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A Review Paper on New Safety System in Elevator

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Abstract: *Elevator-related accidents are uncommon, but can cause significant injury. However, little data exist on these types of accidents. To compile and analyze accident data involving elevators in an effort to eliminate or at least significantly reduce such accidents. Despite their well-regarded safety record, elevators are not without the potential for danger of injury or death. Persons at-risk for elevator-related death include maintenance and construction workers, other employees, and those all who use them. Organizations such as the American Society of Mechanical Engineers (ASME) have set standards for the construction and maintenance of elevators and escalators and for their safe operation. Thus, there are study needed to reduce such accidents and more over to study deeply causes of accidents in elevators either major or minors. In this paper we are going to see how different safety systems are working till this day; And also, information about our new safety system which help to reduce the impact of elevator cabinet and damage to human trapped in elevator.*

Keywords: Elevator, Accidents, Maintenance, Impact, ASME, New safety Sys. , Design and Fabrication

I. INTRODUCTION

A Elevator or lift is a type of vertical transportation device that moves people or goods between floors (level, decks) of a building, vessel, or other structure. Elevators are typically powered by electric motors that drive traction cables and counterweight systems like a hoist, although some pump hydraulic fluid to raise a cylindrical piston like a jack. There are two types of elevators that are used in common passenger travel. These include hydraulic elevators and cable elevators.

Hydraulic elevators are not commonly seen in buildings more than a few stories toll due to the need to position the mechanics farther underground for each story the elevator will need to be raised. A non-compressible fluid is pump into a cylinder to raise a piston, and thus raise the elevator cabin [2].

These elevators are more expensive in their energy use. They also have less safety equipment than cable elevators. Cable elevators are the much more common type of elevator in all over the world. All of the machinery is in a machine room at the top of the elevator shaft. The elevator is attached by cable to a sheave in the machine room. The sheave, which is similar to a pulley, is turned by an electric motor to raise or lower the elevator. A counter weight is attached to cable opposite the side of the elevator car. The counterweight is equal to the elevator's weight at 40% load. This allows the elevator to be moved using very little energy, because the counterweight keeps the weight at the tipping point [4].

A common misconception is that elevator deaths occur from an elevator falling. However, in reality, improper maintenance can cause the counterweight to drop and launch the elevator cabinet upwards. Improper maintenance can lead to a number of other injuries. All cable elevators include a governor that controls the maximum speed of the descent. However, it is possible for the governor to fail due to improper maintenance. Additionally, they must include a level of shock absorption at the bottom of the elevator shaft. All this we had seen is all about elevator, its construction, working and its type. But we will also discuss what type of accidents caused by free falling elevator cabinet. What type of safety systems we are using today and finally we will see our new safety system. We will see how it actually works, and why it is better than existing Techniques. This is Retrospective study. This is a retrospective study and the data were obtained from TSFO. This organization has the most reliable source of elevator-related accident data because it is solely and officially responsible for civilian rescue missions. [12]

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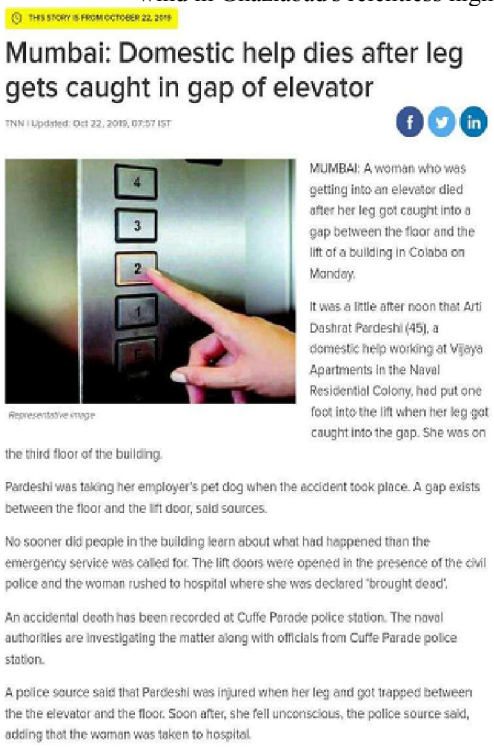
TSFO received reports for last 4 years of 1,819 accidents involving elevators in Tehran that involved 3661 people. The sample comprised of 2,254 (61.5%) males and 1,409 (38.5%) females and males outnumbered females in all age groups, with the male to female ratio of 1.6 to 1. (Fig.3). Also, nearly 57% of the people involved in an elevator accident were less than 30 years old. The main cause of elevator accidents was due to technical problems with 1311 reported accidents (72.1%), followed by power loss with 209 (11.5%) and overcapacity riding of passengers with 144 (7.9%) [12].

