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LIFT DESIGN PRECAUTIONS TO BE TAKEN IN EARTHQUAKE AREAS

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ABSTRACT
A lot of large cities in the world are likely expected to be struck by earthquakes. We should learn to live with earthquakes instead of being afraid of them and take some measures in our daily lives. Earthquakes are natural occurrences and, nowadays, the seismic risk zones are increasingly becoming familiar to us by the constantly developing technologies. Every building in these seismic risk areas needs to be designed to tolerate the earthquake shocks and several precautions should be taken in the lifts used in these buildings. In this paper, some vital precautions which should be taken in lifts of the buildings in these hazardous areas are explained.
Keywords: Lift, Lift Design, Earthquake.

1. INTRODUCTION
The lift system is a vertical transportation system responsible for transporting people and goods in buildings. Nowadays, lifts are necessary in high-rise buildings and it is not possible to travel in the building without them. Diverse levels of seismic disturbances are expected in most countries of the world where there are various types of high-rise buildings. Earthquake is a natural hazard where a sudden slip or a movement of a portion of the earth's crust, accompanied and followed by a series of vibrations occurs. Vibrations travel outward from the earthquake fault at speeds of several miles per second. Although fault slippage directly under a structure can cause considerable damage, the vibrations of seismic waves give rise to most of the destruction during earthquakes [1].

Earthquakes are the most destructive among all the natural hazards and they occur without any warning so that it makes them one of the most frightening and destructive phenomena of nature. Most of the countries like United States, India, Japan, China and Turkey have suffered several damaging earthquakes in the past. As a result, a lot of people died and a number of buildings had casualties during these earthquakes. To reduce their damages, some vital precautions have been taken in our daily life, especially in our buildings. The hazardous areas have been mapped, and both probability and severity ratings are available for most areas. It is illustrated in Figure1 that various shades of red show high hazard zones; various shades of green and yellow indicate medium hazard zones and white shows less hazardous zones. Any building in a seismic-risk area should be designed to withstand earthquake shock, and lifts and their hoistways require certain additional considerations over normal installation practices [2].

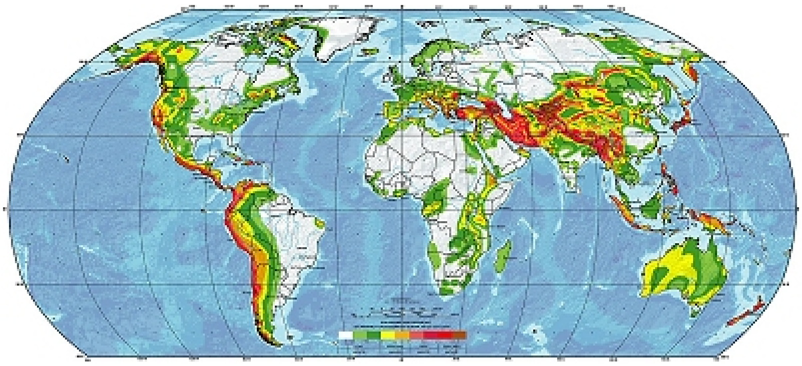

Figure1. Global Seismic Hazard Map [3]

2. THE PRECAUTIONS FOR LIFTS IN EARTHQUAKE AREAS

During a strong earthquake, the most damaged components of lifts (Figure2) are the counterweights out of their rails or some colliding with cars; hoisting ropes damaged or out of their sheaves; broken or damaged rail brackets; hung-up governor cables; broken or loose roller guides; compensating cables out of their grooves or damaged and collapsed hoistways and cars buried at the bottom [4]. We could take some precautions in lifts of the buildings, to minimize all these effects of earthquakes.

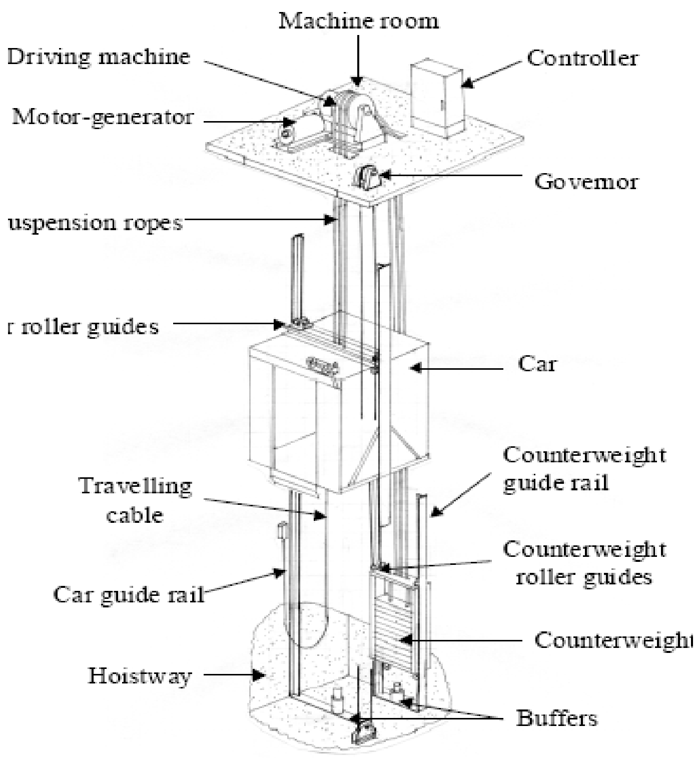

Figure2. Basic components of lifts

2.1. Seismic switches

When an earthquake occurs, a seismic switch in each lift car gauges the severity of the motion and causes the lift to stop if this motion exceeds a preset maximum. The lift then moves in the opposite direction from its counterweight, stops at the next floor, and opens its doors. The lift will remain in this condition until it is thoroughly examined and put back into service by a lift mechanic. If an elevator malfunctions, a passenger should press the alarm button located on the lower right hand panel of the elevator cab and alert the elevator company dispatcher who will then summon a trained technician [5]. Presently the seismic switches should be located in the machine room and seismic sensors are transmitting emergency control signals over telephone lines. This system would give advance warning that earthquake shock waves are approaching the building area [4].

