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BASE-ISOLATION TECHNIQUES FOR REINFORCED CONCRETE STRUCTURE

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Abstract- *Seismic design concept of a structure is different in many ways because of the uncertainty of the earthquake loading and its behavior. Therefore, a restricted damage is allowed without allowing the collapse of the structure when subjected to the most severe earthquake likely at the site thus ensuring safety of lives and its utility. Accepting the probability of damage, on the basis that it is less expensive to repair when hit by an earthquake rather than making the structure earthquake damage proof. This concept results in a cost-effective design, which will be liable to earthquake damage but will not collapse in an event of severe earthquake. These design standards are also based on considerations of allowable stresses, permissible inelastic strain, desired factor of safety against collapse, acceptable damage etc. Careful design & construction detail can vastly improve the presentation of structure. For very significant structures/projects such as nuclear power plants, high dams, high rise buildings, and long span bridges, etc. & their high cost requires high degree of safety than the ordinary structures & therefore needs special design criteria. The major developments in basics idea & principles of seismic design, development of standardized shape of response spectra and its application, base-isolation techniques ,design for strength & ductility, developments in 2D/3D mathematical models and their behavior, soil-structure interaction and dynamic analysis, reinforcement detailing, integrity and continuity of structure, properties of material, Energy dissipating devices, Regular mass and stiffness distribution, increasing the plastic deformation capacity.*

This assessment is presenting the future trends in earthquake resist design features in RCC structure using base isolation methods, devices and concept. Conservative earthquake-resistant structural systems are fixed-base systems that are 'fixed' to the ground base. They originate their earthquake resistance from their capability to absorb seismic energy in specially designed regions of the structures, such as in beams near beam-column joints of RC frames. However, in base-isolated systems, the superstructure is isolated from the foundation by certain strategies, which reduce the ground motion transmitted to the structure. These devices assistance decouple the superstructure from destructive earthquake parts and absorb seismic energy by addition of significant damping. In evaluation to fixed-base systems, this technique considerably reduces the structural response and damages to structural as well as non-structural components. An important number of base-isolation strategies have been developed. Designing a base-isolated arrangement is still a difficult complex process, and its dynamic response tends to be more complex than the fixed-base system. Presently, only certain types of structures are best suited for base-isolation for earthquake resistance, although technology is gradually overcoming these limitations.

Keywords- *RC frames, base isolation, earthquake resistance, fixed-base, 2D/3D mathematical model*

I. INTRODUCTION

Base isolation is the most commanding tool of the earthquake engineering relating to the passive structural vibration control tools. It is destined to enable a building or non-building construction to survive a potentially shocking seismic impact through a proper initial design or following modifications. In some cases, application of base isolation can raise both a structure's seismic performance and its seismic sustainability significantly. Contrary to popular belief base isolation does not make a structure earthquake resistant.

There are two elementary types of isolation systems. The system that has been accepted most widely in current years is characterized by the use of elastomeric bearings, the elastomer made of either natural rubber or neoprene. In this approach, the building or structure is decoupled from the horizontal elements of the earthquake ground motion by interpolating a layer with squat horizontal stiffness between the structure and the substance. This layer gives the structure an essential frequency that is much lower than its fixed-base frequency and also much lower than the major frequencies of the ground motion. The principal dynamic mode of the isolated structure includes deformation only in the isolation system, the structure above being to all intents and purposes rigid. The higher modes that will produce distortion in the structure are orthogonal to the first mode and therefore also to the ground motion. These higher modes do not contribute in the motion, so that if there is high energy in the ground motion at these advanced frequencies, this energy cannot be conveyed into the structure. The isolation system does not fascinate the earthquake energy, but rather bounces it through the dynamics of the system. This type of isolation works when the system is linear and even when undammed; however, some damping is helpful to suppress any possible quality at the isolation frequency.

Another basic type of isolation system is characterized by the sliding system. This works by preventive the transfer of shear across the isolation boundary. Many sliding systems have been planned and some have been used. In China there are at least three structures on sliding systems that use specially selected sand at the sliding interface. A type of isolation comprising a lead-bronze plate sliding on stainless steel with an elastomeric bearing has been used for a nuclear power plant in South Africa. The friction-pendulum arrangement is a sliding system using a special interfacial material sliding on stainless steel and has been used for numerous projects in the United States, both new and retrofit construction.

II. EARTHQUAKE PERFORMANCE OF FIXED BASE STRUCTURES

- Conservative Fixed Base Structures cannot be convincingly designed to remain elastic in large seismic actions,
- Mutual practice is to design them so that they understands damage in a measured manner and have large inelastic displacem ents potential,
- The Dynamic Features of Fixed Base Structures are determined by the general characteristics of the structural system and slightly variation is allowable,
- As a matter of fact, most common Building Constructions have negative Dynamic Characteristic that result in increased sei smic Response.

