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SEISMIC ISOLATION AND ENERGY DISSIPATING SYSTEMS IN EARTHQUAKE RESISTANT DESIGN

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SUMMARY

Seismic isolation and energy dissipating systems present an effective way to common seismic design for improving the seismic performance of structures. These techniques reduce the seismic forces by changing the stiffness and/or damping in the structures, whereas conventional seismic design is required for an additional strength and ductility to resist seismic forces. The research and development works of passive, active and hybrid devices are ongoing intensively. This paper presents a brief history of isolation techniques and introduces these systems from passive devices to sophisticated ones and completely active systems. By focusing on the passive systems especially base isolation systems, development and progress involved in those are reviewed. A note is also made about applications and the conclusion of the recommended provisions from codes for new buildings and other structures is reviewed. On the other hand, this paper reviews the situation of earthquake protective systems used in Turkey. This technique is not yet very common, but a number of research activities is going on in order to investigate the behaviour of the isolated buildings. Civil engineers, architects, constructors and owners have great responsibilities concerning applications of these systems, but especially the users have sanction, therefore widely use of the earthquake protective systems will be provided by the users' awareness.

INTRODUCTION

The purpose of earthquake prevention of buildings is to provide the structural safety and comfort by controlling the internal forces and displacement within the particular limits. The common method for protecting the structures against the destructive effects of earthquakes is to damp the seismic energy for limiting the seismic energy by the structural elements, thus providing the resistance against the earthquake. In spite of using this method for a certain level of protection, the structure could be damaged for real sometimes. Another method for protection of the structures against the earthquake is to isolate the building from the ground and/or to install seismic energy dissipating elements at the appropriate places of the building. With this method, better protection could be provided, by designing correctly against the earthquake and therefore significant structural damage level could be minimized.

The earthquakes have been carried on to be an important factor that threatens the social and economic future of the countries, as we can observe the results of them. Thus, it is insisted on the resolutions that

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minimize the seismic effects of the buildings should demonstrate a high performance level in the expected earthquakes. The seismic isolators and energy dissipating devices are seen to be effective solutions within this context, which are placed in the building appropriately to damp the seismic energy or placed between the foundation and vertical structural systems damping the seismic energy under the ground of the building, thus decreasing the effects of lateral loads on top floors. Application of earthquake protection systems in buildings whether will be constructed and were constructed -especially the historical ones-, increases the importance of these technologies.

THE PRINCIPLE OF SEISMIC ISOLATION

All the operations that are developed in order to protect the buildings against the earthquakes, thus providing the security and comfort conditions under service loads and that include placing certain kind of additional elements in the building are named seismic isolation in general.

Various kinds of devices are used in the buildings for the purpose of seismic isolation. It would be useful to examine the seismic isolation in the framework of the basic principles of dynamics before introducing these devices. Seismic isolation in a building, when considered within the framework of basic principles of dynamics, can be maintained by taking under the control, modifying and changing the characteristics of both restoring-force when affected by seismic forces, and damping of the building, and also the mass of the building and seismic forces that affect the building. As it is known, the equation of motion of a building that is subjected to the ground motion depends on mass, stiffness, and energy damping nature of the building, as well as on external seismic forces affecting the building. The characteristics of response forces can be controlled, by changing stiffness of the building. When stiffness of the building is decreased, the response acceleration also decreases and displacements increase. On the other hand, response of acceleration and displacement can be decreased, by increasing the damping effect of the building. Various kinds of dampers and their combinations can be placed in the building. The dynamic characteristics of the structural system might be varied, by changing total mass and the distribution of the mass within the system. Controlling and arranging the seismic forces that affect the building can be achieved by isolating the building from the ground.

CLASIFICATION OF SEISMIC ISOLATION SYSTEMS

Seismic isolation devices in the structures may be placed as in a way that the foundation of the structure is separated from its superstructure or specific sections of the building for example by isolating the main building from its roof, as in the building itself. The kinds of seismic isolation devices that are placed in the building are usually energy dissipating mechanisms. Two types of classification of the devices can be done; in accordance to their location in the building, and operation principles. According to the classification of devices by their location in the building, isolators can be considered as being of two types, external and internal. Devices of external type are located outside the building and usually are installed in to the foundations. Devices of internal type are the energy dissipating mechanisms. All response control systems are classified in accordance to their operation principles as active, passive and hybrid systems, Torunbalci [1].

