DESIGNING AND ANALYSING STAIR CASE LIFT SYSTEM

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ABSTRACT

A stair case lift is a mechanical device used for lifting old aged and disabled persons up and down on stairs that have no elevators. A chair or lifting platform is attached to the rail. There is D.C. electrical motor connected to rack and pinion gear to transmit the load. The advantages of this case are easy installation, cheap and not needed maintenance or so large place. In this study we designed and analyzed this device (chair & rail together) and gear system by using the solidworks software program. We chose the maximum load 95 kg for our analysis.

Keywords: Analysis**,** Chair & rail, Gear box, D.C. motor, Rack and pinion gear.

INTRODUCTION

A stair case lift is a safe and secure method for human transportation which is a mechanical device for lifting people and wheelchairs up and down stairs. As we know the elevators had been made a lot of developments until it reached to the elevators that we see nowadays in the markets or other places. Sometime the elevator needs extra depth underground for installing and especially in the tall buildings that are consist of many storeys. The argument of people about lifts began with simple rope or chain. The development of industries and beam construction together is the main reason to improve the technology of elevators that we see nowadays. After the installation of the lifts the alteration will be very difficult so the cost will be too much. The lifts basically depend on mechanical means either pulling or pushing the platform.

In the old buildings that do not have elevators or consist of two floors must have a device for transportation as we mentioned before. So we made a research to fill this blank, because it is easy to install and cheap and not needed maintenance.

We will mount two rails to the stairs one of them for connecting the track gear and the other for supporting. The attachment of lifting platform or chair to the rail is done by using rack and pinion. The device is working by D.C. motor which gives motion to chair or platform by gears.

DESIGNING IN SOLIDWORK SOFTWARE

Now, in our research, the stair case motor is 12V D.C. 2400 r.p.m. that is connected to the gearbox which uses 10 different event gears for reducing speed and inverting torque. Shaft of the gearbox transports the rotation to the spur gear and hence all of them moving together upward or downward. The shaft gear box keyed with the spur gear and this spur gear mate with rack gear and thus the chair moves up and down. Stairs specifications are 450 cm length and 100 cm width and 300 cm height the inclination angle of the stair as a result is 33.7 degree.

