



ChatGPT application in ground settlement analysis using LISA V.8 FEA

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ABSTRACT

OpenAI, an artificial intelligence research center situated in Ohio, USA, created ChatGPT. The model can be used to create autonomous discussions in conversational apps, assist with content generation, and even assist with multi-language translation with various degrees of accuracy for each language. ChatGPT is increasingly being used in all scientific domains and has a good influence, as evidenced by past research findings. This research will use ChatGPT in the field of geotechnical engineering by studying the settlement of soil layers with spongy clay type and validating it with modeling using LISA V.8 FEA finite element analysis (license). It is expected that this research will provide similar results to previous studies in engineering and other social fields. This research was conducted to be able to determine and provide validation of the behavior of the subsidence that occurred using ChatGPT and Finite Element Method Software LISA FEA V.8 from the results obtained were in model (a) there was a decrease in soil up to 0.0206 mm and in model (b) there was a decrease of 0.0167 with a ratio of 0.811 and with the ChatGPT model obtained a decrease of 0.0226 mm with a ratio of 1.097.

Keywords: ChatGPT, FEA, Geotechnical, LISA

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INTRODUCTION

ChatGPT was developed by OpenAI, an artificial intelligence research lab based in Ohio, USA (Adamy & Rani, 2022). The model can be used for a variety of activities, including as creating automatic conversations in conversational apps (Barrett dkk., 2019), assisting with content creation, and even assisting with multi-language translation with varying degrees of accuracy for each language.

ChatGPT (Chat Generative Pre-trained Transformer, literally Trained Chat Generative Transformer) is a generative language model-based artificial intelligence chatbot that uses transformer technology to predict the likelihood of the next sentence or word in a conversation or text command (Wilmot dkk., 2022). ChatGPT was built using the GPT-3.5 and GPT-4 large language models (LLMs) and has now been enhanced (transfer learning approach) with directed learning and reinforcement techniques.

Technology and artificial intelligence (AI) have had a major impact on medicine, from the development of life-saving equipment to the adoption of electronic health records (Kooli, 2023). Recently, OpenAI, a San Francisco-based research facility, released a big language model, ChatGPT, to the general public on November 30, 2022 (Kasneci dkk., 2023). Unlike other large language models, ChatGPT can process and respond to orders in a humane manner by admitting flaws and learning from past mistakes.¹ Plastic and reconstructive surgery is an innovative area that relies on research to improve patient-centered outcomes.

For all search phrases, 5 of 20 (25%) questions were comparable when a Google online search and a ChatGPT search were performed (Dewi dkk., 2022). Thirteen of the twenty Google Web Search inquiries were answered by company websites. Government websites answered 15 of 20 (75%) inquiries for ChatGPT (Khan dkk., 2023), with PubMed being the most commonly used. In terms of numerical questions (Kasneci dkk., 2023), a Google web search and ChatGPT provided different responses to 11 of 20 (55%) of the most frequently requested concerns (Dubin dkk., 2023).

The use of ChatGPT is increasing in all scientific fields and has a positive impact as in some previous research results (Aljanabi, 2023). This research will use ChatGPT in the field of geotechnical engineering by studying the settlement of soil layers with spongy clay type and validating it with modeling using LISA V.8 FEA finite element analysis (license) (Baihaqi dkk., 2023). It is expected that this research will provide similar results to previous studies in engineering and other social fields.

THEORETICAL STUDIES

Many leading corporate executives, including Bill Gates and Elon Musk, have declared that OpenAI ChatGPT (Generative Pretrained Transformer) will transform our work and lifestyles (Sugita dkk., 2021). ChatGPT was recognized in Nature as having an impact on the work of researchers (Sugita dkk., 2021). Thorp (2023) in Science mentioned some incorrect information in ChatGPT but believed that it would change education. ChatGPT is a sort of generative Artificial Intelligence (AI) that may be used to create text, code, audio, images, and videos. ChatGPT is based on transformer technology (a neural network architecture that predicts based on inputs) (Van Huis, 2021), which is similar to Bard, a Google-developed competitor to ChatGPT (Korzynski dkk., 2023).

