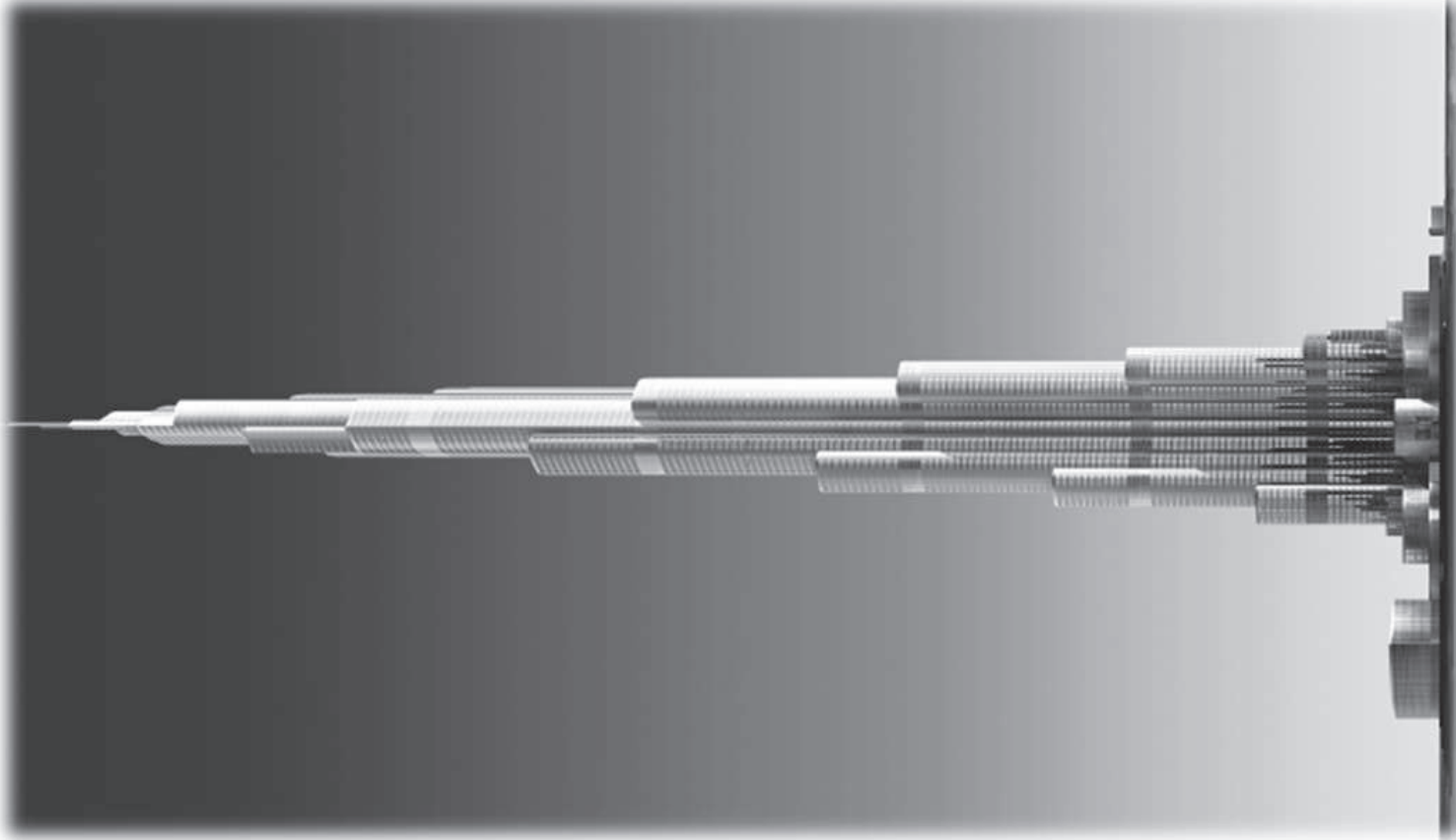


# SURVEY PROCEDURES FOR TALL BUILDINGS

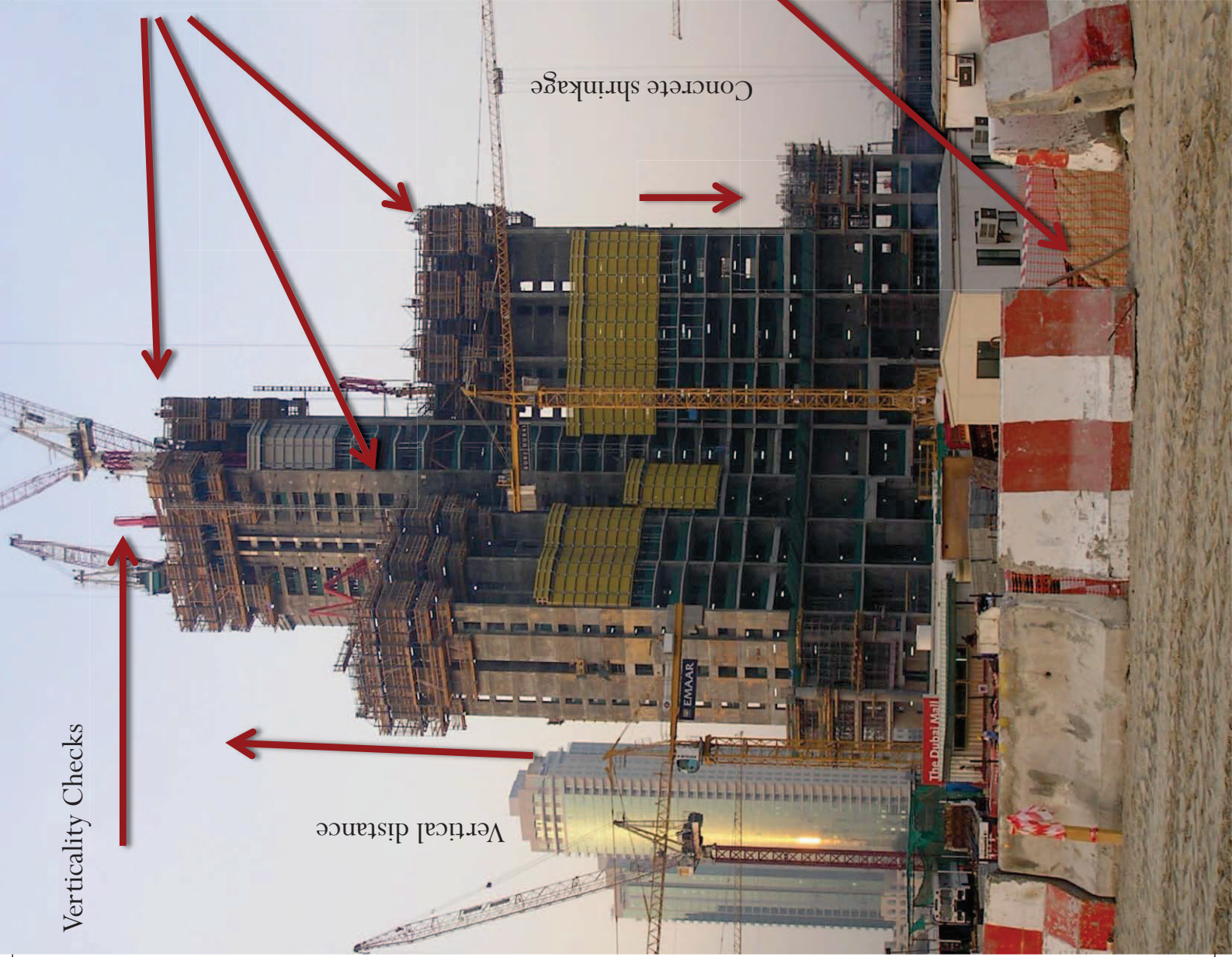
*IAN R. SPARKS*



Verticality Checks

Formwork alignment

Replacing lost control



Vertical distance

Concrete shrinkage

## **1. Horizontal Alignment Survey Program Scope – Central Core Wall System:**

**a) The Contractor's surveyor shall establish a series of at least thirty (30) fixed permanent markers at five (5) level increments, commencing at level B1, throughout the full height of the Tower to verify and maintain control of the horizontal alignment (plumbness) of the Tower core wall system. The distribution of these markers should be generally as follows:**

**Each Wing (3 thus) : 7 markers x 3 = 21 markers**  
**Hexagonal Core : 6 markers**  
**Elevator Walls within Hexagonal Core : 3 markers**

**Temporary sleeves through the slabs adjacent to core wall markers shall be established for vertical laser beam access, or equivalent, to provide horizontal alignment control and monitoring. Following initial reading, readings for each of the 30 points at each fifth level shall be made, and results submitted, on a weekly basis. Included with the weekly horizontal alignment survey results shall be the Contractor's program for horizontal alignment adjustment.**

**b) In addition to the on-building horizontal alignment system survey, the Contractor shall establish an off-building, ground based survey program along the axes of each wing to verify the horizontal alignment at each level.**

KUALA LUMPUR CITY CENTRE  
