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Environmentally Friendly Construction Waste Management Method to Sri Lanka

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Abstract— Construction waste is one of the fastest growing waste streams in Sri Lanka. As a developing country construction waste generation is higher than in developed countries. The construction industry will rise and develop with time despite the county's current economic crisis. Most of the time construction wastes end up in landfills or in an illegal dump which causes many problems for the environment and the community. Thus, this study is focused on identifying the most generated construction waste in Sri Lanka and gathering the ideas and impressions of construction waste recycling from industry professionals. Based on the comprehensive literature review and the collected data, an environmentally friendly waste management method to support the construction waste management in the country is introduced.

Index Terms— Construction Waste, COWAM Plant, Environmentally Friendly, Waste Management, Waste Recycle

1 INTRODUCTION

Sri Lanka is a developing country and therefore the construction industry plays a major part in the development process of the country. As a developing country, a higher volume of construction waste generation happens with respect to the increase in construction. The construction industry generates waste as any kind of debris from the construction process. Construction wastes are bulky solid wastes that cannot be disposed of by incineration or composting.

Construction waste causes environmental pollution and therefore it is important to maintain a proper construction waste management system within the country. This study focuses on finding a better construction waste management system that is environmentally friendly and that can help to minimize the construction waste problem in the country. Through this study, the reasons for construction waste generation, the current waste management practices in construction and the perception of professionals on construction waste recycling are identified and an eco-friendly construction waste management method for the Sri Lankan construction industry is introduced.

2 CONSTRUCTION WASTE MANAGEMENT

2.1 Review of Current Construction Waste Management

The waste management hierarchy which is one of the best environmentally friendly waste management

systems [1] includes four steps: a) reducing waste, b) reusing waste, c) recycling waste and d) disposing of waste [2]. Eco-friendly or else environmentally friendly is zero or little harm to the environment. In this case, the above reducing, reusing and recycling steps are much more eco-friendlier in the management of any kind of waste than reaching the disposing step of waste. The 3R (reduce, recycle, reuse) principles have already been incorporated into construction waste management in Asian countries such as Japan, Hong Kong, India, Sri Lanka, Singapore and Malaysia [3]. However, it mentions that the policies, laws and regulations governing 3R principles for construction waste management are very minimal in Asia.

The authorities have paid less attention to construction waste management after the war period in Sri Lanka. A significant increase in construction projects after the war has generated a considerable amount of construction waste[2]. Identifying the origins of construction waste generation in the Sri Lankan construction industry is very crucial to finding remedies. The research findings state that the main reasons for construction waste generation are design changes and transportation. Other reasons can be identified as client changes, human mistakes, quality of work, labor skills, weather conditions, end of the product life cycle, material handling, poor supervision etc. [4] The attitude of the workforce is positive but the lack of practice of waste management applications causes the increase of construction waste in the industry. Proper training about construction waste management (CWM), development of communication channels and introducing incentives for better waste management practices are some suggestions given to reduce the amount of construction waste generation [5].

2.2 Summary of Construction and Demolition Waste Management in Some Selected Asian Countries

Table 1 shows the summary of Construction and Demolition (C & D) waste management in some selected Asian countries, which include India, China, Malaysia, Singapore, Taiwan, Thailand, Vietnam and Sri Lanka [3]. Asian countries have similarities in topography, weather and culture when compared to European, American, or other continents. Therefore, the construction industry of these countries is much more likely to have similar constructions using similar resources. This helps with the applicability of similar procedures and policies in construction waste management in Asian countries. All the above countries use Reuse and Recycle as the CWM strategy including Sri Lanka. When compared to Sri Lanka, countries like Japan, China, India, and Malaysia are following strict policies and government involvement in construction waste management is higher and ahead of us. U.S. is ahead of Australia in concrete recycling, but lags Japan, especially in using recycled aggregate concrete (RCA) in new concrete production for structural applications [6]. This shows that Japan was one of the countries with the highest progress in concrete waste recycling. All the above conditions prove that we need more government involvement and policies to serve the construction waste problem.

2.3 Construction Waste Management (COWAM) Plant

After the tragic Tsunami, the amount of construction and demolition waste remained in bulks in the affected areas. Also, with the rapid development in the construction industry, the rate of construction waste generation increased and therefore a huge need for a sustainable construction waste management procedure prevailed in the country. During this time the government introduced COWAM (Construction Waste Management) project to overcome the damage caused by construction waste generation. COWAM project is a founding of the European Union and is also considered the best-suited sustainable construction waste.

