





WANCHAI ,HONG KONG

Submitted By

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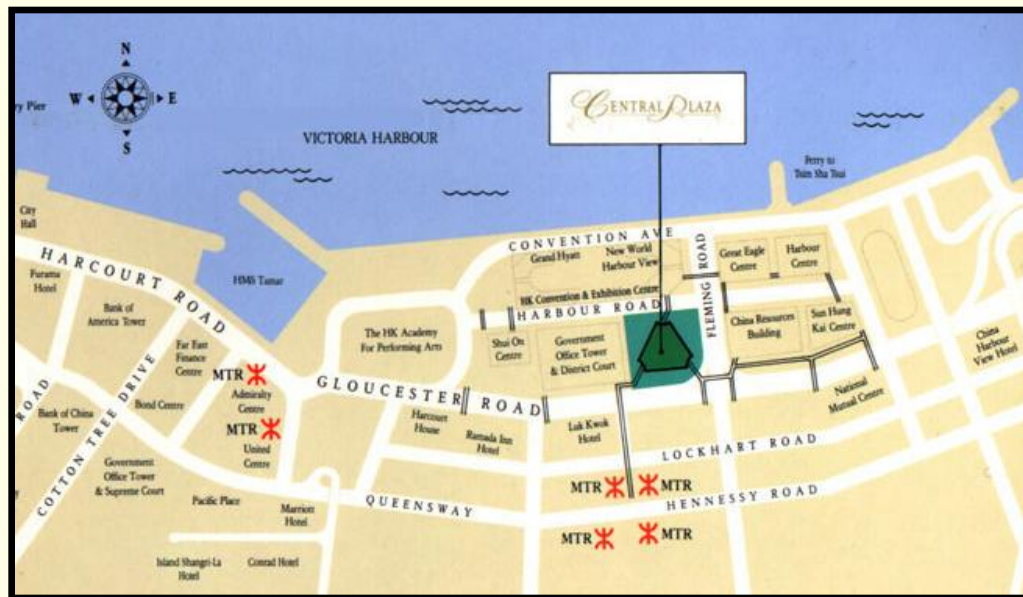
Priyanka Dherange

CENTRAL PLAZA

- 1) **78-storey**: 374m tower
- 2) World's fourth tallest building at the time of construction
- 3) Tallest reinforced-concrete structure in the world until it was surpassed by CITIC Plaza, Guangzhou
- 4) First time Grade **60 high-strength concrete** was used in the territory's private sector



- 1) Represented many *stimulating structural and geotechnical challenges*
- 2) To minimise settlement, *diaphragm walls* were installed down to bedrock, 40m below ground level
- 3) Large-diameter machine and hand-dug caissons, some up to 7.4m wide, were then selected for the foundations, which support *column loads of 200MN and a central core load of 2000MN*



ADDRESS- 18, Harbour Road, Hong Kong.

SITE AREA- 7230 sq m

TOTAL BUILDING AREA- 173,000 sq m

MATERIALS-

- **Granite** 720 tonnes covering 40,060 sqm (9 standard football pitches)
- **Glass** 50,000 sqm (11 standard football pitches)
- **Neon tubings** 6,000 m using 1,000 separate transformers

LIFTS- 39 computerised high-speed lifts.

DESIGN POPULATION- 8000 persons (working=6000)

LAND AND CONSTRUCTION COST

Land cost = HK\$3,300 million (US\$430 million)
 Construction cost = HK\$1,100 million (US\$143 million)
 Unit area construction cost = HK\$6,300 per m²

PHASED COMPLETION-

Phase 1 (B3 - 27/F) - completed October 1991
 Phase 2 (28/F - 45/F) - completed February 1992
 Phase 3 (46/F - Tower Top) - completed August 1992



BASIC DATA

- *ARCHITECT*- Ng Chun Man & Associates
- *STRUCTURAL ENGINEER*- Ove Arup & Partners
- *BUILDING SERVICES ENGINEER*- Associated consulting engineers.
- *MAIN CONTRACTOR*- Manloze Ltd.
- *HEIGHT FROM STREET TO ROOF*- 374m
- *NUMBER OF STORIES*- 78
- *BUILDING USE*- Office
- *FRAME MATERIAL*- Reinforced Concrete
- *TYPICAL FLOOR LIVE LOAD*- 3kPa
- *BASIC WIND VELOCITY*- 64 m/sec(144 mph), 50-yr return, 3-sec gust
- *MAXIMUM LATERAL DEFLECTION*- 400mm(15.8 in.), 50-yr return period wind.
- *DESIGN ACCELERATION*- Less than 10 mg., 10-yr return period (typhoon wind)
- *EARTHQUAKE LOADING*- Not applicable
- *TYPE OF STRUCTURE*- Perimeter tube and core



FOUNDATION CONDITIONS-

Fill over clay over granite bedrock; granite bedrock, 25 to 40 m (80 to 130 ft) below ground.

FOOTING TYPE- Machine and hand-dug caissons to rock.

TYPICAL FLOOR-

STORY HEIGHT- 3.6m (11.8 ft)

BEAM SPAN- 12m (39 ft)

BEAM DEPTH- 700mm (27.5 in.) reinforced concrete

SLAB- 160mm (6.3 in.) reinforced concrete

COLUMNS

SIZE AT GROUND FLOOR- 2m (6.5 ft) diameter

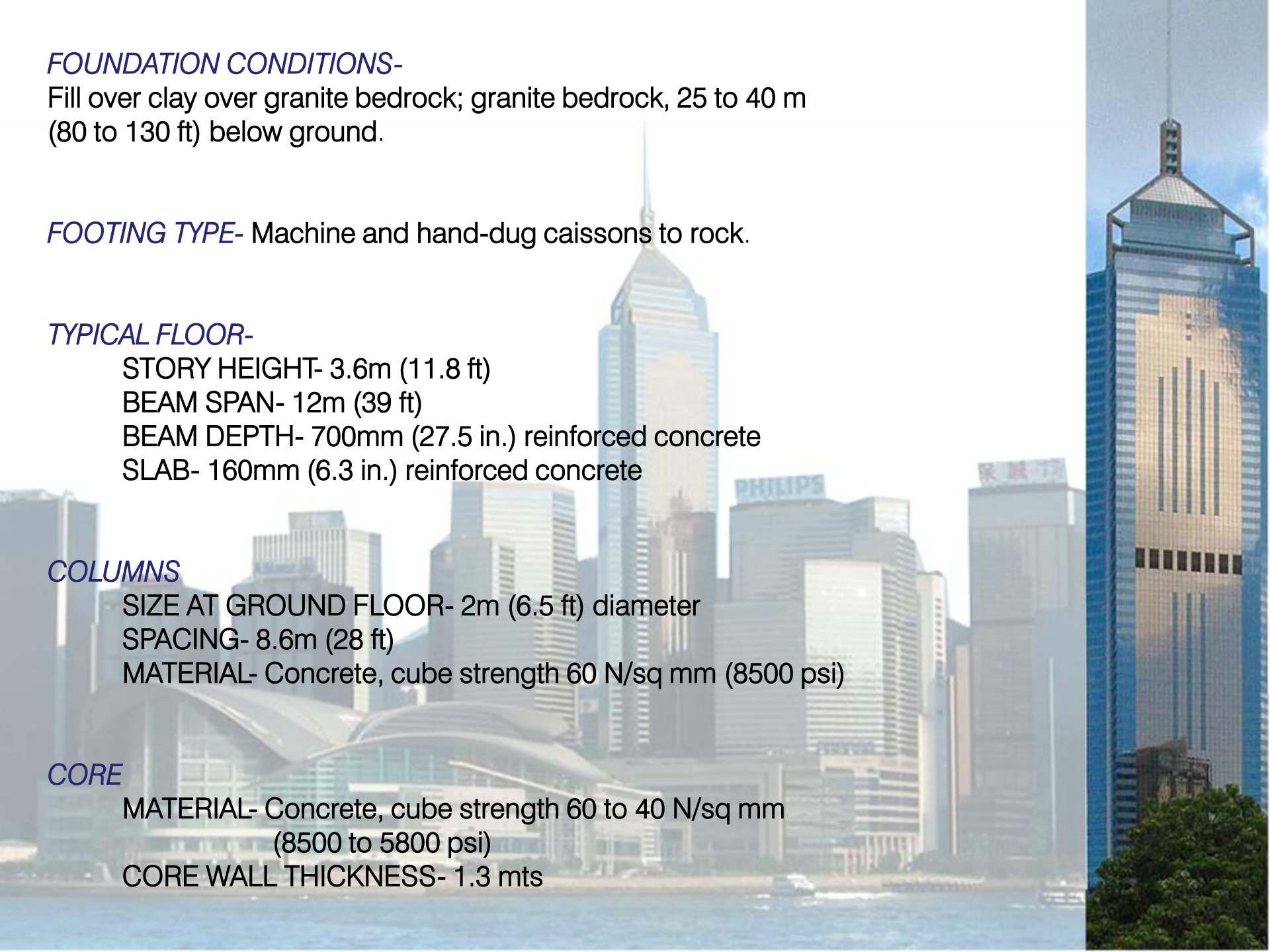
SPACING- 8.6m (28 ft)

