CHAPTER II

LITERATURE REVIEW

2.1. Performance Based Seismic Design

A new design procedure of structure which has one or more performance objectives to meet is referred as Performance-Based Seismic Design (PBSD). The main objective of Performance-Based Seismic Design (PBSD) is to develop design methodologies for predictable and intended seismic performance of structure under stated level of seismic hazards (SEAOC, 1995). The PBSD become familiar to the researchers after the 1994 Northridge Earthquake which is considered as most costly earthquake in US history. The secondary objective of PBSD is to control the property damages under frequent seismic events. Details guidelines for PBSD are described in Appendix 1 of SEAOC Blue Book (1999).

Selection of seismic performance objectives is the first step for the design in PBSD. According to SEAOC Blue Book Appendix G & I (1999), performance level of PBSD is identified in four level which is ranged from fully operational to near collapse. Fully Operational, Operational, Life Safe, and Near Collapse are the four performance level which is described in details in the Vision 2000 reports. As a performance objective is a coupling of expected performance level with expected levels of seismic ground motions. SEAOC Blue Book (1999) define four level of earthquake hazard (seismic ground motion) for the performance objective. Earthquake 1 (EQ-I) represents

EQ-I represents a frequent event and is defined as the earthquake that has an 87 percent probability of exceedance in a 50-year period. Such an earthquake has an annual probability of exceedance of 4 percent (mean recurrence interval of approximately 25 years). Earthquake 2 (EQ-II) has 50 percent probability of exceedance in a 50-year period, Earthquake 3 (EQ-III) has an annual probability of exceedance ranging between 0.12 percent and 0.4 percent, and Earthquake 4 (EQ-IV) has an annual probability of exceedance ranging between 0.04 percent and 0.12 percent. EQ-IV ground shaking is limited by deterministic limits on the Maximum Considered Earthquake (MCE).

Structural and nonstructural performance level is defined as Structural Performance (SP) and Nonstructural Performance (NP) in SEAOC Blue Book (1999). Both SP and NP is divided into five performance level which is shown in figure 2.1. Three standard performance objective like Basic Safety Objective (BSO), Enhanced Objective 1 (EO1), and Enhanced Objective 2 (EO2) is also shown in figure 2.1. The hazard level is determined in terms of return period or annual probability of exceedance by Probabilistic Hazard Analysis (PSHA).

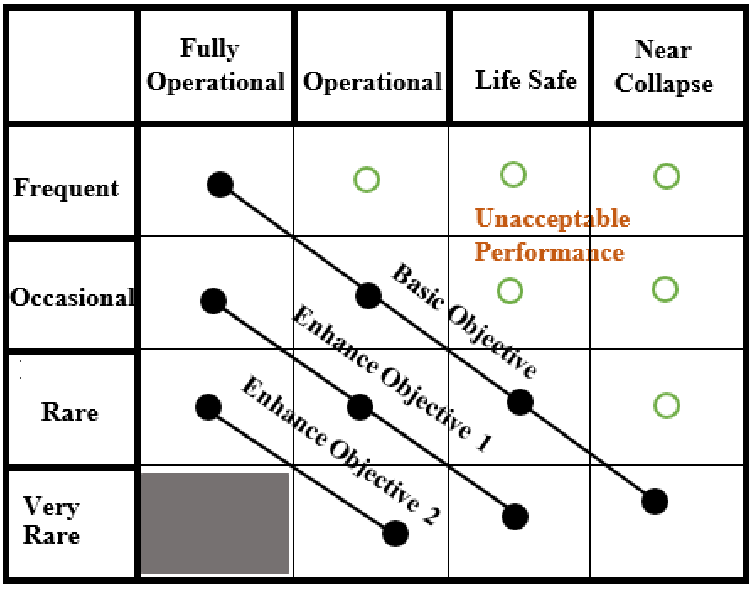

Figure 2.1. Standard performance objective

2.2. Displacement-Based Seismic Design

The performance of a structure mostly depend on ductility demand, displacement, inter-story drift etc. under severe earthquake. Displacement-based design consider the effect of ductility demand, displacement, inter story drift and others factor while designing components of structure. It is also noted that this method can also be used to achieve the performance level for various hazard levels. As a result, displacement-based design method is considered as the main function of performance based design.

