Treadmill Incline System

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Introduction

The project proposed by Life Fitness entailed building a lift system to be located between the rollers of a prototype treadmill to reduce the overall length of the treadmill. Having the reduced length would allow more treadmills to fit into a given area.

Motivation

Objectives:

1. Incline treadmill to 15% incline (rise/run)
2. Reduce the overall length of the treadmill
3. Fit lift system in pink area in figure 1.
4. Withstand the weight of a 90th percentile user (243 lbs) running and impacting treadmill at 3 g's (729 lbs) as well as the weight of the treadmill
5. Have a method to easily remove the lift system to decrease repair time

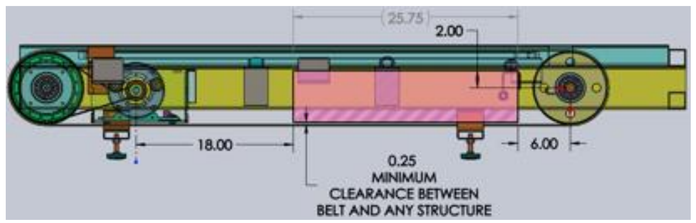
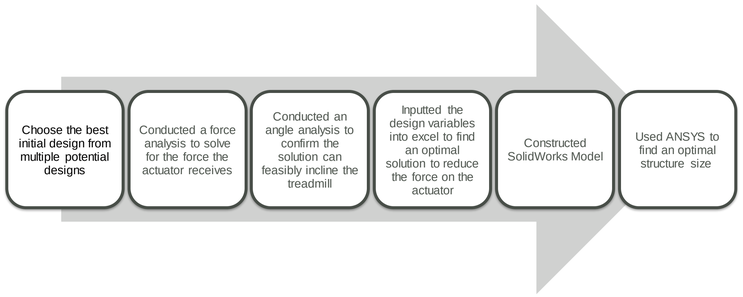


Figure 1: lift system allotted space in pink (Kanakaris, P)

Design Process



Final Solution

- Metal used was A500 steel tubes with thicknesses from 1/8 to 3/16 in.
- Easy disassembly by taking apart components 1-4 respectively in figure 2. Once the actuator and the bolts on beams 2, 3, 4a and 4b are removed, beams 2 and 3 can be taken out.
- Yellow members in figure 2. are welded to the treadmill frame.
- The yellow bars on beams 2 and 3 are made into the shape of a C to keep the lift system in place while allowing it to be easily disassembled.

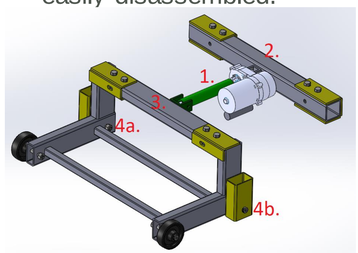


Figure 2: NIU Designed Lift System

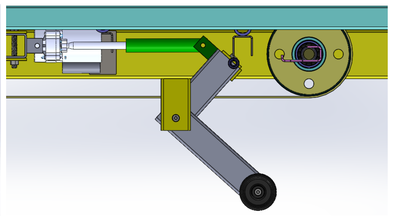


Figure 3: Treadmill at 15% incline

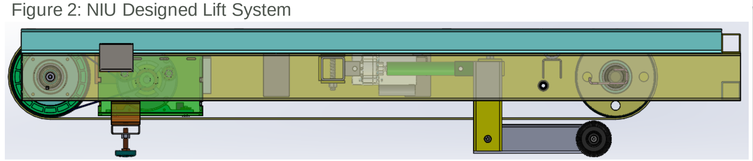


Figure 4: Lift System inside treadmill frame

Testing

Simulation tests the following data:

- Linear actuator load: S-beam load cell placed in position of linear actuator as shown in position 1 of figure 2.
- Vibration: accelerometers
- Output recorded in LabVIEW
- Actuator force used in ANSYS for finite element analysis of the lift frame

Figure 5: 500kg s-beam load cell used to record actuator load

Analysis

- Reduced force on actuator to 808 lbs. (actuator limit = 1300 lbs.)
- Max deformation of 3.14e-4 ft (.00377 in)
- Maximum Elastic strain of .00154 (ft/ft)
- Factor of Safety of 8.4

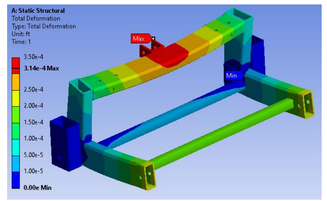


Figure 6: Total Deformation

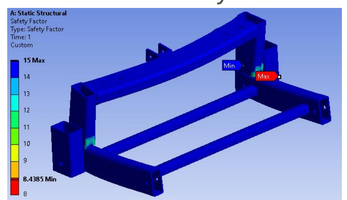


Figure 7: Factor of Safety

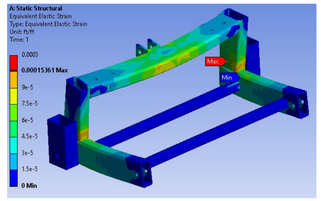


Figure 8: Elastic Strain

Conclusion

- Designed a system to allow the lift system to be easily removed for repairs and to be able to remove the treadmill belt. This involves removing a total of 10 bolts and pins to free the lift system from the treadmill frame.
- Reduced the max force on the actuator to 808 lbs.
- Kept a good factor of safety in order to maintain an acceptable design life
- Budget kept under 140$

Acknowledgements

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References

1. Kanakaris, P. (Oct 22, 2019). Life Fitness, Design Constraints