e-ASIA Joint Research Program
Final Report

1. Project title：「Corrosion Mapping of Structural Materials in Asian Area with Understanding Effects of Environmental Factors」

2. Joint Research period：October 1, 2012 ～ March 31, 2016

3. Research Team：

Japan team（up to 6 people including the Principal Investigator）
Funding period: October 1, 2012 ～ March 31, 2016
Total Funded Amount (in Local Currency):17,992,000JPY

	Name	Position	Affiliation	Role in the project
PI	Tadashi Shinohara	Special Researcher	National Institute for Materials Science (NIMS)	General manager
Collaborator	Akira Tahara	Senior Researcher	NIMS	Analysis of exposure test results of carbon steel
Collaborator	Daisuke Mizuno	Senior Researcher	JFE Steel Co.	Analysis of exposure test results of galvanized steel
Collaborator	Sakae Fujita	Senior Fellow	JFE Techno-Research Co.	Summarizing exposure test results, collection of past exposure tests
Collaborator	Toshiyasu Nishimura	Chief Researcher	NIMS	Analysis of exposure test results of weathering steel
Collaborator	To Dara	Trainee	NIMS	Analysis of ACM sensor
Total number of participants including students: 7				

Vietnam team（up to 6 people including the Principal Investigator）
Funding period: February, 18, 2013 – June, 30, 2016
Total Funded Amount (in Local Currency): 3,700,000,000VND

	Name	Position	Affiliation	Role in the project
PI	Le Thi Hong Lien	Senior Researcher	Institute of Materials Science (IMS)	General manager
Collaborator	Pham Thy San	Senior Researcher	IMS	Analysis of data and mapping corrosion
Collaborator	Hoang Lam Hong	Senior Researcher	IMS	Measurement of corrosion loss of samples, and analysis of ACM sensor
Collaborator	Nguyen Thi Thanh Nga	Researcher	IMS	Measurement of environmental factors
Collaborator	Nguyen Trung Hieu	Researcher	IMS	Measurement of environmental factors
Collaborator	Dao Chi Tue	Researcher	IMS	Perform the exposure tests
Total number of participants including students: 11				

Thailand team（up to 6 people including the Principal Investigator）
Funding period: January 16, 2013 – January 16, 2016
Total Funded Amount (in Local Currency): 4,490,000 THB

	Name	Position	Affiliation	Role in the project
PI	Amnuaysak Chianpairot	Researcher	National Metal and Materials Technology Center (MTEC)	General manager
Collaborator	Ekkarut Viyanit	Senior Researcher	MTEC	Project advisor, troubleshooting, site survey
Collaborator	Wanida Pongsaksawad	Researcher	MTEC	Analysis of ACM and environmental data, linear regression model
Collaborator	Namurata Sathirachinda	Researcher	MTEC	Characterization of corrosion products, analysis of corrosion data
Collaborator	Siam Kaewkumsai	Principal Engineer	MTEC	Supervising student interns
Collaborator	Piya Khamsuk	Senior Engineer	MTEC	Measurement of environmental factors
Total number of participants including students: 9				

4. Summary of the joint research (*up to 4 pages for section 4. to 6. including figures.*)

Exposure tests for carbon steel, weathering steel, galvanized steel sheet and 55%Al-Zn coated steel sheet were conducted at the enough number of sites where the climates were typical in Asia. Based on the analyzed results, database for corrosion behaviors of metals, meteorological and environmental factors were established. Values in those database were categorized by ISO standards and maps of them were established.

For the effect of the temperature, corrosion rates become the largest at around 20˚C except the sites where amount of airborne sea salt is particularly high(in excess of 36mmd), although the peak of corrosion rate at 10˚C reported in ISO9223 was not detected. This temperature-tendency could be found by the exposure tests with the wide temperature range in 3 countries.

It was found that the corrosion rates calculated by the estimated equation proposed by ISO were smaller than the measured ones. It indicates that the estimated equation of corrosion rate suitable for Asian area is needed.

Systematic exposure tests are suggested in this project. Database and maps will be expanded by increasing exposure test sites with those procedures and methods.