MATERIAL- Concrete, cube strength 60 N/sq mm (8500 psi)

CORE

MATERIAL- Concrete, cube strength 60 to 40 N/sq mm (8500 to 5800 psi)

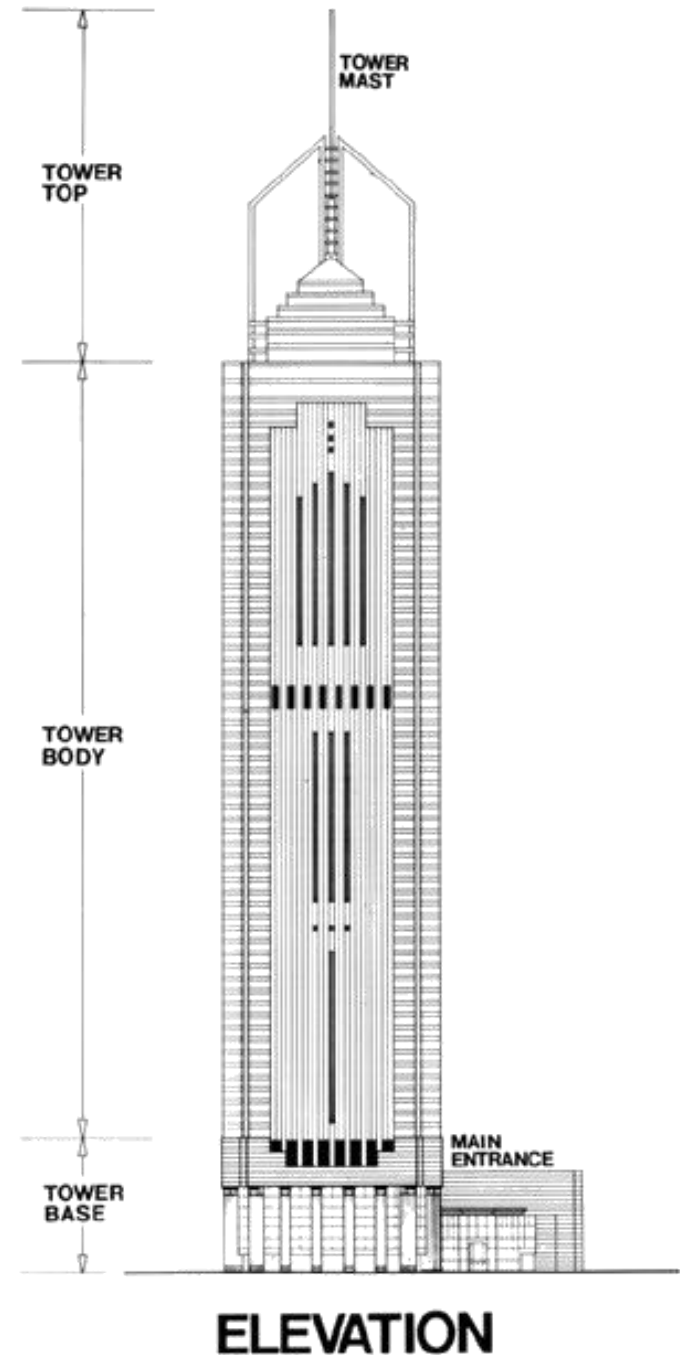
CORE WALL THICKNESS- 1.3 mts

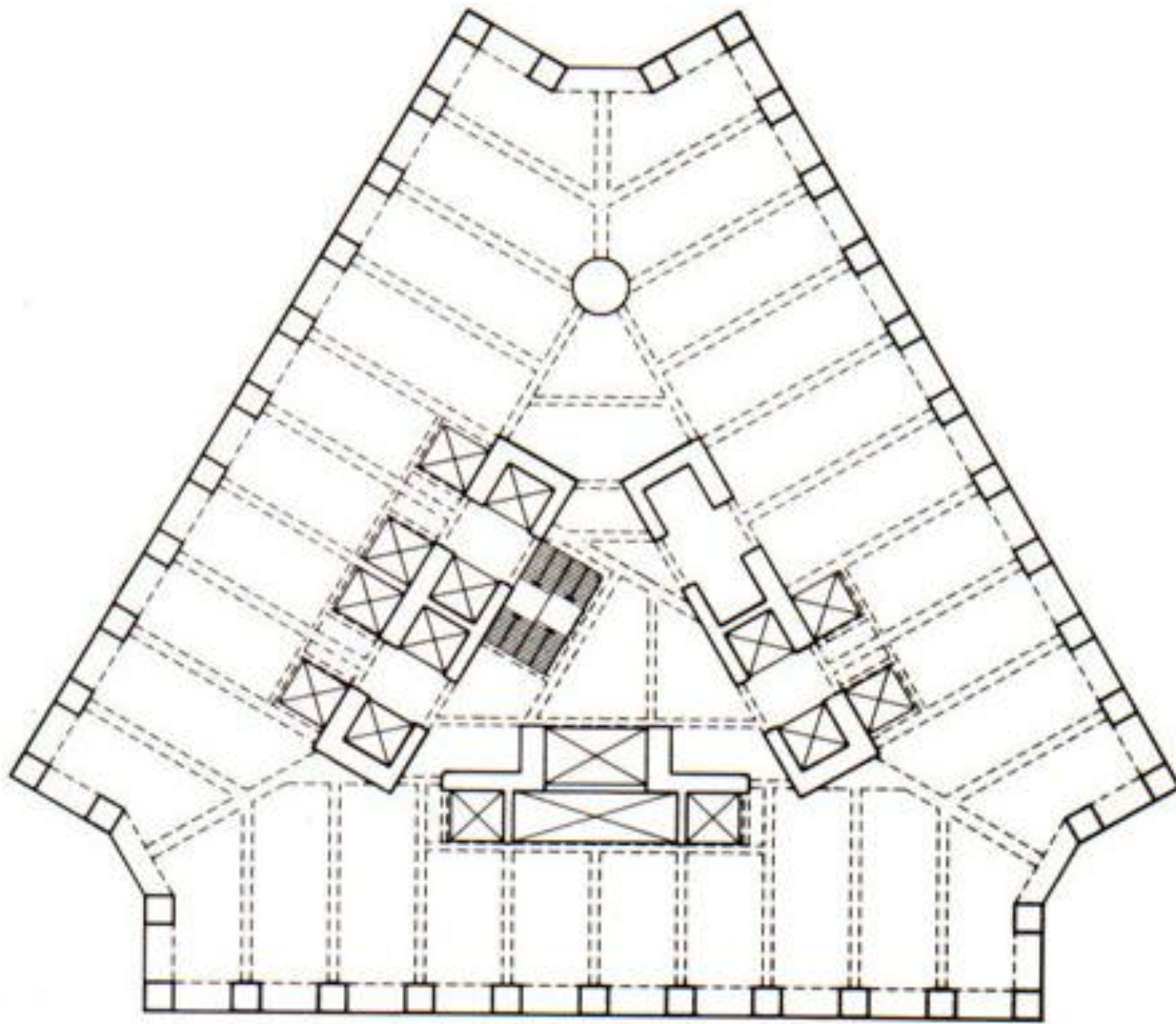


THE DESIGN

THREE BASIC COMPONENTS:

1. 30.5 m high tower base forming
 - main entrance
 - Public circulation spaces
2. 235.4 m tower body containing
 - 57 office floors
 - sky lobby
 - 5 mechanical plant floors
3. Tower top consisting
 - Six mechanical plant floors.
 - 102 m tall tower mast.





