

The Kingdom of Morocco

Autoroutes du Maroc

**Collaboration Program with the Private Sector
for Disseminating Japanese Technology for
Structural Inspection Using Rope Gears,
"Ninja-Tech"**

Final Report

November 2017

**Japan International Cooperation Agency
Hanshin Expressway Company Limited
Tokusyu Kousyo Gijutsu Incorporated**

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Abbreviation

Abbreviation	Official expression
ADM	Autoroutes du Maroc
EIRR	Equity Internal Rate of Return
HEX	Hanshin Expressway Company Limited
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
MAD	Moroccan Dirham
NETIS	New Technology Information System
ODA	Official Development Assistance
TKG	Tokusyū Kōsūyō Gijutsu Incorporated

1. Abstracts

1.1. Abstracts

(1) Project backgrounds

The transportation sector of Kingdom of Morocco (hereafter called Morocco) has been improved along with the economic growth of the country. Especially in the road sector, 1,771km-long of national toll highway network has already in service, which is 98% of the length in planning. This indicates that highway in Morocco has started to move into the phase of planning, and more effective and practical maintenance and operation methodologies are needed to be established.

(2) Target technology to be disseminated under the project

Tokusyu Kousyo Gijutu (literally means “Special High Place Technology” and named “Ninja-tech” for overseas application) is a method of accessing to and conducting works on any high place using special rope gears. Ninja-tech is owned by Tokusyu Kousyo Gijutsu Incorporated (hereafter called TKG). Workers protect themselves from falling down by special gear maneuvering and safety procedures. The validity of Ninja-tech is approved by the national government by registration in the New Engineering and Technology Information System (NETIS) of the Ministry of Land, Infrastructure and Transportation (Registration number: SK-080009-VE). By using Ninja-tech, detailed survey and inspection from close range can be conducted for the structures which have been inaccessible, the cost



and time of those works can be drastically saved because any scaffoldings or crane machine is necessary. Furthermore, the reliability of Ninja-tech is substantially high because workers always keep their body fixed by rope gears during the procedures, all the gears are procured from certifies manufactures and maintained with strict self-control discarding rules, and multiple safety system is established such as setting double rope support points at any time.

(3) Purpose and goal of the project

The final goal of the project is to promote a sustainable and autonomous maintenance framework for the infrastructure in Morocco by introducing and helping disseminate the Ninja-tech technology. This may eventually contribute the sustainable social improvement and economic growth of the country. Also through skill transfer to local engineers as core human resource, it aims to increase the awareness and improve the attitude toward social infrastructure with a long-term vision. Furthermore, it is expected that the establishment and dissemination in Morocco may be expanded further into Sub-Sahara nations in Africa as a core technology for the solution of similar challenging issues on infrastructural maintenance. Business-wise, a new joint maintenance company will be established to conduct actual maintenance works with Ninja-tech in Morocco. The company is funded both by Japan and Morocco counterpart, and the Japan side makes continuous technical inputs and help training more Ninja-tech engineers in Morocco.

(4) Activities in the project

The project makes a skill transfer of Ninja-tech to and improves the system of maintenance management of the counterpart organization, Morocco National Highway Company (Autoroutes du Maroc, hereafter called ADM) through lecture and basic training of Ninja-tech in Japan and on-the-job inspection trainings on bridges in Morocco.

(5) Outcomes of the project

- In order to conduct maintenance works with Ninja-tech only by Moroccan qualified engineers (team with at least 2 persons), it is necessary to get Class-1 Certification after acquiring Calss-2 Certification with 96-hour (2-week)

lecture and basic training and finishing at least 1,000-hour on-the-job training with guidance. This project covers the acquisition of Class-2 Certification and the implementation of the half of required on-the-job training (about 500 hours or 3 months) for 3 trainees from ADM.

- There is a mutual agreement between ADM and Project JV that the remaining on-the-job training (about 500 hours) is implemented in Japan between October and December, 2017 and March and April, 2018 at the expense of ADM.

(6) Current prospect of business development and remaining challenging issues

- The whole concept of Ninja-tech business model in Morocco has received the positive review by the General Manager of ADM, however he emphasized that the first step is to concentrate on the acquiring Class-1 Certification by ADM engineers. There is mutual agreement that the concrete preparation of establishing joint maintenance company and dissemination to other sectors will be carried out step-by-step after confirming the core Ninja-tech engineers are secured.
- Since the establishment of joint company defers, the immediate condition of technical transfer so that ADM can utilize the Ninja-tech for its own maintenance is the license contract between ADM and TKG. It is agreed that the contract shall be made before the acquisition of Class-1 Certification by 3 ADM engineers. A draft of license contract document has been sent to ADM, and it is now under reviewing by ADM.
- For the future business collaboration on infrastructure maintenance, not only Ninja-tech dissemination but also capacity upgrading on maintenance for ADM will become an important key factor. Since ADM directly requested a technical support on that matter, on August 2017, Hanshin Expressway Company Limited (hereafter called HEX) has made a technical advisory contract with ADM regarding operation and maintenance of highway.
- Since the decision on joint company establishment needs the consultation and approval in ADM council, it is required to make a thorough market research and feasibility study and prepare the enough and plausible data for presentation. Those researches and studies will be basically conducted by ADM and the following concrete studies on business finance and development scheme will continue to be jointly conducted for more detail consensus.
- At the time of meeting with General Manager of ADM on July 2017 (5th activity in Morocco), he explained the deference of maintenance business discussion is due to the ADM's debt issue which should be prioritized to be solved before future strategy is planned. He declared that the issue has been settled after negotiations with governmental authority and that ADM is ready to make a positive position to challenge new future projects including this maintenance business.
- As the skill transfer of Ninja-tech has a goal in sight and the administrative barrier on ADM side has been cleared, although further business implementation planning and examination are necessary, the feasibility is getting higher.

(7) Next planning toward business establishment

Skill transfer of Ninja-tech is made to ADM as a core business asset. It is followed by the establishment of Ninja-tech maintenance company and the establishment of Ninja-tech training institute in Morocco to train more Ninja-tech engineers. HEX and TKG will make financial and technical inputs into the company and the institute as well as participate in the management. ADM will be responsible for the dissemination of Ninja-tech application and business expansion into the market of other sectors in Morocco and neighbor countries.

(8) Possibility of collaboration with ODA projects

It is essential to make an enhancement and upgrading of ADM's highway maintenance capacity. Relevant ODA project (technical assistant project) for ADM as the main counterpart is expected to have a synergy effect together with this business plan.

2. Project Backgrounds

2.1. Project backgrounds

Transportation sector of Kingdom of Morocco (hereafter called Morocco) has been improved along with the economic growth of the country. Especially in the road sector, 1,771km-long of national toll highway network has already in service including 181km-long new addition in 2016, which is 98% of the length in planning.

ADM is a state-owned company which has constructed, operated and maintained the abovementioned highway network for more than 25years. Its new construction is nearly completed, and ADM starts to be ready for the coming transition into maintenance phase. For the preparation, ADM needs to study and introduce efficient and effective asset management solutions. Regarding structural maintenance, ADM has already conduct routine inspection works with general observation from remote range, but not a periodical and detailed visual checking from close range as exercised mandatorily in Japan. Such detailed periodical inspection of structures is necessary for tracking the propagation of its aging and deterioration, and the data collected here will be used for timely implementation of preventive intervention. Ninja-tech can be used for such inspection by accessing to any area of subject structures with simple gears and human power.

HEX has expanded its affiliated business related to its main highway management project since its privatization in 2005, and the business domain includes international arena. Here the demand is getting higher among counterparts worldwide who expect HEX assist and collaborate with variety of technologies and know-hows on highway management (construction, operation and maintenance) which has been accumulated through more than 50-year experience. ADM is the newest business partner, and though technical exchanges and the conclusion of Minutes of Understanding in 2015, HEX understands big concern especially on highway maintenance, that prompts the promotion of this Ninja-tech dissemination.

Meanwhile TKG promotes the dissemination and standardization of Ninja-tech both in domestic and overseas markets, and this project in Morocco is the pioneer in the international field.

2.2. Target technology to be disseminated and the contribution of development agenda in the target country

2.2.1. Details of target technology to be disseminated under the project

1) Technical outlines

Ninja-tech is a method of accessing to and conducting works on any high place using special rope gears. Ninja-tech is owned by TKG Co. Ltd. Workers protect themselves from falling down by special gear maneuvering and safety procedures. The validity of Ninja-tech is approved by the national government by registration in the New Engineering and Technology Information System (NETIS) of the Ministry of Land, Infrastructure and Transportation (Registration number: SK-080009-VE).

There is skill certification system for Ninja-tech given by TKG Association. There are 4 classes of certification according to the level of experience. Class-2 Certification is a beginner's class and it needs 96-hour (2-week) lecture and physical training to be acquired. Class-2 engineer can engage in the actual Ninja-tech works together with and under the supervision of at least one Class-1 engineer or above who has finished required work experience hours,



2) Features

- Applicable to any bridge or structural survey and inspection work and capable to reach any area and to identify the degree of degradation visually from close range
- Also applicable to members or areas of structures where installing scaffolding is difficult such as super-high pylons and cables of long suspension and cable-stayed bridges. Also it can be used for sections of bridges on a high place or above the water, where it is inaccessible even with crane machine or inspection vehicle.

3) Benefits

- Inspection can be made for every area which has been neglected due to their inaccessibility. Therefore, maintenance of entire network becomes feasible.
- the reliability of Ninja-tech is substantially high because workers always keep their body fixed by rope gears during the procedures, all the gears are procured from certified manufactures and maintained with strict self-control discarding rules, and multiple safety system is established such as setting double rope support points at any time.

4) Economic efficiency

- The cost and time of those works can be drastically saved because any scaffoldings or crane machine is necessary.

5) Safety

- Under the verification test of NETIS registration process, it is evaluated that the safety level is better than conventional methods.
- Labor Standards and Supervision Office of Japan recognized that Ninja-tech corresponds to “treatments to prevent possible danger of workers at site”.
- There is no fatal accident in the actual works
- All rope gears are certified by European standards (CE,EN) and their quality level is kept with strict self-control discarding rules.
- Workers always keep at least double rope support points at any time to prevent the fall even when one support is missing.
- Thorough checking and repair of all rope gears
- All tools have anti-falling treatment by connecting them with body, and simultaneous action on the same vertical line is strictly prohibited.

- Mandatory acquisition of one-on-one rope rescue skill for all Ninja-tech engineers

6) Environmental consideration

While conventional methods (scaffolding and using vehicles) are associated with gas emission and noise problem, Ninja-tech uses no machine and therefore is very eco-friendly.

7) Domestic and international application records

Survey or inspection works using Ninja-tech (Number of contract, as of September, 2017)

Clients	Bridge	Power Generator	Others
Hanshin Expressway	28	0	9
Other Highway Companies	195	0	31
Ministry of Land, Infrastructure and Transport	326	31	54
Local Governments	587	109	119
Other Public Agency (e.g. research institutes, meteorological agency, royal agency)	13	12	21
Private Sectors (e.g. Japan Railway, wind power company, plants)	44	290	64
Power Companies	7	208	17
Total	1200	650	315

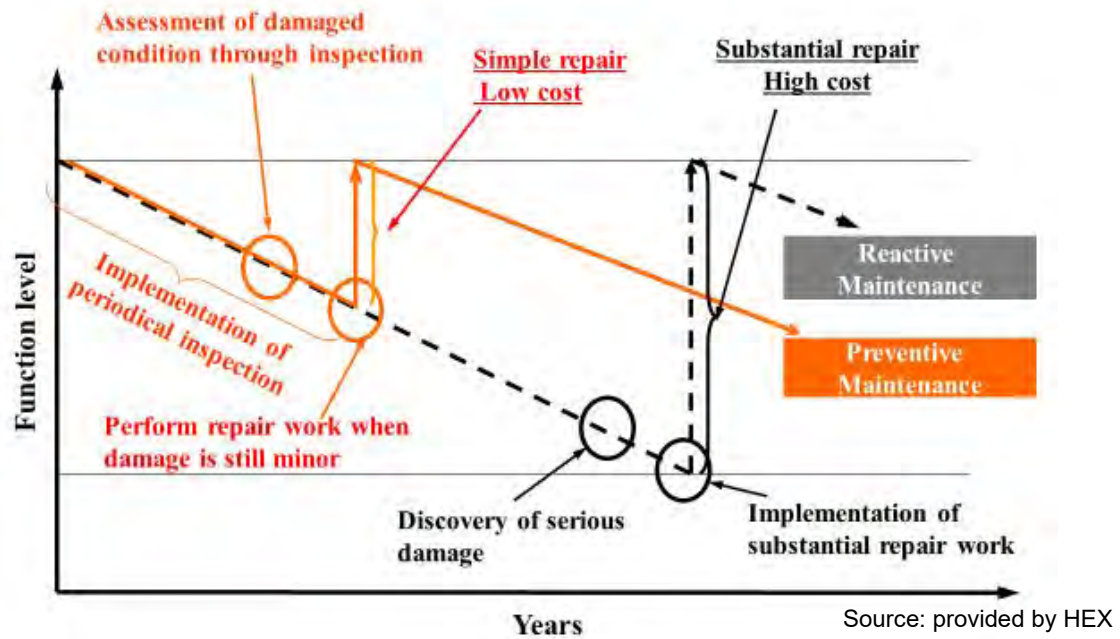
8) Comparison with competitive technologies in Morocco

Similar access technology using rope gears has already provided in Morocco mainly from European companies. However, Ninja-tech has unique features especially guaranteeing the safety during the procedure and the competitive level is low in that sense.

2.2.2. Contribution capability of development agenda in Morocco

Highways in Morocco have moved into the era of maintenance and the establishment of efficient maintenance system is required. In order to deal with this current challenging issue, Ninja-tech enable to conduct detailed inspection from close range, and preventive maintenance system can be carried out. Under the preventive maintenance system, the condition of every part of structure can be routinely monitored and, based on the inspection results, timely and reasonable repair can be applied before the deterioration gets out of hand. Hence missing of finding critical failures and the consequent costly and complicated repairing or reconstruction can be avoided. In total, life time of structures can be prolonged and the life cycle cost can be minimized compared with proactive intervention (see the Figure-2). Large-scale repairing or reconstruction works is expensive not only in direct cost but also in the miscellaneous indirect cost such as the generated by traffic regulation, incidents from structural failures depending on the geographical condition and structural type. Generally speaking, conducting the preventive maintenance is norm for important infrastructure such as highways.

Such efficient structural maintenance system can contribute to the sustainable social and economic development, and once it is established and exercised in Morocco, it can also contribute to the solution of same challenging issues Sub-Saharan countries as the assistance from Morocco.



Concept of Preventive and Proactive Maintenance

3. Outlines of the project

3.1. Purpose and goal of the project

3.1.1. Purpose of the project

The project makes a skill transfer of Ninja-tech to and improves the system of maintenance management of ADM through lecture and basic training of Ninja-tech in Japan and on-the-job inspection trainings on bridges in Morocco.

3.1.2. Target goal of the project (contribution to the development goal of Morocco)

The final goal of the project is to promote a sustainable and autonomous maintenance framework for the infrastructure in Morocco by introducing and helping disseminate the Ninja-tech technology. This may eventually contribute the sustainable social improvement and economic growth of the country. Also through skill transfer to local engineers as core human resource, it aims to increase the awareness and improve the attitude toward social infrastructure with a long-term vision.

3.1.3. Business goal of the project

In order to conduct maintenance works with Ninja-tech only by Moroccan qualified engineers (team with at least 2 persons), it is necessary to get Class-1 Certification after acquiring Class-2 Certification with 96-hour (2-week) lecture and basic training and finishing at least 1,000-hour on-the-job training with guidance. This project covers the acquisition of Class-2 Certification and the implementation of the half of required on-the-job training (about 500 hours or 3 months) for 3 trainees from ADM. After the 3 ADM engineers acquire Class-1 Certification, actual inspection works for bridges in Morocco can be made independently. Business-wise, a new joint maintenance company will be established to conduct actual maintenance works with Ninja-tech in Morocco. The company is funded both by Japan and Morocco counterpart, and the Japan side makes continuous technical inputs and help training more Ninja-tech engineers in Morocco.

3.2. Project outline

3.2.1. Project schedule

Project schedule is mentioned in following table.

No.	Time	Term	Location	Activity purpose and outline
1	March, 2016	7 days	Morocco	<ul style="list-style-type: none">• Pre-coordination for seminar and demonstration• Negotiation for business development
2	May, 2016	9 days	Morocco	<ul style="list-style-type: none">• Maintenance seminar and Ninja-tech demonstration• Pre-coordination for Ninja-tech training in Japan• Negotiation for business development
3	August and September, 2016	60 days	Japan	<ul style="list-style-type: none">• Training program for road maintenance• Ninja-Tech 2nd class certification• Ninja-Tech on-the-job training
4	November, 2016	16 days	Morocco	<ul style="list-style-type: none">• Ninja-Tech on-the-job training• Negotiation for business development
5	April, 2017	23 days	Morocco	<ul style="list-style-type: none">• Ninja-Tech on-the-job training• Negotiation for business development
6	July, 2017	23 days	Morocco	<ul style="list-style-type: none">• Ninja-Tech on-the-job training• Negotiation for business development

3.2.2. Project framework

(1) Counterpart organization

ADM is a state-owned company which has constructed, operated and maintained the 1800km (currently 1,771km is opened in service) long of national toll highway network for more than 25years. Its new construction is nearly completed, and ADM starts to be ready for the coming transition into maintenance phase. For the preparation, ADM needs to study and introduce efficient and effective asset management solutions.

Section autoroutière	Longueur (km)
Casablanca - Rabat	62
Rabat - Kénitra	40
Rabat - Fès	167
Kénitra - Tanger	183
Casablanca - Settat	57
Casablanca - El Jadida	113
Settat - Marrakech	162
Tanger - Tanger Med	54
Tétouan - Fnideq	28
Contournement de Marrakech	33
Marrakech Ouest - Agadir	198
Fès - Oujda	320
Berrechid - Béni Mellal	172
Contournement de Rabat	41
El Jadida - Safi	141
Total	1770

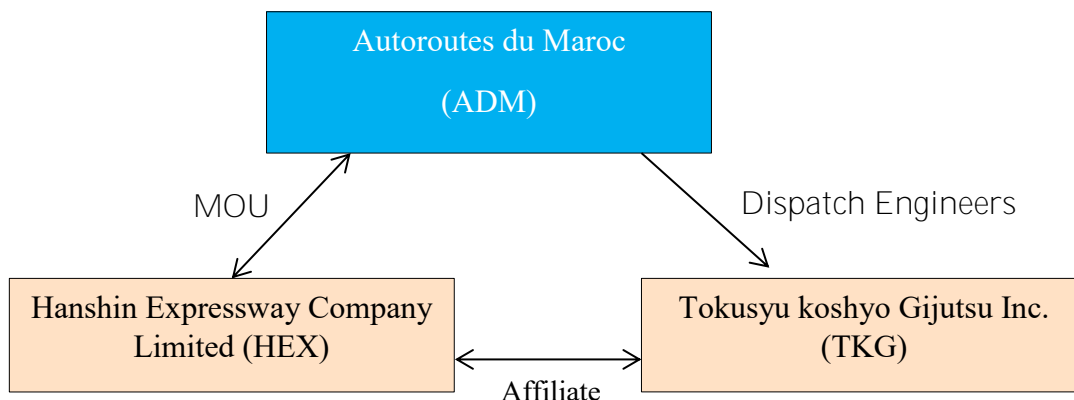


Source: provided by ADM

Highway network of ADM

(2) Project framework

HEX and TKG jointly conduct technical transfer to ADM staff. Business development based on the transferred technology is conducted by ADM, HEX and TKG.



- Project planning
- Maintenance technology transfer
- Ninja-tech transfer

Project framework

3.2.3. Project contents

Contents of the project are mentioned in the following table.

Project contents and target goals

#	Tasks shall be executed through the project	Activity						Contents	Target goals (Achievement at the end of the project)
		1st Morocco	2nd Morocco	1st Japan	3rd Morocco	4th Morocco	5th Morocco		
1	Marketing and needs finding	■ ■ ■ ■						<ul style="list-style-type: none"> Conduct Interview to ADM 	<ul style="list-style-type: none"> Show quantitative data of potential and needs of proposed technology
2	Promotion on Ninja-tech and bridge maintenance		■ ■ ■ ■					<ul style="list-style-type: none"> Implement bridge maintenance seminar for ADM engineers Implement Ninja-tech demonstration for ADM and other infrastructure sector 	<ul style="list-style-type: none"> Promote proposed technology to ADM and other infrastructure sector
3	Ninja-tech skill transfer			■ ■ ■ ■ ■ ■ ■ ■ ■ ■				<ul style="list-style-type: none"> Implement on-the-job training at Morocco and Japan 	<ul style="list-style-type: none"> Implement 500 hours of on-the-job training out of the 1000 hours to acquire Ninja-tech Class-1 certification
4	Alliance agreement with local partner		■ ■ ■ ■ ■ ■ ■ ■ ■ ■					<ul style="list-style-type: none"> Negotiate to conclude alliance agreement with ADM 	<ul style="list-style-type: none"> Conclude alliance agreement on establishing joint company with ADM

4. Project outcomes

4.1. First activity in Morocco

(1) Activity term

From 28th March, 2016 to 3rd April, 2016 (7 days)

(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Seiji Wada (TKG) : Development subject analysis / Leader of Ninja-tech transfer
3. Shizuo Empuku (JICA investment promotion adviser in Moroccan Investment Development Agency) : External supporting member

(3) Activities

Pre-coordination for second activity in Morocco (Ninja-tech demonstration and maintenance seminar) and discussion for business establishment are conducted.

1) Opening ceremony of ADM Academy (1st April, 2016)

- ADM Academy is an affiliate body of ADM responsible for technology development and training, not only for ADM but also outside business area.
- HEX and TKG were invited to attend the facility opening ceremony. We interacted with participants in the energy sector and mentioned great expectations for Ninja-tech on the maintenance of wind power generation.



