ISSN: 0974-5823 Vol. 7 No. 5 May, 2022

International Journal of Mechanical Engineering

Stakeholder's Perception for Developing a Greener Concrete in Thailand

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Abstract - Concrete is the most significant building material second to only water, produces more than 10 million cubic meters per year in Thailand. Concrete is necessary for infrastructure development; however, it has substantial negative impact to the environment. Objectives of this study aim to investigate current practice and trend in developing green concrete in Thai construction industry. Qualitative data was collected from 11 expert interviews to gain understandings related to current practice and trend in developing greener concrete in Thai construction industry. Then, quantitative data was collected from 95 construction practitioners through online questionnaire survey. The results reveal that major barriers in developing green concrete in Thailand are a durability-based mindset among practitioners causing the reluctance to use green concrete which may not be as durable as traditional concrete. The respondents feel the significance of good workmanship as crucial to the development. Thai construction industry needs to develop a standard for green concrete practice and foster the required knowledge and skill for the workforce. The finding was further validated by the expert involving in developing national policy. It is suggested that case study of sustainable concrete practice in government funded projects would significantly raise the awareness and help establishing a foundation of knowledge and standard of sustainable concrete practice in the industry.

Keywords - Green Concrete, Stakeholder's Perception, Thailand

INTRODUCTION

Concrete production is a major carbon emission manufacturing process creating a high level of air pollution especially in the expanding trend of the world's population and urbanization (Gautam et al., 2014). As a part of the industrial society, which is moving to a sustainable habit. The concrete industry is also establishing the sustainability application on its operation activities by improving durability property adding waste from other industries, for example, Fly ash or GGBS. The use of concrete from construction and demolition can solve the problem of concrete waste and the consumption of natural aggregate at the same time. However, the application of recycled concrete as coarse and fine aggregate in practice should be traded-off between performances and sustainability indicators. (ACI, 2001; Thai Industrial Standard, 2017; Mehta,1999; 2001 and 2002).

In 2017, 14 million cubic meters of concrete was made in Thailand which rapidly growing for more than 40 percent in the past decade. (Bank of Thailand, 2018). Due to a vast quantity of raw materials producing concrete such as limestone, river sand either freshwater, concrete is the most economical application for building the structure in this country. From the report of Thai Green Building Institute in 2017, concrete was used around 0.23 cubic meter per square meter of building floor area on average. The figure is greatly contrasted to the U.S. which takes only 0.02 cubic meters. Moreover, half tons of carbon discharged from every ton of cement produced in Thailand (Thai Cement Manufacturers Association, 2016). Through the process from demolition, delivery to the production of a ton of concrete contributed 286 kg/m3 of CO2 emission (Premanoch and Sukontasukkul, 2008). At the end of the service lifetime, the concrete structure will be demolished which contributed around 70 percent of construction and demolition waste is concrete (Leelawat, 2010). Without any serious action, the situation of concrete consumption and management is tended to be a critical problem of Thailand urban in the future.

The concrete waste from demolition process or due to rework which will be easily transported to vacant area for landfill. It will accelerate the depletion of the limited precious landfill space. Especially, in the present-day of modernized economy, "time" is one of the significant key success indicators of the construction project. High early strength concrete contains highly reactive cement and an additive which undergoes higher shrinkage induced cracking has been commonly utilized. The persuade on quality and durability practice mindset should be favored to all players of the industry (Mehta, 2001). Due to a direct linkage between the growth of the building industry and the increasing consumption rate of concrete, the major improvement in the concrete industry will foster the construction more sustainably.

