

## FIG 2012 HIGH RISE CONFERENCE IN HK



Lamar towers survey and monitoring

FIG 2012 High Rise Conference in HongKong



## FIG 2012 HIGH RISE CONFERENCE IN HK

... floors (305m above ground surface)  
... r, one  
... floors (285m above ground) tower two  
... floors podium including retail and office  
... e as well as one  
... floors basement for parking.  
... basement is 8.4m below ground.  
... podium is 61.5m high, which is  
... preised of 2 level retails and 10 level  
... es. Podium structure is integrated with  
... towers



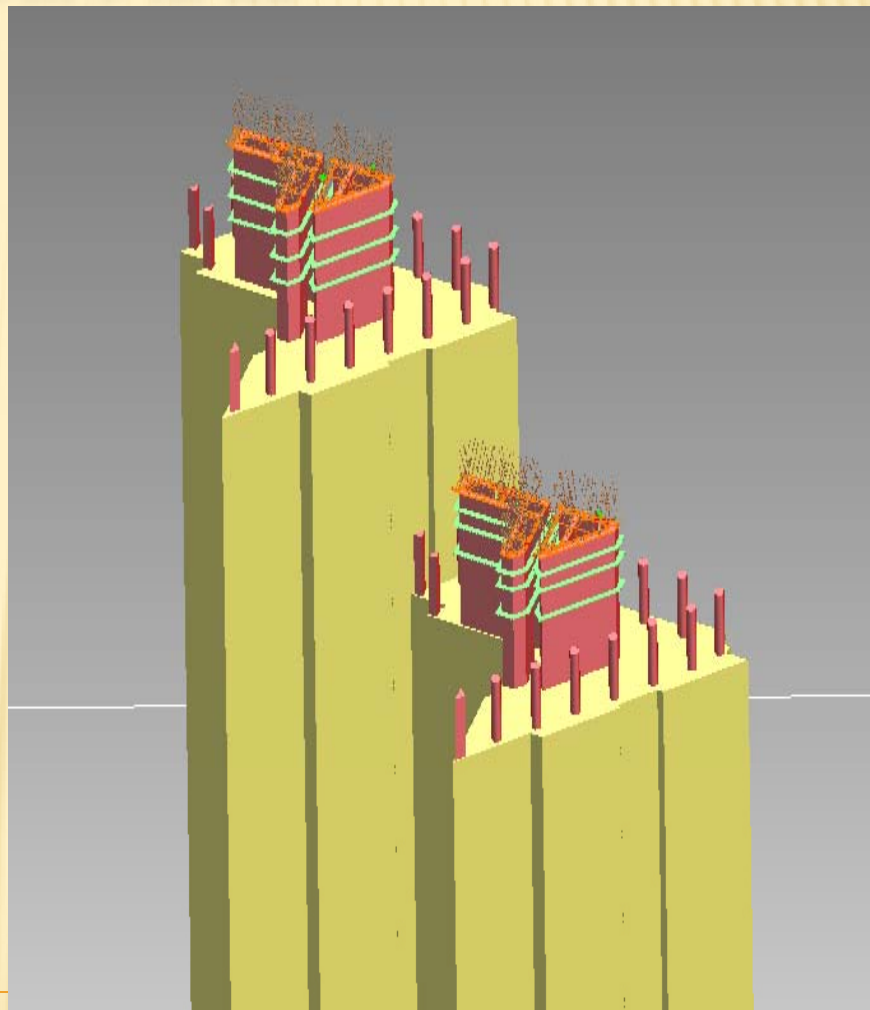
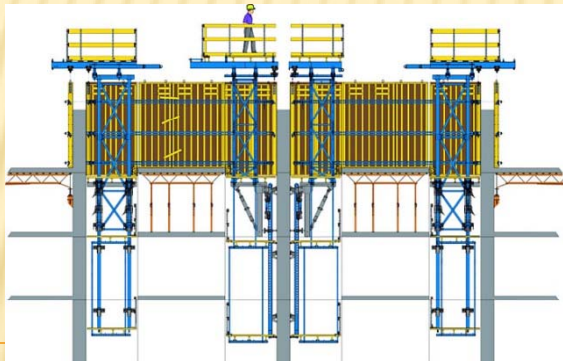
## FIG 2012 HIGH RISE CONFERENCE IN HK

towers have triangular shape

each building has two core walls, it is 7 days for one floor construction and Dokka self-forming work system is used for the core construction.

walls construct before and the slabs follow, there are 5 floors height different between

core wall is slim and there are 2 tower cranes and 2 placing booms in each core wall so the space is too narrow to work on the top of



# IG 2012 HIGH RISE CONFERENCE IN HK

Construction Survey & Monitoring Concept

## Site conditions :

Construction Cycles-

Environmental condition-

- Permanent tilt

- Vibration tilt (Elastic)

Limit of Survey methodology-

GNSS technology problem

Safety obstruction:

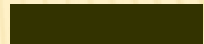




# BUILDING TILTS

## Two major tilts during the survey

Permanent tilt

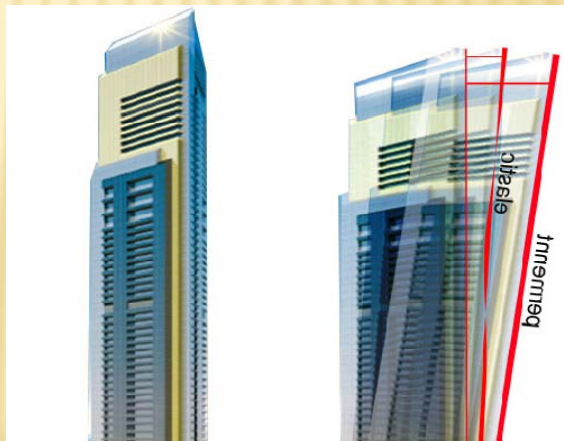
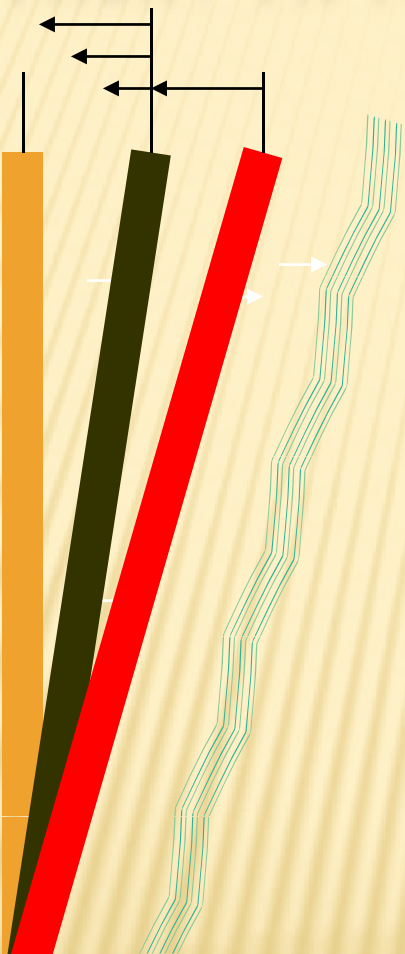
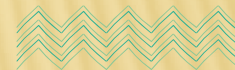


Shall be adjusted, floor by floor not more than one floor tolerance value  
(Step by step Calibration)

Vibration tilt (Elastic)



This movement shall be expected back to original location by it's elastic behavior  
(immediate calibration)