The authors chose a demo research topic titled "Adoption of Artificial Intelligence (AI) in Higher Education" to demonstrate the applicability of ChatGPT and reveal the key challenges of employing AI chatbots such as ChatGPT in academic research (Chun dkk., 2020). ChatGPT 3.5 was used to assess its applicability for academic research. In addition, the researchers used an archival research design (Ebimngbo dkk., 2019). Researchers might use this method to obtain information from historical or non-historical documents (Qiao dkk., 2019). In recent years, Artificial Intelligence (AI) has been regarded as one of the most successful technologies for the advancement of global education (Cai dkk., 2021). In addition, there is significant interest in using AI in higher education.

The study compared the three approaches—manual analysis, ChatGPT, and the Finite Element Method—and examined the outcomes and data processing outputs (Nikat dkk., 2019). The results of the instant value that appears in the three reviews above are very satisfactory because the values of manual computation, ChatGPT, and FEA agree with the findings 95% of the time (Ramadhan dkk., 2024). For instance, the largest torque obtained via ChatGPT is 750,000 N, which is also the greatest torque obtained manually (Zou dkk., 2020). Additionally, the working pressure of 500 N is in line with chatGPT, physical pressure, and the results of the LISA FEA V. 8 (license).

It is frequently discovered in civil building construction engineering that the soil layer has a low bearing capacity (low strength), which has a significant impact on the various stages of construction design, including the planning stage (design), the implementation stage (perform), and the operational and maintenance stage (Operational and Maintenance).

Soil minerology, which is generated by weathering rock material (inorganic) and/or organic material, has a substantial influence on the poor carrying capacity of a type of soil layer in a location (Wang dkk., 2019). Weathering of unorganic and organic elements that form soil layers in a location can result in locally weathered material (residual soil) and/or weathered results carried from other locations (transported soil) (Ahmad dkk., 2019). The presence of both types of weathered material in the formation of soil layers has a significant impact on the properties of the soil in a location (Dewi dkk., 2022). The soil layer's physical and technical qualities (Azzam & Kildishev, 2021). When worn particles are finely graded, they have cohesive characteristics and a soft physical consistency.

The finite element method (FEM) is a numerical method for solving issues in technical analysis. To develop equations for a linear or nonlinear system, the finite element approach incorporates various mathematical principles (Yuziani dkk., 2023). The number of equations formed is typically very enormous, exceeding 20,000. As a result, unless a sufficient computer is used, this strategy is of limited practical value.

Strain (deformation), stress, temperature, pressure, and flow rate are all produced when a structure is subjected to forces such as stress, pressure, temperature, flow rate, and heat (Axelrod, 2021). The distribution of the ensuing action (deformation) on a body is determined by the parameters of the force and stress system (Arrazola dkk., 2021). The distribution of this effect, given as displacement, can be found using the finite element approach.

The temperature rise for three different heat exchanger models was estimated using LISA, a popular finite element analysis tool (Cardoso Dos Santos dkk., 2020). The line element model, shell model, and solid model are the three sorts of models, in order of their simplicity and ease of building (Jaja dkk., 2020). LISA includes a selection of regularly used structural shapes for line elements; users simply need to provide the element's dimensions in one dialog box and thermal conductivity in another (Ababor dkk., 1970). Because we cannot prevent convection from building the baseplate surface with the face

selection tool, the convection coefficient of the baseplate surface must be determined as half the value used elsewhere for line element models alone. It's simply a matter of.

RESEARCH METHODS

In this study, modeling was carried out using the finite element method program LISA V.8 FEA (License) by comparing the results of modeling analysis with the subsidence that occurred, to validate the depth of subsidence that occurred with a uniformly distributed load of 5 kN along 10 meters, on a 2 meter thick soil with a width of 1 meter and a length of 10 meters which is a type of spongy clay with NSPT 20, a soil elastic modulus value of 50,000 kN/m², a cohesion value of 100 kN/m², a specific gravity of 18 kN/m³ and a poison ratio value of 0.25.

RESULTS AND DISCUSSION

Modeling with the help of finite element method software LISA with parameters that adjust the soil data that has been determined (Lee, 2023). Furthermore, a conversation with chatGPT was conducted using the same parameters as the modeling performed.

