Evaluation of environmental impacts in the construction of foundation structures

Sho Miyazaki

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1. BACK GROUND AND PURPOSE OF THIS RESEARCH

Construction works are responsible for large amount of environmental impacts due to the mass material and fuel consumption. This is the reason why the environmental impacts in construction works should be evaluated and reduced effectively. However, few studies have investigated the impacts of foundation structures, although relatively a larger number of cases have been studied for super structures. In this research, following three case studies have been conducted to analyze the environmental impacts associated with the foundation construction; 1) Installing a sheet pile wall by using pressing - in or vibro-hammering methods, 2) Construction of the typical foundations for residential houses, and 3) Reuse of the existing pile structures for a building construction. Environmental impact was quantified by calculating the embodied energy and CO_2 emission during the raw-material extraction, processing the construction material, transportations and constructions. Particularly, the effects of the geotechnical profiles and applied construction methods on the environmental impact were examined. In the case study 3), environmental impacts was evaluated also based on the LIME (Life - cycle Impact assessment Method based on Endpoint modeling) to identify the other dominant indicators of the environmental impact for the construction of foundation structures.

2. SUMMARY OF THE CASE STUDIES

(1) Environmental impacts in sheet pile construction

In the installation of the sheet pile wall (depth is 2-15 m) into the ground to which the sheet pile foundation is typically employed (max. N value $\leq$ 50), the press-in method has the less environmental impacts by 50% at most than the vibro-hammering method, although the differences were minor by comparing with the environmental impacts due to the material production. However, taking into account the temporary work for supporting the vibro-hammering machine, the pressing-in method could provide much smaller impacts.

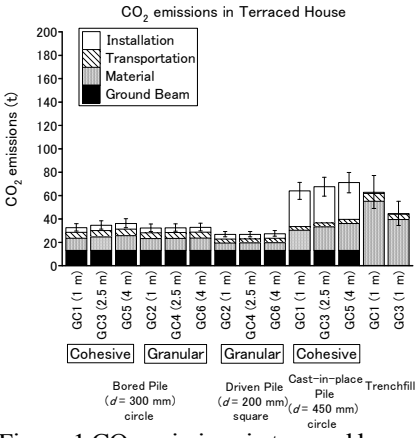

Figure-1 CO_2 emissions in terraced house

(2) Environmental impacts of foundations for residential houses

Environmental impacts in the construction of four typical foundations for various types of residential houses (i.e. bored piles, driven piles, cast-in-place piles, and trenchfill basement) were calculated and compared. Six different geotechnical profiles including two different bearing layers and three different thickness of soft ground layer were assumed. Application of the bored piles or the driven piles can reduce the impacts by approximately 50 %, compared with the cast-in-place piles or the trenchfill basement. The environmental impacts for the cases with the cohesive soil bearing layer were more sensitive to the thickness of the soft ground layer than those for the case s with the granular layer.

(3) The evaluation of the effectiveness of the reuse of the pile foundation

Environmental impacts for the case in which the existing piles were reused were compared to those for the case that all the pile foundations were newly constructed. The result shows that the reuse of the existing piles could reduce 30 - 40% of environmental impacts even though the mat slab needed to be constructed. The analysis based on LIME suggested that the reuse of soil foundation could effectively save the environmental cost in terms of the reduction of waste generation.

3. CONCLUSIONS

In order to save the environmental impacts associated with the construction of foundation structures effectively, each relevant process should be optimized by considering the construction method, foundation type, and geotechnical profiles. Particularly, the reuse of the existing foundations can be an effective option since the waste generation and the material production represent the majority of the environmental impacts caused by the construction of foundation structures.