# BUILDING TILTS

## Two major tilts during the survey

### Permanent tilt

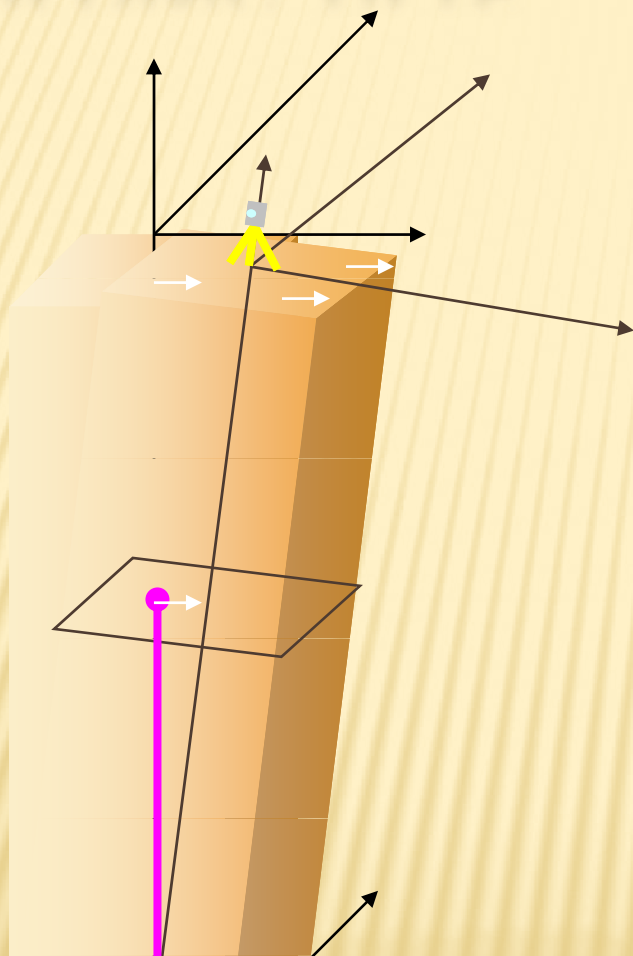
This tilt factor drives by the permanent concrete shortening and foundation mat settlement. The permanent tilt value shall be calibrated by long term base.

### Vibration tilt (Elastic)

This tilt factor drives by the real time factors such as wind and tower crane, sun radiation etc.

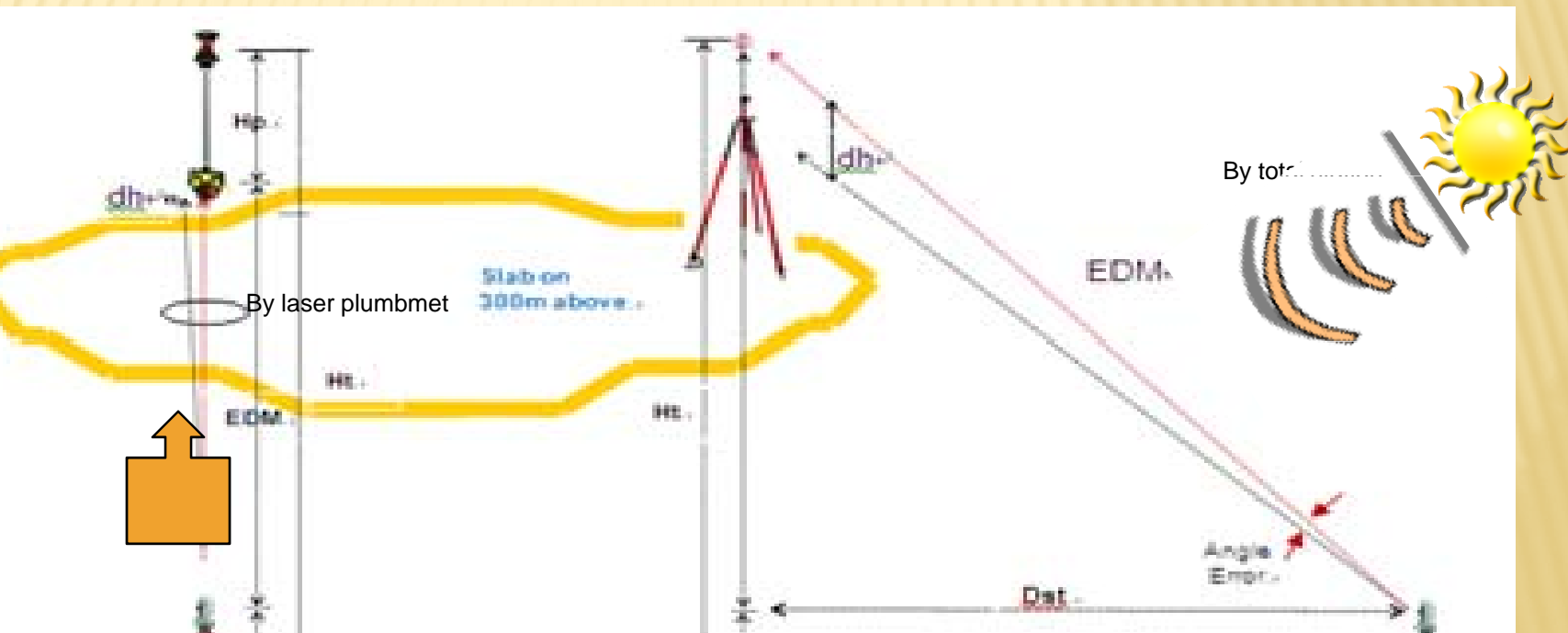
This tilt shall be immediately calibrated during the every survey.

Vibration tilt shall be detected by high frequency measuring instrument such as GNSS, TPS, Tilt sensor for the certain time period

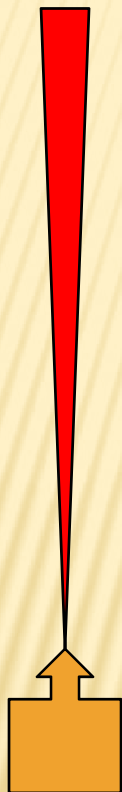


# LIMIT OF SURVEY METHODOLOGY

ways to transfer the BM from ground reference by traditional way  
normal total station have a limit in transferring points from the ground floor the top  
use of the angle calculation ,refraction of the x-ray ,ppm , sunlight effect, delaying in time  
easy to see inside the site ,not easy to recognized the center of the prism no real time  
for the coordinate the top ect



plummet



Laser dot size is increasing by the distance

Difficult to Aim the right position

Optical and laser plummet have a short limit in height which obliged you to transfer your bench marks to 20 floors max ,then close and start new transferring bench marks



