베트남 주상복합시설 및 사이판 숙박시설

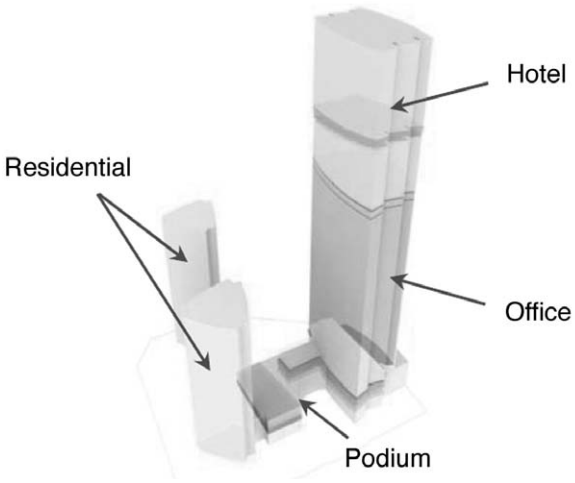

정광량 대표
(주)동양구조안전기술


유성훈 소장
(주)동양구조안전기술

1. Keangnam Hanoi Landmark Tower

1.1. 설계 개요

- 대지위치 : 베트남 하노이
- 층 수 : 지상 70층, 지하 2층
- 대지면적 : 46,096.06㎡ (13,944.06 py)
- 연 면 적 : 576,702.38㎡ (174,452.47 py)
- 용 도 : 공동주택, 업무시설, 숙박시설, 복합시설
- 설 계 : 희림+삼우+엄이
  HOK(SD), VNCC+UNC(베트남현지업체)
- 구조설계 : ARUP(SD), 동양구조안전기술(Landmark tower+podium+basement), ISTS (Residential tower)
- 시 공 : 경남기업(주)
- 현 황 : DD100%+CD50% (Fast-track), 기초 시공중



1.2. 설계기준 및 참고자료

1.2.1. GRAVITY LOADS

- Building Code of VietnamVolumeII-1997
- UBC97 Uniform Building Code ; Volume2

1.2.2. WIND LOADS

- TCVN 2737-1995, Load and Actions-Design Code
- ASCE7-05, American Society of Civil Engineers-Minimum Design Loads for Buildings and Other Structure
- WIND TUNNEL TEST REPORT(BMT)

1.2.3. SEISMIC LOADS

- UBC97 Uniform Building Code ; Volume2,
- TCXDVN (Guide line of Vetnam-2006)

1.2.4. MEMBER DESIGN

- ACI 318 : Building Code Requirements for Reinforced Concrete
- PTI : Post tension institute
- AISC ASD : AISC Manual of Steel Construction. Allowable Stress Design, Ninth Edition, 1989.
- AISC LRFD : AISC Manual of Steel Construction, LRFD, latest

1.2.5. Geotechnical Reports

- Investigation Report (현지업체)
- Consultant Report (진영이엔씨)

1.3. 사용재료 (MATERIAL)

1.3.1. Concrete

- 28-Day Cylinder Compressive Strength
  - Tower Column & Wall(Lintel) : 40MPa~70MPa
  - Tower Slab & Beam : 45MPa
  - Tower Foundation : 40MPa
  - Podium : 27MPa
  - Basement : 30MPa
- Modulus of Elasticity
  - in accordance with ACI318-02 (ch. 8.5.1)

1.3.2. Reinforcing Deformed Bar

Spec	Grade	Strengh (fy)	Diameter
KS (JIS)	SD295	295 MPa	Mild Bar(Dowel Bar)
	SD390	390 MPa	D ≤ D22
	SD490	490 MPa	D ≥ D25
Veatnam	AⅠ (ROUND BARS)	230 MPa	-
	AⅡ	280 MPa	D8~D22
	AⅢ	360 MPa	D25~D36

※ 시공중 철근자재 수급과 자재비 상승으로 제시한 2가지 이외에 중국GB, 미국 ASTM등을 추가로 사용할수 있도록 하였다.

