An Electrical Elevator Projection, using MathCAD Software and Modeling Elevator Actualization.

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ABSTRACT

In this work we will handle the problem of electric elevator projection, based on specific demands. After giving a general view of the elevator as a mechanical device, we will develop its structure and stimulate elevators movement. The stimulation and the solution of the problem is made with the Mathcad software which is a great help in the mathematical solutions. In this work we will also handle the calculation of some of its mechanical parts.
Very important aspects of developing electrical elevators are its security and hazards and a great attention is given to calculation and the selection of breaking system. We will conclude by actualizing a model of an elevator in laboratory conditions.

INTRODUCTION

Constructing an elevator is our aim in this topic. Construction is made in theory and practice, even though in small scale. In this paper, while explaining the steps of construction we will analyze the weight that the elevator can carry upward and downward tested empty and in full load during its movements. Calculations are being made to make aware users for its danger and security measures to be taken. We are calculating speed power and the functioning of the elevator. We also give solution in case of power failure or fire. We will answer some questions such as: what is the capacity, speed, power, security and hazards of an elevator usage?
In this paper the main points to be discussed are:

a. Main principles of the elevator.
b. Projection of elevator projection using the Mathcad software.
c. Security and hazards
d. Executing a maket model.

a. With elevator we understand a mechanism or machine which moves, installed in specific area which has a possibility movement in a vertical direction. All elevators move under the 90 degrees angle horizontally.

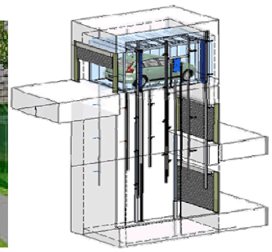
Elevator serves for transportation of goods and people in a vertical direction using a cab which moves into the guiding tracks.

Classification

There are many different elevators which are classified based on what they transport.

- Elevator for transporting people
- Elevator for transporting cars
- Elevators for transporting cars and people.



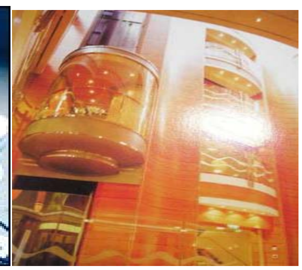


Elevator for people Elevator for goods and people

b. Classification based on construction

- Electic elevator
- Hydraulic Elevator
- Panoramic Elevator





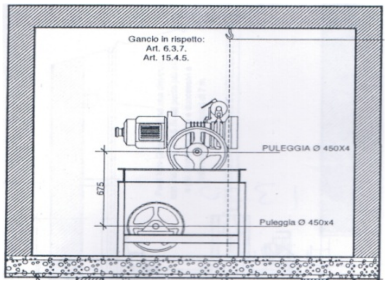
Electic elevator Hydraulic Elevator Panoramic Elevator

Components of power system:

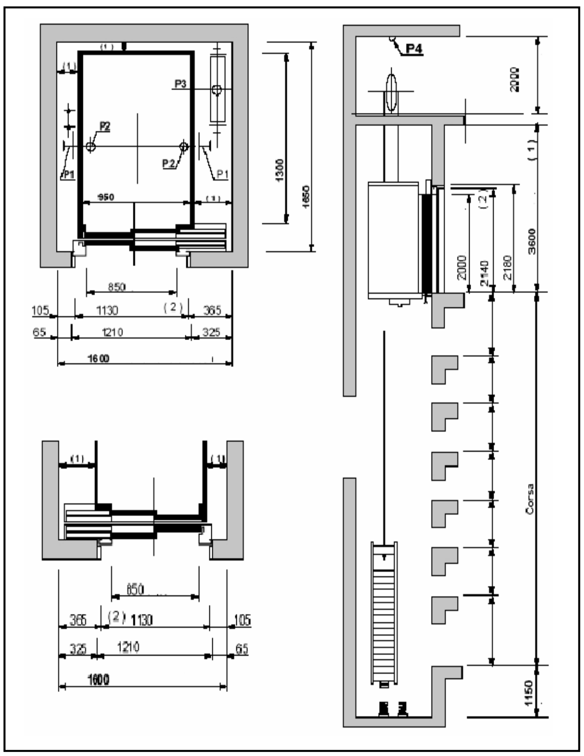
- Electric motor
- Active pulley and adaptor

