Republic of Turkey

Ex-Post Evaluation of Japanese ODA Loan Project

Seismic Reinforcement Project for Large Scale Bridges in Istanbul

External Evaluator: Yasuhiro Kawabata, Sanshu Engineering Consultant

0. Summary

The objective of the project was to enhance quake resistance by conducting the reinforcement works to the existing major large scale bridges and their connecting major viaducts in Istanbul, thereby, contributing to securing the lifeline (transportation) and keeping up the socioeconomic activities in the event of disaster/emergency situations. The project has been highly relevant to the development plans and needs of Turkey, as well as Japan's ODA policies. Thus, its relevance is high. The standards for earthquake-resistance design applied are mostly consistent with the Japanese ones used until the Northeastern Pacific Ocean Earthquake occurred in 2011, and thus there is no problem with appropriateness of technical judgment at the appraisal stage. According to the executing agency, collapse of three bridges would be averted and the lifeline (transportation) would be secured in the event of large earthquakes because of enhancement of quake resistance to three bridges under the project. Thus, the project has largely achieved its objectives, and thus the effectiveness and impact is high. Although the actual project scope (output) was partially changed from the originally planned scope, changes made are considered appropriate. Although the project cost was lower than planned, the project period was significantly longer than planned. Therefore, efficiency of the project is considered fair. No major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system, therefore sustainability of the project effect is considered high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Mecidiyekoy Viaduct

1.1 Background

The target bridges on the First and Second peripheral highways in Istanbul are key and heavily-trafficked structures crossing the Bosphorus Strait and Golden Horn Bay, connecting Europe with Asia. Since there would be no equivalent alternative routes (highways) for crossing the Bosphorus Strait and Golden Horn Bay except crossing by ferries, in the event of collapse or fatal damages to these bridges: 1) both peripheral highways would completely lose their functions as trunk ring highways; 2) the rescue and restoration works after the disaster would be seriously obstructed; and 3) the socioeconomic activities of the country would be stagnated for a long time.

After earthquakes at Kocaeli in August 1999 and Duzce in November 1999, as a result of the subsequent investigations and research, new active faults were discovered under the Sea of Marmara near Istanbul, and high possibility of occurrence of the large earthquakes near Istanbul was pointed out. After the earthquakes in 1999, the investigation of the earthquake damages against the First and Second Bosphorus Bridges and the Golden Horn Bridge was made. As a result of the investigation, no serious damages were found, however, necessity of further seismic reinforcement for those bridges was discussed since those bridges were constructed with the seismic criteria valid at the time of construction. In September 2000, a preliminary study was conducted and in November 2000, a feasibility study was conducted.

In the Disaster Prevention Action Plan prepared by Istanbul City, securing transportation in the event of disaster/emergency situations was considered the top priority agenda. Then, designation of alternative routes for major trunk highways in the event of emergency situations was made. However, it was confirmed that there were no alternative routes for the bridge sections targeted under the project. Based on the above, in January 2001, the Government of Turkey submitted a request for Special Yen Loan for the subject project to the Government of Japan.

1.2 Project Outline

The objective of the project was to enhance quake resistance by conducting the reinforcement works to the existing major large-scale bridges and their connecting major viaducts in Istanbul, thereby, contributing to securing the lifeline (transportation) and keeping up the socioeconomic activities in the event of disaster/emergency situations. The location of the project site is shown in Figure 1.

Figure 1　Location of Project Site

Loan Approved Amount/ Disbursed Amount	12,022 million yen/11,936 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2002/July 2002
Terms and Conditions	For civil work: Interest Rate: 0.95%, Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: General untied For consulting services: Interest Rate: 0.95% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement:　General untied
Borrower / Executing Agency(ies)	Government of the Republic of Turkey/ General Directorate of Highways (KGM), Ministry of Transport, Maritime Affairs and Communication
Final Disbursement Date	February 2012
Main Contractor (Over 1 billion yen)	IHI
Main Consultant (Over 100 million yen)	Japan Bridge and Structure Institute.
Feasibility Studies, etc.	Fact Finding Study: Infrastructure Development Institute (2000) Feasibility Study: Japan Bridge and Structure Institute (2000)
Related Projects	Technical Cooperation: ・ Basic Study for Istanbul Earthquake Prevention Plan by JICA, 2001-2003 ・ Earthquake Disaster Prevention Project by JICA, 2005-2008