5. Outputs and Anticipated Outcomes of Joint Research

5-1 Scientific achievements and implemented activities of the joint research

1. Samples

The samples were carbon steel, weathering steel, galvanized steel sheet and 55% Al-Zn coated steel sheet. The carbon steel and weathering steel were cut into 70mm×150mm×3mmt and polished to #600. The galvanized steel sheet and 55% Al-Zn coated steel sheet (together 1mmt) were cut into 70mm×150mm, then a 50mm×120mm area was used as an exposure surface and the remaining area was covered in insulation tape, including the edges and the back.

2. Exposure sites

There are a total of 37 exposure sites, 16 sites in Japan, 14 in Vietnam and 7 in Thailand (Fig. 1).

3. Exposure tests

The carbon steel and weathering steel were attached to an exposure rack so that one surface faced upwards at 45°. The galvanized steel sheets and 55%Al-Zn coated steel sheets were attached to an exposure rack with two sheets making up one set. One sheet was attached so that the exposed surface

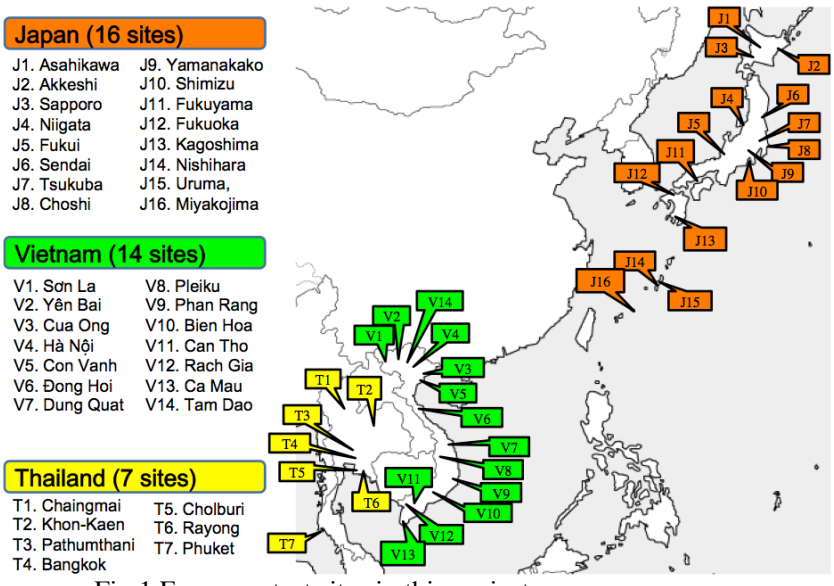


Fig.1 Exposure test sites in this project.

faced upwards at 45° and the other sheet was attached so that the exposed surface faced downwards at 45°.

The corrosion factors (amount of airborne sea salt, sulfur dioxide content) were measured with JIS Z 2381 in accordance with the aforementioned exposure tests. That is, dry gauze and PbO_2 cylinder were installed in an instrument shelter or in a rain-proof location with good airflow, and renewed every month.

ACM sensors were exposed in all the exposure sites in Japan and Thailand and 4 of the exposure sites in Vietnam and they were renewed every month. The ACM sensor output (I) and relative humidity (RH) were recorded every 10 minutes.

4. Results

4.1 Corrosion database

Systematic analysis was performed for the test results in each country and we were able to create a database combining meteorological and environmental data with the ACM sensor output, relating to the corrosion behavior of various types of metal in Asian regions extending from temperate/frigid zones (Japan) through to the tropics (Vietnam, Thailand).

4.2 Effect of environmental factors

The environmental characteristics of the Asian region are reputed to be high temperature and high humidity, as well as the strong effect of sea salt. The carbon steel corrosion rate (CR) is summarized based on temperature in Fig. 2. ISO9223 states that the CR increases with increasing temperature when the temperature is lower than 10°C, but it decreases with increasing temperature when the temperature is higher than 10°C. As can be seen in Fig. 2, in the Asian region the CR does not have a peak at 10°C, and in Japan (◯) the corrosion rate increases with increasing temperature. In contrast to that, in the whole Asian region, corrosion rates become the largest at around 20°C except Miyakojima (J16) and Phang Nga (T7) where the amount of airborne sea salt is particularly high (in excess of 36mmd). This is considered that the specimens are dried easily with increasing temperature when the temperature is higher than 20°C.

