Dr. Shingo Asamoto, Project Coordinator

Japan Society for the Promotion of Science (JSPS) Core-to-Core Program (Asia-Africa Science Platforms) 2017FY–2019FY

"Collaborative research network on standardization of design and construction for hot weather concreting based on Asian climate and materials"

The project entitled "Collaborative research network on standardization of design and construction for hot weather concreting based on Asian climate and materials" was accepted as a JSPS core-to-core program (Asia-Africa Science Platforms) from FY2017 to FY2019. As noted on the JSPS website, the core-to-core program aims to create world-class research hubs in research fields considered to be cutting-edge and internationally important in Japan, or to create high-potential research hubs in fields of special importance or significance to Asia and/or Africa and of high priority in Japan. The program also encourages coordinators to cultivate young researchers. The application is offered to all fields of the humanities, social sciences, and natural sciences. This project is the first to be accepted from the concrete engineering field. The details of the program can be found on the JSPS website (https://www.jsps.go.jp/english/e-c2c/index.html).

This project aims to create a research network to investigate the causes of, and countermeasures for, initial defects and deterioration in concrete structures, focusing on climate and materials in Asian tropical regions, and also to examine the application of mineral admixtures to concrete in hot weather and its effects on construction and durability. It is hoped that the collaborative study by the network will lead to the development of common construction and design standards for concrete in the hot weather conditions of Asia.

In order to create the network, the author utilized personal research and friendly relationships developed during a career of international collaboration to invite people to join the project, as shown in Figure 1. Discussions in Thailand, Vietnam, and Sri Lanka, revealed that hot weather concreting is a common issue, and similar problems, such as thermal cracking, initial shrinkage cracking, cold joints, and map cracking due to ASR(Alkali Silica Reaction) or DEF(Delayed Ettringite Formation), should be discussed to share information among countries in hot regions. In addition, Vietnam and Sri Lanka have expressed great interest in mineral admixtures, such as fly ash and blast furnace slag, while Thailand has seen success with fly ash applications. Also of interest are the effects of mineral admixtures on concrete in hot weather conditions, referring to the research and

experience of mineral admixture applications in Japan.