	ODA Yen Loan: ・Golden Horn Bridge Construction Project (L/A signing: 1972) ・Second Bosphorus Bridge/Motorway Construction Project (I, II, III) (L/A signing: 1985, 1987, 1987) ・Golden Horn Bridge Rehabilitation/Widening Project (L/A signing: 1991) ・Emergency Disaster Reconstruction Project (L/A signing 1999) ・Bozuyuk-Mekece Road Improvement Project (L/A signing: 1999) Other International Organizations: ・Emergency Earthquake Recovery Loan (World Bank) ・Marmara Earth Emergency Reconstruction Loan (World Bank) ・Restructuring of Existing Loan (World Bank)

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasuhiro Kawabata, Sanshu Engineering Consultant

2.2 Duration of Evaluation Study

Duration of the Study: September 2013 – August 2014

Duration of the Field Study: November 24 – 29, 2013, February 16 – 22, 2014

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance to the Development Plan of Turkey

The Five-Year Development Plan effective at the appraisal stage was the 8th Five-Year Development Plan (2001-2005). The development targets and priority agendas set in the Plan were: 1) achievement of sustainable high economic growth rates; 2) development of high-technology economy competitive with the global markets; 3) development of human capacity and increase of employment opportunities; 4) improvement of infrastructure and environmental protection; and 5) improvement of disparity between regions, promotion of rural development, reduction of poverty, and improvement of social disparity (source: Country Assessment Report by the Japanese Ministry of Foreign Affairs). The major development targets in the road/highway sector were: ensuring safe and economical transport of passengers and cargo, establishment of policies for reducing negative impacts to the environment, and enhancement of highway standards. In the Disaster Prevention Action Plan (2000), which was prepared by Istanbul Disaster Prevention Management Center, securing transport mode in the

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ② Fair, ① Low

event of disaster/emergency was defined as one of top priority agendas.

In the current 9th Five-Year Development Plan (2007-2013) effective at the ex-post evaluation stage, the following agendas are defined as the development objectives and priorities: 1) increasing competitiveness; 2) increasing employment; 3) strengthening human development and social solidarity; 4) ensuring regional development; and 5) increasing quality and effectiveness in public services. In the Plan, “securing disaster prevention management in rural development and urban planning” is selected as an agenda, and preparation of hazard maps and quake resistant reinforcement works for buildings and infrastructure have been implemented according to the “National Earthquake Strategy and Action Plan (2012-2023)”, which was prepared by the Emergency Situation Management Agency under the Prime Minister's Office in April 2012.

As mentioned above, at appraisal (2002) and at ex-post evaluation, the implementation of the project conforms to the development policies of the Turkish Government.

3.1.2 Relevance to the Development Needs of Turkey

At the appraisal stage, three large scale bridges (First Bosphorus Bridge, Second Bosphorus Bridge and new and old Golden Horn Bridge) and their connecting viaducts under the project are life-line infrastructure for social/economic activities and citizen's life in Turkey, and are also part of major international trunk highways connecting between Europe and Asia. In Turkey, large scale earthquakes such as two earthquakes occurred in the northwestern Turkey in 1999 have actually taken place in the past. Accordingly, the possibility that large scale earthquakes would occur around Istanbul area in the near future, has been pointed out. Once the assumed large earthquake, which is equivalent to large scale earthquakes occurred in the northwestern Turkey has occurred, the earthquake motion, which exceeds the earthquake-resistance design standards set for subject bridges at the planning stage, would occur, and structures would be most likely destroyed. Thus, the necessity of earlier implementation of quake resistance reinforcement to the large scale bridges and viaducts has been noted.

Three large scale bridges and their connecting viaducts under the project are still lifelines for social/economic activities and citizen's life in Turkey and definitely part of international trunk highway system even at the ex-post evaluation stage. After large scale earthquakes in 1999 as mentioned above, another large scale earthquake with the magnitude of 7.2 occurred in Bingol Prefecture in the southeastern Turkey in May 2003, and also another large scale earthquake with the magnitude of 7.1 in Van Prefecture in the eastern Turkey in October 2011, which both resulted in a large number of victims. The vulnerability to the disaster has become high by expansion of urban area and sophistication of economic structures due to the recent remarkable economic growth. Under these circumstances, the financial assistance by the Turkish Government and other donors has aimed at disaster prevention focusing on main infrastructure

in Istanbul. At the same time, donors including JICA have been providing technical cooperation and assistance to the soft components such as training for disaster prevention and effective disaster risk management.