News Articles

Man dies after falling through lift shaft

Software engineer Sajan S died after falling through lift shaft, it is a reflection of how safety laws have been cast to the wind in Ghaziabad's relentless high-rise boom, reports Peeyush Khandelwal. [17]



THIS STORY IS FROM OCTOBER 22, 2019

Mumbai: Domestic help dies after leg gets caught in gap of elevator

TNN | Updated: Oct 22, 2019, 07:57 IST

Representative image

MUMBAI: A woman who was getting into an elevator died after her leg got caught into a gap between the floor and the lift of a building in Colaba on Monday.

It was a little after noon that Arti Dashrat Pardeshi (45), a domestic help working at Vijaya Apartments in the Naval Residential Colony, had put one foot into the lift when her leg got caught into the gap. She was on the third floor of the building.

Pardeshi was taking her employer's pet dog when the accident took place. A gap exists between the floor and the lift door, said sources.

No sooner did people in the building learn about what had happened than the emergency service was called for. The lift doors were opened in the presence of the civil police and the woman rushed to hospital where she was declared 'brought dead'.

An accidental death has been recorded at Cuffe Parade police station. The naval authorities are investigating the matter along with officials from Cuffe Parade police station.

A police source said that Pardeshi was injured when her leg and got trapped between the the elevator and the floor. Soon after, she fell unconscious, the police source said, adding that the woman was taken to hospital.

Ref. [15]

THIS STORY IS FROM FEBRUARY 6, 2020

Mumbai: Man dies after being crushed by lift in Mulund housing complex

Ahmed Ali | TNN | Updated: Feb 6, 2020, 17:05 IST

Ad

Claim settlement in 4* hours, over 4300 Cashless Garages

IFFCO TOKIO

Sanjay Yadav, the 40-year-old liftman was repairing lift on the 3rd floor of a housing complex when it came cr... Read More

MUMBAI: In a freak accident, a 40-year-old liftman who was repairing lift on the third floor of a housing complex died after the lift accidentally started crushing him to the side wall in Mulund East in Mumbai on Thursday afternoon.

The victim Sanjay Yadav, a resident of Vasai working as technician with Omega Lifts, died on the spot, said Navghar police. According to the police, the incident took place at around 11.40pm when the liftman Yadav was carrying out repair work.

The residents of the New PMGP Society in Mulund East had complained that the lift in I wing was not functioning properly. "The lift was automatically stopping on 7th and 15th floor, because of the shoddy work done by the builder. Our two society members had explained the problem to the liftman. He opened the lift and was doing some repair work when suddenly someone from the 13th floor pressed the lift button and the lift started crushing him," said Deepak Bobhate, a resident. Immediately, they alerted the fire brigade and Navghar police.

Ref. [16]

II. Problem Statement

Design and fabrication of new safety system in residential elevator which would reduce the impact of elevator cabin after accident to save the human life.

2.1 Objective

- To Study which are key factor for elevator accidents.
- To design and fabricate a Safety feature to reduce the impact of elevator cabinet and damage to human trapped in elevator.

2.2 Causes of Accident

From above Review we can list the causes of Accident in Residential Elevators. Causes of accidents can be point out as following:

a. Various Defects in Construction.

b. Mechanical breakdown that causes the elevator to drop rapidly within the shaft.

