

# APPLICATION OF CHATGPT IN THE ANALYSIS OF INTERNAL FORCES OCCURRING IN SIMPLE BEAMS USING LISA V.8 FEA

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## Abstract

*ChatGPT (Chat Generative Pre-trained Transformer, literally Trained Chat Generative Transformer) is an artificial intelligence chatbot in the form of a generative language model that employs transformer technology to anticipate the likelihood of the next sentence or word in a conversation or text command. The increasing use of ChatGPT in all scientific lines has a positive impact as in some previous research results. In this research, we will apply the use of ChatGPT in the field of structural engineering by analyzing a steel portal due to lateral loads which will produce the drift value that occurs by validating it using the finite element analysis program LISA V.8 FEA (license) and against manual calculations. It is hoped that this research can provide satisfactory results as in previous research in other engineering and social fields. The research looked at the results and data processing outputs, as well as the comparison of the three methodologies, which were manual analysis, ChatGPT, and the Finite Element Method. Because the value of manual computation, ChatGPT, and FEA agrees with the results 95% of the time, the results of the instant value that occurs in the three reviews above are extremely satisfying. The greatest torque obtained by calculating manually, for example, is 750,000 N, which is the same as the maximum torque obtained using ChatGPT. Furthermore, the working pressure is 500 N, which is consistent with physical pressure, chatGPT, and LISA FEA V.8 (license) results.*

**Keywords:** Beam, ChatGPT, Force, LISA FEA

## Abstrak

*ChatGPT (Chat Generative Pre-trained Transformer, secara harfiah berarti Trained Chat Generative Transformer) adalah sebuah chatbot kecerdasan buatan berupa model bahasa generatif yang menggunakan teknologi transformator untuk mengantisipasi kemungkinan kalimat atau kata berikutnya dalam sebuah percakapan atau perintah teks. Meningkatnya penggunaan ChatGPT di semua lini keilmuan dan memberikan dampak positif seperti pada beberapa hasil penelitian sebelumnya. Pada penelitian kali ini, kami akan mengaplikasikan penggunaan ChatGPT pada bidang teknik struktur dengan menganalisa sebuah portal baja akibat beban lateral yang akan menghasilkan nilai drift yang terjadi dengan melakukan validasi menggunakan program analisis elemen hingga LISA V.8 FEA (lisensi) dan terhadap perhitungan manual. diharapkan penelitian ini dapat memberikan hasil yang memuaskan seperti pada penelitian terdahulu pada bidang teknik dan sosial lainnya. Penelitian ini melihat hasil dan output pengolahan data, serta perbandingan dari ketiga metodologi, yaitu analisis manual, ChatGPT, dan Metode Elemen Hingga. Karena nilai perhitungan manual, ChatGPT, dan FEA setuju dengan hasil 95%, maka hasil nilai instan yang terjadi pada ketiga tinjauan di atas sangat memuaskan. Torsi terbesar yang didapatkan dengan hitung manual misalnya adalah 750.000 N, sama dengan torsi maksimum yang didapatkan dengan menggunakan ChatGPT. Selanjutnya, tekanan yang bekerja adalah 500 N, yang sesuai dengan tekanan fisik, chatGPT, dan hasil LISA FEA V.8 (lisensi).*

**Kata kunci:** Balok, Beban, ChatGPT, LISA FEA.

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## 1. INTRODUCTION

ChatGPT (Chat Generative Pre-trained Transformer, literally Trained Chat

Generative Transformer) is an artificial intelligence chatbot in the form of a generative language model that employs

transformer technology to anticipate the likelihood of the next sentence or word in a conversation or text command. ChatGPT was created with the GPT-3.5 and GPT-4 large language models (LLMs) and has been modified (transfer learning approach) with directed learning and reinforcement techniques.

OpenAI, an artificial intelligence research center situated in Ohio, USA, created ChatGPT. The model can be utilized for a range of tasks, including establishing automatic discussions in conversational apps, assisting with content production, and even assisting with multi-language translation with various degrees of accuracy for each language.