Active Control Systems

The operation mechanism of active control systems is based on providing a continuous energy from outside. That is why the cost of setting up these systems is high. The system can control the acceleration, displacement or velocity of the structure. Active control systems are composed of electronic devices such as computers, actuators and starters. The design of active control systems is independent from the intensity of the ground motion in the following way. The system changes its rigidity or the quantity of motion according to the intensity of the ground motion. Therefore, the factors such as the uncertainty or unpredictability of the future ground motions are not important in the designs that make use of active control systems. There are three main application forms of active control systems:

Active Mass Damper: In this system, by forming actuator control force, the acceleration, displacement and velocity of the structure affected by lateral forces are controlled by computer systems.

Active Variable Stiffness: In this system, there is no need for forming of actuator control force. However, elimination the resonance that results from coinciding of fundamental period of the system and ground motion period depends on choosing the appropriate rigidity for the system and making the corresponding design. They are developed for utilization in case of strong ground motion.

Active Passive Composite Tuned Mass Dumper: The hybrid structural control systems, which were developed in the recent years, are based on joint utilization of both active and passive systems.

Passive Control Systems

Passive control systems operate without utilization of any external energy source. Therefore, the cost of these systems' setting up is less in comparison with active systems. These systems can control the displacement up to a certain limit. In the passive control systems, the protection systems are designed in accordance to protection level required for earthquakes of certain magnitude. These systems are composed of dampers, isolators and other devices that can easily be found and applied. Passive control systems, which more effective in practical sense, have many types. The utilization of all these systems is based on materials that absorb energy at the certain level, either individually or jointly, Torunbalci [1].

Irreversible displacement systems consist of balls or rolls (Fig.1). By the means of these rolls, the structure can move horizontally during an earthquake. In these systems, the amount of dissipated energy is given by multiplication of the friction force and displacement. Sliding systems are frequently used in applications due to the ease in construction and economic cost. However, when such systems are used in structures, there is the possibility for the building to move from its original location after the earthquake due to the excess drifting. For that reason, auxiliary elements such as stoppers may be required. They consist of sufficient number of rolls that are placed perpendicular to each other or spherical steel balls between the steel plates.

Plastic systems are developed, by benefiting from the plasticity of lead, that provides ideal energy absorption for seismic isolation and other vibrations (Fig.2). In these systems, usually there is a cylinder that contains lead and a piston that moves with difficulty inside that cylinder. The lead in the cylinder limits the motion of the piston, so that absorption of the energy is achieved. Lead extrusion dampers are generally used for controlling the major displacements.

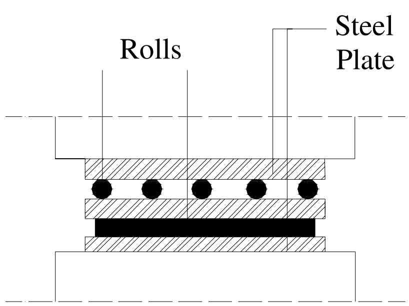


Fig. 1 Irreversible displacement system

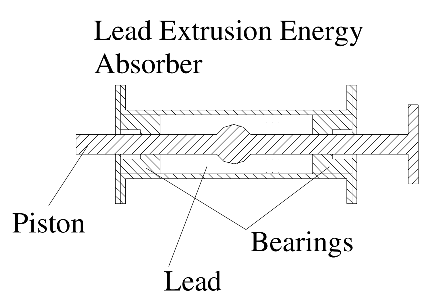


Fig. 2 Plastic system

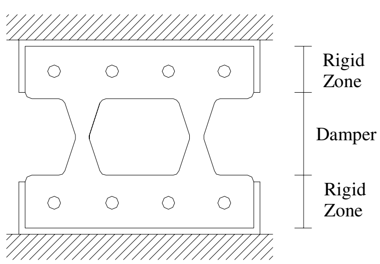
Elastic systems are the systems that have two distinct linear behaviors, which are the rigidity of the structural element and the sum of the structural rigidity and isolator rigidity. Rubber or neoprene dampers that are commonly used can be considered as the examples of such systems. Rubber or neoprene bearings have found a wide utilization area today. The isolation of the building from the ground motion is usually achieved by placing these dampers between the foundation and the columns.

