Investigation of the Most Effective Structural System for Super High-Rise Building (600 meters) High for Kuala Lumpur City Center

By

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4472

Dissertation submitted in partial fulfillment of

The requirements for the

Bachelor of Engineering (Hons)

(Civil Engineering)

JUNE 2007

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
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In partial fulfillment of the requirement for the
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(CIVIL ENGINEERING)

Approved by,

(AP Dr Nasir Shafiq)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
JUNE 2007

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgement, and that the original work contain herein have not been undertaken or done by unspecified sources or persons.

(MOHD FAQRUDIN BIN ISMAIL)

ABSTRACT

The growth of modern tall building construction began in the 1880's, which has been largely for commercial and residential purposes, in USA particularly in Chicago and New York. Tall commercial buildings are primarily a response to the demand by business activities and tourist community which in need for city center hotel accommodations. Besides that, it also a prestige symbols for corporate organizations such as PETRONAS Twin Tower in Kuala Lumpur. The feasibility and desirability of high rise structures have always depend on the availability of materials, the level of construction technology, and the state of development of the services necessary for the use of the building. As a result, significant advances have occurred from time to time with the advent of a new material, construction facilities, or form of service. The purpose of this study is to determine the effective structural system for high-rise building structure, which is up to 600 meters height for Kuala Lumpur City Centre. The scope of this study involves research on those suitable structural systems for high rise building and later, most suitable one is going to be determined in order to be used for that building. The methodology involved within this research consists of three parts which are the conceptual planning, preliminary design (which involves manual calculation) and detailed design (which involves the used of computer software which is STAAD PRO for the purpose of calculating all the relevant data regarding this high-rise structures). In order to meet the architectural and clients requirements, various structural consultants chose the structural system according to the previous experience and approach. This study will be focused on the most effective structural system in terms of stability, human comfort, robustness and cost effectiveness. It will be the theoretical project based on the structural software applications. Based on the analytical and structural design results as well as obtained from computer analysis, the right selection of structural system will reduce the total drift of the building. Through this analysis, it is known that the framed tube system is more suitable for the building up to 600m high compared to rigid frame with shear wall.

ACKNOWLEDGEMENT

First and foremost praised be to ALLAH s.w.t, the Most Merciful and the Most Gratitude, for me being able to complete this final year project within the given time.

Secondly, I would like to take this opportunity to thank AP Dr Nasir Shafiq, my final year project supervisor for his endless support and guidance throughout the project. All his advise and encouragement have given me so much energy and desire to complete this project. It has been such an honour for me to learn and work under his supervision as his experiences in this Civil Engineering field, especially in the structural world, gave me so much courage to understand the concept and withstand the pressure that my project brought with it.

I also would like to thank all the lecturers, tutors and technicians that have given me a helping hand during the period of this project especially Kak Hanani with her guidance in teaching to handle this complex STAAD Pro 2004 program. Special thanks to Miss Koh Moi Ing, Final Year Project Coordinator for his advice and guidance.

Last but not least, I would also like to thank my family and all my friends for their moral support especially those two important persons who are giving me a hand with the software throughout the project.

Once more, I would like to express my deepest gratitude to all parties who have guided me throughout the project.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND: SUPER HIGH-RISE BUILDING

A super high-rise or usually known as skyscraper is a very tall, continuously habitable building. Although there is no official definition, a height of approximately at least 150 meters or 500 feet is often used as a criterion for a building to qualify as a skyscraper. Other criteria like shape and appearance also affect whether or not a building is considered a skyscraper. The word skyscraper or super high-rise building was first applied to such buildings in the late 19th century, reflecting public amazement at the tall buildings being built in New York City. The somewhat arbitrary term skyscraper should not be confused with the slightly less arbitrary term high-rise, defined by the Emporis Data Committee as "a building which is 35 meters (115 feet) or greater in height, and is divided at regular intervals into occupiable floors". All skyscrapers are high-rises, but only the tallest high-rises are skyscrapers. Habitability separates skyscrapers from towers and masts. Some structural engineers define a high-rise as any vertical construction for which wind is a more significant load factor than weight is. Note that this criterion fits not only high-rises but some other tall structures, such as towers. The structural definition of that word was refined later by architectural historians, based on engineering developments of the 1880s that had enabled construction of tall multi-story buildings. This definition was based on the steel skeleton—as opposed to constructions of load-bearing masonry, which passed their practical limit in 1891 with Chicago's Monadnock Building. Philadelphia's City Hall, completed in 1901, still holds claim as the world's tallest load-bearing masonry structure. The steel frame developed in stages of increasing self-sufficiency, with several buildings in New York and Chicago advancing the technology that allowed the steel frame to carry a building on its own. Today, however, many of the tallest buildings are built more or less entirely with reinforced concrete. In the United States today, it is a loose convention to draw the lower limit on what is a skyscraper at 150 meters. Elsewhere, though, a shorter building will sometimes be referred to as a skyscraper, especially if it is said to "dominate" its surroundings. Thus, calling a building a skyscraper will usually, but not always, imply pride and achievement. Currently, Dubai is building its own skyscraper with the expected height of about more than 800 meters which once it completed, will be the tallest towers in the world and a symbol of the nation which will be acknowledged by the world.