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c. Overcapacity riding Problem.
d. Fall due to some Technical problem which leads to failure to passengers from entering/ leaving.
e. Faulty wiring, elevator control malfunction, or a risk of electrocution.
f. Power Loss.
g. Inspections done by Non-experienced worker.
h. Unbalanced leveling and failure of elevator lining up with floor.
i. Wiring malfunction or entrapment due to the heat from fire.
j. Miss-Behavior with Technical systems.
k. Other.

2.3 Figures and Tables

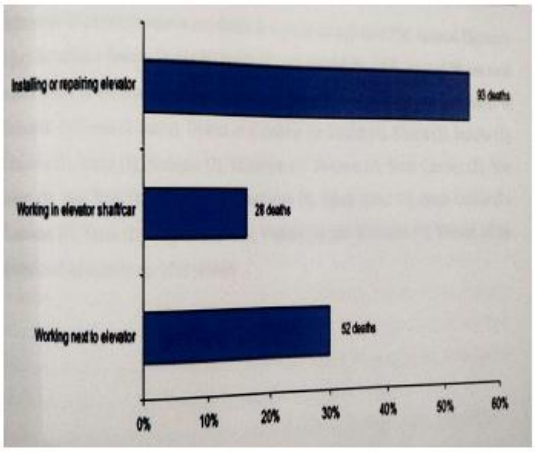

Figure 1: Deaths related to work on or near elevators by activity. [5]

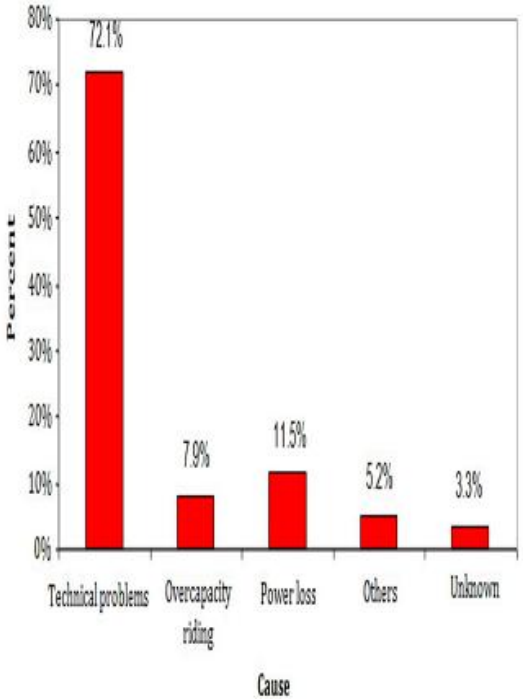

Figure 2: The causes of elevator-related accidents [6]

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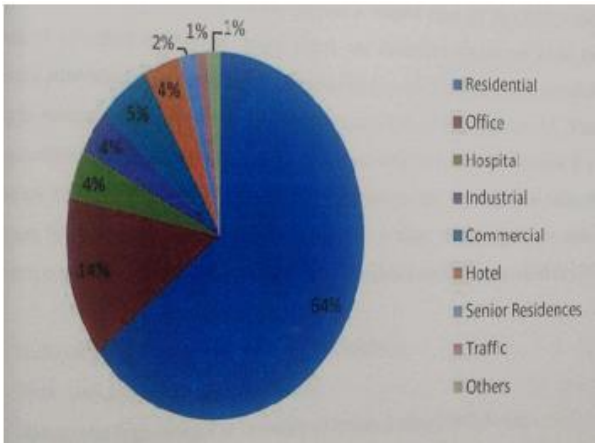

Figure 3: lift distribution according to buildings [1]