When performing a Google web search and a ChatGPT search for all search terms, 5 of 20 (25%) questions were similar. Thirteen of the twenty questions asked for the Google Web Search were answered by business websites. For ChatGPT, government websites answered 15 of 20 (75%) questions, with PubMed being the most frequently used. In terms of numerical questions, 11 of 20 (55%) of the most frequently asked inquiries received different answers from a Google web search and ChatGPT (Dubin et al., 2023).

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. Recently, OpenAI, a San Francisco-based research facility, released a big language model, ChatGPT, to the general public on November 30, 2022. 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 (Gupta, Pande, et al., 2023).

The increasing use of ChatGPT in all scientific lines and has a positive impact as in some previous research results.

In this research, we will apply the use of ChatGPT in the field of structural engineering by analyzing a steel portal due to lateral loads which will produce the drift value that occurs by validating it using the finite element analysis program LISA V.8 FEA (license) and against manual calculations. It is hoped that this research can provide satisfactory results as in previous research in other engineering and social fields.



**Figure 1** ChatGPT icon.

## 2. RESEARCH METHODS

### 2.1 ChatGPT

To showcase the applicability of ChatGPT and disclose the essential obstacles of using AI chatbots such as ChatGPT in academic research, the authors chose a demo research topic titled "Adoption of Artificial Intelligence (AI) in Higher Education." ChatGPT version 3.5 was utilized to evaluate its suitability for academic research. Furthermore, the researchers employed an archive research design. This strategy can be used by researchers to gather information from historical or non-historical documents. In recent years, Artificial Intelligence (AI) has been regarded as one of the most successful technologies for worldwide education development. And there is a growing interest in the use of AI in higher education. As a result, ChatGPT has become a buzzword for the academic world, ranging from students to scholars. To demonstrate this, researchers concentrated on ChatGPT applications in research articles based on practical cases (Aljanabi, 2023; Cascella et al., 2023; Dubin et al., 2023, 2023; Dwivedi et al., 2023; Gunawan, 2023; Gupta, Pande, et al., 2023; Gupta, Park, et al., 2023; Khan et al., 2023, 2023).

OpenAI ChatGPT (Generative Pretrained Transformer) was published a few months ago, and many top business executives, including Bill Gates and Elon Musk, stated that it would revolutionize our work and lifestyles.

ChatGPT was mentioned in Nature as having an impact on researchers' work. Thorp (2023) in Science mentioned some inaccurate information in ChatGPT but believed that it will transform schooling.

ChatGPT is a type of generative Artificial Intelligence (AI) that may be used to generate a variety of content such as text,

code, audio, photos, and videos. ChatGPT is based on transformer technology (a neural network architecture that predicts based on inputs), which is comparable to Bard, a competitor to ChatGPT being developed by Google (Korzynski et al., 2023).

## 2.2 Simple Beam

Beam construction is a structure made up of one or more rods that can withstand normal forces, latitudinal forces, and bending moments. A construction is classified as a static structure if the value of the external forces acting on the element can be determined by static equilibrium equations (equations of equilibrium). Static equilibrium formulae can be used to determine this). As mentioned in this chapter, the construction of rod construction, which is still included in a given static structure, may be solved simply by employing three equilibrium equations in the computation of the analysis, namely the sum of the forces acting in the horizontal direction is zero or  $\Sigma H = 0$ , the sum of the forces that acting in the vertical direction is zero or  $\Sigma V = 0$ , and the sum of the moments of the force is zero or  $\Sigma M = 0$ .

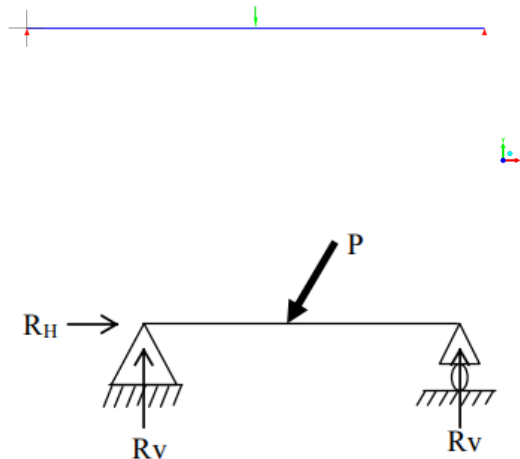


Figure 2. Simple beam

Internal forces are forces that act within the structure or forces that propagate from the load to the bearing reaction.

