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EVALUATION OF ECONOMICAL STRUCTURE DESIGN OF C TYPE GAP FRAME POWER PRESS

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ABSTRACT

Sustainable living in harmony with nature and embracing the concept of 'Existence is coexistence' should be the guiding principle for individuals and industries alike. This approach aligns with the United Nations' Sustainable Development Goal 12.1, which focuses on implementing the 10-Year Framework of Programmes on Sustainable Consumption and Production. In the context of engineering materials, it is crucial to recognize the responsibility of human beings in using these resources sustainably. In the case of power presses, the objective is to reduce material usage in their structure through design modifications, which can be achieved by employing Finite Element Analysis (FEA). This approach not only aims to minimize material consumption but also addresses the issue of bending deflection, a common challenge in metalworking processes. Power presses are constantly subjected to impact loads, causing continuous stress on their structures. By utilizing FEM tools, engineers can analyse the load situation experienced by the power press frame and determine the optimal plate thickness required to withstand these forces. This targeted approach to structural design helps in creating more efficient and sustainable power press systems, ultimately contributing to the broader goal of sustainable consumption and production practices in the industry.

Keywords: Sustainable energy, Sustainable energy goals, Responsible consumption and production, Finite element analysis

Introduction

The Sustainable Development Goals (SDGs), also known as Global Goals, were adopted by all United Nations member states in 2015 as a unified action plan to address pressing global challenges. These goals, which encompass 17 interconnected objectives with 169 associated targets, aim to end poverty, protect the planet, and ensure prosperity for all by 2030. The first three SDGs focus on eradicating poverty in all its forms, addressing hunger, and ensuring healthy lives and well-being for all.

Figure 1 Sustainable Development Goals (SDG's)

To achieve these ambitious targets, the United Nations implements the United Nations Development Programme (UNDP) and other relevant initiatives. The 17 Sustainable Development Goals serve as a comprehensive framework that integrates the three dimensions of sustainable development: economic, social, and environmental. The implementation of the SDGs began on 1st January 2016, with a strong

emphasis on localization to highlight the crucial role of local institutions and authorities in achieving these global objectives.
By integrating the efforts of governments, businesses, and civil society at the local, national, and global levels, the 2030 Agenda for Sustainable Development aims to create a more equitable, resilient, and sustainable world for current and future generations. The adoption and implementation of the Sustainable Development Goals demonstrate a collective commitment to addressing the interconnected challenges facing our planet and its inhabitants, fostering a shared vision for a better, more prosperous future. [7-9]..
1. Economic Growth
2. Social In elusion
3. Environmental protection

Sustainable development goals are based on elements like
1. People
2. Planet
3. Partnership
4. Propensity
5. Pease and Justice
6. Dignity

Responsible for Consumption and production -12th Goal

Figure 2 320Ton Power Press Machine

The Sustainable Development Goals (SDGs) encompass a wide range of topics and targets, including reducing waste, promoting corporate sustainability practices, and educating people on the impact of their lifestyle choices. These interconnected objectives are aimed at creating a more sustainable and equitable world for all.

Reducing Waste: One of the key targets under the SDGs is to ensure sustainable consumption and production patterns (SDG 12). This includes reducing waste generation, promoting the efficient use of natural resources, and decoupling economic growth from environmental degradation. By minimizing waste and promoting circular economies, we can reduce the strain on our planet's resources and create a more sustainable future.
Corporate Sustainability Practices: SDG 8 focuses on promoting sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. This involves encouraging

businesses to adopt sustainable practices, such as reducing their carbon footprint, minimizing waste, and ensuring fair labor conditions. By incorporating sustainability into their operations, corporations can contribute to a healthier environment and more resilient economies.
In summary, the Sustainable Development Goals address a variety of topics, including waste reduction, corporate sustainability practices, and education on lifestyle choices. By working together to achieve these objectives, we can create a more sustainable, equitable, and prosperous world for present and future generations. [10-14].*