TYPICAL TOWER FLOOR PLAN





THE ENTRANCE PODIUM -30.5 M HIGH with 2m dia and 8.6 m spacing of concrete columns M60 grade

DESIGN CONSTRAINTS

1. TRIANGULAR SHAPE FLOOR PLAN

- provides 20% more office area to enjoy the harbour view than rectangle or square.
- Internal column free office area with a clear depth of 9 to 13.4 m.
- Usable floor area efficiency- 81%

2. HIGH WATER TABLE- diaphragm wall

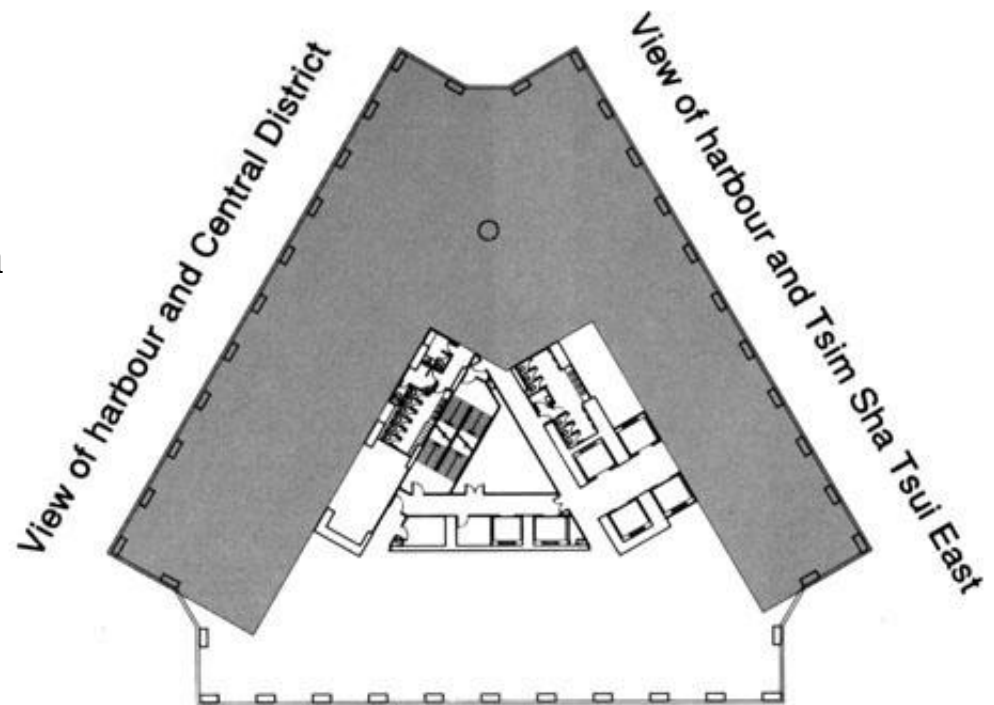
3. TIME WAS THE KEYWORD

4. WIND LOADING- major design criteria

5. MAX. CLEAR CEILING HEIGHT-

FLOOR HEIGHT : 3.6 M

CLEAR CEILING HT. : 2.6 M



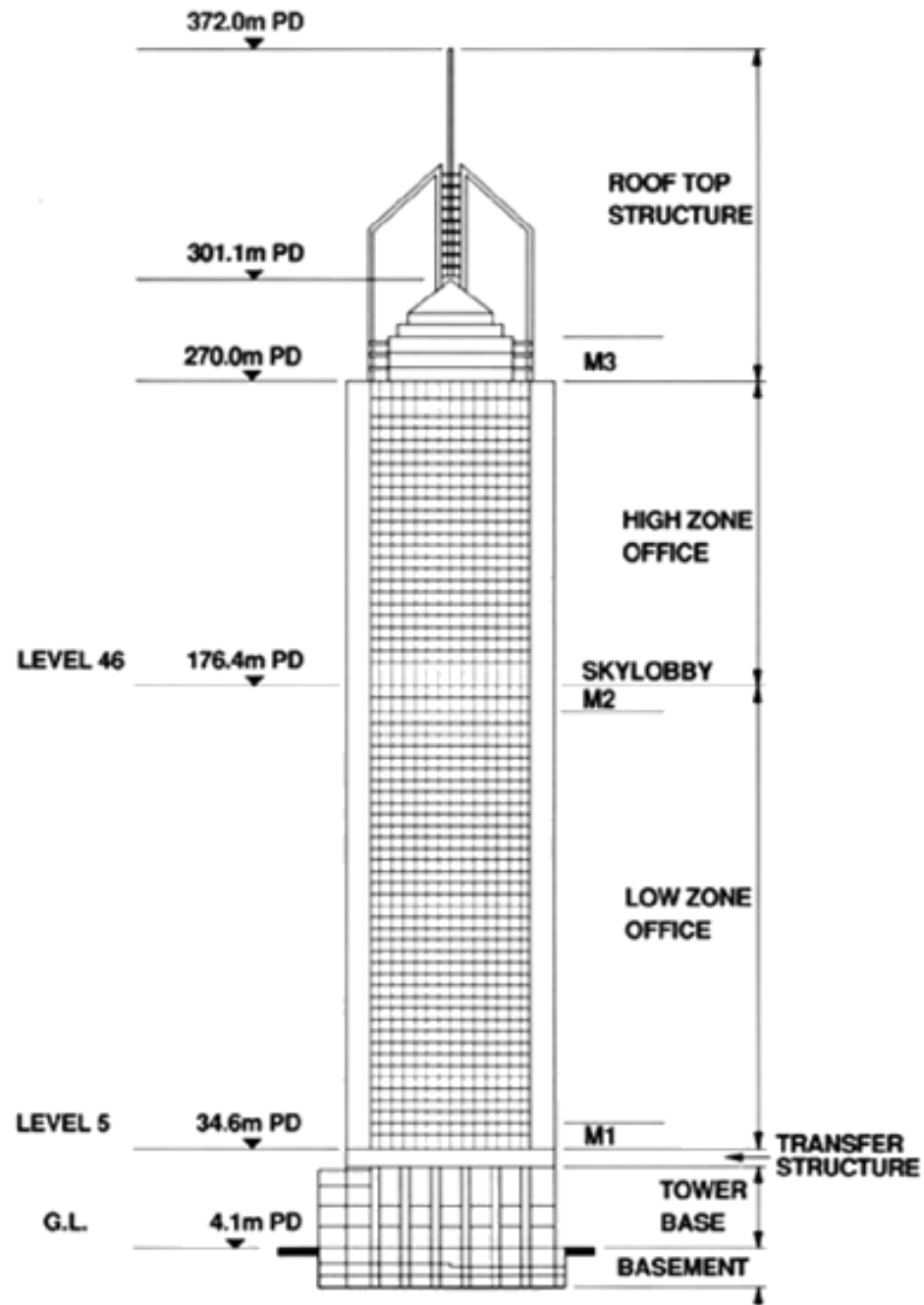
With the triangular plan, 70% of the offices can enjoy harbour view.