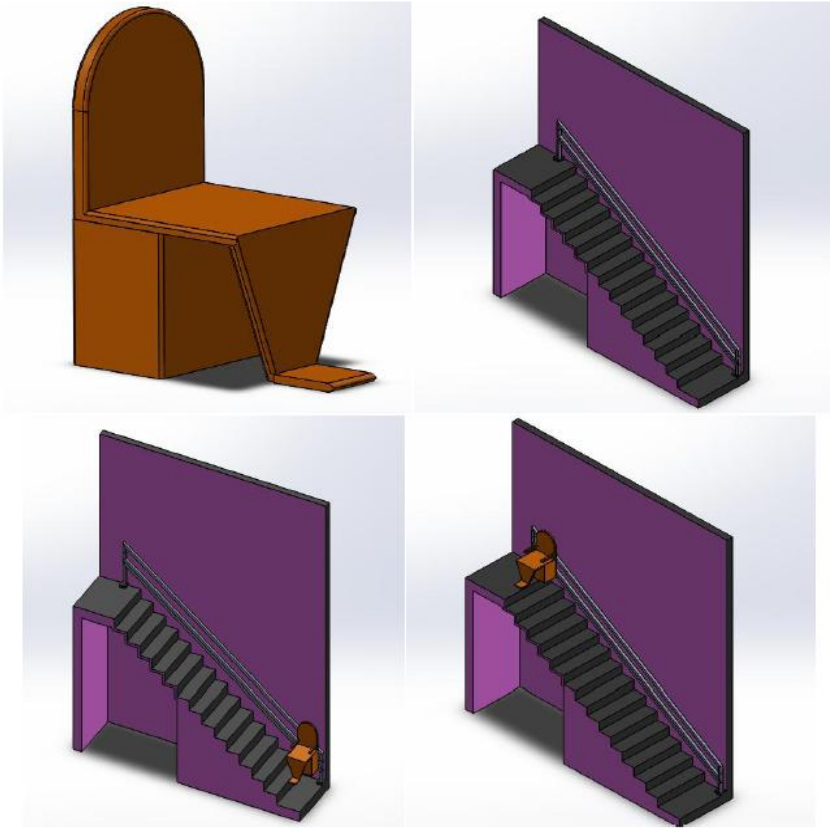

Fig. 1: Cad model of Stair Case Lift

RESULT & ANALYSIS

The movement of the chair was found well over the stair, for maximum load of 95 kg, on (12 V D.C., 3 hp, 2400 r.p.m.) motor the chair was moving in speed of 24 r.p.m. because of the use of reduction gear box for increasing torque. The chair of the body is made of aluminum and railroad made from Cast Alloy Steel. From Solidworks analysis it was found that for maximum load of 95 kg (person load 80 kg, and chair with equipment load 15 kg). Deformation is1.548e+002 mm with maximum stress 4.196e+007 N/m^2, maximum strain 6.767e-005 and factor of safety Min. FOS = 5.7.

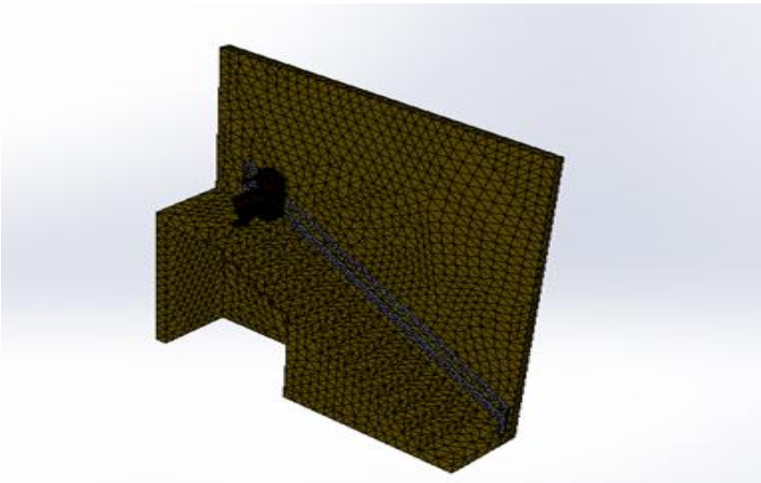

Fig. 2: Meshing of Stair Case Lift

GENERAL ANALYSIS FOR WEIGHT 95 kg.

- Analyzing of chair & rail together (Von Mises stress, Strain, Deformation and FOS).

a. Von Mises Stress

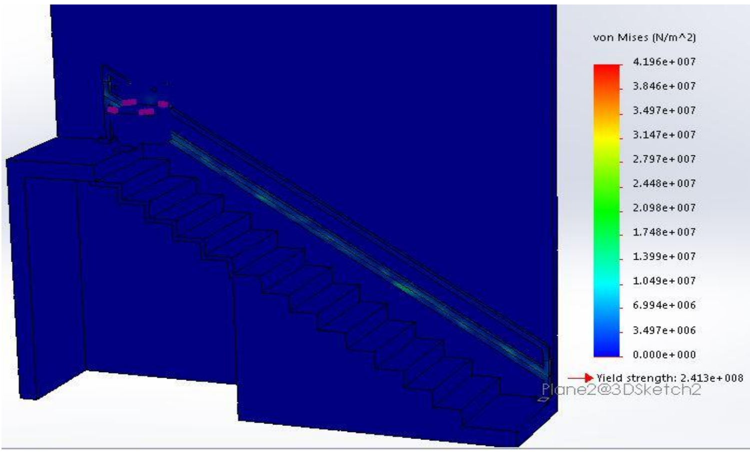

Fig. 3: Von Mises analysis of rail with chair (isometric view)

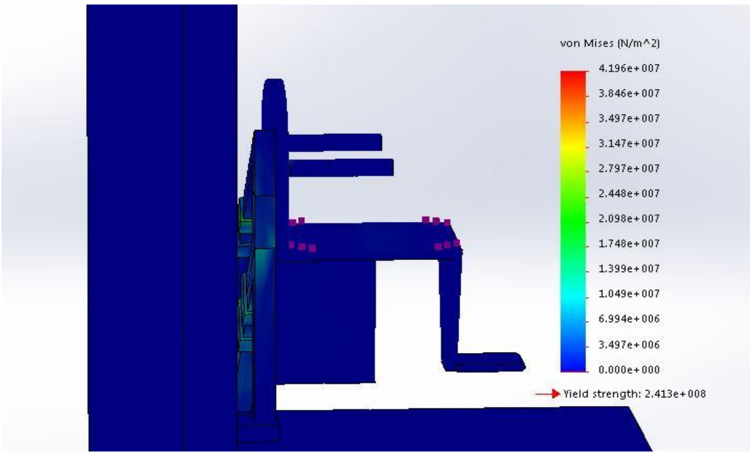

Fig. 4: Von Mises analysis of rail with chair (front view)