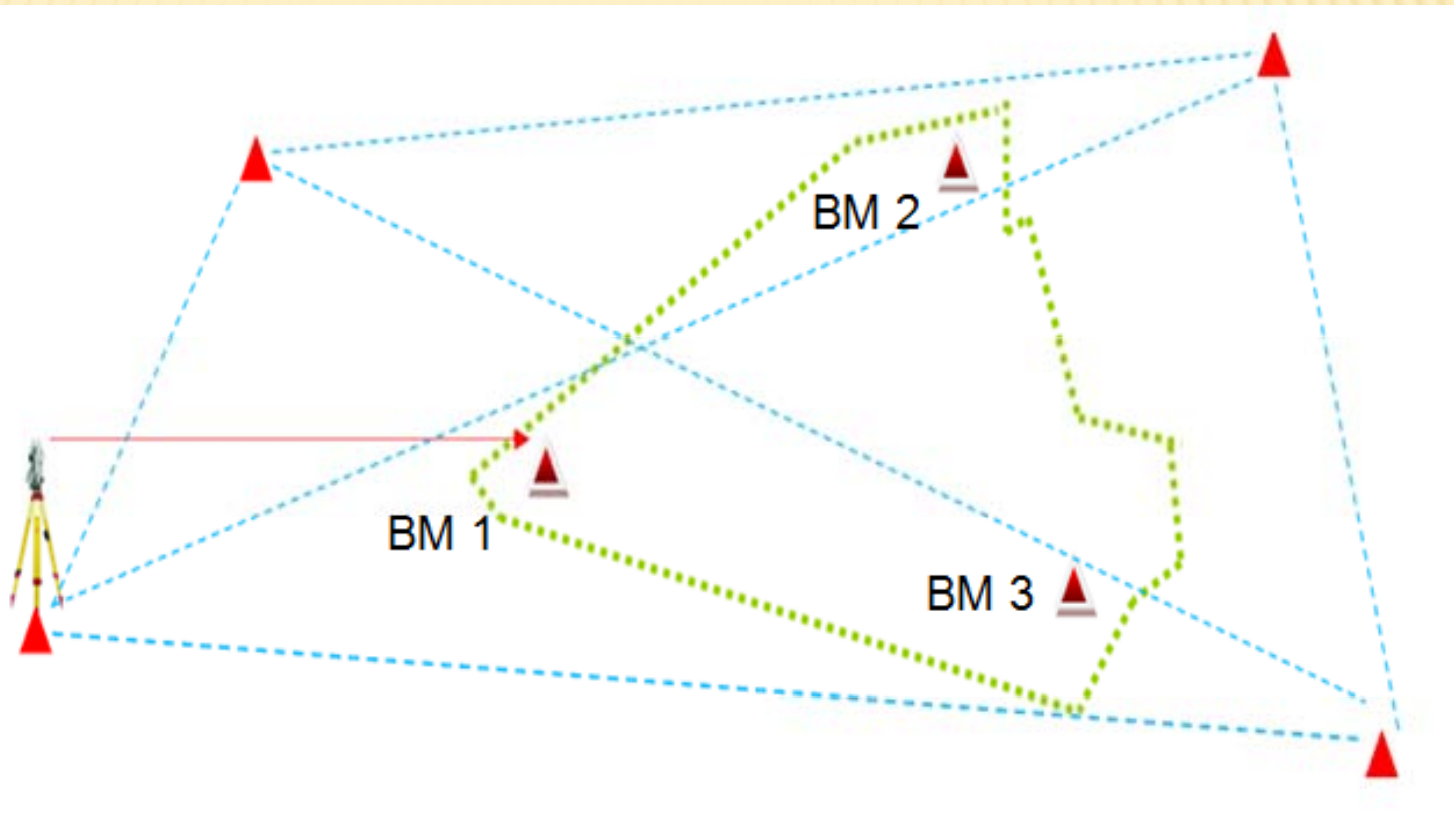
# **ENITH LINE ONBOARD APPLICATION**

# Setting out Control points

site BM  
erse corrected by  
square formula



## OFFSITE BM

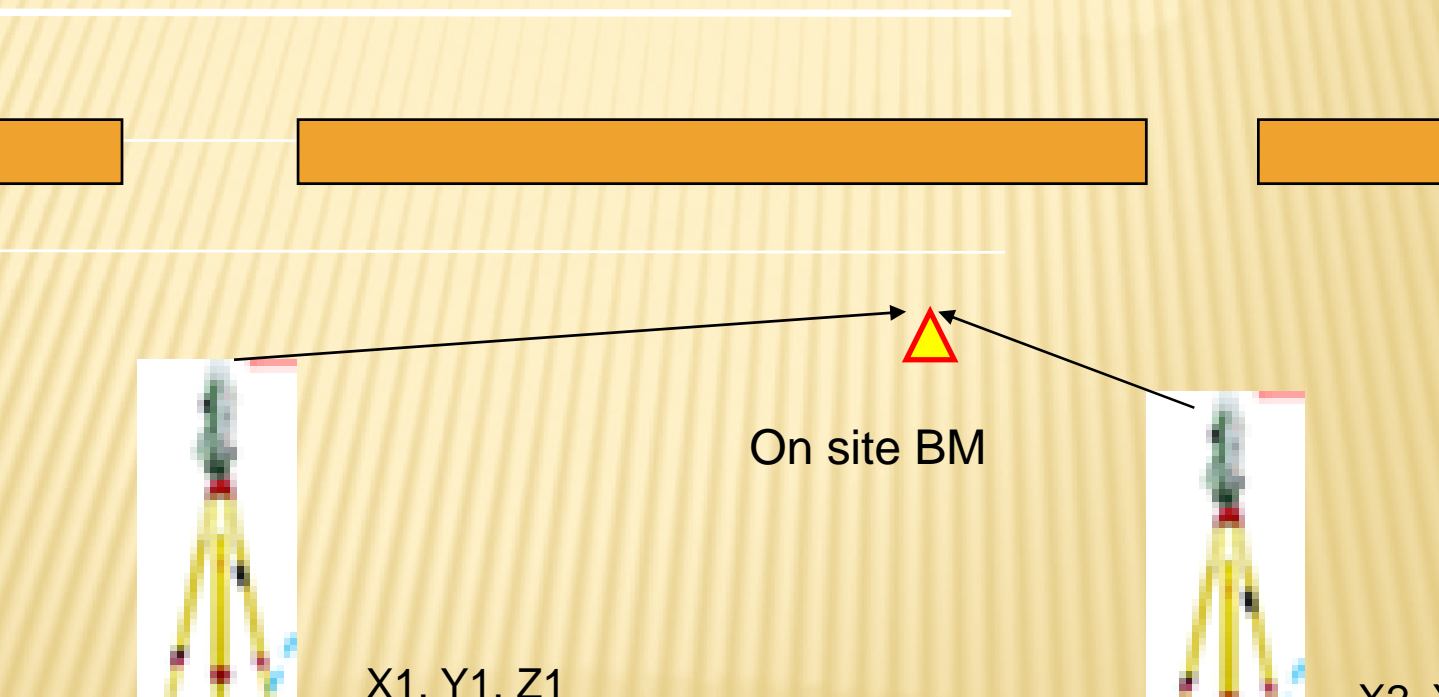


The "Off Site" BM shall be propagate to the construction mat for the all



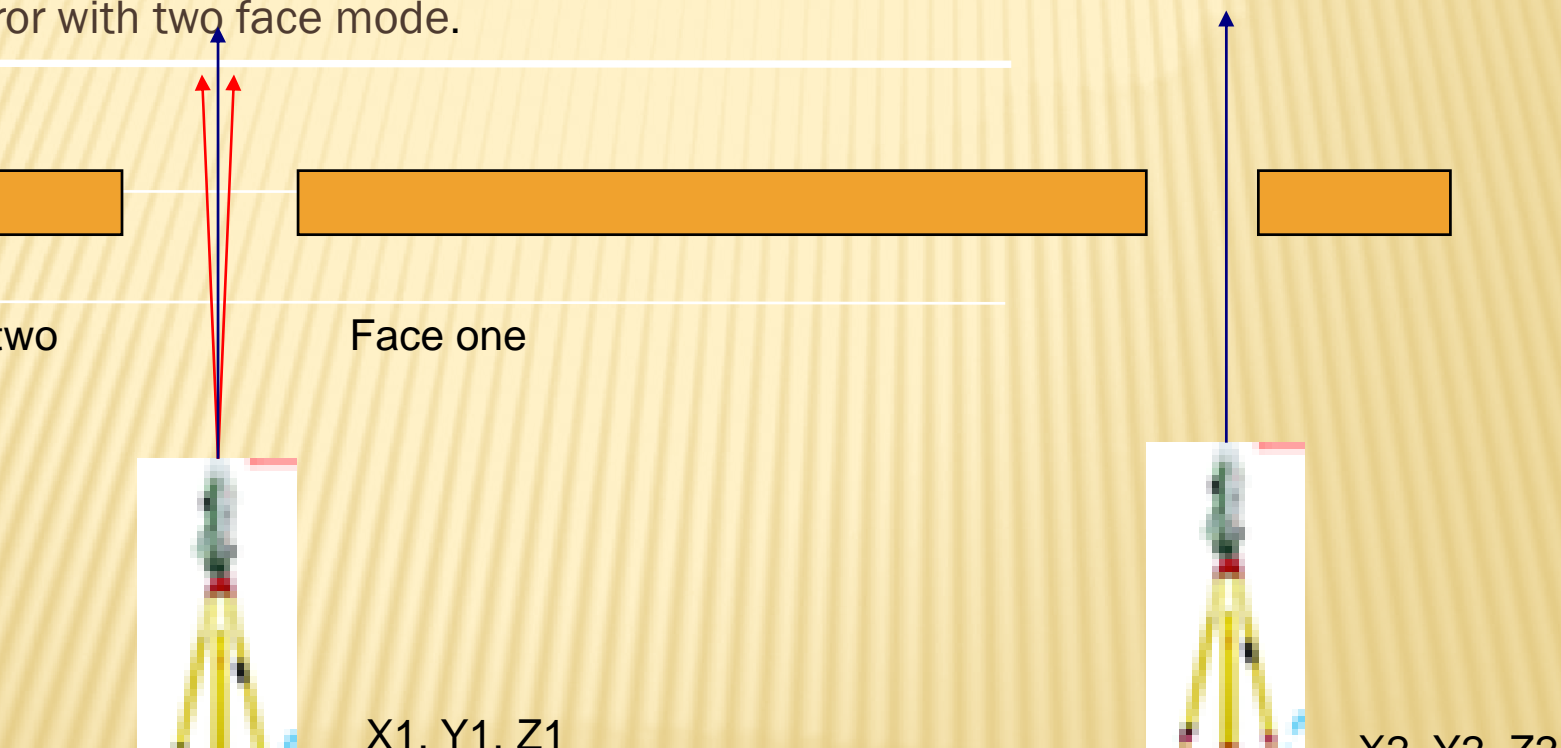