LOAD TRANSMISSION

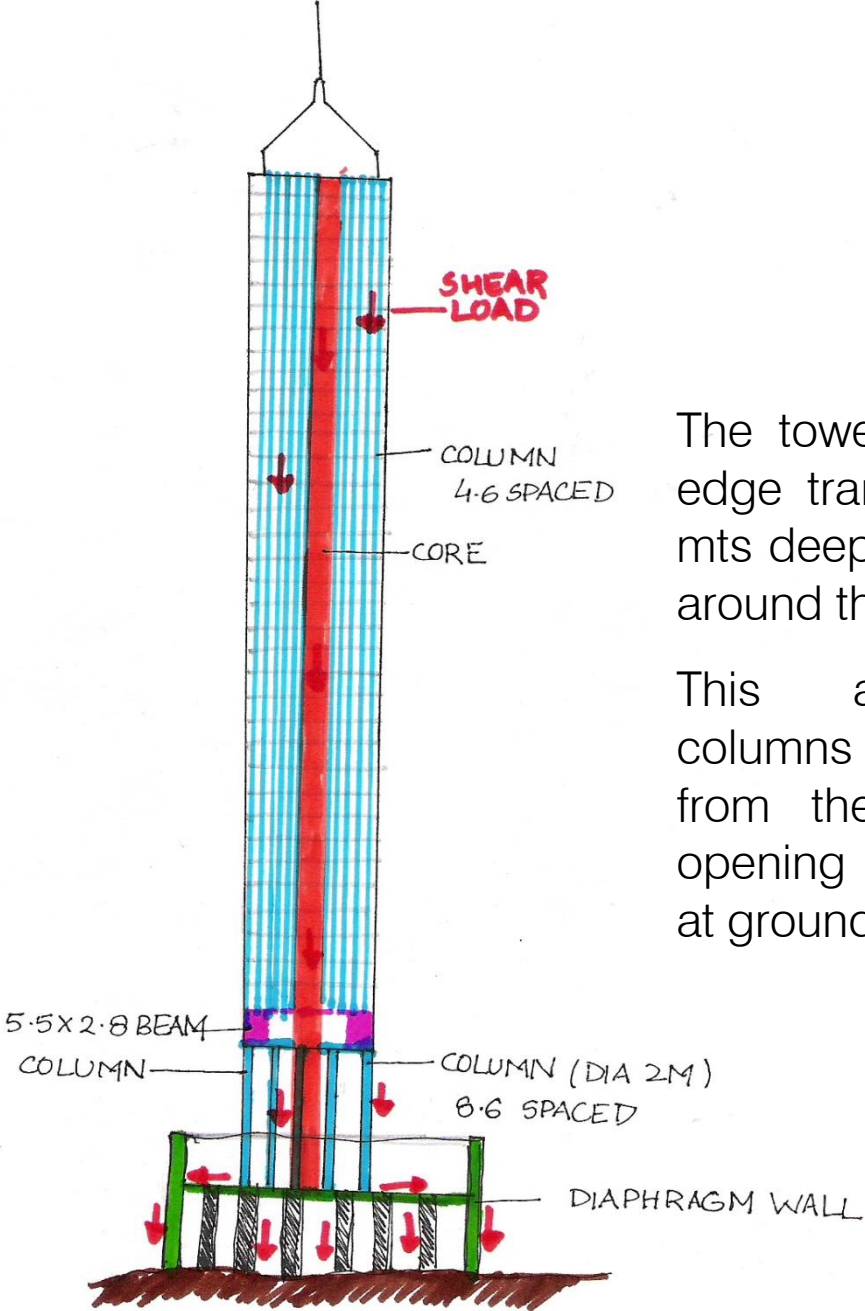
STRUCTURE- Perimeter tube and core

The structural system consists of a **central core** and **peripheral columns** 4.6 mts centers, tied by **floor edge beams** 1.1 mts deep, which **transmit vertical and Horizontal load** to the base level.

Above the tower base, 30.5m above ground level, stability is provided by the external façade frames acting as a tube. **Core** above the tower base carries approx. 10% of the total wind load.



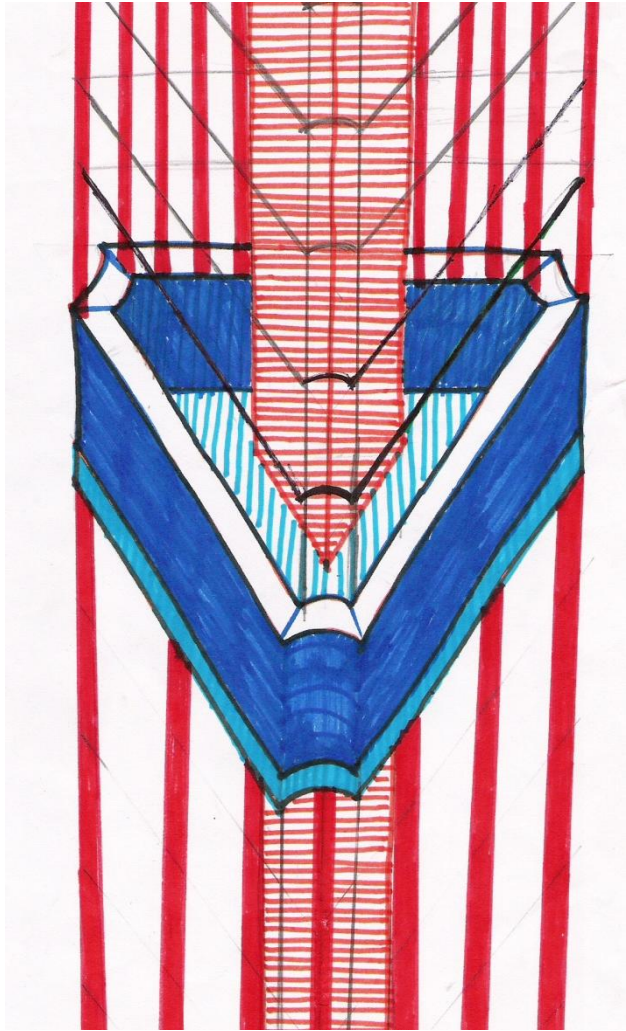
CONCRETE SCHEME: ELEVATION



VERTICAL LOAD TRANSFER

The tower based structure edge transfer beam is 5.5 mts deep and 2.8 mts wide around the perimeter.

