



A Review Article on the Performance Based Seismic Design of Structures

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**مقالة مرجعية عن التصميم الزلزالي
القائم على الأداء للهياكل**

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Abstract:

For the most part, seismic design builds complex structural systems using the same small number of essential structural components as non-seismic design projects. Based on the building regulations, structures are frequently designed to "withstand" the largest earthquake with a given likelihood that is projected to happen at their location. This means that by avoiding structures from collapsing, the number of fatalities must be maintained to a minimal. Seismic design involves knowing the many failure modes regarding a structure and giving it the right stiffness, strength, ductility, and layout for ensuring that these modes do not take place. In this essay, the present level of knowledge on Performance-based Seismic Design (PBSD) approach is summarized. An updated review of PBSD approach's literature is provided in this study. PBSD is an elastic design process that takes into account the building's potential performance under various ground vibrations. It was studied how the PBPD as well as Pushover Analysis (nonlinear static analysis) derivatives of PBSD approach compare to one another as the best technique for usage in seismic design in future.

Keywords: Earthquakes, Performance Based Plastic Design, Pushover analysis, Dynamic Effects, performance-based seismic design.



المستخلص

في معظم الأحيان، يبني التصميم الزلزالي أنظمة هيكلية معقدة باستخدام نفس العدد الصغير من المكونات الهيكلية الأساسية مثل مشاريع التصميم غير الزلزالية. بناءً على لوائح البناء، يتم تصميم الهياكل في كثير من الأحيان "لتحمل" أكبر زلزال مع احتمالية معينة من المتوقع حدوثها في موقعها. وهذا يعني أنه من خلال تجنب انهيار الهياكل، يجب الحفاظ على عدد الوفيات عند الحد الأدنى. يتضمن التصميم الزلزالي معرفة أوضاع الفشل العديدة المتعلقة بالهيكل ومنحه الصلابة والقوة والمرونة والتخطيط المناسبين لضمان عدم حدوث هذه الأوضاع. في هذا المقال، يتم تلخيص المستوى الحالي من المعرفة حول نهج التصميم الزلزالي القائم على الأداء (PBSD) حيث يتم تقديم مراجعة محدثة لأدبيات نهج PBSD في هذه الدراسة. PBSD هي عملية تصميم مرنة تأخذ في الاعتبار الأداء المحتمل للمبنى في ظل الاهتزازات الأرضية المختلفة. تمت دراسة كيفية مقارنة مشتقات PBPD وكذلك تحليل Pushover (التحليل الساكن غير الخطي) لمنهج PBSD مع بعضها البعض كأفضل تقنية للاستخدام في التصميم الزلزالي في المستقبل.

الكلمات المفتاحية: الزلازل ، التصميم البلاستيكي المبني على الأداء، تحليل الدفع ، التأثيرات الديناميكية ، التصميم الزلزالي المبني على الأداء.



First / Introduction

A quick slip on a fault, as well as the ensuing ground shaking as well as seismic energy released due to slip, along with stress due to magmatic or volcanic activity, are all considered earthquakes (according to the USGS). Yearly, there are no less than one million earthquakes all over the world, or two every minute on average. One of the deadliest natural disasters which could happen is a significant earthquake in a city. No less than million people have died as a result of earthquakes worldwide between 1970 and 2023, including China, Armenia, Guatemala, Ecuador, Iran, Haiti, Indonesia, India, Mexico, Japan, Peru, Pakistan, and Turkey. In numerous seismically active areas all over the world, the excessiveness of urbanization had resulted in the creation of mega-cities that are populated with 20000–60000 people per km² or even more. Such communities have extreme susceptibility to the earthquake hazards, including high rates of case fatality for the asphyxiation, hypothermia, trauma, and acute respiratory failures, along with fractures as well as other injuries that result from the collapses of the infrastructure.

Earthquakes are the most important dynamic effect because of what This impact is followed by destruction and human and material losses, especially in gatherings, large population, which imposed the use of seismic engineering science in Construction work to find ideas and ways to ensure the safety of buildings when Even small and inconspicuous. Exposure to earthquakes. Earthquakes reveal design and implementation errors.

Earthquake mechanics is used as an expression to unify seismology with the dynamics of the facilities so that it represents the foundations of seismic engineering sciences. Any building, regardless of its field of use, is



designed and implemented to be resistant for earthquakes that can cause many losses that must be avoided.

