PRIORITY RESEARCH PROJCECTS OF THE PUBLIC WORKS RESARCH INSTITUTE

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Abstract

Since the definition of its first 5-year medium-term plan after its 2001 establishment as an incorporated administrative agency, the Public Works Research Institute (PWRI) has performed socially highly necessary research as part of its priority research projects. In 2006, PWRI has developed and initiated a new medium-term plan and new priority research projects for the 5 years of Phase II. This report outlines priority research projects for the study of highway bridges and the typical individual studies that will be conducted as part of the projects.

Introduction

In April 2001, as part of a reorganization of government agencies and the launch of new research activities, the old Public Works Research Institute attached to the Ministry of Land, Infrastructure, and Transport (MLIT) was transformed into the new Public Works Research Institute, an incorporated administrative agency.

The new PWRI conducts research accurately and efficiently in response to the needs of the public and administrative authorities and is developing a 5-year medium-term plan in accordance with the 5-year intermediate goal defined by the Minister of Land, Infrastructure, and Transport. The Institute is implementing a package of socially highly necessary studies in a focused and intensive way as “priority research projects” under the medium-term plan.

Under Phase I of the medium-term plan (2001–2005), 14 priority research projects were conducted[1)]. One of these projects, which covered research on highway bridges, encompassed the following four research subjects:

- research on economical seismic retrofit technologies for civil infrastructures
- research on improving the durability of structures and evaluating their performance
- research on evaluating the soundness of infrastructure stock and its remedial techniques
- research on reducing construction costs of super-long highway structures

Some outcomes of these studies were reported at the US-Japan Bridge Engineering Workshop.

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In 2006, a new medium-term plan for Phase II was formulated. Before launching the plan, PWRI incorporated the Civil Engineering Research Institute of Hokkaido (CERI) and thus started a new organization.

Under Phase II of the medium-term plan, 17 priority research projects will be conducted. One of these projects, which includes research on highway bridges, covers the following three research themes:

- research on seismic countermeasure techniques against large earthquake for road and flood control facilities
- research on improvement of design methods for the efficient construction of highway structures
- research on advancement of maintenance technology of highway structures

This report presents these priority research projects and typical individual research themes relating to highway bridges.

2. Priority Research Projects for Highway Bridges

2.1 Research on Seismic Countermeasure Techniques against Large Earthquake for Road and Flood Control Facilities

In Japan, large-scale earthquakes such as the Tokai Earthquake and the Metropolitan Epicentral Earthquake are very likely to occur in areas with accumulations of people and assets and can thus cause enormous damage. The damage from earthquakes is estimated to be in the range of some 10 to 110 trillion yen. If the damage caused by such earthquakes is to be mitigated, it is important that lifelines and public infrastructure do not lose their inherent capabilities and that the damage that can result from structural collapses and other disasters is avoided. In this point of view, this priority research project is intended to develop the seismic performance inspection methodology for existing roads and flood control facilities and to develop seismic countermeasure techniques to secure the necessary seismic performance, thus contributing to forming cities resilient to earthquake hazards.

A typical theme of the highway bridge research to be conducted under this priority research project is:

- development of techniques for the urgent repair of highway bridges damaged by earthquakes.

The survey and inspection of highway bridges damaged by earthquakes and the selection of urgent and full-scale repair methods have been summarized and utilized in a

guide that reflects past disaster experiences, including the Hyogoken-Nanbu Earthquake. After the Chuetsu Earthquake in October 2004, however, it took about a week to inspect the affected highway bridges and select and implement repair methods. The roads were closed to traffic during this time, hampering restoration activities in the damaged area. For this reason, it is required to develop rapid inspection method of damaged highway bridges considering the effects of aftershocks, and to develop quick-acting urgent repair techniques. In this study, we intend to develop a evaluation method of damage of highway bridge; defining method of an aftershock scale that can be taken into consideration at the selection of urgent repair method; determining method of achieving seismic performance that incorporates good recovery; and rapid-impact urgent repair techniques. To do this we will examine the issues related to urgent repair after each series of earthquake damage.