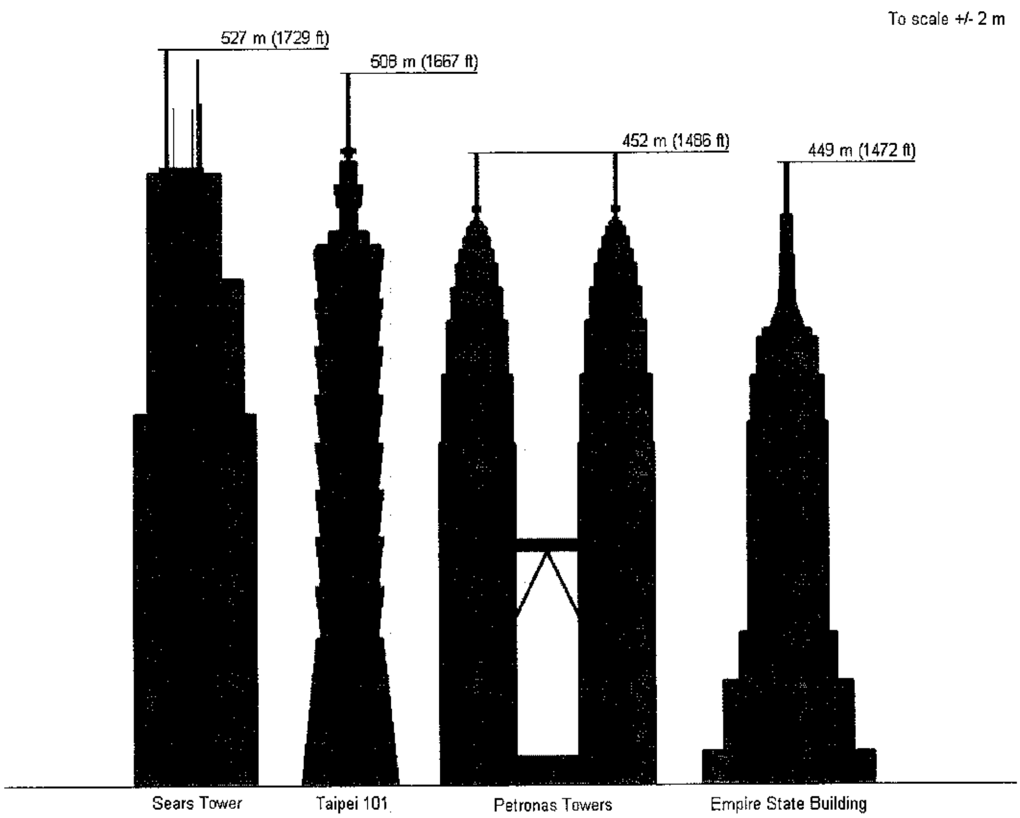


Figure 1.1 – 1 List of world's tall building currently

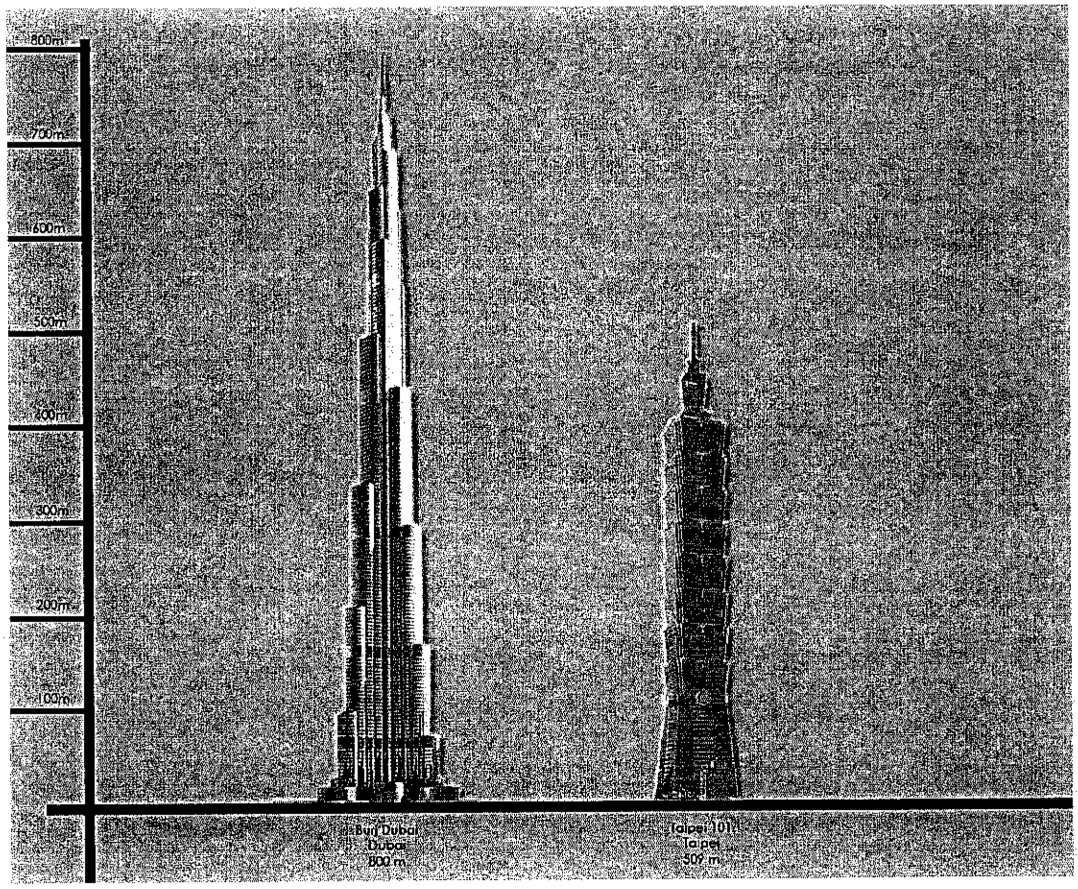


Figure 1.1 – 2 Comparison of Burj Dubai with Taipei 101

1.2 PROBLEM STATEMENT

Due to interest shown by countries around the world in super high-rise buildings, in order to introduce themselves in the eyes of the world, many countries have raced to build their own skyscraper or super high-rise building and Malaysia will not make an acceptation.

This study will be focusing on the proposal of the effective structural system for super high-rise building subjected to moderate wind pressure and other lateral load acted upon the structure with the height of approximately 600 meters (higher than the PETRONAS Twin Tower which is 450 meters).

1.3 OBJECTIVES

The main objectives of this study were:

1) To investigate the effective and robust structural system in compliance with the satisfactory of requirements of the maximum allowable drift.
2) To determine the behavior of building frames with the height varies from 600 meters onwards.
3) To propose the most effective and optimum structural system for super high-rise building for Kuala Lumpur City Center with normal soil condition.

1.4 SCOPE OF STUDY

1. Structural form
2. Floor system
3. Loading

CHAPTER 2

LITERATURE REVIEW

2.1 STRUCTURAL SYSTEM

The type of structures used for high-rise buildings must meet the lateral load performance criteria and they must reasonably efficient in the use of material and of reasonable cost. The most efficient high-rise structure would meet the lateral load criteria using no more material than would be required for carrying the building gravity load alone; in other words, it would have no premium for height. This economic criterion of "no premium for height" has led to a classification of high-rise. Among the structural system that can be used for this super high-rise building are rigid frame with or without vertical shear truss, trussed tube with and without interior column and bundled tube.

2.2 STRUCTURAL LOADING

External forces occurring due to resistance against geophysical effects such as gravity, wind, earthquake, gusts, earth pressure and settlements of supports count as loads. In a more generalized approach, temperature effects and volume forces may regard as loads. At present it is generally assumed that loadings have a stochastic character that may be described by statistics. The random character of the loads is influenced by their variability in space and time.

2.2.1 Gravity loads

Stationary loads determined by the dead weight of the structure contain all members of the structure defined as:

- Load-bearing horizontal floor structures and vertical structures including load-bearing brickwork
- Supplementary structures, flooring, insulation, partition walls, external cladding, etc.

The dead weight of 'finished and service' is accounted for in the continually distributed by conventional values of 1.2 N/mm^2. Further, the assumption of live load is indicating as 1.5 N/mm^2.

2.2.2 Wind loads

Wind loads become important with an increase in height or span and with a decrease in the structural mass of tall buildings (utilization of new materials, more rational utilization of the load-bearing capacity of structures and material). Wind causes the most significant loads in the structures of tall buildings.

