DESIGNED AND ENGINEERED BY SKIDMORE, OWINGS AND MERRILL
CONSTRUCTED FROM 2005-2011

TALLEST BUILDING IN KUWAIT AND CURRENTLY 16TH TALLEST IN WORLD AT 1,352 FT

BUSINESS TOWER ANCHORS A COMMERCIAL COMPLEX – 2.1 MILLION SQ FEET

BUILDING IS EXCEPTIONAL FOR BEING:

FIRST DESERT SKYSCRAPER
ONE OF FEW REINFORCED CONCRETE HIGHRISE STRUCTURES
SCULPTED FORM
CUT-OUTS ORIENTED TO SUN PATH
CONCEPT

STRIVED TO CREATE A CENTER OF EXCELLENCE USING STATE OF THE ART TECHNOLOGY

BUILDING RESEMBLES AN ELEGANT HIDDEN FIGURE WITH A DELICATE GLASS VEIL REFLECTING THE SILHOUETTE OF THE CITY

BASED ON SITE ALLOTMENT AND SUN PATH
- CENTER CORE - CIRCULATION, BATHROOMS
- PERIMETER OFFICE SPACE WITH VIEWS
- REVELATION OF FLOOR SUBTRACTIONS
STRIVE FOR EQUILIBRIUM

STRATEGICALLY PLACED

HIGH OCCUPANCY AREAS

AND MECHANICAL ROOMS

WATER STORAGE AND

HEAVY EQUIPMENT PLACED

AWAY FROM SOUTHWEST

FLARED WALL

GROUND CONNECTION TO

COMMERCIAL
SOLAR SHADING

• FLARED WALLS BASED ON SUNPATH
• DEEP ANGLED WINDOWS
• STONE WALL
• INSULATED GLASS
SOIL CONDITIONS

- SUBSURFACE
- SANDY, SILTY, LOOSE SOIL
- MEDIUM TO HIGH DENSITY
- 1-4M DEEP

- GROUND WATER TABLE
  MIMICS TOPOGRAPHY
- PHREATIC WATER LEVEL: 2M BELOW GRADE

- 75M BELOW GRADE
- CEMENTED SANDSTONE & SILTSTONE

AL HAMRA TOWER, KUWAIT CITY
FOUNDATION SYSTEM

- REINFORCED CONCRETE RAFT
  13FT THICK
  LOAD DISPERSED OVER CONCRETE SLAB
- CONSTRUCTED OVER 15 POURS OVER 4 MONTH PERIOD, ALLOWED CURING TIME FOR CEMENT

- CAST IN PLACE BORED PILES
  ALLOWABLE SPACING: 1200 M
  MAXIMUM PILE DIAMETER: 3600 MM CENTER TO CENTER
PILE PHASING

- ADAPT TO SPIRALING FORM
  ELIMINATE DIFFERENTIAL SETTLEMENT
  DEPENDABLE FOR AREAS WITH FINE GRAINED SOILS
  WITHSTANDS EROSION AND WASHOUTS
  DEEPER PILES SPACED CLOSELY TOGETHER PLACED IN HIGH STRESS AREAS

- 289 PILES
  EACH 66-89FT, RELEASED IN 7 PHASES

PILE CONSTRUCTION PHASING
ON SITE PILE LOAD TESTING
3-DIMENSIONAL NON-LINEAR ANALYSIS

DONE BY SAN FRANCISCO OFFICE OF URS CORPORATION (URS) & PROJECT GEOTECHNICAL ENGINEER (CONSULTANCY GROUP COMPANY) CGC

CALCULATED FOUNDATION SOIL STRATA & STIFFNESS ESTIMATIONS

URS RESULTS:
- GROUP ACTION OF PILES
- PERIMETER PILES STIFFER
- SOIL CAUSED SKIN RESISTANCE TO BE DRUG DOWN

CGC RESULTS:
- PILES ACTING INDIVIDUALLY
- ALL PILES HAD SIMILAR LOADS

Fig. 7 Bearing Pressure (MPa) CGC Case 1
Fig. 8 Bearing Pressure (MPa) URS Case 1
Fig. 9 Deflected Shape (mm) CGC Case 1
Fig. 10 Deflected Shape (mm) URS Case 1
LAMELLA STRUCTURE

FOUR PART STRUCTURAL SYSTEM

1) PRIMARY LOAD BEARING COLUMNS
2) SECONDARY COLUMNS - REDUCE BUCKLING LENGTH
3) CURVED SIDEWAY MEMBERS
4) LATTICEWORK

LOBBY LAMELLA BUCKLING ANALYSIS

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LAMELLA ELEMENTS
LAMELLA UNDER CONSTRUCTION

LAMELLA LOAD DISTRIBUTION

SOM RENDERING
LATERAL LOADS

- IN A REGION OF LOW SEISMIC ACTIVITY
- WIND FORCES ARE PRIMARY LATERAL LOADING
  - AIR MASSES FROM GULF CAUSE BRIEF AND POWERFUL WIND DOWNBURSTS
  - ESTIMATED WIND SPEED: 23 M/S
  - WIND LOADS NOT CRITICAL ABOVE 150 METER ELEVATION

CLOSE PROXIMITY TO PERSIAN GULF = COOL PREVAILING WINDS THAT COLLIDE WITH WARM DESERT AIR AND CAUSE THUNDERSTORMS
LATERAL RESISTING SYSTEM

- “CAST-IN-PLACE REINFORCED-CONCRETE SHEAR WALL CORE SUPPLEMENTED BY A PERIMETER MOMENT-RESISTING FRAME”
- CORE ALSO RESISTS SEISMIC LOADS
- MOMENT RESISTANCE FROM CAST-IN-PLACE FRAME BEAMS
MULTIFRAME ANALYSIS

PLAN VIEW OF BUILDING WITH DIST. LATERAL LOADS

15 K

SHEAR WALL CORE

AXON MOMENT DIAGRAM

AXON SHEAR DIAGRAM

PLAN VIEW OF DEFLECTIONS

AXON DEFLECTION DIAGRAM
CONNECTIONS

• reinforced concrete and structural steel.
• monolithically cast concrete
• Connections are rigid
TORSIONAL RESPONSE DUE TO GRAVITY LOADS

- “flared walls” require the gravity load support
- Torsional gravity load applied to core of the structure require considerations of the long-term vertical and torsional deformation of the structure
- Southeast flared wall leans into the building
- Southwest flared wall leans away from building
• Inclined columns and walls support floor framing

• Slabs add gravity loads to inclined components, and the vertical load is increased.

• Horizontal element of force in the inclined component must increase along with the vertical component.

• Slab must apply a horizontal load to the intersection.

• Inclined components slant away from slab = tension

• Inclined components slants toward slab = compression

• Resolution static equilibrium

• Net torsional moment
