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# Effect of Material Type and Design on Hook Crane Performance: Stress, Deformation, and Safety Factor Analysis

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**Abstract**

This simulation aims to evaluate the stress, deformation, and strain values of the crane hook structure to ensure safe load handling and prevent functional failure. In this study, AISI 1015, AISI 1035, and alloy steel casing materials were tested, along with two different hook designs: trapezoidal and circular. The trapezoidal design had base dimensions of 34.50 mm and 58.00 mm, with a top surface area of 55.00 mm and a radius of 10.00 mm. The circular design has a diameter of 58.00 mm. Simulations were carried out using SolidWorks on AISI 1015 with Mass 10 tons, stress 279.68 N/mm², displacement 0.61 mm. on AISI 1035: Mass 12 tons, stress 310.11 N/mm², displacement 0.61 mm. on Alloy steel with Mass 8.5 tons, stress 236.87 N/mm², displacement 0.59 mm. For circular design on AISI 1015 with a mass of 9.5 tons, stress 279.69 N/mm², displacement 0.57 mm. on AISI 1035 with a mass of 10 tons, stress 310.25 N/mm², displacement 0.76 mm. Alloy steel with a mass of 8 tons, stress 237.28 N/mm², displacement 0.55 mm. Each material exhibits different mechanical characteristics, which affect stress, deformation and strain. Based on the results, the AISI 1035 material with a circular design supports a maximum load of 9.5 tons, achieving a safety factor of 1.68, which is close to the minimum threshold of 1.8 for safe operation.
**Keywords :** Stress, Deformation, Strain, Material Type, Design Structure

## INTRODUCTION

In the transportation and material transfer industry, equipment such as crane hooks play an important role in ensuring smooth and safe operations (Nanda & Dewadi, 2024). Crane hooks are often used to lift heavy loads, so their safety and reliability must be guaranteed to prevent accidents caused by structural failure (Nanda et al., 2024). One way to ensure that crane hooks can function properly under load is to conduct simulation tests that can evaluate the stresses, deformations and strains that occur in the hook structure (F. M. Dewadi, Supriyadi, et al., 2024). Proper material selection and optimal structural design are essential in producing a strong and durable crane hook (F. M. Dewadi, 2023d). Commonly used materials, such as carbon steel AISI 1015 and AISI 1035, as well as steel alloys, have different mechanical properties that affect the hook's performance under operational conditions (Mubina & Amir, 2022). In addition, the shape of the hook design, either trapezoidal or circular, also affects the stress distribution and deformation under load (Kusmiwardhana et al., 2024). Therefore, this study aims to analyze the structural performance of crane hooks using the finite element method (FEM) by simulating various materials and hook designs. The results of this research are expected to provide recommendations on the most effective material and design combinations to improve the safety and operational efficiency of crane hooks.

In the transportation and material transfer industry, structural failures in lifting equipment such as crane hooks can lead to serious occupational accident risks, material losses and operational disruptions (C. Wibowo, Mubina Dewadi, et al., 2024). Crane hooks that are poorly designed or use inappropriate materials are prone to excessive deformation, rapid wear or even cracking when receiving heavy loads (C. Wibowo, Dewadi, et al., 2024). These issues pose challenges in ensuring that crane hooks can function safely and reliably, especially when lifting large loads under various operating conditions (Khoirudin et al., 2021). Without proper evaluation of the stress, deformation and strain distribution in the hooks, the potential for structural failure becomes even higher (Abbas et al., 2021). This research was conducted to address these issues by studying the effect of material selection and hook design on their mechanical performance. By using the finite element method (FEM) in the simulation, it is expected to find a combination of material and design that can improve the strength, reliability and operational safety of the crane hook (F. M. Dewadi, Milasari, A, et al., 2023).

The main objective of this study is to analyze and evaluate the mechanical performance of the tow hook in terms of stress, deformation, and strain using the finite element method (FEM) (Nurmiah et al., 2023). Specifically, this study aims to analyze the effect of material selection (AISI 1015, AISI 1035, and steel alloy) on the stresses, deformations, and strains occurring in the crane hook structure (Yusaerah et al., 2022). Compare the effectiveness of the hook design between trapezoidal and circular shapes in optimally distributing the load (Lulut Alfaris, S.T. et al., 2022). Determining the most suitable material and design combination to achieve optimal performance in terms of strength, durability and safety of the crane hook (F. Dewadi, Puspita, et al., 2024). Calculate the safety factor of each material and design combination to ensure that the crane hook can operate safely at a given load capacity (Mustafa et al., 2023). Achieving these objectives will lead to recommendations that can be used to design stronger, more durable and safer crane hooks in industrial applications (Yunus et al., 2023).