Modeling with LISA FEA V.8 (license)

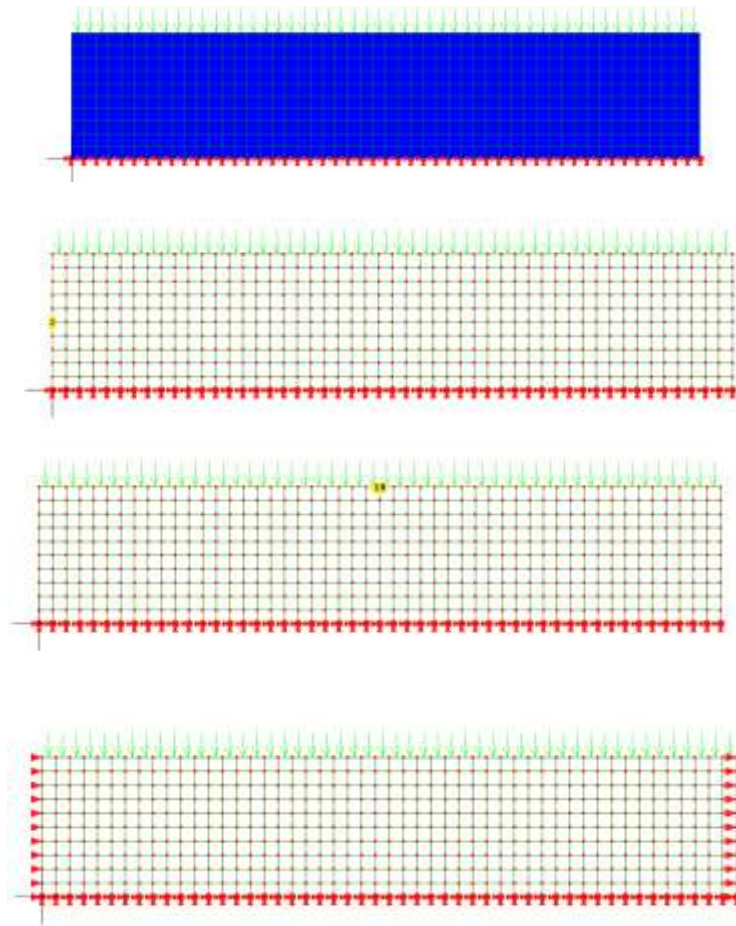


Figure 1. Modeling geometry of the soil layer

Figure 1 shows the modeling geometry of the soil layer with a soil height of 2 meters and a soil modeling length of 10 meters (Petit dkk., 2020). By giving fixed support stiffeners at the bottom of the ground in the x and y directions and providing support with a value of 0 to the displacement on the right and left sides in the x direction in model 1 and not providing support on the right and left sides in model 2. To identify the y direction.

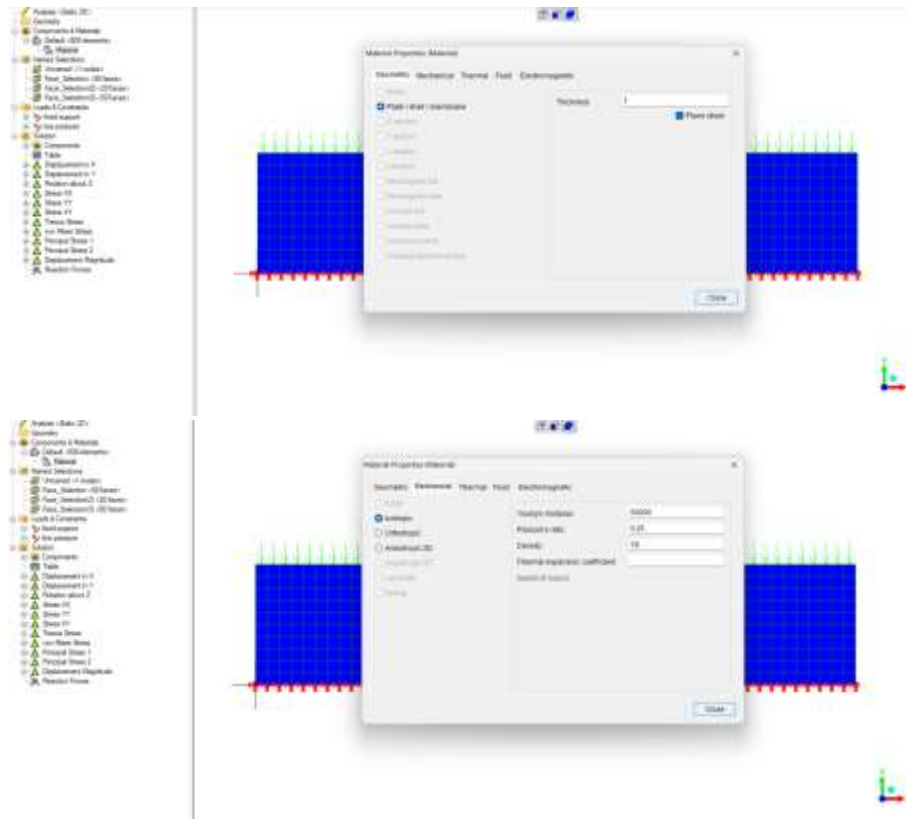
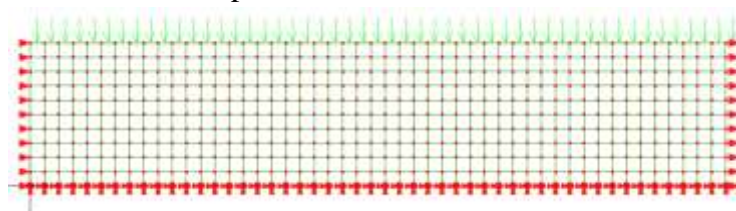
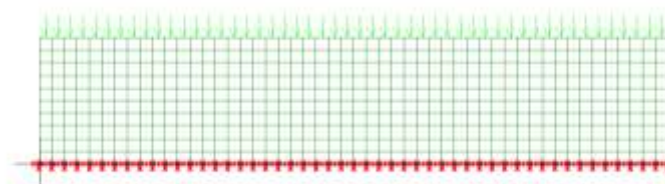