TOWERS 1 AND 2  
PROPOSED COMPENSATION APPROACH  
FOR ELASTIC, CREEP AND SHRINKAGE SHORTENING

(EXAMPLE USING ASSUMED PROPERTIES  
AND CONSTRUCTION SCHEDULE)

\*ACTUAL FLR-FLR DIFFERENCE WILL BE SMALLER  
SINCE SOME SHORTENING WILL TAKE PLACE BEFORE COLUMN  
OR BUSTLE IS CONSTRUCTED (NOT INCLUDED HERE)

LEVEL BEING BUILT	ADDITION TO CORE HEIGHT	TOWER COLUMN VS.CORE	BUSTLE VS. TOWER COL	MAX COL		MAX BSL	
				FLR-FLR DIFF*	FLR-FLR DIFF*		
84M3	6.0	25		5.3			
84M2	6.0	26		5.3			
84M1	6.0	26		5.3			
84	6.0	27		5.3			
83	6.0	28		5.3			
82	6.0	29		5.3			
81	6.0	29		5.3			
80	6.0	30		5.3			
79	6.0	31		5.5			
78	6.0	31		5.5			
77	6.0	32		5.5			
76	6.0	32		5.5			
75	6.0	33		5.5			
74	6.0	33		5.5			
73	6.0	34		5.5			
72	6.0	34		5.5			
71	6.0	35		5.5			
70	6.0	35		6.0			
69	6.0	35		6.0			
68	6.0	35		6.0			
67	6.0	35		6.0			
66	6.0	35		6.0			
65	6.0	35		6.0			
64	6.0	35		6.0			
63	6.0	35		6.0			
62	6.0	35		6.0			



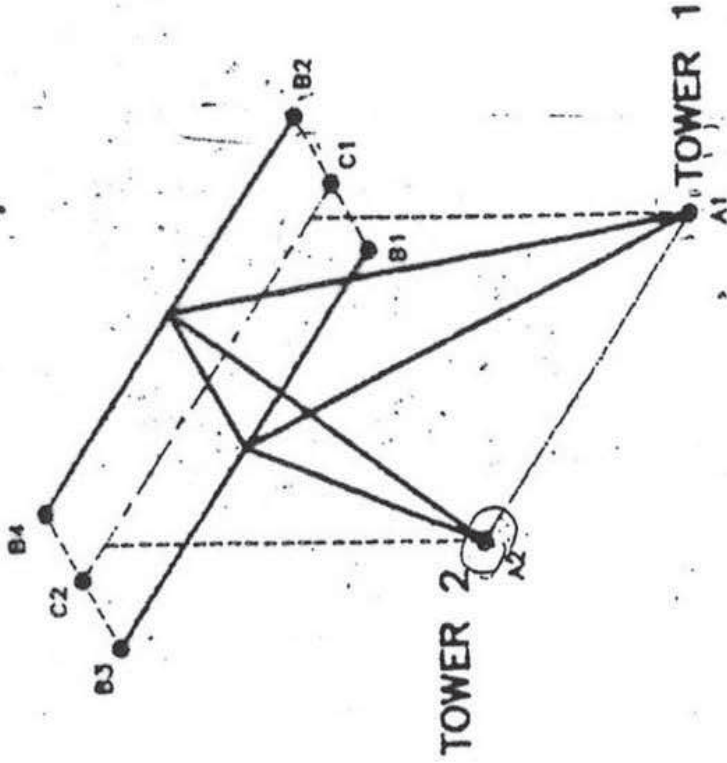
## PRE ERECTION SURVEY FOR SKYBRIDGE

30 DAYS PRIOR TO COMMENCING SKYBRIDGE ERECTION, THE FOLLOWING SURVEYS SHALL BE OBTAINED AND DETAILED REPORTS SUBMITTED TO THE BRIDGE ERECTOR, STEEL FABRICATOR, RESIDENT ENGINEER AND OWNER'S QA/QC PERSONNEL FOR THEIR REVIEW:

- I. POINT A1, A2 (ARCH LEG BOTTOM SUPPORTS AT TOWERS 1 AND 2)
  - 1) TOP ELEVATION OF CONCRETE BRACKET;
  - 2) PLAN LOCATIONS OF BEARING CENTER POINTS, USING BOTH SITE COORDINATES AND LOCAL REFERENCES (NEAREST COLUMNS);
  - 3) PLAN LOCATION OF ALL ANCHOR BOLTS, RELATED TO THE CENTER POINT OF BEARING;
  - 4) PLAN DIMENSION BETWEEN POINTS A1 AND A2.
- II. POINTS B1, B2, B3, & B4 (DESIGN CENTER POINTS OF GIRDER GRAVITY SUPPORT BEARINGS AT TOWERS 1 NORTH AND SOUTH, 2 NORTH AND SOUTH)
  - 1) TOP ELEVATION OF CONCRETE BEAM;
  - 2) PLAN LOCATIONS OF BEARING CENTER POINTS, USING BOTH SITE COORDINATES AND LOCAL REFERENCES (NEAREST COLUMNS);
  - 3) PLAN LOCATIONS OF ALL ANCHOR BOLTS, RELATED TO THE CENTER POINTS OF BEARING;
  - 4) PLAN DIMENSION BETWEEN POINTS:
    - a) B1 -- B2 (TOWER 1)
    - b) B3 -- B4 (TOWER 2)
    - c) B3 -- B1 (NORTH SPAN)
    - d) B4 -- B2 (SOUTH SPAN)
- III. POINTS C1 AND C2 (CENTER LINES OF GIRDER GUIDE/CENTERING PINS ON BRIDGE CENTER LINE AT TOWERS 1 AND 2)
  - 1) TOP ELEVATION OF CONCRETE;
  - 2) PLAN LOCATIONS OF BEARING CENTER POINTS, USING BOTH SITE COORDINATES AND LOCAL REFERENCES (NEAREST COLUMNS);
  - 3) LOCATION OF ALL ANCHOR BOLTS, RELATED TO THE CENTER POINTS OF GUIDE PINS;
  - 4) PLAN ALIGNMENT OF POINTS:
    - a) C1 TO A1
    - b) C2 TO A2

UPON RECEIPT OF THE ABOVE INFORMATION, THE BRIDGE ERECTOR AND STEEL FABRICATOR ARE REQUIRED TO VERIFY ACCEPTABILITY OF THE FIELD CONDITIONS TO WORK WITH THE SHOP DRAWING DETAILS OF THE BRIDGE. IN CASE OF CONFLICTS OR DISCREPANCIES BETWEEN THE SHOP DRAWING DETAILS AND THE INTENDED ERECTION SEQUENCE, THE CONTRACTOR SHALL PROPOSE ANY NECESSARY REMEDIAL MEASURES AND SUBMIT THEM FOR REVIEW AND APPROVAL.

BRIDGE ERECTION CAN ONLY BEGIN AFTER ALL CONFLICTS AND DISCREPANCIES HAVE BEEN RESOLVED AND THE NECESSARY CORRECTIONS OR REMEDIAL MEASURES HAVE BEEN PERFORMED.



**SURVEY POINT KEY ISOMETRIC**

# TOWER SUPERSTRUCTURE-ELEVATIONAL COMPENSATION PROGRAM SCOPE

1. Core Walls are extended at least ten (10) levels ahead of the exterior column/floor slab installation and the core walls are installed to the vertical dimensions, not elevations, indicated on the structural drawings. Special consideration also needs to be given to wall keyway, insert and dowel dimensional layout with respect to these axial shortening effects.
2. Exterior Concrete Columns and Structural Floor Slabs are installed sequentially after the extended core wall system and these concrete elements are installed to the theoretical top slab elevations as indicated on the structural drawings. **To accomplish this true, exact top of slab elevational control, the true elevation, Dubai/Building Datum, must be brought up to each level from an undisturbed base benchmark, and must not be a result of a reference elevation mark up on the Tower.**

## Tower Core Walls – Vertical Compensation – Initial Scope

T/Raft		: Adjust to exact indicated Building Reference Elevation
Ground Level		: + 0 mm
Level 5		: + 0 mm
Level 10		: + 0 mm
Level 15		: +10 mm
Level 20		: +10 mm
Level 25		: +10 mm
...		...























# Appendix - B

SHEET NO

ISSUED BY: **BACHY SOLSTANCHE**

DATE:

TO: COPY FOR

FILE

JOB NO:

JOB NO:

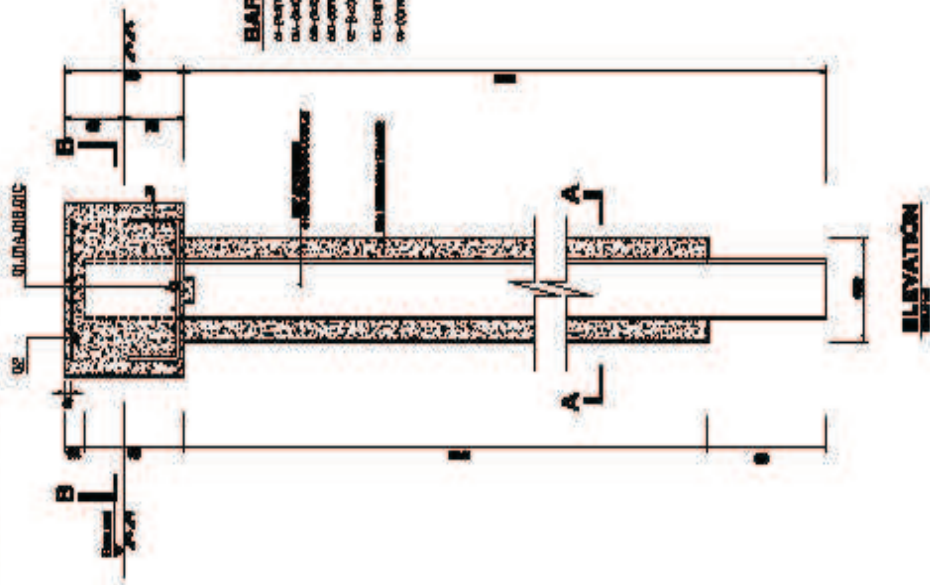
PC:

**BENCH MARK No 1**

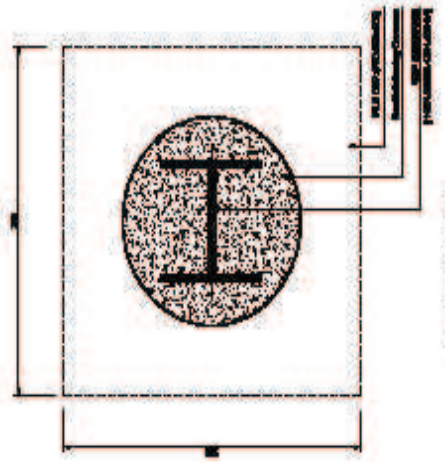
ON HOLD

## BAR BENDING SCHEDULE

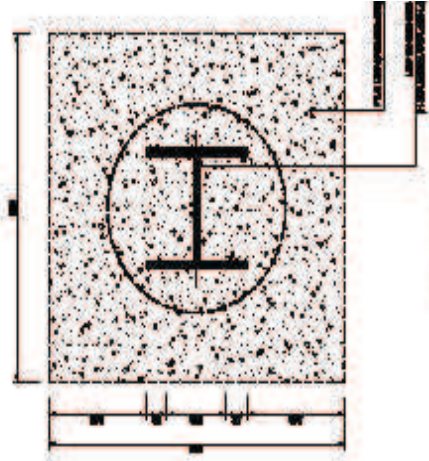
14-000000-10-000
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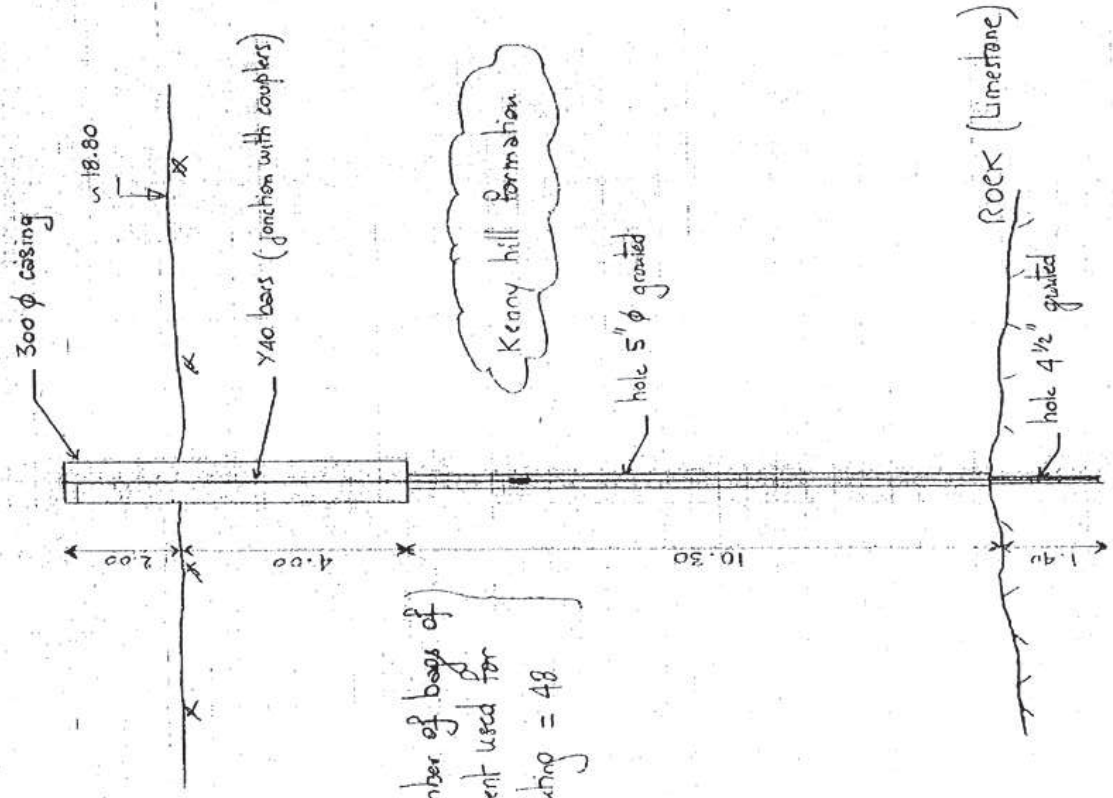
ELEVATION



