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Design and Development of Automated Tilting Ramp

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ABSTRACT
The company that we worked with deals with plastic molding. The equipment and material required is heavy and bulky. It needs concentrated manpower during the offloading and onloading of the raw materials and packaged end product. The primary goal of the project was to create such a platform that allows smooth loading of the product with reduced work force, combining the principles of hydraulics as well as pneumatics. The platform created allows the user to utilize and adjust according to varied heights of transportation vehicles. In turn, the company can operate optimally with reduced wastage of man hours and thus regulate constant employment of the production units, allowing better use of time and resources available to the company. This helps reduce human fatigue as well. The construction of this platform also enables and eases better space management and eliminates any space constraints, as the design has to be compact to accommodate and cover every possible requirement whatsoever. Due to the non-existence of such a platform prior to this project, the practical applications of this project may result in increased production levels.

KEYWORDS: *Platform, loading, pneumatics, varied height, space management, time management.*

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I. INTRODUCTION

Platforms and lifts over the years have helped people in lifting, carrying and transporting weights, materials, products, work force and many more to various levels, carrying them at particular angles and holding them at those heights and inclinations. Various types of lifts are used in the industries, construction sites and in factories to carry goods around. To name some are scissor lifts, cantilever lifts, etc. The most common in the industries is the scissor lifts as they are very stable, and the design is very compact as well.

Hydraulic lifting machines are widely used for the lifting, moving and pushing function in mining, construction and steel industries and in material handling equipments. Since 1950s the applications of hydraulic systems have been started in the industries and this form of power has become standard for the operations of industrial equipments. Today, modern automation technology has a very important place for hydraulic systems. The reason for this is that hydraulic systems are simple, versatile and efficient for the transmission of power. The main job of a hydraulic system is the transmission the power as the power is changed from one form to another.

As these hydraulic systems are popularly used in the manufacturing and production plants, therefore it is required that they are reliable and efficient equipments to achieve the desired results from them like transmission of large number of forces with the use of smaller components which means good power intensity and precise positioning of the equipment with consistent power output. These systems operate smoothly with reversal function possibility and can work well in high temperature environment conditions. These systems are thus cost considerably to provide the above functions and therefore the same system is modified using a simple rack and pinion mechanism to lower its cost and allowing further research and modification in it to make it able to provide all the above functions with the same efficiency.

1.1 Gas Springs

A gas spring is a type of spring that, unlike a typical mechanical spring that relies on elastic deformation, uses compressed gas contained within an enclosed cylinder sealed by a sliding piston to pneumatically store potential energy and withstand external force applied parallel to the direction of the piston shaft. There are two types of gas springs used in this project as per the company requirement. Two of them being lockable rigid type gas springs (to actuate and lock the gas springs at needed elevation) and the other two being push type gas springs to only support the loads from underneath the ramp.

1.2 Arduino Microcontroller:

Microcontroller is a well-chosen name because it emphasizes defining characteristics of this product category. The prefix "micro" implies smallness and the term "controller" here implies an enhanced ability to perform control functions. As stated above, this functionality is the result of combining a digital processor and digital memory with additional hardware that is specifically designed to help the microcontroller interact with other components. The use of a microcontroller is for the automation of the ramp and its synchronization.

1.3 Final Design Components list and their costing:

PARTS	COST
GAS SPRINGS (CYLINDER 28MM DIA. 120MM STROKE, 5000N CAPACITY)	1000 X 4=4000
STEEL PLATE (120MM X 1280MM X 120MM)	1500
STEEL PLATE (250MM X 1280MM X 120MM)	1200
HINGE RODS (10MM DIA. 100MM LENGTH)	1000
RAM ROD (32MM DIA. 100MM LENGTH)	1800
STEEL TUBES (25MM SQUARE 1260MM LENGTH)	2000
STEEL TUBES (25MM SQUARE 660MM LENGTH)	2000
GAS SPRING BRACKETS AND ACTUATORS	1200
BRASS BUSHINGS	400
FABRICATION	7000
TOTAL	22100
SAVINGS ON SCRAPPAGE OF WASTE METAL (3.3KG MS STEEL) (3.4KG SQUARE TUBE) (MS STEEL ROD)	1000
TOTAL COST AFTER SAVINGS	21100