For the uniform building code, the Exposure A has been selected because of the location of the building at the town and the height of building is over than 70 feet. Generally, the Exposure A is a center of large cities where over half the buildings have a height in excess of 70feet. The UBC consider this type of terrain as Exposure B, allowing no further decrease in wind pressure.

2.2.3 Combined loading

The structure will be subjected to various loads occurring during the structural lifetime, starting with production, transport, manipulation with components and utilization until destruction.

Below is stated the basic combinations (code standard BS: 8110) has been used through out the analysis:

- 1.4Dead Load + 1.6Live Load
- 1.4Dead Load + 1.4Wind Load
- 1.0Dead Load + 1.0Live Load + 1.0Wind Load

2.3 DESIGN CRITERIA

2.3.1 Strength and stability

For the ultimate limit state, the prime design requirement is that the building structure should have adequate strength to resist, and to remain stable under, the worst probable load actions that may occur during the lifetime of the building, including the period of construction. This require an analysis of the forces and stresses that will occur in the members, result of the most critical possible load combinations, including the augmented moments that may arise from second-order additional deflections.

2.3.2 Stiffness and drift limitations

The provision of adequate stiffness, particularly lateral stiffness, is a major consideration in the design of a tall building for several important reasons. In fact, it is in the particular need for concern for the provision of lateral stiffness that the design of a high-rise building largely departs from that of a low-rise building.

2.3.3 Human comfort criteria

If a tall flexible structure is subjected to lateral or torsional deflections under the action of fluctuating wind loads, the resulting oscillatory movements can induce a wide range of responses in the building's occupants, ranging from mild discomfort to acute nausea. Motions that have psychological or physiological effects on the occupants may thus result in an otherwise acceptable structure becoming an undesirable or even unrentable building.

2.4 TALL BUILDING AROUND THE WORLD

2.4.1 Burj Dubai

Burj Dubai is supposedly to be the tallest tower in the world once it completed its construction with the height of 808 meters with approximately 162 floors. This tower was design for mix-used development purpose where it will include homes, hotels and parklands. This building used 'bundled tube' structural system. This structural system will be rotated 120 degrees to allow for less stress from prevailing wind. The material used is concrete and steel podium with about 192 piles descending to a depth of more than 50 meters. As for the exterior cladding, it is reflective glazing with aluminum and textures stainless steel spranded panels with vertical tubular fins of stainless steel.

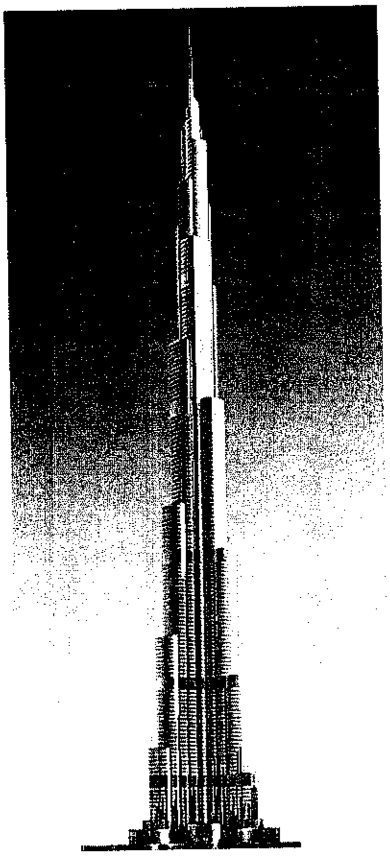


Figure 2.4.1-1Burj Dubai

2.4.2 Taipei 101

Taipei 101 which currently the tallest towers in the world before the construction of Burj Dubai completed is located in Taiwan and it recorded a height of 509 meters. The basic material for this tower is concrete and steel mega frame with an additional glass cladding. This is due to the reason that this tower is located in earthquake and typhoon prone region where the wind speed recorded is 100 mph. It used 'tuned mass damper system' with vital statistics of massive 60 feet spire. The system will transfer the energy from the building to the swinging sphere in order to maintain it stability.

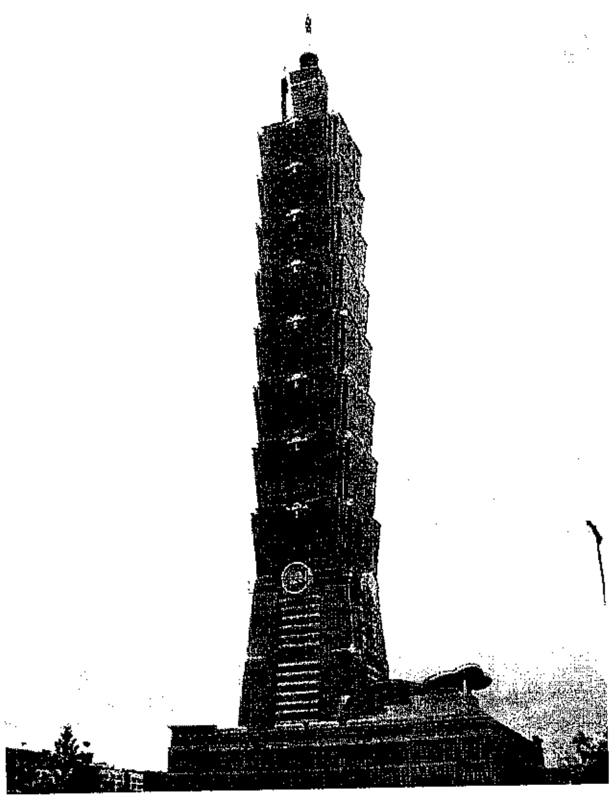


Figure 2.4.2-1Taipei 101

2.4.3 Sears Tower

Sears tower is one the famous building in the world due to its square shaped design and it recorded a height of 527 meters. This tower used to be the highest tower in the world before the completence of PETRONAS Twin Towers in Kuala Lumpur. This tower is equipped with a steel frame with bronze-tinted glass curtain walls and it was design using tube frame design that falls under 'bundled tube' structured system. Each tube is designed as a rigid steel frame and the materials used are prefabricated steel frame, concrete and steel composite floor decks and steel truss floor joints while the foundation is bell-reinforced concrete caissons.

