Proceedings of the 2nd Virtual Conference on Computational & Experimental Mechanics (VCCEM2021)

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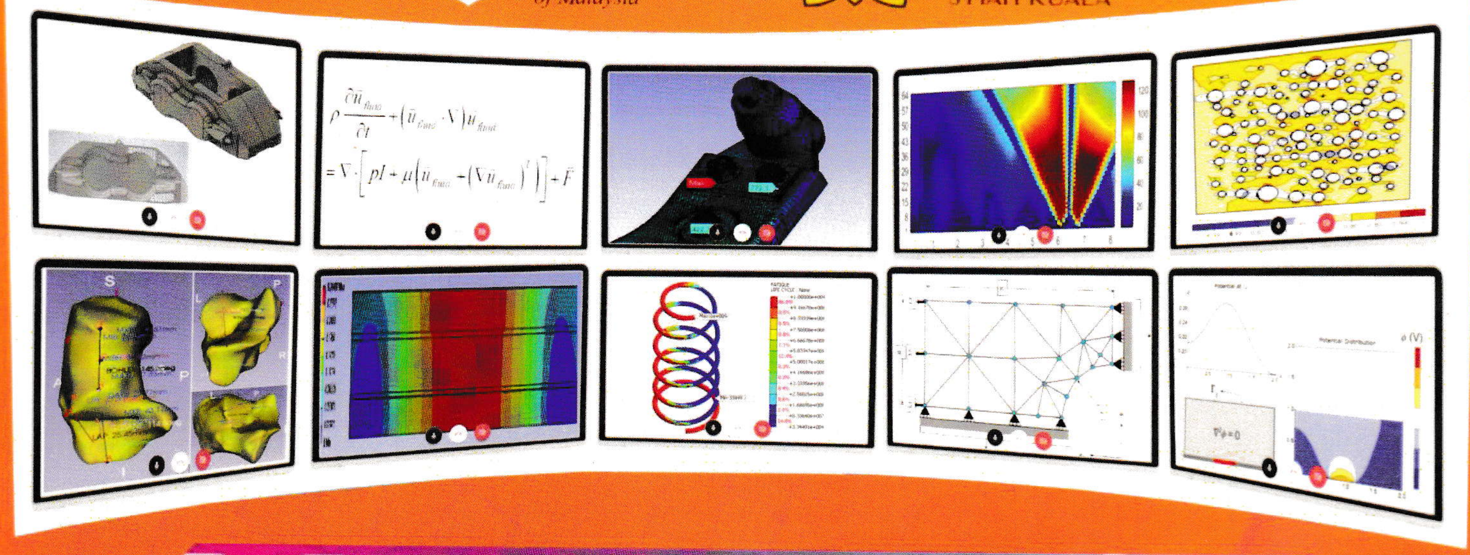

VCCEM'21

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PREFACE

The 2nd Virtual Conference on Computational and Experimental Mechanics (VCCEM) 2021 to be held on 1-2 December 2021 is organized following its success in VCCEM 2020. VCCEM 2020 was initiated as a knowledge sharing platform between two universities, the Computational and Experimental Mechanics Research Group, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM) and the Department of Mechanical and Industrial Engineering, Universitas Syiah Kuala (USK), Banda Aceh, Indonesia. This year the conference has been expanded to reach out to colleagues from other universities in the region.

UKM-USK as the joint-organiser for VCCEM 2021 would like to extend their highest appreciation to the honourable keynote speakers and all colleagues for participating in this conference. This year the conference has received more than 50 submissions from local and abroad namely from Indonesia, Malaysia, Japan and India. Last but not least, to the organising committee of both UKM and USK for their concerted effort in ensuring the success of VCCEM 2021.

We sincerely hope that VCCEM 2021 will provide the knowledge sharing platform for enhancing impactful research and fostering partnerships among participants from the respective universities.

Wishing all participants a successful conference.

Thank you.

Dr Muhammad Alias Md Jedi
Chair of VCCEM 2021

Dr Israr Bin M. Ibrahim
Co-Chair of VCCEM 2021

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Uncertainty Analysis in Two-Dimensional Finite Element Structure via Excel-VBA Method

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ABSTRACT

Complex engineering problems can possibly be solved by advanced computational methods via finite-element simulation. Uncertainties occurred due to the nature of geometry, material properties, loading, and boundary conditions will degrade the accuracy of results obtained from the analysis. These inaccuracies are due to stochastic processes and epistemic errors generated during the simulation or experimental works. This study solved the stress concentration problem on two-dimensional structures by manipulating mesh convergence and applying the Monte Carlo method to analyze uncertainties. Young's Modulus, E, Poisson's ratio, v, and loading are uncertainty input parameters considered random variables in this research. Visual Basic Application (VBA) software is used to perform numerical data analysis and observe the mesh pattern and the solution convergence. Results obtained proved that the finite-element method generated conservative and practical results for solving uncertainties in structural problems.

Keywords: Uncertainty, Monte Carlo Method, Visual Basic Application (VBA), Finite Element Method, Stress Analysis.

