1 INTRODUCTION

1.1 Background

Recently, serviceability of buildings has been emphasized due to an increase in the construction of high-rise buildings and resident requirements. The increasing height and span of structures are resulting in their increased vulnerability to environmental forces such as winds, earthquakes and sea waves. In addition to structural failure possibilities, issues such as functional performance and human discomfort are of major concerns [1]. To improve the design and performance of these structures, several techniques using passive control method, such as Seismic Damper; Tuned Mass Damper; Tuned Liquid Damper and Tuned Liquid Column Damper, are available. The passive control is a device which is attached to a main system to be controlled, thus reducing the responses without external power supply. This method is simpler than active systems because no external forces are needed with expensive feedback of feed forward control.

Tuned Liquid Column Damper (TLCD) systems can be considered as a particular type of passive mass dampers and represent an effective alternative to Tuned Mass Damper (TMD) systems to control the vibration level structures. This liquid column device in a U-shaped container with an orifice achieves the same vibration characteristic as a tuned mechanical damper consisting of a mass and spring system (TMD) [2]. In comparison with another passive vibration control system, TLCD is one of the great interests for some its characteristics such as simpler, easy implementation, low cost of construction and maintenance, and no need to add mass to the structure if the liquid is used as water supply [1]. Among many varieties of control devices [3], [4] the tuned liquid column damper (TLCD) as an energy-absorbing device does not require an external power source for operation. The control force comes from the restoring force in the liquid due to the gravity. The damping effect is generated by the hydrodynamic head losses that arise during the motion within the liquid inside the TLCD [2].

In order to obtain a good performance of the damper, it is important that the fundamental frequency of the liquid motion be tuned to the natural frequency of structure. In addition, the damping of the liquid should be set to an optimal value to achieve the effective liquid damper. Many researches have been conducted to obtain the optimum TLCD parameters. These optimal damper parameters are derived using several optimization algorithms such as analytical method [1] and numerical method [5].

Even though several TLCD models have been proposed and many optimization algorithms have been developed [2], however, it is very low researches that have been conducted to evaluate the TLCD damping factor experimentally. A simple method to adjust the TLCD damping factor is by varying the orifice blocking ratio. In this final project, evaluation of TLCD damping factor is conducted experimentally using several orifice blocking ratios.

1.2 Problem Formulation

Since the orifice blocking ratio can affect the performance of TLCD by friction force between the fluid and the orifice surface, TLCDs can be designed by varying the orifice blocking ratio to get different friction forces. Some friction forces as the result of varying them can determine the damper's ability in damping the vibration. The effect of orifice blocking ratio variation to the TLCD damping factor is evaluated by comparing the Frequency Response Function (FRF) of the structure from the experiment. Figure 1.1 shows two DOF shear structure model with TLCD that is used in the experimental study.

Figure 1.1 Two DOF shear structure with TLCD

1.3 Research Objectives

The objectives of the research:

1. To obtain an optimum orifice blocking ratio.
2. To obtain the relation between orifice blocking ratio and damping factor.

1.4 Benefit

The optimum orifice blocking ratio can help engineers in designing better tuned liquid column damper.

1.5 Research Scopes

1. The TLCD used is a 60^{o} U-shaped TLCD with various orifice blocking ratio.
2. The blocking ratio configurations used are the same.
3. Structure displacement and material used in the research are assumed as linear.
4. Testing model used for the research is modeled by a 2 DOF shear structure.

1.6 Report Outline

The final project consists of 5 chapters. Background, research objectives, benefit, research scopes and report outline are described in chapter 1. Chapter 2 explains about damping vibration using TLCD and 2 DOF shear structure, orifice, and viscous flowing in ducts. Chapter 3 describes flowchart and process of the research. The result of the research is discussed in chapter 4. Conclusions are concluded in chapter 5.