b. ESTRN

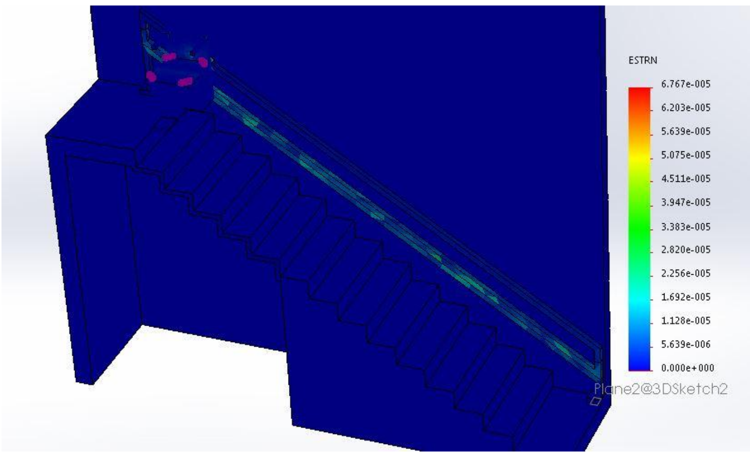

Fig. 5: Strain analysis of rail with chair (isometric view)

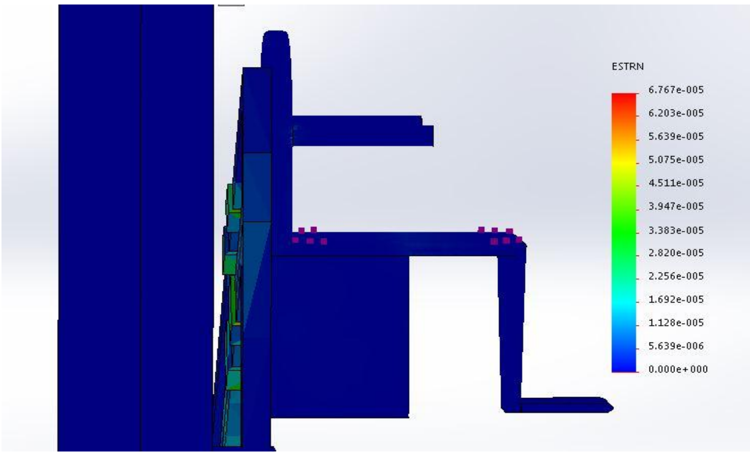

Fig. 6: Strain analysis of rail with chair (front view)

c. Deformation

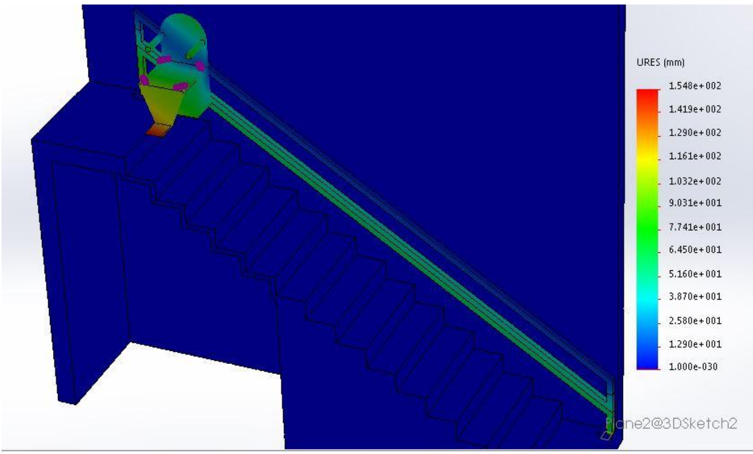

Fig. 7: Deformation analysis of rail with chair (isometric view)