In the past, various materials were used in concrete work to make concrete more sustainability. Since the replacement of cement, natural rock and river sand is applied to reduce the rate of CO2 emission (Henry and Kato, 2010). The use of cement substitutes has been a long time. Because the greenhouse gas emission is the highest ratio from cement production. Fly Ash and GGBS were primary replaced the cement content in concrete mixing due to its pozzolanic reaction which also produces calcium silicate hydrate (CSH) which useful in strength development. Moreover, the durability of concrete containing fly ash is better than normal concrete from due to gap filling in concrete that gives the concrete denser.At a present-day, some of the concrete waste may

partially replacement for the coarse and fine natural aggregate in new fresh concrete. Due to higher water absorption from multi-layer of mortar and Interfacial Transition Zone (ITZ) (Dhir and Dyer, 2005; Otsuki et al., 2004; Rao et al., 2007) reportedly, the substitution amount which not exceed 30% is appropriate to maintain its comparative properties; strength, fresh concrete property, elastic modulus and long-term behaviour.

In 2001, Poon et al. have investigated the Construction and Demolition Waste (CDW) disposal activities in the Hong Kong area. The study has shown that CDW did not have any on-site treatment or sorting facility before dumping, mixed inert and non-inert waste have directly disposed of for land reclamation aspects which reduce the ability of future land use. A short while after, the Hong Kong Government introduced a "Waste Charging Scheme" (WCS) in 2006. 125 HKD charged to every ton of unsorting CDW, in case of on-site waste classification has implemented, only 25 HKD is charged for fill reception which means 100 HKD will be fined to careless contractors. This district price encourages construction projects more activate the on-site waste management program. Lu and Yuan (2012) reported that construction waste to landfill was reduced 23% on average from the period before the WCS.

Another example is the adoption of a sustainable strategy of an urban zone in Lisbon, Portugal. The building that certified Sustainable Assessment System, called "LinderA", will pay up to 25% less TAX (Braganca et al., 2008). As well as the external driving force to Lisbon to establish the frame for sustainable construction management program comes from the EU project enforced "European Manual for Construction Waste" (Saez et al., 2013) that waste recovery must be increased to more than 70% by weight (Gangolells et al., 2014). Through the above attempts encouraging Lisbon creating green momentum to the society, the number of university's course in sustainable building, building assessment methods including sustainable building technology acquisition such as initiating recycle aggregate production plant is noticeably increased.

According to the practice mentioned above, we might conclude that the government will play an important role in guiding or establishing green construction movement by economic instrument (e.g. tax and charging scheme). Besides, all stakeholders could activate more collaboration for developing greener construction industry. The study targets on investigating the current perception of Thai construction stakeholders on sustainability practice. The objective of this research are 1) to a broader scope of sustainable construction challenges in Thailand's environment from the suggestion of professionals in the relevant field; 2) to recommend the major success factor developing greener concrete in Thailand. The following section of this paper includes the interviews and survey of Thai construction's experts were conducted as a qualitative and quantitative approach. The perspective of concrete sustainability approach according to the experts is linked improving the knowledge and skill of construction stakeholders. Durability, reducing returned concrete for promoting code for sustainable concrete has been mentioned frequently during the survey and interview. Meanwhile, the government project case study on a green concrete application could be established. Encouragement of the sustainability practice among the Thai construction industry is added by the government policymaker from the in-depth interview.

METHODOLOGY

Participants

In this research, overseas literature review on sustainable construction and green concrete production was primarily carried out. The objective of the reviews is to identify barriers underneath green construction project management and its effective overcoming approaches. Then, the interview of the construction industry's expert was developed to discover the thematic use from their experiences that could be implemented in Thai's context which may not reflect in the literature review. The practices will be combined to provide a survey questionnaire that consists of a comprehensive and accurate global outlook with local perspectives. The two sections of survey questionnaire that is sent to 1,047 construction and concrete-related professionals listed to the Council of Engineers, Thailand Concrete Association and Department of Business Development, Ministry of Commerce from May to August 2018. The first section asks about their sector in construction projects and experiences. The second section requires the answerer to evaluate the greener practices for utilizing concrete as it is the all-time most utilizing construction materials. Finally, the key success criteria found from the questionnaire will be validated by in-depth interviews with the strong foundation and deep knowledge policymaker to confirmed the ability results can provide a comprehensive account of promoting measures achieving greener concrete in Thailand.

