CHAPTER 1

INTRODUCTION

1.1 General View

In structural design, earthquake becomes a threat for buildings which can collapse anytime and leads to kill inhabitant. The concept of employing control systems in civil engineering structures to minimize the vibrational response was originally suggested by Yao (1972). Significant progress has been made in the design, development and verification of systems to mitigate the effects of environmental loads such as high winds and earthquakes. Recently, active and hybrid control systems have even been implemented in a number of structures. However, the engineering community is not yet ready to fully accept structural control systems to reduce the effects of natural hazards on structures. This lack of acceptance arises, in part, from questions of stability, cost effectiveness, reliability, power requirements, etc.

New control devices and strategies are continually being developed to address these issues in an effort to increase the acceptance of structural control systems. Many agree that the next generation of control research for civil engineering applications must focus on developing systems that are most implementable (Housner, *et al*., 1994a; Kobori, 1994). One necessary condition for a control strategy to be implementable is that it must use available measureable responses to determine an appropriate control action. Most of the previous research in the control of civil engineering structures has assumed that all the structure's states can be directly measured (*i.e.,* full state feedback). However, this situation rarely occurs. Usually the, the number and type of structural response that can be readily obtained is quite limited.

The performance of the structure could be improved in many ways. one of the concepts offered is by applying control system. In addition control devices shall be installed within to the structure in order to reduce structural vibration against wind or earthquake loading. Structural control methods are the most recent strategies for this purpose, which can be classified as active, semi-active, passive and hybrid control methods (Shayeghi et al., 2009).

Active control strategies have been developed as one means by which to minimize the effects of these environmental loads. Active control systems operate by using external energy supplied by actuators to impart forces on the structure. The appropriate control action is determined based on measurements of the structural responses. For approximately two decades, researchers have investigated the possibility of using active control methods to improve upon passive approaches to reduce structural responses.

A variety of active control mechanisms have been suggested. These mechanisms include the active tendon system, the active bracing system and the active tuned mass damper. Theoretically, active control device can be as powerful as they are needed to be but practically, the effectiveness is limited by the actuator capacity. Therefore, to make the device is as effective as possible it requires proper control algorithms. Various control algorithms have been considered for instance output feedback strategies using absolute acceleration measurement were developed by Spencer et al.,(1991, 1994). Control algorithms which account for the force and stroke limitations ofcontrol actuators have been investigated (Asano and Nakagawa, 1993). Non-linear control algorithms have also been considered in an effort to increase the effectiveness of these active systems (Gattulli, 1994).

Some of the challenges appear by applying active control systems, for example reduction of cost and maintenance, eliminating reliance on external power, increasing system reliability and gaining acceptance of nontraditional technology (Fujinoet al., 1996). Though, a number of question still exist regarding to the application of active control systems to civil engineering structures, the future is promising.

The mechanism of structural response in passive control system can be activated by the motion of structure itself. Therefore it does not need external input energy in order to modify the motion of the structure nor structural response measurement. However, these passive device methods have the limitation of not being able to adapt to structural changes. Some examples that have been considered are Tuned Mass Damper (TMD), Tuned Liquid Damper (TLD) and base isolation.

Hybrid and semi-active control strategies appear to have the potential to answer the question from active and passive control strategies. Hybrid control strategies have been investigated by many researchers to exploit their potential to increase the overall reliability and efficiency of the controlled structure (Soong, 1993). A hybrid control system is defined as one which employs a combination of passive and active devices. Because multiple control devices are operating, hybrid control systems can alleviate some of the restrictions and limitations that exist when each system is acting alone. In addition, the resulting hybrid control system can be more reliable than a fully active system, although it is also more complicated.

Semi active control systems take the advantages of the best feature of both active control system and passive control system. They offer the adaptability of active control devices without requiring large power sources. Therefore, it is able to run on batteries. Semi active control system offers highly reliable operation and can be viewed as fail-safe in that they become passive dampers should the control hardware malfunction (Spenceret al., 1997c). A semi active control device is one that cannot increase the mechanical energy in the controlled system both the structure and the device but has properties which can be dynamically varied to optimally reduce the responses of a structural system. Therefore in contrast to active control devices, semi active devices do not have the potential to destabilize the structural system. Examples of such devices include variable orifice fluid dampers, controllable friction devices, variable stiffness devices, controllable liquid dampers and controllable fluid dampers.