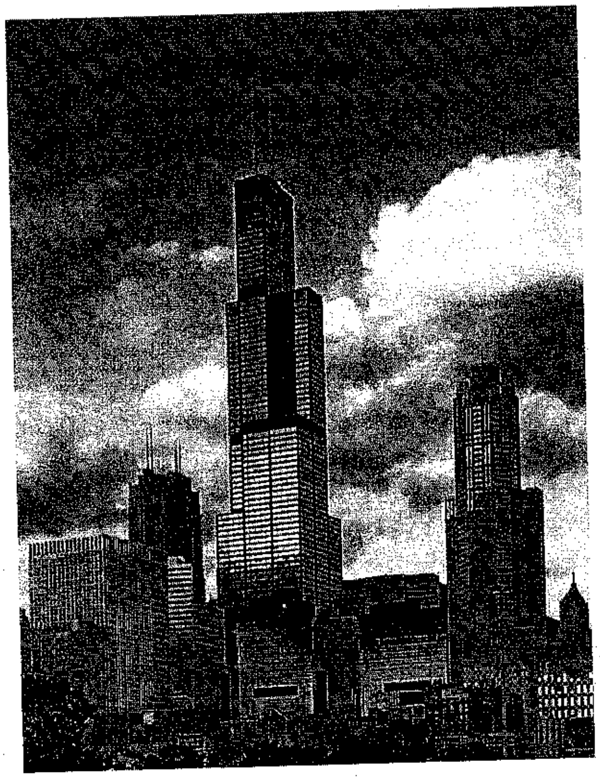


Figure 2.4.3-1 Sears Tower

2.4.4 PETRONAS Twin Towers

PETRONAS Twin Towers is the national symbol and proud of Malaysia as PETRONAS is one of the biggest local companies in Malaysia. These towers is situated in Kuala Lumpur and also known as Kuala Lumpur City Centre with a height of 452 meters consisting of 88 floors. These towers used reinforced concrete with steel and glass façade which is supported by 23 x 23 meter concrete cores and outer ring of widely spaced super columns.

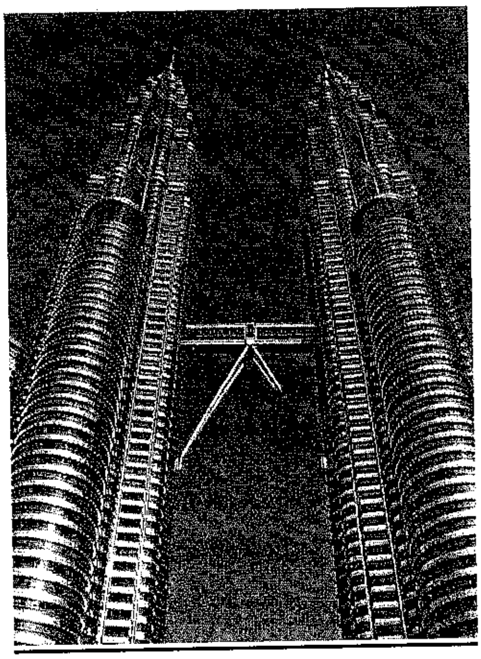


Figure 2.4.4-1 PETRONAS Twin Towers

CHAPTER 3

METHODOLOGY

3.1 CONCEPTUAL PLANNING

In this stage, the author try to identify the suitable type of structural system to be used in this research in order to determine the effective one for the usage on super high-rise building supposedly to be located in Kuala Lumpur City Center. This involves initial selection of structural systems that are suitable to be used in this study such as rigid frame, bundled tube or trussed tube. Method used in conceptual planning:

I. Research from internet
II. Research from text book
III. Discussion with lecturer and tutor
IV. Interview

3.1.1 Design Specification

Location	=	City Center of Kuala Lumpur
Soil Structure	=	Normal clay soil with good soil structure
Ground Structure	=	Flat Terrain
Wind Speed	=	33 m/s @ 73.82 mph
Seismic Effect	=	No Effect (Neglected)
Loading System;		
Live Load	=	2 KPa

Design standards and codes of practice;

- BS 8110: Part 1: 1997 – Structural Use of Concrete
- Uniform Building Code, 1997: Wind Load and Earthquake Load Provision

3.1.2 Building Specification

Total Story	=	170 stories
Storey Height;		
Level 1-5	=	4
Level 6-170	=	3.5
Building Used	=	Commercial
Material	=	Concrete
Concrete grade	=	Grade 80
Steel Grade	=	460 N/mm2
Base support	=	Fixed Support
Exterior column size	=	4 meters
Beam size;		
Exterior	=	2 meters
Interior	=	1 meter

Structural System	=	(Option 1) Framed Tube
	=	(Option 2) Rigid Frame

Framed Tube;

Column Size	=	1 meter x 1 meter
Column Spacing	=	5 meters

Rigid Frame;

Column Size	=	1.5 meter x 1.5 meter
Column Spacing	=	10 meters
Shear Wall thickness	=	0.8 meters

3.2 PRELIMINARY DESIGN

Preliminary design for this stage involves the manual calculation done by the author based on the research and studies done prior to this topic. All data and input related to determination of the optimum structural system for this high-rise structure is being calculated first by hand in order to obtain rough idea of what the value supposed to be when it reached the latter stage. Examples of the manual calculation are wind loading and design for ultimate beams and slabs.

3.2.1 Design Pressure Calculation

Table 3.2.1-1 – Design Wind Pressure Calculation

Level	Height Above Ground (ft)	Windward Pressure (psf)	Leeward Pressure (psf)	Design Pressure (psf)	Floor by Floor Load (kips)	1 kip = 4.448 kN
34 - 170	400.26	20.09	12.56	32.64	175.71	781.54
33	388.78	19.87	12.56	32.42	175.11	778.87
32	377.30	19.64	12.56	32.20	173.90	773.52
31	365.81	19.42	12.56	31.97	172.70	768.18
30	354.33	19.20	12.56	31.75	171.50	762.84
29	342.84	18.97	12.56	31.53	170.30	757.49
28	331.36	18.75	12.56	31.30	169.10	752.15
27	319.88	18.53	12.56	31.08	167.90	746.80
26	308.39	18.30	12.56	30.86	166.70	741.46
25	296.91	18.08	12.56	30.64	165.49	736.12
24	285.43	17.86	12.56	30.41	164.29	730.77
23	273.94	17.63	12.56	30.19	163.09	725.43
22	262.46	17.30	12.56	29.85	161.59	718.75
21	250.98	17.08	12.56	29.63	160.09	712.07
20	239.49	16.74	12.56	29.30	158.59	705.39
19	228.01	16.52	12.56	29.07	157.08	698.71
18	216.53	16.18	12.56	28.74	155.58	692.03
17	205.04	15.96	12.56	28.51	154.08	685.35
16	193.56	15.62	12.56	28.18	152.58	678.67

15	182.08	15.29	12.56	27.85	150.78	670.65
14	170.59	14.95	12.56	27.51	148.97	662.64
13	159.11	14.62	12.56	27.18	147.17	654.62
12	147.63	14.29	12.56	26.84	145.37	646.61
11	136.14	13.84	12.56	26.39	143.27	637.26
10	124.66	13.50	12.56	26.06	141.17	627.90
9	113.17	13.17	12.56	25.72	139.36	619.89
8	101.69	12.72	12.56	25.28	137.26	610.54
7	90.21	12.05	12.56	24.61	134.26	597.18
6	78.72	11.61	12.56	24.16	131.25	583.82
5	65.6	10.94	12.56	23.49	128.25	570.46
4	52.48	10.16	12.56	22.71	124.35	553.09
3	39.36	9.26	12.56	21.82	119.84	533.05
2	26.24	8.15	12.56	20.70	114.43	509.00
1	13.12	6.70	12.56	19.25	107.53	478.28
34	400.26	20.09	12.56	32.64	175.71	781.54
33	388.78	19.87	12.56	32.42	175.11	778.87
32	377.30	19.64	12.56	32.20	173.90	773.52
31	365.81	19.42	12.56	31.97	172.70	768.18
30	354.33	19.20	12.56	31.75	171.50	762.84

3.3 DETAIL DESIGN

Detail design involves the analytical part which include the usage of software as modeling of the proposed structural system for the super high-rise building. In this stage, a model will be built based on the planned design together with data inserted into the software and the software will automatically do the analysis and calculation in which it will produce results relevant to the stability of the structure. Result data obtained from that software will be used and presented in the final report.