Opening ceremony of ADM Academy

2) Discussion with ADM General Manager and person in charge (1st April, 2016)

- Detail of Ninja-tech demonstration and training in Japan was approved by ADM.
- Overview of the business model was presented by HEX and TKG. ADM agreed to concentrate on acquisition of Ninja-tech certification by ADM engineers for the first step. Then we confirmed that the establishment of a joint venture will be carried out step by step with the progress of human resource development.

4.2. Second activity in Morocco

(1) Activity term

From 5th May, 2016 to 15th May, 2016 (9days)

(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Seiji Wada (TKG) : Development subject analysis / Leader of Ninja-tech transfer
3. Takeshi Suzuki (HEX) : Bridge maintenance
4. Yoriko Kawakami (HEX): Business scheme development
5. Takaharu Yamaguchi (TKG) : Sub-leader of Ninja-tech transfer
6. Fumitaka Katamura (TKG) : Ninja-tech transfer
7. Tsubasa Sakai (TKG) : Ninja-tech transfer
8. Shizuo Empuku (JICA investment promotion adviser in Moroccan Investment Development Agency) : External supporting member

(3) Activities

Seminar on Ninja-tech road maintenance was conducted for approximately 50 of ADM staff responsible for maintenance. Ninja-tech demonstration was conducted for approximately 130 of participants from infrastructure sector. Pre-coordination for training in Japan were conducted.

1) Seminar on Ninja-tech and bridge maintenance

time	Topics	Lecturer
9:30 - 12:30	Overview of Ninja-tech	Takaharu Yamaguchi (TKG)
14:30 - 14:50	Concept of maintenance management	Motohiko Nishibayashi (HEX)
14:50 - 15:30	Concept of bridge maintenance	Yoriko kawakami (HEX)
16:00 - 16:20	Concept of long-span bridge maintenance	Takeshi Suzuki (HEX)
16:20 - 17:00	Road maintenance new technology	Yasunori Konaka (HEX)



2) Ninja-tech demonstration

Demonstration was conducted at the Mohammed VI Bridge aiming at promoting understanding of Ninja-tech. Not only members from ADM, JICA, and the Japanese Embassy but also who could be the user in the future listed below were invited. Approximately 130 people were attended.

- ONCF (= Office National des Chemins de Fer)
- MASEN (= Moroccan Agency for Solar Energy)
- OCP (= Office Chérifien des Phosphates)
- Ministère Energie et Mines
- Ministère de la Culture
- Ministère des Habous
- Direction des Routes
- Direction des Aménagements Hydrauliques (Ministère Délégué Chargé de l'Eau)
- l'ONEE - Branche Electricité (Office National de l'Electricité et de l'Eau)
- L'ONEE – Branche Eau (Office National de l'Electricité et de l'Eau)
- LPEE (= Laboratoire Public d'Essais et d'Etudes / Public Laboratory for Test and Study)
- Protection Civile

All the presses in Morocco were invited. Several newspapers and TV program reported about the demonstration (refer to Appendix 3).

10:30 - 10:40	Opening greetings	Mohammed Najib BOULIF Vice minister of Ministry of equipment, transportation and logistics
10:40 - 10:50	Greetings	Anouar Benazzouz, General Manager ADM
10:50 - 11:00	Greetings	Tsuneo Kurokawa Ambassador Extraordinary and Plenipotentiary of Japan to the Kingdom of Morocco
11:00 - 11:25	Construction project of Mohammed VI Bridge	ADM
11:25 - 11:40	Introduction of Hanshin Expressway	Motohiko Nishibayashi, HEX
11:40 - 11:55	Introduction of Ninja-tech	Seiji Wada, TKG
11:55 - 12:30	Ninja-tech Demonstration	Takaharu Yamaguchi, Fumitaka Katamura, Tsubasa Sakai, TKG





4.3. First activity in Japan

(1) Activity term

From 4th August, 2016 to 2nd October, 2016 (60 days)

(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Seiji Wada (TKG) : Development subject analysis / Leader of Ninja-tech transfer
3. Takeshi Suzuki (HEX) : Bridge maintenance
4. Yoriko Kawakami (HEX): Business scheme development
5. Takaharu Yamaguchi (TKG) : Sub-leader of Ninja-tech transfer

(3) Participating trainees

Mohammed EDDINI : Maintenance engineer, Rabat Tanger Highway, ADM

Abdeslam ELMOUKNI : Project manager, Construction department, ADM

Yasine El MOUDENE : Maintenance engineer, Center of exploitation of Marrakesh, ADM

(4) Activities

Technical training on bridge maintenance knowhow of Hanshin Expressway, training required for obtaining class-2 Ninja-tech engineer certification and Ninja-tech on-the-job training at Hanshin Expressway bridge sites as a part of practical experience required for obtaining class 1 Ninja-tech engineer certification were conducted.

Date	Activity	Accommodation
03/Aug/2016(Wed)	Casablanca 14:30 → Dubai 1:10 +1 (EK752)	-
04/Aug/2016(Thu)	Dubai 3:00 → Kansai 17:10 (EK316)	JICA Kansai Center
05/Aug/2016(Fri)- 19/Aug./2016(Fri)	Road structure maintenance (Lecture and practice) Hanshin Expressway Co.,Ltd. (HEX) Headquarters	JICA Kansai Center
20/Aug/2016(Sat)- 04/Sep./2016(Sun)	Ninja-tech certification training Tokusyu Kousyo Gijyutsu Inc. (TKG) Headquarters	Apartment in Kyoto (Walking distance to TKG HQ)
05/Sep/2016(Mon)- 01/Oct./2016(Sat)	Ninja-tech On the job training Hanshin Expressway bridge site.	
02/Oct./2016(Sun)	Kansai 23:40 → Dubai 5:10 +1 (EK317)	-
03/Oct./2016(Mon)	Dubai 7:35 → Casablanca 12:55 (EK751)	

(5) Training program on bridge maintenance management at HEX

To learn the methods and know-how of bridge maintenance management at HEX and to examine a way to develop maintenance management system and methods of close visual inspection at ADM based on the training experience at HEX (refer to Appendix 1).

1) Outline of Road Structure Maintenance (Lecture)

【Contents】

The lecture covered the following topics:

- Current situation of social infrastructure maintenance management in Japan (aging structures, mandatory

close visual inspection in every 5 years stipulated by the revised Road Act in response to the fatal accident in the Sasago Tunnel.

- Concept of maintenance management cycle (PDCA) based on preventative maintenance approach
- Effective operational setup at the Hanshin Expressway Group

【Q&A and Comments】

- In Morocco, there is no legislation mandating inspecting structures. ADM conducts inspections autonomously. There has not been any case of serious accidents up to now, however, in future, with aging structure, it is necessary to make efforts in accident prevention.
- Visual inspection is conducted every year. Close visual inspection has started in 2012 and will be carried out every 5 years. We are interested in learning about the organizational setup (relation with group companies and external companies) for planning and implementation of inspection.



With Mr.Kazunori Yuki, President of HEX

2) Inspection Standard of HEX/ Comparison between HEX and ADM on Bridge Maintenance (Lecture)

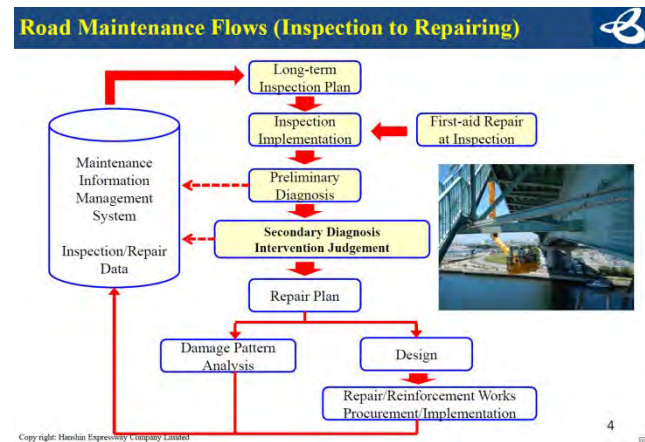
【Contents】

The lecture covered the following topics, especially focusing on the periodical inspection (mandatory and close visual inspection). Inspection concept and methods at ADM were discussed.

- Necessity and objectives of maintenance management at HEX
- Road maintenance flow from inspection to repairing
- Inspection types (timing, frequency, purposes)
- Classification of inspect results
- Five bridge members targeted for inspection (girder, pier, pier cap area, deck and railing/dewatering)
- Typical damages of bridge members
- Fast-aid (temporary repairing) treatment of damages found during inspection
- Preliminary and secondary diagnoses and their purpose
- Intervention judgment based of the result of secondary judgment
- Typical repairing methods
- Use of database for management of asset (plans, design books, etc.), repair histories, and inspection data and for planning of inspection and repairing tasks.
- Periodical inspection (mandatory and close visual inspection)

【Q&A and Comments】

- Basic concept of inspection at HEX is very similar with that of AMD. However, in Morocco, the importance of inspection is not understood and this causes some problems such as prioritization in budgeting for inspection costs.
- At ADM, two inspectors are assigned in each of 11 regions. Within a region, each inspector has structures to be inspected in his charge. The types of structures subject to inspection are bridges, earthworks, pavement, and large signboard. Damages are classified in 6 levels. The database at ADM has a function equivalent to the secondary diagnosis of HEX, which determines priority for repairing works needed by triage.
- A database with a function to alert structures in need of repair works will be useful.



Source: provided by HEX

3) Inspection Trial at Existing Bridge (Practice)

【Contents】

In collaboration with Naigai Kozo Engineering and Hanshin Expressway Engineering, both being subsidiary companies of HEX, an inspection trial was carried out on the structure of Osaka-Nishinomiya Line (Hyogo) West S-3 to West P-3 near the former Amagasaki Office. The trial involved conducting actual inspection tasks on a bucket vehicle using inspection equipment and devices and temporary damage repairing materials. The trainees learned and participated in discovering damages and recording their descriptions (recording on field notes, taking pictures), safety management, maintenance management methods (temporary damage repairing during inspection) by optimizing opportunities of close range inspection. They also learned that above mentioned inspection and maintenance tasks will lead to cost reduction, preventative maintenance, proactive measures, reduction of road closures, and accident prevention.

【Q&A and Comments】

It is impressive to learn how accident prevention and safety management for inspectors and other people during inspection works are strictly followed. It was also interesting to learn about a wide range of heavy machines, equipment and materials used for inspection and temporary repairing. ADM and Hanshin share similar basic policies of inspection, however, on the level of actual inspection tasks on site, we found there are many difference in terms of methods, materials/equipment, the number of inspectors, the time involved with inspection tasks and so on. It will be ideal if inspection of such standard can be implemented at ADM, although it will require time and budgets for training inspectors and securing equipment and materials. Since there are some maintenance materials/products at lower costs (e.g. temporary repairing at inspection, repairing materials such as non-loosening nut, etc.), we would like to start introducing these materials/products as much as possible.



4) Inspection Planning and Cost Estimation (Lecture) : Training Material 5, 6 and 7

【Contents】

The topics covered for planning inspection works are:

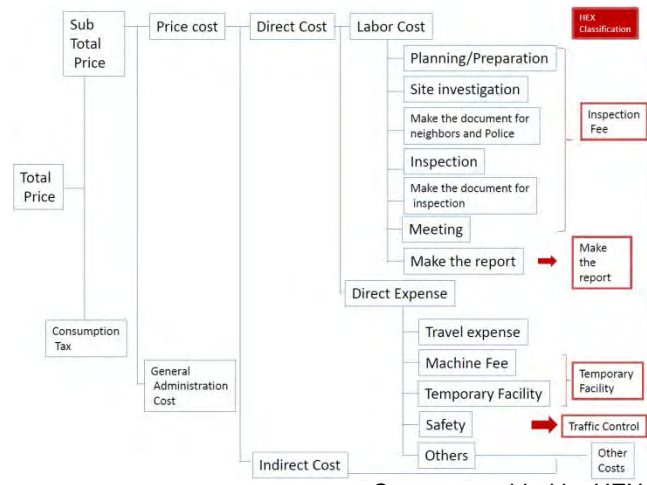
- Examination of contract and its contents which are prepared based on the data concerning structure types, work quantity and methodology extracted from the HEX database
- Preparation of work execution plan and over all schedule
- Establishment of inspection team unit
- Flow from contacting to work commencement
- Preparation in general and site preparation
- Inspection work
- Selection of temporary facilities for inspection
- Bridge member terms

For practice of cost estimation, by using a case study, inspection costs are calculated based on calculation methods and estimates standards used at HEX.

【Q&A and Comments】

- It will be useful for securing budgets for inspection and repairing that a database has a function to estimate such costs for one year. Unexpected repairing can be a problem in terms of securing budget.

- Some questions were raised concerning contracts with inspection and repairing companies.
- The costs for inspection at HEX are expensive.



Source: provided by HEX

5) Maintenance Information Database (Practice)

【Contents】

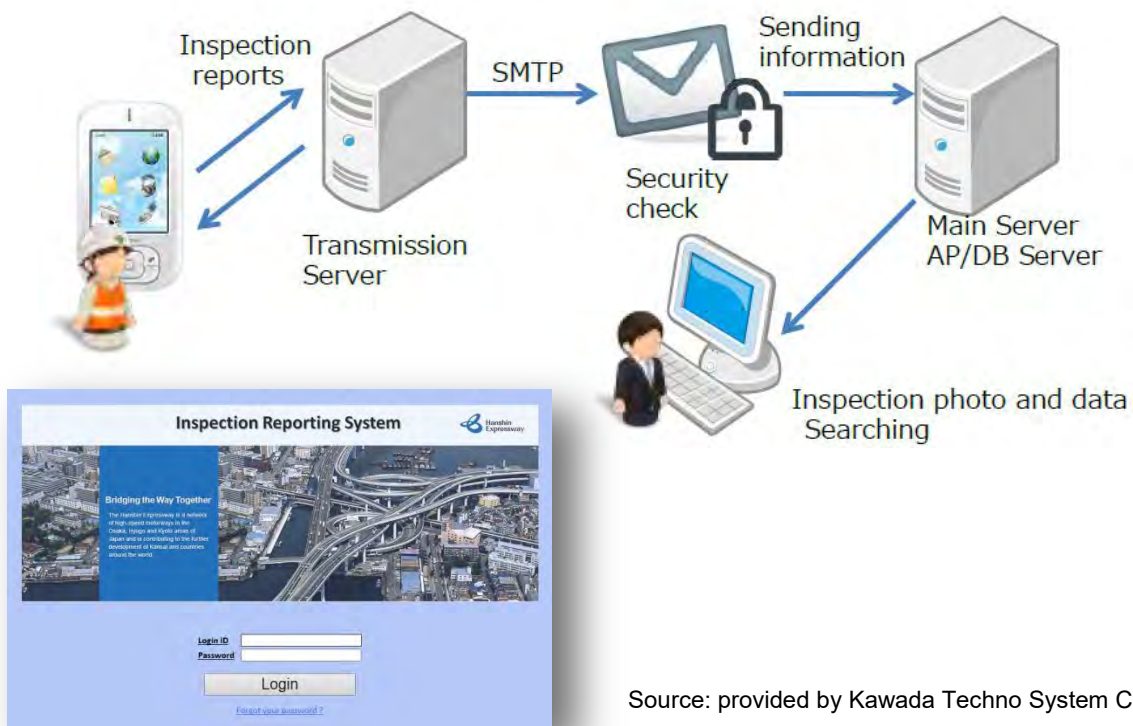
“Basepage,” the information sharing service developed by Kawada Techno System Co., Ltd is introduced as an example and the trainees learned about its system, versatility, actual cases of using the services, fees and so on. Using a smart phone, the trainees practiced recording data and taking pictures outside and sending them to the system and checking the sent data and pictures on the Basepage interface. Demonstration of functions and interfaces of the HEX database was carried out.

A discussion was held on the usability of Basepage in ADM’s inspection and maintenance works, especially for inspection record keeping, automated data transferring, management and sharing of data. The discussion also covered the possibility of convertibility with the current ADM database system which were not fully functioning.

【Q&A and Comments】

Presently, inspection results are recorded on paper based forms on site and inspectors must enter the data by themselves after returning from the site inspection. There are many problems. For examples, the paper forms are cumbersome with a numerous pages containing many items which are irrelevant to actual subjects of inspection; organizing inspection results with corresponding pictures are troublesome and prone to make mistakes; data input is time consuming, and so on. An automated data transferring system using a tablet or smartphone to record inspection results with GIS data and pictures will be very useful. It will be better if the system allows checking previous inspection records during inspection and recoding voice.

The data base used presently at ADM was developed by French consultants few years ago. The functions incorporated and designs of the data base have no problem; however, it is not used well since it is not fully functioning due to “bugs”. How and when this present database problem will be resulted or if a new system will be introduced is unknown. With the present system, ADM manages the server for the database. The Basepage may be a useful system for ADM, however, pros and cons of the database operation and server management by an outside entity of ADM must be evaluated.



Source: provided by Kawada Techno System Co., Ltd

6) Deterioration Mechanism of Concrete Structures (Lecture)

【Contents】

At Hanshin Expressway Engineer Co., Ltd (HEE), a lecture was given on deterioration mechanism of concrete structures, especially on neutralization, chloride contamination and alkali silica reactivity.

【Q&A and Comments】

Cases of alkali silica reactivity are reported in Morocco.



Source: provided by HEX

7) Non-destructive test (salt damage/carbonation/crack depth)(Practice)

【Contents】

At HEE, the following equipment/devices used for non-destructive tests are demonstrated.

[Concrete Structure Inspection and Analysis]

- Digital test hammer
- Ferroskan (Electromagnetic induction)
- Structure Scan (Electromagnetic wave radar)
- M.EYE Checker (Inspection Instrument for Fracture of rebar)
- X-ray Fluorescence Analyzer (Chloride ion concentration)
- Phenolphthalein (Neutralization depth)

[Steel Structure Inspection and Analysis]

- Ultrasonic thickness gauge

[Other Structure Inspection and Analysis]

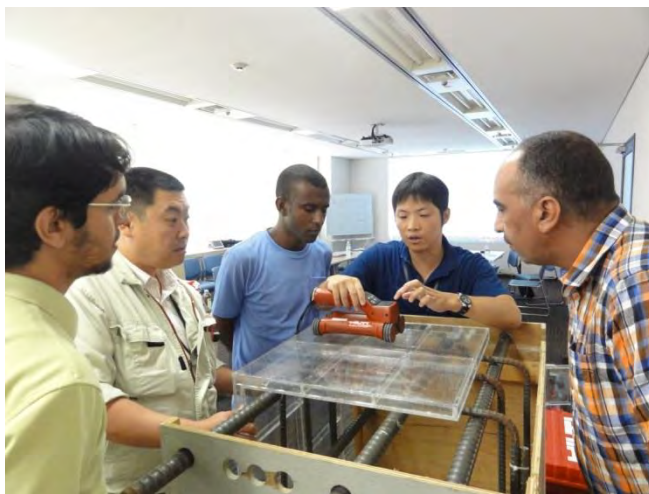
- 3D laser scanner
- Video scope (industrial endoscope)
- Digital binocular

(Use・Merit・Performance)
 3 dimension structures data can be obtained by laser scanner
 50000 data/second

(Remarks)
 In case of composition using target, composition error should be considered
 Special software for data transaction and high spec personal computer are required

○ Location(Object) of use
 Tunnel, Slope, Pavement, etc.

Source: provided by HEX



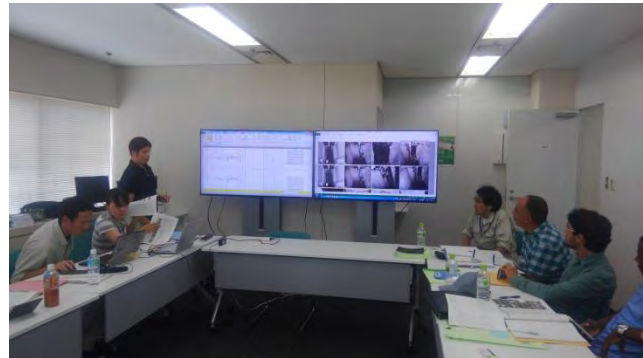
8) Damage Level Judgement and its Record for Existing Bridge (Lecture)

At HEE, a lecture was given on report preparation at HEE and secondary diagnosis. Using actual inspection records and pictures of case studies, a secondary diagnosis meeting was demonstrated by engineers of HEE.

【Q&A and Comments】

Question by ADM : Is it possible to predict the actual cause of damages by observations?

Answer by HEE: It is possible to predict to certain level by observing locations of damages and types of cracks, however, to determine environmental causatives, such as chloride contamination, neutralization, etc., detailed analyses are required.



9) Site Visit (Tempozan Bridge and Umeda Ramp)

【Contents】

The Tempozan Bridge was visited as an example of a steel long span bridge and the Umeda Ramp was an example of a viaduct for optimal use of the space in urban setting (an integral structure of ramp and building).



10) Proposal of maintenance strategy at ADM reflecting knowhow of HEX (Lecture)

【Contents】

Reviewing knowledge and experience gained during the training program at HEX, current situation of maintenance in HEX and ADM was compared to propose ideal future maintenance strategy at ADM. Opinions were raised and

exchanged, not only at the inspector level, but also at the level of ADM as an organization dealing with road inspection and maintenance.

【Q&A and Comments】

Inspection policies, a manual based on such policies, a data base are already existed in ADM, however, there are some problems such as the database is not fully used due to bugs in its system, inspection report is paper based and format is too much complicated, and so on. These tools have to be improved and strengthening PDCA cycle for maintenance activity is needed.

ADM trainee found that they needs to establish a new organization as a subsidiary company, which is specialized in road inspection and maintenance management like HEE (Hanshin Expressway Engineering Company Limited, subsidiary of HEX) and Naigai Kozo Company Limited (subsidiary company of HEE specialized for structural inspection) .