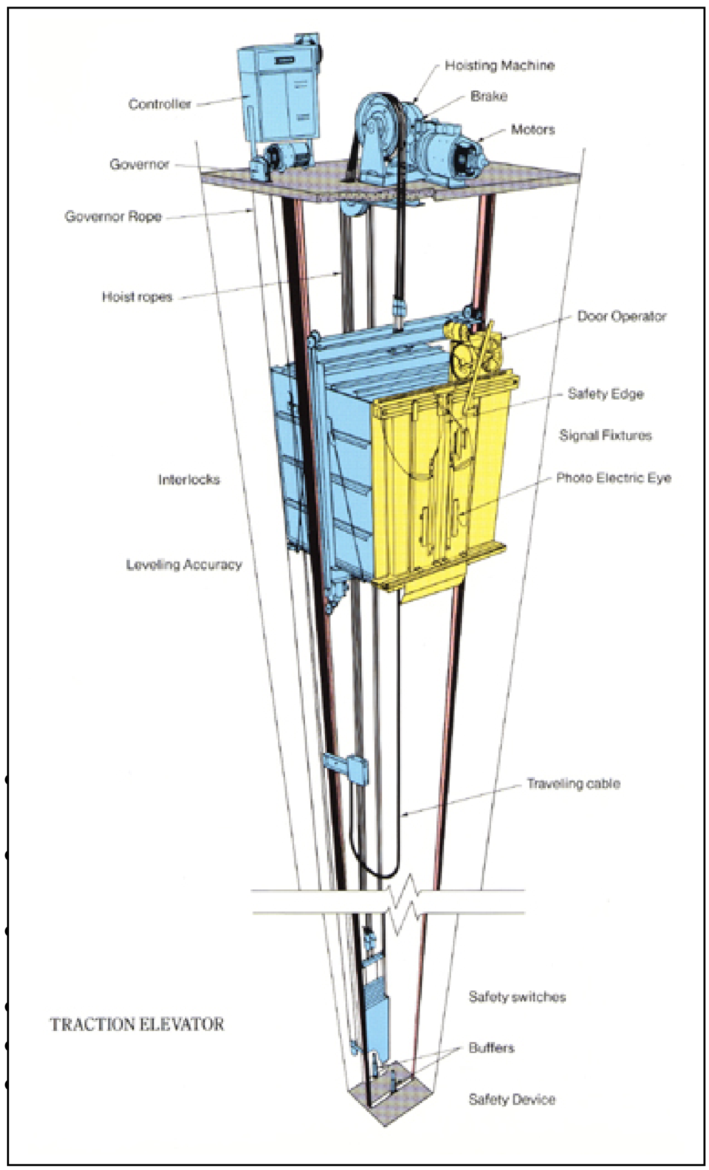
- Closed breaking system is located in the highest speed shaft.

Power system is located in the lower point of movement lane of the elevator usualy in the upper point.



Elevator Projection





<u>Technical Characteristics</u>

Capacity – 450/75=6 people
Speed - v=0.63 m/s
Lane-H=25m
Power =2.2 kW

Problem Solution:

Defining the counterweight
Counterweight measure is calculated: with empty measure sum with the half of the transportable measure.

$$m_{kp} := m_b + 0.5m_t = 675 \ \ kg$$

Selection of ropes

Selection of ropes is important for well functioning of system. For security reasons the joint between elevator and the counterweight in general is conducted with many ropes or at list two ropes put in parallel. Formula to which we refer is an empirical formula taking in consideration the fact that the micro- skates among rope and pulley leads to consumption of filaments of the ropes and the canal of pulley which increases with contact during the work.
For the above reasons we define that the pressure of contact P between rope and canal to be:

$$P = \frac{T}{n \cdot d \cdot D} \cdot \frac{5}{\operatorname{Sin}\left(\frac{\gamma}{2}\right)} \le \frac{12.56 + 3.92 \cdot v}{1 + v}$$

- We have three alternatives which satisfies (3) selected from standards

  UNI EN 12385-5

3 rope with diameter $d_1 := 6\,mm \quad m_1 := 12.9 \frac{kg}{100m}$

3 rope with diameter $d_2 := 6.5\,mm \quad m_2 := 15.2 \frac{kg}{100m}$

2 rope with diameter $d_3 := 8\,mm \quad m_3 := 23.0 \frac{kg}{100m}$

In all three causes the pressure is smaller than the maximal:

$$p_{max} = 7.61027 \ \ MPa$$

All the solutions are acceptable so the ropes consumption is prevented. Ropes must satisfy the security conditions, so we must make further security controls.