3.3.1 Design of Framed Tube

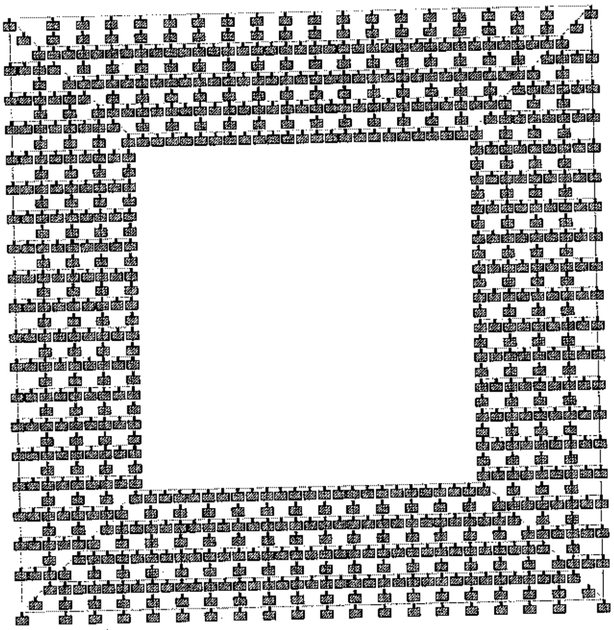


Figure 3.3.1-1 Layout View of the building

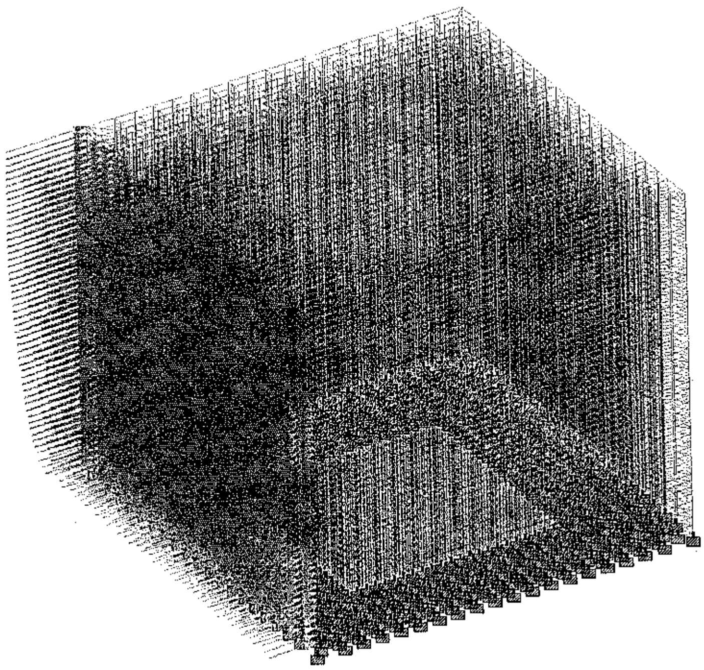


Figure 3.3.1-2 3-D Layout of the Structure with Wind Loading

3.3.2 Design of Rigid Frame with Shear Wall

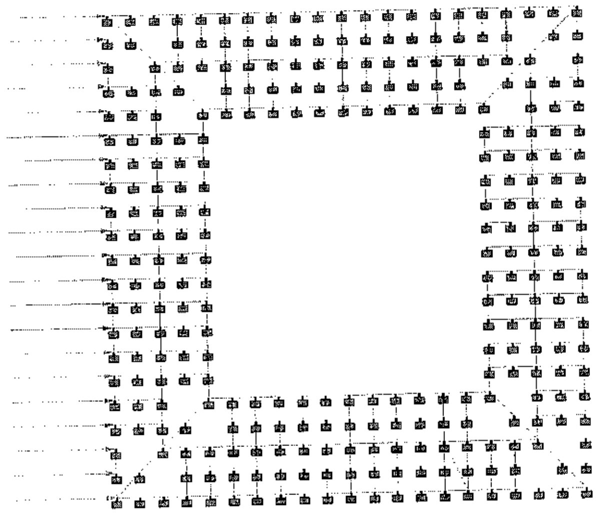


Figure 3.2.3-1 Layout View of building

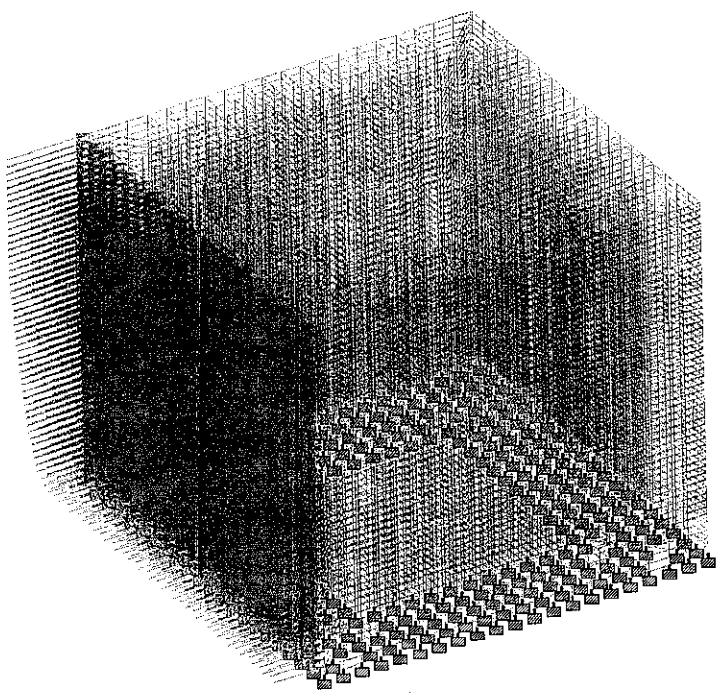


Figure 3.2.3-2 3-D of the Structure with Wind Loading

3.4 TOOLS

- STAAD PRO 2004 computer software

CHAPTER 4

RESULTS AND DISCUSSION

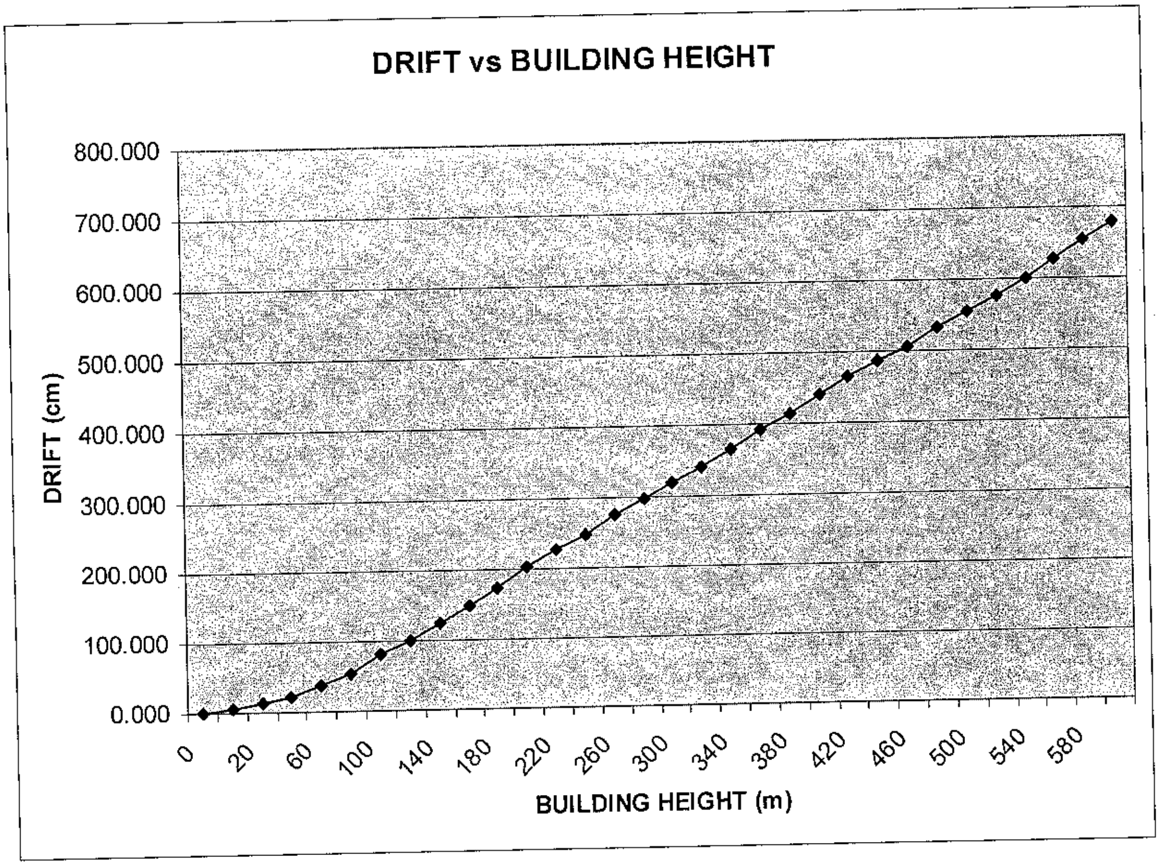