Deaths	Date	Place
200-400 (estimate)	2001-09-11	New York City, New York, U
104	1995-05-10	Orkney, South Africa
52	1987-08-31	Welkom, South Africa
19	2012-09-13	Wuhan, China
19	1932-10-10	Leigh, England
18	1973-07-30	Chesterfield, England
12	2008-10-30	Xiapu County, China
12	1993-06-02	North Point, Hong Kong
11	2019-04-25	Hengshui, China
11	2011-07-29	Makiivka, Ukraine
10	1964-03-27	Heeßen, Germany
10	2014-09-06	Istanbul, Turkey
9	2011-08-09	Salvador de Bahia, Brazil
8-10	1904-01-13	St. Louis, Missouri, U.S.
8	2016-07-15	Longkou, China

Table 1: Major Elevators Accident in World [11]

III. Existing Safety Systems for Residential Elevator

A. Using Multiple Cables

Elevator ropes are highly engineered and made of steel with other composites. Also they are not single wires but several strands of various sizes wrapped together. A typical cable or rope can have over 150 strands of wire precisely designed to be strong, flexible, and give long service. Multiple wire strands are used to increase the life of the cable and give flexibility. When you run a cable over a pulley wheel or sheave, the part of the wire on the sheave makes a shorter trip than the outside of the wire. This stretching over time would create weakness for a single strand. So elevator ropes are flexible strong and give long life if maintained properly.

Most elevators feature between two and eight woven steel cables. Elevator technicians refer to them as “ropes,” a reference to their 19th-century hemp predecessors. The number of ropes in a given elevator depends on something called a “factor of safety.” If the factor of safety, set by building codes, is 12 for a particular building, that means the combined strength of the ropes must be adequate to hold 12 times the mass of a fully loaded car. In effect, each rope can hold more than the weight of the car. Individual cables occasionally fail, but it takes a freak event to sever all of them. [13]

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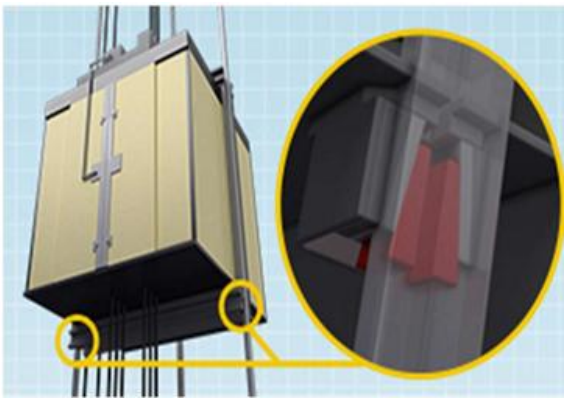
B. Elevator Emergency Brakes

Elevators have two or three types of brakes. If there's an error in the safety chain, a clamp closes on the pulley above the car, preventing the elevator from moving. Unlike an automobile brake, which has to be depressed to engage, the elevator brake is clamped down unless power is supplied to release it. That means that any loss of power, either due to a system error or an electrical grid failure, will set off the motor brake.

The safety check and the motor brake have failed on occasion, but negligence is the usual cause of accidents. Elevators also have a safety brake that is attached to the underside of the car. This is the innovation that made the passenger elevator possible when it was unveiled at the 1853-54 World's Fair in New York.

If the electronics detect that the car is speeding downward, it jams a metal brake from underneath the car into a channel in the guide rails, the metal rods along which the elevator travels. Friction builds between the wedge and the rail, which brings the car to a stop at a comfortable rate.



There is one more fail-safe. On the opposite end of the cables that attach to the elevator car, there is a set of counterweights. Those weights weigh slightly more than an empty car and slightly less than a fully loaded car. If every other safety system failed and you were the only person in the car, these weights would make the elevator ascend rather than descend. It would happen slowly at first, gaining speed as the ascent continued. A fully loaded car would experience a slowly accelerating descent.

In either case, when the counterweights reached the top or bottom of the shaft, they would meet a cushion that would bring the elevator car to an abrupt but hopefully survivable stop. [10]

C. Otis Safety System

This was the great innovation that Elisha Graves Otis made back in the 1860s. His elevators weren't simply supported by ropes: they also had a ratchet system as a backup. Each car ran between two vertical guide rails with sturdy metal teeth embedded all the way up them. At the top of each car, there was a spring-loaded mechanism with hooks attached. If the cable broke, the hooks sprung outward and jammed into the metal teeth in the guide rails, locking the car safely in position.