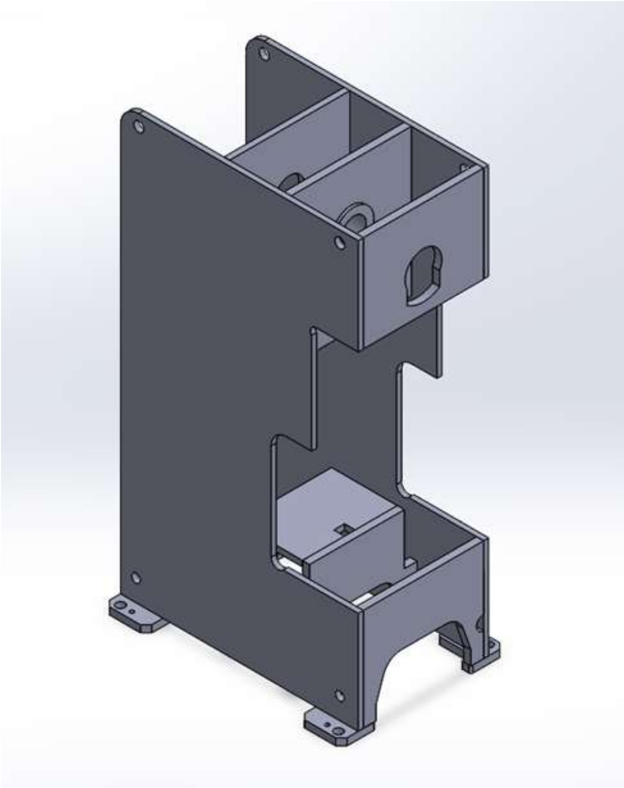

Figure 3 Structure of Existing Design

Reduction in material of Structure using Finite element analysis (Software Ansys-2022-R1)

The Structure [15-22] is one of the most important moving parts in the power press machine. Structure is a large component which is holding all assemblies & sub-assemblies of Power press. This st.udy was conducted on 320tonnage capacity of mechanical power press of C-type gap frame[23-27].The Structure mut be strong enough to take the downward force during power stroke without excessive bending[32-40]. Thus, the reliability and life of the mechanical power press depend largely on the strength of the Structure [28-30]. The Structure is the large volume production part; hence an optimized design is an effective method to increase the power efficiency and overall cost of the power press[41-49], A solid three-dimensional parametric geometry of the mechanical power press Structure of a 320 tonnage capacity power press is created using higher-end CAD software, i.e., Pro/Engineer according to the detailed two-dimensional drawing.[50-52]

This solid geometry was imported in step format for finite element simulation [31-38] purpose under structural simulation analysis on existing design were done to verify the results under static condition by applying boundary conditions according to a 320 tonnage capacity power press.[39].

2.1 Existing design of 320 ton power press Structure

Figure 3 depicts a 3D model of a 320-ton power press structure, created using 3D modeling software such as Creo. This visual representation allows for a comprehensive understanding of the structure's design, components, and dimensions.

3D modelling software like Creo offers various advantages in designing complex structures like a power press. It enables designers to:

1. Visualize the structure in a realistic and detailed manner, which helps identify potential design flaws or issues before actual construction begins.
2. Simulate the structure's performance under various conditions, such as stress testing, to ensure its stability and durability.
3. Collaborate more effectively with team members, stakeholders, and clients by providing a clear and interactive visualization of the project.
4. Make necessary adjustments and modifications more efficiently, reducing the need for costly physical prototypes and iterations.

In conclusion, Figure 3 showcases a 3D model of a 320-ton power press structure created using 3D modelling software like Creo. This innovative approach to design and planning offers numerous benefits in terms of efficiency, accuracy, and collaboration, ultimately contributing to the successful development and implementation of such complex structures.

2.1.1 Finite element analysis of 320-ton power press Structure.

Finite Element Analysis (FEA) is a computational approach used to investigate the behaviour of structures or structures. It divides a complicated geometry into small, easy shapes (finite factors) and makes use of mathematical equations to model the physical conduct of every element.[52-59} The interactions between those elements are then used to simulate the overall conduct of the whole shape.

