DESIGN, MANUFACTURING AND TESTING OF INDUSTRIAL HYDRAULIC LIFTS

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***Abstract*— Every industry, small, medium and big, requires functional machines effectively capable of lifting and hoisting heavy materials. The client of our sponsor industry for our Major Project was in the need of such equipment that helped them carry heavy loads up and down between two stories. The tools that will aid in the analysing and drafting of components are any 2D Drafting and 3D Modelling Software. The tools for manufacturing include conventional machines such as – lathe machines, drill machines and welding machines. The method for our approach to this problem is the installation of lifts or elevators that will support the industry in completing their requirements. The manufacturing process includes the operations of machining such as – turning, drilling and welding. The industry will be benefitted from ease of operations which will directly increase and boost their productivity, and indirectly cut down costs of extra manual labour (manpower) which will be required to perform such exhausting and stressful activity.**

***Keywords*— Elevator, Lift, Industrial Goods Lift, 2D Drafting Software, 3D Modelling Software, Hardness Testing**

I. INTRODUCTION

According to independent analysts, India is currently the second-largest market for lifts or elevators and escalators in the world. Urbanisation has been a vital factor in increasing demand for high-rise buildings across the country. As it continues to expand, the need for housing and commercial space will grow, simultaneously, propelling growth in the lift or elevator industry. Lift/Elevator manufactures are poised to cater to this demand and expect the next developments in lift/elevator technology to be digitalization with a focus on enhancing the passenger experience.

Fig (1) : Left- Small Lift Manufactured, Right- Authors with Big Lift

II. LITERATURE SURVEY AND PROPOSED METHODOLOGY

A. Literature Survey 1:

In multiple industries, the operator or employee is required to hoist or lift goods and stuff (usually raw material) into the respective machines for further production operations. Without proper and appropriate equipment, he/she has to tip it into the feeder of the machine manually. This excruciatingly vigorous and tiresome task develops intense stresses in the body of the operators. These developed stresses can cause multiple serious injuries to them leading to ineffective work. Thus, a small lift or elevator which could perform the rise of a platform equivalent to the height of the feeder of the machine diminishes the need for such tedious tasks and labour. [1]

Proposed Methodology 1:

As the saying goes; 'Modern problems require modern solutions, the power system of the lift or the elevator being manufactured can be of Hydraulic Type with Pistons and Cylinders. This would help and aid in increasing the Factor of Safety and would allow the material of the lift or the elevator to withstand heavier loads without deformation and failure. It would allow more loads to be carried and increase its safety monumentally. *Maintaining the Integrity of the Specifications*

B. Literature Survey 2:

In places of high reach or elevation, the equipment is required to transfer merchandise from either the bottom-most floor to the top-most floor or in-between floors as per requirement and necessity. A motor-powered and chain-driven synthesis of mechanism is employed to carry out the working of the lift or elevator. A cantilever type system of lift system (i.e. overhang beam system) is commissioned and utilized to operate lifting. This lift or elevator system can be used for light loads with minimum stress capacity for cargos or loads of less weight. [2]

Proposed Methodology 2:

The raw material which will be purchased in lot or bulk quantities from third party dealers that will be used in the manufacturing process of the lift or the elevator will be

checked for defects. This will ensure the premium quality of the equipment to be manufactured. Further, a sample piece (a specimen) from the raw material will be equipped and used to be performed various tests on it. This will ensure excellent resistance to stresses and increase the safety characteristics of the lift and the elevator.

C. Literature Survey 3:

For an elevator or a lift, the most prominent and important factor (or characteristic) is its' efficiency. Both mechanical efficiency and power (electric) efficiency are equally significant. Efficiency includes the parameter of mobility, or in the case of lifts and elevators, vertical mobility. The design of the equipment (i.e. the lift or the elevator) is also an important factor as it greatly increases the efficiency of the equipment by being of specific standard generalized and parts. [3]

Proposed Methodology 3:

The use of a Fixed Automatic or Automated Controller Unit (an ACU) will allow more flexible control of the lift or the elevator. It would drastically increase the functions of the lift or the elevator. It can also be used to control various technical parameters of the lift or the elevator; such as – the speed of the lift, the speed of the motor, the stopping of the lift, variations in load capacity, etc. This means that the lift or the elevator can be stopped at stories in between other stories or floors without the lift or the elevator directly going from the bottom-most floor or story to the top-most story or floor and vice-versa.

