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Understanding the regional context of sustainable concrete in Asia: Case studies in Thailand and Korea

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ABSTRACT

Strategies for improving sustainability in the concrete industry need to be understood in the context of regional conditions such as technology level, stakeholder culture, resources, institutional systems, and so forth. This research was conducted to qualitatively understand the relationship between regional context and sustainable concrete in Asia considering the cases of Thailand and Korea through interviews with industry stakeholders in each country. From the interview results, it was found that although both countries share similarities in their general concept for sustainable concrete, the means for implementing sustainability differs, particularly related to the role of stakeholders in each industry and the relationships between stakeholders. In Thailand the major stakeholders focus on a materials perspectives, whereas in Korea they focus on a construction perspective. In both countries, however, the current industrial structure is focused primarily on cost and thus restrains the ability of various stakeholders to implement more environmentally friendly materials or practices or to consider the additional value of concrete.

1. Introduction

Increased awareness of sustainability has led the construction industry to consider a practical interpretation of sustainability and climate change mitigation actions targeted at construction activities (Horvath and Matthews, 2004). For concrete – the second-most used resource in the world after water (Sakai, 2009a) and a fundamental building block for infrastructure construction – discussions on sustainability have generally focused on the environmental impact over the life cycle, with particular emphasis on the generation of CO_2.

Among concrete-making materials, the production of cement alone is estimated to be responsible for up to 10% of global CO_2 emissions (Malhotra, 1999; Sakai, 2009a). Concrete production was estimated to consume more than 11 billion tons of sand, gravel, and crushed rock per year in addition to over one trillion liters of water (Mehta, 2001), and worldwide generation of concrete and masonry rubble from construction demolition was estimated to exceed one billion tons (Lauritzen, 1998) – and these numbers have grown substantially over the subsequent decade due to increases in population and economic development, particularly in Asia. These are in addition to other greenhouse gas and particulate matter emissions related to air pollution and health concerns from concrete dust.

Strategies for improving the sustainability of concrete include reducing resource consumption by utilizing waste and recycled materials; reducing CO_2 emissions by consuming less concrete in new structures, less cement in concrete mixtures, and less clinker when making cement; enhancing the durability of new construction; extending service life through maintenance management; selecting low-impact construction methods; and taking a holistic approach in concrete technology and education (Malhotra, 1999; Mehta, 1999, 2001, 2009; Sakai, 2009a). Although concrete can contribute to improved ratings in existing green building rating systems such as the Leadership in Energy and Environmental Design (LEED), such rating systems do not provide a means for evaluating the environmental impacts of concrete directly. To evaluate the sustainability of concrete, the International Organization for Standardization (ISO) established TC71/SC8, "environmental management for concrete and concrete structures," which is currently developing a standard following existing ISO standards considering the requirements of concrete production and use (Sakai, 2009b).

Globally, there have been a variety of actions taken at the national or multi-national levels to implement sustainability in the concrete industry. One prominent example is the Concrete Joint Sustainability Initiative (JSI) in North America, led by the American Concrete Institute (ACI) and National Ready Mixed Concrete Association (NRMCA). JSI is an industry-wide Memorandum of

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Table 1
Characteristics of Thailand and Korea.

Characteristic	Thailand	Korea
Geographic		
Area	513,120 km^2 (51)	99,720 km^2 (109)
Coastline	3219 km	2,413 km
Climate	Tropical; rainy, warm, cloudy southwest monsoon (mid-May to September); dry, cool northeast monsoon (November to mid-March); southern isthmus always hot and humid	Temperate, with rainfall heavier in summer than winter
Terrain	Central plain; Khorat Plateau in the east; mountains elsewhere	Mostly hills and mountains; wide coastal plains in west and south
People		
Population (July 2011)	66,720,153 (20)	48,754,657 (26)
Urbanization	34%	83%
Economy		
GDP (2010 est.)	$586.9 billion (25)	$1.459 trillion (13)
GDP per capita (2010 est.)	$8,700 (118)	$30,000 (45)
Transportation		
Railways	4,071 km (42)	3,381 km (51)
Roadways	180,053 km (27)	103,029 km (40)

Source: Adapted from CIA (2011).
Note: numbers given in parentheses are world rankings.