Data Collection

The identification of green elements in green concrete development has been notified by 11 of strong engineering basis and broad experience of managers or professional practitioners via face-to-face interview and completed the descriptive questionnaire from email. Table 1 shown the list of interviewees categorized by their organization and position level. Open-end questions were asked on "how could we made greener concrete in Thailand?". Their supplementary knowledge and valuable opinion could beneficially set up as an improvement guideline to the industry.

Table 1

List of Interviewee.

Field	Symbol	Organization	Position	Respond By
Owner	O	Mass Rapid Transit Authority of Thailand	Chief of Construction Management	Interview
		Electricity Generating Authority of Thailand	Civil Design Manager	Email
		Department of Highway	Chief of Bridge Construction	Interview
Construction	C	Building Contractor	Manager	Interview
		Infrastructure Contractor	Project Director	Interview
		Sub-Contractor	Managing Director	Email
Materials Provider	M	Concrete Provider	Manager	Interview
		Chemical Material	Specification and Standards Manager	Email
Researcher	R	University	Professor	Email
		University	Assistant Professor	Interview
		Company's Researcher	Structural and System Engineering Director	Email

Data Analysis

In order to evaluate the significant level of sustainable development ideas in practice, a questionnaire has been conducted by one simply question of "How the impact if these criteria on developing greener concrete?" using five-point Linkert scale (1=Strongly disagree, 3=Neutral, 5=Strongly agree). Indicators provide from interviewee's suggestions and supported by previous global literature from Europe and Asia are: maximizing usage of returned concrete, reducing work error and ordering mistake, durability-based mindset, Reduce cracking, promoting code for the greener concrete and educating on knowledge.

After sending the email contain with URL link to the survey questionnaire by using online application. 95 survey result were received which is 9% of response rate which is acceptable comparing to previous questionnaire survey basis examined in construction industry e.g., 13% in Jin et al. (2017), 4% in Orr et al. (2019). Contractor is the major proportion by 38% follow by Designer and Owner respectively. As shown in Fig. 1. Half of respondents have been worked in construction industry more than 10 years that leads us to strong and consistent of result as shown in Fig. 2.