Viscous systems are composed of a polymer or viscous liquid that is placed between two cross sections. During an earthquake, when a relative displacement occurs between the cross sections, the relative deformation of the viscous substance absorbs the vibrations. Viscous systems could be classical shock absorbers or they can be used as wall-type shock absorbers that function by moving of a vertical steel plate, containing viscous liquid that is suspended from the top storey floor between two open-top plates which are fixed on the floor of the lower storey.

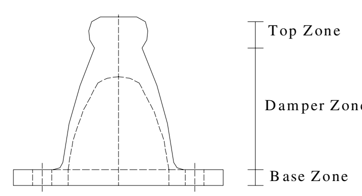
Kinematical systems are the systems such as balls, rolls, elliptic balls and small columns with elliptic ends. The geometric forms of these parts allow them to return to their original positions. Due to these characteristics, they enable the structure to move horizontally in each direction during an earthquake. In the past, the balls or rolls that move in a concave elliptic nest, egg-shaped concrete elements that are placed between two rigid plates and columns with elliptic ends were widely used in the Soviet Union. The balls that move in a concave elliptic nest are accepted nowadays as the prototypes of pendulum bearings that are formed by steel spheres that are placed in between the concave steel plates that are commonly applied.

Friction sliding systems are based on the principle of dissipating energy by means of friction forces. These systems are used both as base isolation systems between the foundation and the columns, and as energy dissipating mechanisms in the superstructure. If friction sliding system is used in bearings then in case of seismic loading, the dissipation of energy is obtained by the friction forces that occur while the system moves on the sliding friction elements. Friction sliding systems can be used as friction devices that are placed in the intersection points of the steel braces in the building.

Mass dampers convert the kinetic energy, which is stored by additional mass, into heat or any other form of energy. By dissipating the vibrations these systems decrease the effects of an earthquake. Examples of these devices are tuned mass dampers and liquid mass dampers in the form of pendulum that are placed at the top floors of the structures.



(a) Honeycomb damper

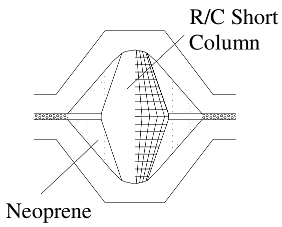


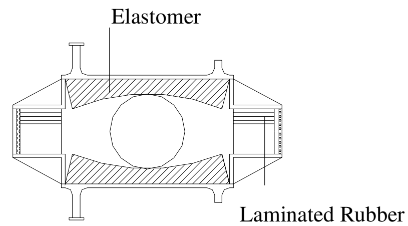
(b) Bell damper

Fig. 3 Steel hysteretic systems

Steel hysteretic systems are the systems that are developed by using the advantages of the torsion and bending characteristics of steel. Steel torsional beams, honeycomb and nodal dampers, that combine both characteristics of steel that allow huge amounts of energy dissipation, bending and torsion plus characteristics of lead and rubber that allow shear and displacement, have perfect energy absorbing qualities. Honeycomb dampers are named like this, because they are made of several steel damper plates put together, represent the shape of a honeycomb (Fig.3a). The dampers are placed in the main structural elements such as walls, columns and slabs. This way, they dissipate the vibration energy by forming a relative motion. A commonly accepted disadvantage of such systems is that they work only if the loads act on the plane itself. The dissipaters that are used in order to dissipate the effect of collision between two buildings that are constructed very close to each other are called nodal dissipaters. Following their geometric forms, these steel dampers are called bell dampers, knob dampers, and hourglass-shaped dampers and they are able to move three dimensionally during an earthquake (Fig.3b).

