INTERCONNECTING OUTRIGGERS SYSTEM IN TALL BUILDING STRUCTURE

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A project report submitted in partial fulfillment of the
Requirements for the award of the degree of
Master of Engineering (Civil-Structure)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2014

Dedicated to my beloved mother and devoted father.

Words cannot describe how much they mean to me.

ACKNOWLEDGEMENT

The realization of this research was only possible due to the several people's collaboration, to which desire to express my gratefulness. I would like to thank in a special way to Assoc. Prof. Dr. Abdul Kadir Marsono, my supervisor, I am grateful g this research. His support was crucial in my dedication this investigation. He has been the ideal thesis supervisor. Without his inspirational instruction and guidance I was not able to complete this project. His sage advice, insightful criticisms, and patient encouragement aided the writing of this thesis in innumerable ways.

ABSTRACT

Tall building are innovative structure that shall be studies their systems and connections to accept stability in related to certain lateral load such as seismic loads post-earthquake and wind loads. Central core are a major structural element that designed in combination to frames which interact through outriggers to transfer the loads to the foundation. The issue of rigidity is the cooperation between elements in tall building systems. Significantly, type of connections among components based on their stiffness can be defined in the form of percentage of safe distribution of loads in tall building system. The research proposes a design of interconnecting of tall building blocks distribution through tensile force and The effect of soil pressure at underground levels that creates a lateral forces that push the face of the frames below ground level is also another form of loads. In summary, this research is to understand the effect of interconnecting of blocks on overall formation stiffness based on different analysis Models. It figures out the effect of inter connecting at abutment in levels on retaining wall and self -stability of frame related to soil pressure.

ABSTRAK

Bangunan tinggi adalah struktur inovatif menjadi dan baban kajian pada sistem dan sambungan pada sistem beban sisi, beban seismik pasca gempa bumi dan beban angin. Fokus kajian adalah pada elemen utama struktur yang berinteraksi melalui outriggers untuk memindahkan beban ke penapak. Isu ketegaran adalah kerjasama antara unsur-unsur dalam sistem bangunan tinggi. Jenis sambungan antara komponen berdasarkan kelakuan mereka boleh menentukan peratusan pengagihan beban dalam sistem bangunan tinggi. Kajian ini mencadangkan satu reka bentuk bangunan berganding dada ketinggian teste utu diantara blok bangunan melalui daya tegangan . Kesan tekanan tanah di peringkat bawah tanah juga mewujudkan daya sisi yang menolak kerangka banguan di bawah paras bumi . Secara ringkasnya, penyelidikan ini adalah untuk memahami kesan bersambung blok pada ketegaran berdasarkan Model analisis yang berbeza. Nilai daripada kesan penampan antara menyambung di peringkat bawah tanah adalah bermaufuat untuk kestabilan diri bingkai.

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LIST OF SYMBOLS

q	-	velocity pressure, in lb/ft2 (IV/m2)
Cq	-	Pressure cofficient.
Ce	-	Cofficient Effect of Hight Exposure and Gust Factor.
I	-	Importance factor
R	-	resonant response factor
Δ	-	Equivalent Elastic
ρ	-	Reliability Factor
Ss	-	mapped MCE, 5% damped, spectral response acceleration
S1	-	mapped MCE, 5% damped, spectral response acceleration
SaM	-	the site-specific MCE spectral response acceleration at period
SDs	-	design 5% damped, spectral response acceleration at periods
SMs	-	the MCE, 5% damped, spectral response acceleration for site class effects
SMl	-	the MCE, 5 percent damped,
T1	-	the fundamental period of the building

T,	-	approximate fundamental period of the building
TL	-	long-period transition period
Ka	-	for the specific condition of a horizontal backfill surface
Φ	-	angle of internal friction of soil backfill
Ls	-	length span

CHAPTER 1

INTRODUCTION

1.1 Introduction

The Tall building system could be located in any site with wide range of different natural conditions that contain natural hazard such as earthquakes and wind storm. The system of tall building put into study are a concrete central core connected to steel outriggers with connection type of rigid, semi-rigid and pinned connections. The concept of connecting separated the tall building blocks could minimize the hazards of an unpredictable force and load combinations. Soil pressure is other item that has an impact on to the structure underground.

Natural disaster such as earthquake and windstorm damages on human's societies, global economic as well as the pride of structural engineers. Researches have always attempting a functional solution to reduce the problem cause by natural hazard. The priority growing up with citizens in crowded in cities and favorite areas. Urban planning tried to decrease the effects of hazards only by predicting several essential crisis for emergency rescue in disaster.

Furthermore, high rise structure was interacted solve several problem such as traffic, transportation, and land scarcity, however, this innovation always requires the new techniques. For this aim, the system of tall building should be protected from excessive unpredictable. In addition, conducting the loads path study that effect stability of structure and reducing the displacements to save the functional of structures during the disaster.