Implementation of the quake resistance reinforcement works for three major large scale bridges under the project, which was intended for securing a lifeline (transportation) in the event of disaster/emergency situations, conforms to the development needs of the Turkish Government, which has been addressing disaster prevention.

3.1.3 Relevance to Japan's ODA Policy

According to the Medium-Term Strategy for Overseas Economic Cooperation Operations, which was effective at the appraisal time, stabilization of the whole Middle East region including countries neighboring oil-producing countries was an extremely important agenda for Japan. Together with development of economic infrastructure, aid to vulnerable groups and rural development were priority sectors and priorities were to be given to assistance to environmental protection and social infrastructure. Thus, the subject project conformed to the assistance policies of the Japanese Government, and to countermeasures for a large scale disaster, which was one of sectors targeted under the Special Yen loans.

Accordingly, the project has been highly relevant with the Turkish development plan and needs, as well as Japan's ODA policies. Its relevance is therefore considered high.

3.2 Effectiveness[3] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

The following indicators are listed up as operational and effect indicators at the time of appraisal: 1) through traffic volume; 2) number of persons killed or injured due to collapse of bridges; 3) number of damaged cars due to collapse of bridges; and 4) number of ferry services to be operated due to collapse of bridges. However, since no large earthquake which resulted in collapse of bridges has occurred after the project completion, application of all of these indicators is considered difficult. Thus, indicators except through traffic volume were not selected. Instead, appropriateness of the information (date of occurrence, seismic intensity and others) of the large earthquakes which occurred in the past, and design standards used for earthquake-resistance design were clarified and verified to examine the effectiveness under the ex-post evaluation.

[3] Sub-rating for Effectiveness is to be put with consideration of Impact.

(1) Through traffic volume

The actual through traffic volume on three large bridges under the project is shown in Table 1.

Table 1 Through Traffic Volume (Actual) on three Large Bridges

Unit: vehicles/day

	2000	2010	2011	2012	2013
First Bosphorus Bridge	186,600	191,000	190,000	196,000	230,000
Second Bosphorus Bridge	174,200	210,000	230,000	213,000	239,000
Golden Horn Bridge	233,300	200,000	-	-	-

Source: Project Completion Report, responses to the Questionnaire

Note 1: Since the Golden Horn Bridge section is not a toll road, traffic volume counting has not been undertaken for the past three years.

The through traffic volume of the First Bosphorus Bridge (3 lanes for one direction) and Second Bosphorus Bridge (4 lanes for one direction) has already exceeded their highway capacity as of 2000. The traffic volume has been increasing since then, and hours of traffic jam in a day have become longer, resulting in the continuous congestion during the day time. Regarding Golden Horn Bridge, since the Bus Rapid Transit system was introduced in the median strip of the bridge in 2008, the number of lanes for normal vehicles was decreased and the highway capacity as of 2010 is lower than that in 2000.

(2) Information of the large earthquakes which occurred in the past (date of occurrence, seismic intensity and others) and the earthquake description assumed in the project design

Since the large earthquake occurred twice in 1999 in the northwestern Turkey (both are more than 90km away from Istanbul), an earthquake with Magnitude 7.2 occurred in the southeastern Turkey in May 2003, and an earthquake with a Magnitude 7.1 in the eastern Turkey in October 2011. However, after completion of the project, no large earthquake has occurred in the vicinity of Istanbul.

The earthquake description assumed at the appraisal stage was also applied at the detailed design stage for the project.

- Magnitude : 7.4
- Epicenter : Marmara Faults (part of North Anatolia Faults, located 20km south from the central Istanbul)
- Occurrence probability : 62±15% (within 30 years counting from 2000)
- Distance the epicenter : 20-30km
- Basic ground acceleration : approximately 0.4G

(3) Design standards used for earthquake-resistance design (Ground Peak Acceleration and Structure Peak Acceleration)

Similarly on the earthquake description mentioned above, design standards used for earthquake-resistance design applied at the appraisal stage was also used at the detailed design stage for the project without any changes.

