Improvement of Structural Stability for Multi –Storey Building by Using Composite Column and Cable Connection

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… In loving appreciation of my dear family and friends …

…May God shower his blessing on you…

…Love you forever...

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Abstract

Two methods for the improvement of structural stability of the building are introduced. These methods ensure that the structural building is safe, reliable and economy with the production of small deflection against seismic loading and any other external effect. The application of composite column as flexible material or non-rigid part of the frame structure is introduced and capable to absorb energy comes from the action and reaction of loading. The second approach in this research is by introducing active spring or prestressed cable connections in order to reduce the instability of structural building. The effect of P-delta on two methods stated is studied by performing non-linear analysis by using SAP2000 software on the building and compared the analysis results to conventional structural building with rigid connection. The results from SAP2000 shows that the proposed composite column and structural building with prestressed cable connection provide small deflections under loading compared with the deflection induced by conventional building with rigid connection. This finding proves that the proposed methods for building construction can increase the stability of the structural building.

Abstrak

Dua kaedah untuk pembaikan kestabilan struktur bangunan diperkenalkan. Kaedah ini menjamin struktur bangunan yang selamat, boleh dipercayai dan ekonomi dengan penghasilan pesongan yang sedikit terhadap pembebanan seismik dan lain-lain kesan luaran. Penggunaan tiang komposit sebagai bahan fleksibel atau bahagian tidak tegar dalam struktur kerangka diperkenalkan dan berkebolehan untuk menyerap tenaga daripada tindakan dan tindakbalas pembebanan. Penggunaan kedua dalam kajian ini tertumpu kepada pengenalan spring aktif atau sambungan kabel prategasan bagi tujuan pengurangan ketakstabilan struktur bangunan. Kesan P-delta terhadap kedua-dua kaedah yang dinyatakan dikaji dengan mengadakan analisis tak linear menggunakan perisian SAP2000 ke atas bangunan dan membandingkan keputusan analisis dengan struktur bangunan bersambungan tegar yang biasa. Keputusan daripada SAP2000 menunjukkan struktur bangunan dengan pembinaan tiang komposit yang dicadangkan dan juga sambungan kabel prategasan boleh menghasilan pesongan yang kecil di bawah pembebanan berbanding dengan pesongan yang dihasilkan oleh bangunan biasa dengan sambungan tegar. Penemuan ini membuktikan kaedah yang dicadangkan bagi pembinaan bangunan boleh meningkatkan kestabilan struktur bangunan tersebut.

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Chapter 1

Introduction

1.1 General

Tall building structure, as like solid cylindrical column, is a slender structure where the deformation comes from gravitational force and lateral load is critical. Small change in gravitational force or lateral load will cause large change of displacement, especially for critical members and induce structural instability and may cause collapse of the entire structure. As it is well known as P-delta effect, the stability of column as important part of the building is intended to be studied. In order to reduce instability and improve the stability of the building; two methods are introduced; by using composite columns (steel-concrete with cable-steel) and pre stress and post tension concrete beam with cable connection, both types are using cables for connection. The effect of instability of the columns is assumed for the whole structure under the same load and the deflection of the column is predicted by using P-delta type of analysis. From last finding for connection, deflection for members in rigid connection frame as P-Delta effect is smaller than semi rigid and pin connection, so rigid connection is assumed to compare with cable connection.

1.2 Statement of Problem

Engineers nowadays normally use linear analysis to analyse building structure. This type of analysis contributes small lateral displacement for the building without considering instability effect or large lateral displacement of the building.

Analysis that considers geometric nonlinearity of the building, called P-delta analysis, is also available by established software such as SAP2000 and Staad-pro. By using nonlinear analysis, engineers nowadays always assumed the connection between column and beam is perfect or rigid. The P-delta analysis conducted to the structure, by assuming the connections are rigid, contributes large lateral displacement or P-delta effect. A quite number of researchers only consider the connections are non-rigid or pin type connection to overcome instability problem of the building.

An extensive study to a new type of connection (pin or non-rigid connections) to reduce instability of the building is become necessary and helpful, particularly for the building located in the country exposed to earthquake. Effect of P-Delta as a displacement on top part of column is reduced by assuming rigid or partially rigid connection compared to pin connection. Rigid connection is not safe in the welding method and connection behavior is out of supervision, also depends on more parameters in the place of erection such as degree of weather and degree of moist.

In analysis and modeling engineer just assume the connection is rigid but how percent is rigid behavior under the loads is not clear. In tall building the displacement of frame is very important and deflection for every floor is too small but additional of displacement will cause the structure become critical and instable.

Using solid column such as steel or concrete is just assumed to transfer gravity load and lateral load from top of building to foundation. The aim of analysis column is designed safe and stable purposed column in elastic part of material behavior and maybe not economical. Rigid connection with solid material (steel or concrete) in the analysis is designed for small width of bay by limitation in high.

1.3 Aim and Objective

The objectives of this study are:

To use composite column with three material components (steel - concrete - steel) by using pre stress cable at middle part (concrete) in order to study P-Delta effect.

To use special connection with pre stress cable at both direction of connection (beam to beam and column to column) to study the P-Delta effect.

Understanding of P-delta type of analysis is the first step necessary to analyse the multi-storey building.

The building made-up of rigid connection, which nowadays normally used for building connection, is analysed by using P-delta type of analysis. The analysis results is used for reference purposes. In the second step of the study, the P-delta type of analysis is used to analyse the building made-up of proposed type of connection, i.e.

flexible composite column (steel-concrete-steel) attached by strain cable at concrete part of the column to absorb the energy. This type of connection is believed capable to reduce instability effect or large lateral displacement problems (p-delta effect). The third objective is the SAP2000 software; which capable to conduct P-delta analysis is fully applied in this study.

1.4 Scope of project

Scope of this study is examination of the behavior of the structure due to P-Delta effect and proposal of suitable methods for controlling this problematic issue according to the following procedures:

1-using composite column with pre stress cable to increase stiffness of element (steel-concrete with pre stress cable , steel).

2-Using the special connection for beam and column.

3-Understanding both above scope for composed together to design long bay and high length structure such as bridge or tall building with assuming top to bottom construct by hanging the members from top and constrict cables with pre stress and post tension methods in connection and composite columns.

1.5 Organization of This Report

This project is organized in five chapters; the first chapter was written about introduction and scope of this issue and following Chapter 1, chapter two was purposed as literature review about some methods for improvement of structural stability and performance of composite column behavior under lateral and compression load as P-Delta effect. The third chapter was modeling of composite column by SAP2000 to compare the results to performance of composite column and steel or concrete column. Also in chapter fourth, connection for column and beam was supposed as cable connection and modeling by SAP2000 to understanding of performance of cable connection. The chapter five was written about the performance of composite column and cable connection as conclusion and recommendation.