Understanding, established in 2009, which provides principles and framework for supporting and coordinating the actions of industry stakeholders towards improving sustainability in the concrete industry (ACI, 2010). Other examples include the Concrete Industry Sustainable Construction Strategy in the United Kingdom or the Nordic Network "Concrete for the Environment." In the case of the Nordic Network, Glavind et al. (2006) noted that Nordic countries had chosen to face environmental challenges in different ways: Denmark established a center for green concrete whereas Norway developed an online, comprehensive database of important documents. These differing approaches suggest an important point related to concrete sustainability: that concrete construction and materials are often region-specific, and thus the implementation of sustainability in the concrete industry must take into account the actual regional and socio-economic conditions in which concrete construction will occur. This problem can be seen to arise from the fundamental issue that sustainability is a human vision with human values (Bell and Morse, 2008), and what may be sustainable in one region of the world under a given set of conditions may not be sustainable in a different region of the world under different conditions.

In order to better understand the region-specific issues related to concrete sustainability, an investigation on the perspectives on sustainable practice and materials was conducted in Japan through interviews and surveys with a wide variety of concrete industry stakeholders (Henry and Kato, 2012). The importance of durability for sustainable concrete in Japan was repeatedly emphasized in the results, which can be understood in the context of a decreasing and aging workforce with decreasing natural and economic resources. In addition, as the efficiency level of the Japanese cement industry is already high, enhancing durability is one strategy to reduce transportation- and construction-related CO_2 emissions. The importance of recycling in Japan could also be understood not as a means to further reduce waste generation, as Japan already enjoys a 96% recycling rate for concrete (MLIT, 2009), but rather as a means for reducing the consumption of natural resources by utilizing recycled concrete as raw material in new construction instead of down-cycling it as backfill. Barriers to the implementation of sustainable concrete practice and materials may be the most specific to Japan's conditions, particularly institutional, social, and organization barriers. One factor may be that, as noted by Chong et al. (2009), sustainability in Japan is more driven by government forces whereas in the USA the private sector is expected to take the lead.

The results from Japan, however, represent the case of a developed country with a fully matured infrastructure system; in contrast, the rest of Asia is still developing and thus the challenges faced by concrete industries in other countries in moving towards sustainability may differ greatly, particularly considering the diversity of geographic and socio-economic conditions. In order to develop a roadmap towards concrete sustainability in Asia, it is necessary to better understand those challenges ahead and identify general issues while clarifying the specific roles and needs of each localized region and common areas which different countries can cooperate on based on their common issues. Towards these ends, and as a continuation of the study in Japan, two more investigations on the regional context of sustainable concrete were conducted in Thailand and (South) Korea.

Thailand and Korea were selected for these investigations based on two factors. The first is that the authors have good professional and social connections in these countries, thus simplifying the process of establishing contacts for the investigation. The second is that the concrete industries in these countries have interesting features which makes their comparison with each other useful for understanding the regional context of sustainable concrete: Thailand represents a growing industry which has widely adopted the use of fly ash, a cementitious replacement material and a strongly recommended means for reducing CO_2 emissions in concrete (Malhotra, 1999), whereas the Korean concrete industry is said to be similar in structure to the Japanese industry. Some select geographic, social, and economic characteristics of Thailand and Korea are summarized in Table 1.

2. Research objectives and methodology

Conditions in the Thai and Korean concrete industries were qualitatively investigated using in-depth, semi-structured interviews with various stakeholders in each country's concrete industry. These semi-structured interviews followed a general outline but allowed for areas of interest to be explored in further detail (Punch, 2005). The interview contents were broken into three sections, as summarized in Table 2, with the objective of understanding the regional differences in industry conditions and general sustainability issues, concept of sustainable concrete practice and materials, and barriers to implementing those practices and materials.

Sixteen interviews were conducted in total, with the distribution of interviewees from both countries shown in Fig. 1. In