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Application of Working Model in calculating parameters for single-stage scissor lifts

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ABSTRACT: This research proposes the utilization of the Working Model software to construct detailed models and simulate the operation of single-stage scissor lift systems with variable cylinder positions. By inputting precise orientation dimensions in the device and the magnitude of the load component, the software enables the accurate computation of reactions acting on joints and the thrust exerted by the cylinder. The results of the study indicate that the adoption of the Working Model software not only reduces computation time but also provides extensive support throughout the design and manufacturing processes.
KEYWORDS: Single-stage scissor lift, simulation, Working Model, cylinder's thrust, mechanism.

I. INTRODUCTION

Linkage mechanisms are fundamental components in mechanical systems that consist of a series of rigid bodies or links connected by revolute or sliding joints. These linkages play a crucial role in transmitting motion and force between different parts of a mechanism, enabling the desired functionality and operation.

The primary purpose of a linkage is to convert input motion or force into a desired output motion or force. Despite their simple structure, these types of devices are widely used in various applications, including machinery, robotics, automotive systems, and industrial equipment. Simple mechanism linkages offer several advantages in mechanical systems. They provide mechanical advantage, enabling the amplification of force or motion in a controlled manner. They are relatively simple to design and manufacture, allowing for cost-effective solutions. Additionally, they have high efficiency and reliability when properly engineered.

Understanding the principles and behavior of mechanism linkages is crucial for mechanical engineers and designers. Through analysis, simulation, and optimization, engineers can determine the ideal linkage configuration, dimensions, and joint types to achieve the desired motion and force transmission characteristics.

Scissor lifts are one of the simplest linkages, which employ a scissors mechanism to raise or lower objects or persons over relatively large distances in height. There have been research studies focusing on analyzing the characteristics of different types of scissor lift systems. While some studies concern simulation software to evaluate the operation of cylinders on these devices [1, 2, 3], others focus on calculating the strength of lift components to determine suitable designs [4, 5, 6]. However, there have been few studies dealing with the arrangement of cylinders or constructing specific equations to calculate the thrust force for cylinders.

Working Model is a powerful software tool that has enhanced the way engineers and designers analyze and simulate mechanical systems. By accurately creating 2D models of mechanical systems and simulating their operations, the software offers a wide range of capabilities, including motion analysis, force and torque calculations, stress analysis, and collision detection. The software provides powerful features to visualize and analyze simulation data, such as graphs, charts, and value measurements, enabling engineers to test and optimize their designs, identify potential issues, and make informed decisions before the physical manufacturing stage.

This research proposes the utilization of Working Model software in constructing a model and calculating forces on a single-stage scissor lift. By assigning the necessary parameters for the design process (arm properties and cylinder positions), the forces acting on the system and the thrust of the cylinder are accurately computed, helping to reduce computation time compared to traditional methods

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and supporting the design and manufacturing processes.

II. CONSTRUCT MODEL

It can be seen in Figure 1 that the structure of a single-stage scissor lift consists of two arms of the same length connected to each other by a hinge joint at the center, forming a scissor mechanism. These arms have one end pinned to either the platform or base, while the other end is designed to slide along the groove of these parts, acting as a sliding joint. During the movement of the cylinder, as it expands in length, the angle between the arms increases, and the distance between the supports connecting the base and platform is reduced.It isalso noted that the operation and control of the mechanism may vary depending on the type and model of the scissor lift, specifically the orientation of cylinders. Safety precautions, such as weight limits, platform stabilization, and proper usage guidelines, should always be followed to ensure safe operation.

Figure 1. Structure of the scissor lifts [7]

The procedure to construct a specific model of a scissor lift can be described as follows:
Step 1: Use the Rectangle button to create the arms, base, and platform.
The Rectangle tool is used to construct rectangle-shaped objects. In this step, designers can specify the parameters of the arms, such as dimensions, weight and mechanical coefficients, by inputtingthese data in the Properties window. To prevent the displacement of the links during the simulation, Anchor option is assigned to the base link, which is denoted by a black anchor in Figure 2.

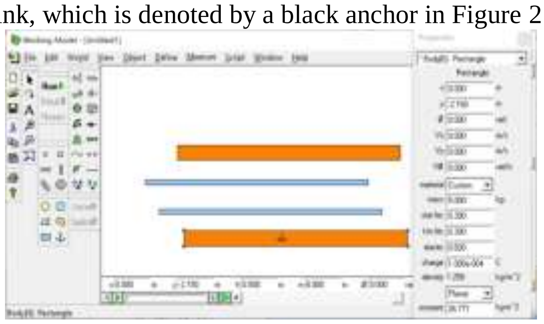

Figure 2. Create rigid links for the system

Step 2: Assign joints for the rigid bars.