1.3.3. POST-TENSIONED BEAM AND SLAB

- Concrete (ACI318-02)
  - Concrete strength
    fc=Vari.(min. 35MPa-high early strengthed portland cement)
  - Concrete strength at transfer
    1st : fc=7MPa
    2nd : fc=22MPa
- Prestressing Strands
  - Strands(7wire) ASTM a416 270 Grade (Low Relaxation)
  - Yield strength
    fy=1680 MPa
  - Tensile strength
    fpu=1860 MPa
  - Relaxation at 1000 hrs at 80% Pult=3.5%
  - Tendon friction parameter
    μ =0.20 / radian
  - Jacking force of tendon=75% of tendon ultimate tensile strength

1.4. 설계하중(횡하중)

1.4.1. Wind Load

- Basic Wind Pressure
  95daN/m^2(0.95kPa)-Return period 20yr, 3sec-TCVN
- TCVN 2737
  - Zoning of Wind Pressure ⅡB
  - Aerodynamic Coefficient, C X-dir : 1.26 / Y-dir : 1.20
- ASCE7-05
  - Exposure Categories C
  - Importance Factor 1.15

• Wind Directionality Factor 0.85

* Convert TCVN 2737 into ASCE7-05.

• Assume the value of the wind pressure in Hanoiis 95kgf/m^2

$$V_{assume} = \sqrt{\frac{95}{0.0613}} = 39.36 m/\sec$$

$$V_o = 39.36 \times \frac{1}{0.83} = 47.42 m/\sec = 106.08 mile/hr$$

• cf.

	TCVN 2737	ASCE 7-05	KBC 2005
Return Period	20 yrs	50 yrs	100 yrs
	0.83	1.00	1.11
Averaging Time Conversion Factor	3 sec	3 sec	10 min
	1.00	1.00	0.67
Basic Wind Speed	39.36m/sec	47.42m/sec	35.27m/sec

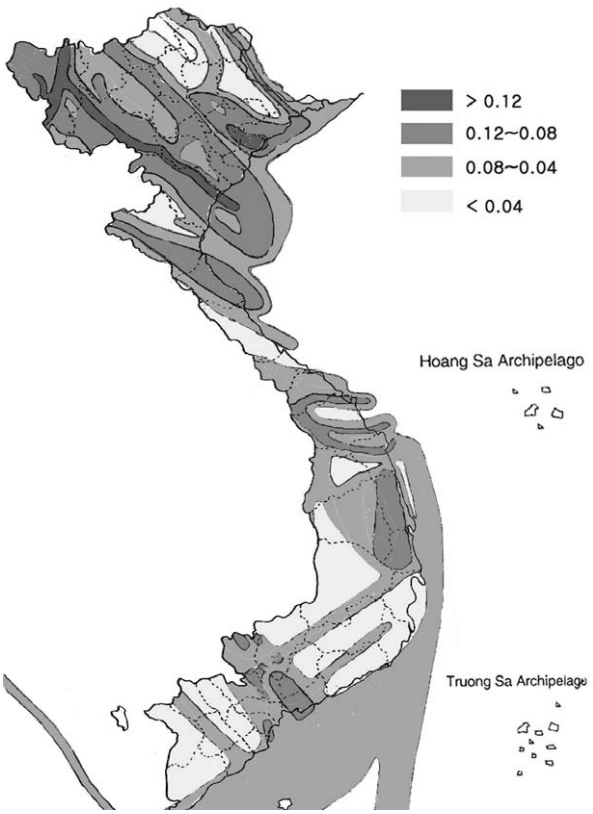
1.4.2. Seismic Load

To be advised by Local Design Institute, currently we assumed the followings in accordance with UBC1997.

- Seismic Zone Factor :

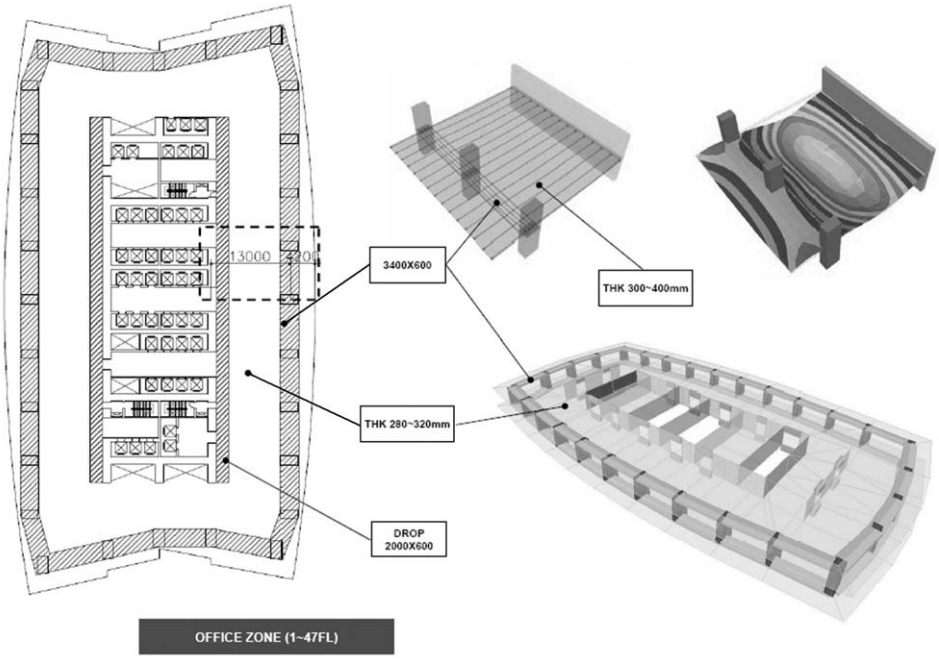
  2A(Z=0.108; Ground Acceleration from geologic associated with specific site)

