CHAPTER I

INTRODUCTION

1.1 Background

In the 21st century, high-rise building is one factor as a solution for residence and offices. Then, high-rise buildings can accommodate a lot of people in a limited area. The height of high-rise buildings is directly proportional to their vulnerability to fluctuation forces like earthquakes and wind. Therefore, to prevent structural failure possibilities, especially dynamic damping, the major concern is increasing the safety factor. To improve structural performance, several methods are using dynamic dampers to reduce the vibration response of the structure by adding a new vibration system, such as Tuned Mass Damper (TMD) and Tuned Liquid Column Damper (TLCD). In a TMD, a mass is attached to a structure with a spring, which tuned its motion with the natural frequency of the structure, and with a dashpot that dissipates energy from the system as the mass moves. In a TLCD, a container partly filled with liquid is attached to a structure and the sloshing frequency of the liquid is tuned to the natural frequency of the structure [1].

Tuned Liquid Column Damper is passive dynamic dampers using a liquid column device in U – shaped container to reduce vibration response [2]. TLCD has definite advantages over other damping devices including lower cost, easier handling, and few maintenance requirements. Indeed, a liquid damper may not important cost or weight penalty when a water tank which is normally used for water supply and firefighter is corporate into the design of liquid damper [3].

To obtain a good performance of damper in TLCD, the fundamental frequency of liquid motion of the liquid must be set to the optimal value to get an effective liquid damper. The TLCD damping factor (ζ) should be set to an optimal value to maximize effectiveness to dampen structure vibration.

Based on the previous research about the optimization of TLCD, the parameter optimization is obtained by experiment, and that parameters are not verified by simulation on a two-story building (Intan et al. 2019). In the research, the simulation and experimental FRF graph are used to verify the performance of the structure and the TLCD damping factor was varied by distinguishing the number of orifice holes. Also, the optimal condition can be determined by varying the volume of TLCD water to obtain good conditions in every number of orifice holes. Based on experimental and simulation, the optimum parameters/; natural frequency and damping ratio of TLCD will be evaluated by experiment in a two-DOF shear structure model.

In the research, TLCD used is 60° U – shaped as a dynamic damper in the structure, and the model used for research is modeled by a two-DOF shear structure. Using pendulum type of TLCD to obtain natural frequency and damping ratio of TLCD is researched by experimental. Numerical simulation was developed to investigate the response of the two-DOF shear structure with TLCD on top and verified with an experimental setup.

1.2 Problem Formulation

Recently, trends in the construction industry demand taller and lighter structures, which are also more flexible and have low damping value. This increases failure possibilities of structural vibration caused by wind and earthquakes. One concept to reduce the vibration is using TLCD. There is some parameter required to obtain the optimal condition for suppressing structural vibration such as the number of orifice holes and volume of water. In the research, a detailed study of a two-story building with TLCD attached will be evaluated to the got optimal conditions of TLCD.

1.3 Research Objectives

The research objectives are:

1. To determine the natural frequency and damping ratio of TLCD using pendulum type of TLCD.
2. To obtain the optimum condition for reducing structural vibration response up to 50% and damping ratio of TLCD.

3. Evaluate the modeling of a two-story building by experimental using the result of TLCD simulation which several orifice holes and volume of water that perform maximum condition for reducing the structural vibration response.

1.4 Benefit

The benefit of the research is to give contribution for designing Tuned Liquid Column Damper by obtaining optimum parameters for several orifice holes and volume of water on the building.

1.5 Idealization

1. Type of liquid fluid used is water.
2. Vibration system assumed linear.

1.6 Report Outline

The final project consists of 3 chapters. Background, problem formulation, research objectives, benefit, idealization, and report outline are described in chapter 1. Chapter 2 explains about literature review of Tuned Liquid Column Damper (TLCD), two-DOF shear structure, pendulum, orifice, and state-space modeling. Chapter 3 describes the research methodology. Chapter 4 explains the result and discussion of the research. The conclusion is concluded in chapter 5.