The research is expected to produce several key findings that will make a significant contribution to the transportation and material movement industry, particularly in the design and operation of tow hooks (Nugroho et al., 2023). The expected results generally include the identification of the most optimal material to be used in the manufacture of crane hooks, based on the results of stress, deformation and strain analysis. The selected material is expected to provide high strength and resistance to wear under heavy load conditions (Darmayani et al., 2023). A more efficient crane hook design that can distribute stress evenly and reduce deformation when lifting loads (Purnomo & Sahabuddin, 2023). It is expected that the analyzed design shapes, both trapezoidal and circular, can provide certain advantages in improving structural performance (F.M Dewadi et al, 2023). Improvement of the safety factor through the selection of appropriate material and design combinations, thereby ensuring that the crane hook can operate safely at a given load without the risk of structural failure (Ir. Fathan Mubina Dewadi, S.T., M.T et al., 2023). Guidelines for the development and mass production of safer and more efficient crane hooks in the future, based on design and material recommendations from the research (F. Dewadi, Octavianti, Nanang, et al., 2023). These results are expected to not only extend the operational life of crane hooks, but also improve safety in the load lifting process in various industrial applications.

Although many studies have been conducted to assess the strength and reliability of crane hooks, there are some gaps in the research that have not been fully addressed, namely limitations in material selection, lack of analysis on design variations, varying factors of safety and the use of finite element method (FEM) (F. M. Dewadi, Nova, et al., 2024). Most previous studies only focus on standard materials such as carbon steel or certain steel alloys, without exploring a comprehensive comparison between different types of carbon steel, such as AISI 1015 and AISI

1035, and steel alloys (Mudia et al., 2023). No study has yet detailed the performance of these materials in crane hooks using finite element simulation (FEM) (N et al., 2024). Previous research tends to focus on a single crane hook design shape, while shape variations such as trapezoidal and circular have not been directly studied in terms of their effect on stress distribution and deformation. No studies have compared these designs in the same simulation to determine the most efficient and safe design.

Many previous studies have not explored in depth the specific factors of safety required for each material and design combination. The factors of safety are often calculated in a generalized manner without considering the specific mechanical properties of the materials and designs under test (F. M. Dewadi, Puspita, et al., 2024). Although the FEM method has been widely used in structural design studies, research integrating FEM analysis to model material combinations and crane hook designs in detail is limited (Simatupang et al., 2013). Especially in evaluating the stresses, strains, and deformations resulting from shape and material variations under operational loads (C. Wibowo et al., 2023). This research seeks to address these gaps by conducting a comprehensive analysis of materials (AISI 1015, AISI 1035, and steel alloys) and designs (trapezoidal and circular) using FEM simulation, resulting in better guidance in the selection of the safest and most efficient materials and designs for crane hooks. This study shows that each material has different mechanical characteristics. AISI 1035 has higher strength than AISI 1015 and steel alloys, which allows it to withstand greater loads before deforming (F. M. Dewadi, Sriwahyuni, Edahwati, et al., 2023). Steel alloys have lower stress, yet can still withstand loads with minimal deformation (Alfianto et al., 2023). Overall, AISI 1035 proved to be the most optimal material for this application. From the simulation results, the circular design shows a more even stress distribution than the trapezoidal shape. The circular design reduces stress concentration at critical points, thereby reducing the risk of structural failure (Dahri et al., 2023). The trapezoidal design has more stress focused at a few specific points, which can increase the risk of wear or failure in those areas (Nanda, Dewadi, et al., 2023). While this is close to the minimum standard, these results show that this design and material can be used in real applications with such loads (F. M. Dewadi, Kristiana, La Ola, et al., 2023). However, some improvements to the design may be required to achieve a higher factor of safety (F. Dewadi, Kusmiwardhana, Hakim, et al., 2023). The finite element method (FEM) proves to be an effective tool for modeling the mechanical behavior of crane hooks (F. M. Dewadi, Milasari, Hermila, et al., 2023). FEM simulations allow detailed analysis of stress, deformation, and strain distributions in various material and design combinations, which cannot be obtained through physical testing alone (F. M. Dewadi, Wibowo, Mulyadi, et al., 2023). The simulation results provide an accurate picture of the performance of the tow attachment under real load. The combination of AISI 1035 material and circular design is expected to withstand loads with deformation still within safe limits. Although the safety factor is slightly below the recommended standard, this combination is still the optimal choice when compared to other materials and designs, indicating lower mechanical performance.