D. Literature Survey 4:

As a kind of industrial lifting weight, a goods lift or an elevator plays an important role in the industry. To meet the needs and requirements of the industry, the types of goods lift are ever-increasing. The basic parameters of the push upward lift in the market and the working device of the lift or the elevator has been introduced. And according to the calculation and checking, the main structural parameters of the lifting have been determined. [4]

Proposed Methodology 4:

The employment of multiple power systems and transmission systems allow the lift or the elevator to rely on other power systems rather than a single power system. The use of Chain Drives, Cable Drives and Hydraulic Power Systems allow the equipment working system to be operated in smoother transmissions and without any hindrance or obstruction of work. The process of Fool Proofing is also carried out to prevent the system from failing if anyone or, in the worst-case scenario, two power systems get damaged; so that at least one power system remains functional and operational continuing the work and supporting the lift or the elevator equipment system.

E. Literature Survey 5:

An industry or a workshop looks for and scrutinizes for essential transportation infrastructure in their premises or campuses to smoothen mobility and utilize it comfortably and feasibly. The smartly designed concept of the lift or the elevator allows it to be assembled and dismantled with great ease and minimal manual labour without the need of a special skilled operator However, the lift or the elevator may require higher expenditure on the maintenance of the lift or the elevator. [5]

Proposed Methodology 5:

The usage of an Automatic or Automated Controller Unit does not explicitly permit or allow the overloading of the lift or the elevator due to heavier loads suddenly impacting on its platform. The function works in the manner that if such a load is detected, the lift or the elevator does not start working (raising or lifting) at all and all operations of it are halted. This is done to avoid the failure of material due to overloading. The act of performing this process carried out careful and at the right time guarantees high safety considerations. This also makes sure that the lift or the elevator requires less maintenance. The operational efficiency and the mechanical efficiency of the lift or the elevator increases and stabilize.

III. DESIGN

Rough Hand-drawn drawings and drawings drawn on AUTOCAD were revised until the following drawings were finalised.