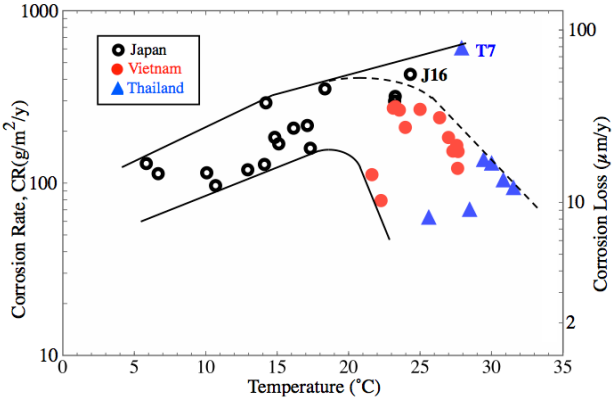
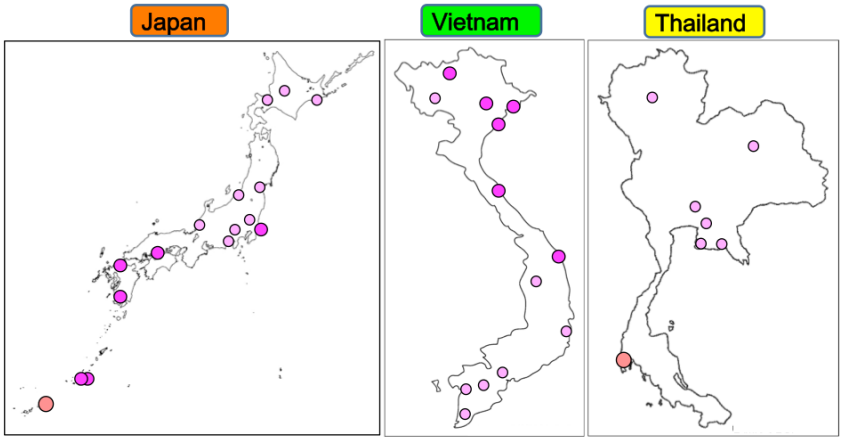


Fig.2 Effect of temperature on corrosion rate of carbon steel.



ISO 9223 Corrosion Category

Category	Corrosion loss /umy-1	Category	Corrosion loss /umy-1
C1	~1.3	C4	50~80
C2	1.3~25	C5	80~200
C3	25~50	CX	200~700

Fig.3 Corrosion map for carbon steel.

Conversely, in terms of the effect of the amount of airborne sea salt (S), the tendency was that the more the S, the faster the CR. In terms of the effect of relative humidity (RH) the tendency was that the higher the RH, the faster the CR, but there was no clear correlation.

The above information presents the effect of each of the independent environmental factors. But in reality, these factors have complex interactions, so further data collection and investigation is needed.

4.3 Environmental factor mapping and corrosion mapping

The corrosion rates of carbon steel were categorized according to ISO regulations and plotted on a map (Fig. 3). The corrosion rate (μm/y) ranking is presented in the Figure using different colors and sizes for the plotted points. With this type of display, a corrosion map for carbon steel could be established. In the same way, corrosion maps for other metals and maps for environmental factors also could be established.

4.4 Comparison with ISO method

ISO 9223 states that either a one-year exposure test is to be conducted or the corrosion rate is to be estimated based on an advocated formula to evaluate corrosivity in the given site. Thus the corrosion rates of metals were calculated by substituting the environmental factors acquired in this project in the advocated formula, and the results for carbon steel are plotted in Fig. 4. The actual measured values (Measured: vertical axis) in almost all the data were higher than the estimated values (ISO: horizontal axis), and some values were 4 or more times higher. These results show that in the Asian region there is a risk that the corrosion rate will be underestimated if the advocated formula by ISO is used. Thus it was confirmed that an estimation formula suited to the Asian region is needed.

