CHAPTER II

LITERATURE RIVIEW

2.1 Tall Building

A tall building is not described by the number of stories or the height of the building itself, but It is defined when a building sway or drift affected by the lateral force such as winds and earthquake. The structural system of a building supports the weight of the building and ensure the safety of the occupants by maintaining the integrity of the building against live and lateral loads (Ali and Armstrong, 2006). The lateral load resisting building system shall be required due to the strength, serviceability and economical.

However, CTBUH (Council on Tall Buildings and Urban Habitat) classified about the minimum height of building shown in Fig 2.1. A "supertall" is a tall building 300 meters (984 feet) or taller, and a "megatall" is a tall building 600 meters (1,968 feet) or taller. As of today, there are 149 supertalls and only 3 megatalls completed globally.

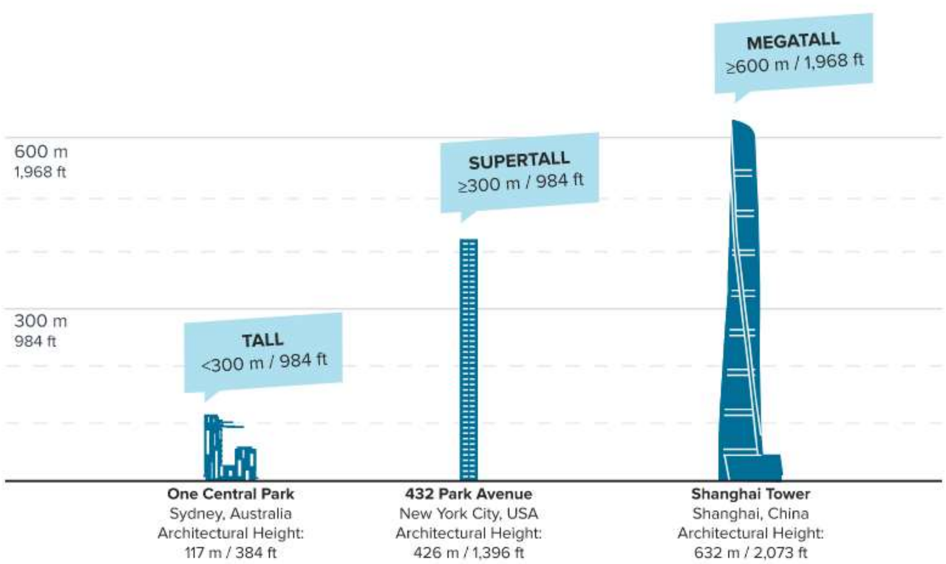


Fig 2.1 Classification of building height
(Source: CTBUH,2006)

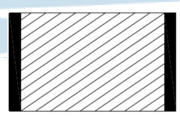
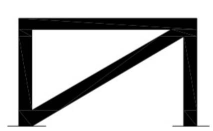
2.2 Lateral Load Resisting System

There are 3 types of structural which are made for resist lateral load, thus commonly serve for countries that have a possibility of an earthquake. These types described bellows:

- Braced frames
- Shear wall
- Moment resisting frames

Every building needs to have some type of thus three system, at least one to preventing building collapse by an earthquake. The differences between each type as follows:

Table 2.1 Types of Lateral Load Resisting System

 **Shear wall**	**More stiff**	**Less efficient**
 **Moment resisting frames**	**Less stiff**	**More efficient**
 **Braced frame**	**Stiff**	**Efficient**

The principles of efficient tall building structural design known for some time. Based on Taranath book "Reinforced Concrete Design of Tall Building" as follows:

1. Resist overturning forces due to lateral loads by using vertical elements placed as far apart as possible from the geometric centre of the building.
2. Channel gravity loads to those vertical elements resisting overturning forces
3. Link these vertical elements together with shear-resisting structural elements that experience a minimum of shear lag effects such that the entire perimeter of the building resists the overturning moments
4. Resist lateral forces with members axially loaded in compression rather than those loaded in tension due to overturning.

The structure system shall require the principles above to satisfying the needs. From Table 2.2 we know that, the dual system of shear wall-frame is suitable for 23 stories building.