Table 1. Summary of C & D Waste Management in some Selected Asian Countries [3].

Country	*Annual C & D waste (amount or proportion of the total waste)*	*Strategies and technologies*	*Practices*	*Policy and institutions*
India (Pappu, 2007)	14.5 MT	Recycling and reuse Recycling and reuse of marble wastes in building application	A portion of C & D waste is recycle and reuse in building materials and share of recycled materials varies from 25% in old buildings to as high as 75% in new buildings	• Ministry of Environment and forests has mandated environmental clearance for all large construction projects
Hong Kong, SAR (HK EPD, 2007)	42%	Reuse – done by selective demolition technique	Reuse of C&D waste in lower grade 37 %-80% public filling areas for land reclamation purposes for period 12 years	• Construction Waste Disposal Charging Scheme • Public Works Programs, the contractors are required to formulate waste management plans • adopt low waste construction techniques, selective demolition • reuse of recycled aggregates in road sub-base and low grade concrete • the tracking system for C&D waste disposal • developed to a GPS-and-GIS-integrated construction M&E management system
PR China (Jones, 2007)	17.5 %	Reuse and recycling		Municipal Construction Waste regulations- Imposes stricter management on waste from municipal construction projects.
Malaysia (Begum et al., 2006)	28.34% (including industrial waste)	Reuse and recycling	Reuse and recycling	Reuse and recycling has been practiced – economic dimension
Singapore (Ofori, 2000)		Recycling of construction waste such as cement, aluminum, steel and sand into aggregates	Reduce, reuse and recycling	Building and Construction Authority (BCA) established an ISO 14000 Certification Scheme – a surveillance audit for construction firms
Sri Lanka (Rameezdeen, 2006)		Reuse and recycling such as door frames, cabok (lataritte brick), among others	Reuse and recycling industry	• Reuse and recycling has been practiced • Development of Construction Waste Management (COWAM) Centre - for environmental education and information resource, awareness raising of construction waste , involvement and participation of citizens or NGOs in the strategy building, dissemination of information to the public
Taiwan (Hsiao et al., 2002)	Approximately 2.4 Million Metric Tons of concrete waste	Recycling – Technology (Recycled concrete and Recycled Concrete Aggregate	Recycled Concrete Aggregate & Recycled Aggregate	• EPA initiated the waste asphalt concrete reutilization program in 1999 to standardize relevant quality requirements • established the Remaining Earthwork Information Service Center
Thailand (Carden, 2005)	No available Data	Portion of C & D waste disposed to landfill	Reduce, reuse and recycling	• Development of Construction and demolition waste program • Investigation on recycling and reuse of Debris from the Tsunami Disaster, which will contribute to the formulation of a future Disaster Debris Management Plan for Thailand
Vietnam (VEM 2002, cited in Vietnam Environment: Monitor, 2004)	Construction waste and sewage sludge make up for about 8% of municipal waste (2004)	Reuse	construction waste is normally used for back filling	

management project to address the prevailing construction waste problem in the country [7]. This resulted in the construction of a COWAM plant in Galle as it was affected mostly by the Tsunami in 2004. The COWAM center's contribution is to recycle demolished concrete waste and to produce end products such as cement blocks and interlocking blocks.

The COWAM (Construction Waste Management) plant is operated for 14 days per month due to a limited number of employees and a limited quantity of construction and demolished waste availability [4]. This is not exactly because of the lack of availability of concrete waste but the main problem occurs due to the high cost of waste transportation. The COWAM plant does not collect the required volume of waste to run the plant at full capacity [7]. Due to these reasons, contractors do not want to transport the generated waste to the plants. This is an excellent project as a solution to treat concrete waste generated in the construction industry but needs to be addressed with more care to maintain the plant at its full capacity.

3 METHODOLOGY

The preliminary data collection, data collection was done through well-structured questionnaires from responsible persons such as Site Engineers, Environmental Managers and Health and Safety officers working in the construction field. Secondary data was collected from websites, articles, journals, books, etc. Also, a focus group questionnaire survey was conducted with selected four construction managers to further clarify the study and to find out about the suitability of suggestions for the country.