## Operation concept

Set up the two instruments on the “On site BM” and orientation.

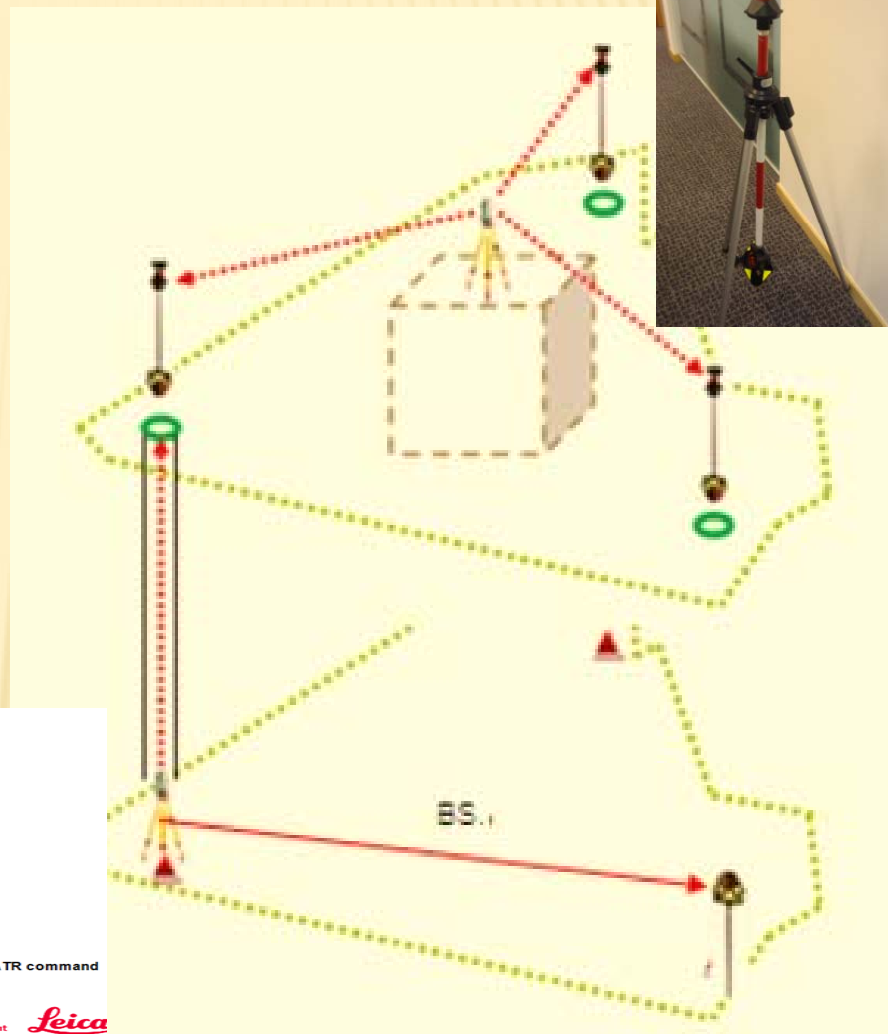
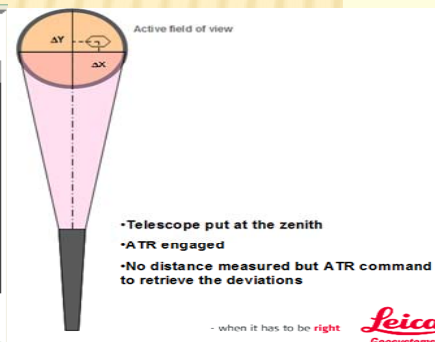
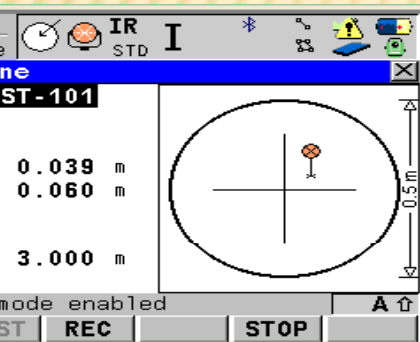


# Operation concept

Set Zenith line function to location to the gravity vertical line.  
to face vertical line orientation. Automatic calibrate the angle  
error with two face mode.