Table 2 Design Standards used for Earthquake-Resistance Design applied

Name of Bridge	Ground Condition	Distance from Fault (km)	Peak Acceleration (G)		
			Ground acceleration at the project commencement	Ground acceleration	Structure acceleration
First Bosphorus	Hard soil	20	0.1	0.316	0.791
Second Bosphorus	Ultra hard soil	26	0.15	0.270	0.690
Golden Horn Bridge	Hard soil	17	0.3	0.353	0.882

Note: The ground acceleration at the project commencement for Golden Horn Bridge is the design standards applied for the new Golden Horn Bridge

Design standards for earthquake-resistance design applied are mostly consistent with the Japanese ones used until the Northeastern Pacific Ocean Earthquake occurred in 2011, and thus there is no problem with appropriateness of technical judgment at the appraisal stage. However, in Japan, design standards were revised in March 2012 after the Northeastern Pacific Ocean Earthquake including the following: standard acceleration of ground motion for the large scale earthquakes (envisaged under the project), which seldom occur at the boundary of plates was increased by 1.2 to 2.0 times (depending on the foundation condition).

3.2.2 Qualitative Effects

(1) Protection of urban functions and assets from earthquake disaster in Istanbul

According to the executing agency (KGM), the quake resistance reinforcement work has been completed mostly as planned and the resistant level was increased. Moreover, collapse of three bridges reinforced under the project would be averted and the lifeline (transportation) would be secured in the event of large scale earthquakes.

(2) Enhancement of the quake resistance reinforcement technology and knowledge in Turkey

The executing agency recognizes that their quake resistance reinforcement technology and knowledge was enhanced through the project management during the implementation period and training provided by contractors. The local consultants, who were involved in review of detailed designs and construction supervision together with the Japanese consultants also recognize that their technological capacity and knowledge

was enhanced through the daily consulting service activities.

3.3 Impact

3.3.1 Intended Impacts

The executing agency believes that regarding three bridges, the lifeline (transportation) and social activities would be secured in the event of large earthquake and that the national anxiety was also lowered. It was heard that the KGM staff were satisfied with quake resistant reinforcement made with the aid from Japan, which is also prone to earthquakes and has more advanced technology.

3.3.2 Other Impacts

(1) Impacts on the natural environment

According to the Project Completion Report, monitoring on traffic noise and air/water pollution was undertaken during the project implementation. Since the project is a reinforcement work for the existing infrastructure, no particular environmental issue was observed. However, according to the executing agency, even though change of expansion joints at the abutment of the Second Bosphorus Bridge was not included in the original reinforcement work, expansion joints at both abutments were totally changed and noise protection facilities were installed since complaints on noise had been drawn. Some degree of protection effects was observed. Although it is technically difficult to completely protect the low frequency noise, KGM First Division is planning to undertake further protection measures (addition and improvement of noise protection facilities), since complaints on noise still has been drawn.

(2) Land Acquisition and Resettlement

No land acquisition and resettlement occurred under the project.

(3) Other Positive and Negative Impacts

None.

It is difficult to examine and assess the effectiveness and impact of the quake resistance reinforcement project for the existing infrastructure in quantitative terms since no large earthquake with the assumed scale/magnitude has occurred after the project completion. However, the executing agency (KGM) believes that collapse of three bridges would be averted and the lifeline (transportation) would be secured in the event of large earthquakes, since the resistance level of three bridges under the project was enhanced.

The project has largely achieved its objectives and thus the effectiveness and impact is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The original and actual output of the project is shown in Table 3.

The project scope to be implemented under the project is stated in the project appraisal related documents. However, the scope was defined based on the results of the feasibility study. Then, during the project implementation stage, the contractor awarded undertook the detailed designs taking into consideration the field conditions, and redefined the work and project scope to be prioritized. Therefore, the actual project scope (output) is partially changed from the originally planned scope. However, the work items and bill of quantity that are implementable within the originally planned budget were selected, among the work and scope on which the priority for resistance reinforcement work is high. Thus, changes made are considered appropriate.