4 RESULTS FROM THE ANALYSIS

4.1 Reasons for Construction Waste Generation

One of the objectives of this study is to identify the reasons for construction waste generation in Sri Lanka. The majority of the questionnaire respondents, which is about 74% (as in Fig 1) stated that the major reason for construction waste generation is poor handling. Contribution of other factors are as for human mistakes 66%, poor supervision 55%, quality of work 55%, weather conditions 39% and design changes 34%. These factors are selected based on previous literature.

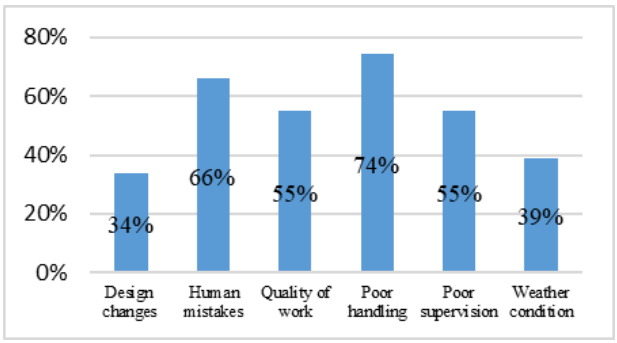

Fig. 1 Reasons for Construction Waste Generation

4.2 Comparison between Waste Generation and Reuse of Construction Waste

Moreover, it is expected to identify the most generated construction waste in the construction industry and to find an environmentally friendly treatment for the selected waste. This analysis proves the most generated waste in construction sites is concrete waste. Furthermore, it shows that even if the industry generates a higher amount of concrete as construction waste, which is about 76%, the reused percentage is only 11% as in Fig 2. This proves that the generated concrete waste is not much reused in the construction

industry. Literally, they are transported and dumped illegally or end up in a landfill. Plywood and steel offcuts are estimated as the second most generated construction waste, but a considerable amount of this waste is reused. The least generated is PVC waste.

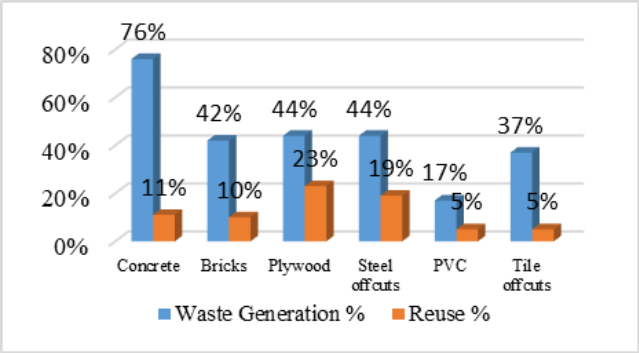

Fig. 2 Comparison between Waste Generation and Reuse

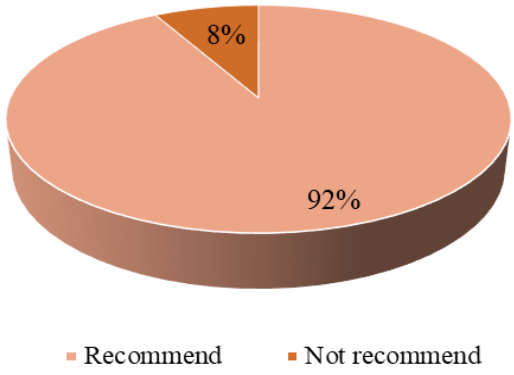

Fig 3: Professionals Preference on Construction Waste Recycling

4.3 Awareness in Construction Waste Recycling

It is essential to know the community's ideas and preferences before implementing or introducing any product, project or concept. This step is taken to prevent any damage that could occur and to successfully implement something for the world. Therefore, a survey is conducted to gather the professionals' preference for construction waste recycling before introducing a recycling method for the most generated construction waste. In here the majority which is about 92 % of respondents recommended construction waste recycling as in Fig 3.

As for the survey answers to an open-ended question regarding the opinion on construction waste recycling, the majority answer that construction waste recycling is good and is more suitable for waste management in the construction industry. Two of the respondents answered that recycling construction waste is practically difficult due to high energy consumption in recycling processes and due to the higher initial costs. Some other answers are that it is an environmentally friendly and sustainable method, better than direct disposal to the environment, can minimize cost for materials, good method of saving natural resources, eliminates the need to send construction wastes to landfills. In addition, they mentioned that it is a good method to earn money from waste by effective use of waste and to make the country clean.