A. Project Drawings:

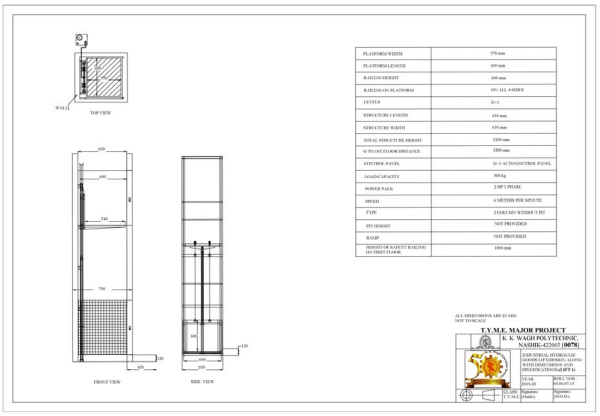


Fig (2) : AutoCAD Drawing for Small Lift

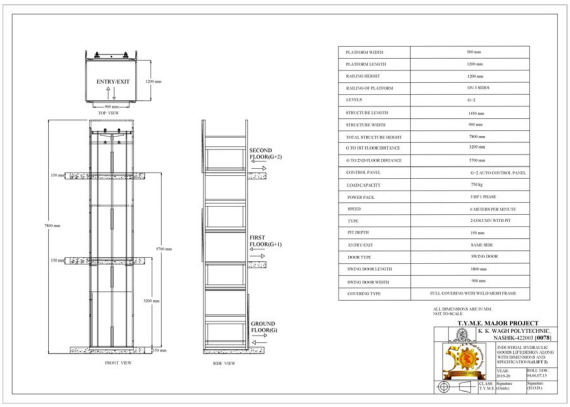
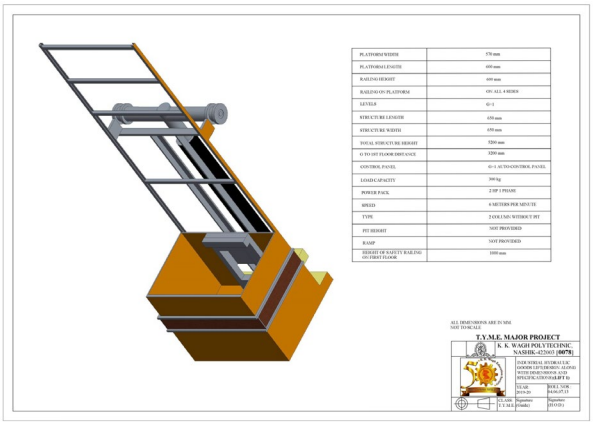


Fig (3) : AutoCAD Drawing for Big Lift



PLATFORM WIDTH	570 mm
PLATFORM LENGTH	650 mm
RAILING HEIGHT	600 mm
RAILING ON PLATFORM	ON ALL 4 SIDES
LEVELS	G+1
STRUCTURE LENGTH	650 mm
STRUCTURE WIDTH	650 mm
TOTAL STRUCTURE HEIGHT	3200 mm
G TO 1ST FLOOR DISTANCE	3200 mm
CONTROL PANEL	G+1 AUTO CONTROL PANEL
LOAD CAPACITY	300 kg
POWER PACK	2 HP 3 PHASE
SPEED	6 METERS PER MINUTE
TYPE	2 COLUMN WITHOUT PIT
PIT HEIGHT	NOT PROVIDED
RAMP	NOT PROVIDED
HEIGHT OF SAFETY RAILING ON FIRST FLOOR	1000 mm

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Fig (4) : Solid Modelling of Small Lift on PTC Creo