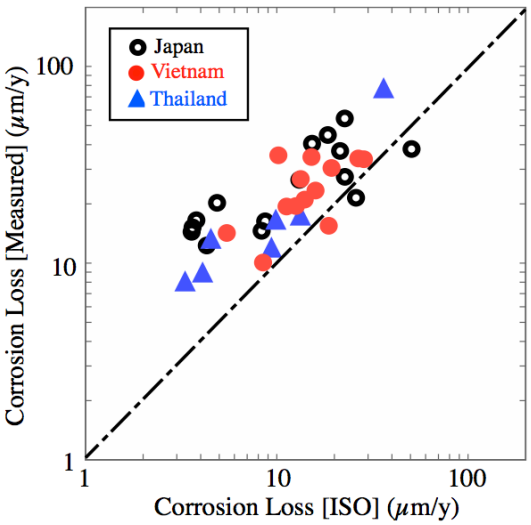


Fig.4 comparison of corrosion loss of carbon steel between the measured one (vertical axis) and the estimated one (horizontal axis).

4.5 Development of new atmospheric corrosion sensor

New types of ACM sensors with substrates of Zn (galvanized steel), Al and Cu were developed. An artificial rain device was also developed, and the outputs of various ACM sensors were measured under simulated rain environments. The sensor output is largely dependent on the substrate metal and the origin of the simulated rain. It was confirmed that the main anion and its concentration was estimated by analyzing outputs of various ACM sensors.

Various types and amounts of electrolytes were deposited on the conventional Fe-Ag galvanic couple ACM sensor and the relationship between sensor output (I) and relative humidity (RH) was investigated in the constant temperature and humidity chamber. It was found that the I-RH relationship (the magnitude of I and its change with RH ($\Delta I/\Delta RH$)) is dependent on the type and amount of electrolytes, and it was confirmed that the main components and amount of the deposited electrolytes can be estimated by analyzing the I-RH relationship.

5-2 Synergistic effects of the international joint research

For the effect of the temperature, corrosion rates become the largest at around 20˚C except the sites where amount of airborne sea salt is particularly high (in excess of 36mmd). It is considered that corrosion rate decreases with increasing temperature because specimens are easily dried and time of wetness became shorter. This temperature-tendency could be found by the exposure tests with the wide temperature range in 3 countries.

At present, ISO 9223 is the mainstream for categorization of corrosivity of atmospheric environments. In ISO 9223, it is said that corrosion rates become the largest at around 10˚C. However, the peak of corrosion rate at 10˚C was not detected in exposure tests in Asian area in this project. It is suggested in ISO that corrosion rate must be calculated by using estimated equation when exposure test cannot be conducted. It was found that the calculated corrosion rates from the data in this project were smaller than the measured ones. It indicates that the estimated equation of corrosion rate suitable for Asian area is needed.

Other Asian researchers were also interested in this project, and a fundamental network of atmospheric corrosion over the whole Southeast Asia could be established.

5-3 Broader impacts including contribution to society

Exposure tests with systematic procedures and analyzing methods are suggested in this project. Database will be expanded by increasing exposure test sites with those procedures and methods, and plots in the maps of corrosion rate, meteorological and environmental factors. By expanding database, meteorological and environmental factors which affect corrosion behaviors are confirmed and extracted, and the estimated equation suitable for Asian area can be established. Finally, a contour map of corrosion rate will be established from interpolation by the estimated equation.

Database, maps and estimated equation of corrosion rate are enriched by utilizing the network of atmospheric corrosion over the whole Southeast Asia.

5-4 Development and sustainability of the cooperation

Japan, Vietnam and Thailand all have long coastlines, and sea salt is a major factor in promoting corrosion. Also, Vietnam and Thailand belong to the ASEAN region and are therefore affected by the monsoon. The monsoon that blows from the southwest from April to October brings sea salt to the west coast of Thailand and carries this salt through the interior of Thailand and onto Vietnam. On the other hand the monsoon that blows from the northeast from October to March carries salt to the east coast of Vietnam and then carries it on across to Thailand. Therefore, it is vital to consider the effect of the monsoon in both these countries. Based on the above information, there has been increased importance of the exchange of information among the three countries, and workshops and researcher exchange have been conducted at a rate of 2 to 4 times a year. There have also been frequent visits to the exposure sites to strive for standardization of test methods.

Many young researchers have participated in the meetings and workshops in Thailand and Vietnam, and the knowledge, technological skill and ability of these researchers have been enhanced through researcher exchange.

The higher level comprehensive partnership agreements on material research have been established between NIMS-IMS and NIMS-MTEC.

