The 2021 World Congress on
Advances in Structural Engineering and Mechanics (ASEM21)
GECE, Seoul, Korea, August 23-26, 2021

Keynote Paper

On the application of deep learning in the finite element method

*Phill-Seung Lee[1)], Seunghwan Park[2)] and Jaeho Jung[3)]

[1), 2)] *Department of Mechanical Engineering, KAIST, Korea*
[3)]*Korea Atomic Energy Research Institute, KAERI, Korea*

[1)] *phillseung@kaist.edu*
[2)] *qkrtmd387@kaist.ac.kr*
[3)] *jungjaeho@kaeri.re.kr*

ABSTRACT

Incorporating emerging technologies into FEM (Finite Element Method) can lead to a leap in FEM technology. Deep learning can be applied to FEM. In this presentation, we introduce two methods of creating finite element stiffness matrices using deep learning, one of the artificial intelligence techniques. In the first method, we generate reference data models from various finite element shapes and creates stiffness matrices by training strains extracted from the reference data models using deep learning. The finite element is called deep learned finite element (DLFE). In the second method, stiffness matrices are created by employing the assumed modal strain for bending modes and setting local coordinates using deep learning. The finite element developed improves the solution accuracy through an iterative solution procedure without mesh refinement, which we call a self-updated finite element (SUFE). The performance of the presented elements is demonstrated by various numerical examples. Through this study, we show that deep learning can be utilized for finite element development. In this presentation, deep learning is employed to improve 2D quadrilateral solid finite elements. In the future, we can extend the methods to various types of finite elements such as 3D solid, beam, and shell finite elements.

REFERENCES

Jung, J., Yoon, K. and Lee, PS. (2020), "Deep learned finite elements", Comput. Methods Appl. Mech. Engrg. Volume 372, 113401.

Jung, J., Jung, H. and Lee, PS. (2021), "Self-updated four-node finite element using deep learning", Comput. Mech. Under review.

[1)] Professor
[2)] Graduate Student
[3)] Researcher