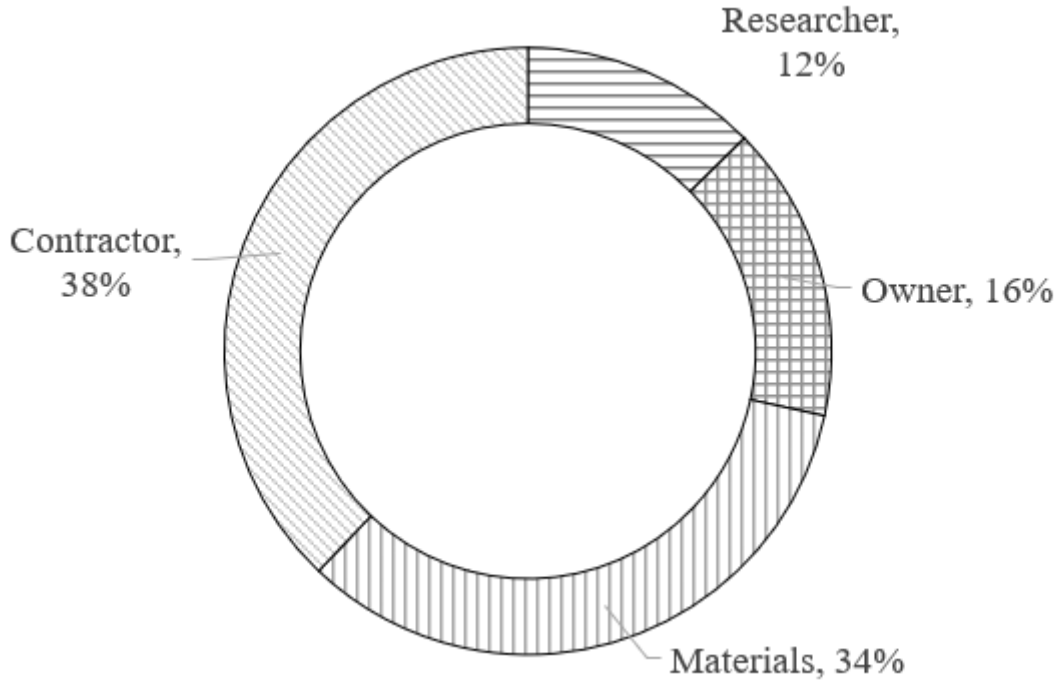

Fig. 1

Number and Percentage of Questionnaire respondent

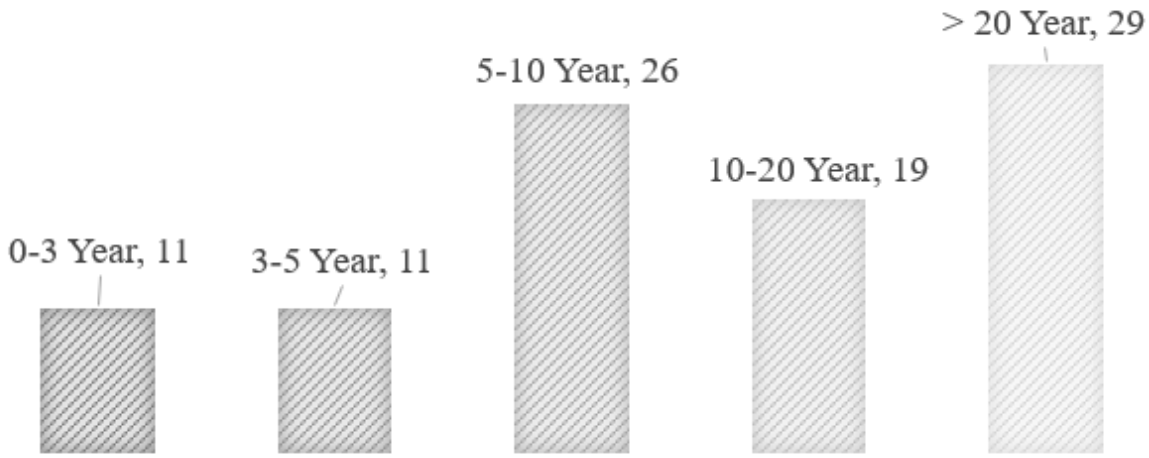

Fig. 2

Year in construction job of the survey respondence

RESULT

The thematic case for sustainable construction and concrete production has been listed in Table 1. From the interview, key major findings of improving a concrete industry that all of the parties have mentioned were 'Workforce' in quantity (shortage of workforce) and quality (knowledge and mindset) is a critical barrier that has been reconfirmed by all group interviewees. In quantity point of view, one of the interviewees has described that Thai construction worker is drastic decreasing in the past-ten-year due to the aging of the workforce and the perception of new-age worker that construction job is too difficult. On another hand of quality aspect, the need to make the project open quickly after signing the construction contract causing the construction work to be accelerated. Resulting in poor quality control of work. After used for a period, it is damaged and needs to be repaired. Another difficulty to made new green concrete as well as the challenges in concrete waste management is the key factor of good practice in concrete work, with the "durability mindset" is recommended amongst all the party of the concrete user. Workability, covering of concrete, placing and curing method will be taken good care during site work "preventing any kind of cracks".

"Rework work is a very complicated process in construction work" remarked by the interview. And maybe worth up to 10 to 30 percent of the project value (Hwang and Shan, 2016). However, there are so little effort has been made to investigate reworks in building construction projects especially in Thailand. Most of the interviewees have been mentioned that rework is a stubborn issue in their concrete application from construction mistakes, missing information in concrete ordering or owner's change order. Reducing rework using pro-active technology could be improving the problem in a more sustainable manner.