Table 2.2 Structural System Structural system for lateral load resisting concrete buildings

No.	System	Number of stories												
		0	10	20	30	40	50	60	70	80	90	100	110	120-200
1	Flat slab and column	—	—											
2	Flat slab and walls	—	—	—										
3	Flat slab, shear wall and columns	—	—	—										
4	Coupled shear walls & beam	—	—	—	—									
5	Rigid frame	—	—	—										
6	Core supported structures	—	—	—	—									
7	Shear wall-frame	—	—	—	—	—								
8	Shear wall-haunch girder	—	—	—	—	—	—	—						
9	Closely spaced perimeter tube	—	—	—	—	—	—	—	—					
10	Perimeter tube and interior corewalls	—	—	—	—	—	—	—	—	—				
11	Exterior diagonal tube	—	—	—	—	—	—	—	—	—	—			
12	Modular tubes, and spine	—	—	—	—	—	—	—	—	—	—	—	—	—

(Source: Taranath (2006))

2.3 The Dual System

The purpose of the shear wall-frame interaction is to resist the horizontal loading provided by the shear walls and rigid frames. While each system carries its appropriate share of the gravity load, known as a dual system of lateral load resisting structure system. The frames are designed to resist 25% of the earthquake load, it means that the shear wall has to carry the load at least 75%. According to evaluate the reliability of a frame and shear wall structural system with static loading. The probability of failure of the combined system in serviceability become almost zero, the controling limit state has changed from serviceability to strength (Lee and Achintya,2003).

Seismic performance of High-Rise RC shear wall building has investigated subjected to ground motion with various frequency contents (afzali et al, 2017) . The buildings are designed with the same dimension of each elements and only different in story level. Thus, buildings level are 35, 30, 25, 20, 15 and 10.

Table 2.3 Maximum drift of buildings subjected to entire ground motions in percentage %

#	Earthquake Name	Station name	PGA in X axis (g)	PGV in X axis (g)	High Rise Building		Mid Rise Building		Low Rise Building	
					35 Story	30 Story	25 Story	20 Story	15 Story	10 Story
1	Chuetsu-oki_Japan	JoetsuOshimakuOka	0.613	2.93	0.1985	0.2117	0.2193	0.3944	0.372	0.3408
2	Imperial Valley-06	Bonds Corner	0.6	1.28	0.8033	0.9079	1.1226	1.0122	1.0058	1.274
3	Victoria Mexico	Cerro Pierto	0.645	1.91	0.4672	0.4833	0.6281	0.8981	1.0681	0.9339
4	Chi-Chi_Taiwan	CHY 028	0.636	1.03	1.5941	1.6613	2.2609	1.3663	1.4975	2.8624
5	Kobe Japan	Takarazuka	0.697	1.01	1.6942	1.7885	2.3019	2.593	2.5275	2.2115
6	Loma Prieta	Corralitos	0.645	1.15	0.6037	0.7277	0.8156	0.927	0.945	1.0827
7	Chuetsu-oki_Japan	Kashiwazaki	0.65	0.68	3.1912	3.0981	3.391	6.641	6.7367	4.0199
8	Chuetsu-oki_Japan	Oguni Nagaoka	0.625	0.79	1.107	1.3085	1.0158	1.1438	1.551	1.4675

9	Kobe Japan	Takatori	0.618	0.52	2.4373	2.159	3.2092	4.8843	4.128	5.5009

(Source: afzali et al, 2017)

Table 2.4 The Average for maximum drift from table above in %

35 Story	30 Story	25 Story	20 Story	15 Story	10 Story
1.344	1.372	1.663	2.207	2.204	2.188

From Table 2.4 it shown or proven that shear-wall system is efficient for building bellow 50 stories and above 20 stories. Under 20 stories flat slab might be more suitable for the system.

2.3.1 Core wall

Shear walls may become imperative from the economical and control of lateral deflection for buildings over 30 stories. In an earthquake design its designed to inhibit inelastic shear modes deformation. A shear wall located at the centre of the building is a core wall and is generally placed around the building services such as elevators and stairs see Fig. 2.2. and Fig 2.3. This considered a spatial system that is capable of transmitting lateral loads in both directions.

