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A-Review Paper on Hydraulic Excavators

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ABSTRACT

Hydraulic excavators have emerged as crucial equipment in industries such as construction, mining, and landscaping. Powered by hydraulic systems, these machines excel in a wide range of tasks, including digging, loading, and lifting. With their boom, arm, and bucket components driven by diesel engines, hydraulic excavators offer a combination of power, versatility, and ease of operation. The advantages of hydraulic excavators lie in their exceptional power, allowing them to handle demanding tasks efficiently. Their hydraulic systems enable them to generate substantial force, making tasks such as digging into the ground, moving heavy materials, and manipulating objects easier. In this paper we have discussed the past study and research work and concluded them.

Keywords: Excavator arm, lifting force, digging force, CATIA, ANSYS 19.0.

1. INTRODUCTION

Hydraulic excavators are used for a variety of tasks, including digging, loading, and lifting. They are commonly used in construction, mining, and landscaping. The advantages of hydraulic excavators include their power, versatility, and ease of operation. However, they are also expensive to purchase and operate, and can be noisy and create a lot of dust. If not operated properly, hydraulic excavators can also be dangerous.

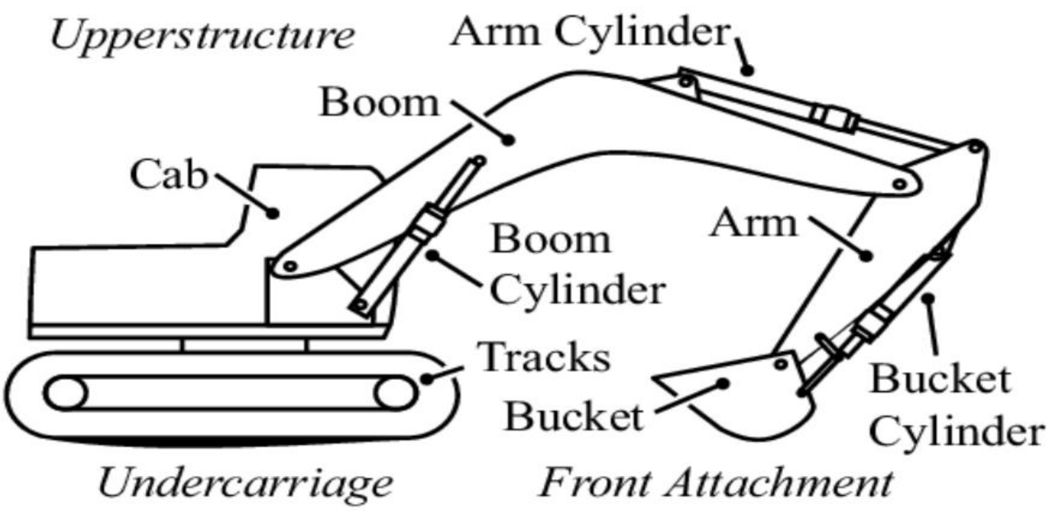

Fig.1 Hydraulic Excavators

2. LITERATURE REVIEW

Takashi YAMAGUCHI and et.al the researchers focus on conducting experimental measurements to analyse the motion of a hydraulic excavator that is operated by a human operator. The objective of their study is to utilize the data obtained from these measurements to develop autonomous control systems for hydraulic excavators, specifically for excavating and loading tasks. They aim to replicate the skill and expertise of experienced operators in the autonomous control algorithms. One of the challenges in excavating and loading work with hydraulic excavators is that the ground materials being handled often exhibit non-uniform properties. These variations in properties make it difficult to accurately determine the characteristics of the materials across the entire work range prior to commencing the operation. [1].

Sharan gouda A Biradar and et.al the researchers performed calculations to determine the forces exerted on the teeth of the excavator bucket. They followed the standard SAE J1179 to calculate the forces, and the result indicated a value of 60 KN (kilonewtons). This measurement provides an estimation of the forces that the bucket teeth experience during excavation tasks. Additionally, the researchers calculated the bucket capacity using the standard SAE J296. The calculated bucket capacity was determined to be 0.75 m^3 (cubic meters). This measurement provides information about the volume of material that the bucket can hold during excavation and loading operations. [2].

Dharmesh h. Prajapati and et.al the researchers reached the conclusion that the capacity of the excavator bucket has been increased from 150 kg to 300 kg. To achieve this increased capacity, they made modifications to the bucket's design. One of the modifications involved adding two additional teeth to meet the functional requirements of the bucket. The researchers conducted various tests and evaluations to assess the performance of the modified design under different loads. This evaluation process involved subjecting the modified excavator bucket to varying loads and examining its response. By analysing the results, they were able to validate the effectiveness of the design modifications and ensure that the bucket met the desired performance criteria. [3].