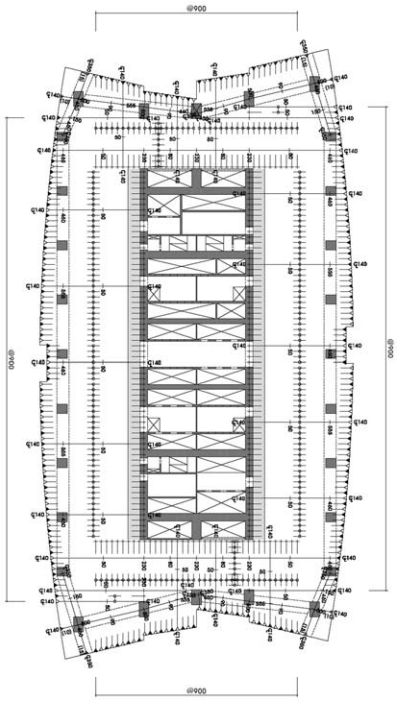
  Ca=0.164, Cv=0.242
- Soil Profile Type : SD
- Occupancy Category : I=1.0
- Structural System Building Frame System Shear Wall; R=5.5

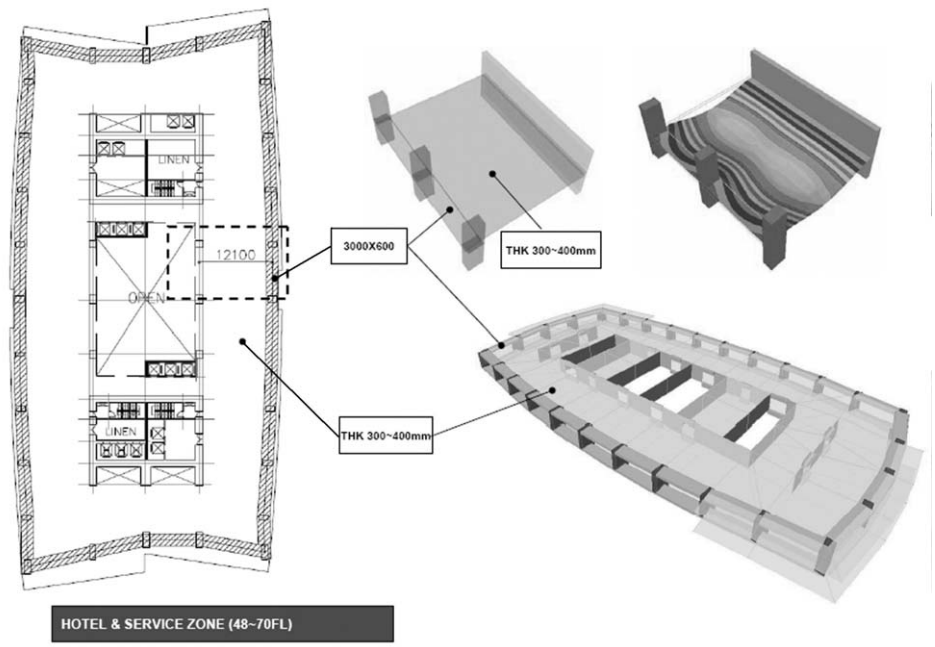


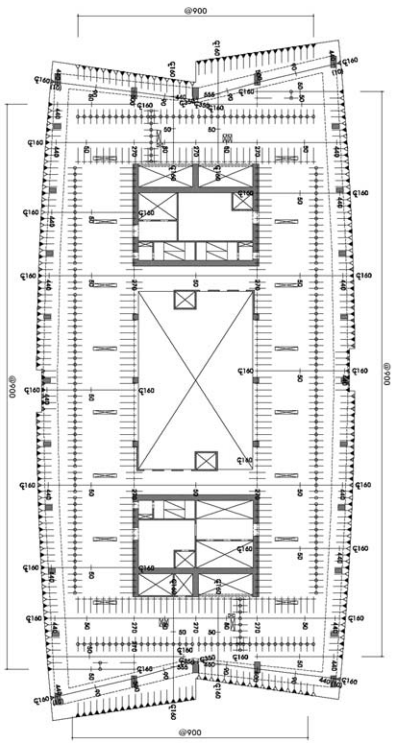
1.5. 구조시스템