AISI 1015, AISI 1035, and steel alloys have different mechanical characteristics in terms of stress, deformation, and strain, but it is not yet known exactly which material is the most optimal to apply to crane hooks in order to withstand heavy loads with an adequate safety factor. Crane hook designs used in industry generally vary, but not all designs are able to distribute stress evenly (Santosa et al., 2022). A comparison between trapezoidal and circular shapes has not been studied in detail to determine which design is more efficient in withstanding heavy loads (Nanda, Supriyanto, et al., 2023). Crane hooks are at risk of structural failure when receiving excessive loads, especially if the stress distribution is not optimal or the materials used are not strong enough (Nanda, Karyadi, et al., 2023). The understanding of how material and design affect the safety factor is not clear and needs to be further analyzed (Muhammad et al., n.d.). The use of the finite element method (FEM) in crane hook simulation has not been fully utilized to model different design and material combinations (F. M. Dewadi, Bachtiar, Alyah, et al., 2023). This approach can provide a more detailed analysis of stress, deformation and strain distribution, but no studies have comprehensively used it for different crane hook designs and materials . Industrial safety factor standards require tow attachments to have minimum safety factors, but no study specifically measures where a combination of AISI 1015, AISI 1035, and steel alloys with trapezoidal and circular forms can meet these standards, especially for loads (Lawi et al., 2023). Analyze the effect of AISI 1015, AISI 1035, and steel alloy materials on the stress, deformation, and strain of the crane hook structure using the finite element method (FEM) (F. M. Dewadi, 2023c). Comparing the effectiveness of trapezoidal and circular designs in distributing stresses and deformations in the crane hook when receiving heavy loads, to determine the most efficient and safe design (F. M. Dewadi, 2022).

Calculating and evaluating the factor of safety of each material combination and crane hook design, to ensure that the design meets industry safety standards with a given maximum load (F. M. Dewadi, 2023b). Using FEM simulation to model the mechanical behavior of the crane hook, such as stress, deformation and strain distribution, to provide better guidance in the development of safer and more efficient crane hooks (F. M. Dewadi, 2023a).

Recommendations were obtained for the most optimal combination and material design for load-bearing tow attachment applications taking into account safety, durability, and good mechanical performance. Identification of the most optimal material (between AISI 1015, AISI 1035, and steel alloy) to be used in the manufacture of crane hooks, based on simulation results regarding stress, deformation, and strain (F. M. Dewadi, n.d.). The selected material is expected to provide the best combination of strength, durability, and structural performance suitable for heavy loads. Determination of the most efficient crane hook design between trapezoidal and circular shapes in distributing stress and reducing deformation (F. M. Dewadi et al., 2019a).

A more efficient design is expected to increase durability and reduce the risk of structural failure when lifting large loads. Calculate valid safety factors for each combination of material and design, and ensure that the combination measures or exceeds the minimum safety factor standards applied in the weightlifting industry (Asari et al., 2023). The use of the finite element method (FEM) as a valid and effective approach in analyzing and modeling the mechanical behavior of crane hooks (F. M. Dewadi & Ma'arof, 2022). It is expected that this method can provide accurate results in predicting stress, deformation, and strain distributions, and assist in design development and material selection. Practical recommendations for industry on the most efficient, safe, and economical combination of materials and designs to apply to tow attachments. These results are expected to be implemented in mass production to improve operational efficiency and safety (F. M. Dewadi, Amir, et al., 2022).

This study will provide recommendations on materials and designs that are safest for use in towing hooks, thus reducing the risk of structural failure and improving workplace safety, especially in industries involving heavy load lifting (F. M. Dewadi, Amir, et al., 2022). The results of this study will help the industry in developing a more efficient, robust, and durable crane hook design (F. M. Dewadi, Lillahulhaq, Karyasa, et al., 2023). With an optimal design, lifting devices will be more stable when used, and more resistant to wear and deformation (Nanda & Dewadi, 2023). This study will provide clear guidance on the best materials that can be used for towing hook applications, based on voltage, deformation, and strain analysis (S. H. Wibowo et al., 2023). This will help manufacturers choose more efficient and economical materials for production. Using the finite element method (FEM), this study shows how simulations can be used effectively in designing and testing tow attachments before production. This allows time and cost savings in product development (C. Wibowo et al., 2022). By using a more efficient combination of material and design, the industry can reduce the cost of manufacturing and maintaining tow attachments, as the resulting product is more durable and requires less repair or replacement (F. M. Dewadi, Maryadi, et al., 2022). This research will contribute to the literature of mechanical engineering and materials science, especially in the development of safer and more efficient lifting devices. This may be a reference to advanced research or applications in other lifting appliance designs.

In the transportation and material moving industry, the reliability and safe functioning of equipment, such as crane hooks, is a crucial aspect (Wiyono et al., 2023). To ensure optimal performance and prevent functional failures, simulation testing is an important step in evaluating the stress, deformation and strain values of crane hook structures (Mulyadi et al., 2023). This research focuses on material selection, by testing AISI 1015, AISI 1035, and alloy steel cases, as well as variations in trapezoidal and circle designs in the structural model.

The development of industrial technology is not far from conducting research to create the type of material requirements that suit the function and design of a component (F. M. Dewadi, 2016). With the discoveries of researchers, choosing the right type of material has now become very easy, but you have to know that choosing a material means understanding the properties of the material to be selected, taking into account stress values, gaps, deformations, etc (Nanda, Supriyanto, et al., 2022).