From the inspection methods learned during this training program, those that should be introduced to ADM are a best mix of close-range and remote visual inspection, applying temporary repairing measures at inspection, establishment an easy reporting system using mobile devices at site.

Comparison of current situation of maintenance activity in HEX and ADM

HEX	ADM
<ul style="list-style-type: none"> • Mandatory close-range visual inspection in every 5 years (stipulated by law) • 5-level damage categorization by bridge type and member which is stipulated in HEX Manual • Report format in paper format. Currently testing online reporting system by mobile device • Stocking damage level and the past transitional history in database • Preventive maintenance is a basic concept • Sharing maintenance tasks within group companies (Hanshin Expressway Engineering and Naigai Kozou) to internalize experienced staff, know-hows and technologies for continuous and efficient implementation of highway maintenance <ul style="list-style-type: none"> ➢ Inspection (preliminary judgement) ➢ Secondary judgement ➢ Intervention judgement ➢ Routine repair and maintenance 	<ul style="list-style-type: none"> • Remote visual inspection in every year • Detail (periodic) inspection in every 5 years (started in 2012) • 6-damage categorization stipulated in ADM Manual • Report format in paper format according to ADM Manual • Unusual damages are investigated and diagnosed by outsourced laboratory or consultant • Database system corresponding manual has been developed, but it now has a computer problems • Human resources will be insufficient for coming maintenance phase

(6) Training program for Class-2 Ninja-tech Engineer Certification at TKG

Technical training for Class-2 Ninja-tech engineer certification to the three trainees from ADM was conducted.

- Lecture: application of Ninja-tech, certification, falling impact, equipment standard, failsafe system, knot types, safety management, laws and regulations
- Practice: Ninja-tech training at training facility, rescue training, final test

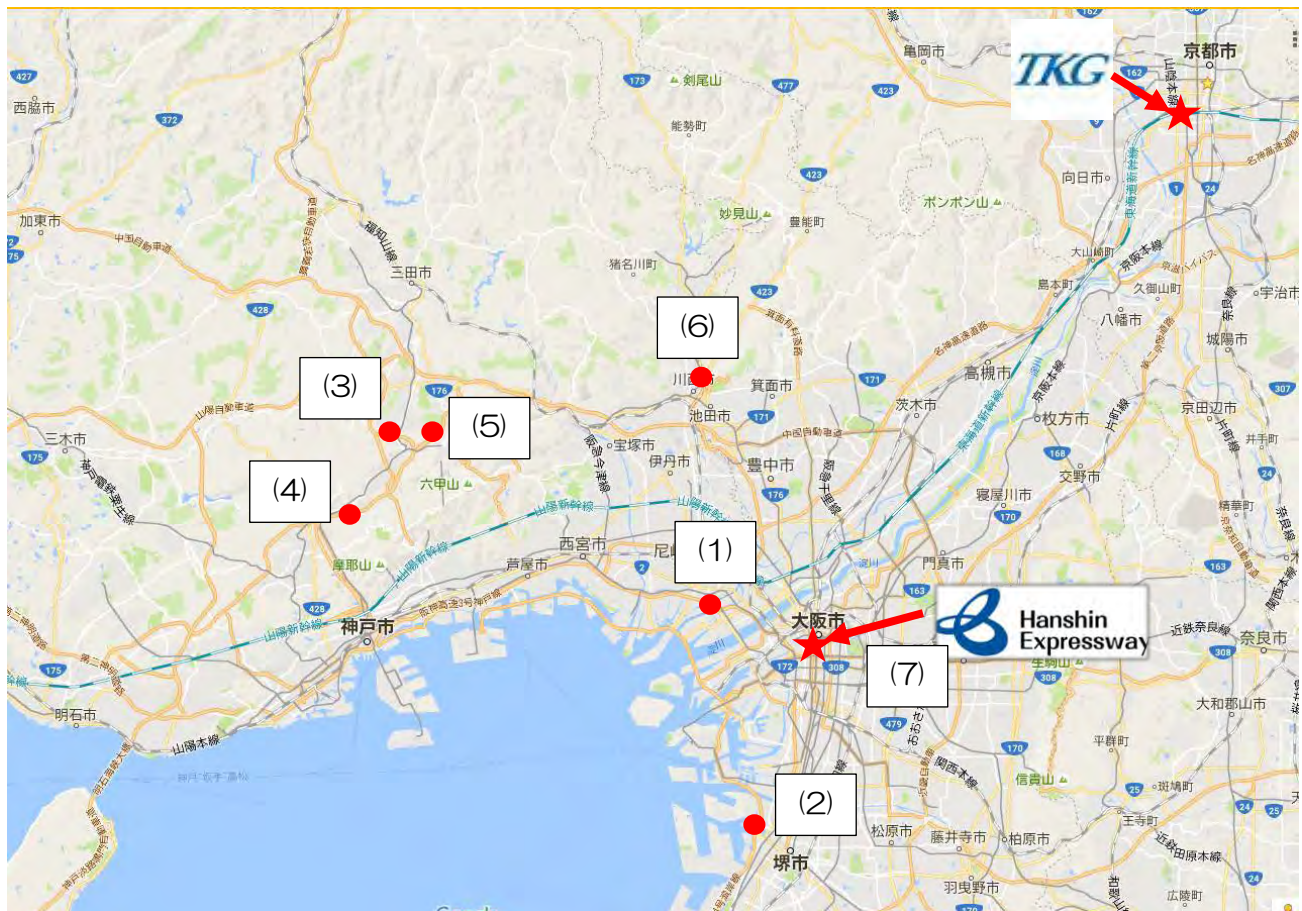


(7) Ninja-tech on-the-job training at Hanshin Expressway bridge site

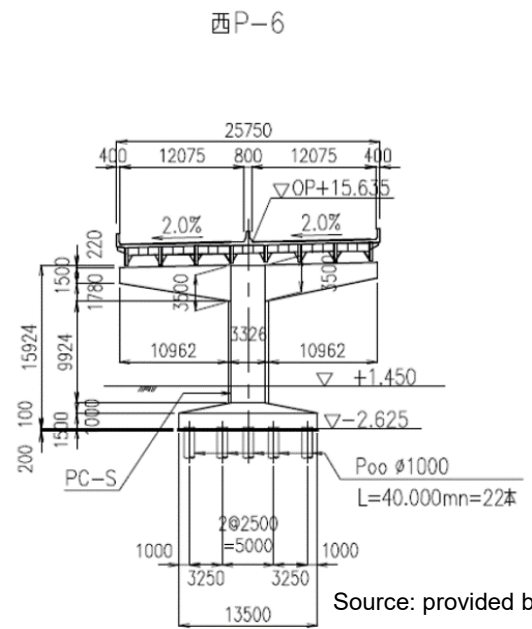
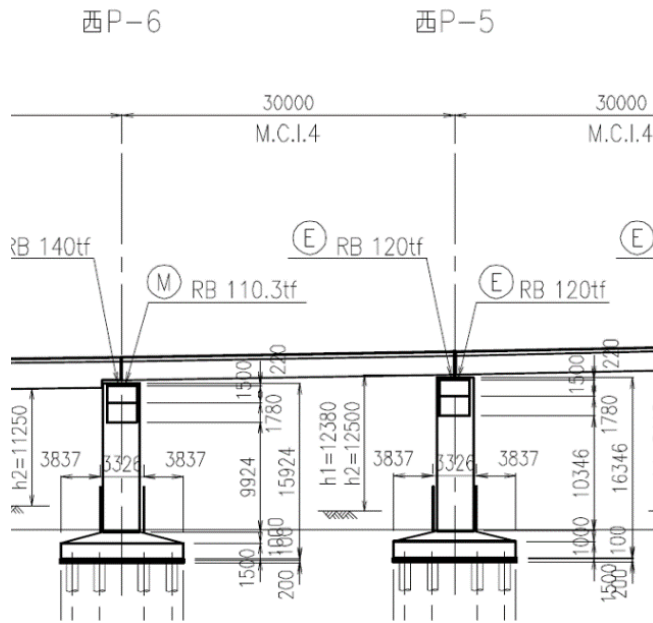
On-the-Job training for four weeks to three trainees from ADM as part of work experience required to be the Class-1 Ninja-tech engineer after obtaining Class-2 engineer certificate was conducted.

Training schedule and location

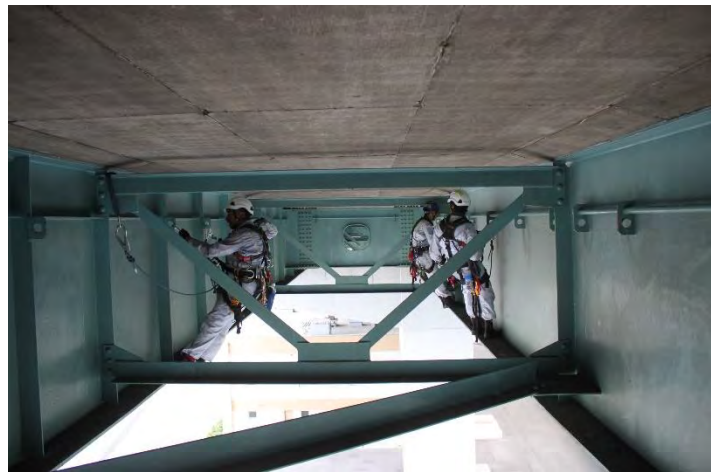
Mon	Tue	Wed	Thu	Sat	Sat	Sun
5/Sep	6	7	8	9	10	11
Preparation		(1) Kobe route			Report making	
12	13	14	15	16	17	18
Report	(2) Wangan route		(3) Kita-kobe route		Report making	
19	20	21	22	23	24	25
Report	(4) Kita-kobe route		Report	TKG	Report making	
26	27	28	29	30	1/Oct	2
(5) Kita-kobe route			(6) Ikeda route	(7) HEX	Report	Departure



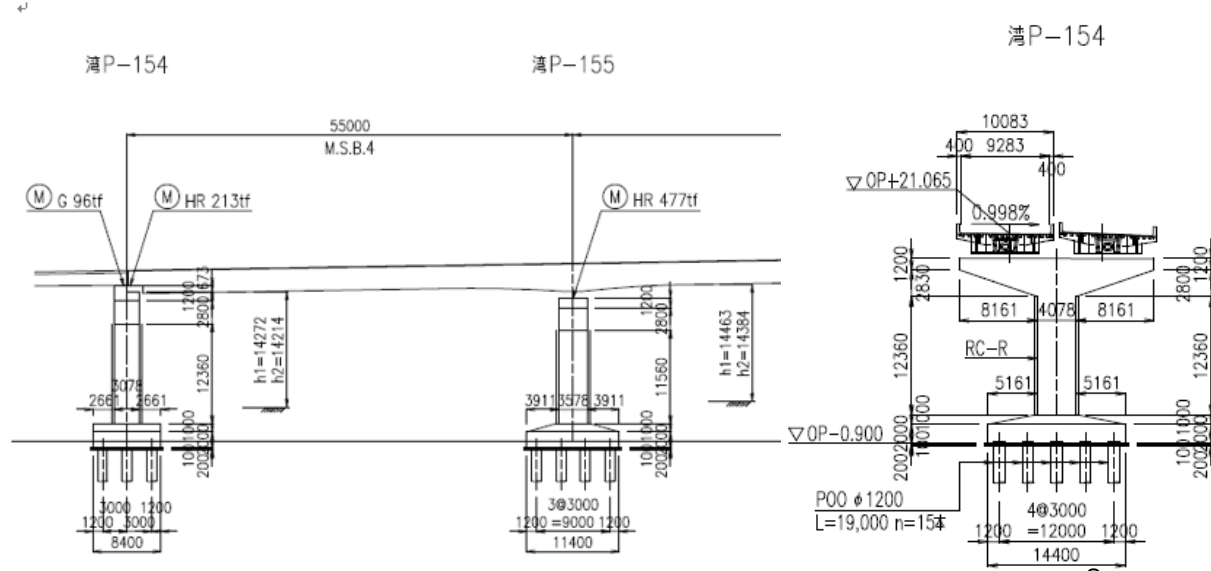
(1) Kobe Route / Nishi-P5- 6 (Steel I shape girder RC deck bridge)



Source: provided by HEX

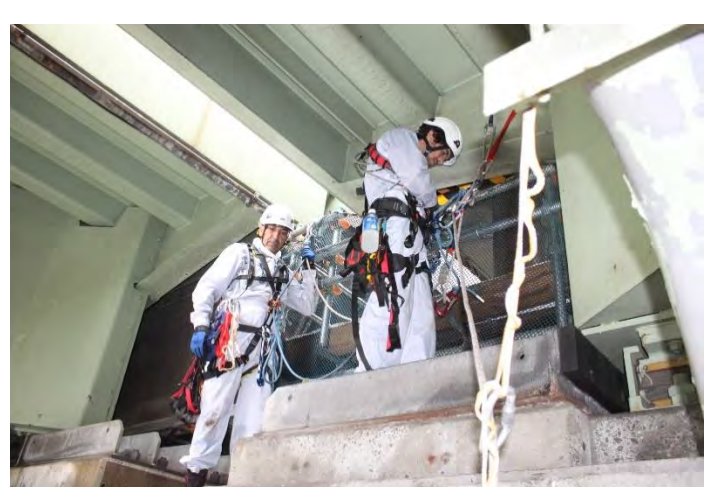


(2) Wangan Route / Wan-P154-155 (Steel box girder steel deck bridge)

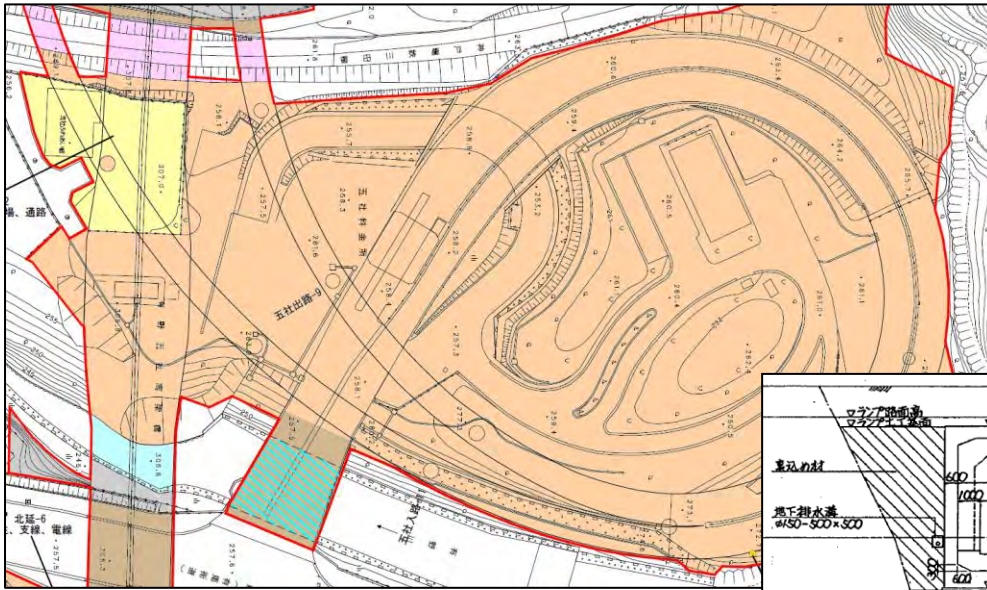


浦P-154

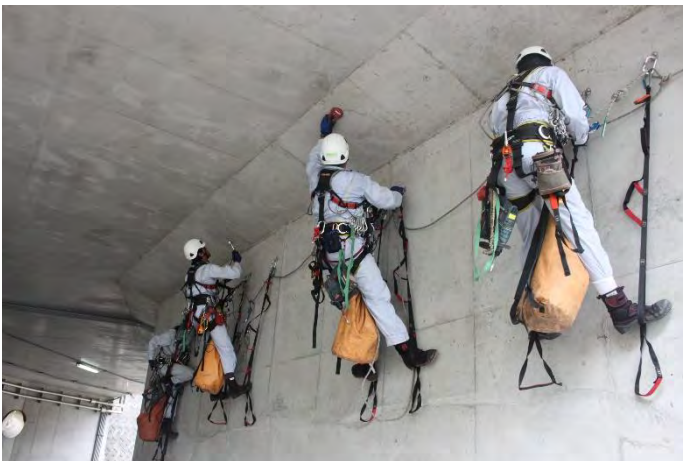
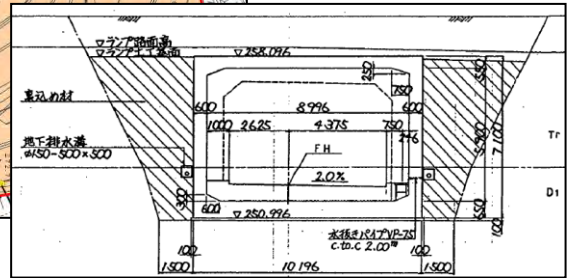
Source: provided by HEX



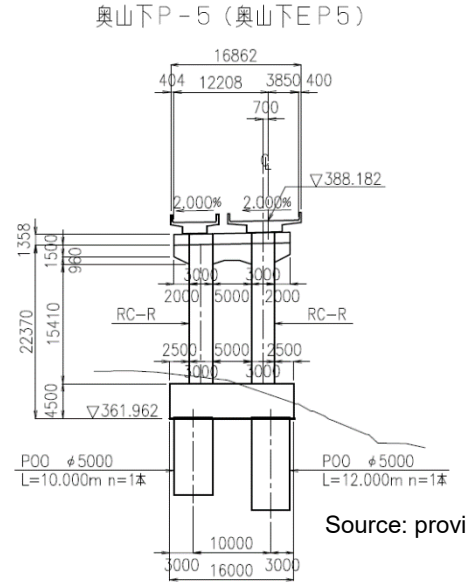
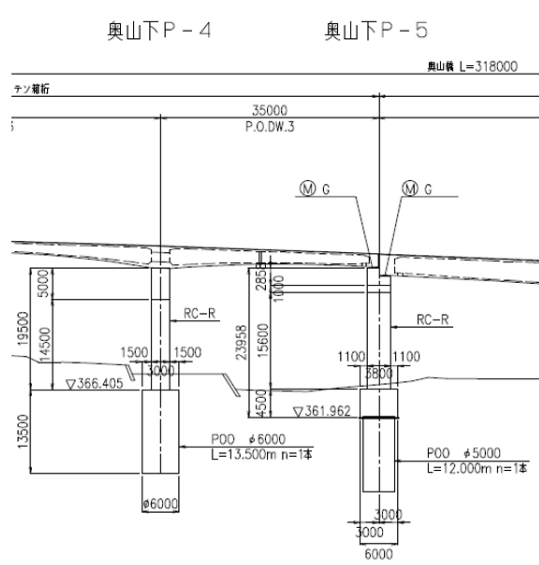
(3) Kita-Kobe Route / Gosha ramp (RC box culvert)



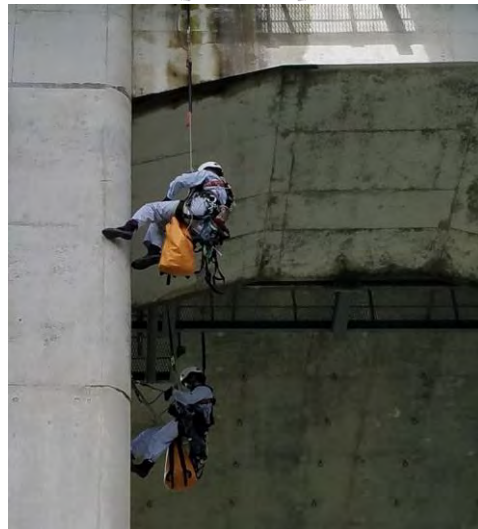
Source: provided by HEX



(5) Kita-Kobe Route / Okuyama-shita-P1 (PC box girder RC pier bridge)

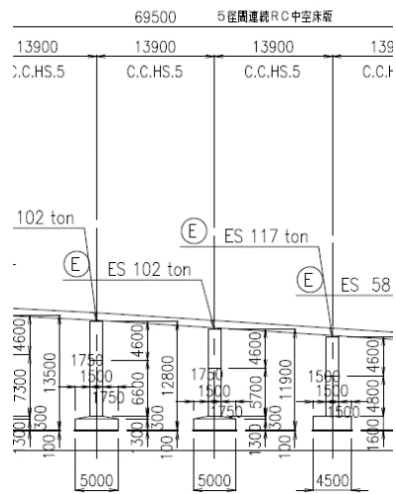


Source: provided by HEX

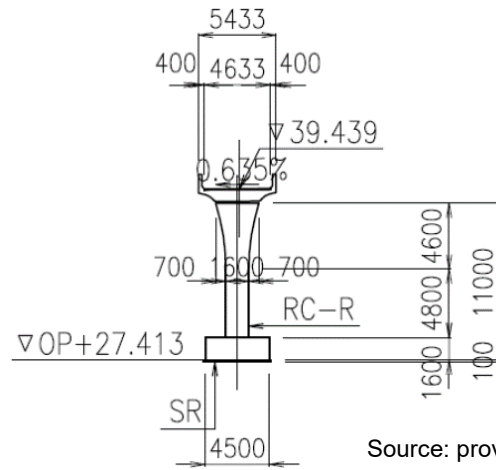


(6) Ikeda Route / Kibe ramp (PC box girder RC pier bridge)