A single simple beam is a single span beam with one joint support at one end and one roller support at the other. The joint support is designed to accept stresses from several directions, resist bending, and keep the beam from shifting out of place.

Roller supports have been used to allow the beam to move freely in the direction of the beam's longitudinal direction. Thus, changes in the longitudinal direction due to beam bending and changes in length due to temperature changes can be neutralized because the roller support does not provide resistance to beam movement. If one of the supports is not a roller, for example, both joints, the beam will be under a lot of stress. If both supports are rollers, the beam will separate from the support.

Figure 2 depicts a loaded rod with force P. The platform experiences three reactions, which are as follows  $R_H, R_{v1}$  and  $R_{v2}$ . The force system is static definite because three equilibrium equations are accessible, and these equations are adequate to determine the three unknown variables in this case, the response forces (Budhi, 2003).

The maximum moment in a simple beam with the load centered at the middle of the span must occur exactly at the middle of the span of the beam. The maximum moment is at a distance of  $\frac{1}{2} L$ . So that the maximum moment occurs at  $\frac{1}{4} FL$ . The explanation can be seen below:

$$\begin{aligned} M_{\text{maks}} &= R_A \times \frac{1}{2} L \\ &= \frac{1}{2} P \times \frac{1}{2} L \\ &= \frac{1}{4} FL \end{aligned} \quad (1)$$

Figure 3 depicts a force diagram in a basic beam with the load located in the middle of the span..

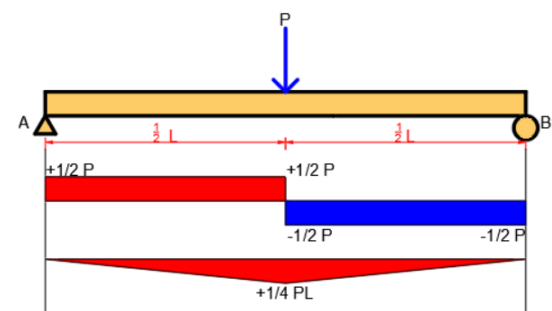
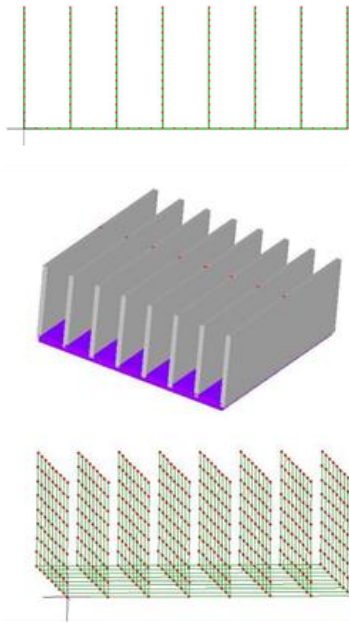


Figure 3. Force diagram

## 2.3 LISA V.8 FEA

The stress element, strain, and temperature rise for three different heat exchanger models were estimated using LISA, a prominent finite element analysis tool. The line element model, shell model, and solid model are the three sorts of models, in order of their simplicity and ease of building.



**Figure 4.** Element model on LISA FEA

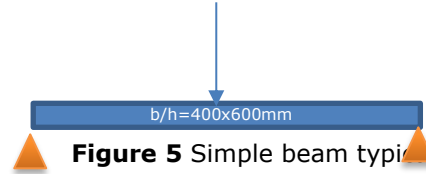
Because the developers cannot exclude convection from assembling the baseplate surface with the face selection tool, the convection coefficient of the baseplate surface must be determined as half the value used elsewhere for line element models only. It's simply a matter of logic.