Table1: Final Parts list and costing

1.4 Final Design Generated as per constraint:

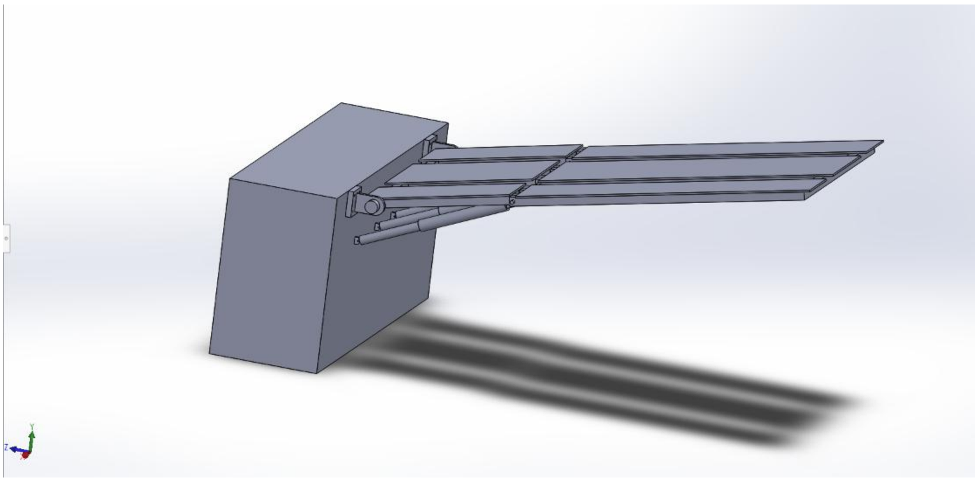

Figure 2: Tilting Ramp in Isometric View

1.5 Simulations and FEA Analysis:

The simulations and FEA analysis of the ramp were done to understand the action of forces of acting on the ramp when in use and to understand the failure points if they occur any. In this simulation we have only undertaken the external forces (external forces or pallet truck load on the ramp), the support forces which are from the gas springs used to support the ramp during transporting the goods.

1.5.1 Full System: Von – Mises Stress analysis(N/mm^2):

With these stresses we understand the fracture points or high stress zones created in the system under actions of different external loads. These stresses compare the yielding stress of the materials and displays them according to the severity.

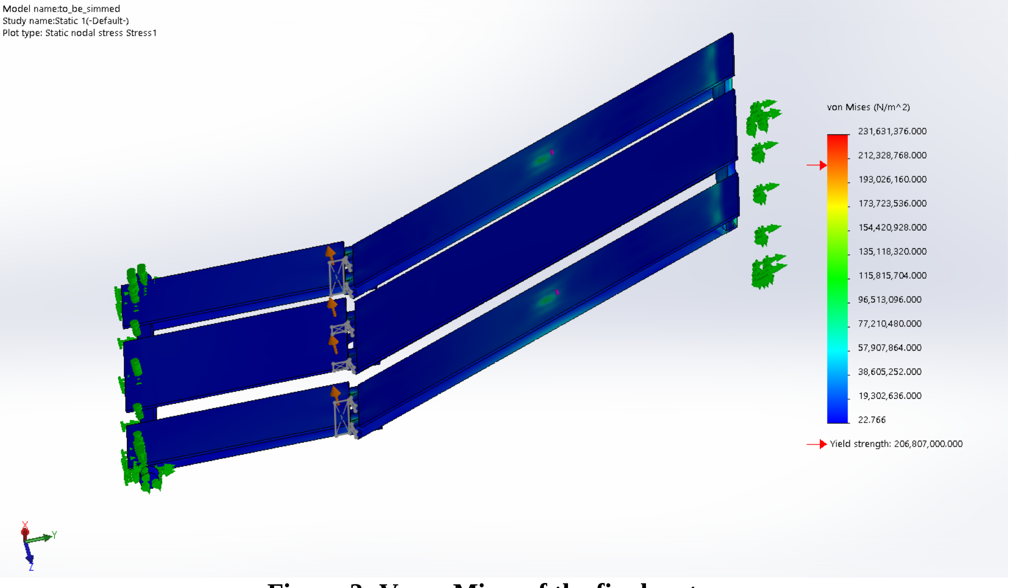

Figure 3: Von – Mises of the final system

1.5.2 Full System: Displacement (mm):

Displacement during simulations helps us understand the maximum displacement occurring in the system in the vertical direction.