6. Recommendations and Comments to the Program

Researchers in other Asian countries (the Philippines, Indonesia, Taiwan, etc.) are also interested in this project, so workshops and information exchanges were conducted in these countries. By conducting new exposure tests in line with this research, the corrosion database will be expanded to improve the accuracies of the maps of meteorological and environmental factors, corrosion maps and the formula to estimate the corrosion rate.

Annex: List of Scientific Achievements and Implemented Activities of the Joint Research

1 Original Publications (All Authors' Names, Title, Journal Name, Volume, Page, Year, DOI)

1.1 Co-authored among research teams

1.2 Published by single team

(1) Thy San P, Hong Lien L.T, Lam Hong H, Trung Hieu N, Thanh Nga N. T, Establish mathematical models to predict corrosion of carbon steel and weathering steel in atmosphere of Vietnam, Journal of Science and Technology (ISN 0866 708X), Vietnam, Vol. 53, N^{o}1A, 2015, pp. 207-215.

(2) Hoang Lam Hong, Le Thi Hong Lien, Pham Thi San, Atmospheric corrosion of weathering steel in marine environment of Vietnam, Journal of Science and Technology (ISN 0866 708X), Vietnam, Vol 53, N^{o}1B, 2015, pp. 341-354.

2 Presentations at conferences (Speaker, Title, Conference Name, Location, Date, Type of Presentation, etc.)

2.1 Co-authored among research teams

(1) Le Hong Lien and Tadashi Shinohara, ″Corrosion Mapping of Structural Materials in Asian Area with Understanding Effects of Environmental Factors″, Seminar on Vietnam-Japan Science and Technology Cooperation: Achievements and Prospects, Hanoi, Vietnam, 2013/6/19, Poster Session.

2.2 Published by single team

(1) Tadashi Shinohara、″Evaluation of Effect of Rain on Atmospheric Corrosion by ACM Sensor″, 177th Corrosion Symposium on Present Status and Problems in Measurements and Evaluation of Atmospheric Corrosion, Japan Society of Corrosion Engineering (JSCE), Tokyo、2013/1/23, Guest/Invited Speaker.

(2) Tadashi Shinohara、"Evaluation of Effect of Rain on Atmospheric Corrosion by ACM Sensor", JSCE Materials and Environments 2013, Tokyo, 2013/5/15, Oral Presentation.

(3) Tadashi Shinohara, "Evaluation of Atmospheric Corrosion Behaviors of Carbon Steel by ACM (Atmospheric Corrosion Monitor) Type Corrosion Sensor", Corrosion Conference by Vietnam Corrosion and Metal Protection Association (VICORRA), Quy nhon, Vietnam, 2013/8/16 , Guest/Invited Speaker.

(4) Tadashi Shinohara, "The Evaluation of Corrosivity in Atmospheric Environment", NACE International East Asia Pacific Rim Conference, 2013/11/20", Guest/Invited Speaker.

(5) Tadashi Shinohara, "Evaluation of Corrosion Rates of Carbon Steel in an Atmospheric Environment by an Atmospheric Corrosion Monitor (ACM) Type Corrosion Sensor", 15th Middle East Corrosion Conference, Manama, Bahrain, 2014/2/4, Guest/Invited Speaker.

(6) Tadashi Shinohara, "Evaluation of Effect of Rain on Atmospheric Corrosion by ACM Sensor", JSCE Materials and Environments 2014, Tokyo, 2014/5/20, Oral Presentation.

(7) Le Thi Hong Lien, Hoang Lam Hong, "Study on Atmospheric Corrosion of Weathering Steel in Vietnam", JSCE Materials and Environments 2014, Tokyo,

2014/5/20, Oral Presentation.

(8) Amnuaysak Chianpairot, Wanida Pongsaksawad, Namurata Sathirachinda, Ekkarut Viyanit, "Atmospheric Corrosion Behaviors of Carbon and Weathering Steels in Thailand Climate", JSCE Materials and Environments 2014, Tokyo, 2014/5/20, Oral Presentation.

(9) T. Shinohara, A. Tahara, H. Kajiyama, S. Fujita, "Atmospheric Corrosion Behaviors of Steels in Japan", 4th Asia Materials Data Symposium, Jeju, Korea, 2014/10/30, Guest/Invited Speaker.