Kinematical-elastic systems combine the advantages of kinematical systems and elastic systems. Pendulum Rubber Bearing systems are the systems that are based on the principle of placing the structures on laminated rubber bearings, which is commonly used in the structures (Fig.4a). They are made from reinforced concrete short columns in the form of a pendulum that are buried in a rubber based mass, which is tied to the column from top and to the foundation from the bottom. The steel parts at the ends of these columns have elliptic form. The columns that operate as a pendulum meet all the vertical loads that come from the structure. The rubber parts are not subjected to pressure unless there is horizontal motion and therefore the risk of abrasion is diminished.

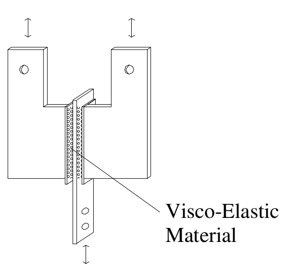


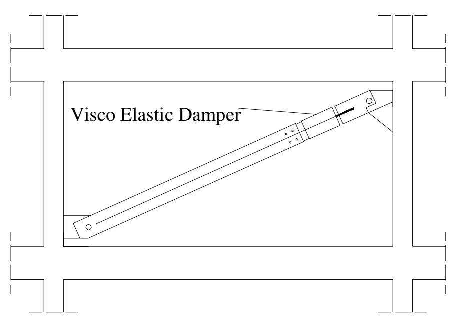


(a) Pendulum rubber bearing **(b) Hercules system**

Fig. 4 Kinematic-Elastic systems

Another type of kinematical-elastic systems is Hercules Systems (Fig.4b). This system is composed of a steel ball in the form of a sphere that moves between the concave elastomer bearings that are located in a cell, protected by steel plates. The bearing has a slowly and gradually increasing deformation pattern, and elastic displacement limit. Hercules system is an appropriate isolator for the foundation isolations of small- and medium-scale structures.





(a) Viscoelastic damper **(b) Designate details**

Fig.5 Viscoelastic systems

Initially, visco-elastic systems were used in order to provide control and protection against the vibrations that emerge as a result of winds, but today they are also used for seismic control purposes. The system is composed of a visco-elastic substance that is placed in between the external steel flanges and the central plate (Fig.5a). The vibration, that causes the relative motion between the flanges and the central plate, is dissipated by the visco-elastic substance placed between the plates. Visco-elastic systems are used in structural frames and steel bracings (Fig.5b).

Elasto-plastic systems are the systems that are made by combining the advantages of elastic systems and plastic systems. In these systems, rubber or elastomeric bearings that have an elastic nature are used together with lead, which has a plastic nature. There is a lead core, which is placed in the center of the bearings. Elasto-plastic systems also make use of the springs and hysteretic dampers. The distinct feature of this system is the parallel motion of the springs and hysteretic dampers. The springs both help the dissipation and possess the effect of returning a part to the initial position, Olariu [2].

BASE ISOLATION SYSTEMS

The most extensively used methods today are the methods which are based on the separation of the building and the ground, allowing a horizontal movement on the foundations of the building/on the bearings of vertical structural members. These systems will be called base isolation systems in general. Since seismic isolators are placed between the superstructure and the ground or to separate certain parts of the building, this type of seismic isolation is also defined as external isolation. Seismic isolation technologies developed on the basis of this principle and extensively used during the past decade, comprise passive control systems classified above.

The base isolations systems in general, consists of a bearings allowing the horizontal movement, a damper controlling the displacements and members providing rigidity under lateral loads. Bearings member has a behavior rigid enough to transfer loads vertically and horizontally flexible. This behavior changes the period of base isolation system along with the superstructure, thus the whole structure and helps to decrease inertia forces. The decrease in inertia forces when compared with traditionally designed buildings depends on the dynamic characteristics of the building in traditional buildings, the shape of response spectra curve in buildings with seismic isolation. The additional ductility to change the first mode period, causes big displacements in the superstructure when compared to seismic isolation system. As a result of this damage and use problems may arise. Displacements can be decreased through increasing energy dumping capacity of the base isolation system.