1.2 Objective

The general objective of this final report is to carry out the analysis and simulation of semi active control structures. In addition, it is expected to be optimum and able to reduce seismic excitation in the building. More specifically, the objective in semi active control system is to obtain the optimum parameter with the desirable requirement of the device. Thus, designing optimum value of the semi active in a simple but still can fulfill the maximum response.

In addition to the problem mentioned above, buildings are naturally three dimensional structures. Most research regarding structural control usually considers only two dimensional structures (Soong, 1990, Housner et al., 1997). Considering from the fact, the writer use the sub program str3dp (Arfiadi, 2004) to perform the analysis. Furthermore, the formulation stiffness matrix is adopted from the general element stiffness matrix of three dimensional space frame. The building is modelled as a strucutre composing of members connected by a rigid floor diaphragm such that it has three degrees of freedom at each floor. (Arfiadi and Hadi, 2000)

Highlighting the above issues, the objective of this study are:

- To show the designing optimum value of semi active control device
- To show the procedure on analyzing three dimensional building

In addition, semi active control devices considered in this study will be simplified as the force which will be working on the system and the control algorithm which will be used is Lyapunov stability control. Further, the building is subjected to the El Centro earthquake motion with the peak acceleration is 3.3909 m/sec^2.

1.3 Benchmark Problem

The bencmark problem is adapted from Chachapara et al.,2011 with the parameter of the building as follow:

No of storey	= 3	f_c'	= 30 MPa
Storey height	= 3 m	f_y	= 400 MPa
Slab thickness	= 120 mm	E	= 2 x 10^5MPa
Column size	= 0.3 x 0.3 m	v	= 0.2
Beam size	= 0.23 x 0.3 m	$\gamma_{concrete}$	= 24 kNm^{-3}

The plan and 3D view of the building mentioned above are shown in Fig. 1.1 and Fig 1.2 below

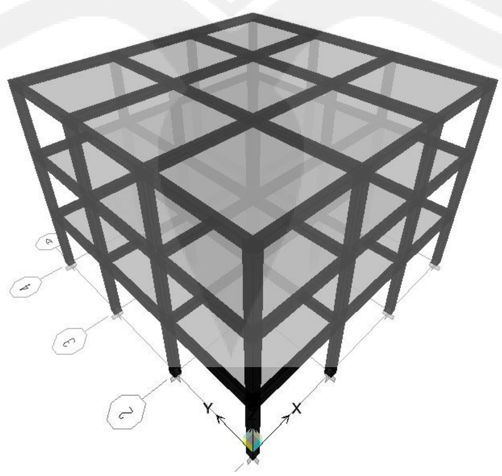

Fig. 1.1. 3D view of Three storey building

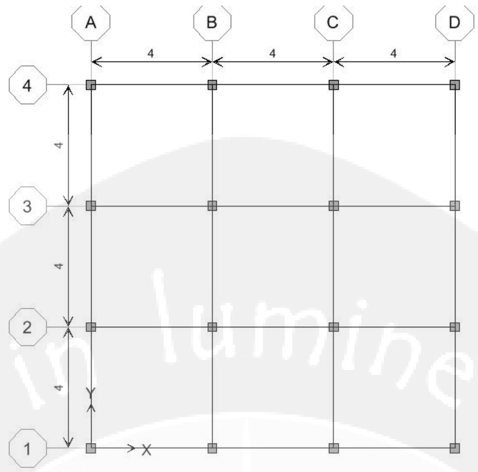

Fig. 1.2.Plan view of Three storey building

1.4 Scope of the Problem

The scope of this project are:

1. The structure behaviour is assumed to be elastic
2. The floor diaphragm is assumed to e rigid in the horizontal direction
3. The interaction of control device is neglected

1.4 Advantages

The expected advantages from this report are:

1. To encourage for the university students whom interested in learning vibration control.
2. Give some input to the practicioner in civil engineering to apply semi active control strategy in practice.