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PERFORMANCE BASED SEISMIC DESIGN- AN INTRODUCTION TO A NEW APPROACH IN EARTHQUAKE ENGINEERING

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ABSTRACT

A large percentage of the building structures throughout the world was constructed either without consideration of seismic resistance or earlier the requirements of earthquake resistant building construction were fully understood. As a result, several buildings in all sections of the world pose a hazard and should be subjected to strong or moderate ground shaking. Techniques are needed for the upgrading and redesign of these potentially hazardous structural buildings. Present seismic design codes and practices were transcribed to achieve a loosely defined objective for providing building resident safety. This paper has been prepared to guide the growth of nextgeneration performancebased seismic design techniques and guidelines applicable to new and existing structural buildings. These procedures or methods are directed towards overcoming key deficiencies in our present design practice. Performance based seismic design aims to produce buildings that perform during earthquakes according to beliefs and with improved economy.This paper offers background on existing code design procedures, performance based seismic design, and enhancement needed in existing seismic design practice

Keywords-. *performance, seismic, design codes, earthquake.*

Introduction

Earthquakes are a global problem, not just a national or regional problem. While the economic consequences of recent earthquakes have been great as they pale by comparison with anticipations for a great earthquake. We need improved and better design procedures that result in enhanced performance, and need to better communicatethe performance prospects and the associated costs to the public.A move in the direction of Performance Based Seismic Design (PBSD) is a move toward a completely fresh generation of seismic design codes. It cannot be attained through the typical process in a timely and effective manner.The performancebased design methodology is not recommended as an immediate substitute for design to traditional design codes. Rather, it can be observed as a prospect to improve and modify the design to match the goals of the community's stakeholders. It sets forwardtasks, objectives, recommended budgets and a schedule to be used as a source for the implementation of a project that builds on current concepts for performance based seismic design and formulates aoutline for a next generation methodology.

EXISTING BUILDING CODE PROCEDURES FOR SEISMIC DESIGN

Design and construction in the India is generally regulated at the local or state level using codes based on national building design codes and standards. When accepted and enforced by local authorities, building codes are proposed to establish least possible requirements for providing safety to property and life from fire and other hazards.This goal is accomplished over the specification of prescriptive criteria that control acceptable materials of construction, identify sanctioned structural and non-structural systems, specify required minimum levels of stiffness and strength, and control the details of how a structural building is to be put together. Prescriptive necessities are based on wide classifications of buildings and occupancies, and are usually stated in terms of fixed values such as allowable area and height, fire resistance ratings, and specifications related to structural design (e.g., live loads, dead loads, snow loads, wind loads, earthquake loads, rain loads, etc.).

Although the prescriptive criteria of typical building codes are intended to result in structures capable of providing certain levels of performance, the real performance capability of individual building designs is not assessed as part of the traditional code design procedure. As a result, the performance capability of structures designed to prescriptive criteria can be flexible and, for a specifiedstructure, may not be precisely known. The performance of some structures designed to these prescriptive principles can be better than the minimum criterions anticipated by the codes, while the performance of others could be worse. The development of seismic design standards is an on-going process of improvement. The advancement of seismic design provisions in typicalstructure codes can be tracked against the

occurrence of destructive earthquakes. Earthquakes in the early part of the 20th century (e.g. 1925 Santa Barbara and 1933 Long Beach earthquakes) led to the improvement of procedures to provide for minimum levels of lateral strength. In the later part of the 20thcentury earthquakes such as 1971 San Fernando Earthquake led to the understanding that, in addition to strength, structures needed to have the ability to deform without catastrophic failure (a characteristic well known as ductility). Building owners and occupants generally believe that adherence to building codes provides for a habitable and safe environment, and anticipated degrees of damage are not a usual consideration for owners and most design professionals. Experience in earthquakes at the end of the 20thcentury (e.g. 1994 Northridge and 1995 Kobe earthquakes) has forced recognition that damage, sometimes severe, can occur in structures designed in accordance with the codes. Property and insured losses as a result of the Northridge Earthquake, led to awareness that the level of structural and non-structural damage that could occur in codecompliant structures may not be consistent with public concepts of acceptable performance.

Changes in the state of knowledge and evolution of seismic design principles have also led to changes in engineering exercise and research. With an emphasis on providing stakeholders the facts needed to make rational business or safety related decisions, practice has moved toward predictive approaches for assessing potential seismic performance. At the same time professionals and researchershave been working on the development of new methodical tools and test data needed to improve assessment techniques. Recognition that code based strength and ductility requirements applicable for the design and development of new structures are not suitable for the evaluation and advancement of existing structures has led to the development of performance based engineering procedures for seismic design.