1.2 Problem statement

Dramatically, structural steel outriggers and reinforced concrete has been design by engineers but it produce more complex structural system that beyond the construction. Concrete central core in tall building resist lateral load to work with steel. involve bolting and, horizontal ties in core walls.

Recently, the use of new details which combined the advantages of steel and reinforced concrete structures has been prepared for tall buildings. But, the lateral force is remain as is created by seismic.

1.3 Objectives of study

The total objectives of the study are as following as:

i. To describe the differences of flexibility between long span outrigger and short span outrigger in connected the concrete central core

ii. To evaluate the type of rigidity of connections in outriggers to concrete central core the study include rigid, semi-rigid, pinned connection.

iii. To evaluate the effect of ground pressure to building system with under ground system.

1.4 Scope of study

The research includes a analysis of 30 stories high rise building with concrete central core and steel outriggers connected to frame system.

Two variation of span of 3.5m to external column and continuous long span that connected to external column and central core are invested. The study of their flexibility, and stability during the seismic loads are included.

1.5 Core study

a) Individual Building block Type A

The building contain central core made of concrete core made of concrete and surrounded by single steel frame. The rigid interconnection are made by outrigger frame located on joint of core wall system.

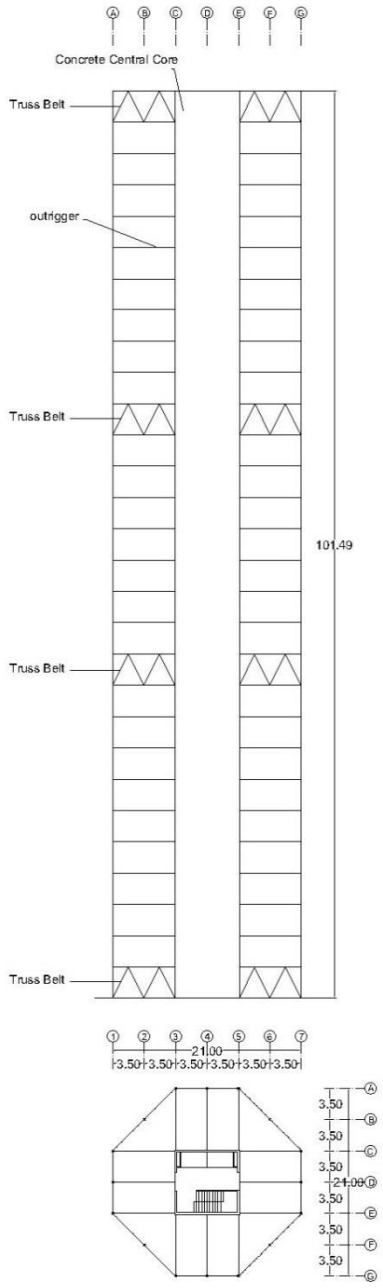


Figure 1.1 Individual building block type A

b) Individual Building block Type B

The building contain central core made of concrete core made of concrete and surrounded by two layer steel frame. The rigid interconnection are made by internal outrigger frame located on joint of core wall system, then connecting fames is semi rigid together.

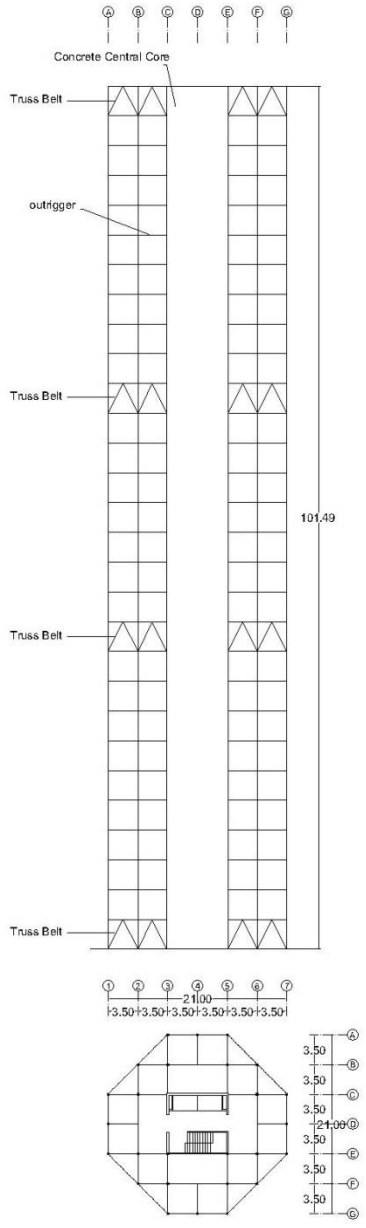


Figure 1.2 Individual building block type B

c) Interconnecting parameters in in model Type A and Type B

Interconnecting of between models in different height can create various negative and positive effects on function of bearing the loads.