1.5.1. Gravity system



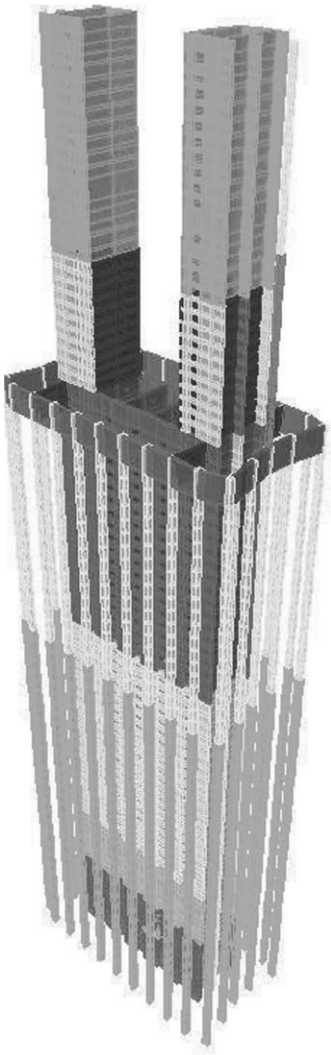


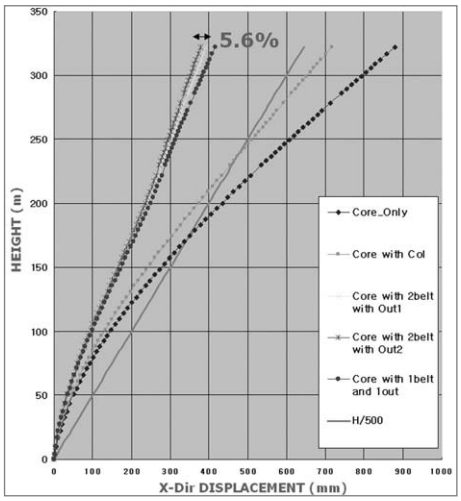


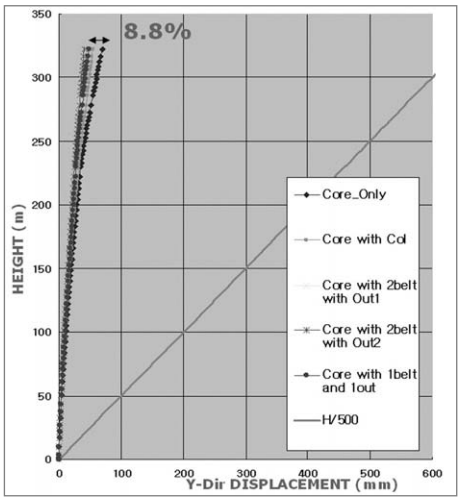


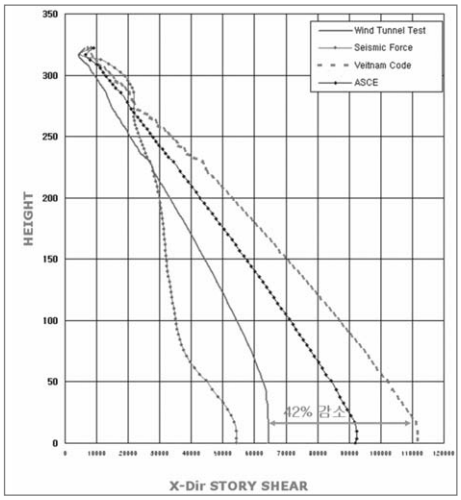
오피스 슬래브 두께 275mm PT 슬래브, 테두리보, 호텔 슬래브 두께 320mm PT 슬래브로 계획하였다. 내부에 보가 없어 설비공간을 절감하여 높은 천정고를 유지할 수 있다.

