# Structural and Load Modifications in Finite Element Analysis

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Abstract: The following work was conducted to outline the alternation of structure and loads in the finite element analysis or analysis in general. Nowadays, computers are able to handle complex analysis but yet the analysis sometimes requires to be solved. With the simplified version, analysis can be done in a faster way and with the fewer errors as well. Hence, the following work outlines the main aspects of the structure and loads alternation. Gives different types of examples of structure and loads alternation. Also, the work shows advantages and disadvantages of alternation of structure and loads during analysis.

## 1 INTRODUCTION

With the advancement of computer calculations, most of the complex analysis can be carried out in a short amount of time. In the past, it would take hours and days to tackle even the simplest calculations. Therefore, with the growth of computing power, there are new ways to solve some complex problems and even problems that were unsolvable in the past due to the lack of solving methods.

Modern days give researchers powerful tools for analysis. With the improvement of computing power, various tools have emerged. These tools (software packages) comes in wide diversity. Some are created for the modeling purposes, some for analysis, and ones with the capability to perform both.

These tools can analysis a given problem with the accurate results if they are carried out correctly. The quality of output results depends on many aspects. In the beginning, the correct method selection can increase the accuracy of the results. Many methods are used for different tasks, and therefore inaccurate or even incorrect results will be obtained when using the wrong method to solve a problem. The second thing is the knowledge of the researcher. For the correct output values, the prescribed steps for analysis needs to be carried out correctly. Therefore, the researcher must be qualified in the given problem. The third is correct representation of the tackling problem and the application of boundary conditions. The analyzing structure must be matching to the real-world object. If some parts of the analyzing structure differ from the real-world one, the output results will as well be different. Boundary conditions play a vital role in whole analysis. Even a slight displacement in applications of these conditions will give different output data. The last one is the interpretation of the results. There is a lot of data after analysis solved. Therefore, it is important to extract correct values and the skills to correctly interpret them. Of course, there are many other things to be looked up for the quality results output, but the main ones are mentioned in this work (Jiménez, 2021; Ordoñez, 2021).

Sometimes correct answers are not necessary in the analysis, but tendency. Some researchers use tools to predict results or in other way to see a tendency of results. In this case, the results will not match the real-world values, but will be on the same path. Hence, the structure can be changed or simplified. Similarly, the boundary conditions also will be altered. In other terms, it can be noted as a simplification or idealization of structure and loads. The following work will look into the use and reasons of altering the appearance and acting loads to it.

## 2 ALTERNATION OF STRUCTURE AND LOADS

For the analysis to be performed, some initial object is required. This object or a structure can be in any



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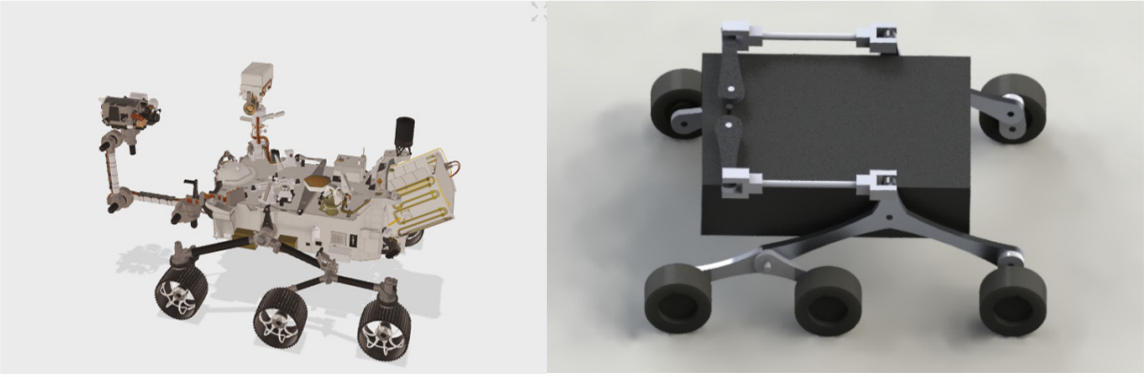

Figure 1: Mars rover.

shape, size, state and etc. Usually, a structure has different appearance and can be simple in one case and complex in others. Consequently, simple one will be easier to be modelled and analyzed than the complex one. The researcher has to make decision to analysis the structure as it is or alter the appearance and hence change the acting loads. Of course, both simple one and complex one can be analyzed as they are. But most of the time, both of the structures are simplified for ease of analysis.