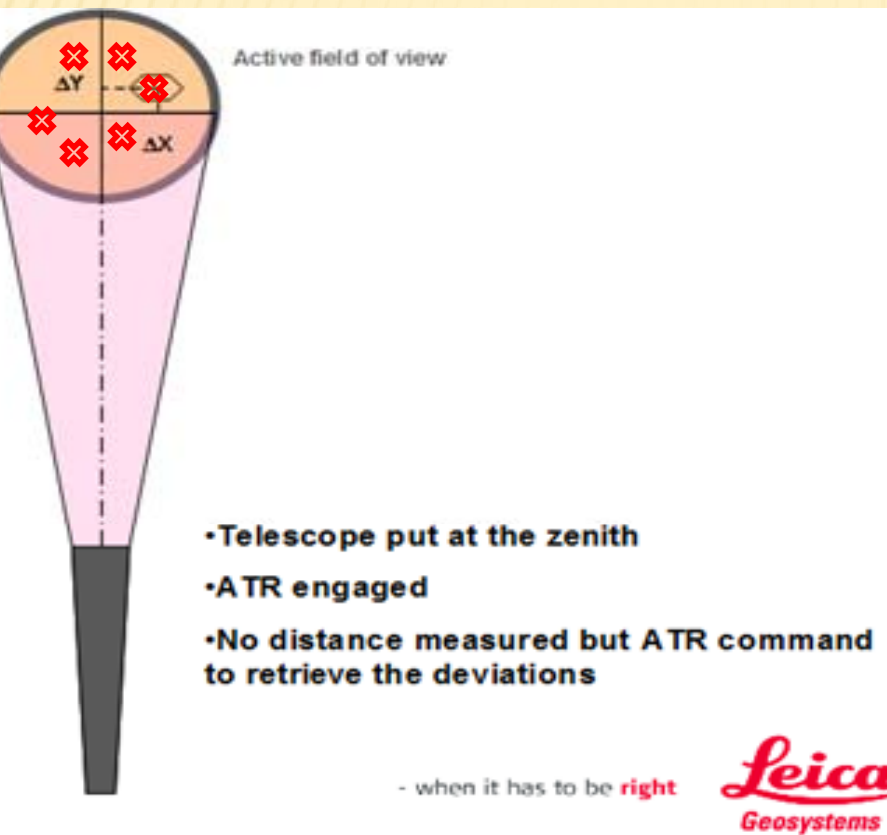


shall be precisely turn to the zenith  
 tion by automatic motorize option  
 o the reflector on working slab. The  
 e application will calculate the dX,  
 bottom circular prism even if the  
 e is not aiming to the centre of  
 “Zenith Line” put the telescope  
 zenith angle =0.0000 gon) which will  
 from the reflector and ATR(Auto  
 recognition) is ON





## SERIES POLE MOVEMENTS AND ZL DX, DY CALCULATION

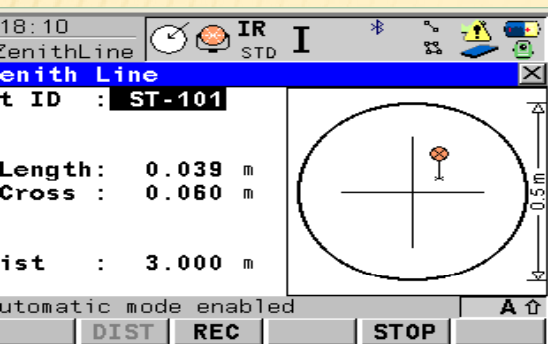


### ✘ Time series pole movements

- ✘ ZL application shall be give the prism real time movement during the verticality monitoring survey.
- ✘ That shall provide the idea of vibration of the building in certain time period.
- ✘ Those monitoring information shall be compared to building tilt information to double check the building tilt and shall be use for the lateral calibration parameters.

# Survey for Core Wall Adjustment

zenith line



Minimum distance for survey

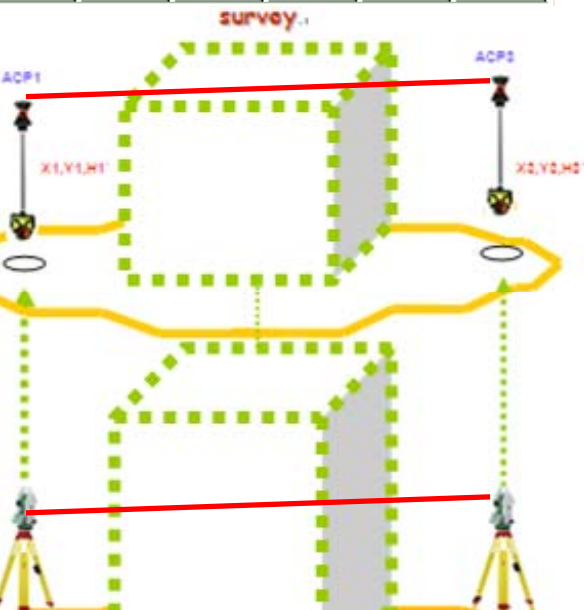
ATR (Auto Target Recognition) technology to aiming the over hundreds meters

(EDM Standard mode 1mm +1ppm, ATR angle accuracy Hz, V 1", base positioning accuracy 1mm).

Auto calculation- The center of the prism coordinate is automatically calculated

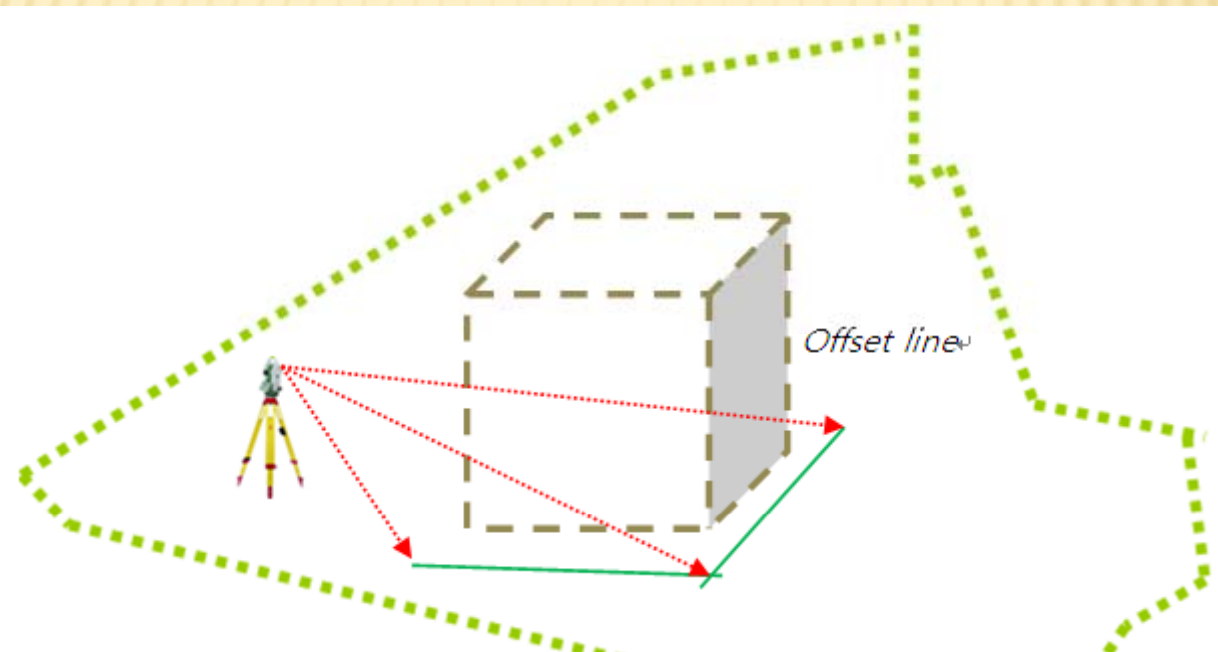
Free from the obstruction by using the survey sleeves. Working under the same condition.