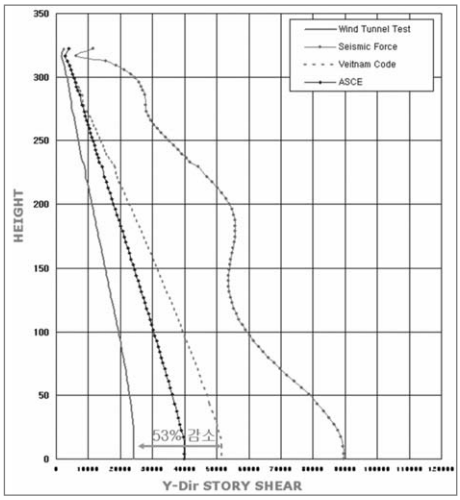
1.5.2. lateral system









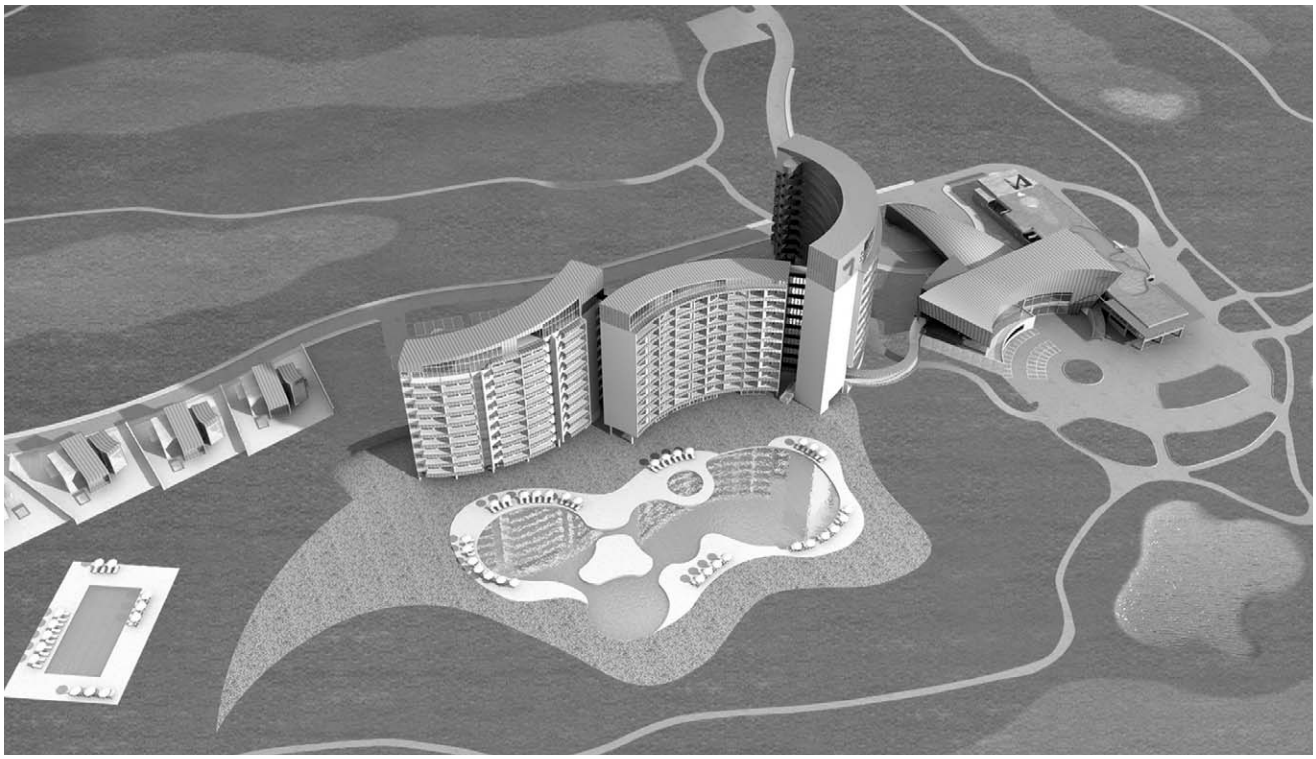


당초 2개의 아웃리거층이 있었으나 DD 설계과정중에 풍동 실험결과를 이용하여 상부 아웃리거를 제거하도록 하였다.