Table 1

Thematic uses of the terms 'Practice promoting green concrete'

Thematic Use	**Description**	**Supporting Group**				**Reference**
		O	**C**	**M**	**R**	
Maximizing usage of returned concrete	Remaining leftover concrete can be casted into non-structural work pieces or decorative materials.		/	/	/	Kim and Goulias (2015)
Reducing work error and ordering mistake	There should be prevention of concrete errors in the work site such as leak formwork and sprawl concrete while conveying.	/	/	/	/	
Durability-based mindset	Having considered the quality of the concrete structure in the long-term since the construction work.	/	/	/	/	Mehta (2002)
Reduce cracking	Construction work must have protection against concrete cracks that do not occur in any case.	/		/	/	Mehta (2002); Henry and Kato (2014); Wang et al. (2010)
Promoting code for the greener concrete	Establish standards for the use of concrete mixtures that are sustainable such as recycle aggregate, GGBS, PFA.				/	Dhir and Dyer (2005)
Educating on Knowledge	Educate the construction industry about sustainable concrete work	/	/	/	/	Mehta (2002); Henry and Kato (2014)

Although the practice of sustainable concrete management was revealed during the interview, however, their significances to the conduct might vary from each other. To explore the relative importance of this suggestion, the selected success factor will be combined with the global literature to producing consistent preference order even if a new alternative or criterion can be added. From the practice of developing greener concrete aspects, the interviewer's opinion is in the same way as previous research data. It is worth investigating the provided characteristics convert to the assessment scale by the survey method.

The demand for concrete production has sharply grown while construction investment is rapidly increasing in a developing country, particularly in Thailand. However, the quality-related issue is still an essentials approach towards concrete sustainability from this survey consequence. The fig.3 shown that "concrete durability mindset for construction practice" is the most effective implementation at the score of 4.50, accompanied by "enhancing green concrete knowledge", 4.33 and "minimizing all kind of cracks", 4.31. These key findings were supported by the research from Mehta (2002) that the durability aspect will make more efficiency of resource utilization which could also be considered lower maintenance cost throughout its entire life. Although, Henry and Kato (2014) have been found the contrary result from the investigation of seven Thai experts in 2014. Their research stated that the price of serving new sustainable technology in a concrete lifetime must be promoted rather than solely on the initial investment.