Individuals are wounded by collapsing walls, falling objects, and falling plaster. Collapsing buildings and vibrations could create electric fires, short circuits, and ignited gas or stove fires. An earthquake doesn't cause by itself cause injuries or death. With sufficient care, it is feasible to prevent the panic and bewilderment that all of this causes.

Earthquake Effects: -

- 1- Primary Effects:
 - Ground Break, Fault formation
- 2- Secondary Effects: -
 - Tsunami
 - Bridges, highway, and railway failures
 - R. C. Structures failure
 - Failure of slope and land slide
 - Failure of foundation and liquefaction
 - Retaining walls failure

As exhibited in Fig. 1

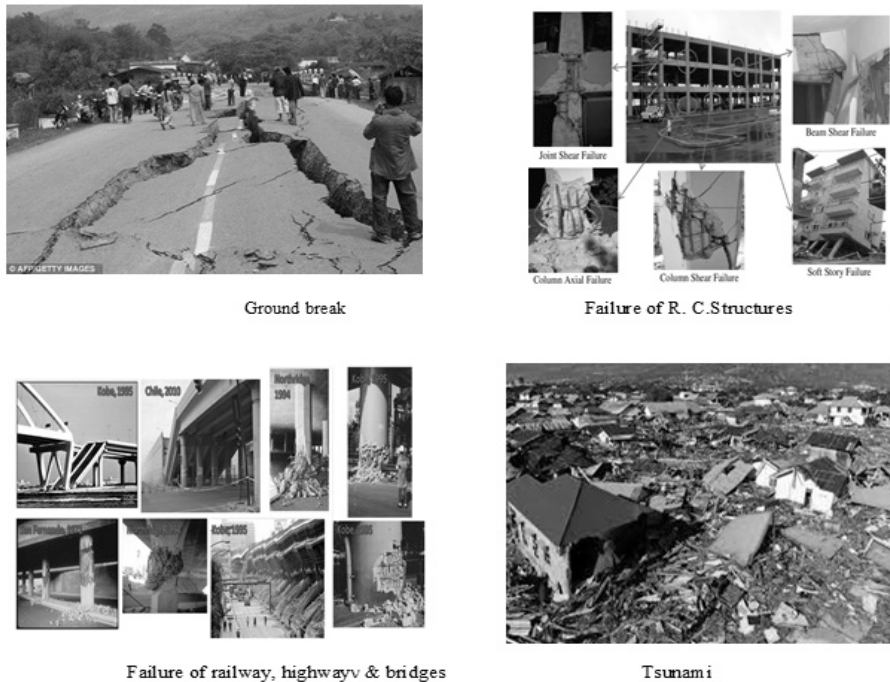


Figure 1: Earthquake Effects

Classification of Earthquakes: -

1- Based on Focal Depth:

- Deep focus earthquakes (more than 300km)
- Intermediate focus earthquakes (between 70 and 300 km)
- Shallow focus earthquakes (less than 70km)

2- Based on magnitude:

- Micro earthquakes (M less than 3)
- Intermediate earthquakes (M between 3 and 5)
- Moderate earthquakes (M between 5 and 6)
- Strong earthquakes (M between 6 and 7)



- Major earthquakes (M between 7 and 8)
- Great earthquakes (M more than 8)

3- Based upon Epicentral distance:

- Local shock (4km range)
- Near shock (between 4 and 10 km)
- Distant shock (between 10 and 20 km)
- Telescopic shock (more than 20 km)

4- Based on origin:

- Explosions Plutonic earthquakes
- Tectonic earthquakes
- Volcanic earthquakes
- Collapse earthquakes
- Reservoir induced earthquakes

Second / Research Background about Seismic Design:

The degree and the distribution of the anticipated structural damages have been determined via the PBPD approach, a direct design approach which leverages pre-chosen target drift as well as yield mechanisms as primary targets of the performance. It depends on formulas created with the use of Newmark-Hall reduction factors (Newmark and Hall,1982) for inelastic demand spectrum as well as capacity spectrum approach.

