modes in China

5. Performance-based maintenance mode

- ◆ **PBMC mode can effectively reduce maintenance cost, ensure maintenance quality and improve road maintenance level and comprehensive economic and social benefits. Presently, however, it is only suitable for daily cleaning and small maintenance work, not suitable for overhaul, medium repair, renovation, etc. Emergency repair tasks in daily maintenance caused by unforeseen factors should also be finished by setting up emergency repair system and special engineering examination and approval system.**

III. Existing RM Modes in China

6. Comparison of maintenance modes

Maintenance Mode	Advantages	Disadvantages	Example
1. Self-operated Maintenance Mode	<p>(1) Can solve the personnel and equipment problem after road completion.</p> <p>(2) Familiar with the actual conditions along the road, and more targeted in maintenance work.</p> <p>(3) Convenient in management, reducing the intermediate steps.</p> <p>(4) Relatively reduces the tax expenditure compared with setting independent company.</p>	<p>(1) Organization overstaffed, high costs.</p> <p>(2) Not meeting the market trend, lacking competition ability, easy to breed inert, difficult to promote the maintenance technology.</p>	Shanghai-Hangzhou-Ningbo Expressway

III. Existing RM Modes in China

6. Comparison of maintenance modes

Maintenance Mode	Advantages	Disadvantages	Example
2. Outside contracting mode in specific repair and overhaul	<p>(1) Reduce personnel and machinery expenses.</p> <p>(2) The owners only needs a few but efficient professional staff to carry out technical management and supervision, thus focusing on management and macro arrangements.</p> <p>(3) Meeting the market trend, fully mobilizing the production enthusiasm of contractor, and increasing the work efficiency.</p> <p>(4) Maintenance is carried out by professional companies in different categories, respectively, ensuring the construction quality.</p>	<p>Responsibilities and benefits between the two sides are completely managed via contract. In case of unexpected events, large engineering quantities events, or works needed to complete timely, problems may emerge in coordination between two sides, thus affecting the construction duration and quality.</p>	<p>Anhui Wan-Tong Expressway</p>

III. Existing RM Modes in China

6. Comparison of maintenance modes

Maintenance Mode	Advantages	Disadvantages	Example
3. Completely marketing maintenance mode	Same as above, but the effect is better.	Same as above	Changzhou section of Shanghai-Nanjing Expressway, Lianhuo Expressway Anhui Section

III. Existing RM Modes in China

6. Comparison of maintenance modes

Maintenance Mode	Advantages	Disadvantages	Example
4. Input-based maintenance mode	<p>(1) Theory in engineering measurement is relatively mature and easier to operate.</p> <p>(2) National and local quota are the guidelines in calculating price.</p>	<p>(1) Motivated by economic interests, contractor will prefer to bigger maintenance work, influencing the timeliness of road maintenance, and far away from its real objectives.</p> <p>(2) Management gets more difficult, and management cost increases correspondingly.</p>	At present, most of the highway adopt this mode

III. Existing RM Modes in China

6. Comparison of maintenance modes

Maintenance Mode	Advantages	Disadvantages	Example
5. Performance-based maintenance mode	(1) Save costs. (2) Maintenance quality can be guaranteed; (3) Enhance the market competitive ability of maintenance company, and increase the economic benefits of the maintenance company.	Only suitable for routine cleaning and minor repairs. Special maintenance and overhaul need to adopt different mode.	Guangzhou-Shenzhen Expressway, Chengdu-Chongqing Expressway

IV. PBMC and Its Characteristics & Implementing Requirements

—— What is PBMC

- ◆ According to the different measuring methods, the market modes of road maintenance include **input-based maintenance contracting mode** and **performance-based maintenance contracting mode**.
- ◆ **Input-based maintenance contracting mode** generally specifies the fixed price standard of the maintenance engineering in the contract, and pays maintenance fund according to the actual work completed.
- ◆ **Performance-based maintenance contracting (PBMC) mode** quantitatively evaluate the work of the maintenance company and pay the fund based on the predetermined technical conditions and service level provided of the road.