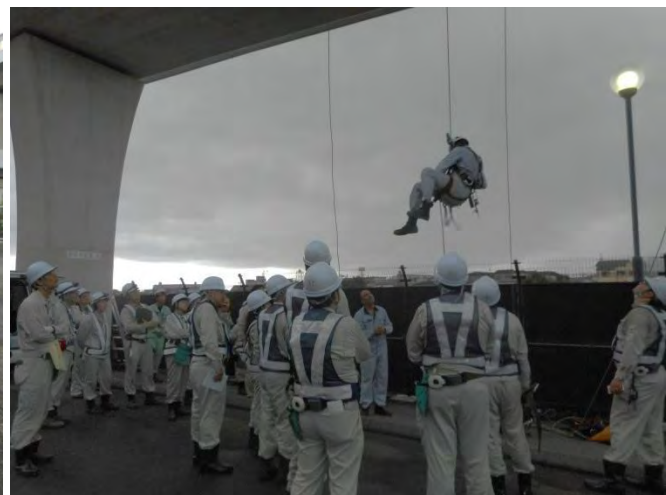
-4 池田木部排P-6 }
池田木部排P-5 池田木部排P-7



池田木部排P-7

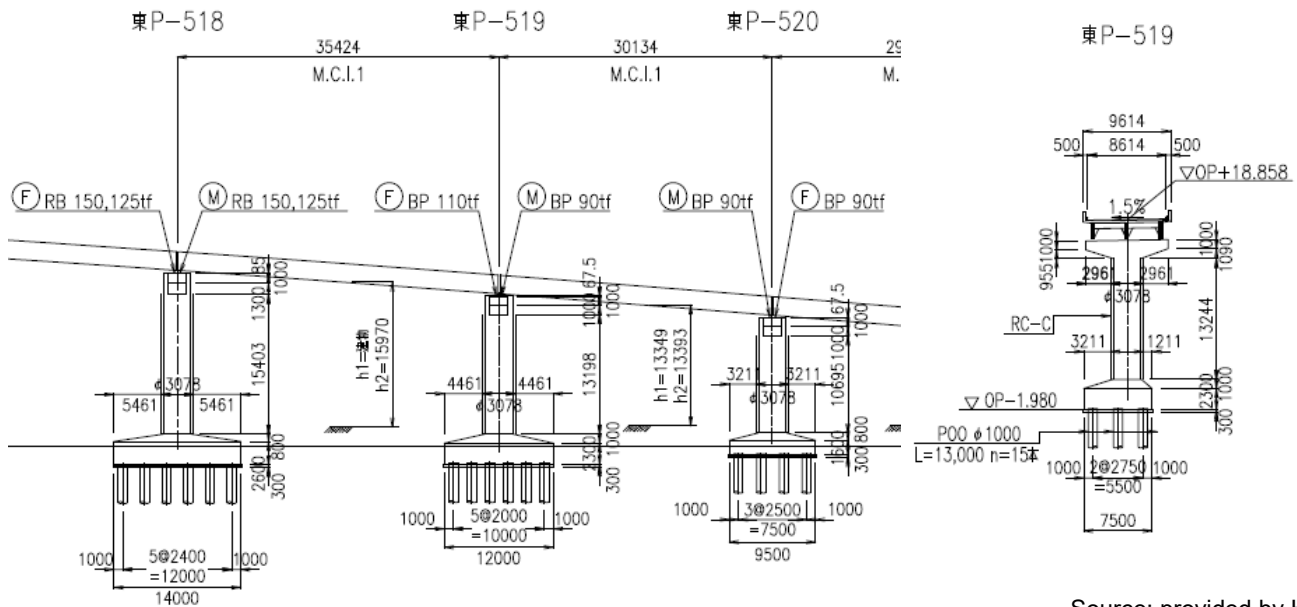


Source: provided by HEX

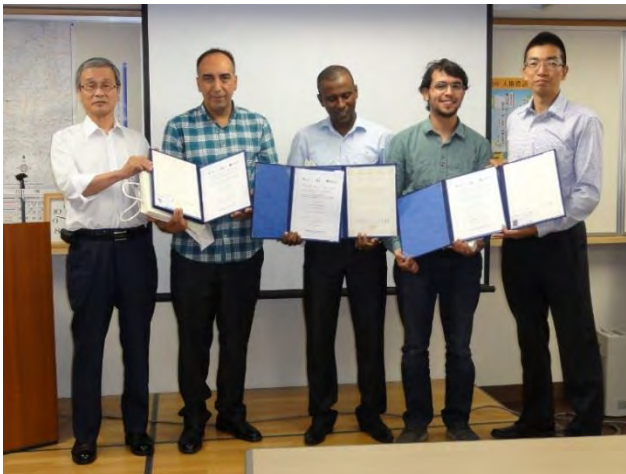


Demonstration for JICA trainee from Tunisia learning long span cable bridge maintenance

(7) Higashi-Osaka Route (Steel I shape girder RC deck bridge)



Source: provided by HEX



Demonstration for HEX staff and closing ceremony

4.4. Third activity in Morocco

(1) Activity term

From 26th November, 2016 to 11th December, 2016 (16days)

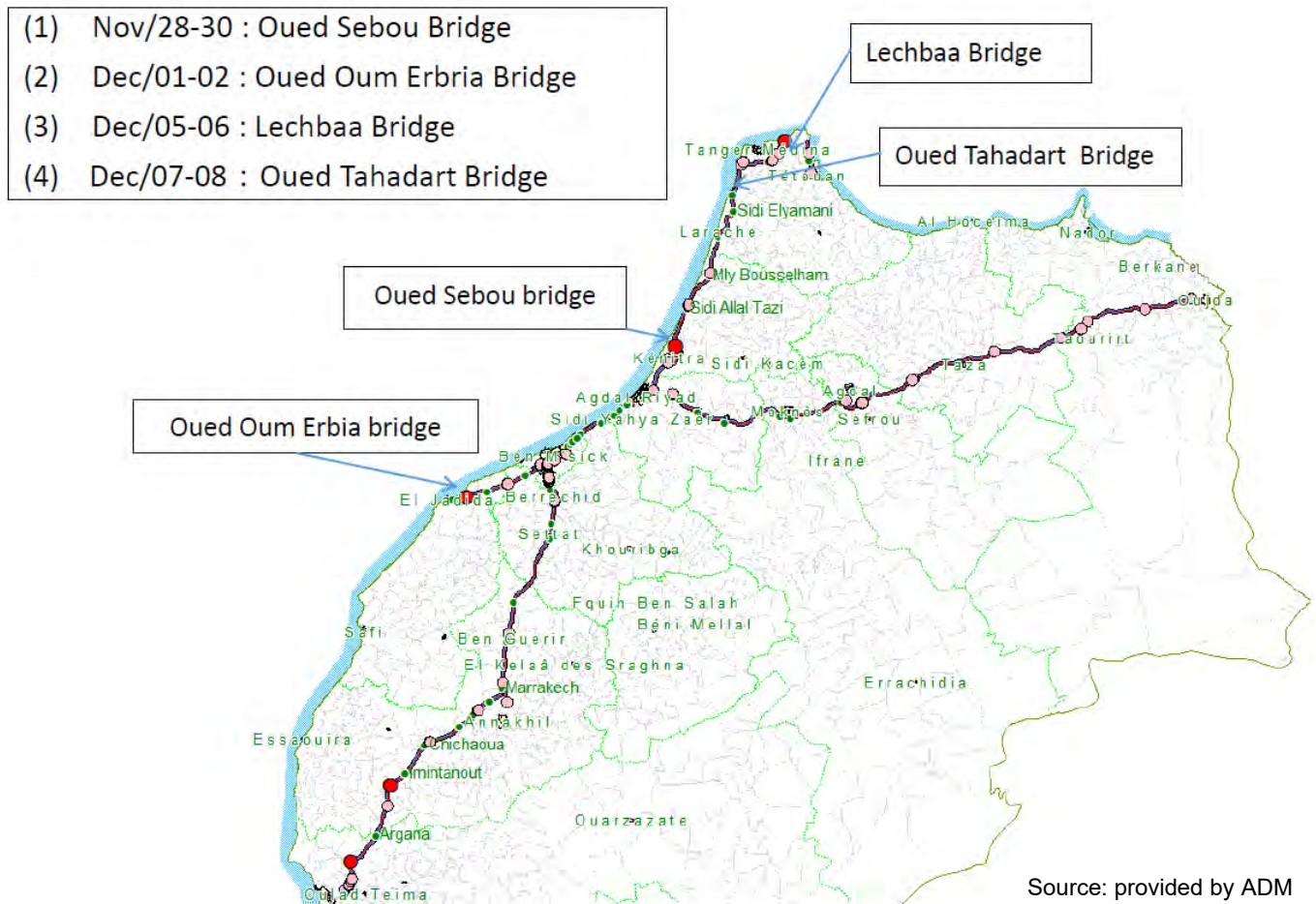
(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Seiji Wada (TKG) : Development subject analysis / Leader of Ninja-tech transfer
3. Yoriko Kawakami (HEX): Business scheme development
4. Takaharu Yamaguchi (TKG) : Sub-leader of Ninja-tech transfer
5. Shizuo Empuku (JICA investment promotion adviser in Moroccan Investment Development Agency) : External supporting member

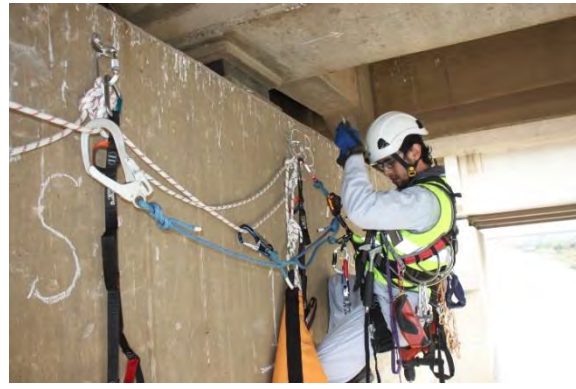
(3) Activities

1) Ninja-tech on-the-job training at ADM bridge site

On-the-Job training for two weeks to three trainees from ADM as part of work experience required to be the class-1 Ninja-tech engineer after obtaining class-2 engineer certificate was conducted.



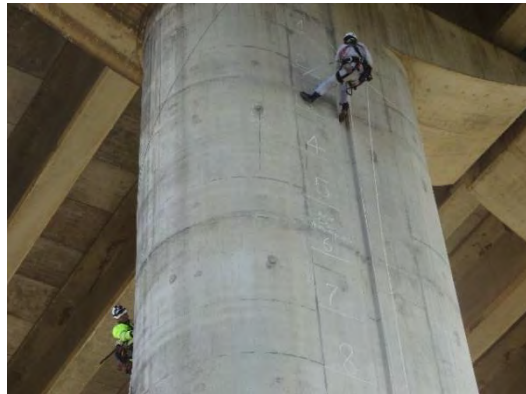
(1) Oued Sebou Bridge (Kenitra)



(2) Oued Oum Erbria Bridge (El Jadida)



(3) Lechbaa Bridge (Tangier)



(4) Oued Tahadart Bridge (Tangier)



4.5. Forth activity in Morocco

(1) Activity term

From 18th March, 2017 to 9th April, 2017 (23days)

(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Yoriko Kawakami (HEX): Business scheme development
3. Takaharu Yamaguchi (TKG) : Sub-leader of Ninja-tech transfer
4. Shizuo Empuku (former JICA investment promotion adviser in Moroccan Investment Development Agency) : External supporting member

(3) Activities

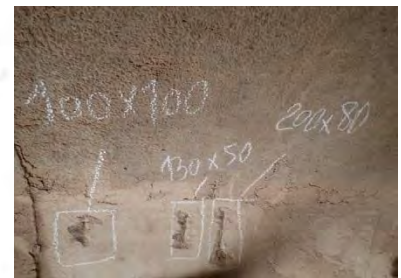
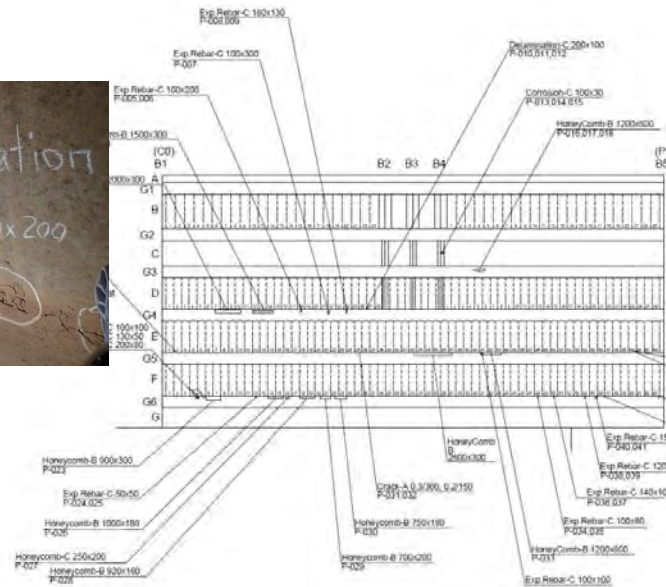
1) Ninja-tech on-the-job training at ADM bridge site

On-the-Job training for three weeks to three trainees from ADM as part of work experience required to be the class-1 Ninja-tech engineer after obtaining class-2 engineer certificate was conducted.

Bridge name	KP	Position on Google Maps
YEKEM bridge	11+000	https://goo.gl/maps/B1cXsuQ1rPH2
CHERRAT bridge	24+800	https://goo.gl/maps/kJUuAxSukB2
NFIFEKH bridge	49+000	https://goo.gl/maps/7nvmPrTPi4x
ELMALEH bridge	57+000	https://goo.gl/maps/BBmK6xZ6hBo



(1) Yekem Bridge (March 20th, 2017 - March 30th, 2017)



- Crack-C-B-1/50 P-047/048
- Exp. Rebar-C 180x100 P-014
- Exp. Rebar-C 60x30 P-044/045
- Exp. Rebar-C 50x60 P-012/013

Source: provided by HEX and TKG

(2) Nfifekh Bridge (March 31th, 2017 to April 7th, 2017)



4.6. Fifth activity in Morocco

(1) Activity term

From 8th July, 2017 to 30th July, 2017 (23days)

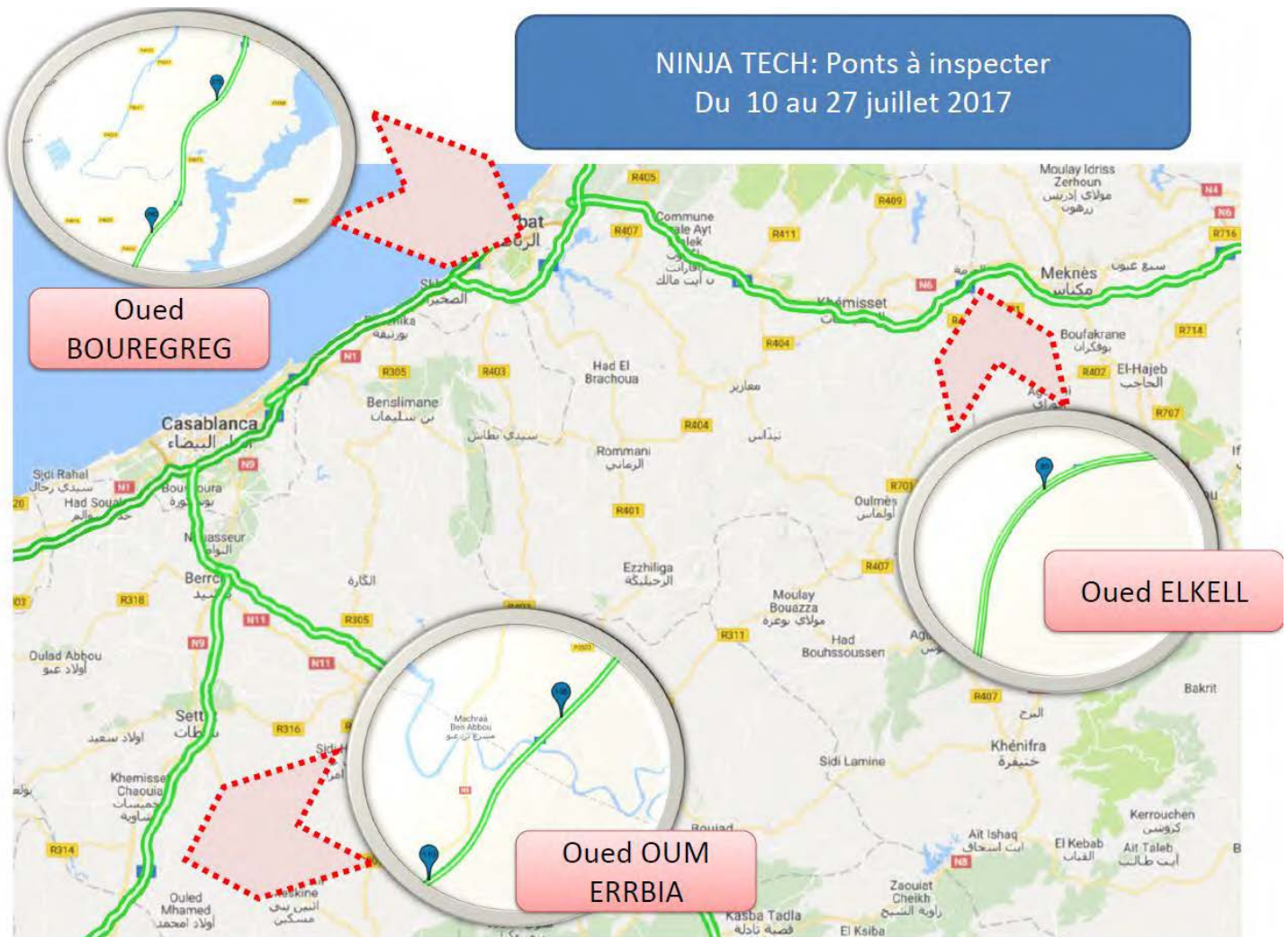
(2) Implementing members

1. Motohiko Nishibayashi (HEX) : Project leader / Project planning
2. Takaharu Yamaguchi (TKG) : Sub-leader of Ninja-tech transfer
3. Shizuo Empuku (former JICA investment promotion adviser in Moroccan Investment Development Agency) : External supporting member

(3) Activities

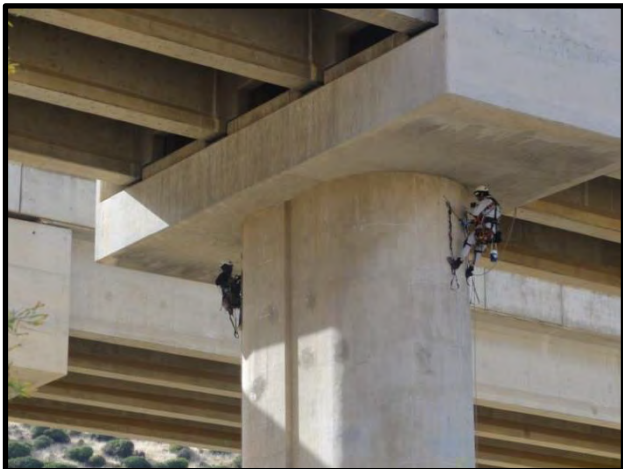
1) Ninja-tech on-the-job training at ADM bridge site

On-the-Job training for three weeks to three trainees from ADM as part of work experience required to be the class-1 Ninja-tech engineer after obtaining class-2 engineer certificate was conducted.



Source: provided by ADM

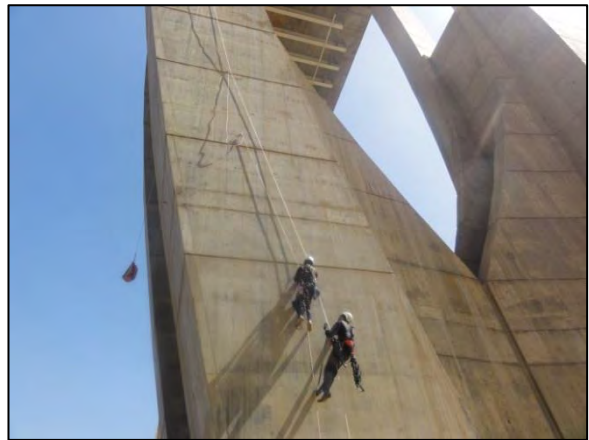
(1) EELKELL Bridge (July 10th, 2017 – July 15th, 2017)



(2) OOUM ERRBIA Bridge (July 17th, 2017 – July 22nd, 2017)



(3) Mohammed VI Bridge (July 24th, 2017 – July 28th, 2017) (refer to Appendix 3)



5.2.1. Outcomes on business establishment

(1) Marketing and needs findings

Market range of inspection and maintenance works using Ninja-tech is all sorts of social infrastructures in and outside of Morocco including road structures (bridges, slopes), railways, power plants (hydro dams, wind turbines) . The number of target facilities in Morocco is quite substantial (details are mentioned in 6.2.2).

Target market outside Morocco includes Cote d'Ivoire where ADM Project, ADM's subsidiary company has a road management advisory contract.

(2) Promotion on Ninja-tech and bridge maintenance

1) Seminar on Ninja-tech and bridge maintenance

Seminar on Ninja-tech road maintenance was implemented for approximately 50 of ADM staff responsible for maintenance.

2) Ninja-tech demonstration

Demonstration was implemented at the Muhammad VI Bridge aiming at promoting understanding of Ninja-tech. Not only members from ADM, JICA, and the Japanese Embassy but also from other infrastructure sector who could be the user in the future were invited. Approximately 130 people were attended. The demonstration ceremony was broadcasted in multiple newspaper articles and TV news.

(3) Ninja-tech skill transfer

- In order to conduct maintenance works with Ninja-tech only by Moroccan qualified engineers (team with at least 2 persons), it is necessary to get Class-1 Certification after acquiring Class-2 Certification with 96-hour (2-week) lecture and basic training and finishing at least 1,000-hour on-the-job training with guidance.
- This project covered the acquisition of Class-2 Certification and the implementation of the half of required on-the-job training (about 500 hours or 3 months) for 3 trainees from ADM.
- There is a mutual agreement between ADM and Project JV that the remaining on-the-job training (about 500 hours) is implemented in Japan between October and December, 2017 and March and April, 2018 at the expense of ADM.