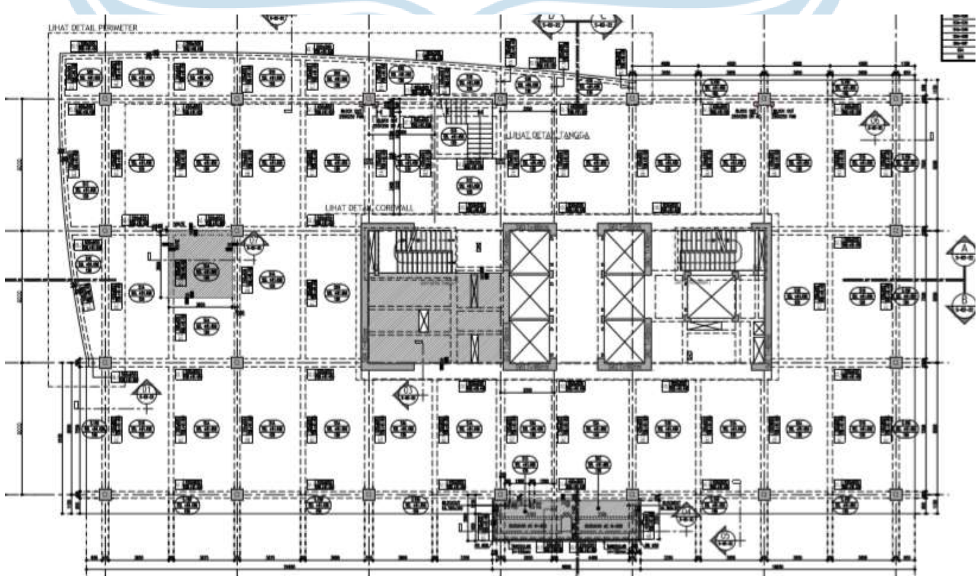


Fig 2.2 Floor plan

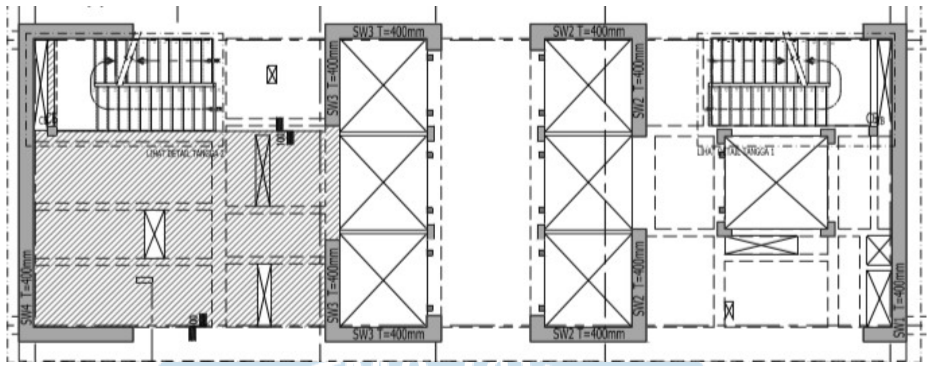


Fig 2.3 Core wall detail location

2.3.1 Wall-frame Behaviour

The system providing shear wall and rigid frame as a combination to resist the horizontal forces. Where each type deformed in different shapes, this can be quite effective to reducing the lateral deflection. The system is applicable for building 10-50 stories or even taller. The taller building the stiffer the frames, the greater the interaction (Taranath, 2006).

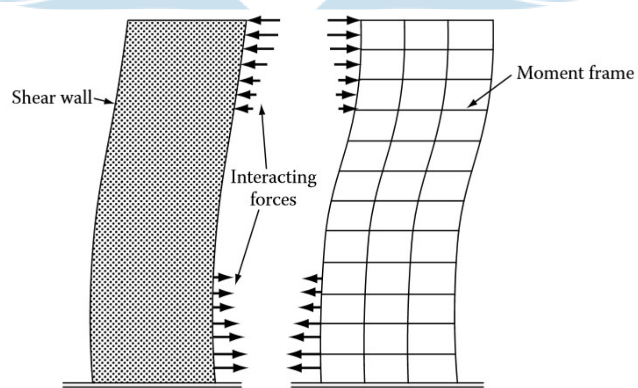


Fig 2.4 Deformation Patterns
(Source: Taranath,2006)

Fig 2.4 shown a shear wall-frame interaction, it is explaining the linear sway of the moment frames combined with parabolic sway of the shear wall. When the wall restrained by the frame at the upper level, at lower level a wall restraining a frame. However, a frame tends to behave more likely a shear wall responding predominantly in bending mode as shown in Fig 2.5 and Fig 2.6. Shear wall acts more likely a frame deflecting in shear mode.

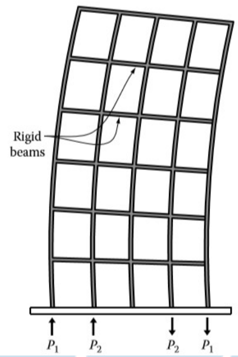


Fig. 2.5 Moment resisted by axial loads in column
(Source: Taranath,2006)

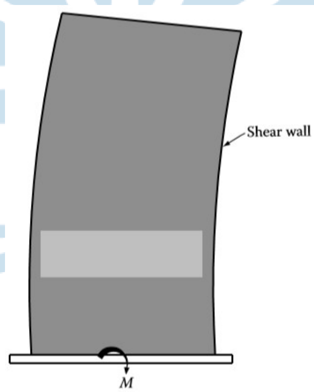


Fig 2.6 Cantilever bending of shear wall
(Source: Taranath,2006)

The structural action is depending on the rigidity and their deformed modes. It is a great deal when a different deflection characteristic of two system tends to help each other. The frame reducing the lateral deflection at top, while the shear wall supports the frame on base.