UNIVERSITI TEKNOLOGI MARA

SEISMIC PERFORMANCE BETWEEN UNREPAIRED AND REPAIRED OF TUNNEL FORM BUILDING UNDER LATERAL CYCLIC LOADING

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ABSTRACT

A total numbers three units of one-third scale 3-storey tunnel form building (TFB) were designed using BS8110, constructed, tested under in-plane and out-of-plane lateral cyclic loading in the heavy structural laboratory. Two numbers of single units TFB were repaired using steel angle, steel plate and CFRP fabric and retested under in-plane and out-of-plane lateral cyclic loading. Another double unit TFB also repaired using additional shear wall, steel angle and CFRP fabric and retested under in-plane lateral cyclic loading only. The visual observation of damages, lateral strength capacity, stiffness, ductility and equivalent viscous damping were determined for all the unrepaired and repaired specimens. Based on the experimental results, the repaired of single unit TFB using steel angle, steel plate and CFRP fabric has higher value of lateral strength capacity, ductility and equivalent viscous damping than unrepaired single unit TFB. Likewise, the repaired double unit TFB using additional shear wall, steel angle and CFRP fabric also has higher value of lateral strength capacity, stiffness, ductility and equivalent viscous damping than unrepaired double unit. It was found that the repaired double unit TFB is the best method of repair and retrofit technique for this research work. It is important to validate the experimental hysteresis loops with model hysteresis loops using the HSTERES program before using this model hysteresis in modeling the TFB using the RUAUMOKO 2D program. Wayne Stewart Rule Model with hysteresis rule number 54 was chosen to validate with experimental results and all the performance parameters were less than 5%. Therefore, this model can be used to determine the dynamic behavior and analysis using Ruaumoko 2D under ten different earthquake excitations inclusive in Malaysia and around the world. From nonlinear time history analysis, it was discovered that double unit TFB can survive under minor to moderate earthquake events which is less than 5 Scale Richter. Further analysis on seismic assessment of repaired double unit TFB was conducting using fragility curve because this is the best method should be adopted to the construction industries if severe damage occurred to the TFB buildings after earthquake. From the analysis of fragility curve, it was noticed that the repaired double unit TFB survive under six local earthquakes in Malaysia, DBE (Type 1 and Type 2) and MCE (Type 1).

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Tunnel form building (TFB) is one type of industrialized building system (IBS) which has been constructed for condominiums and apartments in Malaysia. This system is a transition method of construction of conventional to modern construction techniques adopted since 2007. Moreover, it is also the most practical and systematic approach because this method can shorten the construction period, cost effective, reduce construction waste and minimizes the usage of manpower. Furthermore, it provides a lean construction site by reducing the haze in the air simultaneously improve the air quality and reduces the urban heat environment effect.

The tunnel form building comprises of wall panels and floor slab as their main structural component and having almost similar thickness and cast in-situ under single operation using heavy machinery and cranes. This method is normally used for the construction of a building for 15-20 stories, especially for residential apartments and condominiums. Moreover, the steel formwork can be re-used between 500 to 1000 times for the construction of a tunnel form building using IBS. Therefore, it can contribute to the reduction of the construction period and eliminating the usage of wood formwork. Properly designed and detailing of tunnel form building using seismic code of practice can produce a very good seismic performance as observed from previous earthquake events in high seismic regions. This is due to the fact that shear wall becomes the main structural component which transfer the earthquake load from the top of the superstructure to the foundation. Thus, tunnel form building system becomes the most popular construction technique in many earthquakes prone countries such as Chile, Turkey, Mexico, New Zealand and other Asian countries. Most of this type of tunnel form building experiences minor to moderate damage under earthquake excitation depending on the peak ground acceleration, soil condition and distance from the epicenter.