Setting out the control points and As built work for the previous concrete core wall at the same the same session



## Formwork adjustment

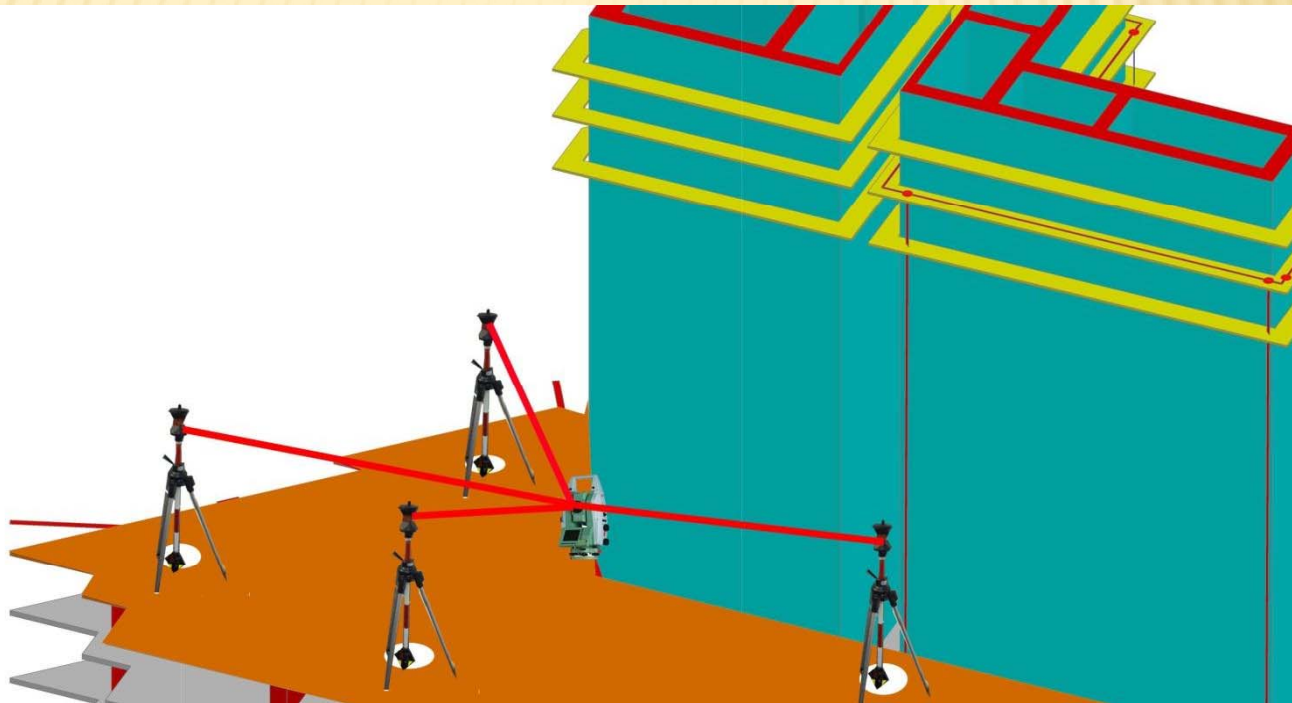
In case TPS and the setting out position have the obstructions or it's not possible to measure directly. The surveyor shall be set 0.3 m offset line from the concrete below the core wall.





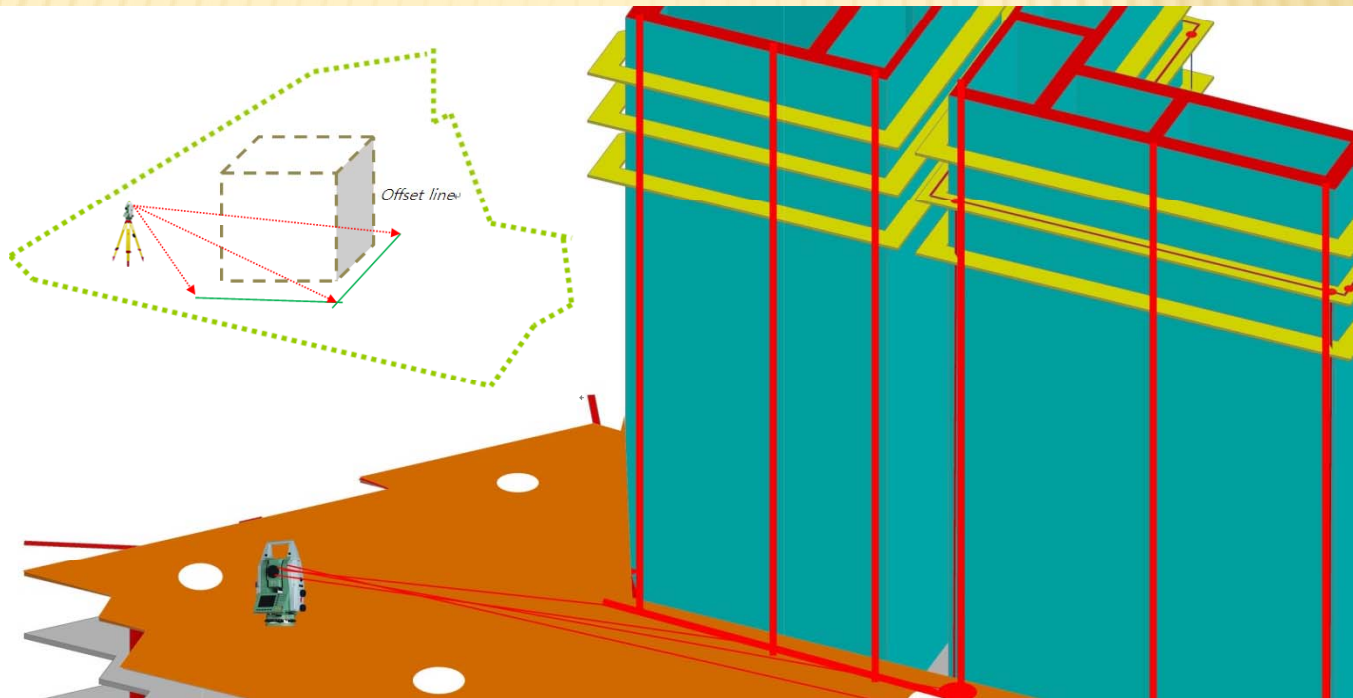
## Formwork adjustment

In case TPS and the setting out position have the obstructions or it's not possible to measure directly. The surveyor shall be set 0.3 m from the set line from the concrete below the core wall.



## Formwork adjustment

In case TPS and the setting out position have the obstructions or it's not possible to measure directly. The surveyor shall be set 0.3 m offset line from the concrete below the core wall.

