Iteration 0

1. Purpose

The goal of this document is to estimate values for the rate of acceleration and deceleration, maximum speed, distance between floors and loading time of a car.

2. Elevator Movement Analysis

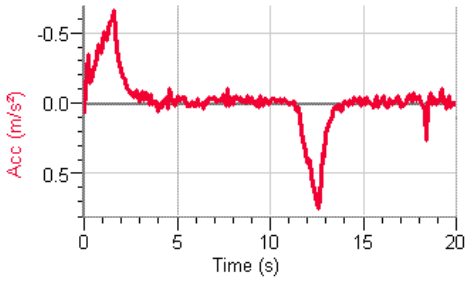

Figure 1: Acceleration-Time graph of an elevator[1]

The graph above dictates the acceleration of a high school elevator from one floor to another. The acceleration begins at the beginning of the elevators motion and goes to zero as it is reaching maximum velocity and then decelerates equally as quickly as it reaches the intended floor. The beginning and ending sections of this elevator are the acceleration and deceleration values of this elevator respectively.

3. Distance between floors

To estimate the distance between floors, add the height of the floors to the typical riser height for all the floors and that will give an estimate as to understand the distance between floors. If we are looking for the distance the elevator travels, we would add only 70% of the height for the top floor as the elevator does not reach all the way to the top of the top floor. Assuming the height of each floor is 10 feet (3.05 meters), a typical riser height is 7 inches (0.1778 meters), and the Canal building has 7 floors the height between floors is:

(3.05 * 7 + 0.1778 * 7)/7 = 3.23 meters per floor from top to bottom.

(3.05 * 6 + 0.1778 * 7 + 0.7 * 3.05)/7 = 3.09 meters per floor that the elevator travels.

4. Acceleration Rate

The only way to find reasonable acceleration data is if there were multiple time and displacement values given when the elevator was accelerating. As such it would also be difficult to gauge the maximum velocity as that would be determined after the elevator stopped accelerating the car.

As such we have done some research to gather information about the average acceleration of elevators and their max velocity can be determined using an estimation of how long the elevator would be accelerating for.

Looking at the industry standard for maximum acceleration sustainable for an elevator while still being comfortable for its passengers is 1.5m/s^2.[2] Assuming that the Canal building being a low-rise low

speed necessity elevator we will assume that the acceleration of the Canal building elevator is 60% of the maximum industry standard at 0.9m/s^2.

We also are assuming that the elevator will be accelerating and decelerating at the same speed.

5. Elevator Maximum Speed

To estimate the maximum speed at which the elevator operates we will be using the acceleration rate of 0.9m/s^2 as chosen above and the time under acceleration seen in figure 1 which is 3 seconds. The reason for taking the value shown in the figure from the high school elevator while having a higher average acceleration (the highest acceleration in the figure is 0.62) is due to the assumption that the Canal Building elevator was built having higher usage and performance requirements. Based on these values we can determine that the maximum speed of the Canal building elevator is approximately:

0.9 * 3 = 2.7m/s

6. Loading Time of Car

per-floor		
Laps	**Time**	**Cumulative Time**
1	0:06.2	0:06.2
2	0:06.5	0:12.8
3	0:09.7	0:22.5
4	0:08.5	0:31.0
5	0:10.6	0:41.6
6	0:07.7	0:49.2
7	0:10.7	1:00.0
8	0:12.7	1:12.7
9	0:10.2	1:22.9
10	0:08.4	1:31.3
11	0:11.0	1:42.3
12	0:13.2	1:55.5
13	0:08.2	2:03.7

Table 1: Per floor time and cumulative time

Based on the data collected on the per floor time of the elevator and the assumption that only the even numbers correspond to the time it takes to go from one floor to another while the odd numbers only indicate the time it takes to open and close the doors of the elevator, we can deduce that the loading time of the car is:

(6.2s + 9.7s + 10.6s + 10.7s + 10.2s + 11s + 8.2s)/7 = 9.5 seconds loading time on average.

7. Conclusion

Based on the data given there can be no reasonable estimates on any values other than the average loading times and distance between the floors. Most of the other values were determined by similar systems and industry standards.

References:

[1] O. Strachna et al, "Acceleration of an Elevator, Hydraulic?". The Physics Factbook. [Website]. Available: https://hypertextbook.com/facts/2005/elevator.shtml. [Accessed Feb. 5, 2022].

[2] J. Brown, "What is the average acceleration of an elevator?". The Knowledge Burrow. [Website]. Available: https://theknowledgeburrow.com/what-is-the-average-acceleration-of-an-elevator/. [Accessed Feb. 5, 2022].