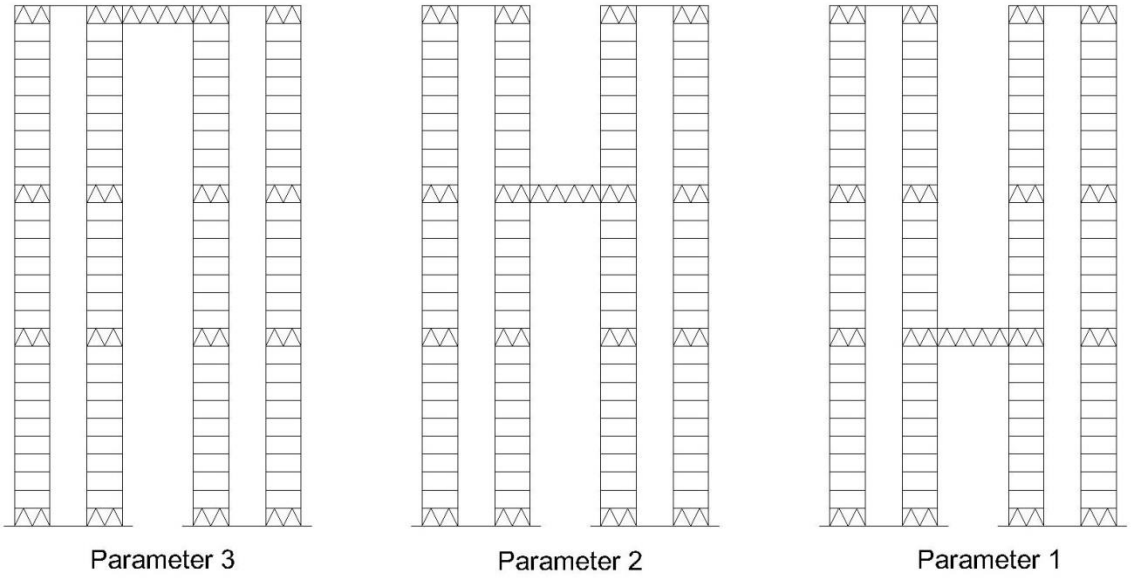
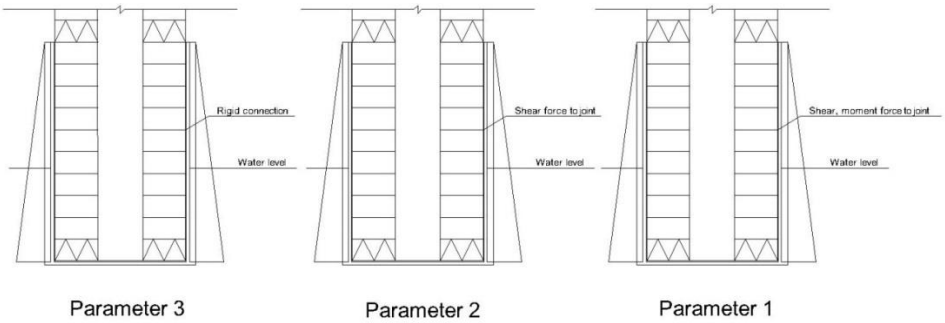


Figure 1.3 Interconnecting parameters in in model Type A and Type B with outrigger at different height

d) Underground structure built in to system

Soil pressure can control in different considerations. It leads shear and moment that that will be taransmitted to structure based the interconnecting and system.



1 **Figure 1.4** Unloaded Underground Structure Parameter 1, 2, 3

2

1.6 Significant of study

Earthquake and wind storm are a universal problem for all building, but more critical for tall buildings as they are more sensitive to lateral movement. Exactly, reducing displacement is the priority without extra cost requires a new method of analysis.