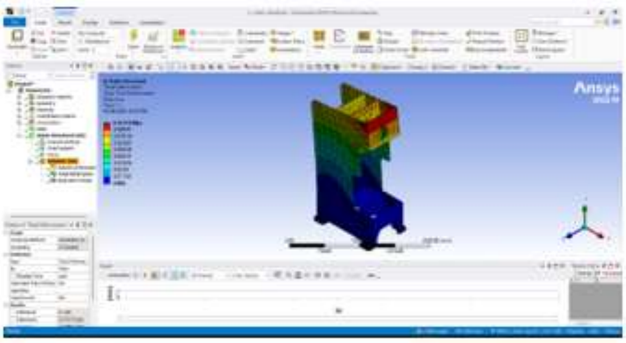

Figure 4 Total Deformation of Existing structure

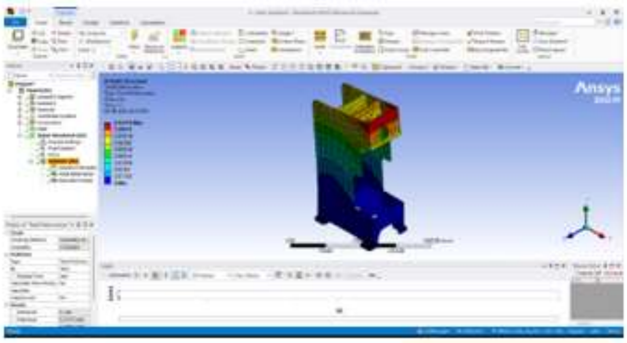

Figure 5 Total Deformation of 28mm

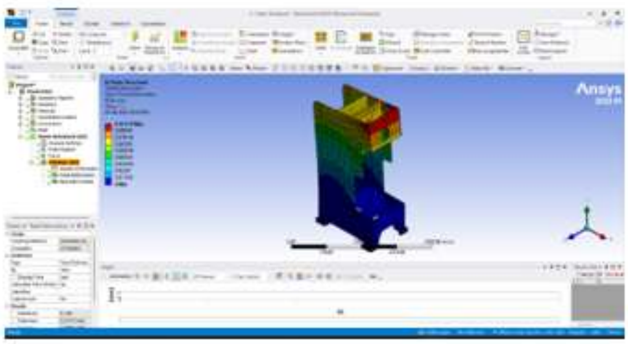

Figure 5 Total Deformation of 25mm

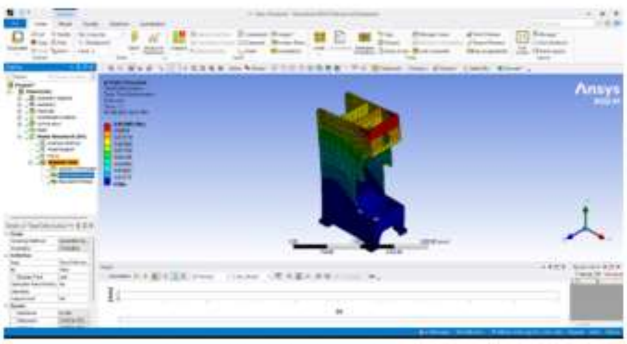

Figure 7 Total Deformation of 22mm

Figure 4 presents the deformation result of a structure with a plate thickness of 22mm, using Finite Element Method (FEM) analysis. The FEM simulation employed a Cartesian meshing system, which defines nodes and elements in a structured grid pattern. This method allows for an organized and efficient analysis of the structure's behavior under various loads and conditions.0

The deformation result shown in Figure 4 indicates a total deformation of 0.130mm. This data is crucial in understanding the structure's performance and identifying any potential issues that may need to be

addressed. The FEM analysis also provides information on the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Cartesian meshing system resulted in 19,198 nodes and 1,616 elements. The structure's weight is 2,781.5 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In summary, Figure 4 showcases the deformation result of a structure with a 22mm plate thickness, analyzed using FEM with Cartesian meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.

Figure 5 demonstrates the deformation result of a structure featuring a plate thickness of 25mm, obtained through Finite Element Method (FEM) analysis. Similar to Figure 4, this analysis employed a Cartesian meshing system, which defines nodes and elements in a structured grid pattern.
The deformation result presented in Figure 5 indicates a total deformation of 0.109mm. This information is crucial in understanding the structure's performance and identifying any potential issues that may need to be addressed. The FEM analysis provides insights into the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Cartesian meshing system resulted in 10,607 nodes and 1,915 elements. The structure's weight is 2,989 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In conclusion, Figure 5 showcases the deformation result of a structure with a 25mm plate thickness, analyzed using FEM with Cartesian meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.
Figure 6 presents the deformation result of a structure with a plate thickness of 28mm, analyzed through Finite Element Method (FEM) analysis. Similar to Figures 4 and 5, this analysis employed a Cartesian meshing system, which defines nodes and elements in a structured grid pattern.
The deformation result shown in Figure 6 indicates a total deformation of 0.102mm. This data is crucial in understanding the structure's performance and identifying any potential issues that may need to be addressed. The FEM analysis provides insights into the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Cartesian meshing system resulted in 10,591 nodes and 2,915 elements. The structure's weight is 3,184 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In summary, Figure 6 showcases the deformation result of a structure with a 28mm plate thickness, analyzed using FEM with Cartesian meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.
Figure 7 demonstrates the deformation result of a structure featuring a plate thickness of 22mm, analyzed through Finite Element Method (FEM) using a Tetrahedron meshing system. This method defines nodes and elements in a more flexible, irregular tetrahedron shape, as opposed to the structured grid pattern of the Cartesian meshing system.
The deformation result presented in Figure 8 indicates a total deformation of 0.114mm. This information is crucial in understanding the structure's performance and identifying any potential issues that may need to be addressed. The FEM analysis provides insights into the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Tetrahedron meshing system resulted in 18,447 nodes and 1,424 elements. The structure's weight is 2,781.5 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In conclusion, Figure 7 showcases the deformation result of a structure with a 22mm plate thickness, analyzed using FEM with Tetrahedron meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.