Table 3 Output (original and actual)

Item	Project Scope at Appraisal Stage (main items)	Project Scope at Project Completion
Civil Work: Resistance reinforcement work for large bridges and viaducts	(1) Steel Bridges ・ First Bosphorus Bridge 1) Additional cable clamp 2) Shock absorber at tower 3) Reinforcement of wind bearing ・ First Bosphorus Bridge Approach Viaducts 1) Drop prevention device at abutment 2) Drop prevention device at tower 3) Reinforcement of pier structures ・ Second Bosphorus Bridge 1) Installation of center cable stay 2) Shock absorber at tower 3) Reinforcement of wind bearing ・ New and Old Golden Horn Bridge 1) Reinforcement of pier structures 2) Drop prevention device at abutment	(1) Steel Bridges ・ First Bosphorus Bridge 1) deleted 2) as planned 3) deleted Additional work: protective painting, reinforcement of lighting pole and bottom plate ・ First Bosphorus Bridge Approach Viaducts 1) as planned 2) as planned 3) as planned Additional work: elastomer support installation at anchorage, change of expansion joins at abutment, change of supports for tower, installation of main cable protection steel sheet, reinforcement of lighting pole and bottom plate ・ Second Bosphorus Bridge 1) deleted 2) as planned 3) deleted Additional work: change of expansion joins at abutment, protective painting of whole deck ・ New and Old Golden Horn Bridge 1) as planned 2) as planned

Item	Project Scope at Appraisal Stage (main items)	Project Scope at Project Completion
	3) Reinforcement of girders on each pier of old bridge	3) as planned Additional work: elastomer support installation at anchorage, change of expansion joins, expansion of pier footing, movement restricting device at the end (dumper), protective painting, change of parapet (new bridge), exchange of approach deck (new bridge)
	(2) Pre-stressed Concrete Bridge	(2) Pre-stressed Concrete Bridge
	・ Old Golden Horn Bridge Approach Viaduct 1) Reinforcement of pier structures	・ Old Golden Horn Bridge Approach Viaduct 1) as planned
	・ New Golden Horn Bridge Approach Viaduct 1) Reinforcement of pier structures	・ New Golden Horn Bridge Approach Viaduct 1) as planned Additional work: installation of drop prevention device, elastomer support installation at piers, movement restricting device at abutment (dumper), movement restricting device at mid piers (dumper), expansion of pier support, protective painting, expansion of parapet
	・ Ortakoy Viaducts (V408, V409) 1) Construction of structures 2) Expansion of pier footing 3) Reinforcement of pier top and drop prevention device	・ Ortakoy Viaducts (V408, V409) 1) as planned 2) as planned 3) as planned Additional work: movement restricting device (dumper), addition of new piers, exchange of expansion joints ・ Ortakoy Viaduct (V411) - additional work 1) Construction of structures 2) Expansion of pier footing 3) Reinforcement of pier top and drop prevention device ・ Mecidiyekoy Viaduct - additional work 1) reinforcement of piers 2) movement restricting device at piers (dumper) 3) reinforcement of pier top
Consulting services	・ Basic designs ・ Assistance for tendering ・ Review of detailed designs ・ Construction supervision ・ Implementation of training ・ Preparation of Public Relation Action Plan	Service scope is as planned.

Item	Project Scope at Appraisal Stage (main items)		Project Scope at Project Completion	
	Foreign Experts:	311 M/M	Foreign Experts:	429 M/M
	Local Experts:	294 M/M	Local Experts:	
	Technical Support Staff:	392 M/M	Technical Support Staff:	
	Administrative Staff:	236 M/M	Administrative Staff:	
	(Local Total	922 M/M)	(Local Total	1,029 M/M)

Source: Project Appraisal Documents, Project Completion Report, responses to the Questionnaire

Main revisions made on the scope of work during the detailed engineering stage are as follows:

1) Regarding Ortakoy Viaduct, the quake resistance reinforcement work (V411)[4] was added.
2) The quake resistance reinforcement work for Mecidiyekoy Viaduct was added.

Priority for the above mentioned 2 works was considered low compared with other viaducts at the feasibility stage. However, since both viaducts are located along the European Highway Network No. 5 (E-5) connecting between First Bosphorus Bridge and Golden Horn Bridge, and are lifelines for socioeconomic activities and citizen's life in Turkey, collapse of viaducts needed to be avoided in the event of earthquakes. Thus, during the project implementation, it was considered that the quake resistance reinforcement work needed to be done, and the reinforcement work was undertaken as an additional work.