We can easily omit the mounting surface from convection in the other two models by not selecting it. In each example, an internal heat generator is used, and the volume of the entire floor slab is assumed to represent the heat source. When applying boundary conditions to a line element model, exercise caution. When the "face" selection is made, LISA chooses all faces of the line elements (Agar et al., 2020; Akcay et al., 2021; A. W. Efendi, 2022c, 2022a, 2022d, 2022b, 2023; A. W. Efendi et al., 2022; EFENDI, 2022; I. A. W. Efendi, 2022; Fumagalli et al., 2022; Hidayat et al., 2020; Kurva & Keilmuan, n.d.).

### 3. RESULTS AND DISCUSSION

#### 3.1 Manual Calculation

In this study using a simple beam sample with a span of 3000 mm, beam dimensions of 400x600 mm and a centralized load of 1000 N with a send-joint support, shown in Figure 5.



**Figure 5** Simple beam type

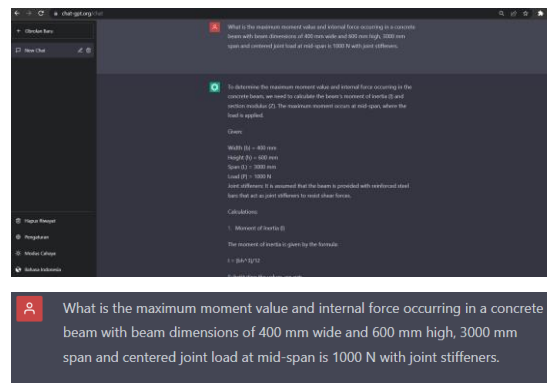
If a manual calculation is made as in equation 1, the maximum moment value that occurs is

$$\begin{aligned} M_{\max} &= \frac{1}{4} FL \\ &= \frac{1}{4} 1000 \cdot 3000 \\ &= 750.000 \text{ N.} \end{aligned}$$

While the value of the reaction that occurs is  $\frac{1}{2} F$ , which becomes 500 N.

#### 3.2 ChatGPT Calculation

Calculations using chatGPT are carried out by making conversations through the chat column provided by the ChatGPT website, with detailed questions as in Figure 6, and will be automatically replied to with the Artificial intelligence (AI) capabilities of chatGPT that have been embedded in this application, the results of the chat answers can be seen in Figure 7.



**Figure 6.** ChatGPT dialog box

"What is the maximum moment value and internal force occurring in a concrete beam with beam dimensions of 400 mm wide and 600 mm high, 3000 mm span and centered joint load at mid-span is 1000 N with joint stiffeners."

To determine the maximum moment value and internal force occurring in the concrete beam, we need to calculate the beam's moment of inertia (I) and section modulus (Z). The maximum moment occurs at mid-span, where the load is applied.

Given:

Width (b) = 400 mm

Height (h) = 600 mm

Span (L) = 3000 mm

Load (P) = 1000 N

Joint stiffeners: It is assumed that the beam is provided with reinforced steel bars that act as joint stiffeners to resist shear forces.

Calculations:

1. Moment of Inertia (I)

The moment of inertia is given by the formula:

$$I = (bh^3)/12$$

Substituting the values, we get:

$$I = (400 \times 600^3)/12$$

$$I = 7,200,000 \text{ mm}^4$$

2. Section modulus (Z)

The section modulus is given by the formula:

$$Z = I / (h/2)$$

Substituting the moment of inertia value, we get:

$$Z = 7,200,000 / (600/2)$$

$$Z = 24,000 \text{ mm}^3$$

3. Maximum bending moment (M)

The maximum bending moment occurs at mid-span and is given by the formula:

$$M = PL/4$$

Substituting the values, we get:

$$M = 1000 \times 3000 / 4$$

$$M = 750,000 \text{ N.mm}$$

4. Maximum bending stress ( $\sigma$ )

The maximum bending stress is given by the formula:

$$\sigma = M / Z$$

Substituting the values, we get:

$$\sigma = 750,000 / 24,000$$

$$\sigma = 31.25 \text{ N/mm}^2$$

5. Shear force (V)

The shear force is given by the formula:

$$V = P/2$$

Substituting the value, we get:

$$V = 1000 / 2$$

$$V = 500 \text{ N}$$

6. Shear stress ( $\tau$ )

The shear stress is given by the formula:

$$\tau = V / (b \times d)$$

Substituting the values, we get:

$$\tau = 500 / (400 \times 600)$$

$$\tau = 0.02 \text{ N/mm}^2$$

Conclusion:

The maximum moment value in the concrete beam is 750,000 N.mm and the maximum bending stress is 31.25 N/mm<sup>2</sup>. The internal force of shear in the beam is 500 N and the shear stress is 0.02 N/mm<sup>2</sup>. Since joint stiffeners are present, the shear stress value obtained is safe.