5 Results of Focus Group Interview and Findings

As for a solution for the most generated construction waste, the professionals agreed to construct COWAM plants in other parts of the country. Before constructing a plant, it is needed to address all the obstacles and to select a proper location for the smooth functioning of a recycling plant. However, one interviewee stated that it is difficult to implement such solutions since most of the contractors and clients in Sri Lanka are not interested in proceeding with non-profitable movements. Hence, this is a barrier to implementing construction waste management projects as the initial cost as well as the running costs are higher than any profit it could gain. In this context, the prior objective needs to be saving the environment and the country and the government need to play a major role in this matter. Generally, processed aggregates are used in structural works in bridges, construction of shoulders, median barriers, curbs, gutters etc. and non-processed aggregates are used for backfilling in river banks and road constructions [8]. Therefore, it is needed to investigate the suitability of using recycled concrete as an alternative aggregate for these purposes. One professional also agreed that "though the regeneration process will be costly if fine aggregate can be produced from recycled concrete, the environment could be saved."

The responses of all the interviewees for considering recycling construction waste and using recycled products as an environment friendly method is a "Yes". The reasons for considering construction waste recycling as an environmentally friendly method are that it reduces the use of natural resources, saves construction waste and could make money from waste. Other than this, the process used for natural resource extraction is a destructive method. Therefore, if recycled products can be used in the construction industry, natural resources and landscapes can be preserved. It is always considered that reusing and recycling is better than disposing or dumping waste into landfills. Generally, construction waste occupies a large volume in landfills and the country does not have an adequate amount of land to serve this purpose. Also, landfills are not maintained properly by the authorities. This creates huge environmental problems in the country. However, though construction waste recycling is considered as environmentally friendly, a life cycle assessment should be carried out to find the best option and the quality of recycled concrete aggregate and the possibility of using them in construction needs to be properly examined.

6 Conclusion

The construction industry is continuously developing, and construction waste generation also rapidly increases with respect to the development. Therefore, the construction and demolished wastes need to be treated to manage the waste in an environmentally friendly manner. We cannot reuse every waste generated in the construction industry and therefore at least the most generated construction wastes need to be handled properly. From this study, it turns out that poor handling, human mistakes, quality of work and poor supervision are the major reasons for construction waste generation. Based on the literature reviews and field surveys, the most generated construction waste in Sri Lanka is found to be concrete waste and the reusable percentage is very low compared with the concrete waste generation. As a treatment for this problem construction of COWAM plants, which can be mainly used for recycling concrete waste, is suggested and accepted by professionals in the construction industry. The major barriers to this solution are the high cost and the energy requirement. The power consumption of the concrete crushing is high and therefore with the prevailing situation in the country, it creates difficulties to maintain a waste management plant. However, a lack of government awareness and support is highlighted in every direction in construction waste management. The field surveys provide strong positive perceptions of construction

waste recycling as a good environmentally friendly solution for construction waste management.

In Sri Lanka construction wastes are treated as solid waste and they are most likely to end up in landfills. Literature and field surveys highlight that higher government involvement is needed for a successful implementation of the waste management process. The Sri Lankan government has not yet been involved in the implementation of proper waste management practices and policies in the country. Therefore, the government should develop a national policy for constriction waste management to improve actions of waste management. Through this, the government could establish the requirements of specifications and technical guidelines on construction waste management practices for the contractors.

COWAM plant already produces recycled aggregates for interlocking and cement blocks. As the most generated construction waste is concrete waste, it is good to address this problem by introducing COWAM centers to other parts of the country. At present gardening decorations are widely commercialized among the locals. Therefore, we could develop a new plant to produce concrete garden decoration items like pond plant pots, and concrete posts for fences other than interlocking and cement blocks. Through that, we could reduce the use of resources and new materials to produce such items. The introduction of new casting frames or machinery to the COWAM plant could help to make it a success. Therefore, the areas that generate higher concrete waste in the country should be checked and the possibility of implementing COWAM plants in suitable areas should be investigated as a better solution to minimize the concrete waste in the country.

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