2.1 Strategy of Base-isolation:

A base isolated structure is buoyed by sequences of bearing pads, which are placed between the structure and structure foundation, the concept of base isolation is enlightened through an example building resting on frictionless rollers. When the ground vibrates, the rollers freely roll, but the structure above does not move. Thus, no force is moved to the building due to the shaking of the ground; simply, the building does not experience the earthquake.

Now, if the same building is rested on the plastic pads that offer resistance against side movement, then some effect of the ground shaking will be moved to the building above. If the elastic pads are correctly chosen, the forces encouraged by ground shaking can be a few times smaller than that experienced by the building built directly on ground, namely a fixed base structure. The elastic pads are called base-isolators, whereas the structures endangered by means of these devices are called base-isolated buildings. The main feature of the base isolation technology is that it presents elasticity in the structure.

2.2 Key of Base-isolation:

2.2.1 Flexibility:

A flexible mounting so that period of vibration of the complete system is elongated, adequately to decrease the force. Considerable decrease in base shear is likely as the period of vibration is elongated, but the degree of decrease is depending on the first fixed base period and shape of the response spectra curve. However, the added flexibility needed to increase the period will also result in large comparative movements across the flexible mount Knowingly increase the period of the structure and the damping so that the response is significantly reduced.

2.2.2 Energy dissipation:

Damping or energy debauchery devices are provided in a base isolation system in order to regulate the relative deflections in between the structure and ground to an applied design level. Damping can be attained through viscous damping, hysteretic dissipation or friction. The term hysteretic refers to the offset in loading and unloading curves below cyclic loading. Work done during loading is not completely improved during unloading and the difference is lost as heat.

The practical means of attaining energy dissipation include mechanical devices which use the plastic distortion of either mild steel or lead to achieve energy dissipation; mild steel bars in tension and cantilevers in flexure; friction between metallic and nonmetallic.

2.2.3 Rigidity under service loads

While lateral flexibility is required to isolate against seismic loads, it is undesirable to have structural system that will shake noticeably under regularly occurring loads such as minor earthquakes or wind loads. Specially expressed elastomers take advantage of requirement of shear modulus on strain amplitude to provide initial resistance to wind. At low strains these elastomers exhibition high moduli that are typically 3-4 times greater than their moduli at higher strains. Some other issues are-

- Isolator mechanisms inserted between the foundation and superstructure.
- Isolators have large distortion potential allowing for large drift on the isolation boundary and most types of isolators exhibit nonlinear performance.
- Isolation units are the basic rudiments of base isolation system which are planned to provide the mentioned decoupling effect to a structure or non-building structure.
- Isolation components are the networks between isolation units and their parts having no decoupling effect of their own.

III. MOST COMMON TYPES OF ISOLATORS OR ISOLATION DEVICES AND TECHNIQUES

In base isolation arrangements, nonlinear devices such as lead-rubber bearings, friction plumb bearings, or high damping rubber bearings are frequently used. The advantage of these types of bearings is that the reinstating force and adequate damping volume can be gained in one device. However, because the dynamic characteristics of these devices are strongly nonlinear, the vibration reduction is not optimal for a wide range of input ground motion concentrations. Some others are-

- Elastomeric Isolators,
- Sliding Isolators,
- Natural Rubber Bearings,
- Low-Damping Rubber Bearings,
- Lead-Plug Bearings,
- High-Damping Rubber Bearings,
- Resilient Friction System,
- Friction Pendulum System.

3.1 Smart Base Isolation System:

A smart base isolation strategy is planned and shown to efficiently protect constructions against extreme earthquake without foregoing performance during the move frequent, reasonable seismic events. The projected smart base isolation system is composed of conservative low-damping elastomeric bearings and controlled (semi active) dampers such as magneto rheological fluid dampers. The main feature of these semi active manageable systems arises from the mixture of the adaptable nature of a fully active control system within the stability features of passive control systems, while maintain low-power requirements. Smart dampers are to provide a superior base isolation system for a broad class of earthquakes including near-source proceedings as well as for a broad range of input levels. Thus a smart damper system can defend a structure from extreme earthquakes without sacrificing performance during the more frequent reasonable seismic events.

3.2 Magneto rheological damper (MRD)-

MRD Semi active governor devices have established significant attention in recent years because they offer the flexibility of active control devices without needful the associated large power sources. Magneto rheological discouragements are semi-active control devices that use MR fluids to produce manageable dampers. They possibly offer highly dependable operation and can be viewed as fail-safe in that they become passive dampers should the control hardware fault. A semi-active control device is one that has properties that head-to-head in real time but cannot input energy into the system being controlled. In the Magneto rheological damper, the main part is the Magneto rheological fluid, which has the main function of vibration fascination. MR fluids are the magnetic analogs of electro logical fluids and typically consist of micron-sized, magnetically polarizable particles discrete in a carrier medium such as mineral or silicon oil. When a magnetic field in applied to the fluids, particle chain form and the fluid becomes a semi-solid and exhibits viscoelastic behavior similar to that of ER fluid. Transition to rheological equilibrium can be attained in a few milliseconds, allowing construction of devices with high bandwidth. MR fluid can collaborate at temperatures form 40-150degree Celsius with only slight variations of yield stress MR fluids are not sensitive to impurities such as are commonly encountered during engineering and usage, and title particle/carrier fluid departure takes place in MR fluids under common flow situations. The MR fluid can be readily measured with a low voltage (e.g.: 12-24 V), current-driven power stock outputting only 1-2amps.