REFERENCES

1. Park, W.-S. and H.-D. Yun (2006). "The bearing strength of steel coupling beam-reinforced concrete shear wall connections." Nuclear Engineering and Design 236(1): 77-93.
2. Park, W.-S., et al. (2005). "Shear strength of the connection between a steel coupling beam and a reinforced concrete shear wall in a hybrid wall system." Journal of Constructional Steel Research 61(7): 912-941.
3. P. Jayachandran, Ph.D, M.ASCE. "Design of Tall Buildings Preliminary Design and Optimization", Worcester Polytechnic Institute, Worcester, Massachusetts, 01609, USA jayachan@wpi.edu, : 1-4
4. Mir M. Ali† and Kyoung Sun Moon. (13 June 2007), "Structural Developments in Tall Buildings: Current Trends and Future Prospects", Structures Division, School of Architecture, University of Illinois at Urbana-Champaign, Champaign, IL 61820, USA†Corresponding Author: Tel: + 1 217 333 1330; Fax: +1 217 244 2900; E-mail: mirali1@uiuc.edu: 5-9
5. N. Herath, N. Haritos, T. Ngo & P. Mendis, Civil & Environmental Engineering, The University of Melbourne, Parkville, Victoria 3010 (2009), " Behaviour of Outrigger Beams in High rise Buildings under Earthquake Loads, Australian Earthquake Engineering Society Conference: 2-4
6. Hi Sun Choi, Goman Ho, Leonard Joseph & Neville Mathias, (2012) " Outrigger design for high rise buildings", An out put of the CTBUH outrigger Working Group. Council on tall buildings and Urban Habitat: Chicago: 48-51

7. Managing Director, VMS Consultants Pvt. Ltd, Mumbai, India, (October 12-17, 2008), "EFFECT OF PERIMETER FRAMES IN SEISMIC PERFORMANCE OF TALL CONCRETE BUILDINGS WITH SHEAR WALL CORE AND FLAT SLAB SYSTEM.", The 14th World Conference on Earthquake Engineering :2-7
8. Li, Q. S. (2001). "Stability of tall buildings with shear-wall structures." Engineering Structures 23(9): 1177-1185.
9. Meftah, S. A., et al. (2007). "A simplified approach for seismic calculation of a tall building braced by shear walls and thin-walled open section structures." Engineering Structures 29(10): 2576-2585.
10. Bahram M. Shahrooz; Jeremy T. Deason; and Gokhan Tunc, (2004) "Outrigger Beam–Wall Connections. I: Component Testing and Development of Design Model" ,
11. Bahram M. Shahrooz; Gokhan Tunc; and Jeremy T. Deason, (FEBRUARY 2004) "Outrigger Beam–Wall Connections. II: Subassembly Testing and Further Modeling Enhancements", JOURNAL OF STRUCTURAL ENGINEERING © ASCE.: 2-7
12. Hayalioglu, M. S. and S. O. Degertekin (2005). "Minimum cost design of steel frames with semi-rigid connections and column bases via genetic optimization." Computers & Structures 83(21–22): 1849-1863.
13. A. Abolmaali a,∗, A.R. Kukreti b, H. Razavi a, "Hysteresis behavior of semi-rigid double web angle steel connections", Department of Civil and Environmental Engineering, University of Texas at Arlington, PO Box19308, Arlington, TX, USA: 3-9
14. Web site: http://web.mit.edu/4.441/1_lectures/1_lecture13/1_lecture13.html
15. Loannis Kourakis, (2007) " Structural Systems and Tuned Mass Dampers of Super- Tall Buildings: Case Study of Taipei 101" Department of Civil and Environment Engineering : 18-20
16. http://www.ctbuh.org/TallBuildings/FeaturedTallBuildings/ArchiveJournal/MarinaBaySands/tabid/1766/language/en-GB/Default.aspx
17. Linear and Nonlinear Static and Dynamic Analysis and Design of Three-Dimensional Structures (1978-2011), "Introductory Tutorial for SAP2000" , Computers & Structures, Inc. 1995 University Avenue Berkeley, California 94704 USA.

18. UNIFORM BUILDING CODE (1997), Chapter 16" STRUCTURAL DESIGN REQUIREMENTS" , Volume 2, Division I—GENERAL DESIGN REQUIREMENTS, 2-2 to 2-8.
19. UNIFORM BUILDING CODE (1997), Chapter 16" STRUCTURAL DESIGN REQUIREMENTS" , Volume 2, Division III—WIND DESIGN, 2-7 to 2-8.
20. UNIFORM BUILDING CODE (1997), Chapter 16" STRUCTURAL DESIGN REQUIREMENTS" , Volume 2, Division IV—EARTHQUAKE DESIGN, 2-9 to 2-18.
21. International Building Code (IBC), BUILDING OFFICIALS AND CODE ADMINISTRATORS INTERNATIONAL, INC. 4051 West Flossmoor Road" Country Club Hills, Illinois 60478-5795 800-214-4321 www.bocai.org
22. Web site: http://peer.berkeley.edu/peer_ground_motion_database/
23. Anile K. Chopra, (1995) " DYNAMIC OF STRUCTURES, Theory and Applications to Earthquake Engineering" , University of California at Berkeley, Eaglewood Cliffs, New Jersey 07632 part 3: 639-703.
24. BS 5400: Part 2: Specification for Loads
25. BS 8002: Code of Practice for Earth Retaining Structures
26. BS 8006: Strengthened/Reinforced Soils and Other Fills