New Golden Horn Bridge Reinforcement of piers (bound with steel plate)

First Bosphorus Bridge Reinforcement of support at abutment

[4] Same as items included in the contracts for V408 and V409 under Ortakoy Viaduct, the following items were included: construction of structures, expansion of pier footing, and reinforcement of pier top and drop.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The estimated project cost at appraisal was 14,199 million yen, of which the Japanese ODA loan was 12,022 million yen. The actual project cost was 14,082 million yen, of which the Japanese ODA loan was 11,936 million yen. The actual project cost was lower than planned, and is equivalent to 99% of the planned cost. The actual project cost was lower than the originally planned cost since KGM aimed to implement the project within the originally planned project cost. Even though additional work occurred, some originally planned items were deleted.

As mentioned above, the project was implemented utilizing the Special Yen Loan (SYL), and the customer satisfaction survey was conducted regarding SYL. The project executing agency (KGM) responded that while the bid price was higher than the government estimate, they were fully satisfied with contractor's construction quality. Regarding the technical transfer, they admit that the technical transfer to local contractors was highly satisfactory. Moreover, even now they can easily contact and expect full support from contractors on the maintenance work.

3.4.2.2 Project Period

The originally planned project period was from July 2002 (signing of the Loan Agreement) to October 2007 (civil work completion) with a total period of 64 months. The actual project period was from July 2002 (signing of the Loan Agreement) to August 2010 (civil work completion) with a total period of 98 months, or equivalent to 153% of the plan.

Table 4 Comparison of Project Period (Planned and Actual)

	Planned (at L/A signing)	Actual
Consultant selection	2002.05-2002.11	2002.05-2003.01
Basic designs	2002.12-2003.11	2003.01-2004.01
Consulting services (review of detail designs and supervision)	2004.10-2007.10	2004.01-2010.08
Bidding for civil work	2003.03-2004.11	2003.01-2006.03
Reinforcement work	2004.10-2007.10	2006.03-2010.08
Defect liability period	2007.11-2008.10	2010.08-2011.08

Source: Project appraisal documents, Project Completion Report, responses to the Questionnaire

Main reasons for delay of the project implementation and extension of the contract period are as follows:

1) Since the executing agency was not familiar with the JICA's procurement guidelines and process, it took longer time to undertake bidding for civil work, resulting in about one and half years delay.
2) Mecidiyekoy Viaduct, which was not included in the original project scope, was added as a part of the project. Construction work commenced in August 2008 and was

completed in August 2010. Due to this additional work, the project period was extended by about one and half years.

3.4.3 Results of Calculations of Internal Rates of Return (Reference only)

Since relevant data on costs and benefits needed to calculate financial internal rate of return (FIRR) and economic internal rate of return (EIRR) at completion of the project was not provided by the executing agency, both rates were not recalculated.

The actual project scope (output) was partially changed from the originally planned scope. However, changes were made by selecting the work and scope on which the priority for resistance reinforcement work is high, and which is also implementable within the originally planned budget, based on the results of detailed designs. Changes made are considered appropriate.

Although the project cost was lower than planned, the project period was significantly longer than planned. Therefore, efficiency of the project is considered fair.

Dampers[5] installed at Golden Horn Bridge

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

Units and Offices, which are responsible for operation and maintenance of the highway section of First Bosphorus Bridge and Second Bosphorus Bridge at the time of ex-post evaluation are: Department of Operations and Maintenance for Motorways, Bridges, and Viaducts (about 780 staff members), Chief Engineer's Office for First Bosphorus Bridge (about 50 staff members) and Chief Engineer's Office for Second Bosphorus Bridge (about 45 staff members) under the KGM First Division (about 1,600 staff members) in Istanbul. The First Division is in charge of operation and maintenance of 737km motorways, 2,101 km national roads, and 1,407km provincial roads, totaling 4,245km highway and road network in Istanbul.

[5] Devise which alleviates shock and prevents from transmitting vibration in the event of earthquakes.

Although in 2012 a plan to privatize operation of the bridge and highway section covered under the project was proposed, privatization has not been done until the time of ex-post evaluation.

The road maintenance for the Golden Horn Bridge section was transferred to Istanbul Municipal Office in 2004. However, since the specific technology and skills are required for the maintenance of equipment/device/infrastructure, which was installed or constructed for substructures under the project, it has been agreed between both parties that three offices under KGM First Division mentioned above would continue to be in charge.