The most effective way to control the displacements is to use members, which have hysteretic energy damping capability. For this reason, mechanical apparatus using the plastic deformation of mild steel and lead and materials such as elastomers have been developed. Another alternative method is to damp energy, thus to use friction to decrease the relative displacements. Viscous liquids and hydrolic dampers are not used extensively because of the expensive price and maintenance requirement although they are highly energy damping.

There are various types of bearings used in the base isolation systems, which vary according to their behavior and to the material they are made of. The most extensively used ones are the ones which belong to elastic systems class such as Rubber Bearing (RB), High Damping Natural Rubber Bearing (HDNR) and Steel Laminated Rubber Bearing (SLR), the ones belonging to elasto-plastic systems class such as Lead Rubber Bearing (LRB) and the ones belonging to kinematic systems class and friction pendulum systems class such as Friction Pendulum Bearing (FPB).

Rubber Bearings

These systems also have steel laminated rubber types and steel laminated rubber types with lead nucleus, along with the ones made of rubber and neoprene. The natural and artificial rubber bearings, which were used in bridge bearings, have later been developed and have been named elastomeric bearings. These bearings, which are used as seismic isolators, are widely used. The rubber laminated isolators are formed through vulcanization of thin steel plates to rubber plates (Fig.6). The more developed of those are laminated rubber types with lead nucleus. Lead Laminated Rubber Bearing systems are constituted by steel/rubber laminated layers with a lead nucleus embedded in the middle, and they are highly developed seismic isolators (Fig.7).

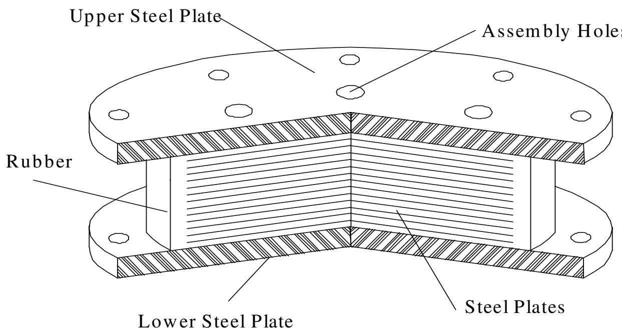


Fig. 6 Rubber laminated isolator

Another type of laminated rubber isolators allowing more lateral displacements are Slider Laminated Rubber Isolators. In these types, the laminated rubber cylindrical mass is surrounded by a sliding plate. Around the sliding rubber isolator, there is a steel stopper with a circular plan placed in such a way to allow displacements of certain size. Thus, in small seismic motions, the vibrations are damped through the deformation of laminated rubber, in larger motions, the structure is allowed to make a larger horizontal move through the sliding of the sliding plate.

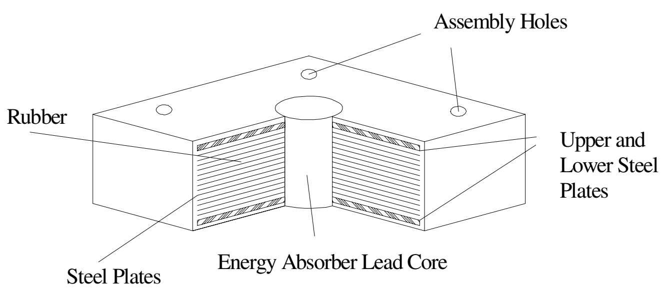


Fig.7 Lead laminated rubber bearing

These types of bearings show a vertically rigid, horizontally flexible behavior. These bearings convey the vertical compounds of earthquake forces relatively to the structure they isolate the structure from the horizontal compounds under seismic loads. They are suitable for low-rise, rigid or pre-stressed buildings. In the systems where are not designed symmetrically for architectural reasons, displacements and internal forces in seismic loading are not balanced within the system. In these types of buildings, use of rubber bearings is very useful. Base isolators are placed to balance the center of mass and center of rigidity. Thus, the negative effects of the irregularly designed structural system are eliminated. These bearings carry pressure loads at large amounts and accompany the movement in one or more direction in sliding different from the mechanical apparatus. Since rubber has a low shear modulus, the torsion freedom of rubber is decreased through placing steel laminates inside, and shear rigidity is increased a lot through these laminates. These bearings are very much resistant to environmental effects and long lasting.