SECTION A-A



SECTION B-B

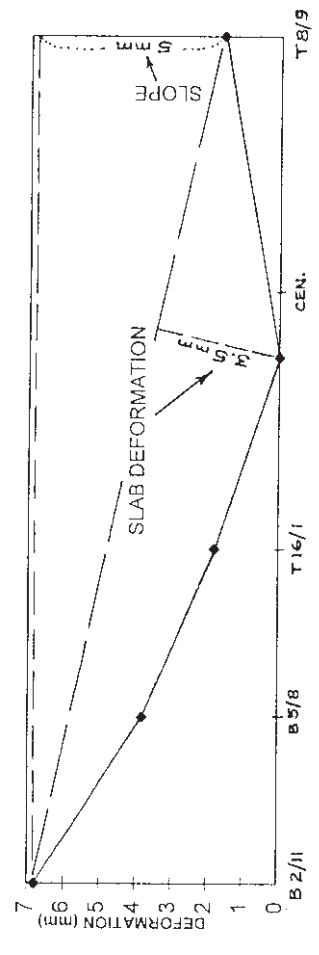


\* number of bags of cement used for grouting = 48

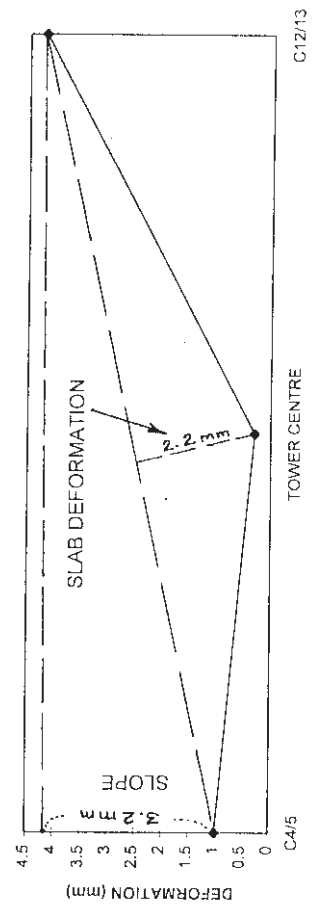


**FOUNDATION SLAB DEFORMATION**

SURVEY : 24 APRIL 1996.