IV. PBMC and Its Characteristics & Implementing Requirements

—— What is PBMC

- ◆ PBMC highway maintenance management mode originated in 1990s in North America, Latin America, Australia, and New Zealand.**
- ◆ Promoted by the World Bank, Asian Development Bank and other international and regional organizations, PBMC has been adopted and spread in some countries in Europe and Asia. Especially in recent years, the mode has been further promoted.**

- ◆ **Professional maintenance company, socialized maintenance;**
- ◆ **Bidding mechanism;**
- ◆ **Contracting management;**
- ◆ **Appraised based on road performance.**

Compared with the traditional Self-operated Maintenance Mode and Input-Based Maintenance Contracting, PBMC has the following **advantages**:

- ◆ Road management has **more clear objectives**, and the process becomes more simple. Only concerning about the maintenance effect, road management authority almost no longer needs to know what the maintenance does, greatly reducing the management workload.
- ◆ Management company can reduce lots of complicated bidding work and lower the management cost.

- ◆ **Maintenance company is highly independent, which favors to make full use of maintenance fund and provides chances for study and adoption for advanced maintenance technology.**
- ◆ **Road maintenance management and implementation are more in accordance with the characteristics of road itself. Road maintenance has obvious social and public interest requirements. The public do not care how much maintenance work has been done , but only concern about the service effect of the road. PBMC is more conducive to the interest coordination between the owners and the public.**

IV. PBMC and Its Characteristics — Implementing & Implementing Requirements Requirements of PBMC

- ◆ **Length of maintenance cycle should be appropriate.** Too long maintenance cycle may lead to the loose control of the maintenance contract and influence the execution company; too short maintenance cycle will restrict the freedom of maintenance company, thus reduce the effect of PBMC.
- ◆ **Maintenance objectives should be appropriate.** Too high maintenance objectives will increase the maintenance cost and may lead to the quality overmuch and even waste, affecting the return of road investment; too low objectives may cause the maintenance work not timely, leading to the increase of post maintenance.

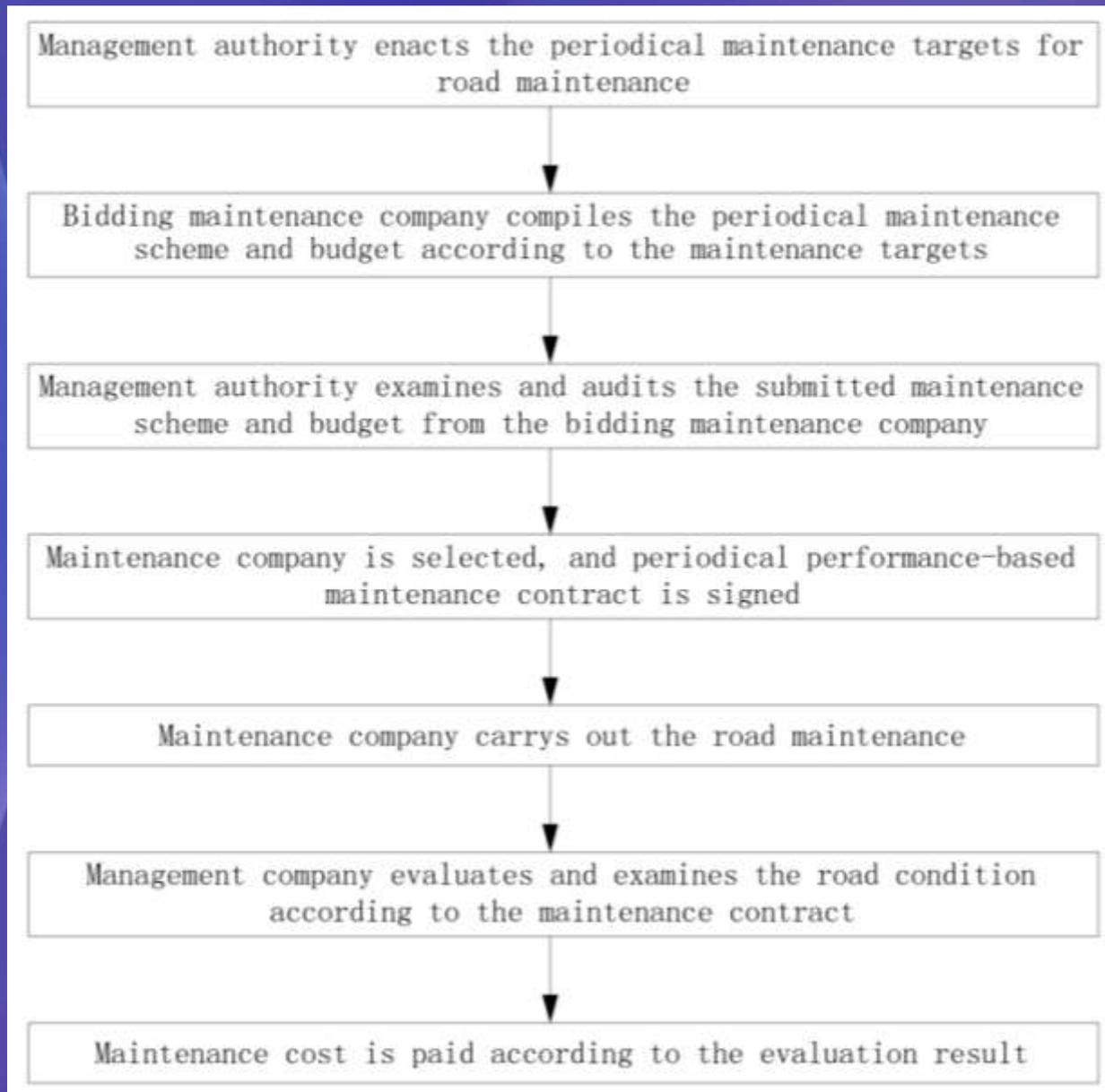
IV. PBMC and Its Characteristics — Implementing & Implementing Requirements Requirements of PBMC