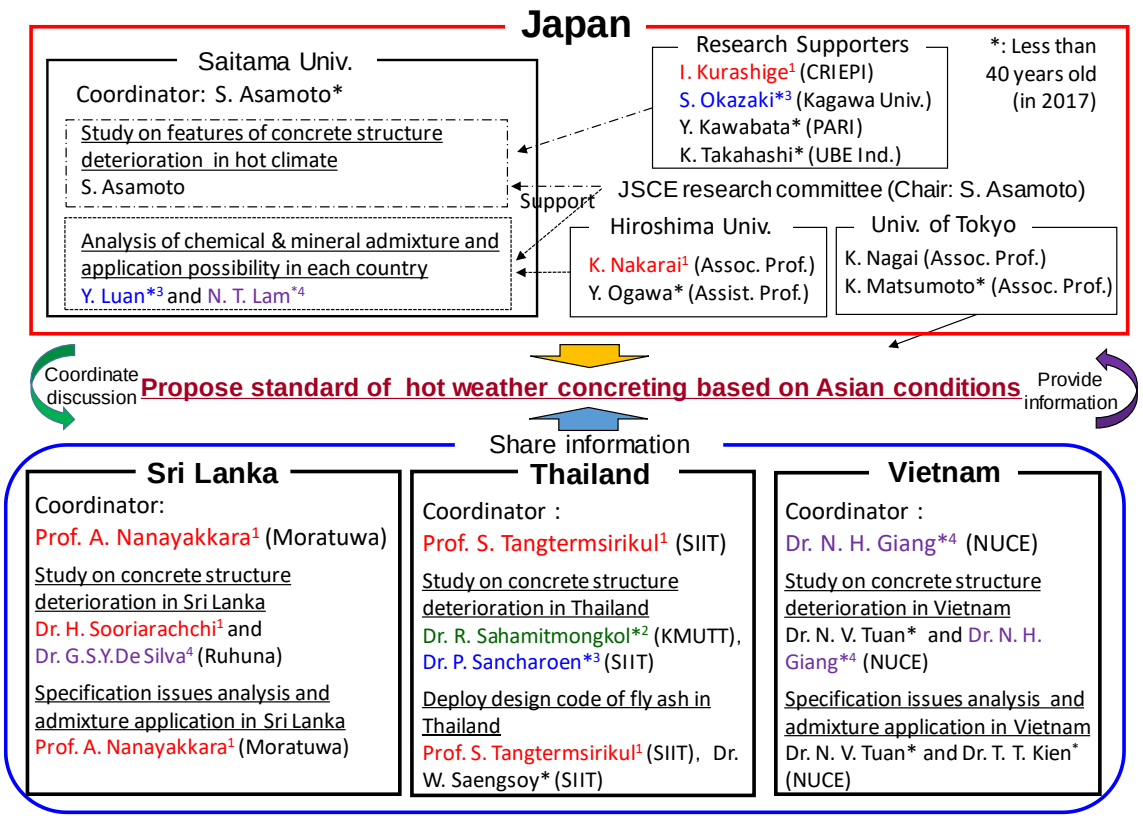

Figure 1: Research network in 2017

The focus of this project is climate and materials in hot regions. Although most developing countries in Asia have followed American and European standards and codes for the materials, construction, and design of concrete structures, those standards and codes do not take into account concrete in hot weather conditions. Instead it considered a special form of “hot weather concreting.” Construction and design codes based on the climate in temperate regions are not applicable to regions where the weather is always hot and the temperature is more than 20 deg. above the minimum temperature in all seasons. Moreover, the materials, especially aggregates and admixtures, have different characteristics in each country. In addition, time-dependent behaviors of concrete, such as shrinkage, creep, and ion transfer, are difficult to predict using the empirical models in the codes, which are based on laboratory experiments under extratropical conditions. Hence, it is not appropriate to directly apply the standards and designed of other countries. Rather, it is necessary for each country to develop their own standards and codes based

on the climate and materials of that country. Material characteristics and the effect of hot weather on construction and performance of concrete also have been discussed in this project. In order to understand the situation of concrete in hot weather conditions, the questionnaire shown in Table 1was conducted. Actually, the answers come mainly from the academic side and might not reflect the practical side, but initial cracking in hot weather conditions seems to be a common issue for both sides in the countries.

Table 1: Questionnaire and answers in the project

	Thailand	Vietnam	Sri Lanka	Myanmar	Japan
Q1	ACI	TCVN 4453-1995 TCVN 9341-2012 TCVN 9345:2012	BS and switching to Euro code	Chinese regulation	JSCE (more than 25 ºC of daily average ambient temperature)
Q2	Cracks at early age (Slab)	Cracks (High strength concrete)	Plastic shrinkage cracking & Thermal cracking	Some capillary cracks on the surface	Maybe, cracks at early ages. Quality reduction of fresh concrete
Q3	Water reducing agent	Water reducing agent	Water reducing agent	Retarding admixture	Water reducing and AE agents
Q4	Slump & strength	TCVN 9340:2012	Slump & strength	Slump & strength	Slump, strength and air content (JR, Unit water test)
Q5	ACI code	TCVN 4453-1995	BS & EC2	Regulation for adequate cover depth	JSCE
Q6	No specification	TCVN 9345:2012 (Measure temperature)	No specification	No special measure	JSCE (Use of cover or water supply)
Q7	No database	No database	Metrological department	Internet database	Japan Meteorological Agency through internet
Q8	Crushed limestone and river sand	Natural aggregate	Charnockite and Gneiss (Scarcity of fine aggregate)	River sand and crushed aggregate	Sandstone, Limestone, Granite, Andesite, etc

Q1: Do you have a category of hot weather concreting?

Q2: Have you had any troubles in the construction or initial defects even though you followed the regulation of hot weather concreting in other countries' standard?

Q3: Do you generally use chemical admixtures such as Air-Entraining agents and water-reducing admixture? Do you use retarding admixtures?

Q4: How do you control the quality of ready mixed concrete?

Q5: What kind of spacer to keep the cover has been used and do you have any regulation for the adequate cover depth?

Q6: What kind of measures for sun radiation do you have during the construction?

Q7: Is the database of climate (ambient temperature, relative humidity, rainfall, hours of sunshine, amount of global solar radiation etc) available in your country?

Q8: What kind of aggregate for concrete has been generally used?

The JSPS program requires the coordinator to hold a seminar every year to share knowledge and research and to discuss collaborations. The 1st seminar of this project was held in 2017 at Thammasat university of SIIT in Thailand. It was entitled “Measures for hot weather concreting in Asian countries and the issue analysis based on climate and materials.” Keynotes were given by each country. Japanese researchers and graduate students from each country gave presentations on ongoing research and the site visit was conducted in final day(Photo 1). About 60 participants from Thailand, Sri Lanka, Vietnam and Japan attended the seminar to discuss fly ash applications and designs in Thailand, concrete design and construction under tropical conditions in Vietnam, massive concrete assessment in Sri Lanka, thermal cracking assessment in Japan, and other topics.