Of the 3 analytical material samples produced using the same design but different types of material and also using different designs but the same material, of course the safety factor values are also different from each other, so this is very important in designing a strong crane hook, so the aim of the research is to seek the best results for a high level of safety (Nanda, Karyadi, & Dewadi, 2022). The hook component is one of the safety factors that cannot be forgotten when applied in the field (F. M. Dewadi, Jati, & Sofiyanti, 2023). Crane hooks can malfunction at any time and result in unwanted work accidents (Fathan et al., 2022). Researchers are currently competing to be able to produce better types of material for the needs of heavy transport equipment components, especially hooks, because continuous use with high mass can experience damage when used before the specified life limit, operational behavioral factors the maximum mass limit must also be taken into account, so updating the type of material and design needs to be carried out continuously and carefully (Suhara et al., 2023).

## RESEARCH METHOD

The method used is the FEA method, where Finite Element FEA Method Analysis is a numerical technique used to model and analyze the behavior of physical systems, breaking them into smaller, more manageable elements (F. M. Dewadi & Sigalingging, 2021). FEA allows detailed analysis of complex structures such as tow hooks that have complicated geometric shapes. With FEA, each part of the structure can be analyzed individually to see how stress, strain, and deformation are distributed when receiving a load (F. M. Dewadi et al., 2019b). FEA allows simulation of loads on materials and designs without the need for physical prototyping or performing destructive testing (Lulut Alfaris et al., 2022). This saves cost, time, and resources in the testing process, and enables virtual experiments with a variety of load scenarios. Through FEA, various combinations of materials such as AISI 1015, AISI 1035, and steel alloys and design variations (trapezoidal and circular) can be analyzed simultaneously to see which provides optimal performance (C. Wibowo, Setiawan, et al., 2021). The FEA facilitates the selection of the best materials and designs based on in-depth simulation data (Abbas et al., 2021). The FEA was able to provide accurate simulation results on the distribution of tension and deformation across the entire section of the tow attachment (C. Wibowo, Dewadi, et al., 2021). Detailed information on areas with potential structural failure due to high voltage concentrations can be obtained by this method. The FEA allows precision calculation of safety factors based on analysis of the maximum voltage produced in the simulation (Dimyati et al., 2021). This is important to ensure that the design and materials used meet the safety standards applied in the industry. FEA allows simulation of various operational load scenarios, including static and dynamic loads. This helps ensure that the tow attachment will function properly under various conditions without failure

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(Ma'arof et al., n.d.). FEA facilitates design iterations, thus allowing quick design changes and optimizations based on simulation results. This is much more efficient than performing physical changes to prototypes and retesting (F. M. Dewadi, 2021). The FEA method was chosen because it provides high accuracy, efficiency, and flexibility in analyzing the mechanical behavior of various materials and designs in tow attachments without the need for costly and time-consuming physical testing (C. Wibowo & Dewadi, 2022). In this study, the shape and type of cross-sectional material used and the maximum acceptable load limit of the material and design were tested on the tow attachment. For this test we will use the 2022 SolidWorks software, with the crane hook design in Figure 1.

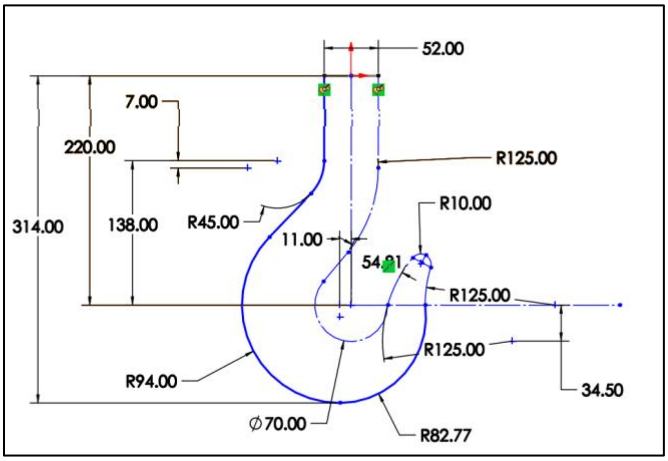


**Figure 1.** Crane Hook Design (Source: Personal Documentation)

In this design, the cross-sectional shape of the crane variety becomes two shapes with circular and trapezoidal shapes. These two variations are analyzed to detect while the shape offers better performance in terms of strength, pressure distribution, and deformation under load (Nanda, Karyadi, Dewadi, et al., 2022). Circular cross-section, this shape usually provides a more uniform stress distribution and minimizes stress concentration points (Nanda & Dewadi, 2023). It is offensive in designs that require symmetric force distribution and structural integrity under high loads. Trapezoidal cross-section, this shape may offer more flexibility in terms of load bearing capability and may be optimized for different loading conditions. However, it may have a high stress concentration at the certification point compared to the circular shape, depending on the design specifications.

By comparing these two forms through simulations (e.g., FEM), the goal is to identify which form provides better safety, efficiency, and durability in the crane hook operational environment. The following will be described in Figure 2.