(4) Alliance agreement with local partner

- The whole concept of Ninja-tech business model in Morocco has received the positive review by the General Manager of ADM, however he emphasized that the first step is to concentrate on the acquiring Class-1 Certification by ADM engineers. There is mutual agreement that the concrete preparation of establishing joint maintenance company and dissemination to other sectors will be carried out step-by-step after confirming the core Ninja-tech engineers are secured.
- Since the establishment of joint company defers, the immediate condition of technical transfer so that ADM can utilize the Ninja-tech for its own maintenance is the license contract between ADM and TKG. It is agreed that the contract shall be made before the acquisition of Class-1 Certification by 3 ADM engineers. A draft of license contract document has been sent to ADM, and it is now under reviewing by ADM.

- For the future business collaboration on infrastructure maintenance, not only Ninja-tech dissemination but also capacity upgrading on maintenance for ADM will become an important key factor. Since ADM directly requested a technical support on that matter, on August 2017, HEX has made a technical advisory contract with ADM regarding operation and maintenance of highway.

5.2.2. Challenging issues and their possible solutions

(1) Alliance agreement with local partner

- Since the decision on joint company establishment needs the consultation and approval in ADM council, it is required to make a thorough market research and feasibility study and prepare the enough and plausible data for presentation. Those researches and studies will be basically conducted by ADM and the following concrete studies on business finance and development scheme will continue to be jointly conducted for more detail consensus.
- At the time of meeting with General Manager of ADM on July 2017 (5th activity in Morocco), he explained the deference of maintenance business discussion is due to the ADM's debt issue which should be prioritized to be solved before future strategy is planned. He declared that the issue has been settled after negotiations with tax authorities and that ADM is ready to make a positive position to challenge new future projects including this maintenance business.

6. Business establishment after the program

6.1. Purpose and goal of the business

6.1.1. Projected outcome through the business (contribution of development agenda in the target area)

The final goal of the project is to promote a sustainable and autonomous maintenance framework for the infrastructure in Morocco by introducing and helping disseminate the Ninja-tech technology. This may eventually contribute the sustainable social improvement and economic growth of the country. Also through skill transfer to local engineers as core human resource, it aims to increase the awareness and improve the attitude toward social infrastructure with a long-term vision. Furthermore, it is expected that the establishment and dissemination in Morocco may be expanded further into Sub-Sahara nations in Africa as a core technology for the solution of similar challenging issues on infrastructural maintenance.

6.1.2. Projected outcome through the business (business side)

New maintenance company centered on three engineers who acquired Ninja-tech technology through this project will be established in Morocco to conduct inspection, diagnosis and repair of the infrastructure comprehensively.

In the initial stage, revenue is expected by ordering structural maintenance work from ADM.

Annual revenue of about 20 million JPY in the initial stage and EIRR =17% in the implementation period of 10 years are anticipated.

Cost estimation of the projected annual work order is as follows;

(a) Labor cost : 105,000 JPY (10,000 MAD) / Man-month = 5,250JPY / Man-day

(b) Productivity of inspection in one bridge: 6 days by 4 inspector (practice of the on-the-job training)

(c) Diagnosis cost for one bridge: 45,500 円 (Unit rate per day of Japanese engineer)

(d) Direct cost for labor in one bridge : (a)×(b)+(c)=5,250×4×6+45,500=171,500 JPY

(e) Total cost in one bridge : (Direct cost + Indirect cost) = (d)×3.08 = 528,220 JPY

(f) Number of bridge inspected in the year: 40

Working day in a year= 240 days, 6days is needed to inspect one bridge, 240/6 =40 bridges

(g) Annual work order: (e)×(f)=528,220×40=21,128,800 JPY

Annual maintenance budget of ADM is currently about 240 million yen where the paving repair is the main expenditure. In case of additional budget is necessary to conduct detailed bridge inspection is conducted, it is considered to be within the range that can be implemented since the estimated cost is about 10% of it.

6.2. Business establishment plan

6.2.1. Business outline

Business establishment is carried out step by step through the following three steps.

STEP-1: Technical transfer and dissemination

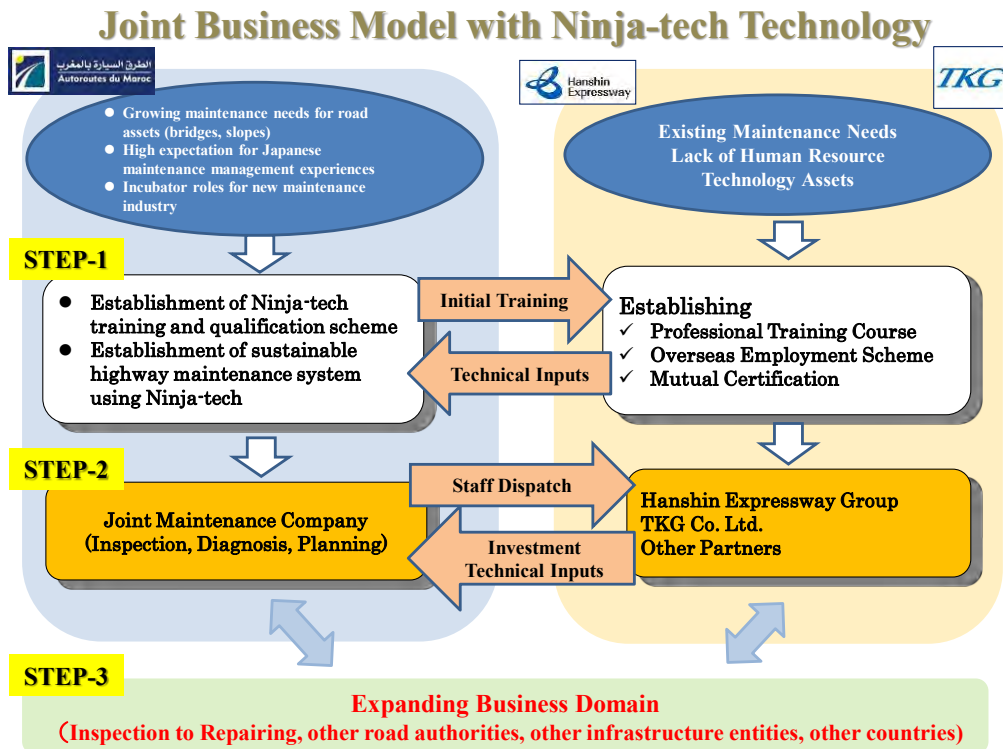
Transfer Ninja-tech technology to Moroccan engineers and disseminate the technology centered on those personnel.

STEP-2: Establishment of business foundation

New maintenance company centered on three engineers who acquired Ninja-tech technology through this project will be established in Morocco to conduct inspection, diagnosis and repair of the infrastructure comprehensively. The company will be funded both by Japan and Morocco counterpart, and the Japan side makes continuous technical inputs and help training more Ninja-tech engineers in Morocco.

STEP-3: Expansion of business domain

Business area will be expanded to the other infrastructure sector and around Morocco.



Source: provided by HEX

Joint business model with Ninja-tech in Morocco

6.2.2. Business Target

Market range of inspection and maintenance works using Ninja-tech is all sorts of social infrastructures in and outside of Morocco including road structures (bridges, slopes), railways, power plants (hydro dams, wind turbines) . Especially due to the national policy of eco-friendly renewable energy promotion, more non-carbon-emission power plants are expected to be built; hence the number of target facilities will be quite substantial in the future.

1) Road network (source: provided by Ministry of equipment, transportation and logistics of Morocco, 2014)

Road network length in Morocco (total length: 57,334km)				
Highway	Paved roads			Unpaved roads
	National roads	Local roads	Municipal roads	
1,771km	9,813 km (24%)	9,221 km (22%)	22,068 km (54%)	14,721 km

2) Bridges and their status (source: provided by Ministry of equipment, transportation and logistics of Morocco, 2014)

Number of bridges on paved roads (total: 7,500)				
Good bridges	Average bridges	Bridges with maintenance needs	Bridges with repair needs	Bridges in danger of collapse
1,500	3,300	1,700	800	200

3) Bridges and tunnels on railways

- Bridges: 624
- Tunnels: 32

4) Bridges on high-speed railway (LGV) (opened on 2018)

- Bridges: 181

5) Power plants

- Wind turbines: 548 (generating capacity: 745MW (current), 1000MW by 2020)
- Hydro dams: 68 (generating capacity: 1,770MW (current), 2000MW by 2020)

Morocco has a tight linguistic and historical relationship with Francophone Sub-Saharan countries. Therefore as target market outside Morocco includes Senegal which operates similar toll highways , and Cote d'Ivoire where ADM Project , ADM’s subsidiary company has a road management advisory contract.

6.2.3. Business steering plan

HEX, TKG and ADM jointly establish a structural maintenance company using Ninja-tech as well as Ninja-tech training institute. Both maintenance company and training institute may be within one entity according to negotiation.

HEX and TKG shall contribute to the establishment of maintenance company and training institute in ways of capital investment and technical transfer with participation in the business management. ADM has a main responsibility on business promotion in and outside Morocco.

6.2.4. Business Schedule

- Acquiring Class-1 Ninja-tech qualification by ADM engineers: May, 2018
- Official agreement on overall business plan: August, 2018
- Establishment of maintenance company and training institute: December, 2018
- Business commencement: January, 2019

6.2.5. Investment Plan

Business form	Initial capital investment	Fund arrangement	Expected payout time
Joint Ninja-tech company in Morocco - Maintenance company - Training institute	About 10 million JPY (e.g. organizational cost, equipment, personnel training)	Private fund (HEX, TKG, ADM)	Initial investment is estimated to be retrieved in about 6 years by maintenance work contracts from ADM

6.2.6. Comparison with competitive technologies in Morocco

Similar access technology using rope gears has already provided in Morocco mainly from European companies. However, Ninja-tech has unique features especially guaranteeing the safety during the procedure and the competitive level is low in that sense.

6.2.7. Challenging issues on business steering and their possible solutions

Official agreement between Japan side and ADM are critical for making business prospectus and concrete execution plans. While business promotion in and around Morocco is mainly conducted by ADM, prospectus and feasibility studies on Ninja-tech maintenance company establishment are carried out jointly. Points to be focused in the feasibility studies are as follows;

- Macro analysis on business environment (e.g. country economy overviews, country risk analysis)
- Micro analysis on business environment (e.g. reliability and financial stability of ADM)
- Studies on legal framework, financial regulation, foreign currency regulation regarding international investment in Morocco
- Studies and making of joint company execution and management system (e.g. corporative scheme, participants and responsibility, investment plan, personal allocation)
- Examination of contents of contract documents

6.2.8. Possible risks during business steering and the countermeasures

International transaction risk (e.g. country risk and commercial risk) may be covered by purchasing due insurances such as trade insurance.

6.3. Collaboration capability with ODA projects

6.3.1. Expectation for ODA project

It is essential to make an enhancement and upgrading of ADM's highway maintenance capacity. Relevant ODA project for ADM as the main counterpart is expected to have a synergy effect together with this business plan.

6.3.2. Possible ODA project scheme

Technical assistant project is inferred as possible.

6.3.3. Details of possible ODA project

Support for strengthening capacity of ADM on infrastructure maintenance technology.

Appendixes

- ✧ Appendix 1. Training materials (Source: provided by HEX)

- ✧ Appendix 2. Inspection report of on-the-job training (Source: provided by HEX and TKG)

- ✧ Appendix 3. Press articles

Appendix 1. Training materials



To advanced road service

Quality Road Management

The introduction of its basic philosophy with a case of an expressway company in Japan



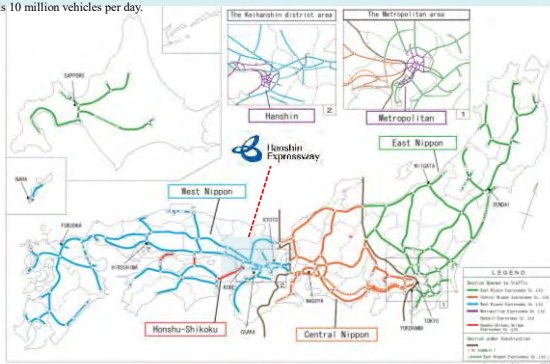
“The roads of Japan are incredibly bad. No other industrial nation has so completely neglected its highway system”



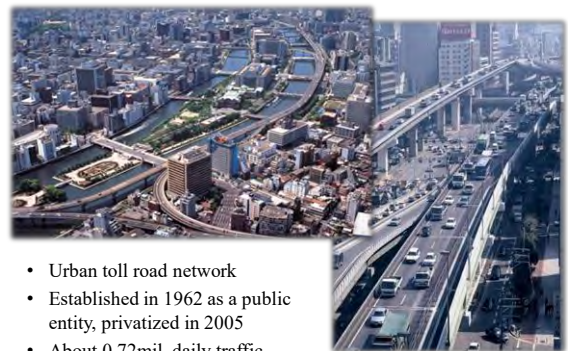
Source: Hagen, E. E., F. W. Herring, G. E. McLaughlin, W. Owen, H. M. Sapir, and R. J. Watkins (1956), *Report on Kobe-Nagoya Expressway Survey*, Ministry of Construction.

Highway Network in Japan Now

The total length of the expressway network has reached about 9,500km since its commencement of the first section about 50 years. 6 companies operate and manage expressways on which the traffic volume is 10 million vehicles per day.



Who is Hanshin Expressway?



- Urban toll road network
- Established in 1962 as a public entity, privatized in 2005
- About 0.72mil. daily traffic

Hanshin Expressway at a glance



Hanshin Expressway's Business Domain



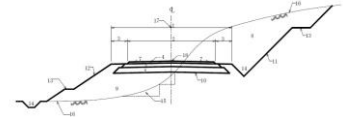
- Planning
- Project Management
- Land Acquisition
- Traffic Management
- Toll Management
- Maintenance

What can Hanshin Expressway Provide for Quality Road

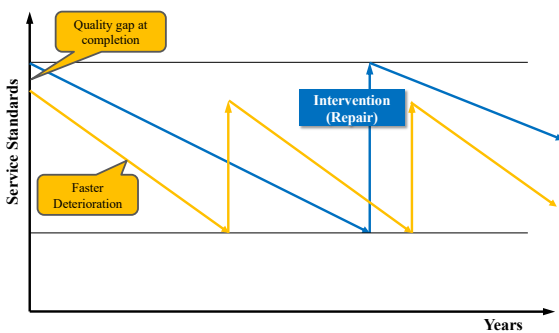


- Abundant assets and development capacity of applied technologies and know-hows on road operation and maintenance
- Project management capability on the employer's side
- Empirical and need-matching approaches

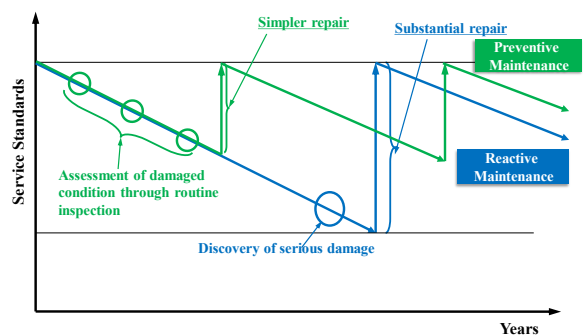
Road Structure = Human Body Road Maintenance = Health Care



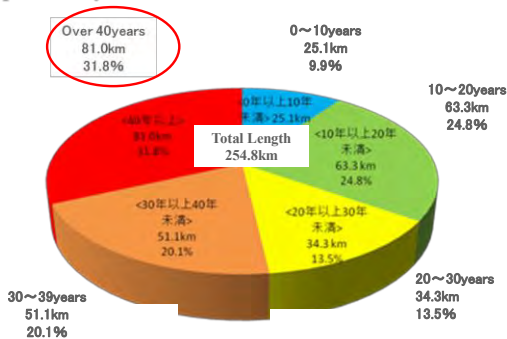
The Meaning of Quality in Road Management (1)



The Meaning of Quality in Road Management (2)



Ailing Bridge Structures in Hanshin Expressway



(As of March, 2013)

Legal Framework on Structural Inspection in Japan

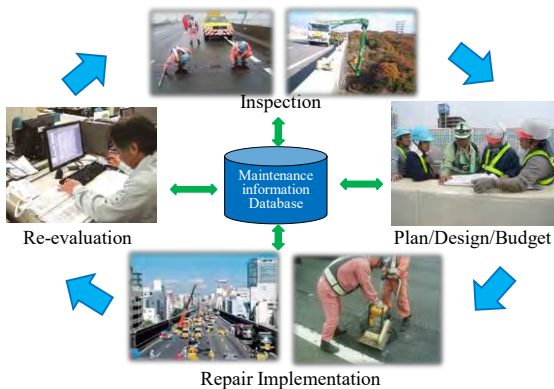


Mandatory structural inspection policy was established by the National government with the momentum of the fatal tunnel ceiling collapse accident in 2012.



All bridge whose span is over 12m (about 0.7M) and tunnel (about 10K) in Japan have to be checked by close visual inspection at least once in every 5 years with the common methodologies.

Basic Road Maintenance Cycle



◆ Basics of Maintenance Cycle

- ✓ Inspection shall be carried out as one function of maintenance cycle, and its main object is to discover damages, to identify their severity and impact level for diagnosis and to obtain basic information for repair planning
- ✓ Therefore conducting inspection itself is not the final outcome.
- ✓ Inspection is an important first step in the cycle in order to smooth annual rotation of the cycle every year to grasp the soundness of structures and to realize preventive maintenance with prompt intervention in time.

【Objects of inspection】

By conducting close-range visual inspection adequately once every 5 years,

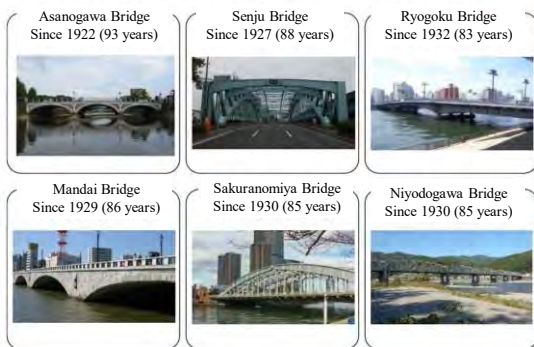
- (1) identifying the extent of structural damages correctly, and
- (2) collection necessary information for diagnosis procedure.

【Objects of diagnosis】

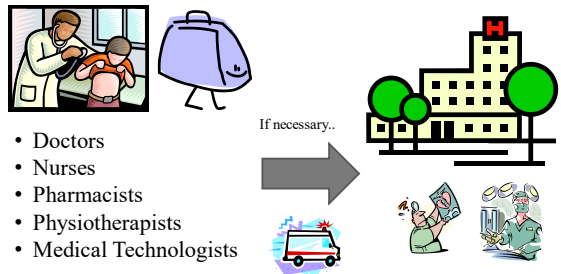
With the common standard,

- (1) judging the soundness of each structures adequately, and
- (2) linking the results with subsequent maintenance activities.

◆ Examples of very old bridges in service by keeping their soundness with appropriate maintenance



Road Authority should be a Home Doctor

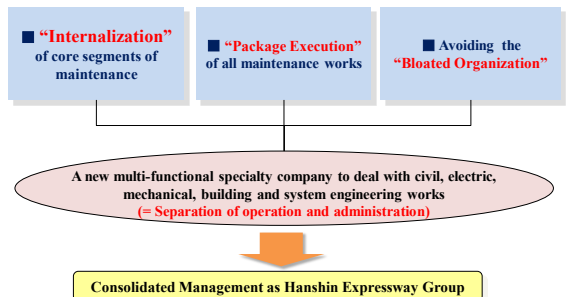


Partial Internalization of Maintenance Works

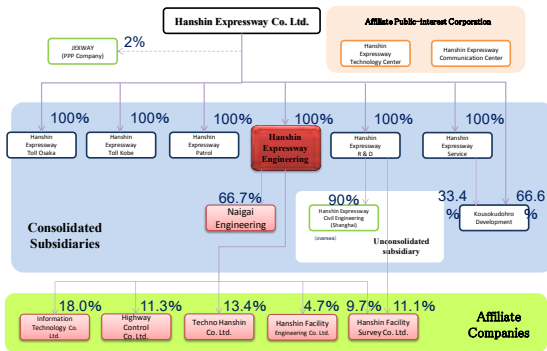


The Foundation of Hanshin Expressway Engineering

At the time of privatization, the new subsidiary company was founded to implement all routine maintenance works of Hanshin Expressway



Capital Relationship of Hanshin Expressway Group (as of May 2014)



Basic Facts about Hanshin Expressway Engineering

- Corporate Name:
Hanshin Expressway Engineering Company Limited
- Headquarter: Osaka, Japan
- Foundation: October 5th, 2005
- Capital: ¥80,000,000 (capital reserve: ¥20,000,000, capital increase: ¥60,000,000 in 2010)
- Shareholder: Hanshin Expressway Company Limited (100%)
- Representative: Atsushi Nanjo, President CEO
- Employees: about 350

Corporate Philosophy, Business Policy and Action Guidelines

Corporate Philosophy

We contribute the enrichment of the society as a whole through the maintenance the safety, security and comfort of expressway network as an important social asset.

Business Policies

- 1 Achieve and inherit the one-step further quality and technologies
- 2 Aim at the corporate structure to obtain higher reliability by customers
- 3 Seek for the clearness, smoothness, transparency and efficiency in the execution of operation and achieve the consequent cost reduction
- 4 System and capacity building to sustain various maintenance activities.
- 5 **Dedicate to the overall enhancement of Hanshin Expressway Group as a member company**

Action Guidelines

Gain the customers' satisfaction and reliability by comprehending the changing business environment and always aspiring the one level ahead from others

Business Outlines

"Maintenance of highway Structures", "Maintenance of Highway Facilities" and "Development, maintenance and operation of ITS" are our core responsibilities and we also dedicate to the maintenance of bridges and tunnels of other highway and road in a contract basis.

