II. LITERATURE REVIEW

For the first time, Den Hartog (1947), proposed an optimal design theory for the TMD for an undamped single degree of freedom (SDOF) structure with the final result he derived the formula for the optimum values of the TMD parameters for a SDOF structure when subjected to a harmonic load. Then many optimal design methods for the TMD have been developed to control the structural vibration induced by various types of excitation source. Warburton et al (1982), further proposed optimal design formulas for the TMD system under different types of load, such as harmonic forces, wind loads, and seismic loads. However, the control effectiveness is highly sensitive to the design parameters of the TMD relative to the parameters of the primary structure. If the design parameters of the TMD deviate from the optimal design values or error exists in the identification of the natural frequency of the primary structure, a detuning effect will occur and the control effectiveness may deteriorate.

Extensive research was also made by Rana and Soong (1998), where formulas for several types of excitations were developed. In this case the harmonic and random excitations were applied either on the main system or at the base of the structure. Sadek *et al.* (1997) suggested a method for estimating the design parameters of TMDs for seismic applications; the criterion used to obtain the optimum parameters was to select, for a given mass ratio, the frequency and damping ratios that would result in equal and large modal damping in the first two modes of vibration. Various assumptions have been made regarding the earthquake loading (harmonic or random), and about the location of the acting force (on the structure or at its base). In this method, earthquake records are used to obtain the optimal TMD properties when subjected to the earthquake forces at its base. In the present research, the new method is needed to obtain the optimum TMD parameters by several objective function.

Mechanical optimization using a genetic algorithm has been widely researchers used previous to optimize a structure that become more efficient. Genetic algorithms are widely used in practical problems which focused on finding optimal parameters. Arfiadi and Hadi (2011), population in the genetic algorithm is a candidate solution for the problems. This population will experience the evolutionary process based on the mechanisms of population has the highest fitness score. These populations will change the chromosome to produce offspring through a phase switch cross (crossover) and mutation (mutation) so that the population survives on next generation.

Abubakar and Farid (2009) explained about the Den Hartog model for obtaining optimum design parameters for a TMD system attached to undamped SDOF structure has been extended to include the structure damping. Numerical results were obtained using numerical optimization with MATLAB program. For further research, they suggest simple design equations for the determination of the optimum design parameters of TMD systems.

Kalvianto (2014) did the research about adding TMD to Univesitas Atma Jaya Yogyakarta's Library with several mass ratios for TMD. TMD has been proven to be able to reduce the response of a structure affected by dynamic loading. The higher the mass ratios, which is the mass of the TMD, the more significant the reduction of the response. The Den Hartog formula were used to calculate the parameters or the TMD. Therefore, determining the proper mass, damping and stiffness is needed to be able to reduce the response.

According to Arfiadi and Hadi (2011), a combination of optimization using a genetic algorithm binary (binary genetic algorithm) and real genetic algorithm in an arrangement called a hybrid genetic algorithm. The use of hybrid genetic algorithm is used to optimize the location and damper properties. It shows that optimization tools are stable and have the ability to explore areas that are not domain unknowns for the first design variables in the real genetic algorithm. This study is expected to optimize of stiffness (k_d) and damping (c_d) using real genetic algorithm.