In Working Model 2D, joints are created by adding "joints" elements using the Join command. For the model of scissor lifts, which consists of both revolution and sliding joints, two different Joint buttons are used, as presented in Figure 3. It is noted that the base and platform have only one pinned joint and one slot joint. On the other hand, the scissor arms have three pinned joints, located at the ends and the centre of each component.

Figure 3. Addingjoints for the rigid links

Step 3: Joining links to create the linkage.

To join the linkage, users just simply select two different joints from the links and click the Joinbutton. As long as the joints are visible and selectable, users can add as many links as needed to construct the mechanism. The result of this operation is the complete shape of the lift (without the cylinder), as presented in Figure 5.

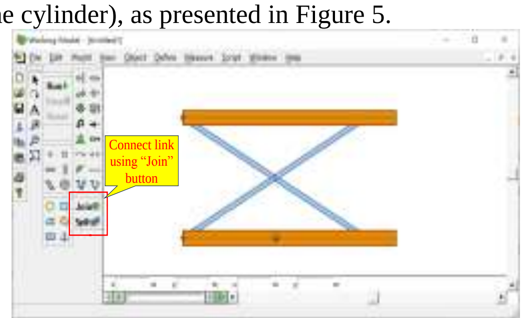

Figure 5. Configuration of the lift

Step 4: Add the cylinder to complete the structure.

It should be noted that since the constructed model does not yet include the cylinder, the movement of the platform is still movable according to the control of the cursor. To incorporate the cylinder, which acts as a rigid bar whose length changes only when the platform is raised, designers can choose the “rope”,“rod” or “separator” element (which are non-weight part in the system) from the software to present the cylinder

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(see Figure 6). Pin joints are addition created on each arm before connecting to the cylinder.

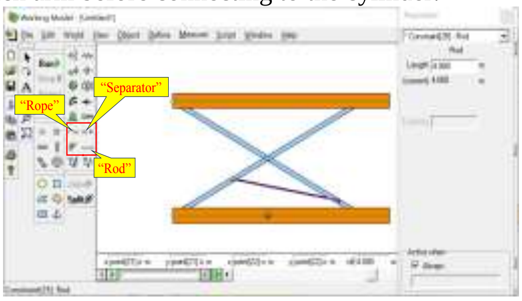

Figure 6. Using rod button to create cylinder

Since the placement of the pin joints determines the geometry and orientation of cylinder in the scissor lifts. Depending on the specific requirements and desired functionality, engineers and designers can experiment with differentconfigurations to achieve the desired output responses. This flexibility allows for customization and optimization of the scissor lift design to meet specific application needs, such as lifting height, stability, and load capacity. Figure 7 illustrates different schemas for the design of a lift table, with each schema will result in different output responses.

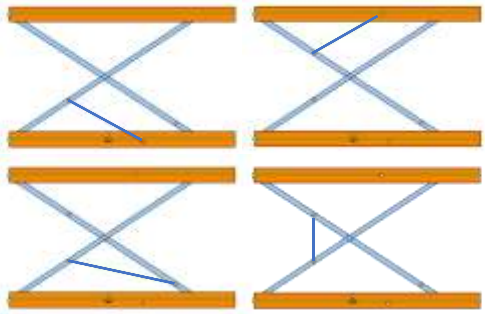
Figure 7. Different schemas for lift table design

To determine the elevation of the device, the positions of both the base and the platform are obtained from the Coordinate bar in the screen window. By comparing the vertical coordinates of these components, the elevation or height differencesof the platform can be determined.
Since all the links in the model are rigid parts, changing the length of the cylinder in Figure 5can accurately provide the accurate position of the platform. This feature allows for a precise analysis of the lift's performance, including its elevation at different points in its operation.

III. EXTRACTING FORCE FROM THE MODEL

Force is an important concept, specified in terms of magnitude, direction, and application point, used to simulate and analyse mechanical devices. By applying forces to different components, users can observe how the system responds and analyse the resulting motion, stress, and other mechanical behaviours.

Working Model provides capabilities to calculate and display the forces acting on different parts of the model during simulation. These forces can be visualized using vectors, diagrams, or numerical values, allowing users to understand the distribution and magnitude of forces within the mechanism.

For the scissor lifts, the main forces are load, scissor arms and the platform' weight. These components can be assigned by add mass for the links, or using Forcebutton to input the forces (see Figure 8)

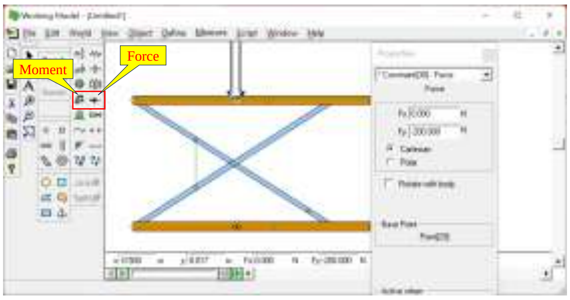

Figure 8. Using Force/Moment button to add external force to the system

After checking the linkage to ensure every link is proper joined, designer can run the simulation to check the force in cylinder (tension of rope/rod element) and reaction in joints (see Figure 9).