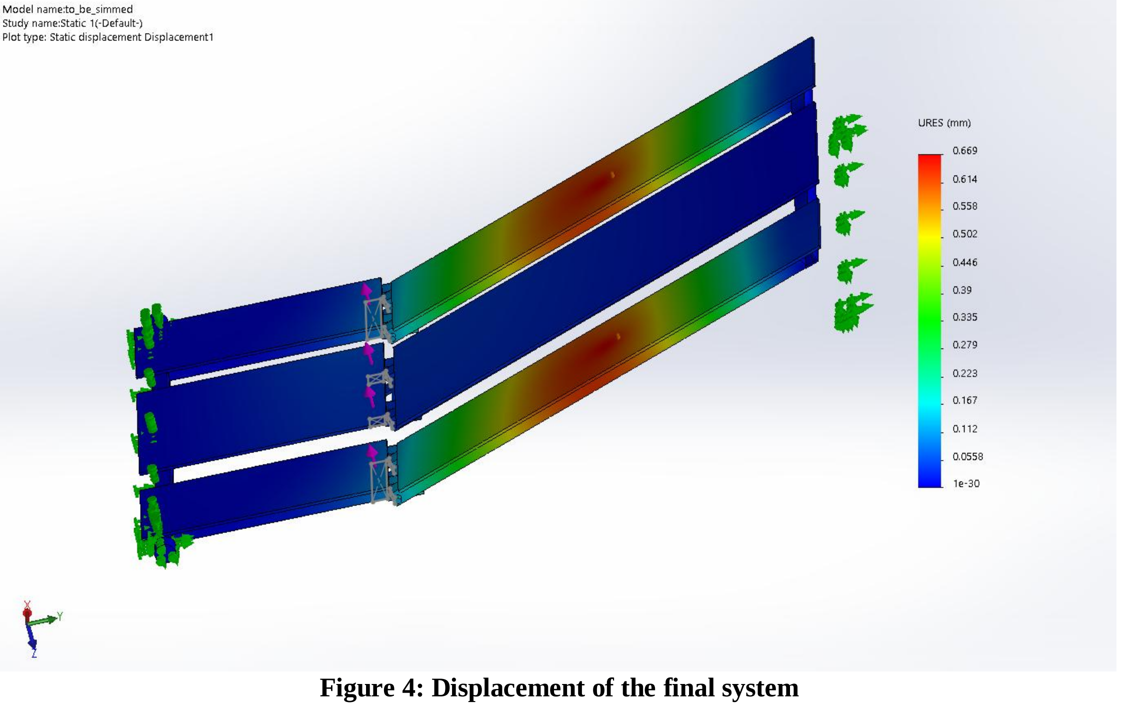

Figure 4: Displacement of the final system

The FEA simulation were also done for the wall mount of the system as it carries most of the load. The simulation is done as follows:

1.5.3. Wall Mount: Von – Mises Stress(N/mm2):

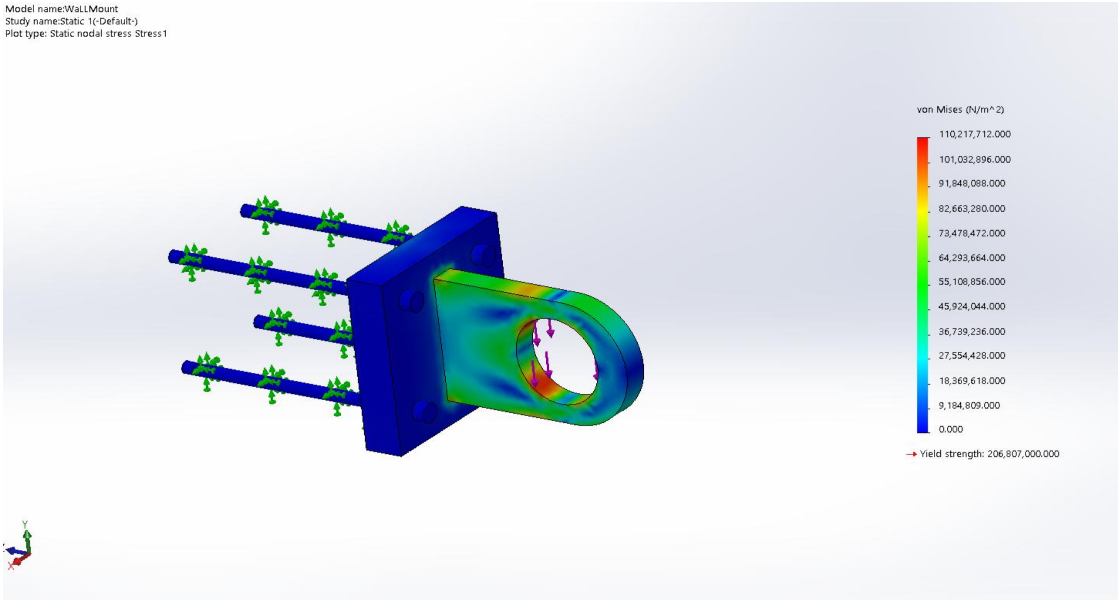

Figure 5: Von – Mises Stress of the Wall Mount

1.5.4. Wall Mount: Displacement(mm):

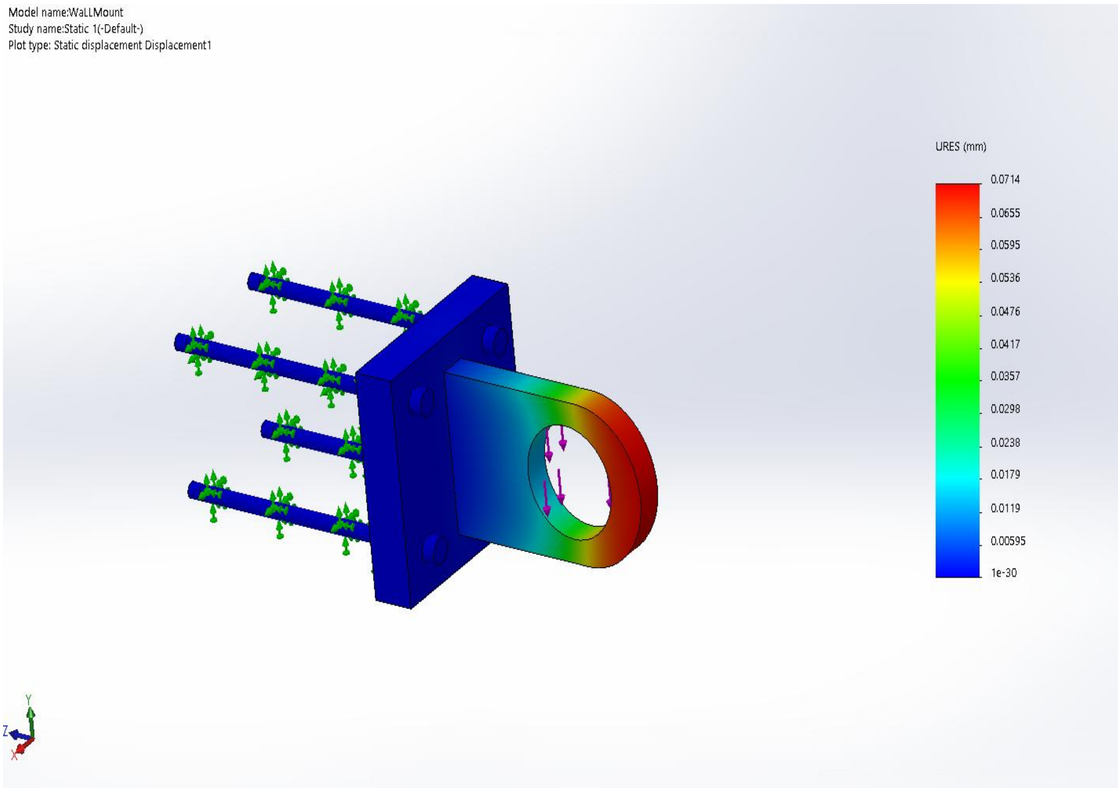

Figure 6: Displacement of the Wall Mount

II. AUTOMATION AND SYNCHRONIZATION OF RAMP

2. 1 The components required for the automation and synchronization are as follows:

1. Microcontroller (Arduino UNO)
2. Load cells x 2
3. Load cell amplifier x 2
4. Solenoid x 4

5. Solenoid Driver circuit
6. Relay x 4

1. Microcontroller:

We have used Arduino UNO as the controlling device. This single-board controller provides multiple digital and analog IO ports as well as compatibility to various modular circuits. It also has featured serial interface with logging and plotting. This controller is based on ATmega328P.

2. Load Cells:

Load cell is the primary sensor for this setup. It measures the current load on the connected structural member. This signal is sent to the amplifier to convert it to the Arduino compatible signal. This signal is then processed by the controller to produce the required actuator signals.

3. Amplifier:

Amplifier is the intermediate circuit used to interface the load cells and the controller. Load cells do not produce enough signal to be detected by the controller. Amplifier converts this weak signal to the matching amplitude required by the controller.

4. Solenoid:

Solenoid is the primary actuation device. Solenoid is given the actuation signal from the driver. This solenoid pushes on the gas actuation button to extend the piston.

5. Solenoid Driver Circuit:

This circuit takes 4 inputs, power, ground input and two data inputs. Encoding the actuation signals in 2 signal lines reduces the number of data lines.

6. Relay:

Relays are used where it is necessary to control a circuit by an independent low power signal. As solenoids require different working voltage and current, the signal from the microcontroller can’t be directly used as the input signal to the solenoid. Hence relay convers this low signal to the signal required by the solenoid.