(10) Le Thi Hong Lien, "The First Results of E-Asia Project from Vietnam: The Corrosion Behavior of Carbon Steel in Vietnam", 4th Asia Materals Data Symposium, Jeju, Korea, 2014/10/30, Guest/Invited Speaker.

(11) T. Shinohara, T. Dara, A. Tahara, Y. Hosoya, O. Umezawa, "Evaluation of Effect of Rain on Atmospheric Corrosion by ACM Sensor", JSCE Materials and Environments 2015, Tokyo, 2015/5/18, Oral Presentation.

(12) A. Tahara, T. Shinohara, "NIMS Data-Sheet for Atmospheric Corrosion Behaviors of Low-alloyed Steels", JSCE Materials and Environments 2015, Tokyo, 2015/5/18, Oral Presentation.

(13) Le Thi Hong Lien, Hoang Lam Hong, "Corrosion Behavior of Weathering Steel in Atmosphere of Vietnam, JSCE Materials and Environments 2015, Tokyo, 2015/5/18, Oral Presentation.

(14) T. Shinohara, "Evaluation of Corrosivities of Atmospheric Environment by ACM Sensor", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(15) A. Tahara, "The Rust Analysis Formed on the Low Alloy Steels", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(16) S. Fujita, "Current Status and Future Issues of Atmospheric Corrosion Test Methods for Metallic Material", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(17) D. Mizuno, "In-situ corrosion monitoring by electrical resistance sensor under exposure test and accelerated corrosion test environments", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(18) Le Thi Hong Lien, "Characteristic of Atmospheric Corrosion of carbon steel in Vietnam", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(19) Amnuaysak Chianpairot, "Evolution of Corrosion Products on Galvanized Steel in Thailand Climate", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(20) Ekkarut Viyanit, "Influence of Thailand Tropical Climate on Atmospheric Corrosion of Carbon and Alloy Steels", Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference, Kenting, Taiwan, 2015/8/28, Oral Presentation.

(21) S. Fujita, "Accelerated Corrosion Tests for Evaluating Corrosion Resistance of Zn- and Zn Alloy-Coated Steel Sheets in Atmosphere", Corrosion Conference by Vietnam Corrosion and Metal Protection Association (VICORRA), Hue, Vietnam, 2015/9/18, Oral Presentation.

(22) Le Thi Hong Lien, Hoang Lam Hong, Nguyen Trung Hieu, Nguyen Thi Thanh Nga,"Seasonal effect on atmospheric corrosion of carbon steel", Corrosion Conference by Vietnam Corrosion and Metal Protection Association (VICORRA), Hue, Vietnam, 2015/9/18, Oral Presentation.

(23) Amnuaysak Chianpairot, "Lessons Learned and Benefits of International Collaboration in Corrosion Mapping Project", The e-ASIA JRP Workshop, NECTEC-Thailand, 2015/10/12, Oral Presentation.

(24) Le Thi Hong Lien, Tadashi Shinohara and Amnuaysak Chianpairot, "Corrosion Mapping of Structural Materials in Asian Area with Understanding Effects of Environmental Factors - Overview and progress", The e-ASIA JRP Workshop, NECTEC-Thailand, 2015/10/12, Oral Presentation.

(25) T. Dara, T. Shinohara, O. Umezawa, "Development of Artificial Rainfall Equipment for Studying The Effect of Rain on The Corrosion Behaviors", 62nd Japan Conf. Materials and Environments, JSCE, Fukuoka, 2015/11/5, Oral Presentation.

3 Organization of workshops, seminars, symposia, etc. (Organizer, Title of Event, Date, Location, Number of Participants, etc.)

Organizer	Title of the Event	Date	Location	Number of Participants (Team Members)
NIMS, IMS	NIMS-IMS Symposium	2013/3/7～8	Hanoi, Vietnam	2
IMS, MOST	Atmospheric Corrosion Session, Seminar on Vietnam-Japan Science and Technology Cooperation: Achievements and Prospects	2013/6/18	Hanoi, Vietnam	3
IMS, VICORRA	Atmospheric Corrosion Session, Corrosion Conference by VICORRA	2013/8/16～17	Quy Nhon, Vietnam	5
NIMS, NACE International	Atmospheric Corrosion Session, NACE International East Asia Pacific Rim Conference	2013/11/19～20	Kyoto, Japan	6
NIMS, NACE International	15th Atmospheric Corrosion Session, Middle East Corroison Conference	2014/2/2～5	Manama, Bahrain	1
JSCE	International Session on Atmospheric Corrosion in Asia, JSCE Materials and Environments 2014	2014/5/19～21	Tokyo, Japan	5