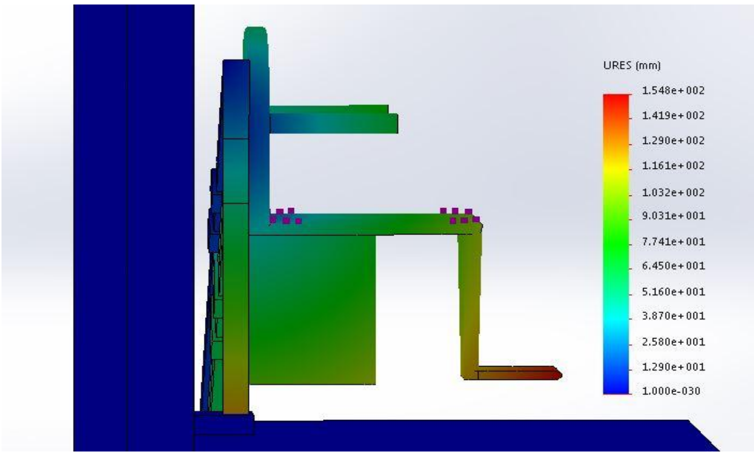

Fig. 8: Deformation analysis of rail with chair (front view)

d. Factor of safety - FOS (Min. 5.7)

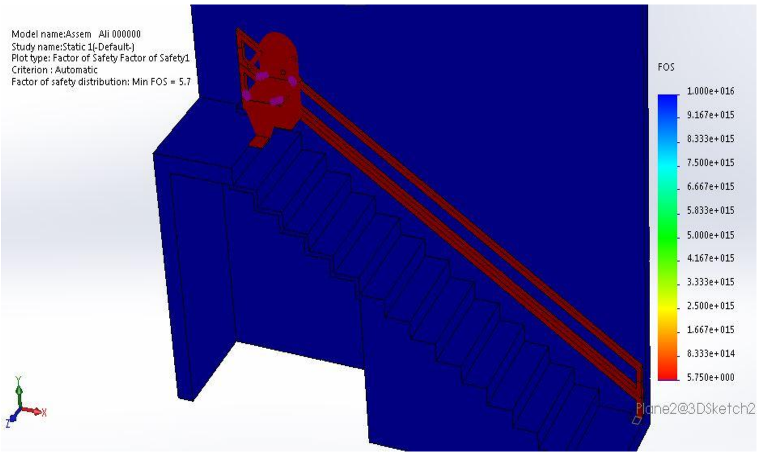

Fig. 9: FOS analysis of rail with chair (isometric view)

- Analyzing of rack and pinion gear together (Von Mises stress, Strain, and deformation).

Specifications of the Rack gear:
Module =1, Pressure angle = 20, Pitch Height = 10 mm, Face Width = 10 mm, Length = 5.4 m, material: Stainless Steel.

Specifications of the Spur gear:
Module =1, Pressure angle = 20, Pitch Height = 10 mm, Face Width = 10 mm, Nominal shaft Diameter = 10 mm, Number of Teeth = 25, material: Stainless Steel.

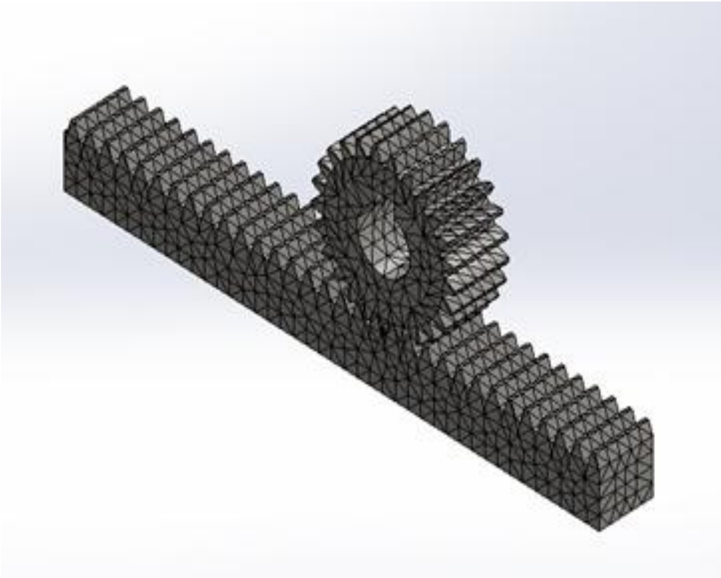

Fig.10: Meshing of Rack and pinion gear

a. Von Mises Stress (max. stress = 2.847+007N/m^2)

