

Design and Finite Element Analysis of a Stair Case Material Handling System

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Abstract: *This topic deals with the fabrication and analysis of a stair case lift, which can be use as Material Handling System. A stair case lift is a mechanical device for lifting people and wheelchairs up and down on the stairs, who may find difficulty in doing so themselves. For sufficiently wide stairs, a rail is mounted to the treads of the stairs. A chair or lifting platform is attached to the rail. A person on the chair or platform is lifted as the chair or platform moves along the rail, old age and goods are to be carried across the stair case. Stair case lift is a type of lift that can be mounted on the stair case without altering civil structure. This lift runs on electric power and consists of a motor, reduction gear box, rope drive, two rails a sliding chair. In this system we use DC motor for changing the polarity of the power supply which will make the motor run in reverse direction connected with the earlier, while the later will form the entire assembly run to in downward direction, with the help of Toggle switches and push buttons. Advantages over the conventional hydraulic lift are no civil structure and alteration is required, low cost, less bulkiness, less power, less maintenance requires. Easy design, easy installations can be of industrial use too. Moreover, considering some drawbacks due to weight carrying capacity completely depend upon the capacity of motor. There is lot of scope for further modification in the project as using monorail instead of two, use of belt drive or chain drive instead of rope drive, Incorporation and automation/ timer unit which will ease the use of device. Rack and carrier arrangement for using the device for curved stair case and use of work & roller reduction gear assembly.*

Keywords: Stair case lift, Material Handling System, civil structure.

1. Introduction

An elevator or lift is vertical transport equipment that efficiently moves people or goods between floors (levels) of a building, or of other structure. Elevators are generally powered by electric motors that either drive traction cables or counterweight systems like a hoist or pump hydraulic fluid to raise a cylindrical piston like a jack. Because of wheelchair access laws, elevators are often a legal requirement in new multi-storey buildings, especially where wheelchair ramps would be impractical. A stairlift is a mechanical device for lifting people and wheelchairs up and down stairs. For sufficiently wide stairs, a rail is mounted to the treads of the stairs. A chair or lifting platform is attached to the rail. A person on the chair or platform is lifted as the chair or platform moves along the rail. Stairlifts are known variously as stair lifts, stair-lifts, chair lifts, stair gliders and by other names. This type of chair lift should not be confused with the chairlift used by skiers. As the name suggests stair case lift is a type of lift that can be mounted on the stock stair case without altering civil structure. This lift of course runs on electric power and consists of a motor two rails a sliding chair. This stair case lift can be mounted stock stair case where the civil structure is not be altered; and still handicapped old age and goods are to be carried across the stair case. These actual size stair case lift will be on could with at which can be assembly, and mounted and wheel as disassembled and mounted. Lifts are invented long back ago. But installation of lift involves ample amount of cost intensive of rails, motor honk, civil structures. If lifts to be installed in the stalk structure then it be alteration cost is too

much. To overcome all these factors and to civil construction cost the concept of stair case lift come with being which reduced extra costing associated with the lift mechanism, the benchmark of the system is that this concept is associated with simplifying as well. Some people argue that lifts began as simple rope or chain hoist. A lift is essentially platform that is either pulled or pushed up by a mechanical means. A modern day lift when consists of a cab (also called a "cage" or "car") mounted on a platform within an enclosed space called a shaft or sometimes a "hoistway". In the past, lift drive mechanisms were powered by steam and water hydraulic pistons or by hand. In a "traction" lift, cars are pulled up by means of rolling steel ropes over a deeply grooved pulley commonly called a sheave in the industry. The weight of the car is balanced by counterweight. Sometimes two lifts always move synchronously in opposite directions, and they are each other's counterweight. The friction between the ropes and the pulley furnishes the traction which gives this type of lift its name.