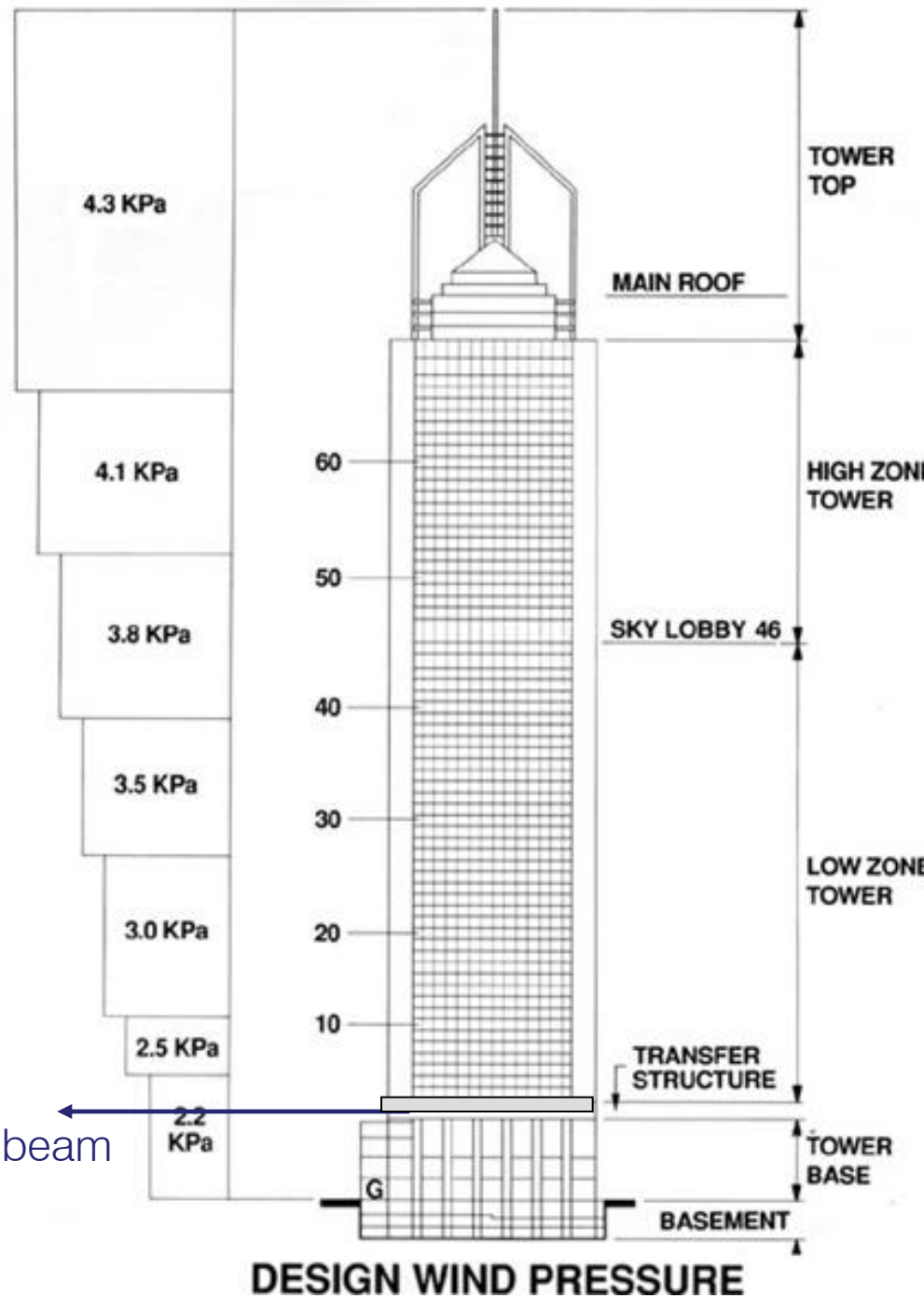
This allows alternate columns to be dropped from the facade thereby opening up the public area at ground level.

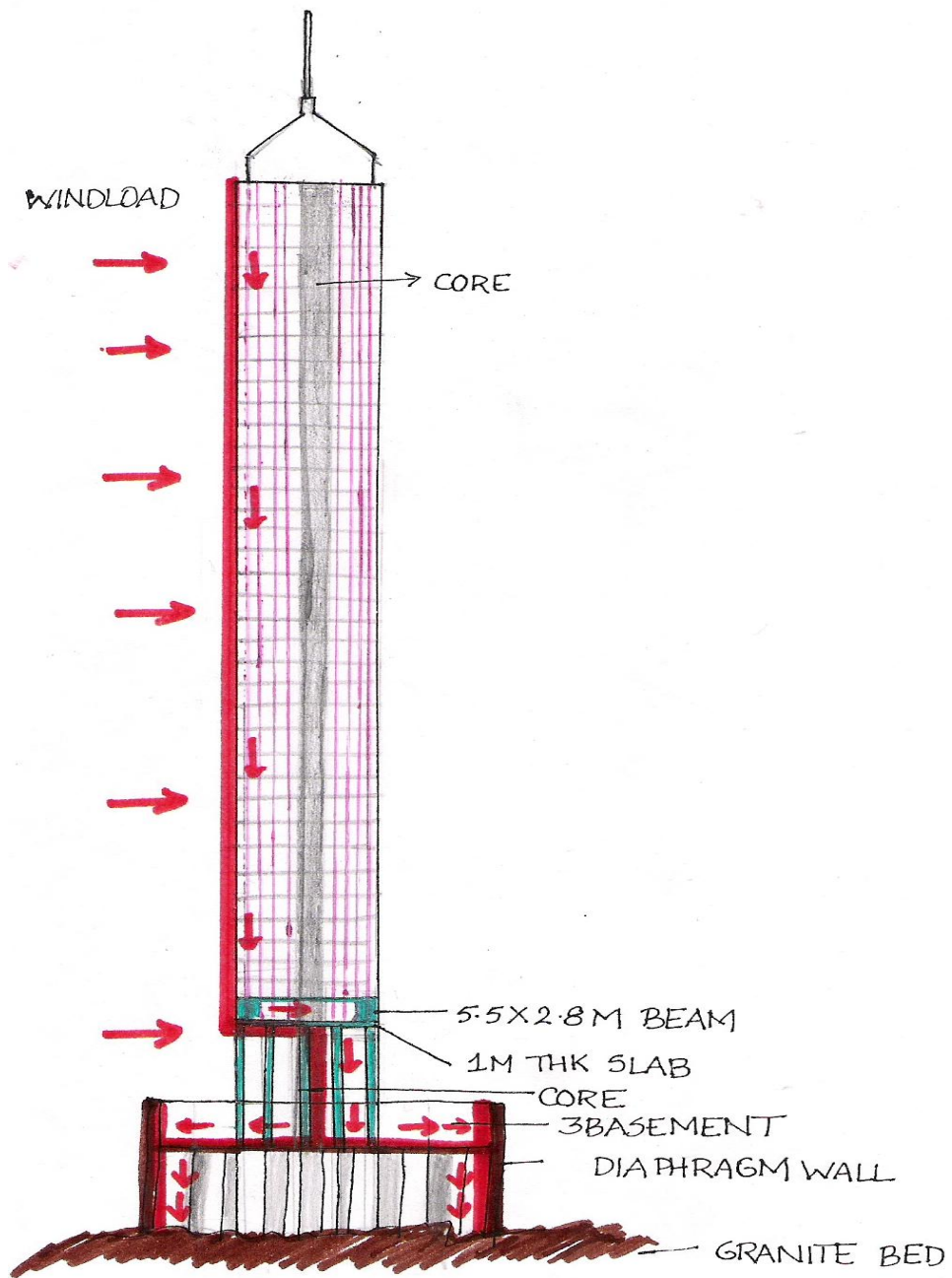


THE WIND PRESSURE:

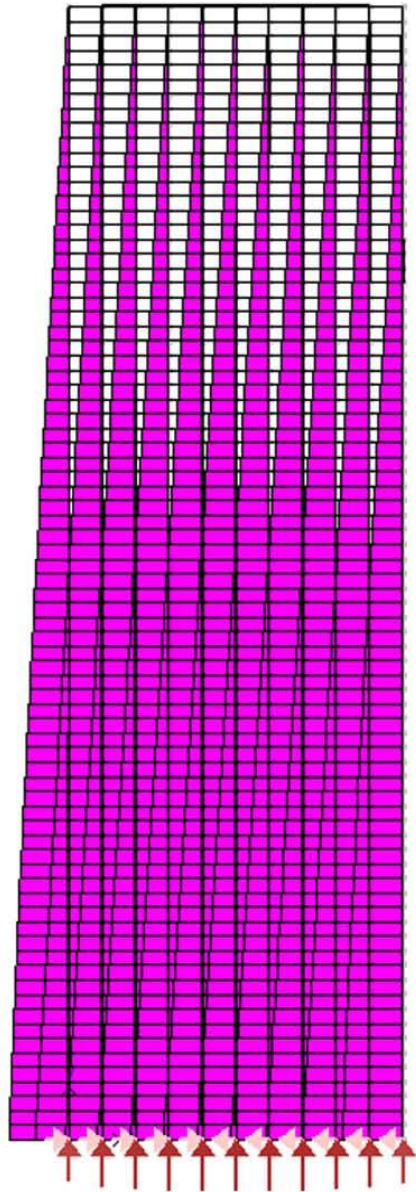
- 1) Increased column spacing together with the elimination of spandrel beams in the tower base results in the external frame no longer being able to carry the wind loads acting on the building.
- 2) Over the height of the base the core transfers all the wind shears to the foundation.
- 3) A 1 mt thick slab at the under side of the transfer beam transfers the total wind shear from the external frame at the inner core below.
- 4) The wind shear is taken out from the lowest basement level, where it is transferred to the perimeter diaphragm walls.