There are two main reasons for alternation of structure and loads. The first of these, as was mentioned before, is related to the ease of analysis and the methods used. The second one is for working out different scenarios of how the structure will act by changing the appearance and the acting loads on it.

## 2.1 Structure Alternation

The following paragraph will be devoted to examples of alteration in the structure. By examining the examples, one can notice that some of structures are altered more, while others are not. In figure 1 presented Mars' Rover, which is currently used for the exploration of water on Mars.

Comparing two models, one can conclude that the difference in parts is vast, but the main body forms are represented in a simpler way (Magomedov, 2022; NASA SCIENCE; Daniela, 2015). Figure 2a and b illustrates the structure of the braking system. The representation of one object can be done in many ways, as illustrated in the figure 2. In one case, the brake system is represented with the closer appearance to the real-world system, and in another one, it has more simple modeled parts. As it was mentioned the appearance, complexity, forms and etc. depends on the researcher. The smartphone screen is shown in the figure 3. Figure 3 shows translation of 3D model to 2D model (Magomedov, 2019). It is not only 3d model simplification one can get, but 2d simplification too. Of course, there are a lot of different ways and methods to simplify the structure that are not represented in this work.

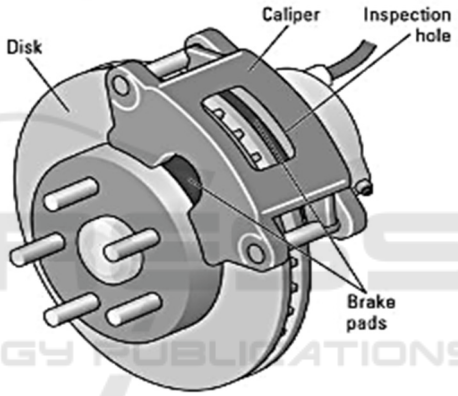


Figure 2a: Disc brake system.

## 2.2 Alternation of Loads

As it was mentioned earlier, the second thing that can be altered is the loads. First of all, by just altering the structure appearance, the loads will respectively change. Second thing is when 3D model is translated to 2d model as illustrated in the figure 4 (López, 2012; Enterfea). As model is translated to 2D model, some loads are changed or reduced. There is another method used in the analysis, which is segments removal. In which the structure is cut to a smaller portion and then one of the segments is analyzed.

In this method not only the structure is simplified but also loads simplification or reduction take place.

Figure 2b: Disc brake system.

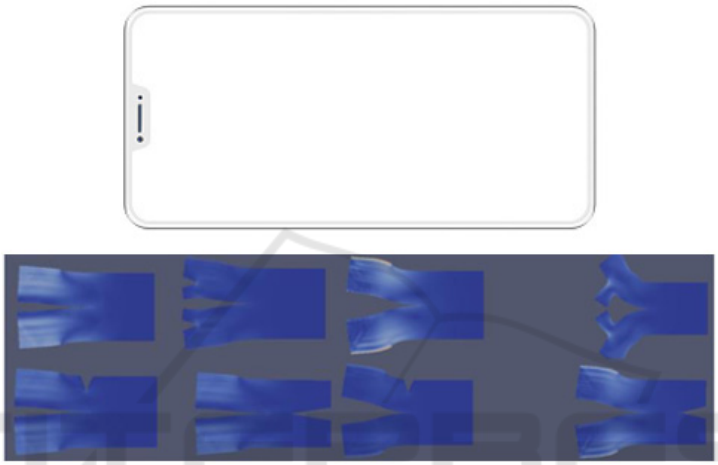

Figure 3: Smartphone screen.



