Chapter 2 Action plan for the individual bridges

2.1 Introduction

In general, a considerably large amount of accumulated data from periodic inspection results is necessary in order to prepare a long-term maintenance plan based on preventive maintenance, however in current situation, no organization has established sufficiently yet.
The situation in DRR is also essentially similar to the above, although the BMMS (Bridge maintenance management system) has been developed. There are various issues to solve which are not yet in a stage to fully execute preventive long-term maintenance.

- Sufficient inspection has not been carried out due to the budget.
- Evaluation methods of the inspection results are not unified among different manuals.
- Inspection results vary depending on the inspector
- The existing BMMS is not a system which can integrate the inspection results as it is.

In the near future, they are expected to carry out inspection and evaluation in a synthetic manner and formulate a long-term maintenance plans according to "Inspection and evaluation manual" and thereby to solve those issues. Note that this process is not stable but should be revised at all times. In other words, it is not sufficient to accumulate data and overcome the above problems. Successive revision (PDCA-cycle) for the future plays a significant role.

The concrete schedule depends on the political judgment at each time. Therefore the items and directions for the successive revision are pointed out and the present initial conditions of the PDCA-cycle are examined.

2.2 PDCA-cycle in the maintenance plan

The PDCA-cycle applied to the long-term bridge maintenance system can be expressed as follows:

Plan	: formulation of a long-term maintenance plan
Do	: execution of repair and reinforcement measures
Check	: periodic inspection of bridge
Action	: sustainable improvement and revision

In a long-term maintenance plan for preventive maintenance, improvement of prediction accuracy is essential and therefore it is necessary to run the PDCA-cycle in accordance with the changes in the surrounding condition such as technical, social, or environmental changes and always update the plans.

2.3 Proposal for the action plan of execution and revision of the maintenance plans

As an action plan for execution and revision of the maintenance plan the general items common for all the bridges are described first and specific items of the steel, concrete, cable stayed-bridges are proposed grouping them.

(1) General items

The following items to update in the PDCA-cycle are sorted out as follows:

1) Change in technical condition
Repair technique is ever-improving so that the repair methods and service life will change. Therefore the repair methods assumed in the maintenance plan and the actually applied methods should be compared and the repair scenarios should be also revised. The damage deterioration prediction methods should be also revised comparing the new knowledge, researches, etc. as needed.

2) Change in social condition
The changes in the traffic volume due to social condition change affect the bridge structures so that the degree of the repair and reinforcement condition will respond them.
The repair budget is also affected by the social condition. It is expected the budget will be increased due to the better social recognition after the full operation of BMMS showing the validity of repair budget. It should be revised appropriately, because it is related to the budget equalization as well as the budget.

3) Change in environmental condition
Deterioration progress is affected by the growing flood and air pollution and varies depending on it. It is necessary to consider such natural environmental conditions in the comparison between the deterioration prediction and the actual inspection results.

4) Change in maintenance system
Organization improvement for the maintenance and personnel training affect the inspection accuracy. These are involved in the PDCA-items. Regarding the latter training course for the inspection- and repair-technique is organized periodically in foreign countries. In inspection practical work and experience are important, while it is likely to be still understaffing of well-experienced lecturers in Thailand. It could be one of the most urgent tasks to apply the practical training by scholarship programs for overseas in order to secure the human resources at least a certain degree of level.
The frequency of periodic inspection and PDCA-cycle should be also considered to revise

according to the actual condition of Thailand after the trial for several years.
Basically it is likely to be appropriately operational with the PDCA-cycle of 5 years.

(2) Action plans for steel truss bridges

Major damages common for the steel truss bridges including Krung Thon, Krung Thep, and Memorial show the following characteristics:

- Damages due to collision by ships or vehicles
- Corrosion in the main members as deterioration over time

a) Collision by ships or vehicles

Since the existing collision prevention measures such as the restriction in height are not effective, the damage problems have been left unsolved. If the countermeasures would be newly applied to this type of damage in the future, it is expected that the damage conditions of the 3 bridges would have same tendency. As this is not the damage due to the deterioration over time, it is recommended to review the deterioration prediction accuracy for 3 bridges at the same time.

b) Corrosion

These bridges have been repainted periodically (once / 4 years) using scaffoldings as the countermeasure to corrosion. (Figure 2.2.1)

Figure 2.2.1: Installation work for Krung Thon bridge

As corrosion is the result of deterioration over time, it is suggested to cycle the PDCA according to the periodic inspection every five years as the basic point. Since the bridges are re-painted every four years, it would be also recommendable for efficient improvement changing the inspection frequency into every four years, using the scaffolding for repainting work. This application should be determined considering the inspection cost and the safety of

the inspectors. In case this is not applied, it is recommended to report at least on the existence and the position of serious damages during the repainting in advance so that the next inspection work could be efficient focusing the specific points.
Painting materials have been shifting into the updated types of high-performance and high-durability in the foreign countries. These may be also recommendable options comparing these LCC as a part of the PDCA-items.

(3) Action plans for concrete bridges

Major damages common for the concrete bridges including Rama 4, Rama 5, Rama 7, Phra Pinklao, Phra Pokklao, Taksin and Rama 3 show the following characteristics. These damages are within the range of general damage except the bridge piers of Rama 5:

- Initial damages during construction. Cracking in the boundary part of the bottom slab and supports (cold joint), free lime through the construction joints of the deck and girder, etc..
- Free lime occurring from the girder bottom due to water leakage from expansion joints.

a) Initial damages during construction
Those causes are within the range of general damage at present. These are preventively maintainable in the long-term observing the progress of the damages in the periodic inspection.

b) Water leakage from expansion joints
While no structural problem has not yet occurred at present, the area affected by water leakage can deteriorate (Neutralization) potentially besides durability of expansion joint itself. For the repair and renewal it is preferable to investigate the improvement of the construction details such as water proofing and high-durability product for the affected area. In that case the repair scenario should be revised.
Since the above causes are within the range of general damage, periodic inspection and repair every five years would be able to handle the condition for the time being.

c) Inclination of the piers of Rama 5
The bridge piers of Rama 5 are inclined and can cause a serious problem to the structure. It is recommended urgent advanced inspection be conducted separately from the periodic inspection.

(4) Action plans for cable-stayed bridges

Major damages common for the concrete bridges including IRR South and North show the following characteristics:

- Diagonal cracking on the overhanging deck
- Cracking on the corner part of the main tower
- Cracking on the bottom part of the main tower
- Cracking on the side of the bridge piers

a) Diagonal cracking on the overhanging deck
This type of cracking is likely to be bursting cracking due to the diagonal compression force in the deck from the stay cable anchorages.
Although this is not influential enough to affect the entire structure of the bridge, it is recommended to check the design drawings and consider installation of waterproofing layers at the same time with the periodic inspection next year.

b) Cracking on the corner part of the main tower
This damage is occurring locally and likely to be cracking due to shear and torsion. Although this is not influential enough to affect the entire structure of the bridge, it is recommended to give close visual checks of crack width etc. using scaffolding to be set up in the periodic inspection next year.

c) Cracking on the bottom part of the main tower and the side of the bridge piers

The former is likely to be the cracking due to the temperature constraining, the latter is shrinkage respectively. Both two are not likely to be related to the structure but were originated during construction, and those are considered to cause no serious condition for the time being if periodic inspection and repair are surely conducted every 5 years.


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