4.1 SELECTION OF STRUCTURAL SYSTEM

4.1.1. Framed Tube

Table 4.1.1-1 Drift for Frame Tube

Height (m)	Drift (cm)
0	0.000
10	3.326
20	9.235
40	17.654
60	28.254
80	38.614
100	53.987
120	66.184
140	85.002
160	98.657
180	112.254
200	130.369
220	144.147
240	160.258
260	178.528
280	197.639
300	218.153
320	235.601
340	254.002

360	271.359
380	288.974
400	305.486
420	322.947
440	339.206
460	354.000
480	372.546
500	388.741
520	405.214
540	420.368
560	437.253
580	456.695
600	473.986



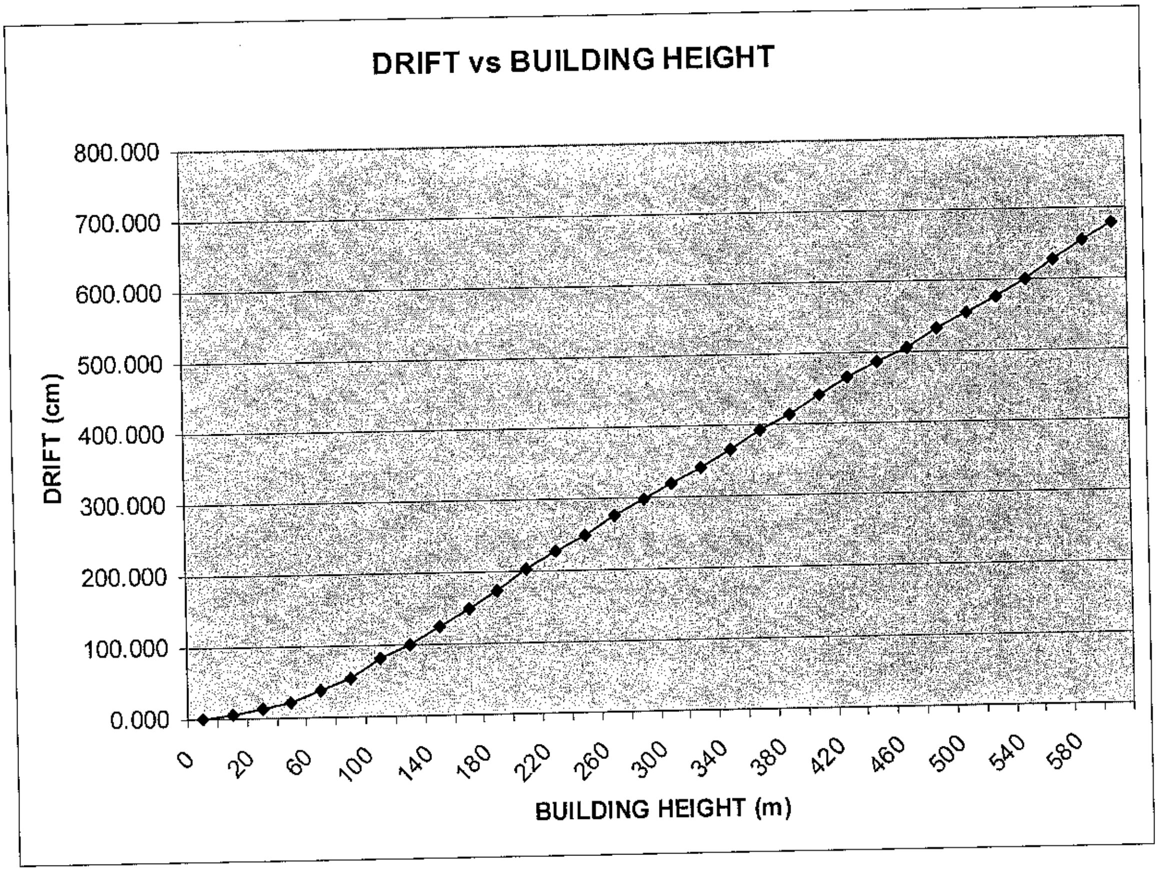
Graph 4.1.1-1 Effect on Building Height on Drift for Framed Tube