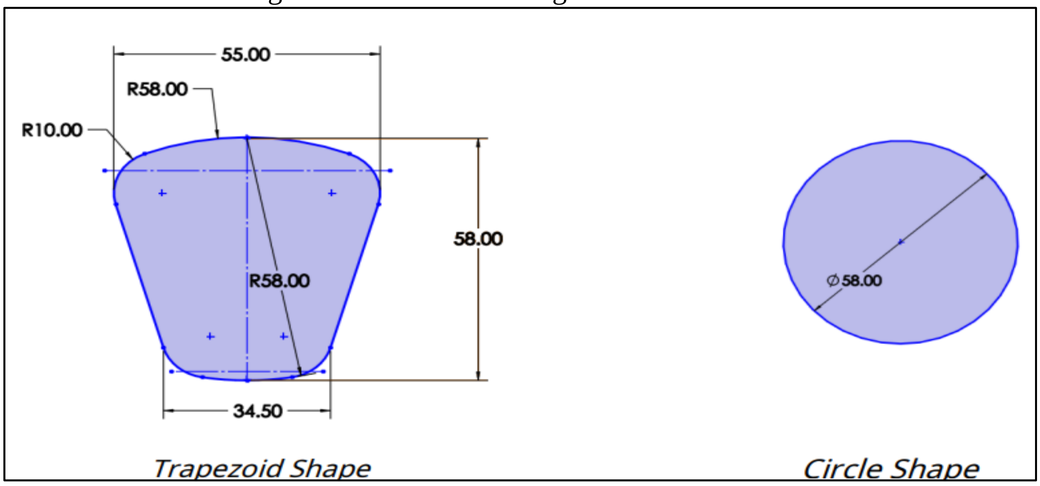


**Figure 2.** Crane Hook Design Shape (Source: Personal Documentation)

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Then of these two cross-sectional shapes, each made with three different types of material, Cast Iron Steel, AISI 1035 Steel, and AISI 1015. Of the three types of materials, they have different mechanical properties and characteristics, detailed material properties are described in table 1.

Table 1. Detailed Material Properties (Source: Personal Documentation)

*Cast iron Steel*

| Property | Value | Units |
|---|---|---|
| Elastic Modulus | 190000 | N/mm^2 |
| Poisson's Ratio | 0.26 | N/A |
| Shear Modulus | 78000 | N/mm^2 |
| Mass Density | 7300 | kg/m^3 |
| Tensile Strength | 448.0825 | N/mm^2 |
| Compressive Strength | | N/mm^2 |
| Yield Strength | 241.2752 | N/mm^2 |
| Thermal Expansion Coefficient | 1.5e-05 | /K |
| Thermal Conductivity | 38 | W/(m·K) |
| Specific Heat | 440 | J/(kg·K) |

*AISI 1035*

| Property | Value | Units |
|---|---|---|
| Elastic Modulus | 205000 | N/mm^2 |
| Poisson's Ratio | 0.29 | N/A |
| Tensile Strength | 385 | N/mm^2 |
| Yield Strength | 325 | N/mm^2 |
| Tangent Modulus | | N/mm^2 |
| Thermal Expansion Coefficient | 1.2e-05 | /K |
| Mass Density | 7870 | kg/m^3 |
| Hardening Factor | 0.85 | N/A |

*AISI 1015*

| Property | Value | Units |
|---|---|---|
| Elastic Modulus | 204999.9984 | N/mm^2 |
| Poisson's Ratio | 0.29 | N/A |
| Tensile Strength | 585.0000029 | N/mm^2 |
| Yield Strength | 282.685049 | N/mm^2 |
| Tangent Modulus | | N/mm^2 |
| Thermal Expansion Coefficient | 1.1e-05 | /K |
| Mass Density | 7849.999987 | kg/m^3 |
| Hardening Factor | 0.85 | N/A |

## RESULTS AND DISCUSSION

Stress analysis is essential to ensure that the tow attachment does not suffer any damage or failure when receiving the load. If the tension exceeds the material strength limit, the structure may break or fail abruptly. By knowing the stress distribution, the design can be optimized to avoid structural failures under operational load. Stress analysis aids in identifying points where stress is concentrated. These points are the areas most vulnerable to damage. By knowing where the stress concentration occurs, the design can be modified to reduce the risk of failure in those critical areas. By analyzing the displacement, researchers were able to determine the extent to which the structure of the tow attachment would change shape (deformation) under load. Displacement that is too large can cause permanent deformation or function failure. Knowing the displacement that occurs allows the selection of materials and designs that can withstand the load with minimal deformation. Large displacement can reduce lift efficiency and cause premature wear to the tow attachment. Displacement analysis helps ensure that the tow attachment is not only strong but also capable of maintaining optimal shape and function during operation. Stress analysis and displacement provide important data for calculating safety factors from the design of tow attachments.

Safety factors must meet industry standards, and this analysis ensures that the design is not only able to withstand load but also has adequate safety margins. This analysis provides a realistic picture of how the tow hook will behave under real load. This helps prevent design errors that can result in failures when practical applications are in the field. By analyzing design variations such as circles and trapezium, researchers can evaluate which is superior in distributing voltage and withstanding deformation. These results provide the basis for the selection of the most efficient and safe design. The following will be described in Figure 3.