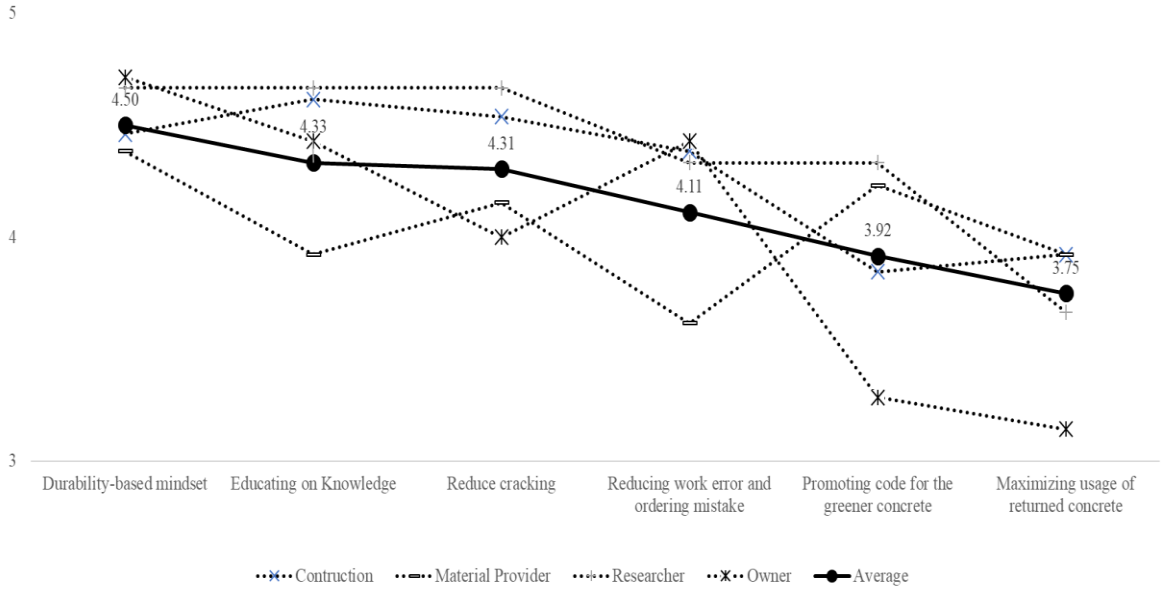

Fig. 3

Solution for better quality in concrete practice

In this research, the results from the survey were also used to ask for parallel opinions with the defining and standardizing policy governor on the use of construction materials in Thailand, by a 40-minute interview. The conclusion from the survey and interview results on the obstacles to sustainable construction in Thailand from this study were explained, the interviewer agrees that it is a matter of skill and quality. Due to the shortage of labour in the construction industry which is dirty, difficult and dangerous work and lack technology aiming to reduce the workload less than other industries. When discussing ways to promote the concrete industry to be more sustainable, the interviewees agreed in accordance with the summary from the questionnaire, the fact that the government sector is the "starting point for enforcing the standards of sustainable construction and concrete work" which will help the direction of the development of such concepts in the construction industry of Thailand promptly.

DISCUSSION

Buildings are built by people, (Glavinich, 2008) emphasized the importance of human capital. Good quality of the building is also made by skilled workers is a critical difficulty to develop greener concrete practice found from the interview and survey in this research. Recently, the shortage of skilled workers is projected to worsen due to the upcoming aging society problem. Reportedly, by 2025 Thailand's population of aged 65 or older will equal number to those who less than 15 year-old-age (Thailand Development Research Institute, 2015). The industry is suggested to prepare the new generation of workforce to be familiar with higher productivity approaches and green construction practices. The report form Hwang and Tan (2012) also supported this result. The education of stakeholders is needing to accomplish for increasing the demand for green building practice as mentioned in the survey result as well as confirmed by the global literature (Zhang et al., 2011). While urban development in a newly industrialized country such as Thailand accelerates with high speed, the literature and knowledge of sustainable construction management are developing at a slower rate. (Manowong and Brockmann, 2010) However, greener concrete concept may not be familiar unless relating influencer such government, industrial firms, and education institution has better collaboration to stimulate the society by enforcing law or regulation policy, setting-up some "standard of working sustainability" and "knowledge sharing events" (Mehta, 2002; Henry and Kato, 2014; Dhir and Dyer 2005; Kasayanond, A., Umam, R., & Jermsittiparsert, K., 2019).

As discuss in reconfirm interview and earlier publications (Mehta, 2002; Dhir and Dyer 2005 and Silva et al., 2016; Meirun, T., Mihardjo, L., Haseeb, M., Khan, S., & Jermsittiparsert, K., 2021), the new construction project needs to consider the durability of concrete structure by using multiple-choice of new materials technologies aiming to lengthen its service life.

CONCLUSION

This study identifies the significant parameters of achieving sustainable development goals from Thai construction member's attitudes. The interview and survey result reveals that collaboration and communication among related parties are potentially required while implementing sustainable practice.

(1) For delivering greener concrete from the survey result implied that a durability-based mindset for the staff related to concrete practice is mitigating the solution of reducing the newly concrete consumption.

(2) High-level employees who are responsible for setting construction standards in Thailand given more recommendation that in the government sector should determine the implementation of sustainable construction and concrete standards as a pilot project

allowing the private sector to recognize the advantages of using such ideas and helps the construction industry standards in Thailand be elevated to be more sustainable.

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