<u>Further Control</u>

The UNI EN 12385-5 norm prospect 6 ,we can choose the rate of resistance of the ropes as result we chose the download relative weights Tr in N taking as an example ropes with rate twice of the resistance as it is shown in the norm 1370/1770 which represents the report between the resistance to transmit in MPa to outside filaments and inner filaments of the steel we have:

We should define the security coefficients of the hanging robes which are defined of the norm UNI EN 81-1. In order to value this coefficient there exist e simple equation which is:

$$S_f = 10^{\,2.6834 - \dfrac{\log\left[\dfrac{695.85\cdot 10^{6}\cdot N_{ek}}{\left(\frac{D}{d}\right)^{8.5678}}\right]}{\log\left[77.09\cdot\left(\frac{D}{d}\right)^{-2.894}\right]}}$$

D = Diameter of engine pulley (mm)
d=diameter of rubes (mm)
Nek=nr equivalent of the pulley

The accepted minimum coefficient of security is: = which takes in to consideration the bend over effects.
So we can accept as a solution and a pulley with clutch diameter $D = 400$ mm

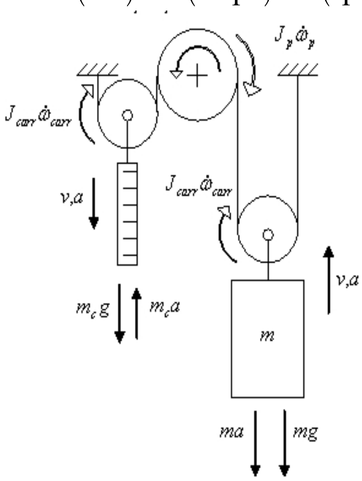
- Functioning conditions of power in to working environment.

Looking again the engine in which we are working, we deliver by graphic the characteristic curve of specific asicrone engine.

Functioning conditions

To define in specific way the natural direction of the power in the straight line and then in return, as we did in the conditions of movement within the working cycle and taking in consideration where in the power calculation, it will appear the power surrounded by powers and moments of inertia.

$$P_i = -(m\cdot a)\,v - (m_{kp}\cdot a)\,v - (J_p\cdot\dot{\omega}_{p.})\cdot\omega_p - 2\cdot(J_{karr}\cdot\dot{\omega}_{karr})\cdot\omega_{kar}$$



$$a = \frac{dv}{dt} = \frac{d\left(\frac{\omega_p\cdot D}{4}\right)}{dt} = \frac{\dot{\omega}_{p.}\cdot D}{4} \quad (65)$$

$$P_u = \left[\left(m + m_{kp}\right)\cdot\frac{D}{4}\cdot g_1 + \left[J_p + 2\cdot J_{karr}\cdot\left(\frac{D}{2\cdot D_k}\right)^2 + \left(m + m_{kp}\right)\cdot\frac{D^2}{16}\right]\cdot\dot{\omega}_{p.}\right]\cdot\omega_p$$

We analyze the functioning conditions

1. *With full load in upward movement.*

$m = m_b + m_t$

In this case based in conversion (v>0,ωp>0) all kinds of speed are positive as result and the direct power flow is positive.

$$\omega_{p.} > -\frac{\left(m_b + m_t + m_{kp}\right)\cdot\left(\frac{D}{4}\cdot g_1\right)}{J_p + 2\cdot J_{karr}\cdot\left(\frac{D}{2\cdot D_k}\right)^2 + \left(m_b + m_{kp}\right)\cdot\frac{D^2}{16}}$$

2. Empty upward

The same constants are valid which we did for the upward loaded elevator with the only difference is that the amount is the same with the amount which is being transported

$m := m_t$.

Power flow movement is:

Engine moment and the angle speed within the working environment.