SECTION AA' NORTH/SOUTH AXIS

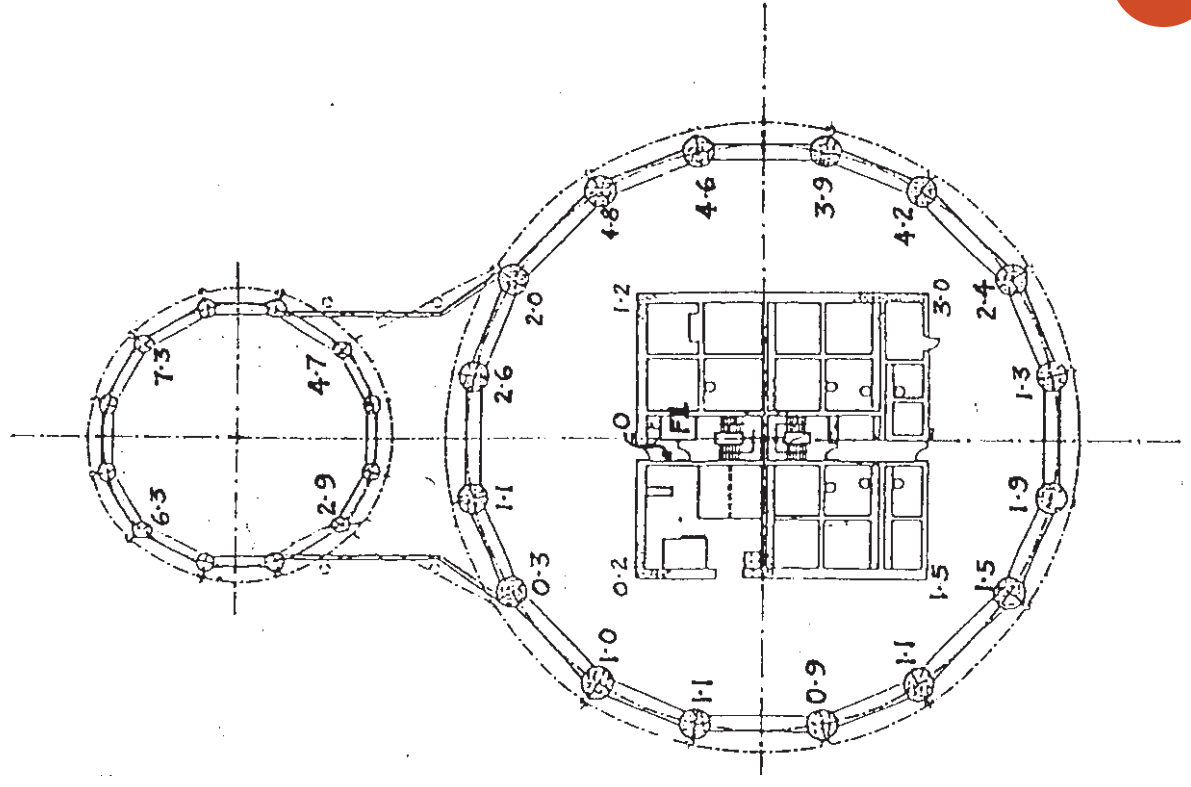


SECTION BB' EAST / WEST AXIS

**TOWER 2 RAFT FOUNDATION**

DEFORMATION 24 APRIL 1996

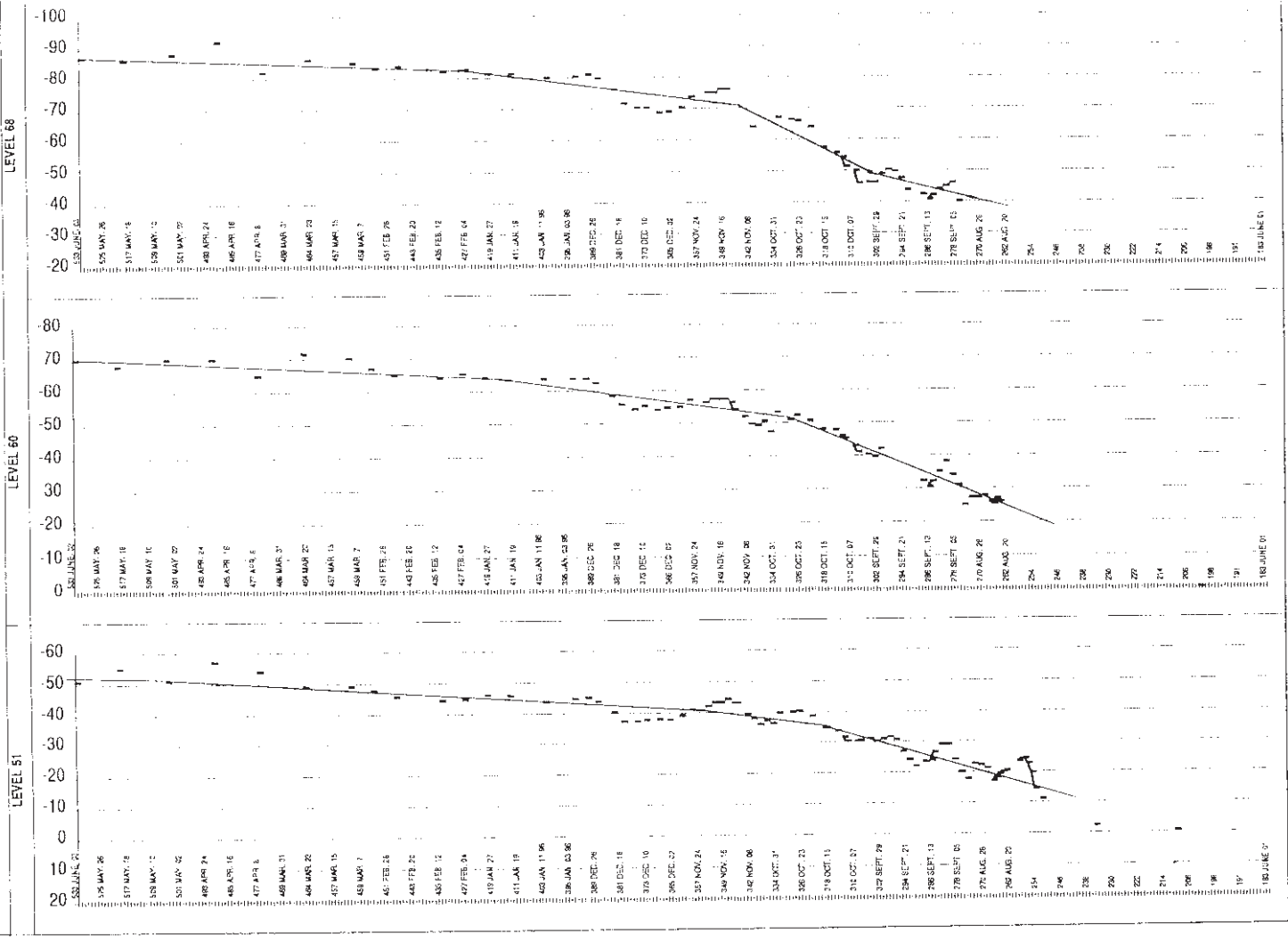
VALUES SHOWN ARE mm ABOVE THE DATUM POINT NEAR LIFT F1



F4

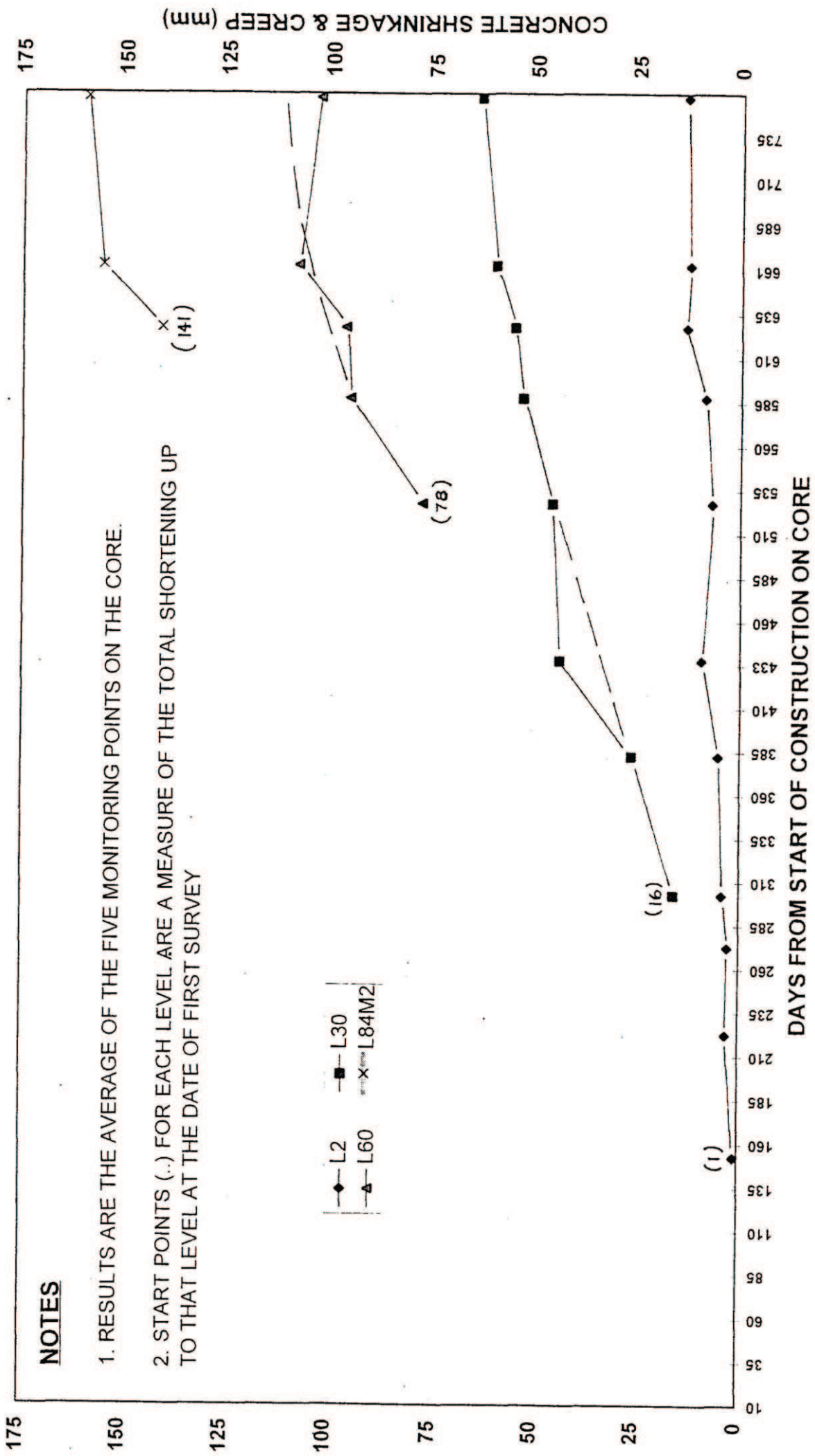
Tower 2 Verticality Survey  
North / South Sheet 3A