MR fluid consists of a suspension of small colloidal elements, each of which contains many tiny, randomly concerned with magnetic grains. An outside magnetic moment in applied in each particle. Each particle then becomes a magnet moment in applied in each element. Each element then becomes a magnet is measured by the applied field strength. A sea of electromagnets cooperates with each other and form chains, which further unite into large, scale structures within colloidal postponement, these fluid induced structures within colloidal suspension. These fluid encouraged structures within colloidal suspension. These fluid induced structures forcefully modify the viscosity, turning the fluid suspension into a solid similar plastic. The properties of an MR fluid can be switched on and off rapidly and repeatedly by the application of outside magnetic fluid.

IV. SELECTION OF BASE-ISOLATION METHOD AND DESIGN

There are numerous isolation approaches and strategies available base isolation design base design and are being advanced, and the code does not “prefer” a type, yet it requires that the system have the following six properties:

- It should be stable for the compulsory movement,
- It should be increasing resistance with increasing movement,
- Should be able to support the structure and able to dissipate energy,
- Should not damage under cyclic loading,
- No buckling and constancy of elastomeric bearings, and
- High-strain stiffening of elastomeric bearings

4.1 Steps for a Code based design:

- Determine and found parameter-dependent issues.
- Select a type of bearing and estimate target values, such as stiffness, damping ratio and bearing movement.
- Relate required dimensions of the isolation bearing unit with target values from step 2.
- Detail actual dimensions for isolation unit.

4.2 Advantages:

Base Isolation also defends non-structural elements and equipment by reducing the whole structure's acceleration during an earthquake, as opposed to reinforcement. It provides-

- Content Protection
- Investment Protection
- Historical Building Preservation
- Maintain Functionality

4.3 Significantly Factors that influence base-isolation design:

- Importance of building
- Soil profile
- Availability and shipping
- Height of structure
- Labor
- Site plan
- Architectural requirements etc.

4.4 Limitations:

- Base isolation enables the decrease in earthquake-induced forces by lengthening the period of vibration of the structure. Benefits gained from base isolation are in structures for which the important period of vibration without base isolation is less than 1 seconds. The natural period of structure increases with increasing height. Taller structures reach a limit at which the natural period is sufficient to attract low earthquake forces without isolation. Therefore, seismic isolation is most appropriate to low and medium rise buildings and develops less effective for tall ones. The cut off mostly depends on structural systems or type of framing arrangement.
- Cost involved in constructing a new building is higher than the cost of conventional earthquake resistant structural system. Seismic isolation bearings are expensive.
- Requirement of tests on prototype bearing of every type increases the cost of the project. Therefore, growth and calibration of testing methods for assessing the properties of isolation devices should be expressed.

V. CONCLUSION-

- Seismic base isolation method has proved to be a reliable method of earthquake resistant Design.
- The success of this method is largely attributed to the development of isolation devices and proper planning.
- Different types of isolation devices have been proposed and extensive research has been made on them. They can help the purpose for nearly all types of conditions.

References-

1. Clark, Peter W., Masahiko Higashino, and James M. Kelly. 1996
2. Kelly, James. M. 1997. Earthquake-Resistant Design with Rubber. 2nd ed. Berlin and New York: Springer-Verlag. "Base Isolation: Origins and Development," EERC News, Vol. 12, No. 1, January 1991 by NISEE.
3. Kelly, James M.; Naeim, Farzad. Design of Seismic Isolated Structures: From Theory to Practice.
4. Deb, S. K., Paul, D. K. and Thakkar, S. K., Simplified nonlinear analysis of base isolated buildings subjected to general plane motion.
5. Chopra, A. K, Dynamics of structures, Pearson Education Asia, 2001.
6. Hoskere, Vidyashankar, Some fundamental aspects of Seismic resistant design, Aug-Sept 2001, Vol: 2.
7. Jain, Sarvesh Kumar, Seismic isolation devices: A Review, Bridge and Structural Engineering Journal, June 2004, Vol: 7.
8. Kasalanati, Amarnath, Base isolated structure, the master builder, Aug-Sept 2001, Vol: 2.
9. Rai, C, Durgesh., Future trends in Earthquake resistant design of structures, Current Science, Oct 2001, Vol: 79, No:9.