PERFORMANCE BASED SEISMIC DESIGN (PBSD)

The performancebased seismic design process clearly evaluates how a building is likely to perform; given the potential hazard it is likely to experience, considering uncertainties integral in the quantification of potential hazard and uncertainties in valuation of the actual building response. In performancebased design, identifying and assessing the performance capability of a building is anvital part of the design process, and guides the many design decisions that must be made.

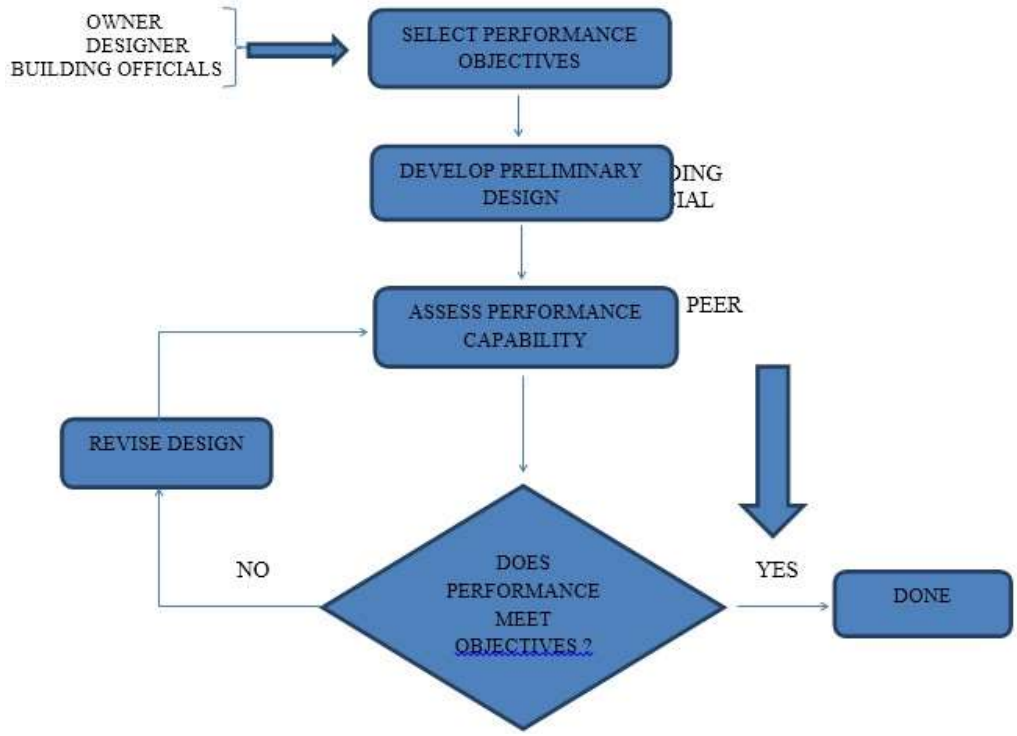

Figure shows a flowchart that presents the main steps in the performancebased design process. It is an iterative process that initiates with the selection of performance goals, followed by the development of a primary design, an assessment,

whether or not the design meets the performance objectives, and finally redesign and reassessment, if required, until the anticipated performance level is achieved.

Performancebased design begins with the selection of design principles stated in the form of one or more performance objectives. Every single performance objective is a statement of the acceptable risk of incurring definite levels of damage, and the consequential losses that arise as a result of this damage, at a definite level of seismic hazard. Losses can be associated with structural damage, non-structural damage, or both. They can be expressed in the form of direct economic costs, casualties, and downtime (time out of service), resulting from damage. Procedures for estimating losses and communicating these losses to stakeholders are at the heart of the evolution of performancebased design.

Usually, a team of decision makers, including the building owner, building officials and design professionals, will take part in the selection of performance objectives for a building. This team may consider the desires and needs of a wider group of stakeholders including prospective tenants, insurers, lenders and others who have influence on the value or use of a building, but may not directly take part in the design process. Stakeholders must estimate the risk of a hazard event occurring, and must obtain consensus on the satisfactory level of performance. The basic questions that should be asked are:

- What events are anticipated?
- What level of damage/loss/ casualties is acceptable?
- How often might this take place?

While specific performance objectives can differ for each project, the notion of acceptable performance follows a trend normally corresponding to:

- Little or no damage for small size, frequently occurring events
- Moderate damage for medium size, less frequent events
- Significant damage for very large size, very rare events

Once the performance objectives are set, a series of simulations (analyses of structural building response to loading) are performed to estimate the feasible performance of the building under numerous design scenario events. In the case of extreme loading(by a severe earthquake) simulations may be performed using nonlinear analysis techniques. If the simulated performance meets or exceeds the performance objectives, the design is complete. If not, the design is revised in an iterative process until the performance objectives are met. In some cases it may not be possible to meet the stated objective at reasonable cost therefore some relaxation of the original objectives may be appropriate.