Buckling restrained braced frames (Lee and Goel,2001), concentric braced frames, steel moment resisting frames, special truss moment frames, and composite buckling restrained braced frames (Chao and Goel,2006a-Chao and Goel,2008- Chao and Goel,2006b-Dasgupta ,et al.,2004) have all seen success with the application of PBPD design. All frames created the



required strong column-weak beam yield mechanisms, and storey drifts as well as ductility demands have been part of the chosen design values, satisfying chosen performance goals (Goel , *et al.*,2010). Lately, (Xue, *et al.*,2008) created a draft code for Taiwan using PBPD technique of design for implementation. (Liao and Goel,2010) used PBPD design for Reinforced Concrete Special Moment Structures. PBPD approach is presently being developed for reinforced concrete buildings with degrading hysteretic behavior. Because of its complicated hysteretic behavior, reinforced concrete structures pose a unique challenge in terms of seismic design in order to ensure targeted response. PBPD approach minimizes or eliminates the requirement for many iterations to reach the final design by controlling yielding and drift from the very beginning of design process. Choosing appropriate yielding members and/or devices and positioning them in advantageous locations allows for development of novel structural schemes, whereas the selected non-yielding members could be designed with no or minimal capacity of ductility. All those might result in improved performance, safety, and life-cycle cost efficiency. Performance of PBPD could be measured, it absorbs damage from seismic events, and it appears to be the most cost-effective alternative (Dalal, *et al.*,2011).

The PBPD approach, a PBSD variant, was examined and discussed. It has been highly acknowledged as the best technique for next procedures of seismic design. PBPD is a straightforward approach to design that begins with pre-quantified performance objectives, after which performs plastic design, specifies frame connections and members, and sets out the goals. The findings indicate that more investigations are required to create PBPD techniques for various kinds of structures (Dalal , *et al.*,2016). Following the



Prieta earthquake and 1994 Northridge earthquake, structural engineers in US started to develop structural design processes which placed a different emphasis on performance rather than strength. The approaches and standards that emerged later became known as "performance-based design." Within the global seismic engineering community, interest in such techniques has grown. A contemporary design idea for seismic-resistant structures is called PBSD. In a broader design philosophy known as performance-based design, the design criteria are described with regard to realizing stated performance goals in the case when structure is exposed to specified seismic hazard levels. Since then, the Northridge earthquake that had happened in 1994 as well as other earthquakes that occurred globally towards the close of the 20th century, served as a wake-up call for the usage of PBSD. A broader design philosophy known as performance-based design (PBD) tries to achieve various performance goals for a structure under specified levels of earthquake ground motion.

The control regarding structural damage is the goal of PBSD approach, which depend on accurate calculations of appropriate response parameters. PBSD approach assesses a building's frame performance for any potential seismic hazards. With regard to irregular RC building frames (10 storeys), the research compares PBSD to the traditional design approach (with the use of I.S. 1893; 2002) and assesses performance utilizing pushover as well as Time History analysis (Arvind, et al., 2014). By comparing this approach to the traditional one, the effectiveness of using it for vertical irregular buildings is demonstrated. Because of increased stiffness and decreased strength, soft storey is more likely to fail. The use of the PBSD for the Soft Storey RC Building Frames (ten Storeys) is the topic of this research. Results of the push



over analysis highlight the importance of the PBSD approach in frames with softer stories on the lower floors as opposed to the higher floors (Rajkuwar, et al., 2014). The most recent examination of literature on performance-based Soft Storey seismic analysis related to nonlinear multi-story buildings. A method of elastic design called as "Performance-based plastic design" is performance-based seismic design. The deformation and strength capacity of a structure's various parts determine its overall load capacity. A weak floor, sometimes referred to as a soft floor, is one that is not as ductile or rigid in order to survive an earthquake which occurs inside the building. A floor that includes much empty space is said to be soft (Devendra, et al., 2019).

Utilizing performance-based seismic design, assess how well structures perform during earthquakes. In the presented work, we will design numerous reinforcement sets at different levels and ultimately present an ideal reinforcement combination for examining the performance regarding a building because of seismic force. **Occupancy.** Finding the building's performance points as well as comparing its seismic response with regard to floor drift, ground thrust, floor displacement, spectral acceleration, and spectral displacement constitute the second step. Second, the design depends on performance-based seismic design in a case when resultant displacement of the roof is put into comparison with the target displacement as well as resulting displacement is smaller compared to target displacement. Put to comparison code-based design and performance-based design, then (Pranali and Joshi, 2020). The goal of this research is to apply PBSD principles to a concrete structure. PBSD, a cutting-edge idea in seismic structure design, is a trustworthy method which could offer more specific information regarding performance levels for both non-structural and structural elements.



