CHAPTER II

LITERATURES REVIEW

2.1. Loading

In the process of structural design it is important to consider about loads that applied to the structure. Based on *Peraturan Pembebanan Indonesia untuk Gedung 1983*, loads can be categorized as follows:

1. Dead load

   Dead load consist of the weight of all materials of construction incorporated into the building including, walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and fixed service equipment.

2. Live load

   Live load is a load produced by the use and occupancy of the building or other structure that does not include construction and environmental loads.

3. Earthquake load

   Earthquake load is a static equivalent load which works on the structure or at some part of structure which follow the effect of soil behaviour due to earthquake.

2.2. Ductility

Ductility according to Indonesian Earthquake Code, SNI – 03 – 1726 – 2002 is the ability of structure to experience the post-elastic large deflection in many times due to earthquake loading more than earthquake loading that causing first yielding, while this structure maintain its strength and stiffnes, so the structure is still able to stand although on constant maximum displacement rule.

2.2.1. Ductility Factor

Ductility factor are computed from non-linear dynamic analysis undergoing different levels of displacement ductility demands and periods when subjected to a large number of recorded earthquake ground motions.

2.2.2. Ductility Level

According to Paulay, T. and Priestley, ductility level is classified as mentioned below:

1. Elastic Because of their great importance, certain buildings will need to posses adequate strenngth to ensure that they remain essentially elastic. Other structures perhaps

   is a ductility level of structure which its structure reaching the collapse verge condition simultaneously with the occurence of first melting, the value of ductility factor is 1.0,
2. Structures with restricted ductility: buildings, because of less than ideal structure configurations, it may be difficult to develop large ductilities, which would allow the use of low-intensity seismic design forces. Instead, it may be possible to provide greater resistance to lateral forces to reduce ductility

demands, the value of ductility factor is between fully elastic structure is 1.0 and fully ductility is 5.3.

3. Fully ductility: These are designed to possess the maximum ductility potential that can reasonably be achieved at carefully identified and detailed inelastic regions. A full consideration must be given to the effects of dynamic response, using simplified design procedures, to ensure that non-ductile modes or undesireable location of inelastic deformation can not occur.

2.2.3. Basic of Ductility Level Selection

Indonesia has six earthquake zones and they are classified into 3 zones, zone 1 and 2 are classified as low risk level of earthquake zone, zone 3 and 4 are classified as mid risk level of earthquake zone, whereas zone 5 and 6 are classified as high risk level of earthquake zone. Earthquake zone classification is helpfull to determine appropriate ductility level in structural design.

Jakarta is located in earthquake zone 3 with mid risk level of earthquake, so it is better if structure is designed by using full ductility level. In full ductility level design concept is based on the collapse of the plastic hinge of beams and columns at the base floor. In this case careful detailing of structural element must be considered.

2.3. Concrete Slab

Slabs are elements of buildings that are be supported by beams, girders or columns. Slabs experience bending and shear. Tension side in flexural slabs may be reinforced with steel. The shear stress in slab normally must be resisted by the concrete itself. Therefore, generally, there is no shear reinforcement in slab.

2.4. Beam

A beam is a structural element that carries load primarily in bending (flexure). Beams generally carry vertical gravitational forces but can also be used to carry horizontal loads (i.e. loads due to an earthquake or wind). The loads carried by a beam are transferred to columns, walls, or girders, which then transfer the force to adjacent structural compression members.

Depending on the properties of a beam, flexural failures may occur in three different ways, there are:

1. Tension failure, reinforcement yields before concrete crushes (reaches its limiting compressive strain) such a beam is said to be under-reinforced concrete
2. Compressive failure, concrete crushes before steel yields. Such a beam is said to be over-reinforced concrete
3. Balance failure, concrete crushes and steel yields simultaneously. Such a beam has balanced reinforcement.

2.5. Column

A column is a vertical structural element that transmits, through compression, the weight of the structure above to other structural elements below. Column normally support combined bending moment and axial load, under certain conditions column may support axial tension and bending moment, for example under earthquake and wind load.

For SMRF the building structures should fulfill the requirement of “Strong Column Weak Beam” concept. It means when building structure is subjected to seismic load, plastics hinge may occur at the end of beams and at the bottom of columns and structural walls. To avoid collapsed due to earthquake, it is important to design the structure in order to the structure has a ductile behavior.