OUTRIGGER SYSTEM FOR INTERCONNECTING THREE DIMENSIONAL MULTI-STORIES BUILDINGS

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ABSTRACT

In tall buildings design, lateral loads induced by wind or earthquake forces are often resisted by an outrigger system. This system is often chosen as its function by tying the structural components together to provide sufficient lateral stiffness to the structure and control the excessive drift due to the lateral load. This thesis is to analyze the behavior of two 30 stories residential buildings that interconnected by a link bridge which acted as an exterior outrigger system at different heights and also the outrigger system location optimization. A total of five models with different configuration of exterior outrigger system which interconnecting the two multi-stories buildings had been analyzed by using ETABS software program. There is one model with no outrigger system is applied, three models with outrigger system interconnected at different height locations which are level 10, level 20 and level 30 of the buildings respectively, and last model with outrigger system is applied at three levels which are level 10, 20 and 30. The modeling process was carried out in such a way that the behavior and performance of the structure was within the limitations suggested by BSI (2001) CP 3: Chapter V-2: 1972. From the results, the percentage of reduction in lateral displacement is directly proportional to the number of level of outrigger system applied to the multi-stories buildings. By comparison, it is structurally efficient to locate an exterior outrigger system at the top of a building. Study has shown that it is indeed helpful in reducing the lateral displacement of building structure by applying the outrigger system as an exterior structural system for interconnecting between the multi-stories buildings.

ABSTRAK

Dalam sebuah reka bentuk bangunan tinggi, beban sisi yang disebabkan oleh angin atau daya gempa sering ditentang menggunakan sistem katir. Sistem ini sering digunakan kerana fungsinya yang boleh mengikat komponen struktur untuk menyediakan ketegangan yang mencukupi bagi struktur dan seterusnya mengawal pergerakan yang melampau yang disebabkan oleh beban sisi. Kertas kerja ini adalah untuk mengkaji tingkah laku dua bangunan kediaman 30 tingkat yang dihubungkan oleh sebuah jambatan. Jambatan ini berfungsi sebagai sistem katir luaran pada ketinggian yang berbeza dan perbezaan pengoptimuman lokasi sistem katir. Lima model yang berlainan konfigurasi pada sistem katir luaran telah dianalisis menggunakan perisian ETABS. Satu model dianalisis tanpa menggunakan sistem katir luaran, tiga model dengan sistem katir luaran pada ketinggian yang berbeza iaitu pada aras 10, 20 dan aras 30, dan model terakhir mempunyai sistem katir luaran pada tiga aras iaitu aras 10, 20 dan aras 30. Kelakuan dan prestasi model bangunan yang dikaji adalah seperti yang dicadangkan oleh BSI (2001) CP 3: Chapter V-2: 1972. Keputusan menunjukkan model bangunan dengan sistem katir pada aras 10, 20 dan aras 30 masing-masing dapat mengurangkan anjakan sisi sebanyak 15.32%, 26.04% dan 29.76%. Daripada keputusan yang diperolehi, peratusan pengurangan pada anjakan sisi bangunan adalah berkadar terus dengan nombor aras di mana letaknya sistem katir luaran pada bangunan. Melalui perbandingan, ianya efisien untuk meletakkan sistem katir luaran pada bahagian atas bangunan. Menurut kajian, sistem katir luaran terbukti dapat membantu dalam mengurangkan anjakan sisi pada struktur bangunan apabila ianya berfungsi sebagai sistem struktur luaran yang menghubungkan dua bangunan.

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INTRODUCTION

1.1 Background

The demands for taller structures are becoming imperative almost everywhere in the world. The trigger of the construction of taller structures initially is due to the trend of people moving toward city and caused scarcity of living space. But current tall building development involves various complex factors such as economics, aesthetics and technology.

In the design of tall buildings, nominal moment resistant frames or braced core may not provide adequate stiffness to resist lateral load such as wind and earthquake. When the building increases in height and becomes more slender, the building's sway due to lateral forces becomes critical (Khan, 1969). For the reason, the introduction of structural system helps to provide necessary lateral stiffness and significant drift control to the structure.

Structural systems of tall buildings can be divided into two broad categories which are interior structures and exterior structures. If the major part of the lateral load resisting system is located within the interior of the building, a system is categorized as interior system. Moreover, a system is categorized as an exterior structure when the major part of the lateral load resisting system is located at the building perimeter (Ali, Mir M. and Kyoung Sun Moon, 2007).

1.2 Problem Statement

Recently, the application of interconnecting system between building structures is becoming more popular not only because it creates socially an extra multi-functional space, but also because its function of increasing the building stiffness by tying the structure components rigidly together. However, most of the related building structures which applying interconnecting system were not completely described in most of the cases due to their individual uniqueness. For that reason, this research work presents the study of interconnecting two multi-stories buildings by an exterior outrigger system that changes the overall behavior of the building system. It also checks how well the link bridge does help on the reduction of lateral displacement of the building structure.

1.3 Objectives of the Study

The objectives of the study were described as follow:

1) To determine the behavior of multi-stories buildings that connected by a link bridge as an exterior outrigger system at different height locations.

2) To determine on how well the link bridge does help on the reduction of lateral displacement of the building structure.

3) To determine the optimum height location of the link bridge that connecting the two multi-stories buildings.

1.4 Scopes of the Study

The scopes of the study utilize ETABS as the software program to perform the analysis modeling.

1) There are five models of building system are practically studied with a different configuration of exterior outrigger system of a two 30 stories buildings.

2) Model one is with no outrigger system to act individually as a building and the other four models are connected with external outrigger system at different height locations that at level 10, level 20 and level 30.

3) The floor height of the multi-stories buildings was fixed at 3.3 m and the total height of the buildings was 99 m. The span of the link bridge was fixed at 33 m and the height of the truss was 3.3 m.

4) For the building structure components in the models, the dimension of reinforced concrete column is 600mmx600mm and the reinforced concrete beam is 250mmx600mm.

The output sought during the parametric analysis is deflection and shape of deform of the building to indicate the stiffness that generated by combining the strength of buildings together.

1.5 Significance of Research

Introduction of outrigger system to tall building design has become a great interest among researchers in the last few decades. Numerous studies have been carried out on the analysis on the behavior of outrigger structures. But, most of the studies were involved by applying outrigger system in an interior structure to stiffen the tall building.

This research process is involved by introducing a link bridge as an exterior outrigger system to connect two 30 stories buildings at different height locations. The results concern the global behavior of the two multi-stories buildings. Significant improvements such as increase in the building stiffness as well as a decrease in lateral displacement are expected to be achieved in this study work. Higher in stiffness will lead to the reduction of deflection (P. Gelfi and E. Giuriani, 1999).

New improvement of the existing buildings can be well developed by adapting an external outrigger system in high rise construction in Malaysia since it does not critically districts the occupant activities during the process of strengthening of the buildings. Apart from that, the optimum configuration of outrigger system including its location of tall building design will be justified so that there will be a large potential use for this system in Malaysia.

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