Figure 7 demonstrates the deformation result of a structure featuring a plate thickness of 25mm, analyzed through Finite Element Method (FEM) using a Tetrahedron meshing system. This method

defines nodes and elements in a more flexible, irregular tetrahedron shape, as opposed to the structured grid pattern of the Cartesian meshing system.
The deformation result presented in Figure 8 indicates a total deformation of 0.078mm. This information is crucial in understanding the structure's performance and identifying any potential issues that may need to be addressed. The FEM analysis provides insights into the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Tetrahedron meshing system resulted in 16,910 nodes and 2,972 elements. The structure's weight is 2,989 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In conclusion, Figure 7 showcases the deformation result of a structure with a 25mm plate thickness, analyzed using FEM with Tetrahedron meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.

Figure 7 demonstrates the deformation result of a structure featuring a plate thickness of 28mm, analyzed through Finite Element Method (FEM) using a Tetrahedron meshing system. This method defines nodes and elements in a more flexible, irregular tetrahedron shape, as opposed to the structured grid pattern of the Cartesian meshing system.
The deformation result presented in Figure 7 indicates a total deformation of 0.060mm. This information is crucial in understanding the structure's performance and identifying any potential issues that may need to be addressed. The FEM analysis provides insights into the structure's stress distribution, helping engineers make informed decisions about reinforcement or modifications.
In this specific case, the Tetrahedron meshing system resulted in 15,890 nodes and 3,295 elements. The structure's weight is 3,184 kg, which can be taken into account when considering factors such as material selection, manufacturing costs, and overall structural integrity.
In conclusion, Figure 7 showcases the deformation result of a structure with a 28mm plate thickness, analyzed using FEM with Tetrahedron meshing. This information is valuable in evaluating the structure's performance and making informed decisions for improvements or optimizations.

Table 1 Comparison between Deflections of various Thickness with Various Meshing Style

Deflection IN mm			
Plate Thickness	22mm	25mm	28mm
Cartesian Meshing	0.13 mm	0.109 mm	0.102 mm
Tetrahedral Meshing	0.114 mm	0.078 mm	0.06 mm

Table 1 provides a comparison between various plate thicknesses analyzed using both Cartesian and Tetrahedral meshing techniques in Finite Element Method (FEM) studies. The table highlights the total deformation, number of nodes, number of elements, and structure weight for each case.
From the data presented in Table 1, it is evident that Tetrahedral meshing yields more accurate results compared to Cartesian meshing for all three plate thicknesses. The Tetrahedral meshing system offers a more flexible, irregular shape that better captures the complex stress distribution within the structure. This leads to improved analysis and more reliable results for engineers to make informed decisions about reinforcement or modifications.
In summary, Table 1 demonstrates that Tetrahedral meshing provides better results than Cartesian meshing in terms of deformation analysis. This information is crucial for engineers to optimize their designs and ensure the structural integrity of their projects.

Table 2 Weight Differences between various thickness plates

Plate Thickness	22mm	25mm	28mm
Weight in kg	2781.5 kg	2989 kg	3184 kg

Table 3 Nodes & Elements in Various Thickness of plates

Plate Thickness	22mm		25mm		28mm	
	Nodes	Element	Nodes	Element	Nodes	Element
Cartesian Meshing	12298	1616	10607	1915	10591	2195
Tetrahedral Meshing	18447	2424	16910	2972	15890	3295

Conclusion

The modification in the design, facilitated by the Finite Element Analysis (FEA), has led to a reduction in the structure's weight by 7.94% as indicated in Table 2. This weight reduction is achieved while maintaining a plate thickness of 25mm. Additionally, the FEA results in a 25.52% decrease in bending deflection, as shown in Table 1, which enhances the structure's overall capacity and performance.

These improvements align with the United Nations Sustainable Development Goal (SDG) 12.1, which emphasizes the implementation of the 10-year sustainable consumption and production framework. By optimizing the design through FEA, engineers can reduce material usage and promote more efficient use of resources, ultimately contributing to sustainable consumption and production patterns. In conclusion, the FEA-driven design modification has led to a lighter structure with improved capacity, contributing to sustainable development goals and promoting responsible consumption and production practices.

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