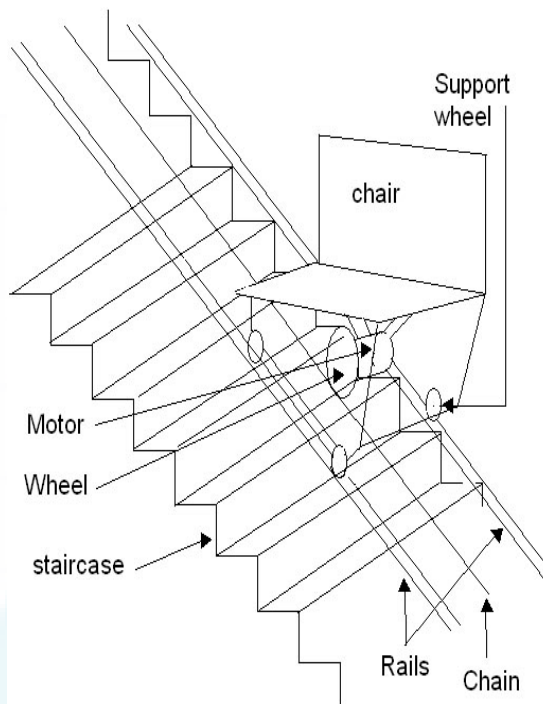


Figure 1: Stair Case Lift

Hydraulic lifts use the principles of hydraulics (in the sense of hydraulic power) to pressurize an above ground or in-ground piston to raise and lower the car. Roped hydraulics uses a combination of both ropes and hydraulic power to raise and lower cars. Recent innovations include permanent magnet motors, machine room-less rail mounted gearless machines, and microprocessor controls. The technology used in new installations depends on a variety of factors. Hydraulic lifts are cheaper, but installing cylinders greater than a certain length becomes impractical for very high lift hoist ways. For buildings of much over seven storeys, traction lifts must be employed instead. Hydraulic lifts are usually slower than traction lifts. Lifts are a candidate for mass customization. There are economies to be made from mass production of the components, but each building comes with its own requirements like different number of floors, dimensions of the well and usage patterns.

2. Fabrication and Working

In this project, the final design was an outcome of a sequential analysis and modification of stages. Stair lifts are easily installed into any situation where the condition of the stair tread is good as the railing that the chair lift uses is attached to the stair tread. A chair lift for stairs can be both battery operated and AC power operated. Stairs present a mobility challenge and often danger for the elderly who are struggling with mobility issues. Falling down stairs are a leading cause of serious injury among the elderly and purchasing a chair lift for stairs can significantly reduce concerns about falls. A chair lift will not only be a safer method for movement up and down stairs by those with mobility issues but they will also be securing an important degree of independence. The concept of stair case lift is meant for transportation of human, goods across stair case

hence it needs something like chair, platform using which human, goods can be transported, something on which these platforms, chair case run on like rails. Something with which the platform, chair can be made to run across rails such as pulling pushing mechanism, system which involves a motor, a gearbox, a pulley and a rope drive. The rails are two in numbers. These can be mounted on the stalk stair case with clamping with ease. Inside these 'C' cross sectioned rails slides are mounted which slide through the length of rails. These staircases and fixed to each other with the help of structural mechanisms support the motor and other components like gearbox, pulley, platform, chair, control panel. Now, on these staircase a motor is mounted which is an out scale down model in 2V DC 2400 rpm Mabuchi, Indonesian made motor, which is associated with the gearbox which uses 10 different event gears for reducing speed and inverting torque. On the output of the gearbox is mounted a guide pulley. This output shaft of the gearbox is also used to wheel and moved the rope with the help of which these stair case lift can move upward and downward. Other end of this rope is attached with the upper end of rail. Wherever supply is given to these motor its runs the gearbox which in-return starts winding the rope on its outer start wheels makes the apparent through of the gearbox shoulder resulting in pulling of the gearbox and the motor in the direction in which the rope has been fixed. As motor and gearbox along with the platform, chair are mounted on the suitable platform which can be slide on the rails the entire unit starts moving upwards then human / goods can be motivated very easily. Reversing the supply to the DC motor on changing the polarity of the power supply will make the motor run in reverse direction connected with the earlier, while the later will form the entire assembly run to in downward direction then by making the entire / single must be use for the future purposes.

The direction of the motor of stair case lift can be changed with the help of button mounted on the chair at self making the use of stair case lift very carry the power cables are protected with a cable carrier. Then project model makes of 6V DC power supply which is managed using a 220V AC adapter giving output of 6V DC, 1 amp and a battery backup in advance supplied that gives 6V DC, 4 Ah output. The project model is constructed out of MDF material that is first plated with various required designs and then cut to the drawing then flushing & before drilling operation is carried out. There parts are then assembled for the project model.



Figure 2: Model of stair case lift

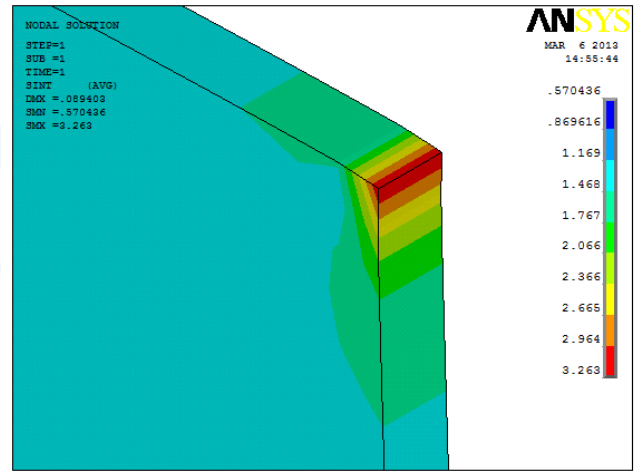


Figure 4: Stress in saddle for 5kg = 3.263 N/mm²

3. Result and Analysis

It was found that the saddle was moving well over the stair, for maximum load of 5 kg, on 2V DC, 500mA, 2400 rpm motor, which we used in this model. The chair was moving in speed of 24 rpm because of the use of reduction gear box for increasing torque. In this model we used MDF (Medium density fire core hard plywood) for making stair, and saddle. From ANSYS analysis it was found that for maximum load of 5 kg deformation is 0.0089403mm with maximum stress 3.263 N/mm².