1 mt thick slab
With 5.5m wide beam

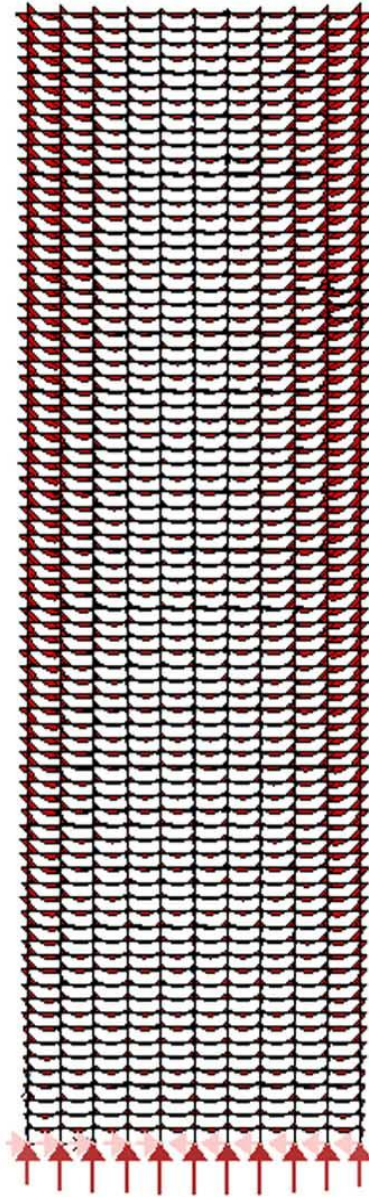




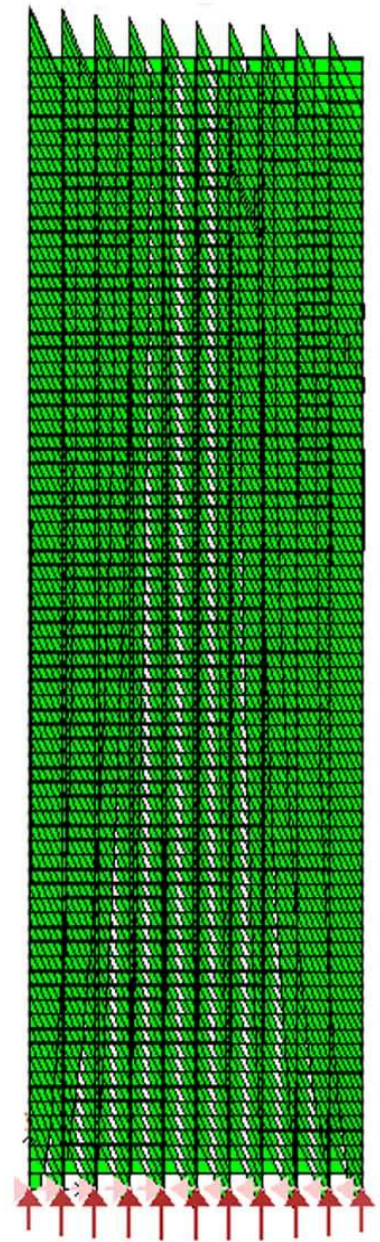
LATERAL LOAD TRANSMISSION



LOAD TRANSFER DIAGRAM



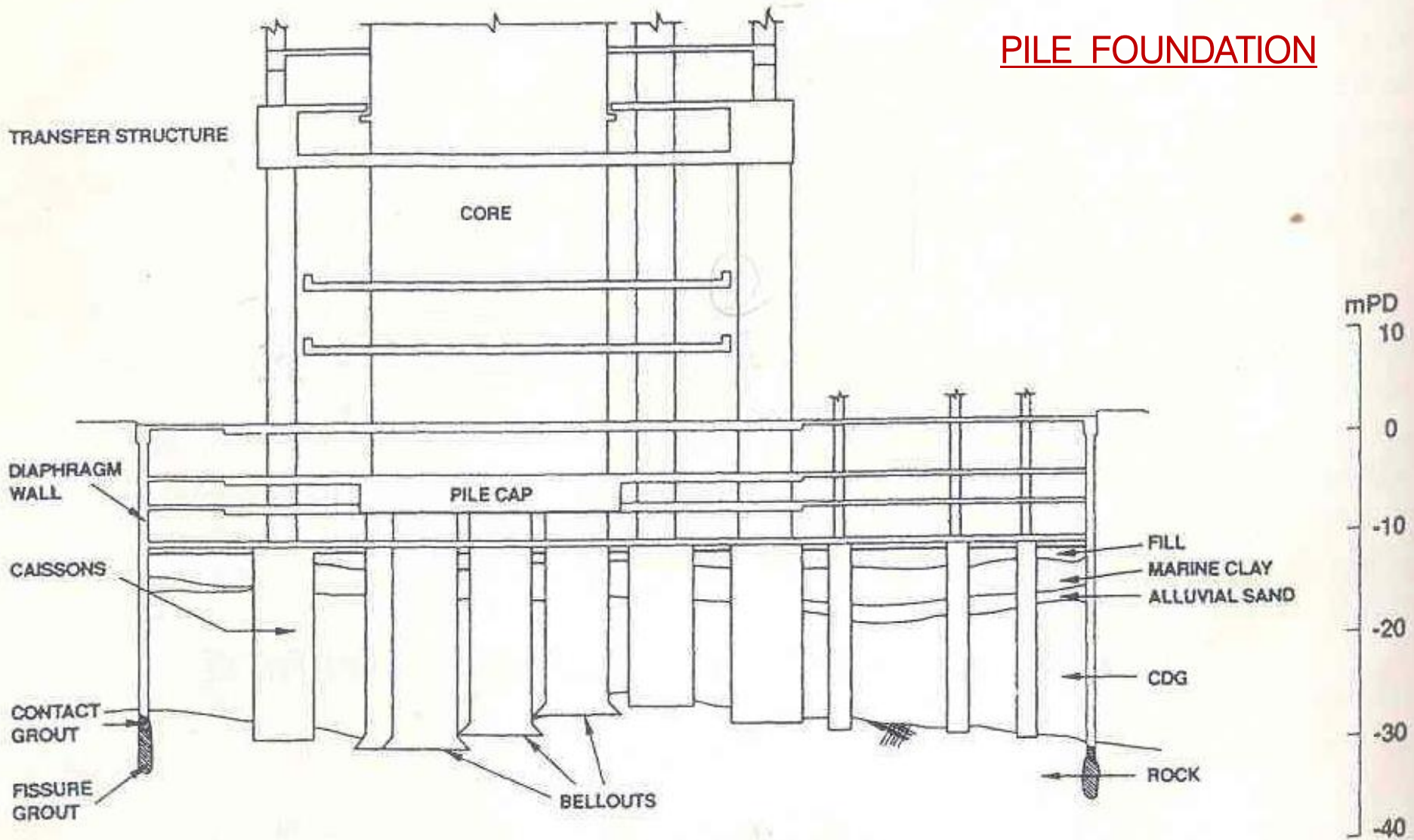
BENDING MOMENT DIAGRAM



SHEAR FORCE DIAGRAM

MUTLIFRAME ANALYSIS

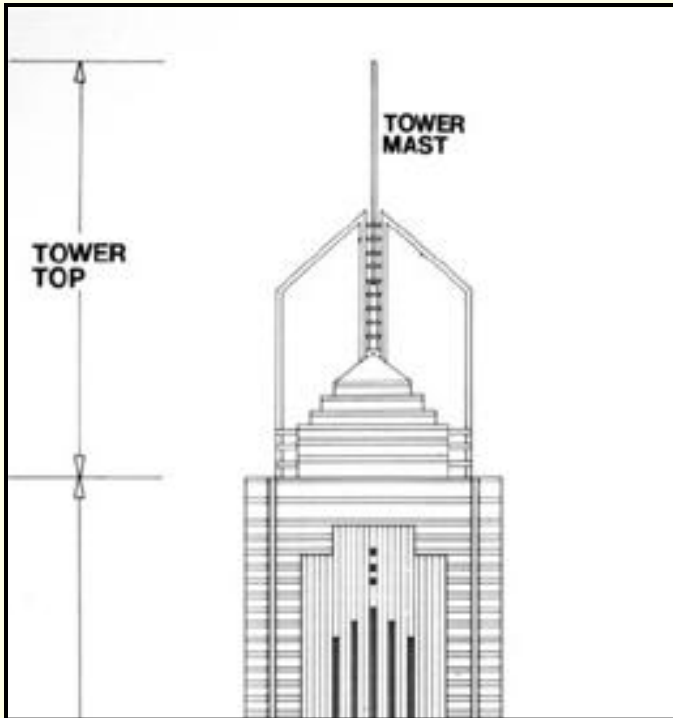
PILE FOUNDATION



FOUNDATION CONDITIONS

Fill over clay over granite bedrock; granite bedrock, 25 to 40 m (80 to 130 ft) below ground