Elastomeric bearings cannot resist to tensile stress formed by overturning moments. Equipment to resist tensile forces can be placed to this isolator to enable the rigidity of its structure. Elastomeric bearings can be made of low or highly damp rubber. Although there are big displacements in the buildings where these bearings are used, since the vibration is low, the equipment in the building is not damaged.

Friction pendulum bearings

Friction pendulum systems are the most extensively used kinematic systems especially in base isolation. Pendulum system consists of a steel globe placed in two steel concave curved surface (Fig.8) or a cylindrical member with global contact surfaces. In these parts special metals are used (Fig.9).

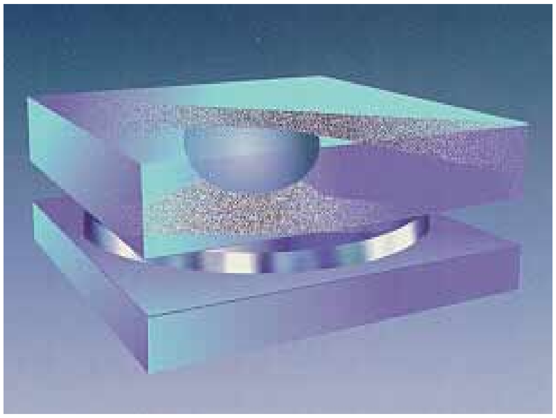


Fig. 8 Cross section of a friction pendulum bearing   Fig. 9 Detail of a friction pendulum bearing

These bearings, which have all the benefits of rubber bearings, through a bearing member which can slide on the global concave surface, it damps the energy because it assumes a position elevating the building during a lateral motion, and decreases the effect of earthquakes a lot. These bearings can be used in buildings, in spannings and in heavy roof systems, and also, through mechanical properties of special metals in their structure, they can be used successfully in cold regions with danger of freezing.

EARTHQUAKE REGULATIONS AND DESIGN GUIDES

In the developed countries where intensive seismic activity is observed, various seismic isolation types are widely applied. Some earthquake regulations have special conditions regarding the seismic isolation and passive energy dissipating systems. In particular, the regulations in the USA and Japan are the most detailed ones in this field. In the USA, many researches and applications have been performed since 1980's. These works were evaluated in scientific gatherings such as ATC, ASCE Structural Congress, EERI Spectra, US and World Conferences on Earthquake Engineering.

Regulations regarding earthquake protection systems entered in to the technical codes of the USA by the end of 1989. An appendix was added to Blue Book by SEAOC under the title "General requirements for the design and construction of seismic-isolated structures". These rules were presented to ICBO and were published UBC1991 as an appendix. In 1991, FEMA initiated a six-year program for preparation of a national and applicable guide for seismic rehabilitation of the present buildings. These regulations, which are known as NEHRP, are now available in FEMA 273 [3] and FEMA 274 [4]. The appendix of UBC had been revised annually in accordance to current requirements and the last version has been published in UBC 1997 [5]. Finally, in the year 2000, the recommendations that were prepared jointly by NEHRP and FEMA were published [6]. The application of seismic isolation is permitted by the EU regulations in Euro Code 8. Seismic isolation is also included in the codes of such countries as Japan (BSL) and Canada (NBCC).

In Turkey, the seismic isolation concept is mentioned in the Turkish Earthquake Code-1998 which has become effective in 1998 and which was prepared by the Ministry of Public Works and Settlement, and it is stated that the provisions of this regulation can not be applied for buildings which are equipped with special apparatus between its foundations and the ground, and also having other active and passive control systems, to isolate the building structure from the earthquake motion, however, it is also stated that contemporary international standards can be used until its own special regulations are prepared [7].

