

A new computational platform of structural reliability analysis developed by coupling FERUM and OpenSees

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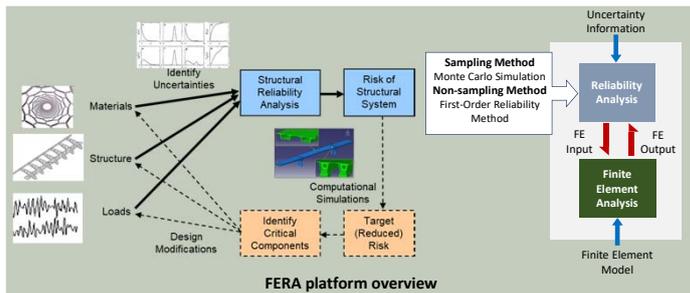
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ABSTRACT

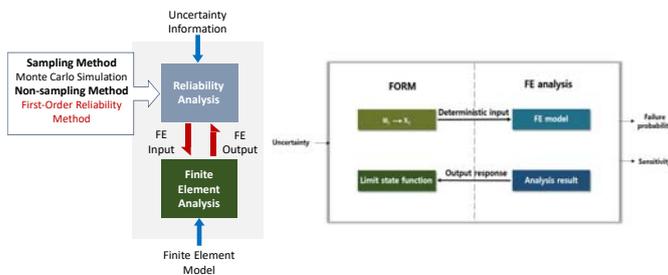
A structural reliability analysis employing a sampling-based technique such as Monte Carlo simulation (MCS) may require a significant amount of time, particularly when dealing with a complicated structural problem (Moon *et al.* 2018). In this paper, a new computational platform of structural reliability analysis is proposed. By coupling sophisticated software packages of reliability analysis (FERUM) and structural analysis (OpenSees), the computational platform enables an efficient analysis of structural reliability. In addition, it employs the first order reliability method (FORM), which provides useful byproducts as well as probabilities. It is applied to a numerical example and the corresponding analysis results are compared with those by MCS, demonstrating that the proposed platform allows us to perform a structural reliability analysis in an accurate and efficient manner.

INTRODUCTION



There is performing the reliability analysis which is probability-based for assessment of structures in various fields. To conduct a reliability analysis for complex structures, there has been often performing **finite element reliability analysis (FERA)** which is linked up sophisticated structural and reliability analysis. There is divided reliability analysis sampling-based method and non-sampling-based method. Sampling-based method, typically **Monte Carlo Simulation (MCS)**, is that generate random probability variables within the probability distribution and then calculate them repeatedly. Non-sampling methods, typically **First Order Reliability Method (FORM)**, do not require samples in calculating probability.

MAIN ISSUE



For the more reliable analysis of complex structure it has been utilized finite element reliability analysis (FERA) which is combine sophisticated structural analysis and reliability analysis. Therefore, non-sampling-based methods are often used to reduce the overall analysis time Moon and LEE et al (2018). First Order Reliability Method (FORM), is non-sampling methods, do not require samples in calculating probabilities and can reduce the time costs, which can remedy sampling-based methods shortcomings. Therefore, to conduct the finite element reliability analysis for sophisticated structural analysis, FORM is one of commonly used reliability analysis methods.

CONCLUSION

In this study, the structural reliability analysis was performed using the new computational platform FERUM-OpenSees. In addition, to verify the new platform, it is applied to the 3D frame structure similar the actual structure. Finally, compare the result of new platform (FERUM-OpenSees) and MCS, two results are confirmed to be almost identical. Therefore, if the FERUM-OpenSees platform is used, the time cost can be reduced because a non-sampling method is used when performing FERA for sophisticated structural analysis.

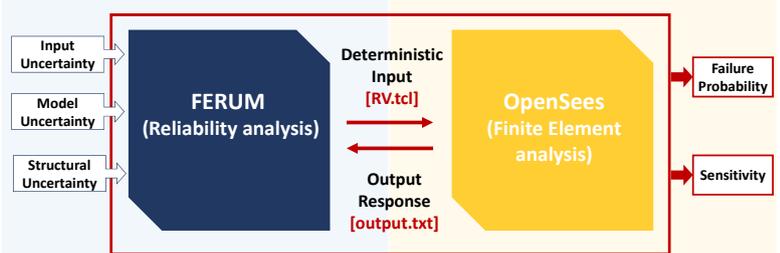
ACKNOWLEDGEMENT

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Moon, D.-S., Lee, Y.-J. and Lee, S. (2018), "Fragility analysis of space reinforced concrete frame structures with structural irregularity in plan", *J. Struct. Eng.*, 144(8), 04018096.

FERUM-OpenSees

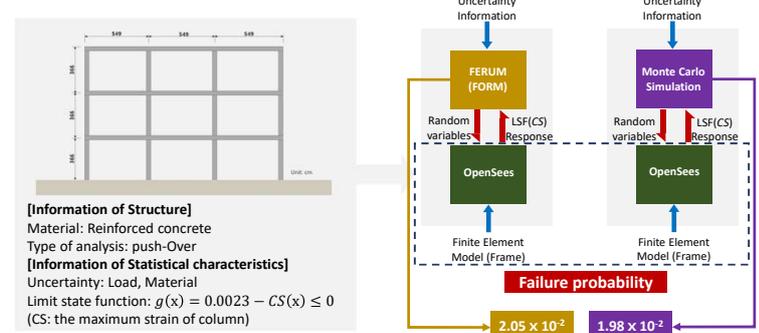


Finite Element Reliability Using Matlab (FERUM) is software which is developed by a research team at the University of California at Berkeley. It can perform several **reliability analysis** methods such as FORM, SORM, MCS and importance sampling simulation.

OpenSees is a proprietary object-oriented, software framework created at the National Science Foundation-sponsored Pacific Earthquake Engineering (PEER). OpenSees has been known for its finite element analysis software specialized in the field of seismic analysis.

In this study, FERUM-OpenSees is a new computational platform of structural reliability analysis. It enables an efficient analysis of structural reliability. When the input value is executed in FERUM, it is converted into Tcl file which is an OpenSees scripting language, by additional commands and applied to OpenSees. The result of OpenSees is derived from text file and MATLAB reads the results. Adding a random variable file to mode of OpenSees in a different way and that can be advantage.

EXAMPLE



The result of **FERUM-OpenSees** which is proposed the new computational platform find the design point with $\beta = 2.04$ in five iteration, the probability of failure is 2.05×10^{-2} . Meanwhile, there is verified by comparing the result of the MCS. The probability of failure with **MCS** is 1.98×10^{-2} at 40,000 samples, there is no significant difference from the result of the FORM.