Method. With regard to irregular reinforced concrete frames, seismic designs depend on the performance have been applied in this work. Thus, a pushover analysis has been conducted. For a specific seismic hazard level, floor drift ratio has been chosen as the limit of deformation in order to establish the level of performance. The research's findings demonstrate that the achieves its performance and financial objectives by using a PBSd for its structures. Additionally, it is possible to draw the conclusion that PBSd which has been derived by the aforementioned approach satisfies tolerance requirements for immediate occupation of different seismic intensity levels and life safety limitations (Gil-oulbe, *et al.*, 2020).

In the case where a structure would be subjected to specified amounts of earthquake ground motions, the major goal of PBD is accomplishing numerous performance targets. PBD generally aims to create engineered structures that will operate predictably in future earthquakes. PBD is becoming a more important and effective design tool when compared to the traditional coding approaches because of improvements in research as well as test facilities and the quick development regarding structural analysis and design software (Sharma, *et al.*, 2020). The fundamental idea behind PBSd is to give engineers the tools they need to create structures with predictable and dependable seismic performance. PBSd is an elastic design approach that takes into account ground movements to predict how well a building will perform. PBSd offers a way for evaluation of the seismic performances of the structures which ensures life safety and little economic loss as opposed to a force-based method. Pushover analysis, another name for nonlinear static approach, is utilized to evaluate how well the structure performs under shear loads. In addition to other structural metrics, pushover analysis offers



a plastic hinge formation sample regarding the component, which directly relates to the component's performance during an earthquake. Standard elastic and geometrical stiffness matrices for the frame elements (columns, beams, and so on.) are gradually modified for accounting for non-linear elastic-plastic behaviour under constant loads of the gravity and progressively increasing the levels of lateral load. This is done by using plasticity-factor that gauges plastification level. The behavior model allows for the monitoring of progressive plastification regarding frame components as well as structural systems under escalating earthquake ground motion, taking into account material inelasticity resulting from both single and coupled stress states (Mishra and Singh, 2021).

Pushover analysis can be defined as a technique where a mathematical model that directly addresses non-linear load-deformation properties regarding individual structural components and elements has been subjected to a pattern of lateral loading that increases monotonically over time, simulating the effects of earthquake, until a desired displacement is attained. The push over analysis approach applies an incremental earthquake load to the model. The building experiences yielding in a few places with the increase in loads. The structural properties are roughly altered for reflecting the yielding each time such yielding occurs. The examination is carried out until the building topples over or reaches a particular threshold of lateral displacement. A pushover approach depends on the response spectrum was investigated to evaluate the seismic response regarding three different asymmetrical building systems. A few of 3D effects that have been brought on by torsion's response were part of the technique. The primary components of the technique have been the load distributions employed in



pushover analysis and using elastic response spectra analysis regarding the building in order to determine goal displacements (Moghdam and Tso, 2000). Presented a straightforward pushover analysis method depending on a computer for performance-based building framework design susceptible to earthquake loads. This approach's foundation was the traditional displacement approach to elastic analysis (Hasan, et al., 2002). The value of Pushover analysis as performance-based method of seismic engineering for examining a structure's post-yield behavior because it needs less work and works with far less data than a nonlinear response history analysis (Rahul, et al., 2004).

The study focuses on push-over analysis method for PBD of steel structure frames that are vulnerable to earthquake loading. The standard elastic as well as geometric stiffness matrices with regard to frame elements (columns, beams, and so on.) are gradually modified to be accounting for the non-linear elastic-plastic behaviour under constant loads of gravity as well as increasing lateral loads incrementally by using a plasticity-factor which measures plasticization degree. Two steel frameworks with hollow and solid elements are subject to analysis. This study tries to examine how solid and hollow frames behave structurally differently. The approach used in the presented study depends on the traditional elastic analysis displacement approach (Vijay and Vijayakumar, 2013). In Khartoum, Sudan, an existing reinforced concrete building with three stories that was susceptible to seismic stresses was examined. Latest earthquakes in Sudan have shown that it is not immune to earthquakes; earlier research in this area has supported this claim. The examination of seismic performance regarding current hospital structures in Sudan is the main topic of this essay. The failure mode in