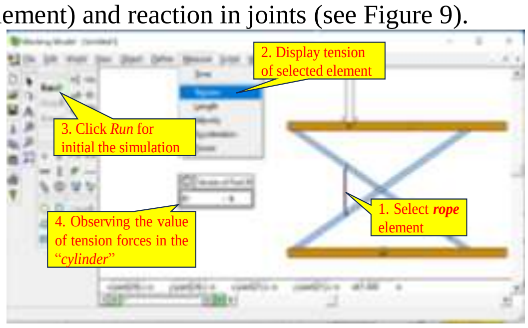

Figure 9. Extract thrush force in the cylinder

The resultant forces in the whole system can be visualized by enabling display options within the software, as illustrated in Figure 10.

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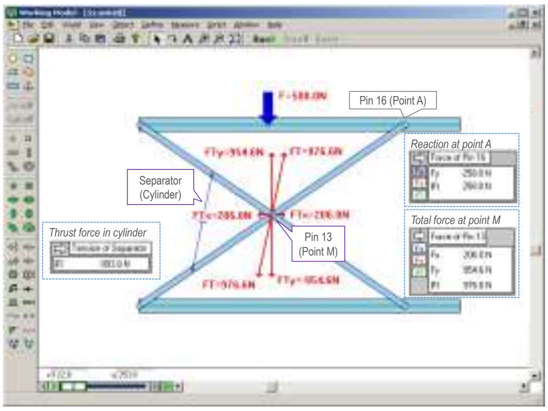

Figure 10.Display force in the system

IV. CONCLUSION

The applicability of Working Model software in constructing a model and calculating forces on a single-stage scissor lift is a promising approach for supporting the design and manufacturing processes.

Traditionally, calculating forces in mechanical systems like scissor lifts would require complex mathematical calculations and simulations. This process can be time-consuming and labour-intensive. By using Working Model to assignthe necessary design parameters, the software can assist designers to accurately compute the forces on joints and the thrust of the cylinder, aiding engineers and designers to reduce computation process.This information is crucial for evaluating the lift's performance, identifying potential issues, and optimizing the design.The feature of the study based on the advantage of the Working Model are follow as:

Accuracy: The software employs advanced physics-based algorithms to calculate forces and other parameters accurately, ensuring the design requirement and operates of the system as intended.

Efficiency: With the use of Working Model software, engineers can significantly reduce the time and effort required for force calculations. The software automates conducts many complex calculations and provides quick results, enabling designers to iterate and refine the design more efficiently.

Visualization: the software provides visual representations of the scissor lift's operation, allowing engineers to gain a better understanding of the system's behaviour, aidingthe identification of potential issues, optimizing the structure.

Simulation capabilities: Working Model enables engineers to simulate the scissor lift's behaviours under various operating conditions., allows for testing the system's performance and evaluate different optionaldesigns, and assessing the impact of changes before physical prototyping or manufacturing process.

Overall, the application of Working Model software in the design and calculation process of a single-stage scissor lift offers several benefits. It enhances accuracy, reduces computation time, and supports the optimization of the design and manufacturing processes.

Conflict of interest

The author declares no conflict of interest.

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REFERENCES

[1]. T. Hongyu, Z. Ziy (2011), Design and Simulation Based on Pro/E for a Hydraulic Lift Platform in Scissors Type, Procedia Engineering, vol 16, pp 772 – 781.

[2]. Ren G. Dong et al (2012), An Investigation on the Dynamic Stability of Scissor Lift, Open Journal of Safety Science and Technology, Vol 2, pp 8-15.

[3]. W. Zhang, C. Zhang, J. Zhao, C. Du (2015), A Study on the Static Stability of Scissor Lift, The Open Mechanical Engineering Journal, Vol 9, pp 954-960.

[4]. Lukasz Stawinski*, Andrzej Kosucki, Adrian Morawiec, Malgorzata Sikora, A new approach for control the velocity of the hydrostatic system for scissor lift with fixed displacement pump, Archives of Civil and Mechanical Engineering, Volume 19, Issue 4, August 2019, Pages 1104-1115

[5]. W. Zhang, C. Zhang, J. Zhao, C. Du (2015), "A Study on the Static Stability of Scissor Lift", The Open Mechanical Engineering Journal, Vol 9, pp 954-960.

[6]. Sabde Abhijit Manoharrao, Prof. Jamgekar R.S. (2016), "Analysis & Optimization of Hydraulic Scissor Lift", IJEDR, Vol 4(4).

[7]. ULINE: Electric lift table. https://www.uline.com/Product/Detail/H-3935/Lift-Tables/Electric-Lift-Table-2000-lb-48-x-36. Accessed 20 May 2022