Civil Engineering



Inspection



Diagnosis, Database
Repair Work Planning



Repair Works

Business Outlines (cont'd)

Highway Facility Maintenance



Electric Facilities



Tunnel Facilities



Toll Booth Facilities



Central Monitoring System

Business Outlines (cont'd)

Information Systems



Management of ITS (ETC and Traffic Control) Systems



Development and Management of Road Work Coordination System



Business Outlines (cont'd)

R & D of Maintenance Technology



"Doctor Patrol"
(Automatic Road
Surface Inspection
Vehicle)



Fatigue Damage Detection Device
of Orthotropic Steel Deck



Infra-red Measurement System
for detecting void in pavement



Phased Array Ultrasonic Testing Device

Business Outlines (cont'd)

Affiliate Business



Road and tunnel
management
contracts from other
road authorities



Tunnel soil
recycling
project



Maintenance
Vehicle Rental
Business

Training of Hanshin Expressway Inspectors

Inspectors for Hanshin Expressway structures are all required to get a certification after participation of workshop and passing the examinations both provided by HE Engineering.

Type of Inspectors

Chief Inspector, Inspector, Assistant Inspector

1. Workshop: one-day

- Purpose and techniques of the structures inspection
- The safety management of inspection site
- The features of structural damages and their typical examples (Concrete, Steel, Tunnel, Earthwork, Pavement)

2. Paper test and practical exams at actual site: one-day

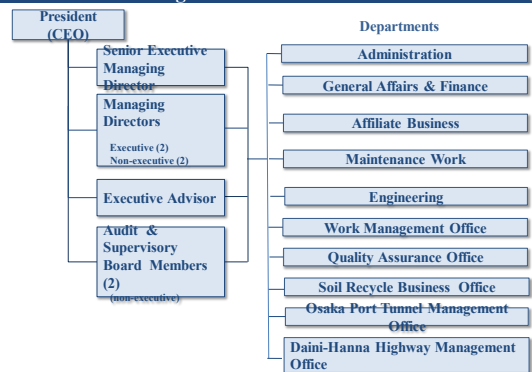


Workshop



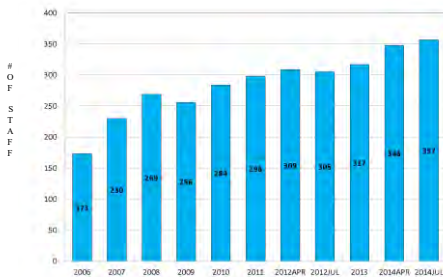
Practical Exams

Organizational Structures



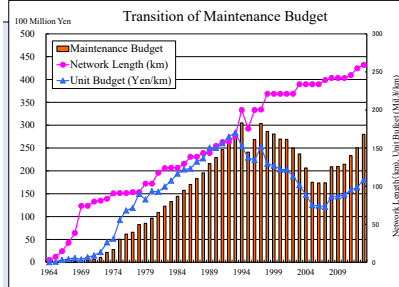
Transition of Staff Composition

Since the foundation, the number of staff has been steadily increased, and about 350 engineers and officers are employed as of now.



History of Business Performance

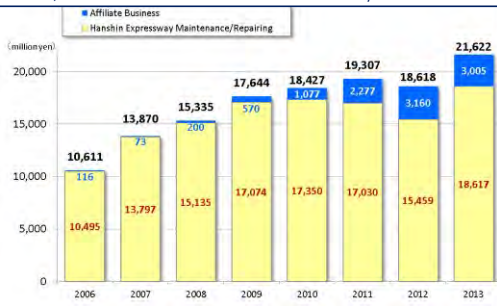
- The core business is routine maintenance including repairing
- The main client is the parent company. 60 - 70% of Maintenance of HE are done by HE Engineering.
- Most of routine maintenance works of Hanshin Expressway is outsourced to us by agreement
- The efficient maintenance is carried out under the limited budget while meeting the required service level



Note: Maintenance budget include the spending of routine maintenance and improve/rehabilitation

History of Business Performance (cont'd) - Transition of Revenue -

- The revenue has been steadily increasing, and 2013FY marked the highest earning due to the growing demand of maintenance and consequent repairing orders from parent company
- Since 2010FY, revenue from affiliate business has been remarkably increased



Growing Affiliate Business with other Clients

Type of Business and the main clients

- ◆ Engineering Contracts (Inspection and Survey of bridge structures)
 - Clients: local municipalities
- ◆ Maintenance Contracts
 - Clients: local municipalities, toll road authorities
- ◆ System Development/Management/Upgrading Contracts
 - Clients: toll road authorities
- ◆ Comprehensive Toll Road Management Contracts
 - Clients: toll road authorities adjacent to Hanshin Expressway network
- ◆ Leasing Business (Solar power plant operation)
- ◆ Vehicle Rental
 - Clients: subcontractors

Inspection Contracts from other Road Authorities

- Contract Name: Inspection of Taicho Bridge and 3 other Bridges
- Client: Kakogawa City Government
- Contract Period: Jul. 2012 – Dec. 2012
- Contract Sum: ¥3,045,000



- Contract Name: Inspection of Hyosaka Tunnel, 8 other Tunnels and 386 Traffic Signs
- Client: Kinki Regional Development Bureau, Ministry of Land, Infrastructure and Transport
- Contract Period: Oct. 2013 – Mar. 2014
- Contract Sum: ¥39,585,000,000



Merits of Doing Maintenance within the Group

- Child company shares the common concepts and long-term visions of management as a road asset owner with parent company, with which efficient maintenance activities comes before corporate profits.
- A firm trust relationship and communication between the employer and employee lead to the sharing of inspection or repairing results without hesitation and scapegoating.
- Examples of damage and maintenance failure can be accumulated within the group, which can be a quick feedback to the development of new maintenance technology through the experiments and trial applications on actual road structures
- Maintenance experts can be trained through the experience on the actual field

Keys of Quality Road Management



➢ Sustainability and long-term vision

➢ Empirical Approach

➢ Skill Transfer



<http://www.hanshin-exp.co.jp/english/>
<https://www.facebook.com/#!/hanshin.exp>



To advanced road service

Bridge Maintenance Management Inspection / Diagnosis / Repair



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Why maintenance is Necessary?



- We should aware that structural durability is not permanent
- ✓ Damages due to aging are inevitable, and
- ✓ Damages are progressive followed by the degradation of strength and functionality

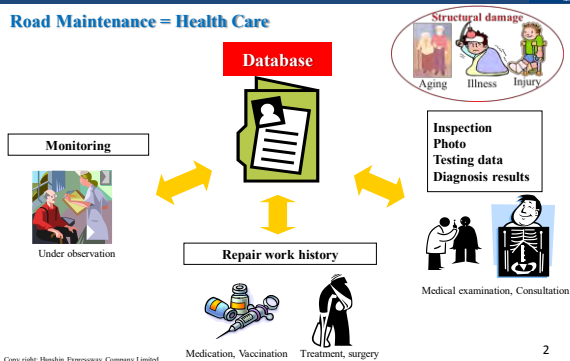


- In order to put structures in to service in a good condition, we have to
- ✓ Inspect structures in a planned and sustainable manners,
- ✓ Identify damages before getting out of hand, and
- ✓ Repair the damages timely and appropriately.

Why maintenance is Necessary?



Road Maintenance = Health Care



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2

Concept of Road Maintenance



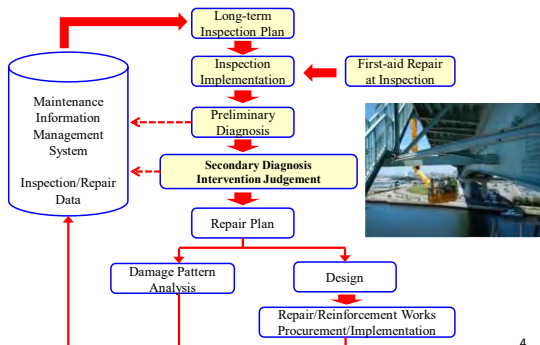
Road maintenance is to choose intervention method according to extent and causation of damage identified by inspection result

- ◆ Identify extent of structural deterioration and damage
 - Position of concrete crack, crack width, surroundings condition
 - Member deformation
- ◆ Identify causation of structural deterioration and damage
 - Environment, material, loading, etc.
- ◆ Judge intervention necessity
 - Future impact level (damage progressivity and extent of redundancy)
 - Impact level on third party disaster
 - Importance of the intervention, accountability

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Road Maintenance Flows (Inspection to Repairing)



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4

Types of Inspection



- **Initial Inspection**
 - Overlook the initial conditions of structures after the completion and acceptance (Visual checks from close range in principle)
- **Routine Inspection**
 - Confirm that there is no irregularity against safe and smooth traffic (Road surface checks, remote visual checks)
- **Periodical Inspection**
 - Identify and assess the level of damage and its consequence (Detail checks of road structures from close range with a specified interval (once every 5 years))
- **Ad-hoc Inspection**
 - Discover any irregularities right after disaster or incident
 - Supplement routine/periodical inspection

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Routine Inspection



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Periodical Inspection



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7

Inspection Result Classification



Failure Level	Classification	Definition
High	S1	There is a significant functional decline and immediate intervention is necessary from the structural safety perspective
	S2	There is a high risk of affecting on people, vehicle or any property under or adjacent to structures and immediate intervention is necessary
Low	A	There is a functional decline and an intervention is necessary
	B	There is a failure whose progress should be monitored
	C	There is a minor failure for which no intervention is necessary for the moment
	OK	There is no failure

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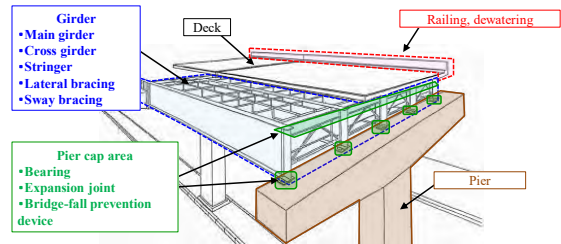
8

Bridge Member Terms



5 structural category in inspection

(1)Girder (2)Pier (3) Pier cap area (3) Deck (4)Railing, dewatering



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Typical Bridge Damages



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10

Typical bridge damages



Concrete structure

Damage type	Causation	Phenomenon
Structural damage	Cyclic load, vibration	Fatigue, seismic damage
Material deterioration	Ambient environment, material condition	ASR, neutralization, chloride damage
Initial defect	Construction failure, material condition	Honeycomb, cold joint, rough surface

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Typical Bridge Damages

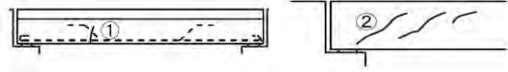


Steel structure

Damage type	Causation	Phenomenon
Structural damage	Cyclic load, vibration	Member deformation, Fatigue cracking
Material deterioration	Ambient environment, material condition	Corrosion, fatigue, bolt looseness
Initial defect	Construction failure, material condition	Deformation/stress due to welding/assembly failure, inefficient bolt tightening

12

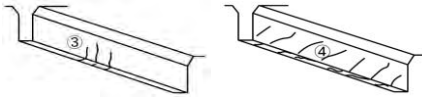
Reinforced Concrete Girder (1)



No.	Position	Crack pattern and possible causation
1	1/4 of Span	Vertical cracks on the web and the underside of girder at the main bar bending point Possible causation: reinforcing bar deficiency due to bending
2	Supporting point	Diagonal cracks on the web Possible causation: crack due to shear stress. Deficiency of diagonal tensile bar or excessive applied load.

13

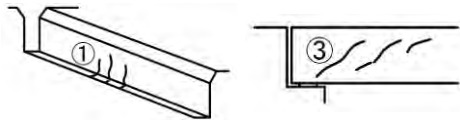
Reinforced Concrete Girder (2)



No.	Position	Crack pattern and possible causation
3	Mid-span	Vertical cracks on web and the underside of girder. Possible causation: crack due to bending moment. Large crack with more than 0.2mm in width shall be paid attention
4	Others	Diagonal cracks on all over the girder surfaces. Possible causation: girder torsion due to pier inclination triggers the crack in case of box girder with triple supporting points.

14

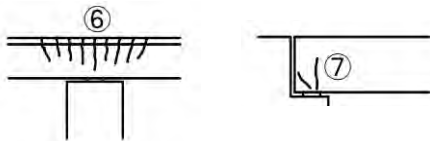
Pre-stressed Concrete Girder (1)



No.	Position	Crack pattern and possible causation
1	Mid span	Vertical cracks on the web and the underside of girder Possible causation: crack due to bending moment. Pre-stressing deficiency, PC bar corrosion fracture due to grouting deficiency or excessive loading
3	Supporting point	Diagonal cracks on the web near the supporting point Possible causation: crack due to shear stress. Deficiency of diagonal tensile bar or excessive applied loading.

15

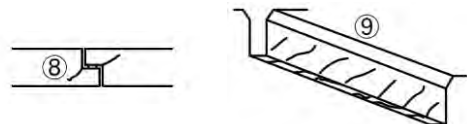
Pre-stressed Concrete Girder (2)



No.	Position	Crack pattern and possible causation
6	Supporting point	Vertical cracks in the upper part of intermediate supporting point of continuous girder. Possible causation: negative bending moment, pre-stressing deficiency against negative bending moment, PC bar fracture or subsidence at the supporting point.
7	Supporting point	Vertical or diagonal cracks on the underside or the web of girder on the end supporting point. Possible causation: excessive support friction or local.

16

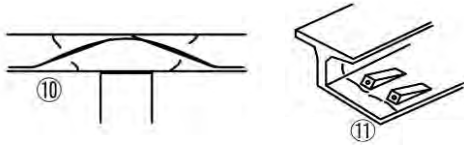
Pre-stressed Concrete Girder (3)



No.	Position	Crack pattern and possible causation
8	Supporting point	Cracks on the corner points of Gerber girder hinge Possible causation: crack due to local stress. Reinforcement steel material deficiency or excessive loading.
9	Other	Diagonal cracks on all over the girder surfaces Possible causation: girder torsion due to pier inclination triggers the crack in case of box girder with triple supporting points.

17

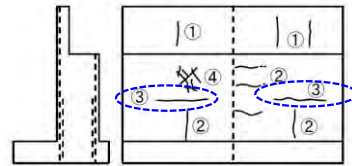
Pre-stressed Concrete Girder (4)



No.	Position	Crack pattern and possible causation
10	PC bar Inflection point	Diagonal cracks at PC bar inflection point of intermediate supporting point of continuous girder. Possible causation: reinforcement steel material deficiency at the upper or lower margin area or excessive loading.
11	Other	Cracks near the PC bar anchorage points. Possible causation: local tensile stress near the anchorage points.

18

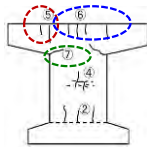
Reinforced Concrete Abutment (1)



No.	Position	Crack pattern and possible causation
3	Front side surface	Cracks near the termination points of main reinforcements Possible causation: reinforcement deficiency due to termination or stress concentration due to sharp cross-sectional change.

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Reinforced Concrete T-shaped Pier



No.	Position	Crack pattern and possible causation
5	Pier Top Beam	Vertical cracks on the upper side surface of pier top beam. Possible causation: Excessive bending moment. Large crack with more than 0.2mm in width shall be paid attention.
6	Pier Top Beam	Vertical cracks around the pier center point. Possible causation: insufficient reinforcement overlapping length
7	Main Column	Cracks on the underside of the corner point between main column and pier top beam Possible causation: local stress at the corner due to uneven loading

20

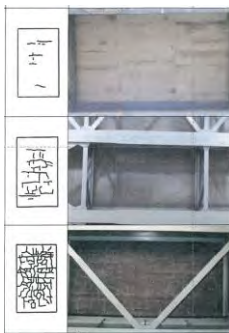
Reinforced Concrete Rigid Frame Pier



No.	Position	Crack pattern and possible causation
8	Corner Point	Cracks at the end points of column and beam haunch Possible causation: shift or rotation of footing or excessive horizontal loading on the pier
9	Column and Beam	Cracks around column surface (9) Cracks around beam haunch area at the upper end of the column (10) Possible causation: Footing subsidence
11	Beam Center	Vertical cracks on the underside surface of the beam center. Possible causation: excessive loading, reinforcement deficiency, or shift/rotation of the pier

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Reinforced Concrete Deck (1)



Cracking in a single direction
(Main re-bar direction)



Grid Cracking (Main and distribution re-bar directions)



Alligator cracking

22

Reinforced Concrete Deck (2)



Crack penetration with leakage of Isolated lime



Crack edge defects



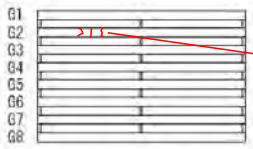
Punch-out defects

23

Reinforced Concrete Girder Defect (1)



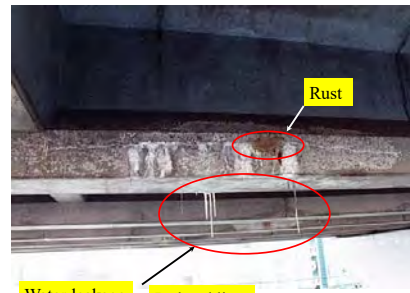
Type of Cracks	Crack width	Judgement
	More than 0.3mm	A
	More than 0.2mm and less than 0.3mm	B
	Less than 0.2mm	C



Crack width less than 0.2mm

Member	Location	Damage condition	Judgement
RC girder	G2-1	Crack width less than 0.2mm	C

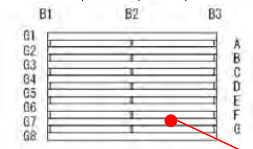
Reinforced Concrete Girder Defect (2)



Reinforced Concrete Girder Defect (2) cont'd



Item	Rank S	Rank A	Rank B	Rank C
Water leakage Isolated lime	PC girder	(1) Water leakage (2) Isolated lime is sticks around crack (3) Serious water saturation in box girder (4) Water saturation triggers A rank damage	(1) Trace of water leakage (2) Crack surface color is changed in white (3) Water saturation in box girder (4) Water saturation triggers B rank damage	Trace of water saturation is found
	RC girder	(1) Outflow of rust with total area of water leakage, isolated lime more than 0.3m ² (2) Water saturation triggers A rank damage	(1) Outflow of rust with total area of water leakage, isolated lime less than 0.3m ² (2) Water saturation triggers B rank damage	Slight water leakage and isolated lime



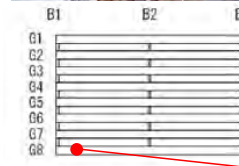
Member	Location	Damage condition	Judgement
RC girder	G7-2	Water leakage, isolated lime, rust more than 0.3m ²	A

Water leakage, isolated lime

Reinforced Concrete Girder Defect (3)



Item	Rank S
Crack	Load carrying capacity is deteriorated due to extremely large crack



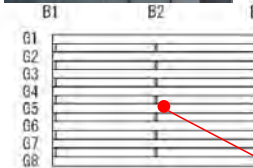
Member	Location	Damage condition	Judgement
RC girder	G8-1	Shear failure	S

Shear failure

Pre-stressed Concrete Girder Defect



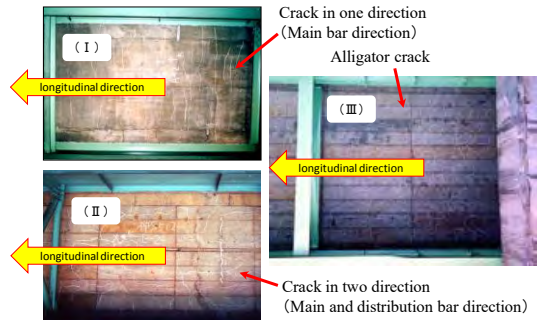
Item	Rank A
Exposure of PC bar, sheath, anchor	PC bar, sheath, anchor are exposed



Member	Position	Damage condition	Judgement
PC girder	G5-2	PC bar exposure	A

PC bar exposure

Concrete Deck Defect (1)

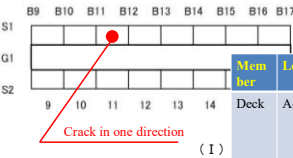


Concrete Deck Defect (2)



Crack in one direction
(Main bar direction)

Item	Crack width	Crack interval	Judgement
Average crack density	More than 0.2mm	Less than 50cm	A
	0.1 to 0.2 mm	50cm to 1m	B
	0.1 to 0.2 mm	More than 1m	C
Locally concentrated crack	More than 0.2mm	Less than 1m	B
	0.1 to 0.2 mm	More than 1m	C



Mem ber	Location	Damage condition	Judge ment
Deck	A-11	Crack in one direction (More than crack width of 0.1mm and average interval of 1m)	C

(I)

30

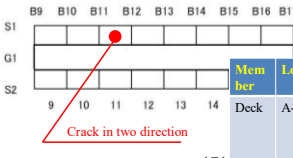
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Concrete Deck Defect (3)



Crack in two direction
(Main and distribution bar direction)

Item	Crack width	Crack interval	Judgement
Average crack density	More than 0.1mm	Less than 40cm	A
	0.1 to 0.2 mm	40cm to 60cm	B
	0.1 to 0.2 mm	More than 60cm	C
Locally concentrated crack	More than 0.2mm	-	A
	0.1 to 0.2 mm	-	B
Crack edge defect or gap	-	-	A



Mem ber	Location	Damage condition	Judge ment
Deck	A-11	Crack in two direction (Crack width more than 1mm and average interval of 0.4 to 0.6 m)	B

(II)

31

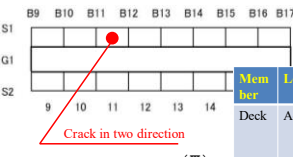
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Concrete Deck Defect (4)



Crack in two direction
(Alligator crack)

Item	Crack width	Crack interval	Judgement
Average crack density	More than 0.1mm	Less than 40cm	A
	0.1 to 0.2 mm	40cm to 60cm	B
	0.1 to 0.2 mm	More than 60cm	C
Locally concentrated crack	More than 0.2mm	-	A
Crack edge defect or gap	0.1 to 0.2 mm	-	B
	-	-	A