columns and beams in the case when the member yields is represented by a plastic hinge. With the aid of SAP2000 software (Ver. 14) and equivalent static approach in accordance with UBC 97, the pushover study of the building has been carried out. To determine the expected seismic performance regarding a structure, inelastic structural analysis and seismic hazard are integrated. This analysis is guided by the concepts of performance-based seismic engineering. A key result of pushover analysis is the structure's base shear vs tip displacement curve, or pushover curve. Both Y and X directions are used in pushover analysis. With regard to each member, default hinge properties are applied depending on Applied Technology Council (ATC40) and FEMA-356 recommendations, which are available in a few programs. Thus, only one case study was used. The three-story hospital building has been shown to be seismically secure by examination (Ismaeil, 2013). The goal of PBSD, a relatively new and cutting-edge method for seismic analysis as well as engineering of structures, is to produce a structure that can achieve specific predictable performance goals under various levels of earthquake motion. To satisfy designer-specified and code criteria, PBD, which necessitates extensive and complex computing work, uses non-linear static analysis (also referred to as the pushover analysis). Nonlinear static analysis can be utilized in order to assess the performance of structural systems (Ashish, et al., 2014).

Standard pushover as well as modal pushover analyses are employed to look into power-based seismic designs for structures with irregular planning. To assess the accuracy regarding the two approaches, nonlinear time analysis is used. The "C", "L", and "T" building models of (G + 6) floor irregular and regular buildings have been used in this work. They were



created using ETAB computer program (V9.7.3). floor plan building shapes have been chosen in such a way that the overall floor plan area is similar, resulting in roughly equal dead load as well as payload values. Examined are a number of characteristics, including power point, pushover curve, twist, plastic hinge mechanism, and so on. The findings demonstrate that for regular structures, results of traditional pushover analysis are identical to results of modal pushover and time-lapse analyses, yet for irregular buildings, the modal pushover analysis yields better results. Better outcomes come from taking into account the fashion influence. Additionally, as a twist in irregular buildings is about 20% higher when compared to the typical buildings, the consequences of twist must be taken into account. The above-mentioned method yielded a power-based seismic design that also complies with tolerance requirements for immediate occupancy and life-time safety limit states for particular seismic intensity values (Ashish and Abhijeet, 2015).

The majority of Sudan's existing infrastructure is neither designed or structured to withstand seismic pressures appropriately. The research examined the seismic damage to existing, five-story reinforced concrete structure in Khartoum, Sudan. The research took into account three levels of performance: life safety, immediate occupancy, and prevention of collapses. Utilizing SAP2000, gravity push has been performed by utilizing the force control approach and the lateral push with the control of displacement. Push curve, which is comprised of the demand spectrum, capacity spectrum, and performance point, is a result of pushover study. It displayed the degree of building component performance as well as the maximum foundation shear carrying capacity. Between point B and point C at X direction, which represents the level of life safety, and between point B and point C at Y



direction, which represents the level of collapse prevention and life safety, it was noticed that the demand curve crossed the capacity curve. As a result, several structural components must be strengthened (Ismaeil, 2018). Similar to various other cities throughout the world, Basrah's engineers did not take seismic forces into account when designing the city's structures. It was once thought that earthquakes were not common in Basrah. Latest seismological investigations revealed that the city is close to active fault with significant damage potential as well as a thick alluvial city soil layer which is prone to liquefaction throughout the earthquakes. As a result, the seismic assessment of present buildings attracts more attention and is increasingly demanded by the general public. In the present paper, a G+5 storeys reinforced concrete building has been examined by the use of the non-linear static analysis (Pushover analysis) depending upon ATC-40 capacity spectrum method.

Three scenarios—irregular in plan, regular, and irregular in height—are used to examine the structure. Depending on the UBC97 code, seismic coefficients for design earthquake were employed in analyses. Findings indicated that the building is overdesigned in each of the three situations and that its performance throughout design earthquake is only a small bit over the value of the elastic limit. All of the plastic hinges that have been created for building perform below the level of the immediate occupancy. Additionally, the building had weak beam, and strong column characteristic. The building is therefore anticipated to be secure throughout any earthquakes that are smaller than or equal to the design one (Al-jassim and Abdul Hussain, 2018). Through assessing their performance with the use of non-linear pushover analysis, a G+20 story symmetrical building structure's PBSD was completed. The performance regarding the structure



was examined after different structural elements, such as the beams and columns, received enhanced reinforcement in different combinations. The SAP2000 Non-linear software package was used to complete the Non-Linear analysis once the reinforcement design was completed in ETABS. The key objective of this research is to use performance-based seismic engineering to examine seismic responses of RC-framed constructions. With the use of nonlinear pushover analysis, the impact of an earthquake force on a multi-level building with a height of (G+20) has been examined for several distinct sets of reinforcements at different levels (Shashi and Mohd,2020).