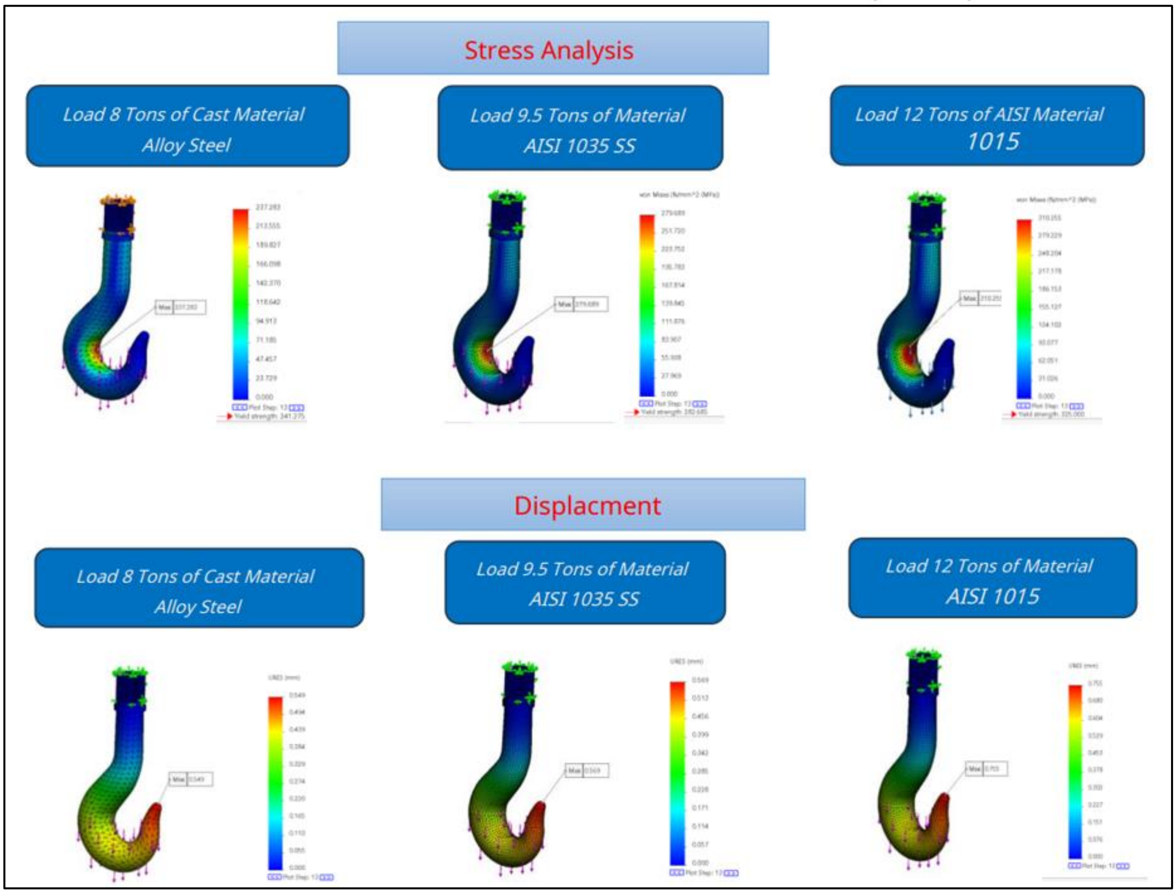


**Figure 3.** The Simulation Results of a Material with a Circular Cross-Section (Source: Personal Documentation)

Force (force) values help to calculate the amount of load a tow attachment can receive before undergoing over-voltage. This is important for determining the maximum load capacity that is safe for practical applications to use. The stress (stress) values are taken to understand how the material (AISI 1015, AISI 1035, and steel alloys) reacts to the external force acting on the tow attachment. The tension indicates whether the material is capable of holding a load without plastic deformation or structural failure. By analyzing stress, researchers can choose materials that have sufficient strength for this application. Stress values help in identifying critical areas where stress is concentrated. If the voltage is too high in one area, the risk of failure increases. Taking this value allows for more precise design improvements or material selection to distribute the stress more evenly. Displacement values are taken to determine how much shape or displacement changes occur in the tow attachment when it receives a load. If the displacement is too large, it can cause structural instability, permanent deformation, or damage. Displacement measurements ensure that the tow attachment remains within safe deformation limits and does not interfere with its function. Force, stress, and displacement values are required to calculate safety factors. With this data, researchers can determine whether the design and materials used are capable of holding loads with sufficient safety margins, in accordance with industry standards. Taking this value allows a direct comparison between various combinations of material and design (e.g., circles vs. circles and etc.