- ◆ Maintenance budget should be determined fully in combination with the financial ability of the management company. With the rapid development of maintenance market, requirements on road maintenance and management enhance correspondingly.**
- ◆ In order to ensure the implementing quality of the maintenance contract, road maintenance task should undertaken by the professional company.**
- ◆ Maintenance company should have rich management experience and ability. PBMC has high requirements not only for the maintenance construction, but also for the management experience and ability of the management company.**

IV. PBMC and Its Characteristics — Implementing & Implementing Requirements Requirements of PBMC

- ◆ **Management company only pays attention to the maintenance effect, not to calculation of the maintenance work. Maintenance company should report the road condition and adopted methods to the management company via effective ways.**
- ◆ **Maintenance content shall be objectively defined in the contract. Generally, performance-based maintenance contract doesn't contain the contents such as road overhaul, modification and hardships. If such works happened, other methods are needed.**

V. Implementing Process of PBMC



VI. Problems in Implementing PBMC

- ◆ PBMC mainly concerns with the work effect, rather than with the specific work. It is suitable routine cleaning, greening maintenance, facilities maintenance, minor repairs, etc, but not applicable to renewal and reconstruction. More suitable management modes should be explored for such items.
- ◆ Emergency repairs due to unforeseen factors often happen in routine road maintenance. It is difficult to quantify such work for PBMC mode. As the effective supplement of PBMC mode, emergency repair regulations shall be made.

VI. Problems in Implementing PBMC

- ◆ PBMC sets the maintenance effect as the evaluation target. The management company shall have high technical ability to audit the maintenance plan and budget of the maintenance company, and supervise its maintenance result and effect using advanced management system and performance-based appraisal methods.
- ◆ Owner of the road should find the proper position in road maintenance. In PBMC mode, specific maintenance work belongs to the responsibilities of maintenance company. Owner of the road should not participate the specific work of road maintenance, but concern about the quality evaluation system of road maintenance.

VI. Problems in Implementing PBMC

- ◆ **PBMC mode distribute the maintenance risk between the owners and maintenance company via the maintenance contract. But the distribution should be clearly specified in the contract and pay attention to the balance and the rationality. The risk should not excessively transfer to the maintenance company.**

VII. PBMC Cases in China

—— Guangzhou – Shenzhen Expressway

- ◆ **Total length of Guangzhou-Shenzhen expressway is 122.8km. The road opened to traffic in 1994.**
- ◆ **Before implementing PBMC, the road experienced self-operated maintenance mode, target maintenance mode, etc.**
- ◆ **In 2000, maintenance company was organized based on the maintenance stations. Relationship between the management company and maintenance company transferred from the subordinate relationship to the owner and the contractor relationship. PBMC mode was adopted, which is the earliest in China.**

◆ PBMC maintenance contract of Guangzhou – Shenzhen expressway includes three parts:

1. Maintenance scope and items: including routine maintenance and minor repairs, and the special facilities maintenance in this road.

2. Maintenance cost: according to the statistics of maintenance costs in past years, the routine maintenance and responsibility (including the work due to natural disasters) is contracted to the maintenance company with a fixed total cost. Unless the newly added maintenance items required by the owner, maintenance cost will not be supplemented in any cases.