Mem ber	Location	Damage condition	Judge ment
Deck	A-11	Crack in two direction (Alligator crack, crack width more than 0.2mm)	A

(III)

32

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Concrete Pier Defect (1)



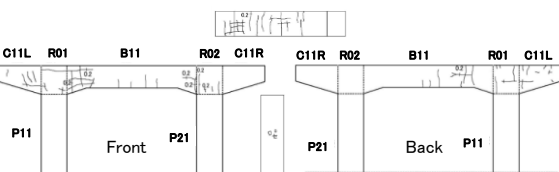
Classification of Cracks	Factors of Judgement		Judgement	Note
	Width of Crack	Distance of Cracks		
RC Structure	0.3mm ≤	-	A	
	0.2mm ≤ x < 0.3mm	-	B	
	< 0.2mm	-	C	
PC Structure	0.2mm ≤	-	A	
	0.1mm ≤ x < 0.2mm	-	B	
	< 0.1mm	-	C	
RC Structure	0.3mm ≤	< 50cm	A	
	0.2mm ≤ x < 0.3mm	50cm ≤	B	
	< 0.2mm	> 50cm	C	

No.	Crack Pattern
①	Regularly vertical cracks
②	Cracks perpendicular to the cold joint
③	Cracks near the termination of main reinforcement
④	Alligator crack, map crack
⑤	Cracks on the upper side of the overhanging beam
⑥	Vertical cracks on the center of the pier
⑦	Cracks on the underside of the overhanging beam
⑧	Cracks at the end of column or end of the haunch
⑨	Cracks go around column
⑩	Cracks go around haunch at the upper end of the column
⑪	Cracks on the underside at the center of the beam
⑫	Horizontal cracks on the beam

Concrete Pier Defect (2)



Member	Damage Location	Damage Condition (Situation)	Judgement
RC Pier	B11	Cracks of the RC structure 0.2mm ≤ x < 0.3mm	B
RC Pier	C11L	Cracks of the RC structure < 0.2mm	C
RC Pier	R01-P11	Cracks of the RC structure < 0.2mm	C
RC Pier	R02-P21	Cracks of the RC structure 0.2mm ≤ x < 0.3mm	B

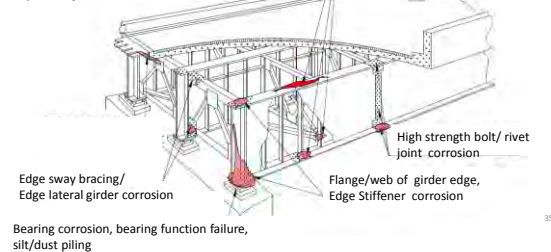


Steel Pier Defect (1)



Corrosion prone area in I steel girder

Silt piling in joint drainage trough
Expansion joint face corrosion



35

Steel Pier Defect (2)



Corrosion of steel girder due to water leakage
(Thickness reduction more than 10%)



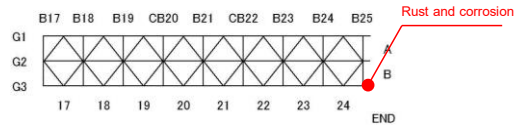
36

Steel Pier Defect (3)



Damage Item	Rank S	Rank A	Rank B	Rank C
Rust and corrosion	Dangerous condition which may leads traffic accident	Section loss is more than 10% of thickness	Wide area is rusted Partly corroded	Slightly rusted

Member	Location	Damage condition	Judgement
Steel girder	3G-E	Rust and corrosion (Thickness loss is more than 10%)	A



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Judgment Trial



Question :

Let's try Judgement for damages shown in the photos!
(S, A, B, C, OK)

※Refer to Inspection Manual



Judgment Trial



[Q1] Steel Girder

Rust on the upper flange (Partial corrosion)



[A1] Rank C

Evidence: Sporadic rust

39

Judgment Trial



[Q2] Steel Girder

Thickness loss of vertical stiffener on the main girder 2/9mm



[A2] Rank A

Comment: Thickness loss is more than 10% of member thickness.
(In case of just above the bearing, the damage is judged as rank T1 (Priority Repair) for secondary judgement considering structural safety.)

40

Judgment Trial



[Q3] Pre-stressed Concrete Girder

Crack on PC girder 0.1~0.2mm



[A3] Rank B

Comment: $0.1\text{mm} \leq x < 0.2\text{mm}$ cracks on PC girder is judged as Rank B.

※In case of reinforced concrete girder, this crack is judged as Rank C

41

Judgment Trial



[Q4] Pre-stressed Concrete Girder

Exposure of tendon anchor



[A4] Rank A

Comment: Exposure of tendon or sheath or anchor

42

Judgment Trial



[Q5] Reinforced Concrete Girder

Cracks on the side of RC girder 0.2~0.3mm



[A5] Rank B

Comment: $0.2\text{mm} \leq x < 0.3\text{mm}$ cracks on RC girder is judged as Rank B.

※In case of reinforced concrete girder, this crack is judged as Rank A

43

Judgment Trial



[Q6] Reinforced Concrete Pier

RC Pier $0.3\text{m}^2 \leq$ water leakage or free lime



[A6] Rank A

Comment: Total area of water leakage and free lime and rust is 0.3m^2 or more

44

Judgment Trial



[Q7] Steel Pier

Bend of splice plate
(Side: 10mm, Underside: 5mm)



[A7] Rank A

Comment: Bend of splice plate is occurred by corrosion

45

Judgment Trial



[Q8] Reinforced Concrete Deck

Local alligator cracks on RC Deck (Crack width : 0.1~0.2mm)



[A8] Rank B

Comment: Local alligator cracks with 0.1~0.2mm width on RC deck is judged as Rank B

46

Judgment Trial



[Q9] On the Substructure Beam

Anchor Bolt for Bearing Touch between upper member and bolt



[A9] Rank C

Comment: Touch between members
※In case of touch and rust, damage is judged as Rank B

47

Judgement Trial



[Q10] Expansion Joint

Breakage of Gutter (L=1150mm)

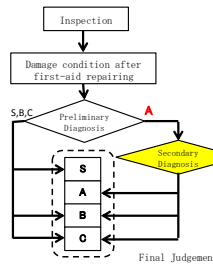


[A10] Rank S2

Comment: The damage is remarkable and broken member is expected to fall

48

Secondary Diagnosis (1)



✓ Preliminary diagnosis is the initial judgement on mere damage conditions and is based solely on classification standards by structural type prescribed in the Inspection Manual.

✓ Secondary diagnosis adds on A-class damages the judgement regarding their future impact level such as **damage progressivity and the extent of redundancy**.

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Secondary Diagnosis (2)



➢ Damage Progressivity (speed of proliferation)

Judging when the identified damage extends and reaches to the state where the member ruptures and loses its function completely, or whether the speed to reach to such state is within the interval up to the next inspection and there is enough time to give any preventive intervention.

➢ Damage Redundancy (functional margin as the whole structural system)

Evaluating whether the function as the whole structural system can be lost such as collapsing when the identified damage extends and reaches to the state where the member lose its function such as rupturing

Preliminary diagnosis	Secondary diagnosis			
	Redundancy	Progressivity		
		Small	Middle	Large
S	S			
A	Small	A	A	B
	Middle	A	B	B
	Large	B	B	C
B	B			
C	C			

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Intervention Judgement (1)



Class	Intervention	Definition
T1	Individual Repairing	<ul style="list-style-type: none"> To recover or upgrade the structure's durability, usability and functionality, to mitigate the negative impact on the third parties, and to regain the structure's physical strength such as stiffness of structural members or the structure as a whole Preventive repairing which should be taken immediately judging from the current condition or which is rather economical than proactive interventions. Either permanent or first-aid repair method shall be chosen according to the current damage status.
T2	Planned Repairing	<ul style="list-style-type: none"> To recover or upgrade the structure's durability, usability and functionality, to mitigate the negative impact on the third parties, and to regain the structure's physical strength such as stiffness of structural members or the structure as a whole A systematic repairing which enables more efficient functional recovery coupled with other associated middle- or long-term maintenance plans.
T3	Supplementary Inspection/ Testing	<ul style="list-style-type: none"> Further examination of the identified damages such as detail inspection, sampling and/or non-destructive testing to estimate their cause and to predict the extent and speed of their progress.

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Intervention Judgement (2)



Further classification to determine the contract types of repair works

Class	Intervention	Sub-Class	Intervention timing and contract type
T1	Individual Repairing	T1	<ul style="list-style-type: none"> Giving higher priority
T2	Planned Repairing	T2t	<ul style="list-style-type: none"> Repair work is undertaken in an internal repair work
		T2a	<ul style="list-style-type: none"> Repair work is packaged with other similar failures and outsourced to contractors
		T2b	<ul style="list-style-type: none"> Repair work can be undertaken independently in the scaffolding set for other contracts
		T2c	<ul style="list-style-type: none"> Repair work is undertaken after the work methodology is determined
T3	Supplementary Inspection/ Testing	T3	<ul style="list-style-type: none"> Planning of mid-term or ad-hoc inspection/testing

52

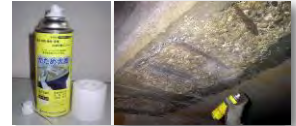
First-aid Treatment during Inspection



First-aid treatment should be conducted by making the most of close range visual inspection opportunity

Advantageous in cost and time consumption

~ Concrete surface protector ~



- After removal of loose concrete, honeycomb
- Exposed rebar

~ Cleaning and removal of jamming on the structure ~



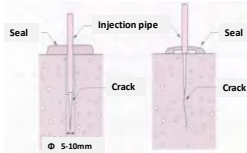
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Concrete Structure Repair (Crack injection)



Injection of epoxy resin or cement mortar by automatic low pressure injector



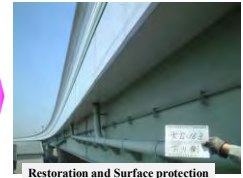
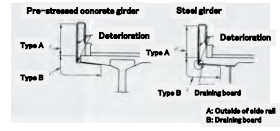
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Concrete Structure Repair (Surface Restoration)



Removal of broken concrete, corrosion protect, restoration, surface protection



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Concrete Structure Reconstruction



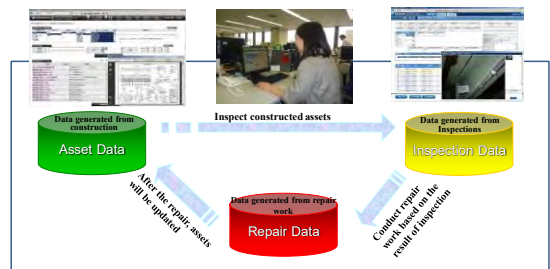
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Organizing Database for Maintenance Management



- A "Maintenance Information Management System," which is an unified management concept of associated various types of data and information, shall be built and operated.



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Conclusion



Road maintenance management is ...

Maintain road structures efficiently and in planned manner by estimating condition of structure objectively, predicting future deterioration and determining maintenance plan under budget constraints.



- ◆ Assessment of structural condition by inspection
- ◆ Development of database
- ◆ Prediction of structural deterioration
- ◆ Optimum plan of maintenance work

Inspection and diagnosis are the basis of maintenance cycle

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Appendix 2.

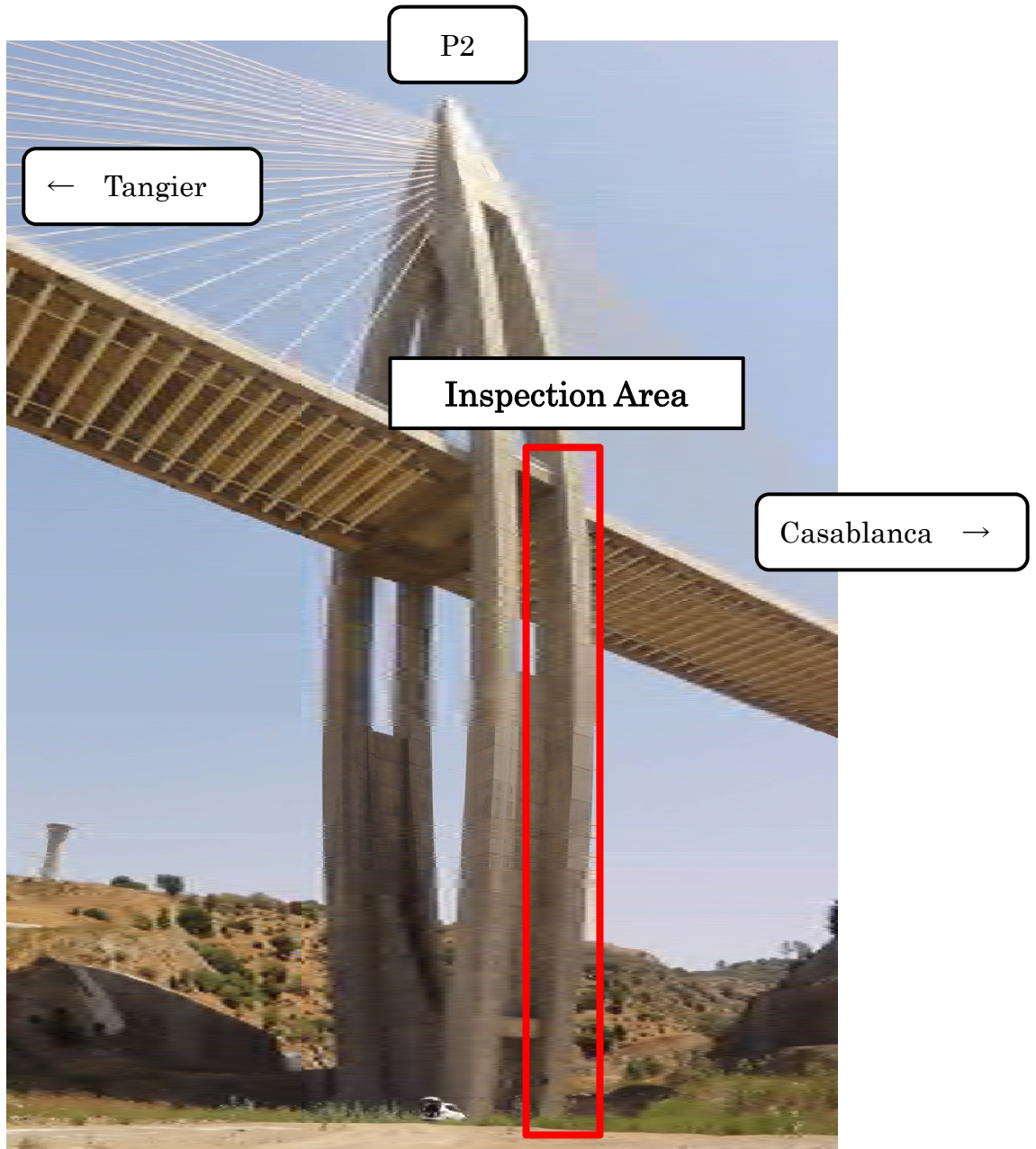
Inspection report of on-the-job training

Inspection Result Report
Bouregreg Bridge
- 3rd Ninja-tech On-the-Job Training in Morocco-

July, 2017

Societe Nationale des Autoroutes du Maroc
Hanshin Expressway Company Limited
Tokusyū Kōsūyō Gijyūtsu Inc.