Earthquake regulations include the criteria that would limit the inelastic behavior of the structure on the isolation system. That is due to the fact that what is ideal in seismic isolation, is the occurring of lateral displacements of an isolated structure caused from the significant deformation of isolation systems, rather than the displacements of the superstructure. That is why the lateral-load bearing system in the isolation system should be designed so that it possesses the appropriate sufficient stiffness and strength in order to avoid large and inelastic displacements. Design-based earthquake damage control is not the specific purpose of the conditions of regulations. At the same time, an isolated structure designed in order to limit the inelastic behavior of the structural system will decrease the level of damage that might occur during an earthquake. In general, isolated structures designed in accordance with the regulations should be able to:

- Resist the earthquakes of minor and moderate magnitude preserving structural elements, nonstructural components, or building contents from damage,
- Resist the earthquakes of major magnitude not allowing a failure of the isolation system, significant damage to structural elements, extensive damage to nonstructural components, and major disruption to facility functions [6].

The conditions set forth in regulations, which should be followed in the buildings with seismic isolation are concerning isolator design displacements, structure design shear forces and other special requirements. For conventional fixed-base structures, the other design conditions concerning such things as the loads other than seismic loads, load combinations, allowable forces, and stresses and horizontal shear distribution correspond to the conditions in the earthquake regulations.

DEVELOPMENT AND APPLICATIONS

The modern period of passive structural control started in New Zealand in the beginning of 1970's. During the first decade, many research and development studies were conducted and by the beginning of 1980's the first seismic isolation applications were seen in Japan and in the USA. During the period rapid growth of Japan economy in the second half of 1980's, many construction companies have developed projects in order to demonstrate for the introductory purposes the technical advantages of these systems. The buildings that had gotten the construction permission before Kobe earthquake, such as dormitories, apartment buildings, research and computer centers or construction companies' office buildings were constructed mainly for the advertising purpose.

However, these buildings had no experience of a major earthquake until Kobe earthquake. In Kobe earthquake, Matsumura-Gumi Research Laboratory and the West Japan Postal Savings Computer Center were seriously affected, which were located in the same area. In Kobe earthquake of 1995, these two buildings with seismic isolation, which were 30 km away from the epicenter of the earthquake, demonstrated a very good performance. At the same time, Post Center was the building had the most comprehensive seismic isolation application in the world. Both buildings were designed according to 0.3g ground acceleration. It was estimated that the acceleration decreased down to 0.1g at the superstructure of the Post Center. Before Kobe earthquake, no building, in which passive seismic control was applied, experienced such a noteworthy earthquake.

After Kobe earthquake in Japan, the number of buildings on which passive seismic control was applied increased considerably. Official permission has been obtained for only fifteen buildings in three years before the earthquake, whereas this number has increased up to four hundred and fifty in three years after the earthquake. On the other hand, seismic isolation has been applied only to the buildings with four to five stories until 1995, whereas after 1995 it was applied to eight stories buildings. Today, more than fifty per cent of high buildings in Japan are designed to incorporate passive energy dissipating systems, and seismic isolation application permission is obtained for about 10 to 15 buildings each month. This situation can be explained as follows: the seismic isolation technologies have reached a very advance level today and huge number of life and economic loss pushed the society from traditional seismic design approaches to the alternative searches. Statistics also show that there is a similar increase for energy dissipating systems. It is obvious that the acceptance of new technologies by Japanese seismic design authorities was triggered by Kobe earthquake. Another factor is that the passive control technologies reached a sufficient maturity during this earthquake, Clark [8].