INTRODUCTION

Nowadays, construction of buildings and structures requires tedious decision in order to construct a safer environment and long-lasting lifetime, especially when facing with uncertainties. According to Farkas et al. (2010), uncertainties occurred from incomplete information due to ambiguity. Ambiguity is a result of imprecise information of human perspective from unknown resources. Uncertainties can be classified to probabilistic and non-probabilistic method (Choi et al. 2007). Thus, in this work, the Excel-VBA, the cost saving simulation software, has been applied. This software capable of automate any FEM applications and with the help of VBA, repetitions can be abolished and be replaced with macro function.

This research helps to determine the uncertainty factors which affect the accuracy of the stress analysis result. Besides, the meshing properties may have a significant influence on the previous stress analysis result.

A quarter part of a steel plate will be applied for modeling purpose. Non-continuity of geometry exists on this component. A hole or stream was created on its surface as a result of reducing its weight and to prepare an access point to reach its instruments. A high intensity of stress and shear stress will be produced around the hole.
Stress intensity factor, K_t can be represented as

$$K_t = \frac{\sigma_{nom}}{\sigma_{max}} \tag{1}$$

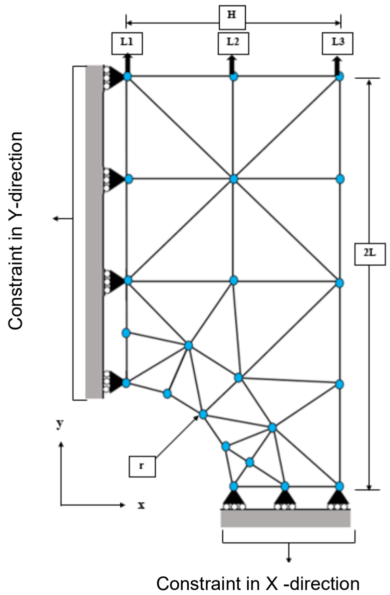

Fig. 1 Quarter steel plate model

In this study, three different types of meshing were applied to the model to observe the influence of meshing types towards stress analysis. The three different types of meshing are course, medium, and fine mesh. The focus on the model is relatively achieved based on small meshing elements in stress intensity problem (Nishio et al. 2012).

RESULTS AND DISCUSSION

Monte Carlo simulation via Microsoft Excel-VBA software were applied in this research. Input parameters were implemented in this simulation in order to integrate the uncertainties factors. Two-dimensional model was simulated and the input parameters are the position and number of nodes, elements, boundary conditions, loads, material properties and Poisson's ratio. The node displacement, stress, and boundary reaction were the output and this simulation process were performed for 20 iterations.

In order to analyze the existence of uncertainties in this study, the material properties, *E*, Poisson's ratio, *υ*, and loading were implemented as the input parameters for the simulation. This approach was not performed simultaneously as one parameter was manipulated while others were constant. Based on the research findings, the precision of the stress intensity simulation is increased when more meshing elements are generated close to the plate's hollow part. Triangular meshing elements helped to improve the simulation's precision and coarse meshing generated more error compared to other meshing types.

Figure 2 shows the maximum displacement of plate when all the input parameters are simulated simultaneously for 20 iterations.

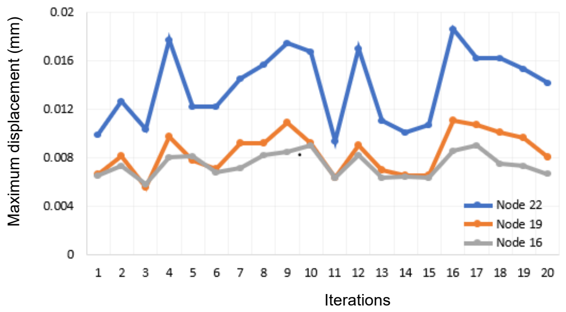

Fig. 2 Maximum displacement with 20 iterations

The result shows that the value of the maximum displacement is not constant when different value of input parameters was inserted in the Monte Carlo Simulation. This shows that there are uncertainties in the input parameters of the material properties of the plate that needed to be discovered. Furthermore, uncertainties in geometry might be the reason as most of the maximum displacement occurred at the edge of the hollow part of the plate.

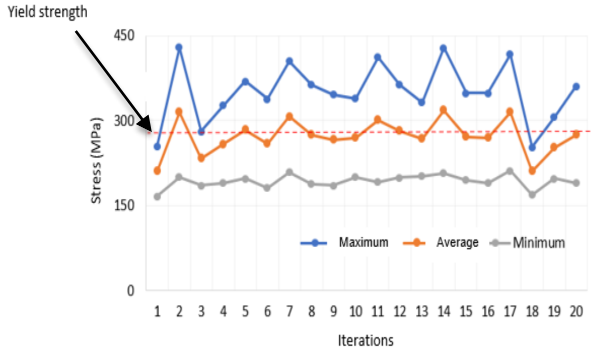

Fig. 3 Stress intensity with 20 iterations

Figure 3 shows the result of the stress intensity with 20 iterations, including the indicator of the material's yield strength. Almost 40% of the iteration indicates that the plate failed and break apart as it surpassed its limit. This can be due to fatigue and non-continuity of the meshing element in the model, especially at the edge of the hollow part.

CONCLUSION

Uncertainties exist in any input parameters for Monte Carlo simulation via Microsoft Excel – VBA application and the safety of any application used in daily life is in doubt. Values applied in any parameters are still uncertain. Loading, boundary condition, material properties, and geometry of a system must be evaluated precisely. More meshing elements generated accurate results in simulation.

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