BENEFITS OF PERFORMANCE-BASED SEISMIC DESIGN

In contrast to prescriptive design methodologies, performancebased designprovides a systematic methodology for evaluating the performance capability of a structure, system or component. It can be used to verify the equivalent performance of alternatives and deliver standard performance at a reduced cost, or confirm greater performance needed for critical facilities. It also establishes a vocabulary that enables meaningful discussion between design professionals and stakeholders on the development and selection of design options. It provides aoutline for determining what level of safety and what level of property protection, at what cost, are acceptable to stakeholders based upon the specific needs of a project.

Performancebased seismic design can be used to:

- Design individual structures with a higher level of confidence that the performance intended by current building codes will be achieved.
- Design individual structures that are capable of meeting the performance intended by current building codes, but with lower construction costs.
- Design individual structures to achieve higher performance (and lower potential losses) than intended by current building codes.
- Design individual structures that fall outside of code prescribed limits with regard to material, configuration, and systems to meet the performance intended by current building codes.
- Assess the potential seismic performance of current structures and estimate potential losses in the event of a seismic event.

- Evaluate the potential performance of existing prescriptive code requirements for new structures, and serve as the basis for improvements to code based seismic design criteria so that future structures can perform more consistently and reliably.

Performance based seismic design offers society the potential to be both more effective and efficient in the investment of financial resources to avoid forthcoming earthquake losses. Further, the technology used to implement performancebased seismic design is transferable, and can be modified for use in performancebased design for other extreme hazards including snow, fire, wind, flood, blast, and terrorist attack.

THE NEED FOR NEXT-GENERATION PERFORMANCE-BASED SEISMIC DESIGN PROCEDURES

In order to fulfil the promise of performancebased engineering and help ensure that performancebased seismic design delivers on its full potential for decreasing future losses from earthquakes, nextgeneration performancebased design procedures are required to:

- Revise the discrete performance levels to create new performance measures (e.g. repair costs, time of occupancy interruption and casualties) that better relate to the decision making needs of stakeholders and professionals , and that communicate these losses in a way that is more significant to stakeholders;
- Create procedures for estimating probable repair costs, time of occupancy interruption and casualties for both new and existing structures;
- Expand existing non-structural procedures to explicitly evaluate the damageability and post-earthquake functionality of non-structural systems and components, which can constitute a significant percentage of the economic loss related with damaging earthquakes;
- Develop a framework for performance assessment that correctly accounts for, and adequately communicates to stakeholders and professionals, limitations in our ability to precisely predict response, and uncertainty in the level of earthquake hazard;
- Refine existing analytical techniques to improve our ability to more correctly simulate building response;
- Fill knowledge gaps and investigate the conservatism and reliability of acceptance criteria; and
- Modify existing structural procedures to assess performance based on global response parameters, so that the response of distinct components does not unnecessarily control the prediction of complete structural performance.

CONCLUSION

Earthquakes are worldwide problem not just a national problem. There is a great need to understand the behaviour of this natural phenomenon. There are lots of seismic design codes which produced satisfactory results in the field of earthquake resistant building construction. As the earthquake is a natural phenomenon therefore its varying nature results in catastrophic failure of some of the effectively designed structures. So performance based seismic design is an alternate to this problem. This PBSD methodology is in its initial phase and needs to be modified for the benefits of construction industry. In this paper number of points was discussed to enhance the PBSD methodology.

REFERENCES

[1] FEMA, “Performance Based Seismic Design of Buildings” September 1996.
[2] Pacific Earthquake Engineering Research Center, “Guidelines for Performance Based Design of Tall Buildings,” Version 1.0, Nov. 2010.
[3] Katsuhiko Yamawaki, Haruyuki Kitamura, Yasuhiro Tsuneki, Nobuyuki Mori, Satoru Fukai, “Introduction of a Performance-Based Design,” in 12WCEE 2000.
[4] FEMA, “Next-Generation Performance-Based Seismic Design Guidelines,” FEMA-445, Aug 2006.
[5] M J N Priestley, “Performance Based Seismic Design,” in 12WCEE 2000.
[6] Bruce R. Ellingwood, “Performance Based Engineering for Multiple Hazards: The Role of Structural Reliability and Risk Assessment,”.
[7] MitumasaMidorikawa, IzuruOkawa, Masanori Iiba, MasaomiTeshigawara, “Performance-Based Seismic Design Code for Buildings in Japan,” in Earthquake Engineering and Engineering Seismology, Vol. 4, No. 1.