**Figure 7.** ChatGPT answer dialog box.

"To determine the maximum moment value and internal force occurring in the concrete beam, we need to calculate the beam's moment of inertia (I) and section modulus (Z). The maximum moment occurs at mid-span, where the load is applied.

Given:

Width (b) = 400 mm

Height (h) = 600 mm

Span (L) = 3000 mm

Load (P) = 1000 N

Joint stiffeners: It is assumed that the beam is provided with reinforced steel bars that act as joint stiffeners to resist shear forces.

Calculations:

Moment of Inertia (I)

The moment of inertia is given by the formula:

$$I = (bh^3)/12$$

Substituting the values, we get:

$$I = (400 \times 600^3)/12$$

$$I = 7,200,000 \text{ mm}^4$$

Section modulus (Z)

The section modulus is given by the formula:

$$Z = I / (h/2)$$

Substituting the moment of inertia value, we get:

$$Z = 7,200,000 / (600/2)$$

$$Z = 24,000 \text{ mm}^3$$

Maximum bending moment (M)

The maximum bending moment occurs at mid-span and is given by the formula:

$$M = PL/4$$

Substituting the values, we get:

$$M = 1000 \times 3000 / 4$$

$$M = 750,000 \text{ N.mm}$$

Maximum bending stress ( $\sigma$ )

The maximum bending stress is given by the formula:

$$\sigma = M / Z$$

Substituting the values, we get:

$$\sigma = 750,000 / 24,000$$

$$\sigma = 31.25 \text{ N/mm}^2$$

Shear force (V)

The shear force is given by the formula:

$$V = P/2$$

Substituting the value, we get:

$$V = 1000 / 2$$

$$V = 500 \text{ N}$$

Shear stress ( $\tau$ )

The shear stress is given by the formula:

$$\tau = V / (b \times d)$$

Substituting the values, we get:

$$\tau = 500 / (400 \times 600)$$

$$\tau = 0.02 \text{ N/mm}^2$$

Conclusion:

The maximum moment value in the concrete beam is 750,000 N.mm and the maximum bending stress is 31.25 N/mm<sup>2</sup>. The internal force of shear in the beam is 500 N and the shear stress is 0.02 N/mm<sup>2</sup>. Since joint stiffeners are present, the shear stress value obtained is safe."

### 3.3 Finite Element (LISA FEA) Calculation

Pada permodelan menggunakan Finite Elemen Analisis (FEA), peneliti hanya membuat elemen balok sederhana berupa elemen garis yang mengidentifikasi struktur balok sesuai pada tinjauan yang dilakukan, ini dapat dilihat dari properti elemen seperti pada gambar 8.

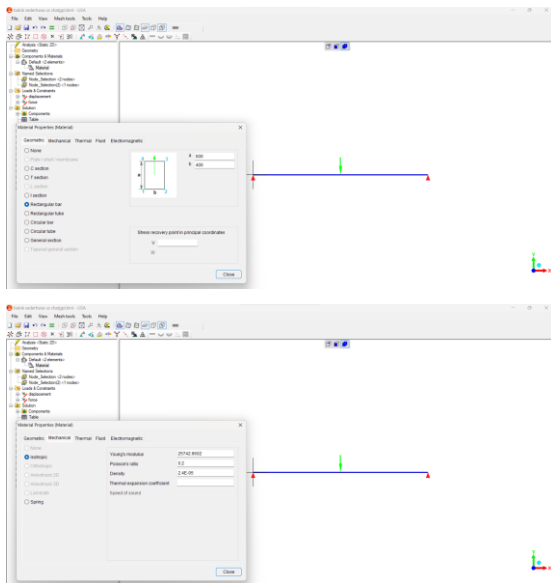


Figure 8. Material Properties

And the loading carried out is similar to manual calculations and chatGPT, namely a centralized load of 1000 N located at the middle of the span, shown in Figure 9.