4.1.2 Rigid Frame with Shear Wall

Table 4.1.1-1 Drift for Rigid Frame with Shear Wall

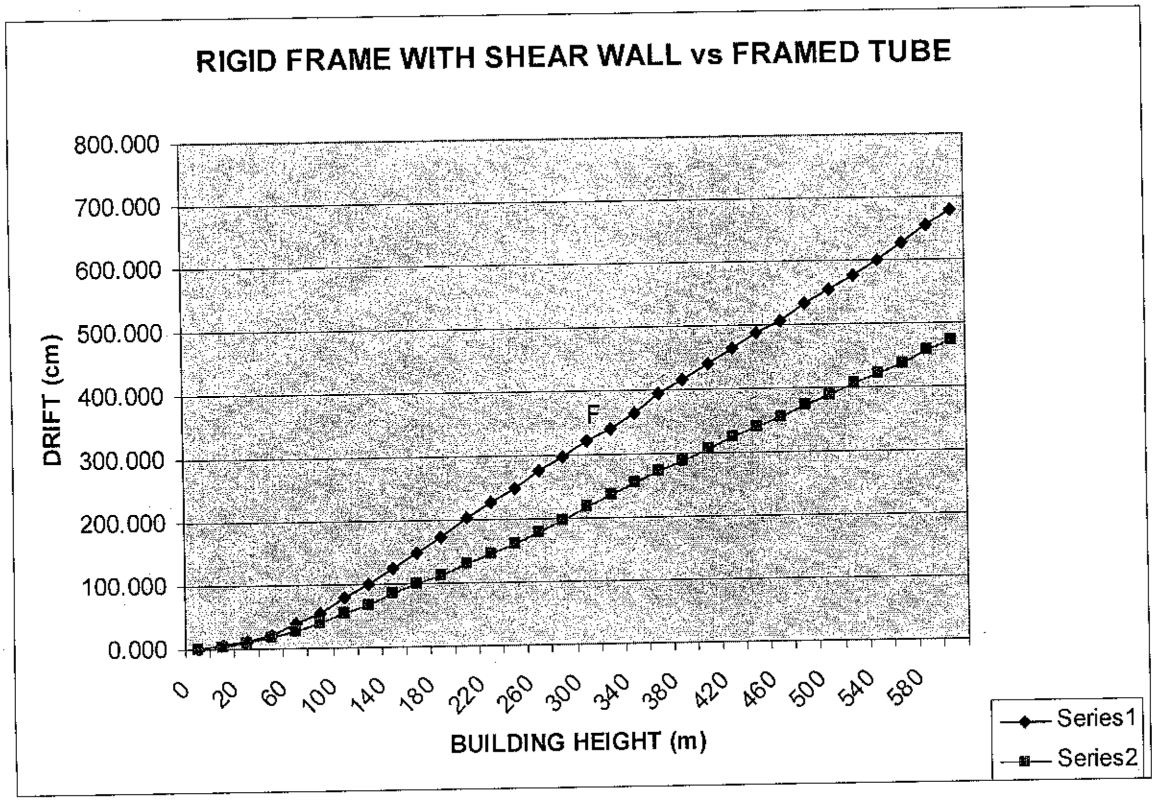
Height (m)	Drift (cm)
0	0.000
10	5.623
20	12.215
40	21.652
60	38.256
80	54.268
100	79.995
120	100.258
140	124.957
160	149.635
180	173.559
200	203.658
220	227.965
240	249.774
260	276.985
280	297.146
300	320.144
320	340.226
340	365.012
360	392.672
380	414.652
400	440.157
420	464.014
440	487.235
460	504.684
480	532.635
500	554.965

520	575.658
540	600.209
560	627.362
580	655.148
600	679.129



Graph 4.1.2-1 Effect on Building Height on Drift for Rigid Frame with Shear Wall

4.2 COMPARISON BETWEEN RIGID FRAME WITH SHEAR WALL AND FRAMED TUBE



Graph 4.2 -1 Effect on Building Height on Drift for Framed Tube and Rigid Frame with Shear Wall

Series 1 = Rigid Frame with Shear Wall
Series 2 = Framed Tube

4.2.1 Rigid Frame with Shear Wall

The advantages in using rigid frame structure is that can provide an open rectangular arrangement much more bigger than the framed tube because of the arrangement of the column can be spaced at quite a distance with each other. Besides, rigid frame also provide inherent rigidity for the reinforced concrete joint. Shear wall also will act as a structural member because these walls are permanent and therefore does not have the flexibility for the walls position to be altered in near future. Shear in the frame is made uniform throughout the frame. Rigid frame is estimated to be using less steel compared with the framed due to less number of column contains within the structure.

4.2.2 Framed Tube

As for the framed tube, the lateral resistance is provided by very stiff moment resistance frame that form a 'tube'. Usually, the design of building using this structure system is quite repetitive which at same time; the construction is being done rapidly. Besides, the drift displacement shown by the framed tube is much lesser compared to the rigid frame with shear wall.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

From the computational based analysis, results and discussions, following conclusion were made:

- Framed Tube structure system came out on top for this kind of design as it has less drift distance and within acceptable range.
- Structural system chosen significantly produced various result according to the structure concept chosen based on the height and design of the building.
- For the internal floor framing system, flat – plate can be used without the presence of beams as it is performed the same way as using one.

5.2 RECOMMENDATION

The recommendations derived from this project include:

- Detail analysis for the structure can be made using more advanced software because STAAD PRO 2004 takes quite some time in order to model the building and detailed design analysis. There are also many limitations encountered in using the STAAD PRO 2004.
- The analysis can be done by incorporating more structure design with several of size for the column and several of spacing between each column and various thickness of the wall plate.

- For the next analysis, if there is, maybe the value for area of steel required should be added as criteria for selection. Area of steel required is an important criterion due to the sudden increase in the price of steel.
- Maybe for the next project, several student should be appointed to analyze various structure but with the same design concept in order to obtain more options for the selection of structural system. This is due to the duration taken to do the analysis is quite long based on the height of the structure.