Altaf S. Shaikh and et.al the researchers focused on calculating the forces exerted on the excavator and specifically determined the forces transmitted to the excavator arm. Through their analysis, they identified potential areas for optimization within the analysed component. To optimize the excavator parts, the researchers carried out multiple iterations of design modifications. They systematically refined the design based on the identified optimization opportunities, aiming to improve the performance and efficiency of the excavator. After several iterations, they obtained the final optimized results. [4].

Sachin B. Bende and et.al in the paper, the authors describe their modifications to the design of an excavator arm and provide an analysis of the redesigned arm. The analysis shows that the modified design is safe for the calculated digging force, indicating that it can withstand the forces exerted during excavation without issues such as dislocation of the pin at the bucket end or cracking at the adapter end. During the design process, the authors considered important factors such as productivity and fuel consumption. By reducing the digging force, they were able to eliminate the problems associated with pin dislocation and cracking. However, reducing the digging force directly affects productivity since less force is available for digging. To compensate for this loss in production, the authors increased the bucket capacity. By increasing the bucket capacity, they aimed to maintain or even improve productivity despite the reduction in digging force. [5].

A. V. Pradeep and et.al the authors focused on designing an excavator bucket and conducted an analysis using three different materials: steel, wrought iron, and cast iron. They examined the von Mises stresses, deformation, and strain energy for each of the materials and compared the results. [6].

P. Govinda Raju and et.al in the paper, the authors conducted a static structural analysis of both the excavator arm and bucket. They evaluated the maximum shear stress and deformation that developed in the model during the analysis. These results provide insights into the structural behaviour and performance of the arm and bucket under applied loads [7].

G.Ramesh and et.al In the mentioned paper, the authors introduced a topology optimization approach for designing an innovative excavator Lower Arm. Topology optimization is a technique used to optimize the material distribution within a given design space, aiming to achieve an optimal structure that meets certain performance criteria while minimizing weight. The authors applied this approach to the Lower Arm design and compared the final optimized design with the initial design in terms of weight and component performance. The results of the comparison demonstrated that structural optimization techniques are effective in producing higher quality products at a lower cost. By optimizing the structure, they were able to achieve a design that met the required performance criteria while reducing the weight of the Lower Arm. [8].

Roshan V. Marode and et.al in the mentioned paper, the authors conducted an analysis of the backhoe-loader bucket using finite element method (FEM). They applied maximum loads and boundary conditions to simulate the working conditions of the bucket. Specifically, the analyses focused on evaluating the maximum forces exerted on the hydraulic cylinders and considering symmetrical boundary conditions. One important aspect of the analysis was examining the fatigue life of the bucket. Fatigue life refers to the ability of a component to withstand repeated loading and unloading cycles without experiencing failure. The authors likely assessed the fatigue life of the bucket by estimating the number of cycles it could endure before failure occurred. [9]

Nitin S. Patil and et.al in the paper, the authors performed multiple iterations during the optimization process, and the final iteration yielded better results compared to previous iterations. Based on these results, they concluded that the optimized model would be a suitable replacement for the conventional model. The optimization process resulted in a significant weight reduction of approximately 120 kg. This weight reduction not only contributes to improved performance but also leads to cost reduction, as lighter components require less material and potentially have lower manufacturing and transportation costs. [10].

R M Dhawale and et.al the authors developed a mini hydraulic backhoe excavator attachment specifically designed for light-duty construction work. They conducted a static force analysis to evaluate the performance of the attachment. Additionally, finite element analysis (FEA) was carried out to analyse the individual parts as well as the entire assembly of the backhoe excavator, considering both with and without welding. The analysis showed that the stresses generated in the various parts of the backhoe excavator attachment were within the safe limits of the material stresses, regardless of whether welding was taken into consideration. This suggests that the design and construction of the attachment were able to withstand the applied forces and stresses without exceeding the material's strength limits. [11].

Chinta Ranjeet Kumar and et.al the authors made several modifications to the model of the excavator bucket. These modifications involved adding rectangular ribs, round ribs, and half sphere ribs to the inner surface of the bucket. The purpose of these ribs was likely to reinforce the structure and enhance its performance. Furthermore, the authors replaced the original material, EN19 Steel, with AISI 1059 Carbon Steel to potentially achieve improved results. This material substitution was likely based on the desired properties and performance requirements of the bucket. [12].

Swapnil S. Nishane and et.al the authors conducted modelling and analysis of a backhoe excavator bucket. They compared the existing bucket design with an optimized design and observed certain improvements.

Firstly, they noted that the values of von Mises or equivalent stresses were relatively similar between the existing and optimized buckets. However, in the optimized design, the area of stress was reduced compared to the existing design. This reduction in stress concentration is beneficial as it indicates a more uniform distribution of stresses throughout the structure, potentially leading to improved structural performance and longevity. [13].

3. CONCLUSION

Designing an excavator arm by considering forces and loads is a common practice in optimizing excavator components. To proceed with the design process, you have specified the digging force, lifting force, and maximum load as the boundary conditions for analysis. This is a good starting point to determine the requirements and constraints for your excavator arm design.

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