2.2. Counterweight

One potential danger is the possibility of a counterweight becoming disengaged from its rails and swinging into hoistway. If a lift is running, there is the potential hazard of the car colliding with the free-swinging counterweight. A number of protective methods may be applied to prevent the counterweight from becoming disengaged. One method is reinforcing the counterweight rails by way of box brackets so the counterweight is restrained from swinging out. Another method is an electrical detector, which consists of a displacement ring attached to the counterweight and a stretched wire from top to bottom passing through it near the counterweight's path. If the counterweight is displaced, the detector will be electrically intercepted and cause an electrical circuit to stop the lift [2].

2.3. Guide rails and brackets

The motion of the counterweight in the vertical direction is guided by two guide rails. The guide rails are supported along the building height, usually at each floor level, by steel brackets and clamps as shown in Figure3 [6]. The rail and rail structure are required to be reinforced to withstand horizontal shocks in addition to the normal forces of loading and safety gear application that the rails are designed to withstand [2].

The two guide rails are linked to each other by intermediate tie and brackets or box brackets to avoid spreading of the two rails and to decrease the chance of disengagement of the roller guide assembly from the rails. This tying of the two guide rails increases the stiffness of the system and leads to the sharing of the forces by the two rails in the in-plane motion. For this reason, the code permits a heavier counterweight for a given spacing of the brackets or permits a larger spacing between the brackets for a given size counterweight [6].

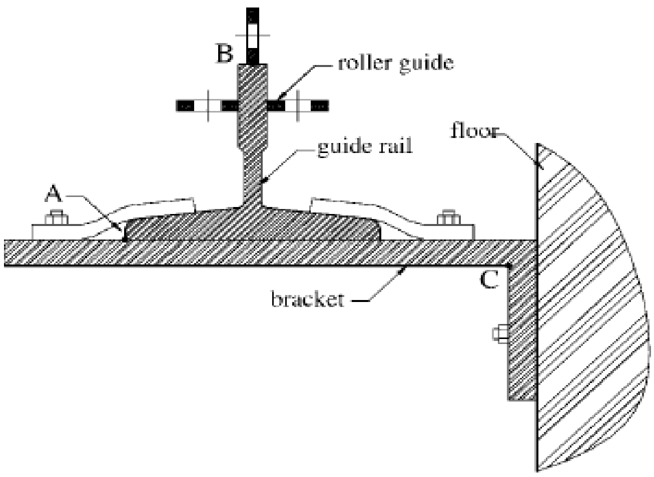

Figure3. Guide rail and bracket assembly [6]

2.4. Roller guide

A roller guide assembly is shown in Figure4. Each roller is supported by a pivot arm with a helical steel spring which adjusts the roller and keeps it in continuous contact with the rail. The roller assembly is an important parameter that affects the seismic response. To prevent large deformations of the roller guide and also to prevent the roller guides coming off the rails, restraining plates are now required under the roller guide assemblies [6].

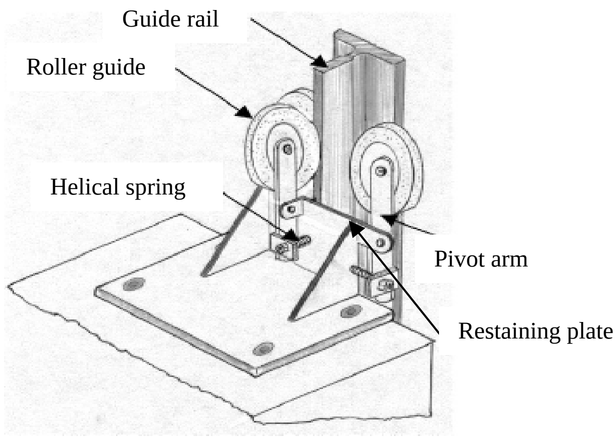

Figure4. A typical three-wheel roller guide assembly[6]

2.5. Structural support frames and other countermeasures

The number of seismic-isolated buildings that can reduce the damage from earthquakes should be increased in hazard zones. A seismic-isolated building that undergoes different motion at the upper and lower storied during an earthquake. In this system, the elevator guiderails and hoistway doors of three stories including the seismic isolator are supported with structural-support frame. Fastening this support frame between the upper and lower hoistway allows the elevator to run up and down in the support frame when it is curved because of horizontal displacement during earthquakes [7].

The elevator hoisting machine and other machine room equipment is tied down with fastenings sufficient to withstand the expected shock. Rope guards are provided to prevent the ropes from jumping from the sheaves, and the car-to-counterweight compensating rope system is tied down with an arrangement to prevent the car and counterweight from bouncing upward during an earthquake shock [2].

3. CONCLUSION

Lifts are used in high-rise buildings and many of them are located in highly seismic risk zones. Therefore, lifts are vulnerable when a strong earthquake shakes these building. An earthquake can break the components of a lift system. Mostly, the counterweight rails, the guide rails, the brackets and roller guide assemblies are potentially the most dangerous component in a lift system and the most likely to be adversely affected by earthquakes. Therefore, it should be taken pre-emptive measures that can be taken to minimize the potential damage of an earthquake.

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