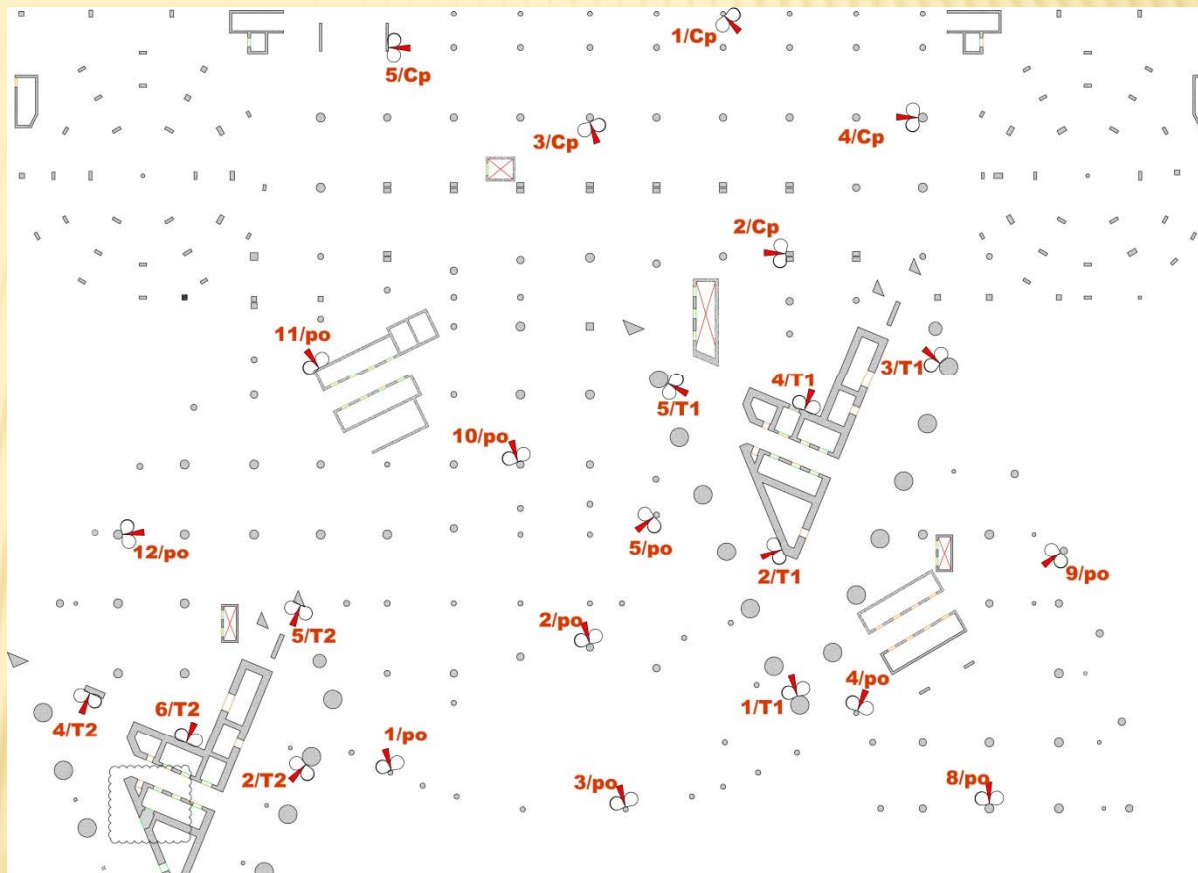


## CONSTRUCTION MONITORING

- Foundation Settlement monitoring
- Structure Vertical shortening monitoring
- Building tilt monitoring

## FOUNDATION SETTLEMENT MONITORING

The 28 settlement  
monitoring points in B3 level  
are on mat. Those are  
checked every week  
according to the monitoring  
plan. The monitoring  
points are marked into the  
plan and the core walls  
height and securely  
checked.





## FOUNDATION SETTLEMENT MONITORING

t class digital level  
 e is used for every  
 ing survey The  
 ing BM gets from  
 away Off site  
 ce. The site BM for  
 onitoring is updated  
 monitoring  
 s. After casting of  
 detect the max  
 ent its around 2 cm  
 after 6 monthes only

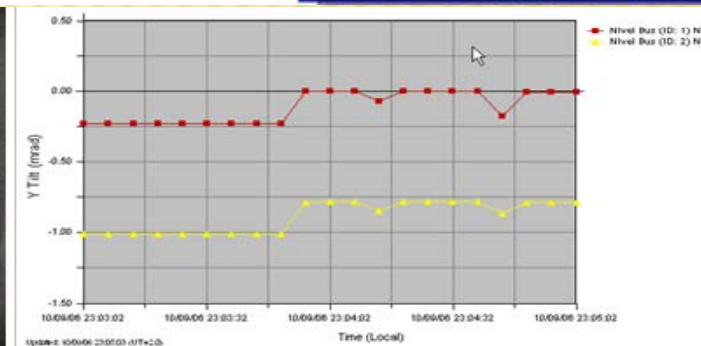
Records of settlement at ground floor													Tower 1		
LOCATION	REFERENCE LEVEL MARK				"=" 1.5				10 Nov New point						
	1/po 8-M	2/po 11-L	3/po 11-N	4/po 15-M	5/po 12-J	6/po 15-Q	7/po 18-R	8/po 17-N	9/po 18-J	10/po 10-H	11/po 7-F	12/po 4/J	TIME	DATE	
27TH INSPECTION	.+1.496	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.497	. +1.5	. +1.5	11:00AM	17-Nov-11	
28th INSPECTION	.+1.496	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.497	. +1.5	. +1.5	11:00AM	26-Nov-11	
29th INSPECTION	.+1.496	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.5	. +1.497	. +1.5	. +1.5	11:00AM	03-Dec-11	
30th INSPECTION	.+1.495	.+1.498	.+1.498	.+1.498	.+1.498	.+1.499	.+1.497	.+1.497	. +1.5	.+1.497	.+1.495	.+1.499	11:00AM	31-Dec-11	
31th INSPECTION	.+1.495	.+1.498	.+1.498	.+1.498	.+1.498	.+1.499	.+1.497	.+1.497	. +1.5	.+1.497	.+1.495	.+1.499	11:00AM	08-Jan-12	
32nd INSPECTION	.+1.495	.+1.498	.+1.498	.+1.498	.+1.498	.+1.498	.+1.497	.+1.497	. +1.5	.+1.497	.+1.495	.+1.499	11:00AM	15-Jan-12	
33 rd INSPECTION	.+1.495	.+1.498	.+1.498	.+1.498	.+1.498	.+1.498	.+1.497	.+1.497	. +1.5	.+1.497	.+1.495	.+1.499	11:00AM	22-Jan-12	
34th INSPECTION	.+1.495	.+1.499	.+1.498	.+1.498	.+1.499	.+1.499	.+1.499	.+1.498	. +1.5	.+1.497	.+1.494	.+1.498	11:00AM	28-Jan-12	
35th INSPECTION	.+1.494	.+1.499	.+1.498	.+1.498	.+1.499	.+1.499	.+1.499	.+1.498	.+1.499	.+1.497	.+1.494	.+1.498	11:00AM	05-Feb-12	
36th INSPECTION	.+1.494	.+1.499	Erased	.+1.498	.+1.498	.+1.499	.+1.499	.+1.498	.+1.499	.+1.497	.+1.494	.+1.498	11:00AM	22-Feb-12	
37th INSPECTION	.+1.493	.+1.498	Erased	.+1.498	.+1.497	.+1.499	.+1.498	.+1.497	.+1.499	.+1.496	.+1.493	.+1.497	11:00AM	05-Mar-12	
38th INSPECTION	.+1.493	.+1.497	Erased	.+1.498	.+1.497	.+1.499	.+1.498	.+1.497	.+1.498	.+1.495	.+1.493	.+1.497	11:00AM	27-Mar-12	
39th INSPECTION	.+1.493	.+1.497	N.A	.+1.497	.+1.496	.+1.499	.+1.498	.+1.497	.+1.498	.+1.495	.+1.493	.+1.497	11:00AM	05-May-12	
40th INSPECTION	.+1.493	.+1.497	N.A	.+1.497	.+1.496	.+1.499	.+1.498	.+1.497	.+1.497	.+1.496	.+1.493	.+1.497	3:15PM	24-Jun-12	
41st INSPECTION	.+1.493	.+1.497	N.A	.+1.497	.+1.496	.+1.499	.+1.498	.+1.496	.+1.497	.+1.496	.+1.493	.+1.497			