Figure 2. Material Properties

The width of the soil reviewed in the modeling is 1 meter, shown in Figure 2, using shell elements (Lo, 2023). The soil type used in this modeling is spongy clay with NSPT 20, soil elastic modulus value of 50,000 kN/m², cohesion value of 100 kN/m², specific gravity of 18 kN/m³ and poison ratio value of 0.25.



(a)



(b)

Figure 3. Soil layer modeling support (a) side stiffeners (b) without stiffeners

Two behaviors of soil layer modeling were made, with right and left side stiffeners (a), and without stiffeners (b) as shown in Figure 3.

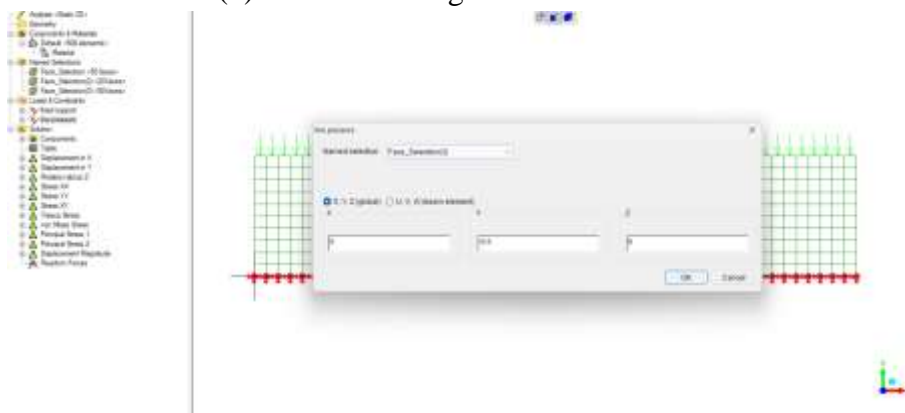
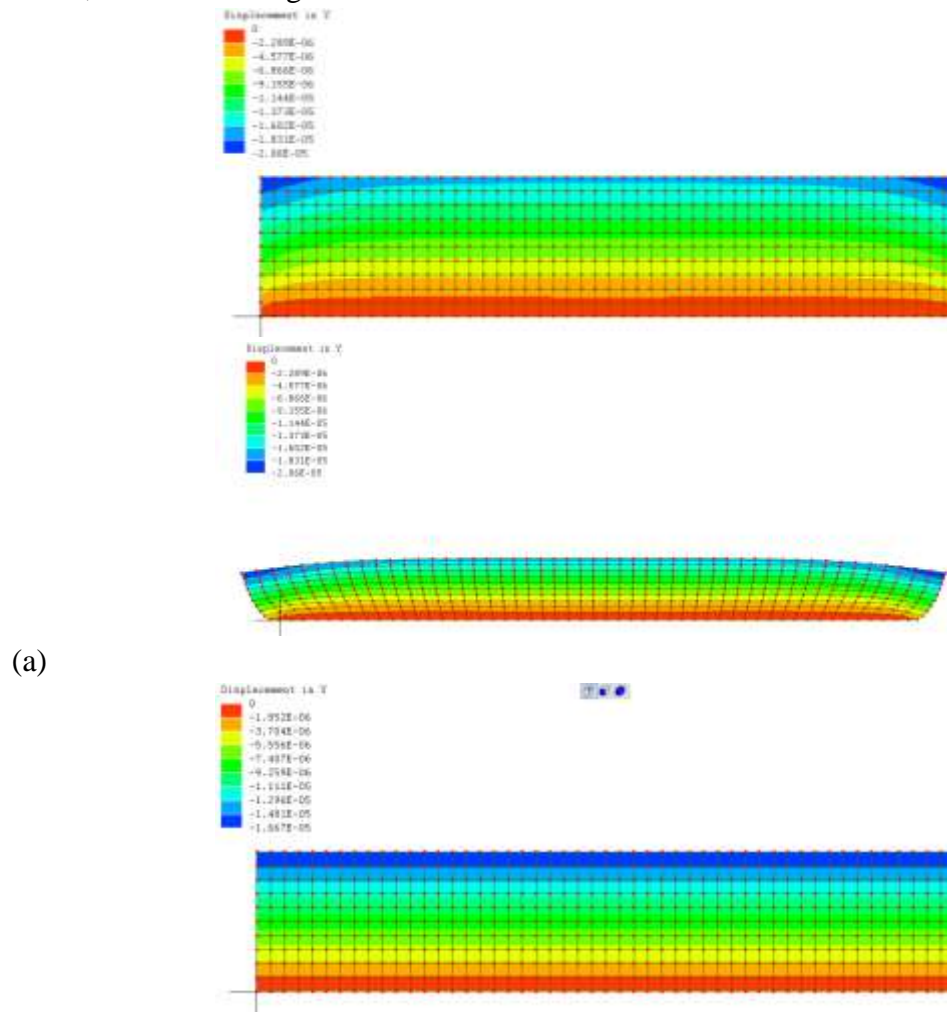
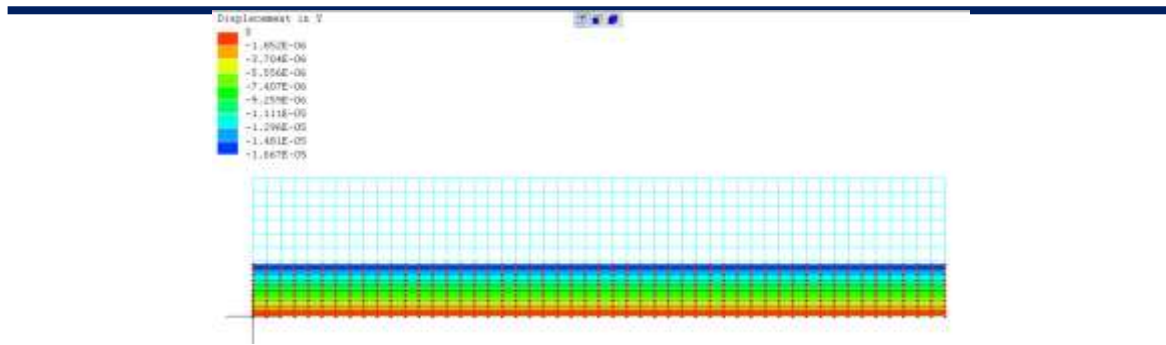


Figure 4. Load

The load applied is 5 kN along 10 meters so that it becomes evenly divided at 0.5 kN/m, as shown in Figure 4.





(b)

Figure 5. Behaviour and soil settlement value

In the analysis results using the Finite element method (FEM) software LISA FEA V.8 (License), the value of the settlement that occurs in the soil layer without side stiffeners (a) is 0.0000206 m or 0.0206 mm and in the soil layer with left and right side stiffeners, the settlement value is 0.00001667 m or 0.0167 mm. for the behavior of soil movement towards the settlement that occurs is shown in Figure 5 and the settlement value and the location of the settlement review in Figure 6.