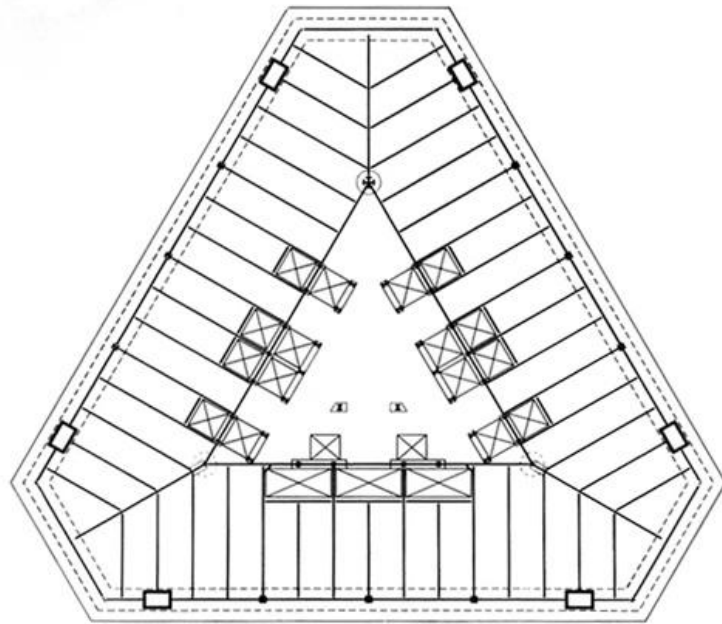
The tower top incorporates a mast, which is constructed of structural steel tubes with diameters of upto 2mts.



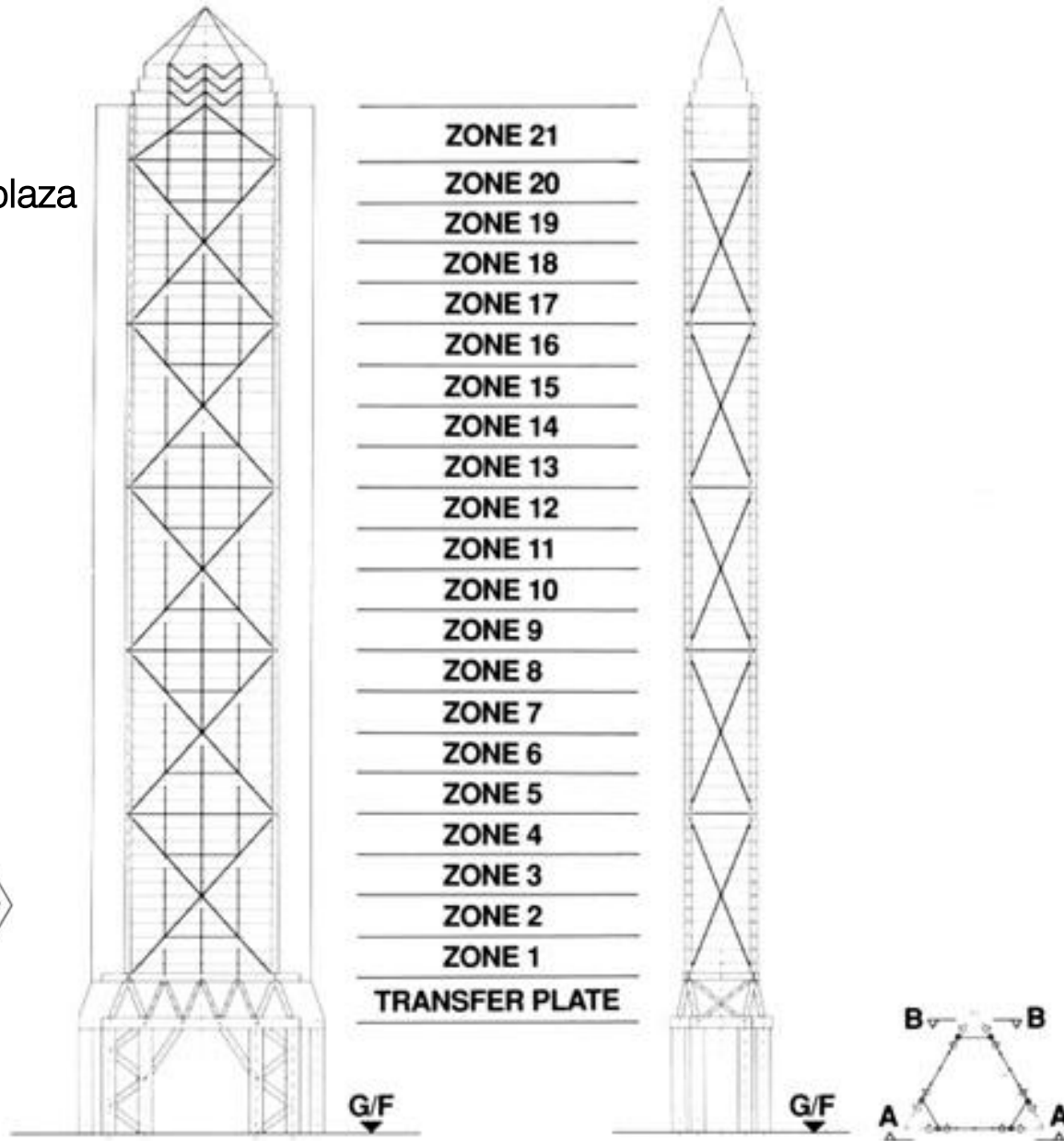
The diaphragm wall design allowed for the basement to be constructed by the top-down method. It allows the superstructure to be constructed at the same time as the basement, thereby removing time consuming basement construction period from the critical path.