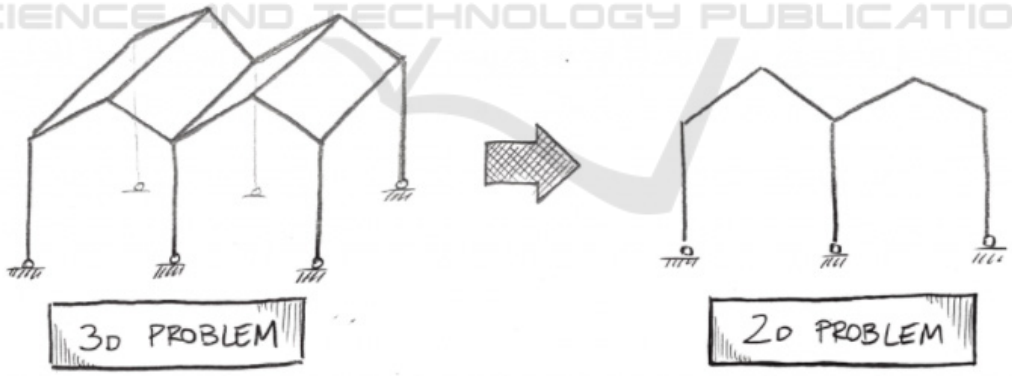


Figure 4: Beam models.

## 3 ADVANTAGES AND DISADVANTAGES

As it was discussed above, simplification of the structure leads to easy analysis. By the simplification of the structure nodes or finite elements get reduced (of course, mesh can be added to refine the divisions of structure even with the less parts), hence making it easier for the solver to calculate. It is also fair to mention that complex structures often give errors. Errors are inevitable part of the modern tools for the analyses. They occur way more often and there are a lot of reasons for their occurrence. However, simplification can sometimes eliminate them. If given the simplified structure to the solver it will calculate it faster (in some cases it can introduce more errors)

hence reducing time needed. In any production of goods, technique, food or in this case any analysis reduction of time is essential for the future prosperous. Time in our society is equals to profit, which means any reduction in time will positively effect in any given task.

With the advantages, there are some disadvantages for structure alternation before the analysis. First and the main disadvantage is precise values, which are collected at the end of the analysis. By the idealization or alternation of any given structure, the output results will only illustrate tendency or somehow close results, but no correct results. Therefore, the researcher should choose the correct method and decide, which result are expected from the analysis, whether precise or correlates with the correct values. The other outcome of alternation is incorrect values, which is not even correlates with the tendency. With the simplification of the structure, the output values can go in any direction, meaning that they won't carry any value at the end. Introduction of new error also possible with the alternation.

## 4 CONCLUSIONS

To conclude, the following work was performed to understand the use of alternation of the structure in the analysis. The work described the process and the meaning of the alternation or idealization of the structure. The examples also were presented in this work to illustrate the different ways of alternation. The importance of use of these methods were also presented with the advantages and disadvantages. With the improvement of the software, the alternation process will be easier to performed, but today it's a method that researchers use manually.

## REFERENCES

Jiménez, H. F., et al, 2021. *IOP Conf. Ser.: Earth Environ. Sci.* 776. 012012.

Ordoñez, M., et al, 2021. *Propuesta metodológica para el diseño de prótesis utilizando CAD generativo y análisis CAE.* p. 7

Magomedov, I. A., José, Luis Ordoñez-Avila, Bagov, A. M., 2022. *Statistical evaluation of a robotic six-wheel structures mechanism based on motion simulation.*

*NASA SCIENCE* (Mars exploration program) Mars Perseverance Rover, 3D Model. https://mars.nasa.gov/resources/25042/mars-perseverance-rover-3d-model/.

Daniela, N. Lastra. 2015. *Modelado y control dinámico de un Aerogenerador*. Universidad de Cantabria, Cantabria.

Magomedov, I. A., et al, 2019. *IOP Conf. Ser.: Earth Environ. Sci.* 378. 012064.

*Enterfea*, 2D vs 3D Finite Element Analysis (with examples). https://enterfea.com/2d-vs-3d-finite-element-analysis/.

López, V., 2012. *Ingeniería de la Energía Eólica*. Barcelona: Marcombo S.A.