We analysis the stress and deformation for aluminum rail with the help of ANSYS and it was found that for 5kg of load stress is 37.463 N/mm², and deformation is 0.179663mm.

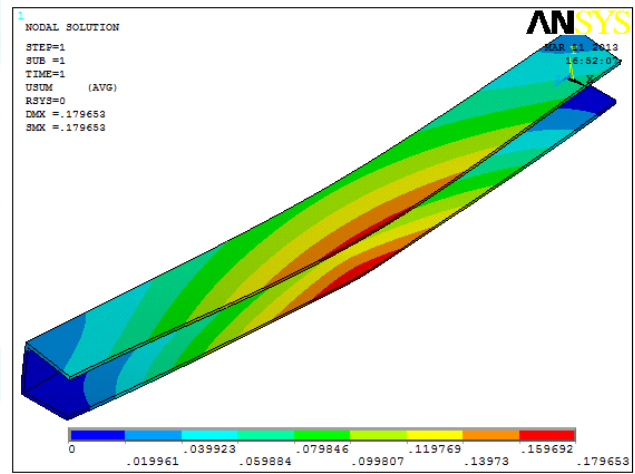


Figure 5: Deformation of rail for 5kg = 0.179663 mm

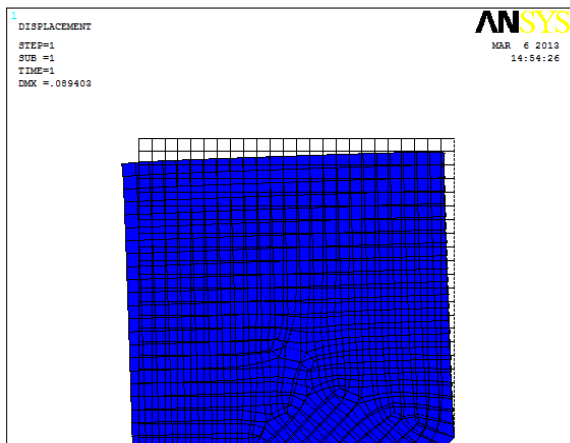


Figure 3: Stress in saddle for 5kg = 3.263 N/mm²

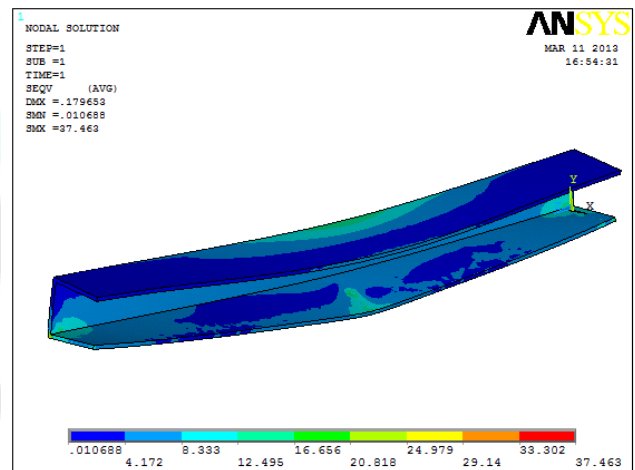


Figure 6: Stress in rail for 5kg = 37.67 N/mm²

4. Recommendations

With the distinguished advantages and the benefits associated there of the reasons to be being for stair case lift. In context to Indian the economical aspect of this system proves to be very promising and the typical Indian context

would always insist upon economy without compromising quality & multi utility. In this case no one has altered the civil structure for installation thereafter shortest cost for installation procedure as compared to that of lift. So future seems to be very bright. There is lot of scope for further modification in the project as follows.

Using monorail instead of two, Incorporation and automation / timer unit which will ease the use of device. Push button ON/OFF using timer circuit, a swivel seating arrangement, Seatbelt for future safety, Rack and carrier arrangement for using the device for curved stair case, use of work & roller reduction gear assembly, folding seat arrangement

5. Conclusion

Stair case lift can be adapted for its sheer use simplicity and economy. During the test run of this project, it was realized that it would be capable of carrying heavy load without suffering any deformation or local fractures if it would go into real world production at an ideal scale. Therefore it can be widely used for home as well as industrial which ensures a promising future to the concept.

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