Fajfar and Gaspersic (1996) using a method called N2 determined demand roof displacement and calculated damage index for structure. This N2 method was applied on two 7 story RC frame and frame wall structure. Chopra and Goel (1999) presented two displacement based design procedures which is modified version of ATC-40 and FEMA-274. In this modified method, they used Newmark-Hall $R-\mu-T$ relationship to develop the inelastic demand spectra.

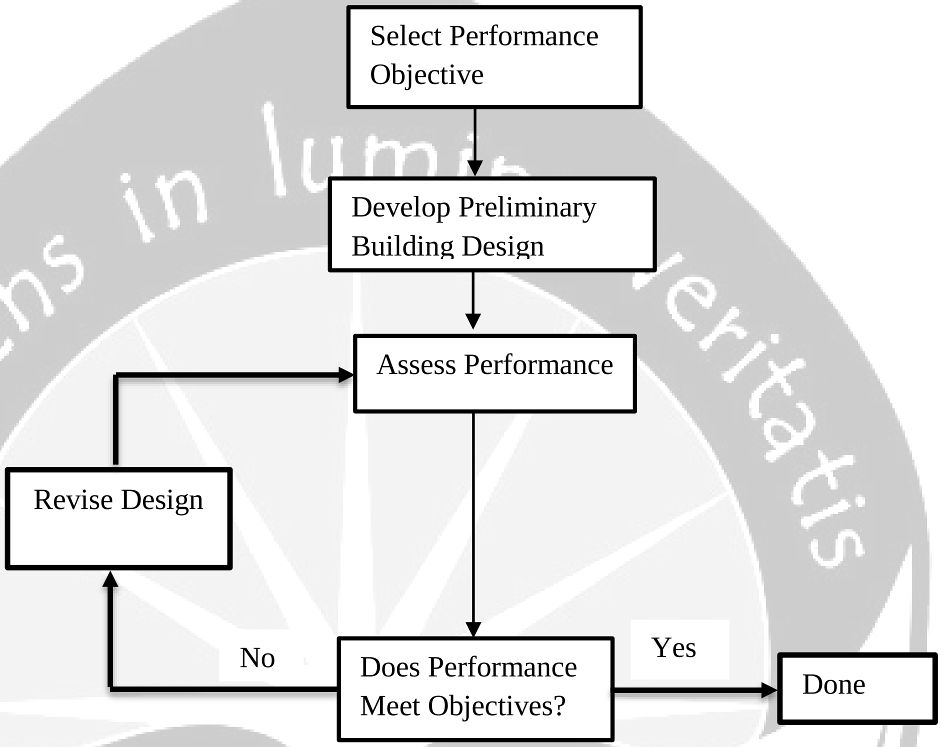

Figure 2.2. Design flowchart according to FEMA 445

FEMA 445 is describe the design flowchart to meet the performance objective of the structure. In the section of preliminary design, there is little guidance to design the component at this stage. In this study, plastic design based method is used in this section to design an 8 story RC-SMF with setbacks and analysis the results.

2.3. Major Weakness of Current Seismic Code

Present seismic design code basically based on force based methodology. Recent research works on displacement based design shows that current seismic provision is not sufficient to prevent the collapse and damage of the structure under severe earthquake. The major weakness of design code procedure is that the increasing value of design base shear will ensure the safety of structure. Moreover, lateral force distribution is based on elastic behavior. Furthermore, stiffness of the member is considered as elastic, but stiffness of member change significantly due to cracking or yielding of member.