The elevator compartment (1) is raised and lowered by a hoist and pulley system (2) and a moving counterweight (not visible in this picture). You can see how the elevator is moving smoothly between vertical guide bars: it doesn't just dangle stupidly from the rope. The cable that does all the lifting (3) wraps around several pulleys and the main winding drum. Don't forget this elevator was invented before anyone was really using electricity: it was raised and lowered by hand. At the top of the elevator car, there's a simple mechanism made up of spring-loaded arms and pivots (4). If the main cable (3) breaks, the springs push out two sturdy bars called "pawls" (5) so they lock into vertical racks of upward pointing teeth (6) on either side. This ratchet-like device clamps the elevator safely in place. [9]

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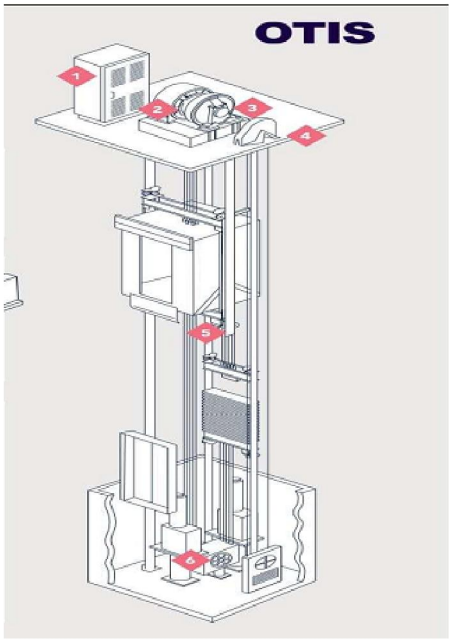
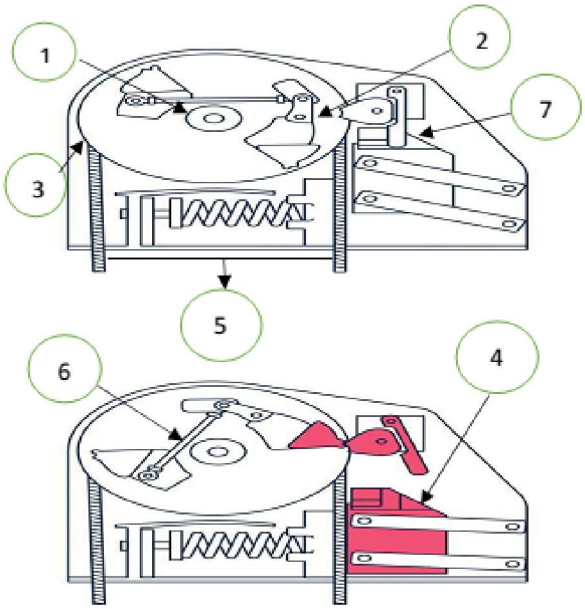


Figure 4: Otis Safety System [9]

D. Speed Governors

Most elevators have an entirely separate speed-regulating system called a governor, which is a heavy flywheel with massive mechanical arms built inside it. Normally the arms are held inside the flywheel by hefty springs, but if the lift moves too fast, they fly outward, pushing a lever mechanism that trips one or more braking systems. First, they might cut power to the lift motor. If that fails and the lift continues to accelerate, the arms will fly out even further and trip a second mechanism, applying the brakes. Some governors are entirely mechanical; others are electromagnetic; still others use a mixture of mechanical and electronic components.



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How a governor works. The lift motor (1) drives gears (2) that turn the sheave (3)—a grooved wheel that guides the main cable. The cable supports both the counterweight (4) and lift car or cabinet. A separate governor cable (5) is attached to the lift car and the governor mechanism on the right. The governor consists of a flywheel with centrifugal arms inside it (6). If the lift moves too quickly, the arms fly outward, tripping a safety mechanism (7) that applies brakes to the governor cable and slows it down. Because the governor cable is now moving slower than the main cable and the car itself, it activates another mechanism that causes friction brakes to shoot out from the elevator car onto its outer guide rails, bringing it smoothly and safely to a halt (in a similar way to the original Otis safety mechanism) [14].