풍동실험 결과 ASCE7-05의 80%내외의 값을 얻었으며 기준에 의하여 풍동실험과 ASCE7-05의 80%값을 적용하였다.

2. Laolaobay Asiana CC

2.1. 설계개요



- 대지위치 : Saipan (USA)
- 층　수 : 지상 7층, 지하 1층
- 연 면 적 : 24,452m^2
- 용　도 : 숙박시설
- 설　계 : SKM (KOR+USA)
- 구조설계 : 동양구조안전기술(SD~CD)
- 시　공 : 대우건설
- 현　황 : CD100%, 토목 공사중

2.2. 설계기준 및 참고자료

2.2.1. Gravity Loads

- UBC97 Uniform Building Code ; Volume2

2.2.2. Wind load

- ASCE 7-05 Minimum Design Loads for Buildings and Other Structures

2.2.3. SEISMIC LOADS

- UBC97 Uniform Building Code ; Volume2,

2.2.4. MEMBER DESIGN

- ACI 318 : Building Code Requirements for Reinforced Concrete
- AISC ASD : AISC Manual of Steel Construction. Allowable Stress Design, Ninth Edition, 1989.
- AISC LRFD : AISC Manual of Steel Construction, LRFD, latest

2.3. 사용 재료 (MATERIAL)

2.3.1. Concrete

- Density = 2300kg/m^3
- 28-Day Compressive Cylinder Strength

a. Tower Condo

-Tower : 30 MPa

-Podium, Bridge : 27 MPa

b. Club House : 27 MPa

c. Villa Condo : 27 MPa

d. Guest House : 27 MPa

e. Staff House : 27 MPa

f. Tea House : 27 MPa

- Concrete shall be prevented from chloride attack.

2.3.2. Reinforcing Deformed Bar

KS D 3504 SD400=400Mpa

ASTM A615 Grade60=414MPa

KS D 3504	HD10	HD13	HD16	HD19	HD22	HD25	HD29	HD32
ASTM A615	#3	#4	#5	#6	#7	#8	#9	#10

2.4. 설계하중 (횡하중)