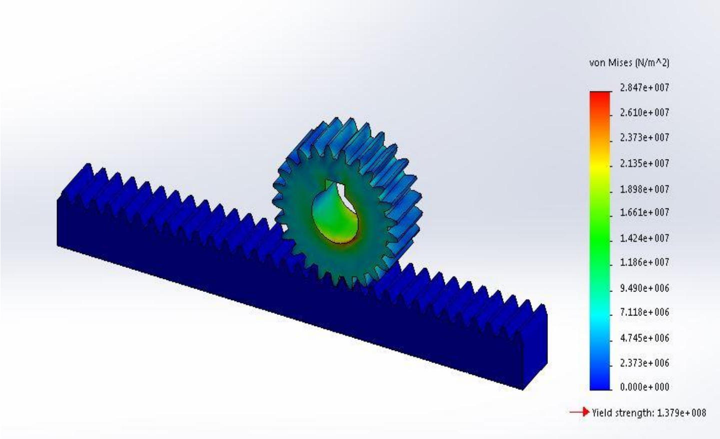

Fig.11:Von Mises Stress analysis of Rack and pinion gear

b. ESTRN (max. Strain = 1.006e-004)

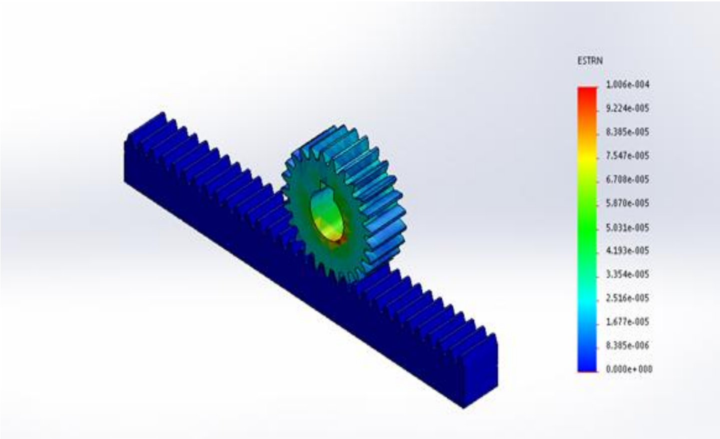

Fig.12: Strain analysis of Rack and pinion gear

c. Deformation (max. deformation = 9.005e-004)

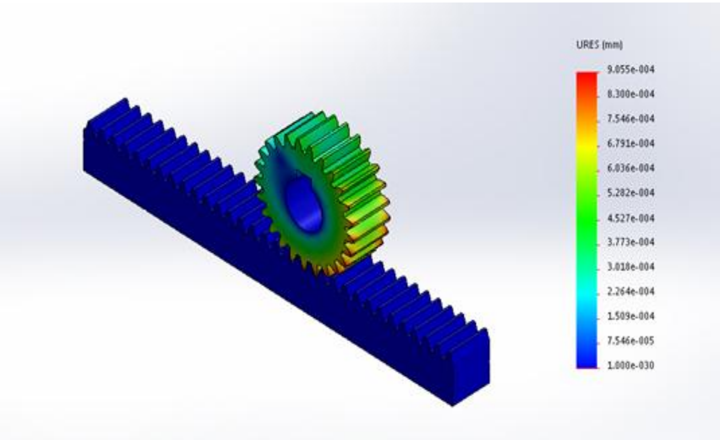

Fig.13: Deformation analysis of Rack and pinion gear

CONCLUSION

The analysis of device (chair and rail) is done by the solidworks software as shown above. These analyses show the von mises, strain, deformation and factor of safety (FOS) for maximum weight 95 kg. The deformation is 1.548e+002 mm with maximum von mises stress 4.196e+007 N/m^2. The rail section shape is square. Also we analyzed the rack and pinion gear. As we see from the analysis that our design by the given parameters above is in safety zones.

RECOMMENDATIONS

The designed rail section shape is square. In the future we can design other shapes according to the need, and if the section shape is circular, the stair case lift can move in circular path.

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