IV. Construction and Working of Our Safety System

In our safety system model, elevator cabin runs in structure made up of mild Steel L shaped angle having dimensions 35*4 mm. The structure is having total four floors and pit at base Elevator cabin is made up of mild Steel Sheet having thickness 3 mm. Elevator cabin movie upward and downward with the support of steel rope. Steel rope is having diameter 4 mm. At another end of steel rope there is dead weight. Steel rope moves with the help of pulley installed 2 the top of structure. For guiding purpose guide rails are installed for elevator cabin and dead weight.

The mechanism structure holding composite material is installed at basement which will rest vertically beside the walls. The mechanism structure is made up of mild steel pipe having diameter 15 mm. This mechanism is driven by motor which nuns on AC supply. This motor will be activated by electric circuit which will sense speed of freefalling elevator cabin when rope of elevator breaks. If speed of free-falling elevator cabin is greater than regular descending speed then sensor will send signal to circuit & circuit will actuate the mechanism at basement which will release composite material bed to fall on springs installed at basement horizontally. Four springs are used at basement.

In addition, we had designed Springs in such way that it has less stiffness value than regular springs but by ensuring the safety of elevator cabinet. Purpose of reducing stiffness is that it reduces the re-bounce of elevator cabinet. After its re-bounce small mechanism like Latch and Lock actuated by Sensors catch or lock the elevator cabinet thus re-bounce is totally absorbed.

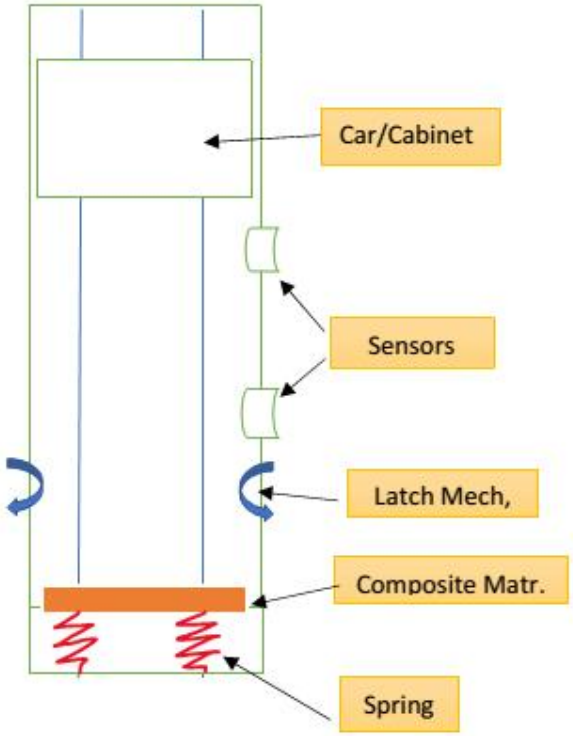

Figure 5: Simple Diagram of Prototype.

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V. CONCLUSION

An elevator is type of vertical transportation machine that moves people between floors, levels. Elevators are typically powered by electric motors. And we see that accidentally Free falling of elevator can causes the death or serious injuries to person. From above review, we can conclude that, To avoid these various techniques was used like elevators emergency brakes, governing of elevator, hydraulic brakes which have some drawbacks also like leakage of gas, breakage of rope etc. But using OTIS Safety system can minimize the accident possibility as it is using various techniques in one combination.

Also, Our system will ensure the safety of inner person when elevator is falling freely. Due to composite material and spring stiffness the elevator re-bounce effect will be reduced and further re-bounce is interlocker by Latch mechanism. Due to the latch the cabinets will lock and rebounce totally absorbed. Due to this life of person can be saved. And other systems are suitable for buildings having a greater number of floors. But our System have no limitations of levels or floors.

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