2.4.1. Wind load

- Basic Wind Pressure

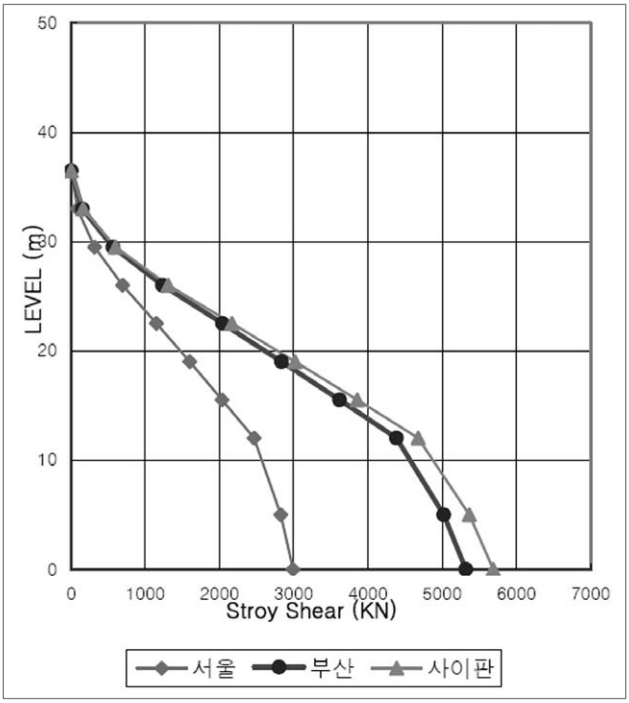
155mph (70m/s) windspeed in Saipan

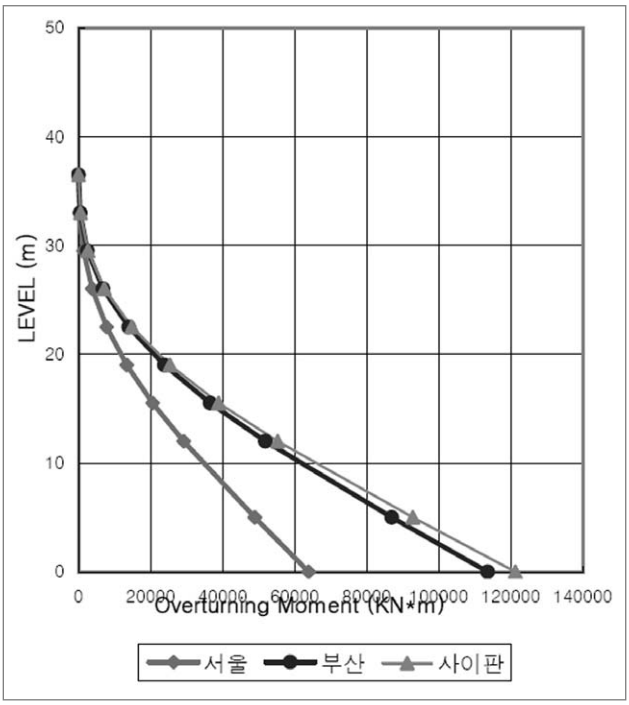
ASCE 7-05

- Occupancy Category III
- Exposure Categories D
- Importance Factor 1.15
- Wind Directionality Factor 0.85
- Gust Effect Factor 0.85

* Comparing KBC2005 to ASCE7-05.

	ASCE 7-05	KBC 2005
Return Period	50 yrs	100 yrs
	1.00	1.05
Averaging Time	3 sec	10 min
Conversion Factor	1.00	0.67
Basic Wind Speed	70.00 m/sec	48.54 m/sec