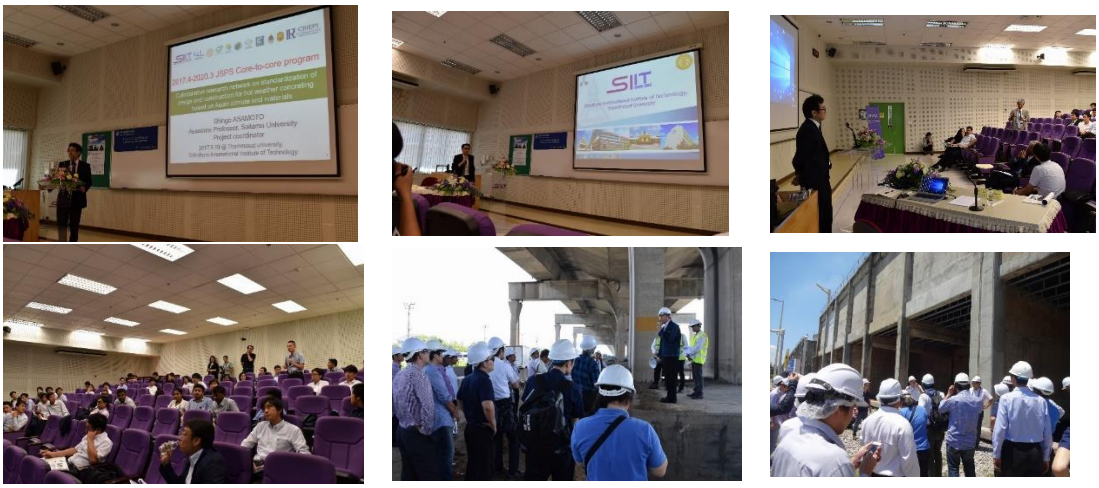

Photo 1: Seminar at SIIT and site visit

The 2nd seminar was held in 2018 at the National University of Civil Engineering in Vietnam. The seminar was entitled “Deterioration of concrete structures and application of mineral admixture in hot weather conditions.” Keynotes were given by each country, and young researchers from Vietnam, Thailand, and Sri Lanka gave presentations. The panel discussion included the 1st and current presidents of the ACF (Asian Concrete Federation), and research presentations were mainly given by graduate students (Photo 2). The seminar was attended by over 100 people from Vietnam (including the Vice Minister of the Ministry of Construction, the President and Vice President of the Vietnam Cement Association), 9 from Thailand, 13 from Sri Lanka, 3 from Indonesia and 24 from Japan. In the seminar, the 2016 JCI guidelines for controlling cracking in mass concrete were presented, along with presentations on mineral admixture applications in Vietnam and ongoing researches related to hot weather concreting and mineral admixtures. In the panel discussion, the first ACF president, Prof. Uomoto, introduced the history of the ACF, and the current president, Prof. Yokota, presented the current situation of the ACF. In

addition, the ACF treasurer, Prof. Tangtermsirikul, explained the utilization of off-spec fly ash. Concrete issues and the effect of mineral admixtures in hot weather conditions were actively discussed among the participants.

Photo 2: Seminar at NUCE and visit to precast factory

In 2019, a seminar was held in Singapore, where blast furnace slag has been utilized for massive concrete structures with cement replacement ratios over 60%. In a half-day workshop at Nanyang Technological university (Photo 3), the president of the ACI (American Concrete Institute) Singapore Chapter, Mr. Jinping Lu, presented issues with hot weather conditions, such as the maximum temperature related to DEF, thermal cracking, cold joints, and initial cracking, which are similar to the issues discussed in the project. The author introduced the project activities, and core members from Thailand, Sri Lanka, and Vietnam presented mineral admixtures applications in each country. Researchers from Japanese companies, such as Kajima corporation and UBE industries Ltd., also presented their technologies. About 100 people joined the workshop and had a fruitful discussion. In Singapore, seminars on maintenance and thermal cracking will be carried out on the 5th and 6th in March, respectively (They were finally canceled due to Coronavirus problem).

Photo 3: Workshop at NTU

In September 2019, some project members joined the ACF symposium at Hokkaido

University to present research related to the project. This was followed by a JSPS seminar at Hokkaido University entitled “Future collaboration toward establishment of suitable specification based on materials and environmental conditions in Asian countries” (Photo 4). In the seminar, the author introduced the achievements of the project. The practical issues in Thailand, Vietnam, and Sri Lanka due to hot weather conditions were presented to help establish suitable specifications in each country. Also introduced was the newly approved Technical Committee (TC) in the ACF (Chairperson: Dr. Shingo Asamoto, secretary-general: Dr. Luan YAO), which presented “Concrete practices and feasible measures for construction and design in hot weather conditions based on material characteristics.” The TC aims to survey the problems of concrete practices in Asian countries with hot climates to comprehend the common practical issues and characteristics of initial defects and deterioration due to hot climates and then to discover possible countermeasures according to the technical level, cost, and local materials in each country. Finally, the activities of this TC will lead to the development of an Asian Concrete Model Code. The kick-off meeting is scheduled for February 2020 and activities will subsequently begin. If someone is interested in the TC, please contact the author or Dr. Luan Yao (http://www.mtr.civil.saitama-u.ac.jp/).