Second Bosphorus Bridge

Damper installed at Mecidiyekoy Viaduct

3.5.2 Technical Aspects of Operation and Maintenance

Among 1,600 staff members of KGM First Division, 360 staffs have qualification of above university graduate, and 190 staffs have engineering degrees among 360 staffs. About 100 staffs have qualification of college graduate level, and the remaining staffs are field workers, technicians, and administrative staffs. The engineering and technical skills of technical staffs (managers, engineers, and technicians) of the First Division is considered appropriate and the number of staffs assigned are likely sufficient. Regarding the training of staff, new university graduates take training regularly, twice a year after employed. The internal training has been also undertaken for the staff assigned by each unit. The notable training module is the one on analysis of monitored results and its operations, offered to the staff in charge of the Structural Health Monitoring System, which was installed to First Bosphorus Bridge by First Division with its own fund. This module covers operations of bridges in the event of disaster/emergency situations (judgment on necessity of closure of bridge sections in the event of earthquakes) and risk management, and is a unique module, which is not observed in bridge construction projects in other countries.

The standard manuals are prepared for toll collection, traffic control and management, maintenance work, support services and others, including Motorways Maintenance and Operations Technical Principals-2012, Motorways Maintenance Handbook-1998, and Highway Technical Specifications-2013. These manuals are utilized by the relevant staff.

3.5.3 Financial Aspects of Operation and Maintenance

The KGM budget is allocated from the nation's general budget and the budget for 2011 was 5.51 billion Turkish Lira, which is about 1.8% of the national budget. About 1.85 billion Turkish Lira was allocated to the First Division, and about 70% of expenditure was spent for new construction and rehabilitation work. The allocated amount to Department of Operations and Maintenance for Motorways, Bridges, and Viaducts of the First Division is 32 million Turkish Lira, but costs for operation and maintenance is also included in other budget items. No additional budget for routine maintenance of equipment/device/infrastructure installed or constructed under the project is needed. Maintenance costs needed for the periodic maintenance work can be also covered under the budget currently allocated to the First Division.

Regarding the First Bosphorus Bridge, completed in 1973 and the Second Bosphorus Bridge, completed in 1988, as part of normal maintenance work, implementation of major rehabilitation work is planned. The work is to be commenced in early 2014 and to be completed by summer of 2015. The total project cost is about 247 million Turkish Lira (about 25 billion Japanese yen) and the contact has been made with the Japanese and Turkish joint venture entity. The highlight of rehabilitation work is to change the current skew hanger cables of First Bosphorus Bridge to vertical hanger cables.

3.5.4 Current Status of Operation and Maintenance

According to the executing agency, regarding the regularly undertaken maintenance on equipment, device and infrastructure installed or constructed under the project, as part of the routine maintenance, existence or non-existence of abnormality has been checked by ocular inspection. The regular inspection on structures is to be undertaken every 5 years after completion of the project.

In order to collect the data, which would be basis for determination on traffic operation and management on bridge sections in the event of earthquake, KGM has installed the monitoring system to both First and Second Bosphorus bridges with its own fund. With respect to First Bosphorus Bridge, the Structural Health Monitoring System, which monitors the bridge condition has been installed. Censors and devices including accelerometers, tilt meters, force transducers, strain gauges, laser displacement, and GPS have been installed at 168 locations. The information and data collected by these censors and devices is transmitted to the field management offices of both bridges and is used for analysis and judgment (for closure of bridges in the event of earthquake) at the management offices.

The current maintenance management system is well organized and the number of staff assigned is considered appropriate. There are no particular issues on implementation of training and manuals prepared and thus, there are no technical issues in order to sustain the effectiveness

of the project. The maintenance budget has been properly allocated and thus, there is no issue in financial aspects. Regarding the equipment and infrastructure installed or constructed under the project, no major damage nor defect were observed by ocular inspections during the field visit.