This provides a scientific basis for determining which combinations are most efficient at distributing voltage and holding back deformation without reducing structural strength. By knowing the value of force, stress, and displacement, researchers can detect potential failures before they occur, either due to insufficient material strength or excessive deformation. This is important in the context of operational safety, where failure of the tow attachment can lead to

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serious accidents. These values are used to validate the FEM (Finite Element Method) simulation results. By analyzing the force, stress, and displacement that occurred in the simulation, researchers can compare the simulation results with real conditions and ensure that the design will function as expected. The following will be described in Table 2.

Table 2. The Test Results (Source: Personal Documentation)

| Material | Force (N) | Stress (N/mm²) | Displacement (mm) |
|---|---|---|---|
| Cast Alloy Steel | 8 | 237.28 | 0.55 |
| AISI 1015 | 9.5 | 279.69 | 0.57 |
| AISI 1035 SS | 10 | 310.25 | 0.76 |

Furthermore, from the test results, a test based on the safety factor, the safety factor in the design of the tow attachment is > 1.8. for the parameters tested are load 8 tons of cast alloy steel material, load 9.5 tons of AISI Material 1035 SS and load 12 tons of AISI material 1015 so that from the test results the results are obtained as shown in Figure 4.

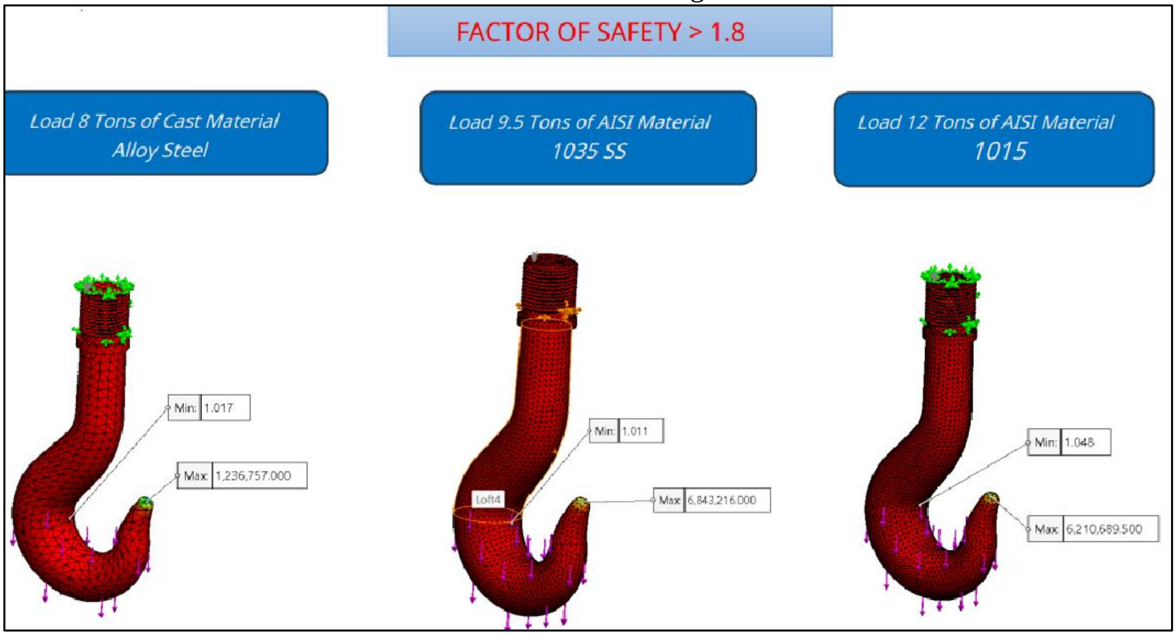


**Figure 4.** The Test Results for Safety Factor > 1.8 (Source: Personal Documentation)

From the test results, the safety factor values for the type of material used are preserved. Of the three tests, the scores obtained were 1,011 – 1,045 people. By standard, cranes with this design cannot be used for safety factor reasons. Then the test is carried out again with the trapezoidal cross-sectional design which will be described in Figure 5.

