The 6th International Conference on Construction Engineering and Project Management (ICCEPM 2015)
Oct. 11 (Sun) ~ 14 (Wed) 2015 • Paradise Hotel Busan • Busan, Korea
www.iccepm2015.org

Development of framework to estimate environmental loads of PSC beam bridges based on LCA

Wan Ryul Lee[1], Kyong Ju Kim[2], Won Gun Yun[3], In Kyum Kim[4]

***Abstract:** This study aims at giving the framework to estimate the environmental load at planning and schematic phase. With increasing awareness of environmental issues, the effort to reduce the environmental impacts caused by human activity has been increasingly enlarged. So far most of researches estimating CO_2 emissions have analyzed energy consumption based on BOQ (Bills of Quantity) acquired after detailed design. There is also lack of reliability in the estimated environmental impact using the basic unit of a facility at the planning stage, because it uses a limited specific section of historical data. Thus, this study is targeted at developing framework to assess reliable environmental loads based on information available at project early phases by making case-bases from historical design information on PSC Beam Bridge. Historical database is built on the basis of the LCA (Life Cycle Assessment) and in order to set input information for estimating model, the literature about information in an early project phase are reviewed. Using the information available in the planning and schematic design stage, the Framework is presented to estimate the environmental load in an early stage in the project. Developing an environmental load estimation model in accordance with the Framework presented in this study, it is expected that the environmental load in the initial project phase can be estimated more quickly and accurately.*

***Keywords:** LCA (Life Cycle Assessment), Estimating environmental loads, Decision making framework, Concrete bridges*

I. INTRODUCTION

A. Background and purpose of the study

Environmental problems like global warming have now become important issues that should be considered in all industries, including construction (T. Hong et al, 2013). South Korea has establish 「Framework Act on Low Carbon Green Growth, Article 42」 in early 2010, set a goal of reducing Greenhouse Gas emission by 30% compared to BAU(Business As Usual) until 2020. In this regard, South Korea is pursuing substantial reductions through Energy target management system implementation and introduction of emissions trading, the carbon emissions trading system was implemented in January 2015.

Most of researches estimating CO2 emissions have utilized energy consumption based on BOQ (Bills of Quantity) acquired after detailed design. In addition, the estimated environmental impact using the basic unit of a facility at the planning stage is short of reliability because it uses a limited specific section of historical data. In this reason, in order to improve the reliability of the estimate of environmental load at the planning and schematic design phase, the environmental load estimation model based on the historical cases is needed. Therefore, the goal of this study is to develop a reliable framework estimating environmental load in an early project phase to make a right decision through the PSC Beam bridge case which has been highly valued in terms of environmental load.

B. Range and method of the study

This study aims at the framework development for environmental load estimation of the PSC Beam Bridge of the national roads in the planning and schematic design phase based on LCA (Life Cycle Assessment) concept. Almost all information available on making decision is analysed in the planning and schematic design phase of the PSC Beam Bridge. Based on this, input information of the estimation model of environmental load is decided. The framework for the model to estimate the environmental impact is established on the environmental load database built on analysis of detail design case.

II. FRAMEWORK DEVELOPMENT

A. LCA

Life Cycle Assessment (LCA) is a versatile tool to investigate the environmental aspect of a product, a service, a process or an activity by identifying and quantifying related input and output flows utilized by the system and its delivered functional output in a life cycle perspective. This LCA forms the technical basis of the ISO 14000 series. The main process for the implementation of the LCA consists of four steps- Goal and Scope Definition, Inventory Analysis, Impact Assessment, Interpretation- and Reporting and Critical Review. This study is prepared in accordance with the basic rules for the environmental load estimation model of PSC Beam Bridge on LCA analysis of the ISO 14040, 14044.