In light of the above, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is considered high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of the project was to enhance quake resistance by conducting the reinforcement works to the existing major large scale bridges and their connecting major viaducts in Istanbul, thereby, contributing to securing the lifeline (transportation) and keeping up the socioeconomic activities in the event of disaster/emergency situations. The project has been highly relevant to the development plans and needs of Turkey, as well as Japan's ODA policies. Thus, its relevance is high. The standards for earthquake-resistance design applied are mostly consistent with the Japanese ones used until the Northeastern Pacific Ocean Earthquake occurred in 2011, and thus there is no problem with appropriateness of technical judgment at the appraisal stage. According to the executing agency, collapse of three bridges would be averted and the lifeline (transportation) would be secured in the event of large earthquakes because of enhancement of quake resistance to three bridges under the project. Thus, the project has largely achieved its objectives, and thus the effectiveness and impact is high. Although the actual project scope (output) was partially changed from the originally planned scope, changes made are considered appropriate. Although the project cost was lower than planned, the project period was significantly longer than planned. Therefore, efficiency of the project is considered fair. No major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system, therefore sustainability of the project effect is considered high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

None.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Output 1) Civil Work	(1) Steel Bridges ・ First Bosphorus Bridge 1) Additional cable clamp 2) Shock absorber at tower 3) Reinforcement of wind bearing	(1) Steel Bridges ・ First Bosphorus Bridge 1) deleted 2) as planned 3) deleted Additional work: protective painting, reinforcement of lighting pole and bottom plate
	・ First Bosphorus Bridge Approach Viaducts 1) Drop prevention device at abutment 2) Drop prevention device at tower 3) Reinforcement of pier structures	・ First Bosphorus Bridge Approach Viaducts 1) as planned 2) as planned 3) as planned Additional work: elastomer support installation at anchorage, change of expansion joins at abutment, change of supports for tower, installation of main cable protection steel sheet, reinforcement of lighting pole and bottom plate
	・ Second Bosphorus Bridge 1) Installation of center cable stay 2) Shock absorber at tower 3) Reinforcement of wind bearing	・ Second Bosphorus Bridge 1) deleted 2) as planned 3) deleted Additional work: change of expansion joins at abutment, protective painting of whole deck
	・ New and Old Golden Horn Bridge 1) Reinforcement of pier structures 2) Drop prevention device at abutment 3) Reinforcement of girders on each pier of old bridge	・ New and Old Golden Horn Bridge 1) as planned 2) as planned 3) as planned Additional work: elastomer support installation at anchorage, change of expansion joins, expansion of pier footing, movement restricting device at the end (dumper), protective painting, change of parapet (new bridge), exchange of approach deck (new bridge)
	(2) Pre-stressed Concrete Bridge ・ Old Golden Horn Bridge Approach Viaduct 1) Reinforcement of pier structures ・ New Golden Horn Bridge Approach Viaduct 1) Reinforcement of pier structures	(2) Pre-stressed Concrete Bridge ・ Old Golden Horn Bridge Approach Viaduct 1) as planned ・ New Golden Horn Bridge Approach Viaduct 1) as planned

Item	Original	Actual
		Additional work: installation of drop prevention device, elastomer support installation at piers, movement restricting device at abutment (dumper), movement restricting device at mid piers (dumper), expansion of pier support, protective painting, expansion of parapet
	・ Ortakoy Viaducts (V408, V409) 1) Construction of structures 2) Expansion of pier footing 3) Reinforcement of pier top and drop prevention device	・ Ortakoy Viaducts (V408, V409) 1) as planned 2) as planned 3) as planned Additional work: movement restricting device (dumper), addition of new piers, exchange of expansion joints ・ Ortakoy Viaduct (V411) - additional work 1) Construction of structures 2) Expansion of pier footing 3) Reinforcement of pier top and drop prevention device ・ Mecidiyekoy Viaduct - additional work 1) reinforcement of piers 2) movement restricting device at piers (dumper) 3) reinforcement of pier top
2) Consulting Services	・ Basic designs ・ Assistance for tendering ・ Review of detailed designs ・ Construction supervision ・ Implementation of training ・ Preparation of Public Relation Action Plan Foreign Experts: 311 M/M Local Experts: 294 M/M Technical Support Staff: 392 M/M Administrative Staff: 236 M/M (Local Total 922 M/M)	Service scope is as planned. Foreign Experts: 429 M/M Local Experts: Technical Support Staff: Administrative Staff: (Local Total 1,029 M/M)
2. Project Period	July 2002 - October 2007 (64 months)	July 2002 - August 2010 (98 months)
3. Project Cost Amount paid in Foreign currency Amount paid in Local currency Total Japanese ODA loan portion Exchange rate	 7,623 million yen 6,576 million yen 14,199 million yen 12,022 million yen 1 yen = 10,802 TK Lira (as of December 2001)	 N/A N/A 14,083 million yen 11,936 million yen 1 yen = 0.02082 new TK Lira (as of January 2014)