Summary of “Evaluation of in-situ technology performance and decision analysis by combining economic and environmental impact analysis for a case study”

By: Elham Tamadonyazdian
Master´s program of: Energy-efficient and Environmental Building Design (2021-2023)

Introduction:

This study was conducted to assess the environmental impacts and life cycle costs associated with the A1-A5 stages (production and construction stages) of the Köping Port project and eight additional proposed scenarios. The Solidification/ Stabilization method along with the in-situ technology was utilized in this project.

Main text:

In the contemporary global context, the global focus on reducing environmental impacts in any format has intensified. The purpose of this research was to evaluate the ecological consequences and overall expenses throughout the A1-A5 phases (covering production and construction) of the case study as well as eight other potential scenarios. The study is based on a port with an area of 48,586 m^2 located in Köping, Sweden which was stabilized with treated soil, a composition of sediment, cement, slag, and activated carbon.

This study was performed in different sequenced steps of data collection, LCA modeling, environmental assessment, economic analysis, and future decision analysis. Data collection for the project was conducted by collecting project-specific data regarding the project process, consumed materials and involved workforce as well as related costs. Data collection process also continued by investigating and selecting the most appropriate EPDs for slag and activated carbon materials. Based on the type of cement and different binder mixture, 8 scenarios were defined. To investigate the environmental impacts, the Life Cycle Assessment (LCA) was performed by GaBi (LCA for Experts) version 10.6.1 and Excel files. The next step was assessing the economic aspect by the Life Cycle Costing (LCC) method. Then, by applying the Single-Point Rate (SPR) calculation, decision analysis was conducted and the best scenario was selected regarding the integration of LCA and LCC.

According to the results, Scenario 2 which includes cement type I, with the binder mixture of 20%-80% for cement and slag respectively, was selected as the optimum scenario. This result was obtained based on all three options that were defined for weighting factors for the LCA and LCC. In fact, this scenario demonstrated almost 29% lower environmental impact and around 1.5 MSEK less initial cost compared to the base case which cement type 1, with the binder mixture portion of 20% cement and 80% slag is utilized in it.

An interesting perspective that can be explored in the results of this study is the integration of "normalized and weighted" outcomes from LCA with the total Life Cycle Cost in a single graph which is represented in Figure 1.

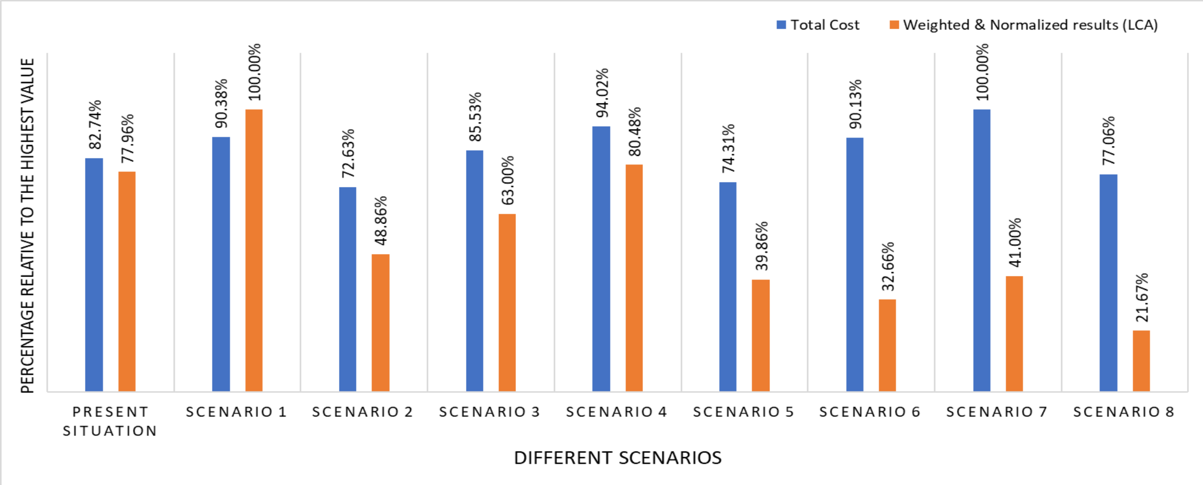

Figure 1: Integration of "weighted and normalized" results with LCC results.

In the base case, cement type I with a slag-cement portion distribution of 70%-30% is utilized. In Scenario 6, cement type III is employed with the same portion distribution in the binder mixture. Analyzing the total cost for each scenario, it becomes evident that the difference between them is merely around 1 MSEK (Million Swedish Krona). However, when considering the total environmental impact, the present scenario exhibits approximately 2.38 times higher impact compared to Scenario 6.

Furthermore, an intriguing comparison between the base case and Scenario 8 can be made. In Scenario 8, using cement type III with a slag-cement portion of 80%-20% results in a total Life Cycle Cost estimated to be around 1 MSEK less than the present situation. Moreover, the total environmental impact of Scenario 8 is about 3.59 times lower than the present scenario.