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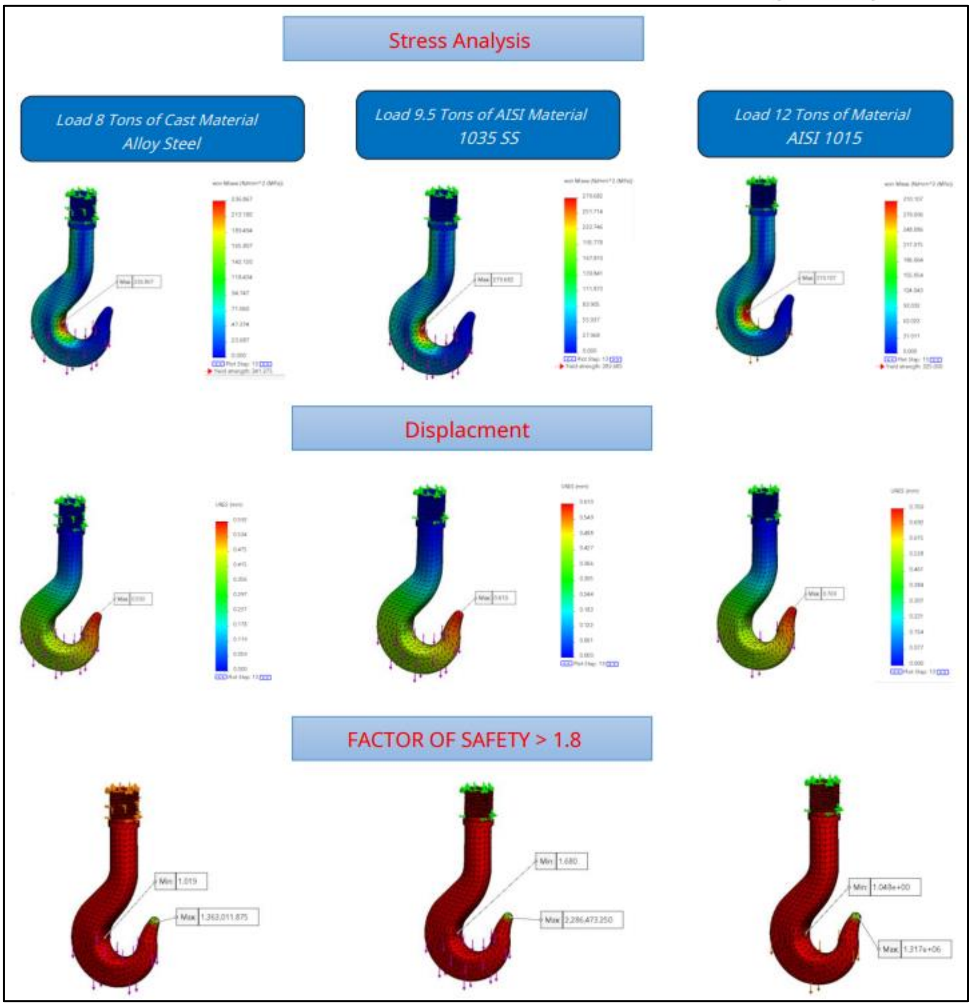


**Figure 5.** Trial for Stress Analysis, Displacement and Safety Factor (Source: Personal Documentation)

Meanwhile, the confounded safety factor values of this design are 1,019–1.68, and this value is still below the standard safety factor values for crane hook designs, but the resultant safety factor values are better than circular cross-sectional areas. From the results of this test, the results are obtained which will be described in table 3.

Table 3. The Results of This Trial (Source: Personal Documentation)

| Material | Force (N) | Stress (N/mm²) | Displacement (mm) |
|---|---|---|---|
| Cast Alloy Steel | 8.5 | 236.87 | 0.59 |
| AISI 1015 | 10 | 279.68 | 0.61 |
| AISI 1035 SS | 12 | 310.11 | 0.77 |

## CONCLUSION

In this research, a series of tests were carried out on three types of materials commonly used in crane hook construction, namely Cast Alloy Steel, AISI 1015, and AISI 1035 SS. Testing involves critical parameters such as force (N), stress (N/mm2), and displacement (mm) to identify the performance of each material under varying load conditions. From the initial test results on a design with a circular cross section, it was found that Cast Alloy Steel provided a safety factor value that did not meet crane hook safety standards. With a safety factor value of only around 1,011 – 1,045, this design is considered unsafe to use. Next, trials were carried out with a trapezoidal cross-sectional design.

The results show that although there has been an increase in the safety factor value, it still does not meet the recommended safety standards (> 1.8). This design still provides a safety factor value of around 1.19 – 1.68. In the next stage, trials are carried out again with the same material on a modified design. The results show a significant increase in the safety factor value, but it remains below the desired safety standard. From the overall results of this trial, several important conclusions can be drawn. First, crane hook designs with circular and trapezoidal cross-sections have limitations in achieving adequate safety factor values. Second, although there has been an increase in the safety factor value with the trapezoidal design, it has not yet reached the desired safety standard. It should be noted that safety is a key aspect in crane hook design, and safety factor values below standard can pose serious risks. Therefore, it is recommended to make further modifications to the design or consider using materials that have better mechanical properties.

## SUGGESTIONS

Make further modifications to the hook crane design to improve the safety factor. This could include changing the dimensions, cross-sectional shape, or incorporating additional design elements that can better distribute the load. Consider testing other types of materials that may have better mechanical properties, such as different alloy steels or composite materials. Choosing materials with higher tensile strength and durability can improve safety. Use more advanced simulation software or physical experiments to perform dynamic and static load analysis under more realistic conditions, such as sudden load changes or extreme environmental conditions. Perform failure analysis on existing designs to understand the main causes of structural failure under different load conditions. This can help in designing more effective solutions. Standardize the test parameters to ensure that the results are comparable to previous studies and can be applied to other hook crane designs. This will strengthen the validity of the research.

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