**POINTS NUMBER ON THE ATTACHED PLAN**  
**PO - PODIUM AREA**

## BUILDING TILT MONITORING

on tilt (Elastic)  
ment tilt

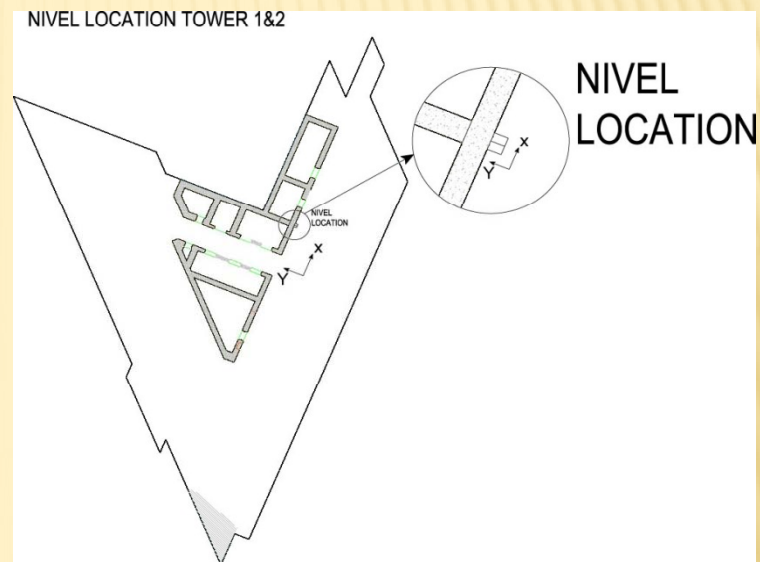
ion sensor was  
d every 15 floor at  
al interval height and  
ted to each other to  
d to a logging file  
ecord in real time  
ination angle  
n the sensor 24/7



## BUILDING TILT MONITORING

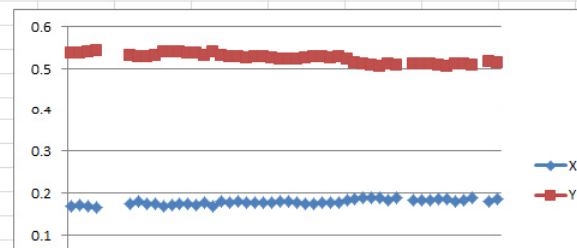
- Vibration tilt (Elastic)
- Permanent tilt

inclination sensor was installed every 15 floor at an equal interval height and connected to each other to reach to a logging file which record in real time the inclination angle between the sensor 24/7



	FROM				30-07-12		19-09-12	
	X				Y			
	Average	Max	MIN	Median	Average	Max	MIN	Median
30-07-12	0.16904	0.17400	0.162	0.169	0.538145	0.54200	0.533	0.538
31-07-12	0.172947	0.17500	0.170	0.173	0.537493	0.54000	0.536	0.537
01-08-12	0.169038	0.17400	0.165	0.169	0.540247	0.54400	0.537	0.540
02-08-12	0.167702	0.17100	0.164	0.168	0.54401	0.54700	0.538	0.544
03-08-12								
04-08-12								
05-08-12								
06-08-12	0.176448	0.18200	0.168	0.176	0.533495	0.53700	0.531	0.533
07-08-12	0.18013	0.18200	0.176	0.180	0.529385	0.53300	0.524	0.529
08-08-12	0.175364	0.17800	0.172	0.175	0.528998	0.53200	0.526	0.529
09-08-12	0.175657	0.17900	0.168	0.176	0.533566	0.54200	0.530	0.533
10-08-12	0.170458	0.17700	0.161	0.170	0.541156	0.54300	0.539	0.541
11-08-12	0.173144	0.17800	0.169	0.174	0.541009	0.54400	0.539	0.541

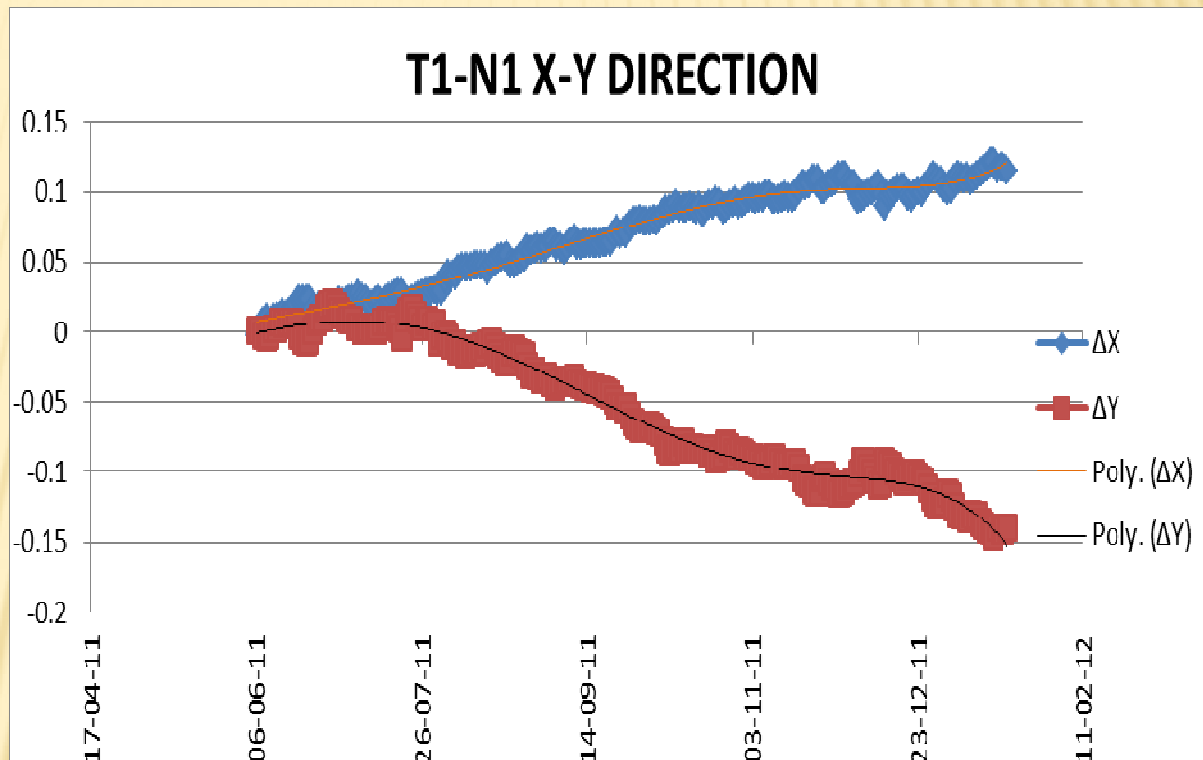
monthly report



## BUILDING TILT MONITORING

on tilt (Elastic)  
ment tilt

ion sensor was  
d every 15 floor at  
al interval height and  
ted to each other to  
d to a logging file  
ecord in real time  
ination angle  
n the sensor 24/7





**THANK YOU VERY MUCH**