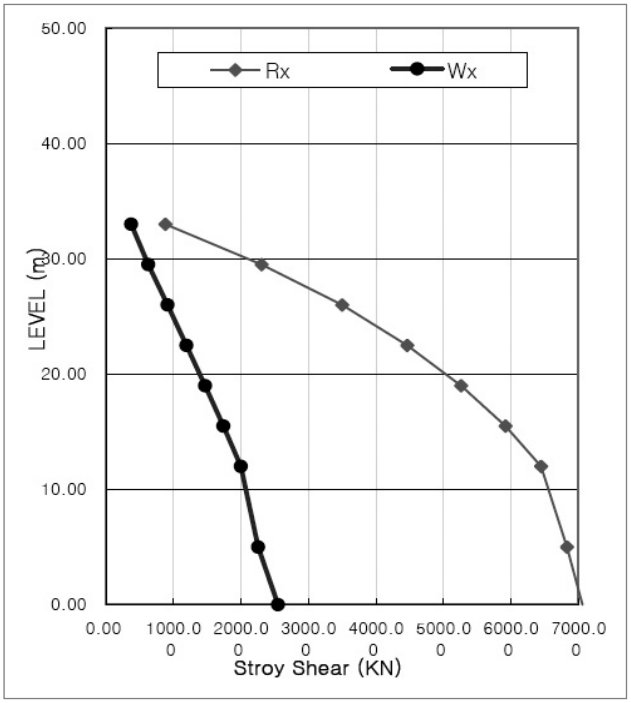


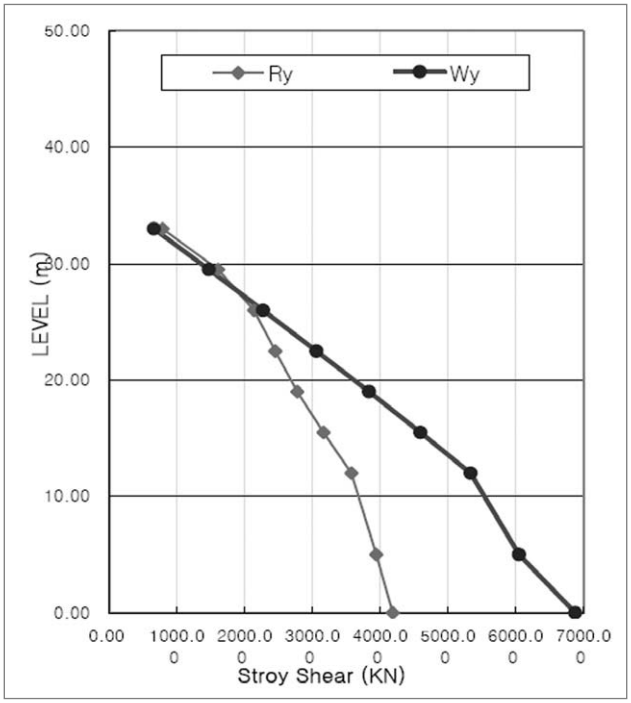


2.4.2. Seismic Loads

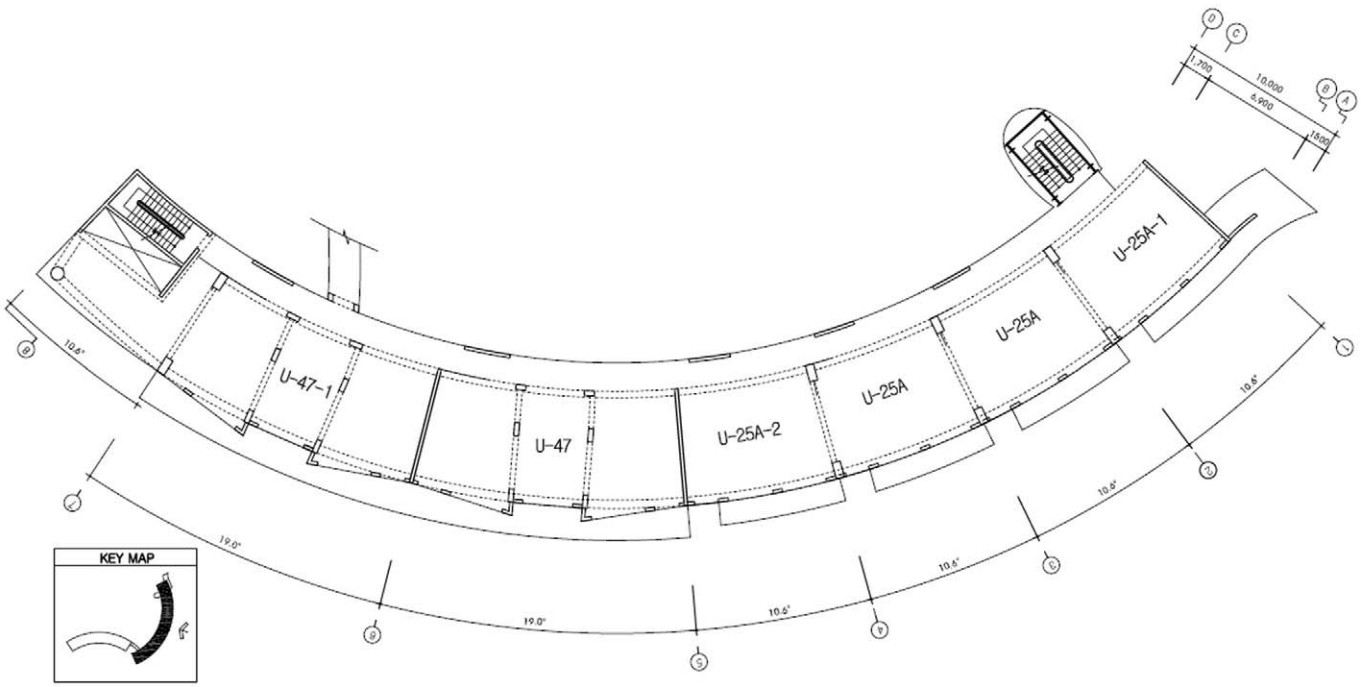
- Seismic Zone Factor 3 (Z=0.30)
- Soil Profile Type Sc
- Occupancy Category I=1.0
- Structural System All buildings

R=4.5(Bearing wall system with shear walls)





2.5. 구조시스템



TOWER-A

지상 9층, 8층의 콘도 타워는 모두 필로티 형식으로 계획되어졌다. 사이판은 UBC97에 의한 지진지역 3으로 강진지역에 속한다. 따라서 내진설계시 큰 횡력뿐만 아니라 잉여력계수, 시스템에 따른 시스템 초과강도계수가 주요 고려사항이 된다. Tower-a는 편심코아로 응력의 분포를 고르게 분포시키지 못하여 잉여력계수를 적용하여야 하나 Tower-b는 응력을 고르게 분배시켜 잉여력계수를 적용하지 않도록 하였다. 또한 매층에 보를 설치하여 결과적으로 전이되는 층을 제거하여 시스템 초과강도계수를 적용하지 않도록 계획하였다.

또한, 지역특성상 콘크리트 재료비가 매우 큰 지역으로 타 국가에 비하여 4배이상 비싼지역이므로 최대한 콘크리트사용을 억제하며 대신 보강블럭을 사용하였는데 이때 강진지역에 따른 보강상세를 적용하였다.