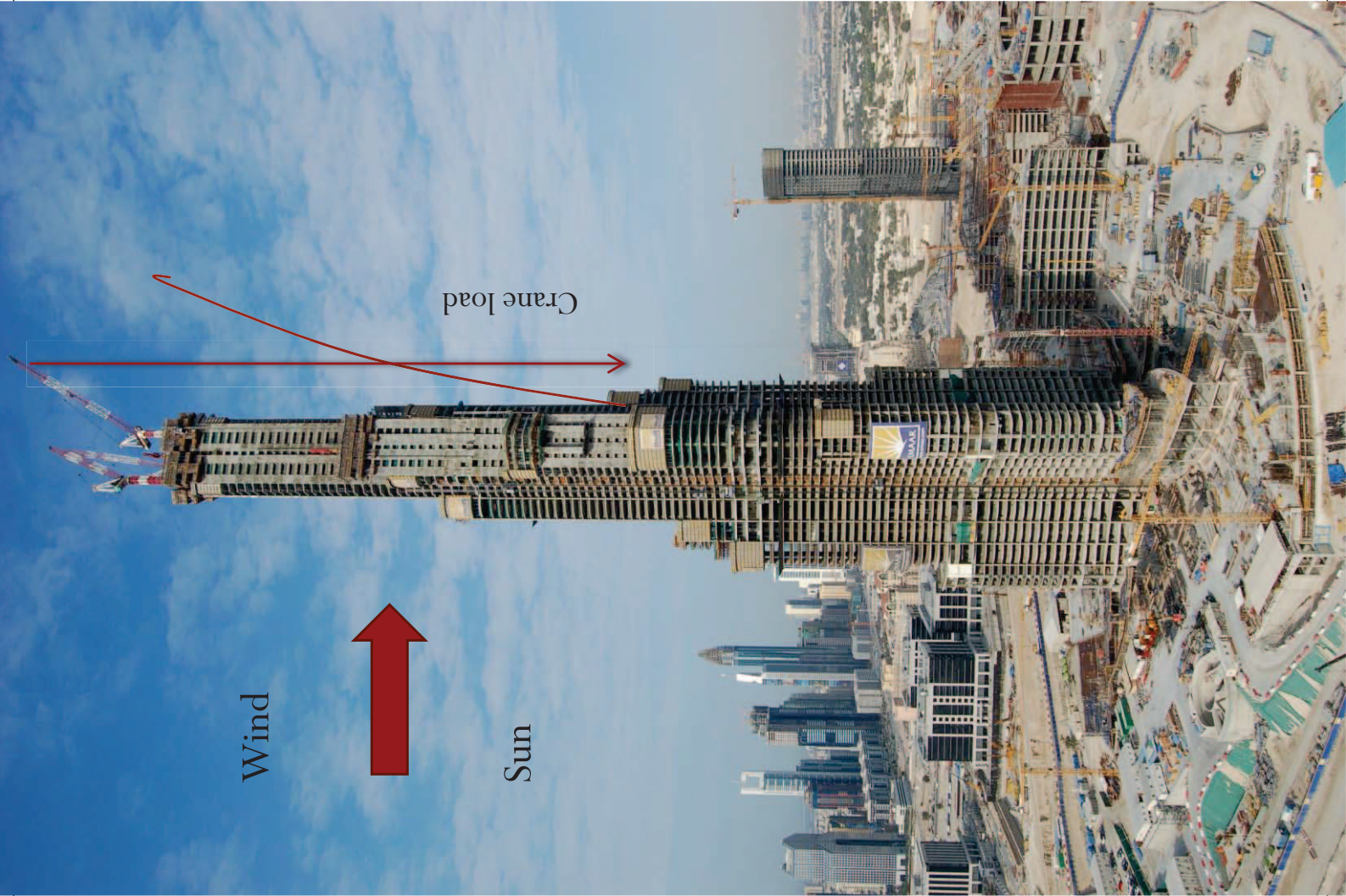
AS of: 05/06/1996





# CORE WALL - CONCRETE SHRINKAGE AND CREEP





Wind



Sun

Crane load

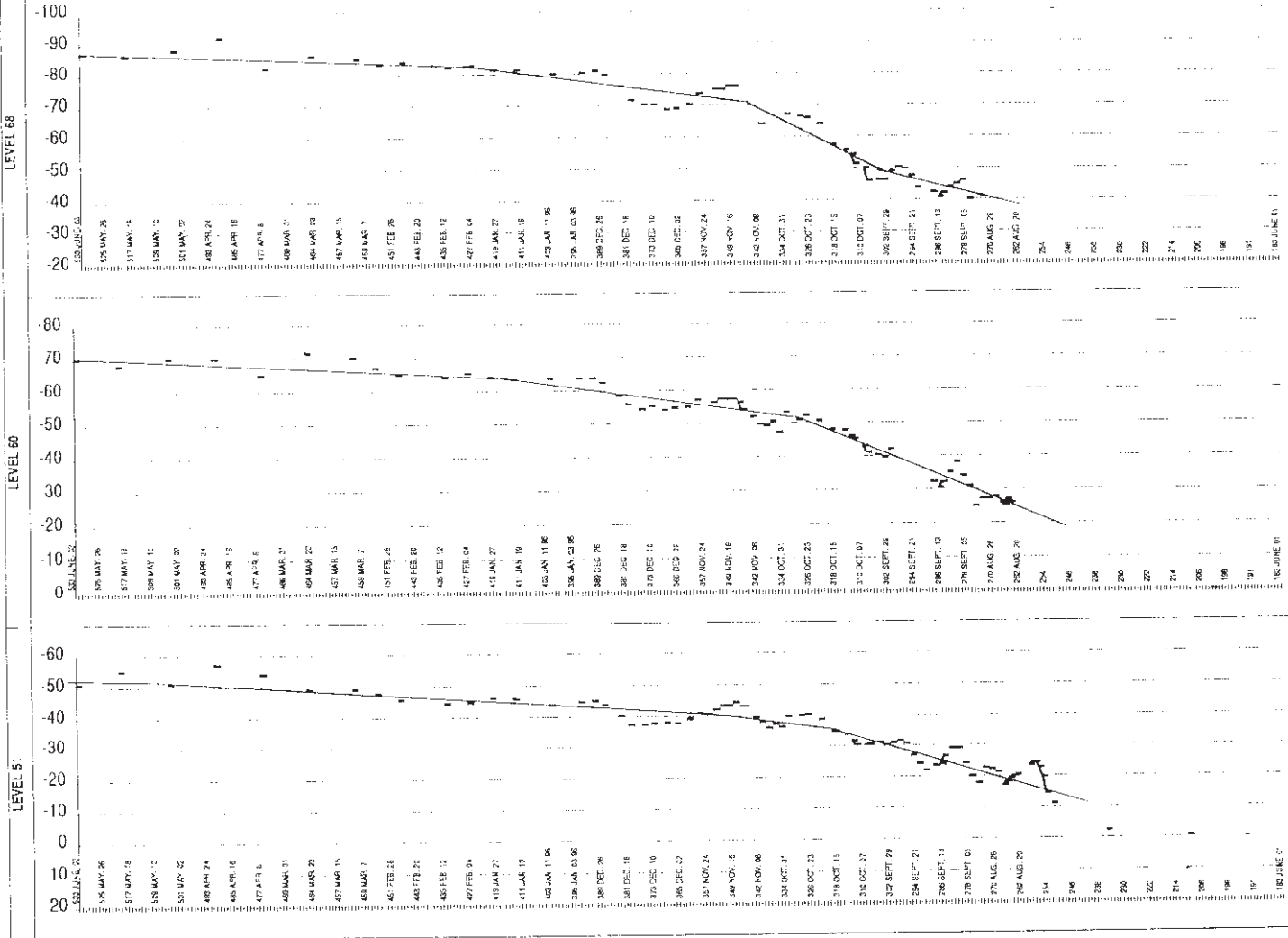


F4

Tower 2 Verticality Survey

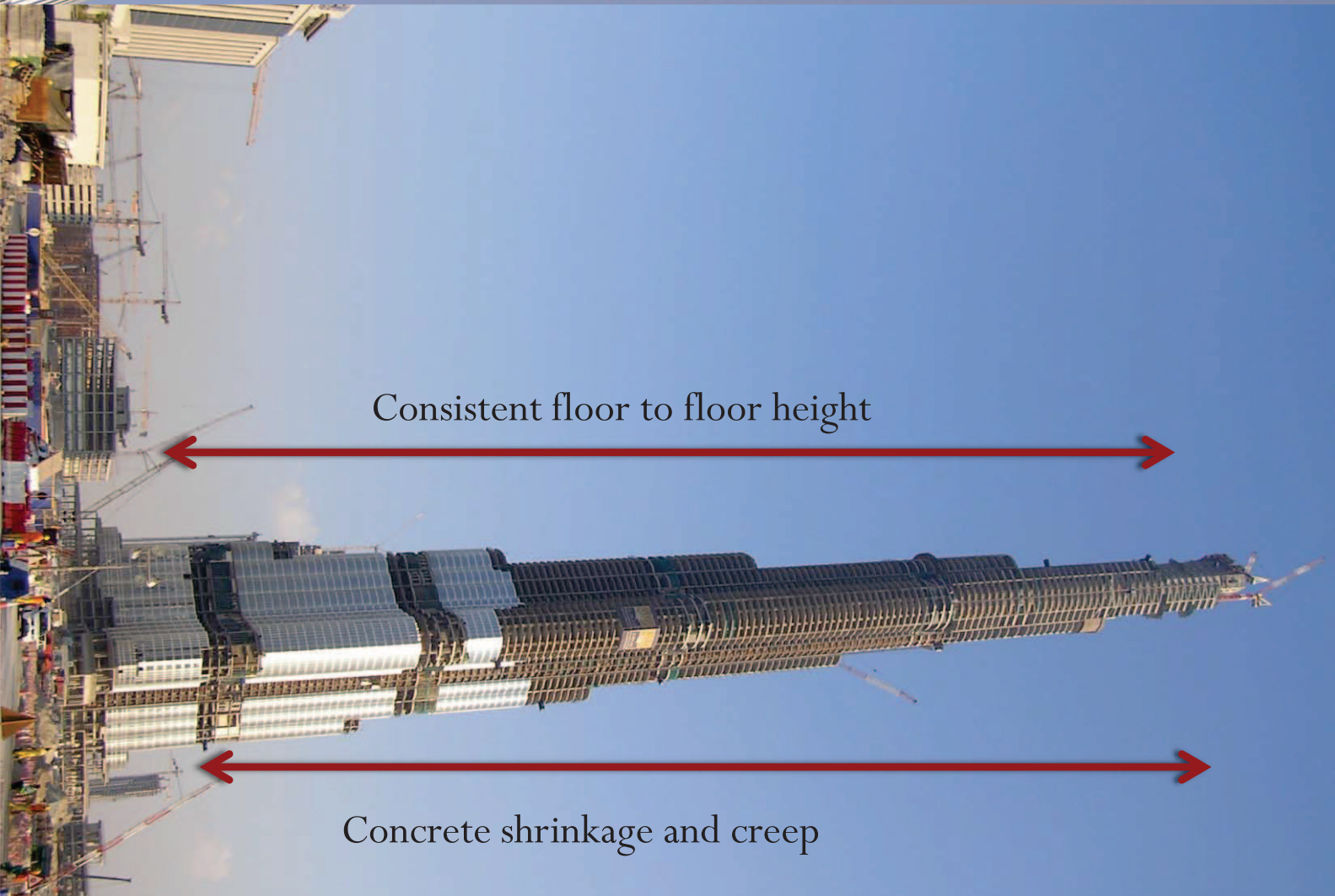
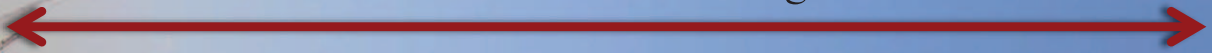
AS of: 05/06/1996

North / South Sheet 3A





Consistent floor to floor height



Concrete shrinkage and creep



















- Long term monitoring
- The survey programme
- Survey equipment

**Thank you**

**Any Questions?**