[1] Graduate Student, Dept. of Civil & Environmental Engineering Chung-Ang University, Seoul, 20071197@hanmail.net
[2] PhD, Dept of Civil & Environmental Engineering, Chung-Ang University, Seoul, kjkim@cau.ac.kr (*Corresponding Author)
[3] Graduate Student, Dept. of Civil & Environmental Engineering Chung-Ang University, Seoul, ogun78@naver.com
[4] Graduate Student, Dept. of Civil & Environmental Engineering Chung-Ang University, Seoul, kpanda@naver.com

B. Scope of environmental impact assessment model

The Life Cycle of construction industry can be divided into several stages; Extraction of the raw materials, processing the construction materials, transportation, construction, operation, maintenance, demolition, recycling and waste treatment (Ali Azhar Butt, 2012). This study aims to estimate the environmental load generated during construction stage of the project process of PSC Beam Bridge at the planning and schematic design phase. To improve the prediction accuracy of the environmental load at the planning stage, by analysing the historical design information that is applied in the detailed design phase, so that the database is built. By analysing the construction materials and equipment to be added during construction, it aims to build the Environmental Load Data Base in connection with LCI DB.

C. Input information in accordance with the project phases

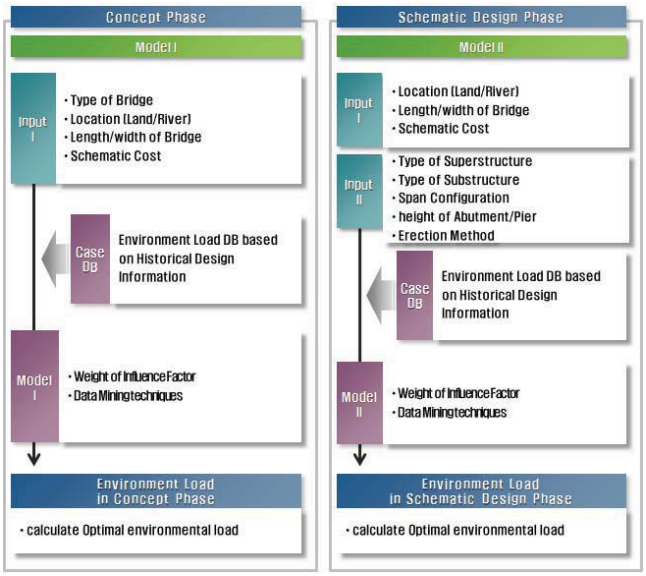
The information available when pushing the project through a literature survey are analysed. The planning phase is to review the feasibility of the project and determine promotion. In the planning stage to measure the budget and the project size, the information available is extremely limited. Therefore, bridge type, construction location (land / river bed), length and width, approximate costs can be selected as influencing factors.

In the schematic design phase, the optimal route chosen for the project at the planning stage can be selected, the design work is also proceeding through a real alternative assessment. Since the practical design is carried out at this stage, the more information available than the planning phase may be used. At this stage, therefore, including the information available applied at the planning stage, the additional information such as bridge superstructure / substructure types, span configuration, abutment / pier height, the construction method can be used.

D. Framework

The environmental load estimation model be divided into planning model (Model 1) and the basic design phase model (Model 2). In Model 1, bridge type, construction location, bridge length / width, approximate construction cost is used as input information in the planning stage. Using this information, the model to estimate the environmental load can be made by analyzing the database using data mining techniques. Next, in Model 2, more information such as superstructure / substructure types, span configuration, abutment / pier height, the construction method at the design stage including the input information used in Model 1 can be obtained, thus the environmental load of a higher reliability can be estimated (See Figure 1)

Figure I
FRAMEWORK OF ESTIMATING ENVIRONMENTAL LOAD



III. CONCLUSION

Most of researches estimate Environment load based on BOQ acquired after detailed design. In this study, using the information available in the planning and schematic design stage, the Framework is presented to estimate the environmental load in an early stage in the project. Developing an environmental load estimation model based on the Framework presented in this study, it is expected that in the early stage of the project the environmental load estimate can be more quickly and accurately made.

ACKNOWLEDGEMENT

This research was supported by a grant (Grant No. 14SCIP-C085304-01) from Construction Technology Research Program funded by the Ministry of Land, Infrastructure and Transportation of the Korea Government)

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