In 1980's, there was a great consensus between the researchers from New Zealand, Japan and the USA. However, New Zealand and USA could not keep up with Japan in utilization of this technology. Until 1990's, only four buildings with seismic isolation were built in the USA and passive dissipaters were not used at all. By the end of 1993 and only three weeks prior to Kobe earthquake, eleven buildings with seismic isolation were completed and reinforcement of two buildings with passive dampers was performed. During Northridge earthquake, which took place in 1994 in California, ground motion could be measured in five different buildings with seismic isolation. In Los Angeles USC University Hospital, which was located 35 km away from the epicenter, ground acceleration was measured as 0.38g and at superstructure it was measured as 0.13g. This satisfactory performance in the building proved how beneficial and appropriate seismic isolation was in earthquake-resistant designs. In 1999, seismic isolation was applied to about forty buildings in the USA and passive dissipating systems were placed in more than twenty buildings, Clark [8]. Today, the number of the buildings, in which seismic isolation and energy dissipating technologies are applied, is increasing rapidly in the USA.

In the recent years, scientific researches on seismic isolation and energy damping systems are made in Turkey. These new techniques are especially persuaded intently in Turkey after 1999 Kocaeli Earthquake and the consecutive earthquakes. Certain companies of US and Japanese origin are active in Turkey within this context. The first building that seismic isolation has been applied is Istanbul Ataturk Airport International New Terminal Building. This complex which has 250.000sqm construction area and which has started its service towards the end of 1999, has been strengthened against earthquake with seismic isolators of friction pendulum type. A total of 130 seismic isolators are placed on the reinforced concrete columns of 7 meters high, and the roof construction. Thus glass facade is protected against a probable magnitude of 8, Richter earthquake. Furthermore, viaducts and bridges in some motorways located in high seismic activity regions of Anatolia have been built with seismic isolation and energy dissipation devices. Some activities, related to the applicability of the isolation techniques for seismic and vibration protection of the Marmara Motorways' viaducts have been planned. The studies to strengthen highway viaducts and bridges are still going on.

EVALUATION OF SEISMIC ISOLATION SYSTEMS

Seismic isolation is a technology that was developed in order to minimize the earthquake damage. It is a design method that is based on the principle of decreasing the earthquake energy affecting the structure by extending the structure period instead of increasing the resistance capacity of the building against the earthquake. In the buildings that are constructed by using this technology, the elastic behavior of the building is ensured even during major earthquakes. Initially, the purpose was to prevent the collapsing of the buildings during an earthquake, but today, the designs that aim to maintain comfort in addition to earthquake security are on the foreground.

As it is known, the modern regulations of today aim providing the life security in addition to elimination of the damages in buildings caused by major earthquakes. Therefore, here we have a situation in which the building would become unusable after a major earthquake that is probable only once during the life of the building or its reinforcement would not be economical. This situation can also bring a huge financial and work loss. Although the application of seismic control systems increases the project-related cost to a certain degree, these losses can be escaped at a great scale with the correct design. Especially in case of reinforcement of the public buildings and the buildings, which contain valuable equipment, when the expenses of their reconstruction, loss of function and destruction of the equipment after an earthquake are considered, it will be seen that this increase in cost is negligible.

It is seen from the past experiences that seismic isolation provides a considerable decrease in the acceleration and shear forces that affect the buildings; prevents the excess load on the existing superstructure and foundation systems by decreasing the effects of lateral forces during an earthquake; improves the behaviors of both horizontally and vertically irregular structures by the architectural consideration; prevents, at the large scale, structural and nonstructural damages; prevents the sliding and turning over of either furniture and equipment or prevents the people from getting injured from this events; and the most importantly, provides life security.
Besides all these positive aspects, the negative aspects can be listed as follows: some uncertainties in the designing processes such as the variability of the wind and earthquake loads and directions, and the variability of the structural characteristics; some possible mistakes in selecting the appropriate method; the problem of turning over in some systems; the difficulties in applying some systems to the present buildings which were constructed adjacently; and the most important one, is the lack of sufficient information regarding these systems within the society.

If an earthquake, which is a natural disaster, could not be prevented, then the important issue is to eliminate the damages by taking the precautions against the earthquake. It is clear that the most effective method to provide this is to apply seismic isolation. Although the seismic isolation applications are very expensive, it should be accepted that this is not more important than human life. The task of spreading this application belongs to architects and civil engineers. However, ones who have the highest authorizing power are the users. Therefore, spreading such applications will be possible by increasing the awareness among the users seriously.

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