REFERENCES

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APPENDICES

APPENDIX 1

DESIGN WIND PRESSURE

Exposure	=	B				
Basic wind speed	=	33	m/s	=	73.82	mph
Building length	=	200	m	=	656.20	ft
Building width	=	100	m	=	328.10	ft
Roof	=	5	m	=	16.41	ft
Building height	=	600	m	=	1968.60	ft
Storey height (Level 6 and above)	=	3.5	m	=	11.48	ft
Storey height (Level 5 and below)	=	4	m	=	13.12	ft
Total estimated height	=	600	m	=	1968.60	ft
I_w	=	1				
$q_{s\ (v=m/s)}$	=	0.6671	kN/m2			
$q_{s\ (v=mph)}$	=	13.9504	psf			

Design pressure on Primary wind resisting system

1	2	3		4		5	6	5 + 6		
Level	Height above ground (ft)	Ce		Cq		Windward Pressure psf	Leeward Pressure psf	Design Pressure psf	Floor by Floor Load kips	1 kip = 4.448kN
		Windward	Leeward	Windward	Leeward					
171	1973.50	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
170	1962.02	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
169	1950.53	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
168	1939.05	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
167	1927.57	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
166	1916.08	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
165	1904.60	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
164	1893.12	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
163	1881.63	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
162	1870.15	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
161	1858.67	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
160	1847.18	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
159	1835.70	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
158	1824.22	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
157	1812.73	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
156	1801.25	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
155	1789.77	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
154	1778.28	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
153	1766.80	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
152	1755.32	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
151	1743.83	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
150	1732.35	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
149	1720.86	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
148	1709.38	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
147	1697.90	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54

146	1686.41	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
145	1674.93	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
144	1663.45	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
143	1651.96	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
142	1640.48	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
141	1629.00	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
140	1617.51	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
139	1606.03	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
138	1594.55	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
137	1583.06	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
136	1571.58	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
135	1560.10	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
134	1548.61	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
133	1537.13	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
132	1525.65	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
131	1514.16	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
130	1502.68	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
129	1491.19	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
128	1479.71	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
127	1468.23	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
126	1456.74	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
125	1445.26	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
124	1433.78	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
123	1422.29	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
122	1410.81	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
121	1399.33	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
120	1387.84	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
119	1376.36	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
118	1364.88	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
117	1353.39	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
116	1341.91	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
115	1330.43	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54

114	1318.94	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
113	1307.46	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
112	1295.98	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
111	1284.49	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
110	1273.01	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
109	1261.52	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
108	1250.04	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
107	1238.56	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
106	1227.07	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
105	1215.59	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
104	1204.11	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
103	1192.62	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
102	1181.14	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
101	1169.66	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
100	1158.17	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
99	1146.69	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
98	1135.21	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
97	1123.72	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
96	1112.24	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
95	1100.76	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
94	1089.27	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
93	1077.79	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
92	1066.31	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
91	1054.82	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
90	1043.34	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
89	1031.85	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
88	1020.37	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
87	1008.89	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
86	997.40	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
85	985.92	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
84	974.44	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
83	962.95	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54

82	951.47	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
81	939.99	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
80	928.50	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
79	917.02	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
78	905.54	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
77	894.05	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
76	882.57	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
75	871.09	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
74	859.60	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
73	848.12	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
72	836.64	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
71	825.15	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
70	813.67	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
69	802.18	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
68	790.70	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
67	779.22	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
66	767.73	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
65	756.25	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
64	744.77	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
63	733.28	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
62	721.80	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
61	710.32	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
60	698.83	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
59	687.35	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
58	675.87	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
57	664.38	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
56	652.90	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
55	641.42	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
54	629.93	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
53	618.45	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
52	606.97	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
51	595.48	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54

50	584.00	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
49	572.51	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
48	561.03	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
47	549.55	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
46	538.06	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
45	526.58	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
44	515.10	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
43	503.61	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
42	492.13	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
41	480.65	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
40	469.16	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
39	457.68	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
38	446.20	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
37	434.71	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
36	423.23	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
35	411.75	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
34	400.26	1.8	1.8	0.8	-0.5	20.09	12.56	32.64	175.71	781.54
33	388.78	1.78	1.8	0.8	-0.5	19.87	12.56	32.42	175.11	778.87
32	377.30	1.76	1.8	0.8	-0.5	19.64	12.56	32.20	173.90	773.52
31	365.81	1.74	1.8	0.8	-0.5	19.42	12.56	31.97	172.70	768.18
30	354.33	1.72	1.8	0.8	-0.5	19.20	12.56	31.75	171.50	762.84
29	342.84	1.7	1.8	0.8	-0.5	18.97	12.56	31.53	170.30	757.49
28	331.36	1.68	1.8	0.8	-0.5	18.75	12.56	31.30	169.10	752.15
27	319.88	1.66	1.8	0.8	-0.5	18.53	12.56	31.08	167.90	746.80
26	308.39	1.64	1.8	0.8	-0.5	18.30	12.56	30.86	166.70	741.46
25	296.91	1.62	1.8	0.8	-0.5	18.08	12.56	30.64	165.49	736.12
24	285.43	1.6	1.8	0.8	-0.5	17.86	12.56	30.41	164.29	730.77
23	273.94	1.58	1.8	0.8	-0.5	17.63	12.56	30.19	163.09	725.43
22	262.46	1.55	1.8	0.8	-0.5	17.30	12.56	29.85	161.59	718.75
21	250.98	1.53	1.8	0.8	-0.5	17.08	12.56	29.63	160.09	712.07
20	239.49	1.5	1.8	0.8	-0.5	16.74	12.56	29.30	158.59	705.39
19	228.01	1.48	1.8	0.8	-0.5	16.52	12.56	29.07	157.08	698.71

18	216.53	1.45	1.8	0.8	-0.5	16.18	12.56	28.74	155.58	692.03
17	205.04	1.43	1.8	0.8	-0.5	15.96	12.56	28.51	154.08	685.35
16	193.56	1.4	1.8	0.8	-0.5	15.62	12.56	28.18	152.58	678.67
15	182.08	1.37	1.8	0.8	-0.5	15.29	12.56	27.85	150.78	670.65
14	170.59	1.34	1.8	0.8	-0.5	14.95	12.56	27.51	148.97	662.64
13	159.11	1.31	1.8	0.8	-0.5	14.62	12.56	27.18	147.17	654.62
12	147.63	1.28	1.8	0.8	-0.5	14.29	12.56	26.84	145.37	646.61
11	136.14	1.24	1.8	0.8	-0.5	13.84	12.56	26.39	143.27	637.26
10	124.66	1.21	1.8	0.8	-0.5	13.50	12.56	26.06	141.17	627.90
9	113.17	1.18	1.8	0.8	-0.5	13.17	12.56	25.72	139.36	619.89
8	101.69	1.14	1.8	0.8	-0.5	12.72	12.56	25.28	137.26	610.54
7	90.21	1.08	1.8	0.8	-0.5	12.05	12.56	24.61	134.26	597.18
6	78.72	1.04	1.8	0.8	-0.5	11.61	12.56	24.16	131.25	583.82
5	65.6	0.98	1.8	0.8	-0.5	10.94	12.56	23.49	128.25	570.46
4	52.48	0.91	1.8	0.8	-0.5	10.16	12.56	22.71	124.35	553.09
3	39.36	0.83	1.8	0.8	-0.5	9.26	12.56	21.82	119.84	533.05
2	26.24	0.73	1.8	0.8	-0.5	8.15	12.56	20.70	114.43	509.00
1	13.12	0.6	1.8	0.8	-0.5	6.70	12.56	19.25	107.53	478.28