Up to now we have considered the transition of power from transmission in to the load, now on we will take in to consideration that power will move from engine in to the load, taking in to consideration the presence of the reducer. We mark with Mm, r the engine moment within the working cycle; we can apply the theorem of the power within the system.

$$P_m + P_r + P_p = \frac{dE_c}{dt} \text{ku} :$$

P_m - power of the engine

P_r - power of resistance

P_p - lost power within the reducer and within the pulley of klatch.

E_c - kinetic energy of the system

$$P_m := M_m\cdot\omega_m$$

$$P_r = m\cdot g_1\cdot\nu + m_{kp}\cdot\left(g_1\cdot\nu\right)$$

$$P_{p2} := -\left(\frac{1-\eta_{karr}}{\eta_{karr}}\right)\cdot m\cdot g_1\cdot\nu - \left(1-\eta_{karr}\right)\cdot m_{kp}\cdot g_1\cdot\nu$$

$$\omega_{p.} > -\frac{\left(m_b - m_{kp}\right)\cdot\left(\frac{D}{4}\cdot g_1\right)}{J_p + 2\cdot J_{karr}\cdot\left(\frac{D}{2\cdot D_k}\right)^2 + \left(m_b + m_{kp}\right)\cdot\frac{D^2}{16}}$$

3.*With full load downward*

In this case based on indicator of figure 11(v<0) speed is negative so to gain positive speed must have: $m = m_b + m_t$

$$\omega_{p.} < -\frac{\left(m_b + m_t + m_{kp}\right)\cdot\left(\frac{D}{4}\cdot g_1\right)}{J_p + 2\cdot J_{karr}\cdot\left(\frac{D}{2\cdot D_k}\right)^2 + \left(m_b + m_{kp}\right)\cdot\frac{D^2}{16}}$$

4. Empty downward

The same constants are valid that we did in full load downward process with the only difference where amount is equal to transportable amount. Condition of power flow in during the process of must be: movement: $m_{..} := m_b$

$$\omega_{p.} < -\frac{\left(m_b - m_{kp}\right)\cdot\left(\frac{D}{4}\cdot g_1\right)}{J_p + 2\cdot J_{karr}\cdot\left(\frac{D}{2\cdot D_k}\right)^2 + \left(m_b + m_{kp}\right)\cdot\frac{D^2}{16}}$$

Conditions of power flow in straightway direction are the same as those of power flow movement in return and vice versa.

Hazards and Security

Possible hazards:

- Fire
- Mechanical defects
- Electrical defects
- Corrosion

Security

•Elevators are projected, constructed and installed in a way that the immoral start is being prevented in case of overload.
•Elevators are provided with an over speed regulator.
•High speed elevators are provided with and equipment which monitors and reduces the speed depending on circumstances.
In other security measures we think for the well-functioning of the elevator in case of power failure and fire. In case of power failure the elevator stops wherever it is found. It can stop between two floors where residents can be trapped. In this case we provide elevator with a battery which turns on automatically when main power goes off and sends elevator in ground floor and opens its door.
In case of fire, the elevator is provided with alarm systems. In case of fire within the elevator the doors open to the nearest floor and open. Provided with sensors, it will not stop in the areas where the fire is present. Systems may be automatic which in case of fire operates as it is programmed and manual when a user can press a button to put on alarm and get out where he considers safe. Fire Alarm systems can be programmed that when fire happen within the elevator it will not open, preventing entering of residents in an elevator which is burning.

Parachute

In practice, in case of breaking down as an element of security, we activate the so called parachute. Its role is to block the cabin with the supporting pillars, when the speed downward reaches over 20% of the speed we have projected.

Executing a model of an elevator
In fact we have projected a real one and we have executed it in a scale 1 : 10. Calculation of weight and counterweight is: m.kp=m.b+1/2 m.t

Power of the system is composed of:
-Electrical engine

-Active pulley

- Deviation pulley

Power system is located at lower point of the lane where the elevator moves.

We have operated using an electrical engine with the 12 volt capacity, which have resulted appropriate during the tests we have made.

CONCLUSION

Executing an elevator is closely related to calculation of weight, power, security, and hazards. Weight which an elevator can carry is calculated based on its power for transportation. Security of elevator is provided by choosing the building material. The better the material, the greater is the security we have. Also weight calculation which elevator can transport is an important overweight lead to hazards. Also system alarms in case of power and power failure is important to avoid the hazards. Security is the main feature of the elevator functionality

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