2.2 Circuit Diagram:

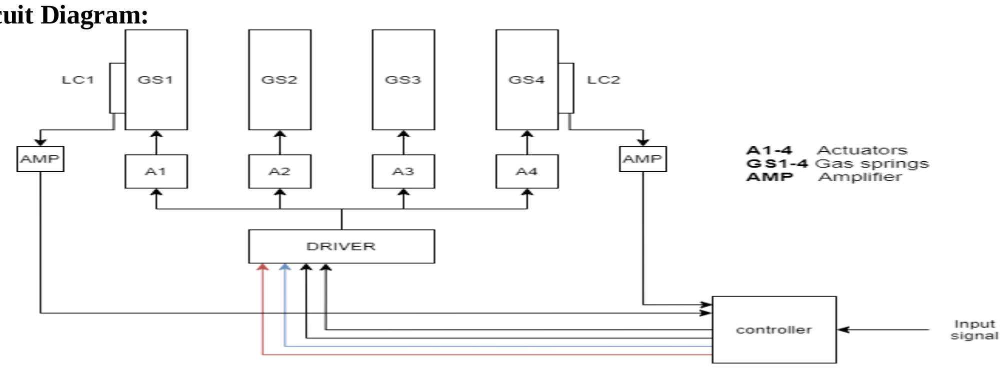

Figure 7: Circuit Block Diagram

III. RESULTS AND DISCUSSION

3.1 Tabulation of results

For Design - III	
External Force (Newton)	2452.5 each arrow
Support Force (Newton)	565.28 each arrow
Fixed Support Definition	At the main hinge and the Frame 2 resting side
Von - Mises Stress (N/mm2)	
Minimum Stress	0
Maximum Stress	1,31,63,13,76,000
Yield Strength	2,06,90,70,00,000

Displacement (mm)	
Minimum Displacement	1.00E-30
Maximum Displacement	0.66

Table 1: Result Table for Design – III

For Wall Mount	
External Force (Newton)	5000 per mount
Support Force (Newton)	Wall Mounted with 4 bolts
Fixed Support Definition	In the walls with 4 bolts 150mm bolts each
Von - Mises Stress (N/mm2)	
Minimum Stress	0
Maximum Stress	1,10,21,77,12,000
Yield Strength	2,06,90,70,00,000
Displacement (mm)	
Minimum Displacement	1.00E-30
Maximum Displacement	0.0714

Table 2: Result Table for Wall Mount

IV. CONCLUSION

In this project we designed two lifting and tilting ramps with the use of hydraulics and gas springs. As it is observed in the result summary and from the report, the hydraulic system requires a lot of space and the entire system is very expensive in general. Considering both the factors and on-site problems, we realized that hydraulics wasn't the right move moving forward with this project. As our constraints was that the design should be compact, collapsible, cheap and maintenance should be easy and should not cost much. In this case, in the use of hydraulics none of the constraints were fulfilled and hence the shift to gas springs as alternative to hydraulics was discovered, explored, proposed and accepted. Gas springs are very easy to operate and easy to maintain. Given their small size and collapsible design, they give the project a new dimension. Not only gas springs cut the cost of the project by more than half, their maintenance and assembly are easy. With the use of gas springs, the space requirement considerably reduces as compared to the hydraulic system. This is achieved as the gas springs don't require a reservoir or a pump or any kind of valve or safety mechanism. The automation of this system is also designed as above. The code will give the necessary tilt to the ramp and can be changed and adapted as per requirement.

V REFERENCES

V.B. BHANDARI, "Design of Machine Elements"

[1]. TUSHAR BHATNAGAR et al, "Low-cost hydraulic lift", April-2007

[2]. SURAJ B. DHANAWADE et al, "Design, Analysis and Development of Hydraulic Scissor lift", March-2017

[3]. LIJING DONG et al, "Design and Advanced Control of Intelligent Large-Scale Hydraulic Synchronization Lifting Systems", August – 2019

[4]. DYANA ANDERSON et al, "Surgical Lift Project", September – 2008

[5]. TIAN HONGYU et al, "Design and Simulation Based on Pro/E for a Hydraulic Lift platform in Scissors Type", August – 2011

[6]. TAO SUNA et al, "Design and Research of Large Height Lifting Mechanism for Ultra – Large Structures", March – 2018

[7]. CORNEL CIUPAN et al, "Algorithm for designing a hydraulic scissor lifting platform", February - 2019

[8]. GEORGY OLENIN, "Design of hydraulic scissors lifting platform", March 2016