NIMS, IMS, Ministry of Trade, Industry & Energy, Korea	Atmospheric Corrosion Session, 4th Asia Materials Data Symposium	2014/10/29 ～11/1	Jeju, Korea	2
MTEC	Atmospheric Corrosion Seminar	2014/11/19	Bangkok, Thailand	5
NIMS, Hokkaido Univ.	(E-Asia)-NIMS-Hokkaido Univ. Joint Symposium	2015/2/25 ～26	Sapporo, Japan	10
JSCE	International Session on Atmospheric Corrosion in Asia, JSCE Materials and Environments 2015	2015/5/18 ～20	Tokyo, Japan	3
NIMS, IMS, MTEC, ITRI, National Sun Yat-sen Univ.	Atmospheric Corrosion in Asia Workshop	2015/8/26	Kaohsiung, Taiwan	8
NIMS, IMS, MTEC, The Corrosion Engineering Association of the Republic of China	Atmospheric Corrosion Workshop @ 2015 Taiwan Annual Corrosion Conference,	2015/8/28	Kenting, Taiwan	8
IMS, VICORRA	Atmospheric Corrosion Session, Corrosion Conference by VICORRA	2015/9/18 ～19	Hue, Vietnam	6
NIMS, ITDI	ITDI Corrosion Seminar	2015/12/7	Taguig City, The Philippines	2
NIMS, CorrPhil	Corrphil Corrosion Seminar - "Materials Corrosion and Protection in the Industry"	2015/12/8	Pasing City, The Philippines	2

＊MOST: Ministry of Science and Technology, Vietnam
VICORRA: Vietnam Corrosion and Metal Protection Association
JSCE: Japan Society of Corrosion Engineering
ITRI- Industrial Technology Research Institute, Taiwan
ITDI: Industrial Technology Development Institute, The Philippines
CorrPhil: Corrosion Organization of Philippines Inc.

4 Researcher exchanges including students (Description of Exchange, Destination, Duration, etc.)

Description of Exchange	Exchange Destination	Duration
Kick-off Meeting	NIMS	2012/12/21~24
Workshop for Exposure Test Procedures	NIMS	2012/12/25~28
NIMS-IMS Symposium	IMS	2013/3/6~9

Exposure Test Site Tour	IMS, MTEC	2013/3/10~14
Seminar on Vietnam-Japan Science and Technology Cooperation: Achievements and Prospects, Workshop for Exposure Test Procedures, Exposure Test Site Tour	Melia Hotel, Hanoi IMS	2013/6/18~21
Atmospheric Corrosion Session, Corrosion Conference by VICORRA, Workshop for Exposure Test Procedures	Hai Au Hotel, Quy Nhon, Vietam	2013/8/14~19
NACE International East Asia & Pacific Rim Area Conference Workshop for Exposure Test Procedures, Exposure Test Site Tour	Kyoto International Conference Center JFE Steel Co., West Japan Works, Keihin Area	2013/11/18~23
Workshop for Treatment Procedures of Exposed Samples	NIMS	2013/11/25~12/3
15th Middle East Corrosion Conference	Gulf Hotel, Bahrain	2014/2/1~7
Workshop for Exposure Tests JSCE Materials and Environments 2014	Surugadai Memorial Hall, Chuo Univ. Hitotsubashi Memorial Hall, National Institute of Informatics	2014/5/16~5/22
Workshop for Exposure Test	NIMS	2014/5/23~24
9th ASEAN Science and Technology Week (ASTW) Workshop for Exposure Test	Bogor, Indonesia IMS, MTEC	2014/8/17~23
Workshop for Exposure Test	NIMS	2014/9/14~21
"Atmospheric Corrosion Seminar" Workshop for Exposure Test Exposure Test Site Tour	MTEC Phang-Nga/ Thailand	2014/11/18~23
Workshop for Treatment Procedures of Exposed Samples	JFE Steel Co., East Japan Works, Keihin Area	2015/2/21~23
(E-Asia)-NIMS-Hokkaido Univ. Joint Symposium	Hokkaido Univ., Sapporo, Japan	2015/2/24~27
Workshop for Treatment Procedures of Exposed Samples	NIMS	2015/2/28~3/5
JSCE Materials and Environments 2015	Tokyo Denki Univ.	2015/5/17~19
Workshop for Treatment Procedures of Exposed Samples	NIMS	2015/5/22~6/1
"Atmospheric Corrosion in Asia Workshop" "2015 Taiwan Annual Corrosion Conference"	National Sun Yat-sen University, Kaohsiung, Taiwan Howard Beach Resort, Kenting, Taiwan	2015/8/25~31
The 4th Corrosion Conference by VICORRA on “Corrosion and Metal Protection for Sustainable Development"	Hue University of Science, Hue, Vietnam	2015/9/17~21