Geometric irregularities in the constructions—whether in elevation or plan—had evolved into one of the frequent difficulties which structural engineers currently confront as a result of design requirements. The existence of setbacks in the building is typically related with irregularities in elevation. Pushover analysis, a non-linear static analysis method, is utilized in this work for examining and assessing seismic responses of numerous of the R/C multi-storey moment-resisting frame constructions with a single symmetric setback. This method is utilized for determining the seismic capacity regarding buildings for design reasons. Mass proportionate triangular pushover analysis, mass proportionate uniform pushover analysis, the approach of the modal combinations, and enhanced upper bound approach are the four techniques of pushover analysis that have been used for various vertical setback configurations. Additionally, the non-linear time-history analysis has been used in order to calculate the mean values as well as standard deviations of seismic responses with the use of seven scaled earthquakes. The mean findings generated through nonlinear time-history analysis are put to comparison with results of inter-story drifts for



damage as well as base shear for strength determined by using pushover analyses approaches. The enhanced upper bound pushover approach is best to calculate the damage depending upon the inter-story drifts for the R/C multi-storey moment-resisting frame buildings with setbacks, according to a comparison study with a nonlinear time-history analysis, while mass proportionate uniform pushover approach is more sufficient for determining base shear capacities of the buildings (El-esnawy, *et al.*, 2020).

Third / The Dynamic Effects of Forces on Buildings:

A structural analysis form that is called structural dynamics examines the way that a structure responds to dynamic (activities with a high acceleration) loading. Dynamic loads include traffic, blasts, waves, wind, humans and earthquakes. Dynamic loading can be applied to any structures. Finding dynamic displacements, modal analysis, and time history, could all be done by using dynamic analyses. The key objective of the structural analyses is ascertaining the way that a physical structure responds to the force. This activity could take a shape of load that is brought on by weight of some things, such as furniture, wind, snow, people, and so on, or it might be involving another excitation type, such as earthquake or ground shaking due to nearby blast. As a result of the fact that such loads have been absent at a point in the time, all such loads—which include the own weight of the structure—are dynamic in their nature. Whether applied action has good acceleration with respect to natural frequency of the structure is distinguishing dynamic analyses from the static ones. The forces of the inertia (i.e. Newton's 1st law of motion) could be disregarded and the analysis might be reduced to a static analysis if a load is applied slowly enough. When a load varies very

slowly, it is said to be static. A dynamic load is one that alters quite quickly over time compared to the inherent frequency of the structure. Static analysis could be used to identify a structure's responsiveness if it changes slowly, while dynamic analysis is required if it changes quickly with respect to structure's capability to respond.

Fig. 2 shown effects:

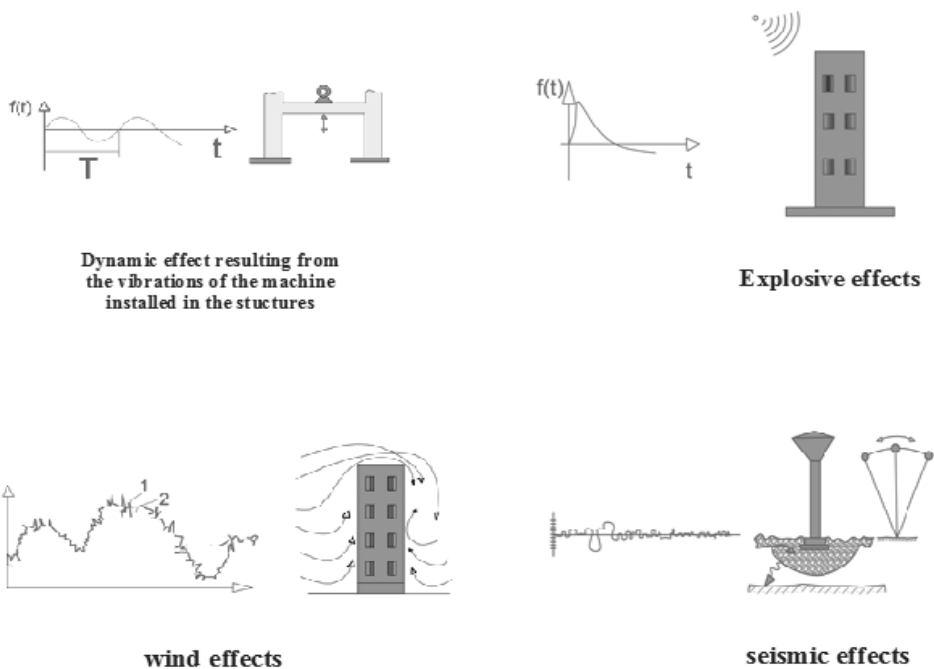


Figure 1: Dynamic Effects of Forces on Buildings



Fourth / Protecting buildings from earthquakes:

1 - Construction of flexible foundations for buildings

This technique involves lifting the building's foundation above the ground through what is referred to as base insulation in order to resist vibrational force. Buildings are raised on flexible bases that are comprised of rubber, steel, and lead that have been insulated. The insulators vibrate as base shakes throughout an earthquake, but the structure of the building does not move. This technique helps absorbing seismic vibrations and keeps the building from being destroyed by them.

2 - Placement of seismic bumpers or dampers

This method comes with the same idea as shock absorbers in cars and engineers have used the same idea in earthquake-resistant buildings. It is also used in cars to absorb and reduce road shocks, so it works in the same way in buildings to reduce the size of shock waves and reduce pressure above the building.

3 - Vibration Controllers

This approach is based on inserting dampers between the columns and walls, as well as on each floor of the structure. Each damper is made up of piston heads that are housed in a cylinder that contains silicone oil. Those dampers receive vibrational energy from the building during an earthquake, which is then pushed up on the existing oil. The force of the vibrations is after that concealed by the energy's transformation into heat.



4 - The power of the pendulum to repel earthquakes

Another well-known method of protecting buildings from earthquakes is the power of the pendulum, and this method is used especially in skyscrapers. Engineers install a sizable ball of steel cables that are linked to hydraulic system at top of a building when this technique is being used. This ball serves as pendulum and swings in the opposite direction so as to steady the building in case where it begins to move due to an earthquake. This technique is similar to damping in that this force is modified to correspond to the movement of the building during an earthquake.

5 - Seismic Cloak of Disappearance

The idea of this method is not only for buildings to face seismic forces, but researchers are seeking to create ways in which buildings can divert energy from earthquakes and redirect it to another benefit. This method is done through what is known as a "seismic disappearance cloak" and this cloak consists of 100 rings united in the center made of plastic and concrete placed at least 3 feet below the foundation of the building. When seismic forces occur inside the rings, the vibrations are converted to move towards the outer rings and as a result, the force is directed away from the building and scattered inside the ground.

6 - Building structure enhancement

To resist any fall of buildings, the forces in the buildings must be redistributed in the event of any earthquake. Reinforcing concrete walls, cross arches, membranes, and ceilings with strong core elements increases the protection of the building.



7 - Materials used in earthquake-resistant buildings

Materials that are used in earthquake-resistant buildings have the goal of maintaining the stability of the structure. Some materials are placed during the construction of a strong and stable building not only to deal with the movement of earthquakes, but also because they are basic materials for construction.

Materials used in earthquake-resistant buildings include:

- Steel for construction.
- Wood.
- Bamboo.
- Reinforced concrete. (How to protect buildings...daqaeq.net).

Conclusion:

The goal of PBSD, a relatively new and cutting-edge method for seismic analysis as well as engineering of structures, is to produce a structure that can achieve specific predictable performance goals under various levels of earthquake motion. To satisfy designer-specified and code criteria, PBD, which necessitates extensive and complex computing work, uses non-linear static analyses. Nonlinear static analysis could be utilized so as to assess the performance of structural systems. This approach entails estimating the structural strength as well as deformation requirements as well as comparing them to the capabilities that are available at acceptable performance levels. A certain set of performance standards serves as the foundation for PBSD. This approach aims to improve the design industry's professionalism and client orientation. A quick scan of available literature reveals that significant strides were made in recent years. PBD generally aims to create engineered



structures that will operate predictably in future earthquakes. PBD is an increasingly important and effective instrument of design compared to the traditional code approaches, because to improvements in research and test facilities and the quick development regarding structural analyses and design programs.

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