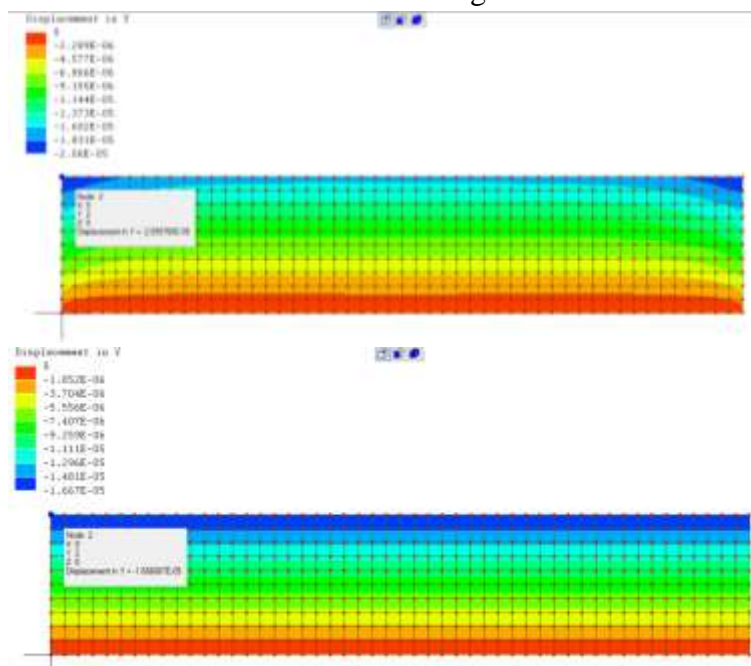


Figure 6. soil settlement value

ChatGPT.

Questions made in the ChatGPT conversation field.

“What is the depth of subsidence that occurs if the load is evenly distributed 5 kN along 10 meters, on soil 2 meters thick with 1 meter wide and 10 meters long which is a springy clay type with NSPT 20, soil elasticity modulus value is 50000 kN/m², cohesion value is 100 kN/m², specific gravity of 18 kN/m³ and a toxic ratio value of 0.25.”

Answer given by ChatGPT

“The depth of subsidence can be calculated using the formula:

$$\Delta h = q/(2Es(1-\nu)) * [(1+\nu)/(1-\nu^2)] * [1+2\nu(\ln L/d)]$$

where:

q = load per unit area = 5 kN/ (1 m x 10 m) = 0.5 kN/m²

E_s = soil elasticity modulus = 50000 kN/m²

ν = toxic ratio = 0.25

L = length of loaded area = 10 m

d = thickness of soil layer = 2 m

Substituting these values in the formula, we get:

$$\Delta h = 0.5/(2 \times 50000 \times (1-0.25)) * [(1+0.25)/(1-0.25^2)] * [1+2 \times 0.25(\ln 10/2)]$$

$$\Delta h = 0.5/(2 \times 50000 \times 0.75) * 1.33 * 1.69$$

$$\Delta h = 0.5/50000 * 2.258$$

$$\Delta h = 0.0000226 \text{ m}$$

Therefore, the depth of subsidence that occurs if the load is evenly distributed 5 kN along 10 meters, on soil 2 meters thick with 1 meter wide and 10 meters long which is a springy clay type with NSPT 20, soil elasticity modulus value is 50000 kN/m², cohesion value is 100 kN/m², specific gravity of 18 kN/m³ and a toxic ratio value of 0.25 is approximately 0.0000226 meters or 0.0226 mm.”

Result

No	Model	Settlement (mm)	Ratio
	LISA FEA V.8		1
1	(a)	0.0206	
	LISA FEA V.8		0.810679612
2	(b)	0.0167	
3	ChatGPT	0.0226	1.097087379

* (a) without side stiffeners

(b) with side stiffeners

In modeling type (a) is the basis of reference for determining the comparison ratio of modeling results, where the type (b) model has a ratio of 0.811 and with the ChatGPT model has a ratio of 1.097.

CONCLUSIONS AND SUGGESTIONS

This research was conducted to be able to determine and provide validation of the behavior of the subsidence that occurred using ChatGPT and Finite Element Method Software LISA FEA V.8 (license), from the results obtained were in model (a) there was a decrease in soil up to 0.0206 mm and in model (b) there was a decrease of 0.0167 with a ratio of 0.811 and with the ChatGPT model obtained a decrease of 0.0226 mm with a ratio of 1.097.

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