3. Assessment: according to relevant technical codes and specifications and the actual situation of the road, evaluation and assessment standards of the maintenance contractor are determined. The assessment results is the payment basis of the maintenance fund.

◆ **Economic and social benefits** of PBMC in Guangzhou – Shenzhen expressway:

(1) Greatly reduced the maintenance cost. After implementing PBMC, maintenance cost of the road lowered from 16 million yuans to 14 million yuans, saving 2 million yuans. Maintenance cost per kilometer and per carriageway lane reduced from over 20,000 yuans to 16,000 yuans.

(2) Maintenance quality was promoted. Good road rate reached achieves 100%, performance score of the road were generally over 90, even 98. Complaints from the customer also reduced.

(3) Relationship between management and maintenance got disentangled, and workload of management company reduced.

After implementation of PBMC, management company only cared about the maintenance quality and effect, not the specific maintenance quantity. Maintenance target got more clear, saving a lot of management workload and cost. Management company paid more attention to the lift of management level.

(4) Management and economic efficiency of maintenance company increased. After implementing PBMC, in order to achieve more profits under the fixed total maintenance cost, maintenance company had to strengthen the management and exploit more effect methods in maintenance, e.g. simplify the organization, improve work quality and efficiency, reduce the rework rate, reasonably organize the machineries and materials, pay attention to research and adoption of advanced maintenance technologies, etc.

(5) Social benefit is significant. Because no other fund was added after implementing PBMC, in order to save the maintenance cost, maintenance company must strengthen quality control. Good road rate increased obviously, road closure time due to repair and maintenance work reduced, winning a good social image for the expressway.

- ◆ Total length of Chongqing segment of Chengdu – Chongqing expressway is 114.2km. The road opened to traffic in 1995.
- ◆ Technical standards:
 - 4 lanes
 - Width of subgrade: 24.12m
 - Design speed of vehicle: 80km/h
 - Maximum longitudinal slope: 5%
 - Minimum horizontal radius: 450m
- ◆ Main structures include a single hole tunnel long 12km, 4 bridges, 131 medium and small bridges.

VII. PBMC Cases in China

— Chengdu – Chongqing Expressway

◆ Structure of asphalt concrete pavement:

Structural Layer	Thickness (cm)	Structure Type
Asphalt Surface Layer	5	medium grained asphalt concrete
Asphalt Under Layer	7	Coarse grained asphalt concrete
Base	20	second-mortar gravel
Excavation (Fill) Subbase	20 (30)	many slag crushed stone

VII. PBMC Cases in China

—— Chengdu – Chongqing Expressway

- ◆ Before the implementation of PBMC, the maintenance work was carried out by the management substation which subordinated to Chengdu-Chongqing Expressway Management Office, the predecessor of Chengyu company.
- ◆ In 1997, maintenance substation was established, in charge of the maintenance of subgrade, pavement, bridges and culverts, tunnels, interchanges, and greening. Highway Management Authority periodically inspected and checked the maintenance quality, and comprehensively assessed at the end of each year. As a semi-professional maintenance mode, when the maintenance work was not full, the high cost of maintenance equipments and staff led to low utilization rate and great waste.

- ◆ In 2000, management company and maintenance company were established, respectively. Relationship between the two companies changed from leader-member to owner and contractor.
- ◆ Maintenance work of the road was subdivided into 6 groups, including routine maintenance, greening maintenance, road facilities maintenance, minor repair, special purpose engineering and overhaul engineering. The first 3 maintenance works are small but huge in quantity, belonging to the simple laboring. They were carried out by the maintenance staff of the management company; the later 3 maintenance works were implemented by the professional maintenance company via bidding and contracting. PBMC was introduced in the maintenance of the road.

◆ **Economic and social benefits** of PBMC in Chengdu – Chongqing expressway:

(1) After the implementation of PBMC, the maintenance content and targets were clearly prescribed in the contract, and the total cost would not change. For bigger profit, maintenance company had to pay more attention the actual maintenance quality and effect. Maintenance quality can be ensured. By comparing the maintenance effect before and after implementing PBMC, good road rate increased constantly.

(2) Maintenance company had more clear maintenance targets. It only concerned about the maintenance quality and cost, which reflected the actual maintenance effect. Maintenance did not need to care about the specific maintenance work, saving a lot of manpower and management cost.

Thank you !