The following additional research on highway bridges will be conducted as part of this priority research project:

- research on development of seismic strengthening techniques for existing highway bridges that are difficult to reinforce
- research on evaluation of the safety of existing highway bridge foundations
- research on development of seismic strengthening techniques for abutments on soft ground

2.2 Research on Improvement of Design Methods for the Efficient Construction of Highway structures

In Japan, with the increasing maintenance and updating costs of old infrastructure associated with falling birthrate and population aging, it is feared that these problems with a reduction in the reserve of investment in the construction of new infrastructure. Therefore, it is called for constructing highway infrastructures more efficiently with keeping good quality. For this reason, we need to enhance reliability and flexibility of design technique and establish performance-based design method for the easy development and utilization of new technologies, as well as to develop reasonable design concept that support international trends. From this viewpoint, in this research we intend to develop a partial safety factor design method and incorporate this method into specifications for highway bridge. An additional aim of this research is to develop a method for evaluating performance indicators of pavement (e.g. skid resistance or the number of wheel passes that causes fatigue failure) that supports reliability-based theoretical design and performance stipulations.

A typical theme of the highway bridge research to be conducted under this priority study project is:

- research on partial safety factor design method for the substructures of highway bridges

Specifications for highway bridges are being revised to promote performance-based design methods as well as to introduce a partial safety factor design method and rationalize ways of verifying new technologies. To define the partial safety factors used to design substructures, characteristic values in accordance with the number of past loading tests and the accuracy of past soil investigations have been reviewed. In this study, on the basis of the results of our review, we intend to intensively examine partial safety factors for designing pile foundation and spread foundation areas frequently used.

In addition to the above issue, the following research on highway bridges will be conduced through this priority research project:

- research on partial safety factor design method for steel highway bridges
- research on partial safety factor design method for concrete highway bridges
- research on partial safety factor design for seismic design of highway bridges

2.3 Research on Advancement of Maintenance Technology of Highway Structures

Enormous numbers of highway structures built during the period of high economic growth from the 1960s to the 1970s are aging. In order to maintain these structures in an efficient manner, we need to develop individual component techniques for survey inspections, diagnosis, and repair/reinforcement. We need to integrate these techniques in an organic way and to establish a system for managing them strategically. Some of these techniques were developed in one of the studies performed under the previous medium-term plan, but we need to develop more techniques in order to implement maintenance that supports various conditions. From this viewpoint, the purpose of this study is to develop high-priority component techniques for highway bridges, embankments, tunnels, and pavements, as well as a management system based on the concept of asset management.

A typical theme of the highway bridge research to be conducted under this priority study project is:

- improvement of fatigue durability of existing steel plate decks.

Over 50 000 steel highway bridges in Japan are suffering from fatigue damage in their individual sections as a result of severe live-load conditions in recent years. However, the complex mechanism that causes fatigue damage has not been fully solved, so standard repair and reinforcement techniques have not been established. This evokes a critical maintenance problem. In particular, steel deck plates that are being overtly damaged have areas of high local stress and require repair work involving traffic regulation. For these reasons, we need to analyze the cause of damage and to develop effective repair and

reinforcement techniques in accordance with the damage status. In this study, we intend to identify the mechanism by which steel plate decks are damaged and develop effective repair and strengthening construction methods in accordance with the damage status.

In addition to the above issue, the following research on highway bridges will be conducted through this priority research project:

- use of desalination to repair concrete structures subject to salt damage
- investigation of the durability of coating materials used in concrete repair/reinforcement
- repair of steel bridge corrosion-protection works.

3. Conclusion

Of the research issues presented in this report, technical standard-related issues will be implemented through the collaboration of PWRI, the National Institute for Land and Infrastructure Management (NILIM), and other relevant institutions. The outcomes will be incorporated into technical standards such as specifications for highway bridge. Additionally, for issues aimed at technological development, we intend to conduct behavioral research with private companies as necessary. We will verify the adequacy of the technologies developed, apply them to actual sites, and then disseminate them.

The results of these studies and of case studies in which we will apply the techniques developed will be reported in this workshop as they come to hand.

Reference

1) PWRI website: http://www.pwri.go.jp/eng/project/epro01.htm