PROPOSED STEEL SCHEME

Initial proposal for the central plaza structure - braced steel frame and core



TYPICAL FLOOR PLAN



A-A

B-B

KEY PLAN

STRUCTURAL STEEL SCHEME

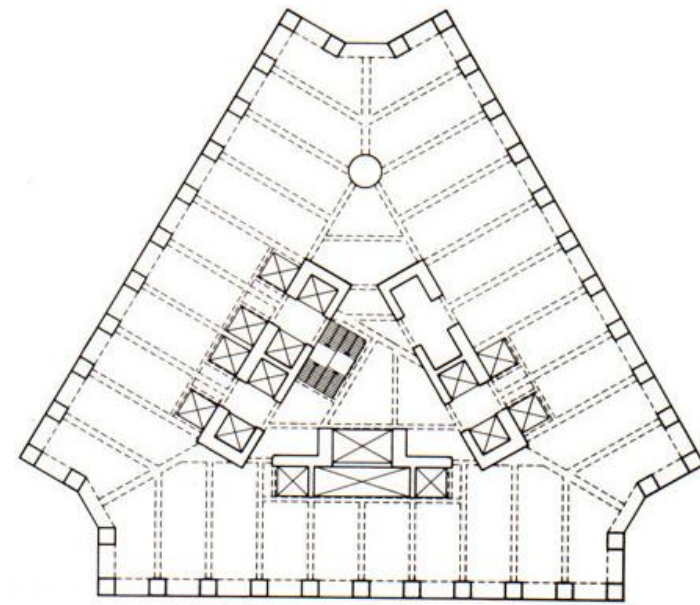
Steel Structure Vs Reinforced Concrete

1) Originally, an externally cross-braced framed tube was applied with beams carrying metal decking with reinforced concrete slab. The core was also of steelwork, designed to carry vertical load only.

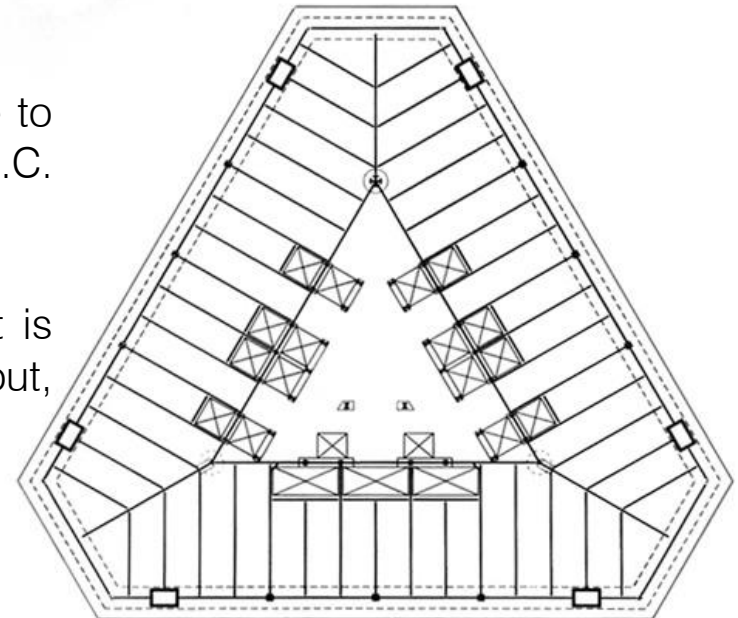
2) Later after a financial review they decided to reduce the height by increasing the size of the floor plate so as to reduce the complex architectural requirements of the tower base which means a high strength concrete solution became possible.

3) The R.C. scheme can save HK\$230 million compare to that of steel structure. Central Plaza is now the tallest R.C. building in the world.

4) Another advantage of using R.C. structure is that it is more flexible to cope with changes in structural layout, sizes and height according to the site conditions by using table form system



TYPICAL TOWER FLOOR PLAN



TYPICAL FLOOR PLAN

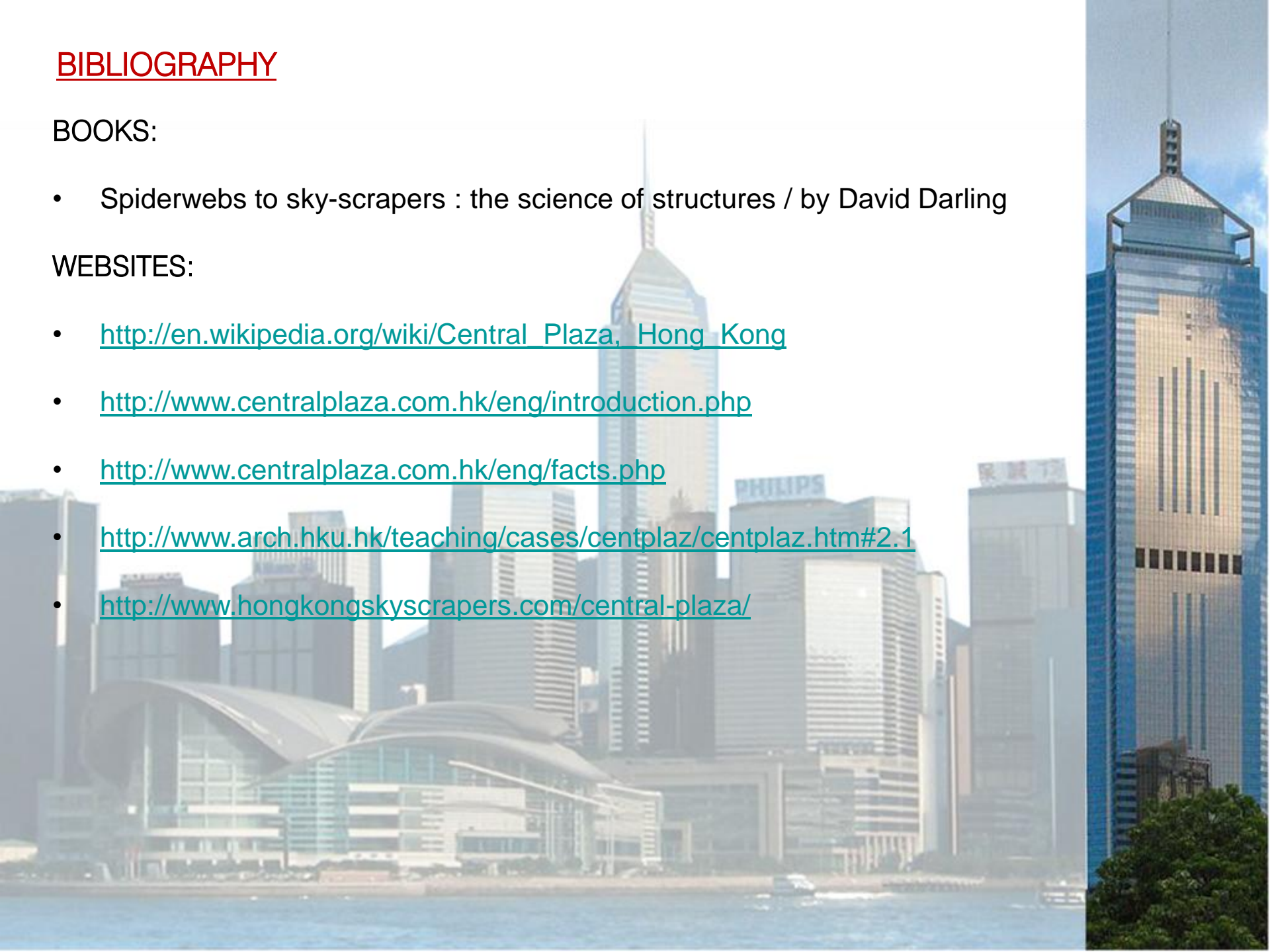
BIBLIOGRAPHY

BOOKS:

- Spiderwebs to sky-scrapers : the science of structures / by David Darling

WEBSITES:

- http://en.wikipedia.org/wiki/Central_Plaza,_Hong_Kong
- <http://www.centralplaza.com.hk/eng/introduction.php>
- <http://www.centralplaza.com.hk/eng/facts.php>
- <http://www.arch.hku.hk/teaching/cases/centplaz/centplaz.htm#2.1>
- <http://www.hongkongskyscrapers.com/central-plaza/>



THANK YOU



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