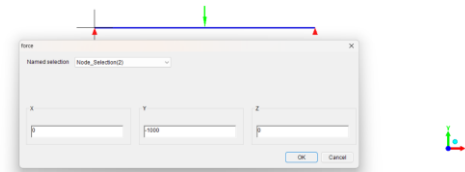


Figure 9. Force

Observing the modeling and application of a centralized load at the mid-span of a simple beam with joint stiffeners, the value of the maximum moment was found to be 750,000 Nmm.

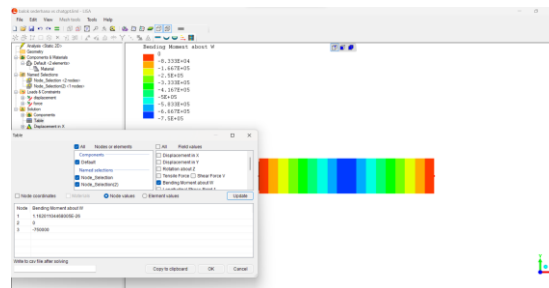


Figure 10. Bending moment

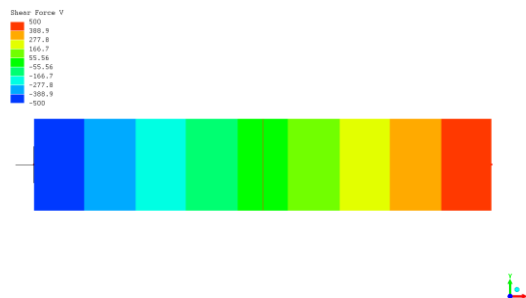


Figure 11. Shear Force

And the reaction that occurs in this simple beam shown in Figure 11 is 500 N.

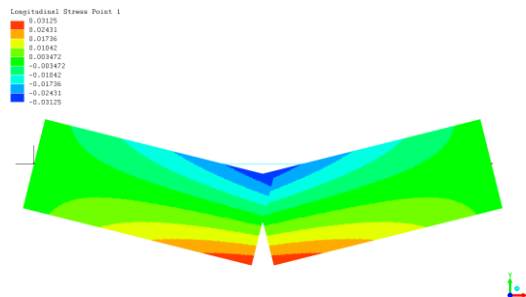


Figure 12. Longitudinal Stress of simple beam.

Figure 12 explains that the behavior that occurs is the same as the manual and ChatGPT results. That is, there is a stress on the middle side of the span of 0.03125 MPa, while from the ChatGPT results there is a stress of 0.02 MPa, there is a difference in results of 0.01 MPa from both simple beam conditions.

The analysis results of the three methods, namely manual analysis, ChatGPT and Finite Element Method, are shown in Table 1.

Table 1. Internal force

No	Overview	Bending Moment (Nmm)	Shear Force (N)	Longitudinal Stress (MPa)
1	Simple beam (manual)	750000	500	-
2	Simple beam (ChatGPT)	750000	500	0.03125
3	LISA FEA	750000	500	0.02

From the results of the table above, the nominal obtained is quite satisfactory and tends to succeed the same except for the longitudinal stress value which has a difference of 0.01 MPa.

#### 4. CONCLUSION

The research examined the results and data processing outcomes, as well as the analysis of the three approaches, namely manual analysis, ChatGPT, and Finite Element Method. The results of the instant value that occurs in the three reviews above are extremely gratifying because the value of manual computation, ChatGPT, and FEA agrees with the results 95% of the time. As an example, the maximum torque obtained by manual hitung is 750,000 N, which is the same as the maximum torque obtained via ChatGPT. In addition, the working pressure is 500 N, which is the same as the results of physical pressure, chatGPT, and LISA FEA V.8 (lisensi).

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