B. *Stress Analysis of Lift Components:*

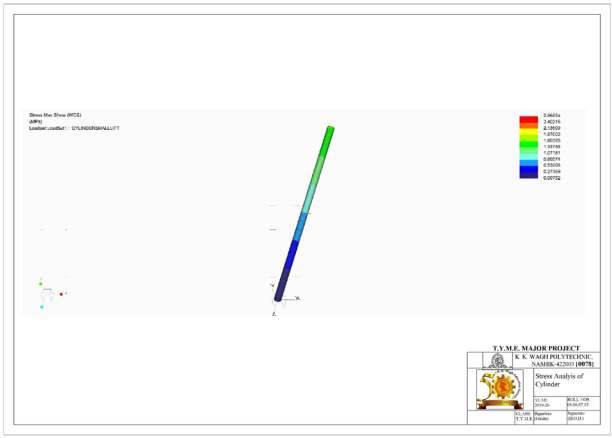

Fig (5) : Stress Analysis of Cylinder

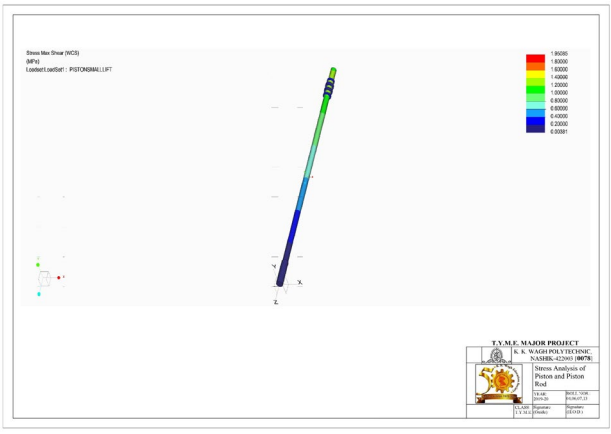

Fig (6) : Stress Analysis of of Piston & Piston Rod

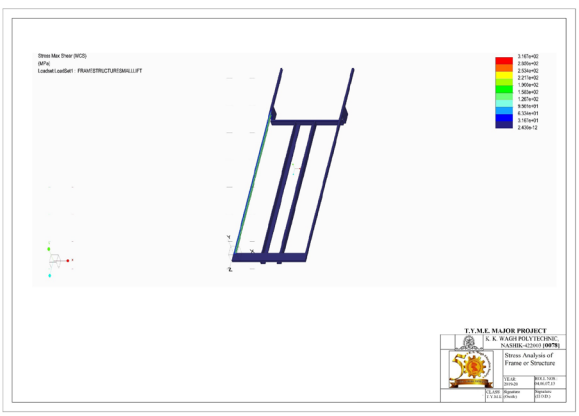

Fig (7) : Stress Analysis of Structural Frame

C. *Testing:*

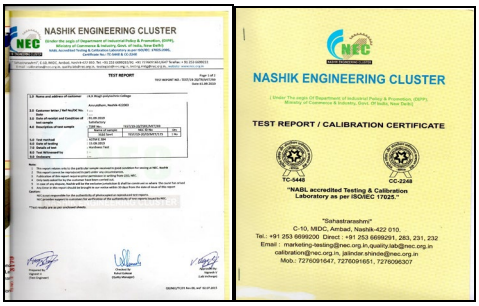

Fig (8) : Micro-hardness test of Material used

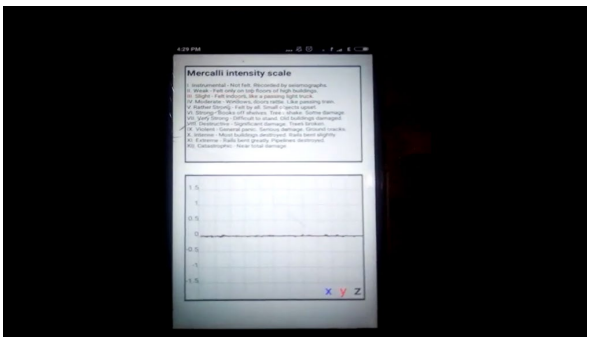

Fig (9) : Mercalli Intensity Test of Big Lift

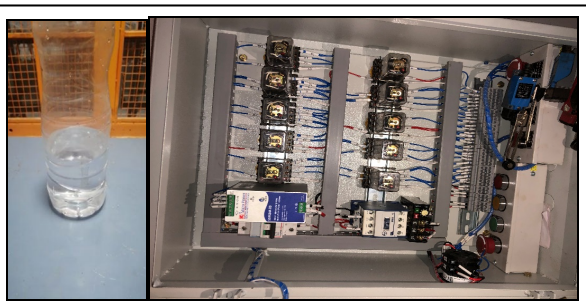

Fig (10) : Vibration and Control Panel Testing of Lifts

D. Working:

The concept of an elevator is incredibly simple -- it's just a compartment attached to a lifting system. Tie a piece of rope to a box, and you've got a basic elevator. Of course, modern passenger and freight elevators are a lot more elaborate than this. They need advanced mechanical systems to handle the substantial weight of the elevator car and its cargo. Additionally, they need control mechanisms so passengers can operate the elevator, and they need safety devices to keep everything running smoothly.

Hydraulic elevator systems lift a car using a hydraulic ram, a fluid-driven piston mounted inside a cylinder. The cylinder is connected to a fluid-pumping system (typically, hydraulic systems like this use oil, but other incompressible fluids would also work). The hydraulic system has three parts:

- A tank (the fluid reservoir)
- A pump, powered by an electric motor
- A valve between the cylinder and the reservoir

The pump forces fluid from the tank into a pipe leading to the cylinder. When the valve is opened, the pressurized fluid will take the path of least resistance and return to the fluid reservoir. But when the valve is closed, the pressurized fluid has nowhere to go except into the cylinder. As the fluid collects in the cylinder, it pushes the piston up, lifting the elevator car. When the car approaches the correct floor, the control system sends a signal to the electric motor to gradually shut off the pump. With the pump off, there is no more fluid flowing into the cylinder, but the fluid that is already in the cylinder cannot escape (it can't flow backwards through the pump, and the valve is still closed). The piston rests on the fluid, and the car stays where it is.