Photo 4: Seminar at Hokkaido University

In order to discuss the practical problems of deterioration in concrete structures, the author asked the maintenance experts of JR (Japan Railway) East to give a presentation to practical engineers in Hanoi and Ho Chi Minh. A half-day seminar was held in December 2019 at the National University of Civil Engineering and the Hochiminh City University of Technology (Photo 5). Mr. Mitani from Taiheyo cement corporation also gave a presentation of fly ash cement effect on massive concrete in hot weather conditions the Hochiminh City University of Technology. Dr. Phan Huu Duy Quoc from Shimzu corporation gave a presentation of fly ash application in Vietnam and translated all presentations to Vietnamese in order to discuss with practical engineers in Ho Chi Minh straightforwardly. About 60 company engineers and more than 40 students and lecturers joined the seminar to discuss corrosion and cracking measures, mineral admixture applications, thermal cracking, maximum temperature issues and other issues. It is very

important to discuss practical issues among the practical engineers in Asia to share information and develop countermeasures.

Photo 5: Seminars at NUCE and HCUT

The JSPS project will be finished in March 2020, but it is necessary to continuously discuss the issues of concrete construction in hot weather conditions in order to establish appropriate construction and design standards based on the climate and materials of each country in tropical regions. Financial considerations may lead to an end to international collaboration, which is sad. Continuous collaboration is a win-win relationship that can, among other benefits, solve practical issues, reveal research topics, and publish papers. E-mail and internet meetings are now available to easily continue discussions. Hopefully, this network will continue even after the project ends. Finally, the list of our publication owing to the project is shown. Since the publication would motivate young researchers to collaborate internationally, the author would like to continue the effective and inspiring collaboration.

Presentations in international conferences

- W.M.K.M Dasanayaka, S. M. A. Nanayakkara and S. Asamoto: Evaluation of concrete durability indicators with different supplementary cementitious materials, The 3rd ACF Symposium 2019 “Assessment and Intervention of Existing Structures”, Sapporo, Japan, (2019)
- K. Takahashi, S. Asamoto, H. Sooriyaarachchi and T. Bier: Reducing Effects of Shrinkage Reducing Agents on Early-Age Shrinkage in High Temperature Conditions,20. ibausil 20th International Conference on Building Materials, Weimar, Germany, 2018
- J. Sato, S. Asamoto, P. Wiwatrojanagul, and R. Sahamitmongkol: Preliminary field survey of deteriorated concrete structures in tropical conditions with non-destructive methods - Case study: Short span bridges in Bangkok, Thailand -, Proceedings of The 8th Asia and Pacific Young Researchers and Graduates Symposium (YRGS 2017), in USB (2017)

Publications in international journals

- Keisuke Takahashi, Shingo Asamoto, Mari Kobayashi, Thomas Bier: Effects of Fatty Alcohol-Based Shrinkage Reducing Agents on Early-Age Shrinkage under High Temperature Conditions, Journal of Advanced Concrete Technology, 17 (11) pp.648-658, 2019
- Nguyen Trong Lam, Shingo Asamoto, Kunio Matsui: Microstructure and Shrinkage Behavior of Autoclaved Aerated Concrete(AAC) -Comparison of Vietnamese and Japanese AACs-, Journal of Advanced Concrete Technology, 16 (8) pp.333-342, 2018
- G. B. Illangakoon, S. Asamoto, A. Nanayakkara, L. T. Nguyen: Concrete cold joint formation in hot weather conditions, Construction and Building Materials, Vol. 209, pp. 406-415, 2019
- Liyanto EDDY, Koji MATSUMOTO, Kohei NAGAI, Piyaphat CHAEMCHUEN, Michael HENRY, Kota HORIUCHI: Investigation on Quality of Thin Concrete Cover using Mercury Intrusion Porosimetry and Non-destructive Tests, Journal of Asian Concrete Federation, Vol.4, No.1, pp.47-66, 2018
- S. Asamoto, K. Murano,I. Kurashige and A. Nanayakkara: Effect of carbonate ions on delayed ettringite formation, Construction and Building Materials, Vol. 147, pp. 221-226, 2017.8
- Awasthi, K. Matsumoto, K. Nagai, S. Asamoto and S. Goto: Investigation on possible causes of expansion damages in concrete - a case study of sleepers in Indian Railways, Journal of Asian Concrete Federation, Vol. 3, No. 1, pp. 49-66, June 2017