Inspection Area





Bouregreg Bridge

P2

E00m_1

Residue



Bouregreg Bridge

P2

E00m_2

Residue



Bouregreg Bridge

P2

E00m_3

Residue



Bouregreg Bridge

P2

N00m_1

Residue



Bouregreg Bridge

P2

N00m_2

Residue



Bouregreg Bridge

P2

N02m_1

Residue



Bouregreg Bridge

P2

N02m_2

Residue

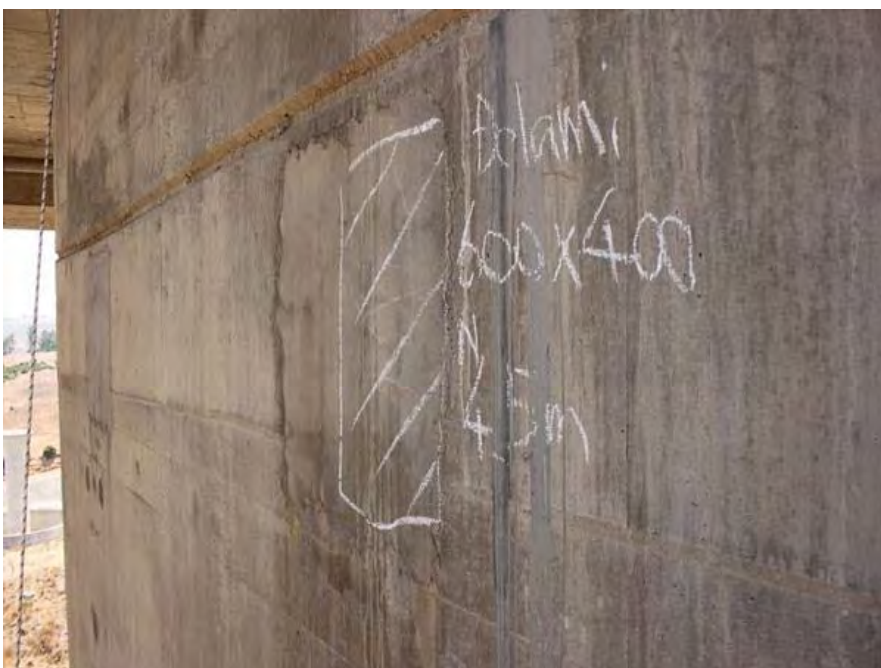


Bouregreg Bridge

P2

N02m_3

Residue



Bouregreg Bridge

P2

N05m_1

Delamination 600x400



Bouregreg Bridge

P2

N05m_2

Delamination 600x400

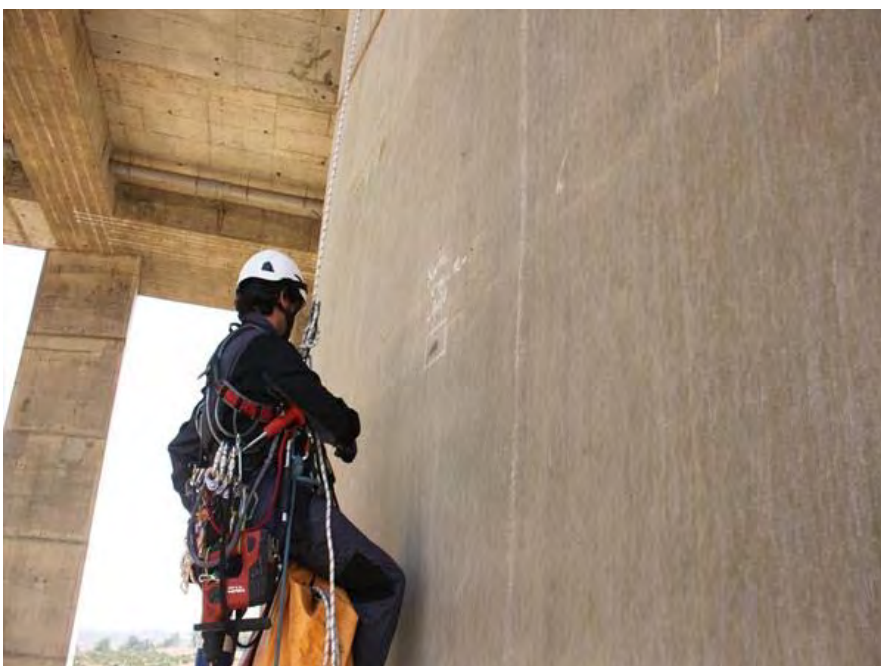


Bouregreg Bridge

P2

N05m_3

Delamination 600x400



Bouregreg Bridge

P2

N15m_1

Exposed Rebar 40x70



Bouregreg Bridge

P2

N15m_2

Exposed Rebar 40x70



Bouregreg Bridge

P2

N15m_3

Exposed Rebar 40x70



Bouregreg Bridge

P2

N17m_1

Stain

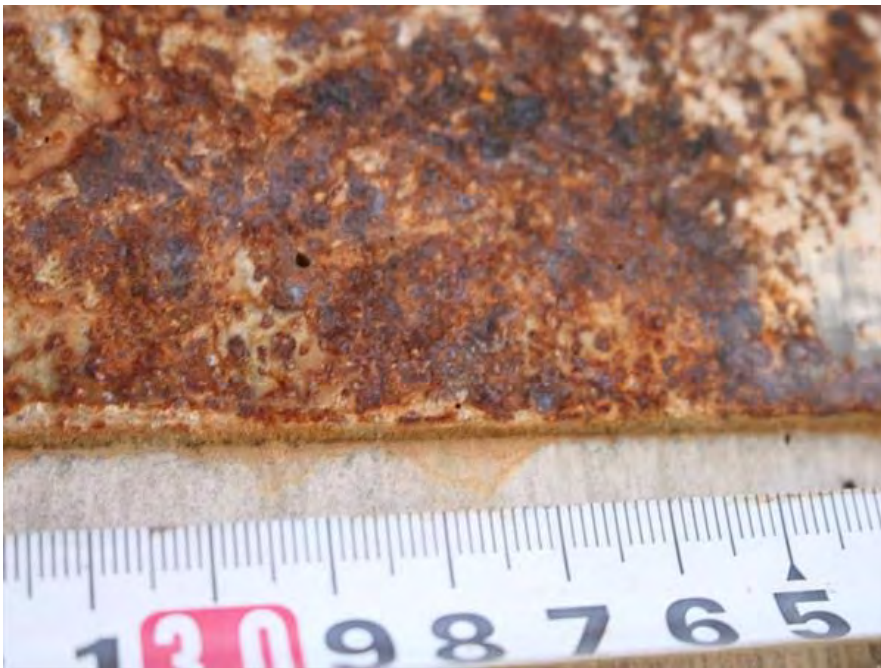


Bouregreg Bridge

P2

N17m_2

Stain



Bouregreg Bridge

P2

N17m_3

Stain



Bouregreg Bridge

P2

N37m_1

Exposed Rebar 330x100



Bouregreg Bridge

P2

N37m_2

Exposed Rebar 330x100

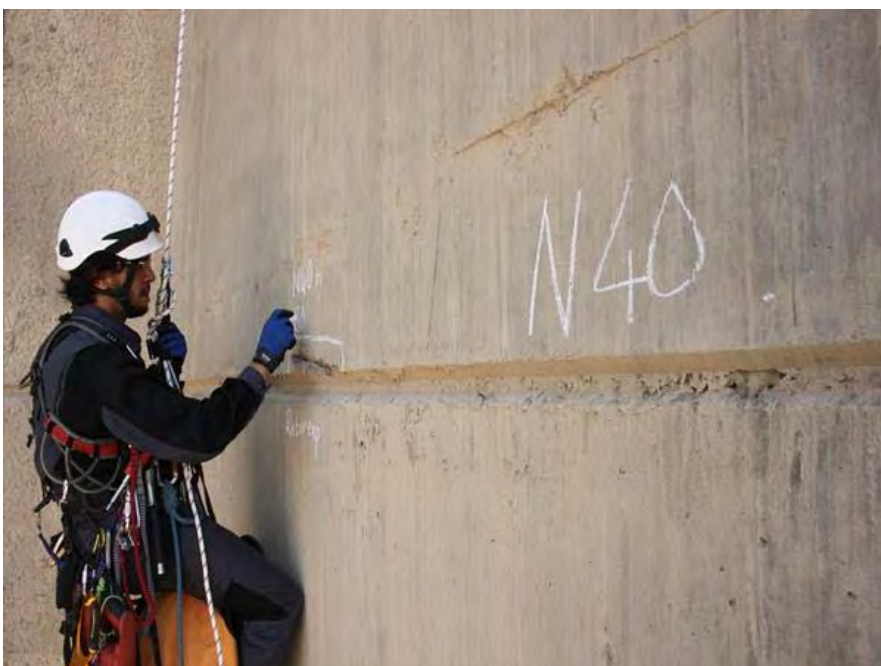


Bouregreg Bridge

P2

N37m_3

Exposed Rebar 330x100



Bouregreg Bridge

P2

N40m_1

Exposed Rebar 80x420



Bouregreg Bridge

P2

N40m_2

Exposed Rebar 80x420



Bouregreg Bridge

P2

N40m_3

Exposed Rebar 80x420



Bouregreg Bridge

P2

S00m_1

Residue

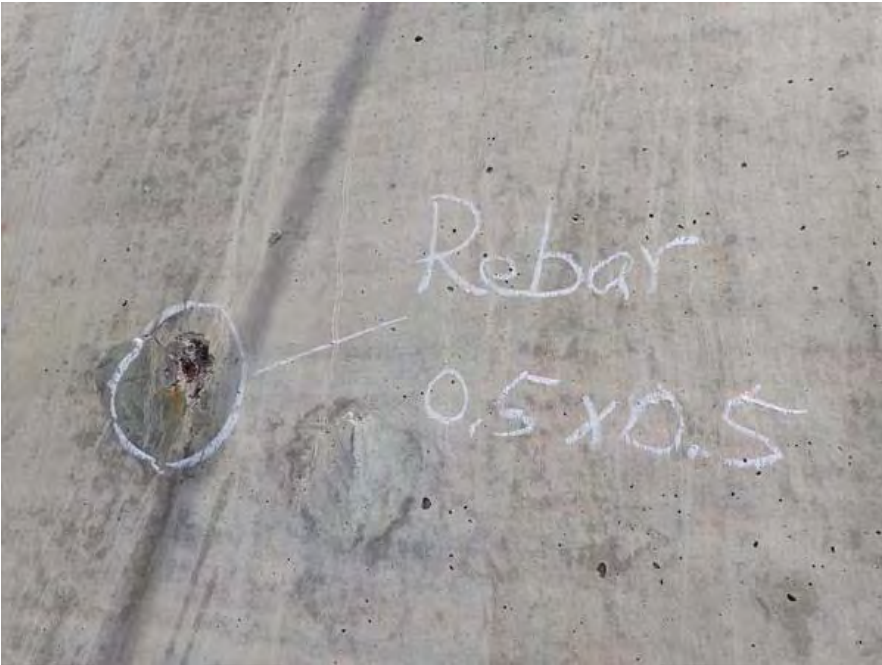


Bouregreg Bridge

P2

S00m_2

Residue



Bouregreg Bridge

P2

S04m_1

Exposed Rebar 50x50



Bouregreg Bridge

P2

S04m_2

Exposed Rebar 50x50



Bouregreg Bridge

P2

W20m_1

Residue



Bouregreg Bridge

P2

W20m_2

Residue



Bouregreg Bridge

P2

W28m_1

Residue



Bouregreg Bridge

P2

W28m_2

Residue

余 白

余 白

Appendix 3. Press articles

(English translation of an article of local newspaper “Les Eco” dated 12/05/2016)

Cable-Stayed bridge on the Bouregreg River : “Ninjas” keep eye open on for trouble



The main piece of the highway of by-passing of Rabat, this bridge is the concentrate of technology.

The Japanese technology NINJA TECH is utilized for controlling the quality of the bridge thanks to the highly qualified persons.

The cable-stayed bridge, on the Bouregreg River, the symbol of the new highway of bypassing of Rabat, having the length of 41 km, was presented yesterday to the press.

The bridge, the first in Africa, has length of 950 m with two pylons of 200 m of height.

Inspired by the doors of Rabat and of Sale, the bridge utilizes 1000 km of wires, 3,200 tons of steel, imported from China.

The significant fact, it encompasses the longest wire put under tightness in the world, which is of 261 m.

The bridge is so high that due to violent wind, the canopy accommodating the officials and the journalists, has been shaken so much and there was a moment of panic and of rushing.

Not hurt so much as frightened fortunately.

As to the roadway, it has 3 lanes in each direction and it is supported by 160 stays.

When it will enter into function (the date has not been informed), the bridge will enable users of the highway coming from north and from Fes to by-pass Rabat in order to go to the south.

This by-pass will relieve congestion definitely in the transit traffic in the capital, showing a strong component of heavy vehicles.

For Mohamed Najib BOULIF, minister of Equipment and of Transportation, it is an important ceremony which demonstrates the strong relations with Japan.

“Autoroutes du Maroc has, to his name, several projects, but the cable-stayed bridge is the first in Africa and the technical masterpiece. It shows that Morocco has capacities to be in tune world-widely with and capable to compete with the big projects in terms of highway”, emphasized the minister.

And to add that with 1,800 km of highways, Morocco gives a good impression on the subject of the connectivity that classifies Morocco in the second position.

The ambassador of Japan in Morocco, Tsuneo KUROKAWA, emphasized the importance of development and maintenance of road infrastructures.

He quoted in this connection the technic of control from close position, Ninja Tech, in partnership with a leading Japanese company in this field.

“I am convinced that Ninja Tech will help Morocco for the maintenance of the infrastructures”.

The Japanese company has contributed to re-construct the stricken regions with zero accident.

On the other hand, the partnership with the Japanese concessionaire of highways HANSHIN EXPRESSWAY, has been decisive for carrying through the infrastructures to a successful conclusion.

For Anouar BENZAOUZ, DG of ADM, the apprenticeship passes by the Human Resources.

In this sense, three persons will be trained in the technics of Ninja Tech.

“We are the footbridge between Morocco and Japan concerning this technology, which can also profit by MASEN in the control of its wind infrastructures, especially”.

(English translation of an article of local newspaper « L'Economiste » dated 12/05/2016)

The highway of by-passing of Rabat soon opened

The highway of by-passing of rabat is finally ready.

It is, in fact, proceeded to the last finalization for its opening to the traffic in coming several weeks.

The information has been announced by Mohamed Najib Boulif, the delegated minister of the Transportation at the time of a visit to the big cable-stayed bridge, which is a part of this project.

With a length of nearly 40 km, this highway necessitated an investment of nearly 4 billion DH.

This visit has also been an occasion for the Japanese company HANSHIN to present the technic of auscultation Ninja Tech which will be adopted for the maintenance and the preventive maintenance of the cable-stayed bridge of Bouregreg with a real demonstration by a team of the company.

(English translation of an article of local newspaper "La Nouvelle Tribune" dated 12/05/2016)

ADM presents the method of auscultation "Ninja Tech

A demonstration of new technic, called « Ninja Tech », specialized in the inspection and the auscultation of big structures, including the bridges, took place Wednesday in Rabat.

Presented at the time of a meeting initiated by Autoroutes du Maroc (ADM), « Ninja Tech », is based on revolutionary technology for the structures in inaccessible high zones and is consist of a visual auscultation from close position, enabling the immediate interventions.

On this occasion, the delegated minister of Transportation, Mohamed Najib Boulif, indicated that the adoption of this technic of auscultation of structures, to be specific, the bridge of the River Bouregreg, is inscribed in the framework of a partnership agreement between ADM and the Japanese company « Hanshin Expressway Ltd ».

It is a new technic to be able to preserve and prolong the life duration of this bridge, indicated the minister in a declaration to MAP, marking that it is the first in its genre in African and Arabic countries. This solution will enable the inspection and the auscultation, far away from traditional method, of numerous structures and bridges, he said.

During this meeting, which took place in presence of the Ambassador of Japan in Morocco, Tsuneo Kurokawa, of the Director General of Japan International Cooperation Agency (JICA), Koichi Shoji, M. Boulif announced that the cable-stayed bridge on the River Bouregreg, the works of which have been achieved, will be operational in June 2016.

On his side, the Director General of ADM, Anouar Benazzouz, noticed that this event is an occasion for presenting the project « Ninja Tech » which constitute one of the major challenges in terms of maintenance of the structures and of the infrastructures, raising, in this viewpoint, that the company will work in partnership with « Hanshin Expressway » for the training of the Moroccan experts for inspection of structures and structures of general civil, presenting the difficulties of access.

On its side, the Director of the Cooperation in Japanese company « Hanshin Expressway », Nishi Bayashi, stated precisely that this demonstration is supposed to be an occasion for introducing « Ninja Tech », a unique method in its genre and utilized for the first time outside of Japan, expressing the expectation to reinforce the cooperation in the field of road.

In parallel with this meeting, ADM and the company « Hanshin Expressway » proceeded to the real demonstration of an auscultation on the cable-stayed bridge of Bouregreg on a pylon of 200 meters (m) of height.

The cable-stayed bridge over the River of Bouregreg is an integral part of the project of construction of the highway of by-passing of Rabat.

It is a work of 950 m of length with two pylons of 200 m of height, while the roadway has 4 lanes in each direction and is supported by 160 cables.

(English translation of an article of local newspaper “La Vie Eco” dated 12/05/2016)

【 Ninja Tech 】, the Japanese technology for the service of Moroccan working sites

A demonstration of a new technic, called 【 Ninja Tech 】, specialized in the inspection and the auscultation of big structures, including the bridges, has taken place Wednesday on 11 May 2016 in Rabat.

Presented at the time of meeting initiated by the Autoroutes du Maroc (ADM), 【 Ninja Tech 】, is based on a revolutionary technology for the structures in inaccessible high zones and is consist of a visual auscultation from close position, enabling the immediate interventions.

This technic will be utilized for the cable-stayed bridge of the river Bouregreg.

It is a new technic in order to enable to preserve and to prolong the life duration of this bridge, indicated the delegated minister in charge of the Transportation, Mohamed Najib BOULIF, marking that it is the first in its genre on African and Arab scale.

Before pursuing, this solution will enable the inspection and the auscultation, far away from the traditional methods, of numerous structures and bridges.

During this meeting, which has taken place in presence of the Ambassador of Japan in Morocco, Tusneo KUROKAWA and the resident representative of Japanese International Cooperation Agency (JICA), Hitoshi TOJIMA, Mr. Boulif announced that the cable-stayed bridge on the River of Bouregreg, the works of which have been achieved, will be operational in June 2016.

(English translation of an article of local newspaper « Le Matin » dated 30/11/2016)

Preservation of the bridges

Autoroutes du Maroc involves the Japanese expertise



The choice of Japan for perpetuating the bridges in Morocco, states precisely ADM, is explained by the pertinence of the model Nippon.

Autoroutes du Maroc (ADM) has concluded a partnership with Japanese Hanshin Expressway Company Ltd for the training of her staff.

The Japanese enterprise trains the officers and technicians of ADM for the professions of preservation of Moroccan bridges, not existing in the country.

“The partnership with Hanshin Expressway Company Ltd enabled the Moroccan officers to benefit by a training for technics of auscultation of several months in Japan and In Morocco”, indicates ADM.

The officers have been trained on the concrete case of Japanese bridges with a view to initiate them for the technics of knowledge of the real status of the bridges (examinations, specific measures, etc.)

and for the materialization of eventual diagnostics.

Ensured under cooperation with Japanese International Cooperation Agency (JICA), the training is ratified by a certificate of expertise which enables the Moroccan officers to train on their turn other collaborators of ADM.

The choice of Japan for perpetuating the bridges in Morocco, states precisely ADM, is explained by the pertinence of the model Nippon.

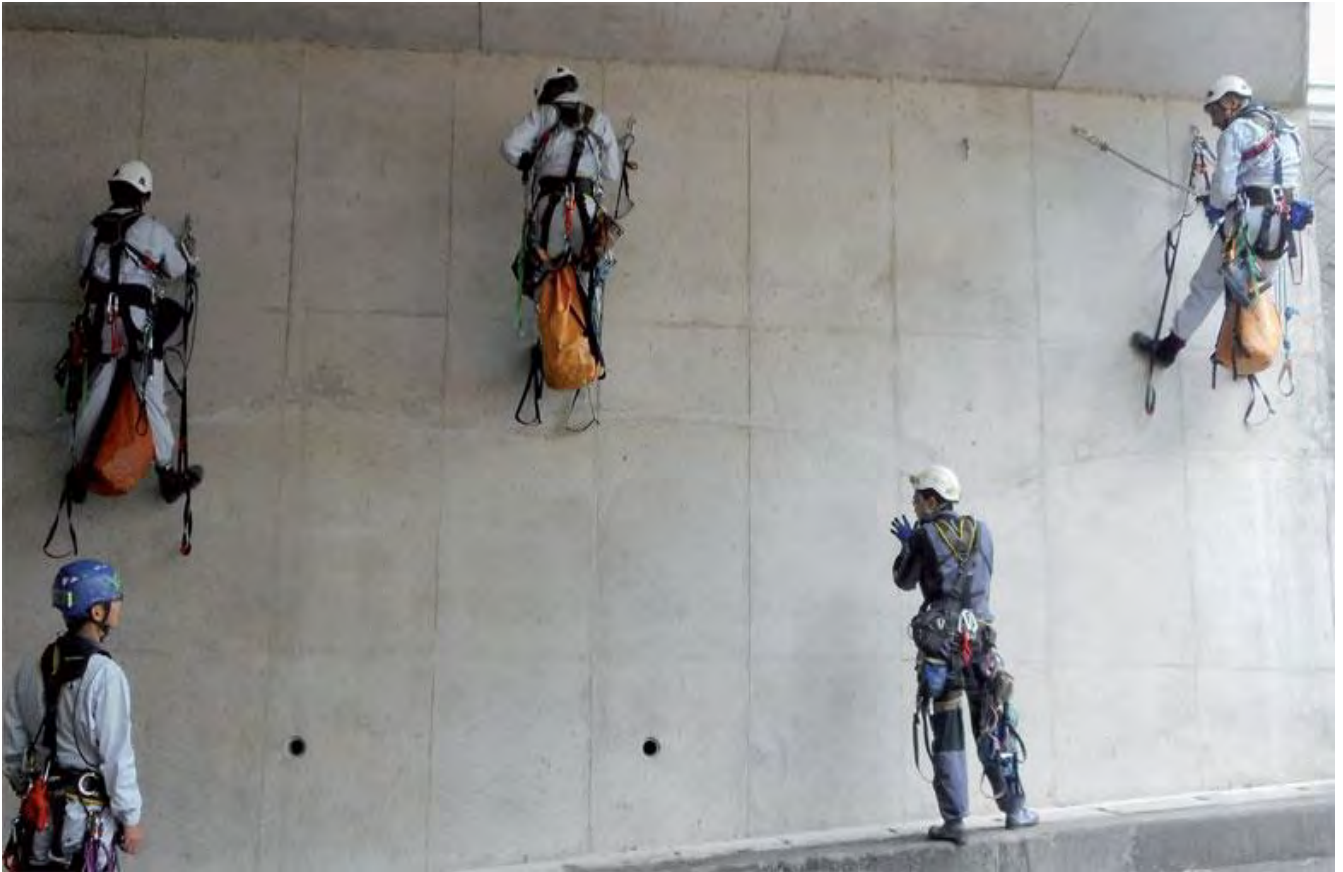
The latter makes, in fact, the reference in the world, because it is obligation to do inspection of the bridges minimum once in every five years.

Real specialist, Hanshin Expressway Company Ltd has experience of more than a half century and is considered as a model in this area.

(English translation of an article of local newspaper « Le Matin » dated 01/12/2016)

Preservation of bridges

A training for the officers of Autoroutes du Maroc



The Moroccan officers have been initiated for technics of diagnostics of bridges.

Autoroutes du Maroc has trained her officers for the preservation of bridges. This training, not existing in Morocco and ensured by Japanese group, has enabled them to learn to diagnose with precision the real status of the bridges. On their turn, they could train their colleagues.

Perpetuate the bridges beyond a century.

Such is the objective of partnership concluded between Autoroutes du Maroc (ADM) and Japanese Hanshin Expressway Company Ltd. This agreement is concerned with the training of staff of the Moroccan company for the preservation of bridges of the country. "This agreement has enabled the Moroccan officers to benefit by a training for technics of auscultation of several months in Japan and In Morocco", indicates ADM.

Not existing in Morocco, this training was concerned with the concrete case of bridges in Japan with a view to initiate the Moroccan officers for technics of knowledge of the real status of the bridges

(examination, specific measures, etc.) and for the materialization of eventual diagnostics.

Ensured in cooperation with Japan International Cooperation Agency (JICA), the training is approved by a certificate of expertise which enables the Moroccan officers to train on their turn other collaborators of ADM. The choice of Japan for perpetuating the bridges in Morocco public company, is explained by the pertinence of the model Nippon.

The latter makes in fact reference in the world, because it is obligatory to inspect the bridges minimum once in every five years. Veritable specialist, Hanshin Expressway Company Ltd has experience of more than a half century.

Her partnership with ADM has provoked the interest of Japanese media and especially of TV Tokyo.

The latter “has dispatched a team of shooting for materializing a reportage on ADM from 28 November to 9 December 2016. This reportage will reveal the progress of Morocco in the field of highway infrastructures as well as her strategy of preservation of patrimony”, shares ADM.

Several sites are concerned : the bridges Oued Sebou adjacent to Kenitra, Oued Oum Rbiaa adjacent to El Jadida and Ksar Nord adjacent to Tanger.

Since creation in 1989, ADM has constructed more than 1,800 km of national highway network, ensuring the development of territory by linking the most important cities in Morocco.

(English translation of an article of local newspaper « Aujourd'hui Le Maroc » dated 01/12/2016

The officers of ADM trained by the Japanese company HANSHIN EXPRESSWAY



“Veritable specialist, Hanshin Expressway Company Ltd has an experience of more than a half century and is considered as a model in the concerned field”

Morocco involves the Japanese expertise in terms of preservation of bridges.

La Société Nationale des Autoroutes du Maroc (ADM) has become allied with Japanese company Hanshin Expressway Company Ltd with a view to train her officers in the field of auscultation of the bridges.

This partnership first in its genre, has ambition to perpetuate and valorize the national patrimony in particular the bridges beyond one century.

The training of the officers of La Société Nationale des Autoroutes du Maroc has been made in the two countries.

“The Moroccan officers have benefited by training for the technics of auscultation of several months in Japan and in Morocco.

They have been trained on the concrete cases of Japanese bridges with a view to initiate them for technics of knowledge of the real status of the bridges, to be specific, the examinations and the specific measures, as well as for the materialization of eventual diagnostics”, emphasizes in this connection ADM. And state precisely that “the training, materialized by Hanshin Expressway Company, Ltd, in cooperation

with Japan International Cooperation Agency (JICA), is approved by handing-over of a certificate of expertise which enables the Moroccan officers to train on their turn other collaborators of ADM and to participate at the end into transmission of know-how of the company in Morocco and in Africa”.

Explaining about the choice of Japan as partner, La Société Nationale des Autoroutes du Maroc explains it by the pertinence of the model Nippon.

“Veritable specialist, Hanshin Expressway Company Ltd has experience of more than a half century and is considered as a model in the field concerned. Japan makes in fact reference in the world, because it is obligation to do inspection of the bridges minimum once in every five years”, we learn from ADM.

The partnership sealed by La Société Nationale des Autoroutes du Maroc and Hanshin Expressway Company Ltd is followed closely by Japanese medias.

Besides, a team of shooting belonging to TV Tokyo is doing at this moment and until 9 December a reportage which will reveal the progress of Morocco in the field of highway infrastructures as well as its strategy of preservation of patrimony.

The sites which will be brought out are to be specific, the bridges : Oued Sebou adjacent to Kenitra, Oued Oum Rbiaa adjacent to El Jadida and Ksar Nord adjacent to Tanger.

Let's remember that ADM has put on the rails a new policy of human resources.

ADM has, in this sense, implemented a program of training and of accompanying of competency which covers all of the aspects of highway infrastructures.

ADM has, on the other hand launched ADM Academy.

A structure which proposes the cycle of training to the officers, managers, technicians and supervisors.

Supporting the strategy of competitiveness of ADM, this institution is dedicated to the expertise, to the research and to the innovation.

ADM Academy plays role of catalyst in the acquisition of new competencies for the collaborators of ADM.