To lower the car, the elevator control system sends a signal to the valve. The valve is operated electrically by a basic solenoid switch (check out How Electromagnets Work for information on solenoids). When the solenoid opens the valve, the fluid that has collected in the cylinder can flow out into the fluid reservoir. The weight of the car and the cargo pushes down on the piston, which drives the fluid into the reservoir. The car gradually descends. To stop the car at a lower floor, the control system closes the valve again

RESULT

The final result of our Project established two (2) fully completed and functioning hydraulic lifts, both of which are perfectly capable of performing their respective applications – one which carries industrial heavy loads and the other passengers and minor loads. The industrial small lift carries a load of up to 300 KGs (Factory of Safety included) from the Basement Floor to the Ground Floor. The passenger lift carries people and minor loads carry a load up to 750 KGs (Factor of Safety included) from the Basement Floor to the Second Floor with the ability to halt in-between at the First Floor.

Both the lifts satisfy strict safety measures and are made of materials that are economically sourced and tested for defects with maintaining high-level quality standards.

Lifts provide great convenience to the people as compared to using stairs. Lifts are of greater use for carrying heavy loads in the form of the machine but due to excessive heavyweight, standard lift design is not very efficient for this purpose. Hydraulic lifts are greatly suitable for transporting heavy items. Hydraulic lifts are mainly used for loading heavier items. The following are their applications: -

- Passenger Elevators are designed to move people between different floors of a building, their capacity being related to available floor space. Passenger elevators may be specialized for the service they perform, including Hospital emergency (Code blue), front and rear entrances, double Decker, and other uses.
- Express elevators are designed to move people from the ground floor to a sky lobby skipping several floors in between at a high speed.
- Wheelchair, or platform lifts, a specialized type of elevator designed to move a wheelchair 6 ft (1.8 m) or less, often can accommodate just one person in a wheelchair at a time with a maximum load of 1000 lb. (455 kg).
- Freight Elevators are meant to carry heavy loads generally 2300 to 4500 kg. They usually don't comply with fire service requirements and carrying passengers is generally prohibited unless specified.
- On aircraft carriers, elevators carry aircraft between the flight deck and the hangar deck for operations or repairs. These elevators are designed for much greater capacity than any other elevator.
- A small freight elevator is often called a dumbwaiter, often used for the moving of small items such as dishes in a 2-story kitchen or books in a multi-story rack assembly. Passengers are never permitted on dumbwaiters.
- A special type of elevator is the paternoster, a constantly moving chain of boxes, generally used in industrial plants.
- Grain Elevators are used to elevate grain for storage in large vertical silos

CONCLUSION

The hydraulic Goods lift was simple in use. It can also lift heavier loads. Material handling and providing comfort to the operator was our main motivation behind developing this lift. With such design of Goods lift, the complexities in a design and fabrication time were reduced. But the limitation of this lift is the high initial cost.

The Project is a program that exposes students to the real working environment and experience. This helps students who will graduate to gain experience before they get to the real situation in the future where the students are

being exposed to many kinds of jobs or work with the time given. Through project execution, the student also can learn to communicate better and be polite when facing the worker and staff.

As urbanization drives the increased need for housing, the need for smart and efficient technologies to support growth will become a must. Because of this, there is an increasing demand for 'green' elevators that can reduce energy consumption by 75 per cent compared to conventional systems with non-regenerative drives. Existing elevators can be made more energy-efficient by adding Variable Frequency Drives (VF drive) in the door system and elevator control system. This helps to optimize energy consumption by better regulation of power.

In the Indian scenario, high-speed elevators are observing maximum demand owing to the boom in the construction of mid and high-rise buildings to avert the urban sprawl. Consumption of energy increases correspondingly with speed due to which manufacturers are constantly working towards developing newer elevators employing energy-saving regenerative drives that supply power back to the building.

To tap the lucrative Indian market, manufacturers must launch affordable elevator models to meet the demand of price-sensitive segments. To achieve this, companies must establish local manufacturing units to source raw materials and labour at competitive prices.

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