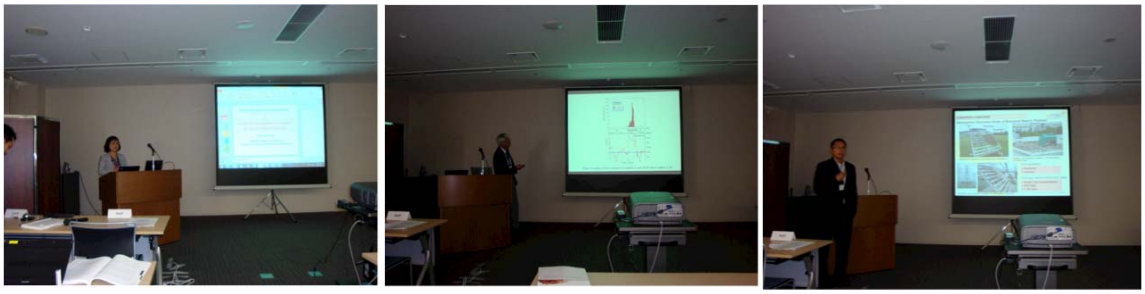
"Corrosion Seminar" in ITDI, CorrPhil Corrosion Seminar	ITDI Astoria Plaza, Ortigas Center, Pasing City, The Philippines	2015/12/5~9

5 Number of patent applications
Zero

6 Awards
(1) Tadashi Shinohara, Received the GO OKAMOTO MEMORYAL LECTURE AWARD, Japan Society of Corrosion Engineering, JSCE (2014/5/19).

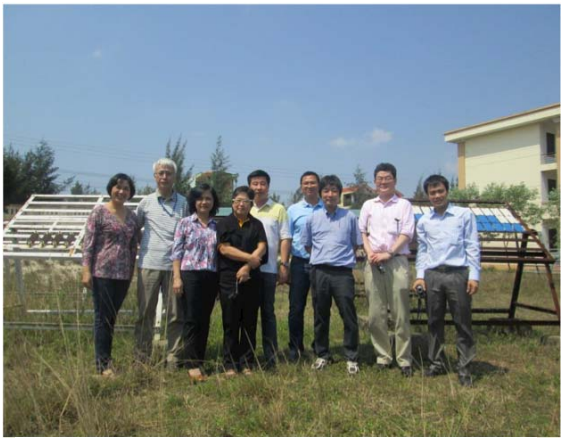
(2) Tadashi Shinohara and Akira Tahara, Received the SPECIAL TECHNICAL ACHIEVEMENT AWARD, The Suga Weathering Technology Foundation (2015/4/22).

7 Others (Including agenda of workshop, photos of research teams, meetings, and etc.)



Kick-off Meeting at NIMS (Nov., 2012)

Kick-off Meeting (NIMS, Nov., 2012)



Exposure Test Site Tour
(Dong Hoi/ Vietnam, Mar, 2013)

Setting Exposure Test Rack (MTEC members)

Workshop at MTEC (Nov., 2014)

Exposure Test Site Tour
(Phang-Nga/ Thailand, Nov., 2014)

Joint Symposium at Hokkaido Univ.
(Feb., 2015)

Exposure Test Site Tour
(Hokkaido Univ., Nov., 2014)

The 4th Corrosion Conference by
VICORRA
(Hue, Vietnam, Sep., 2015)

Exposure Test Site Tour
(Yamanakako/Japan, May, 2016)