

## Analysis of Wind-Induced Response of Tall Reinforced Concrete Building Based on Data Collected By GPS and Precise Inclination Sensor



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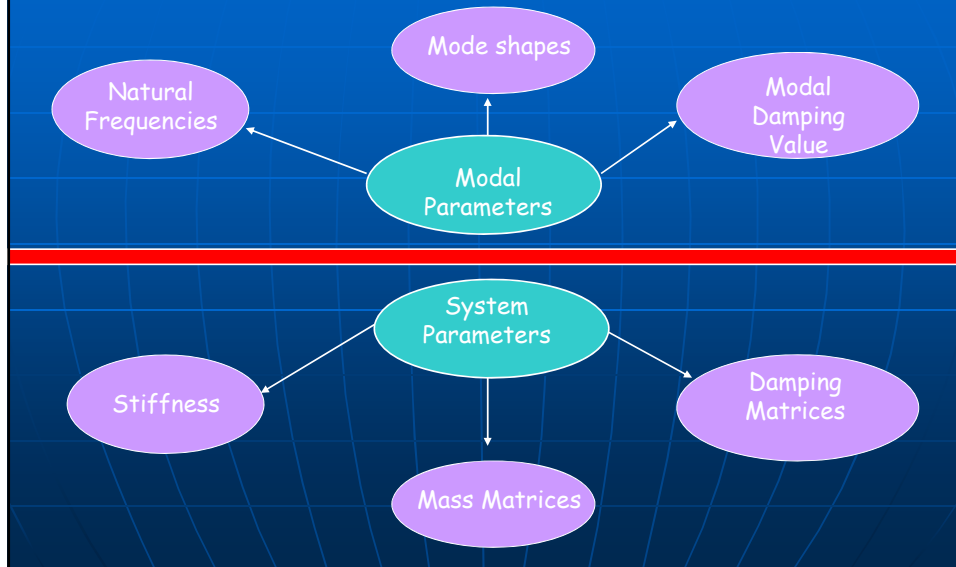
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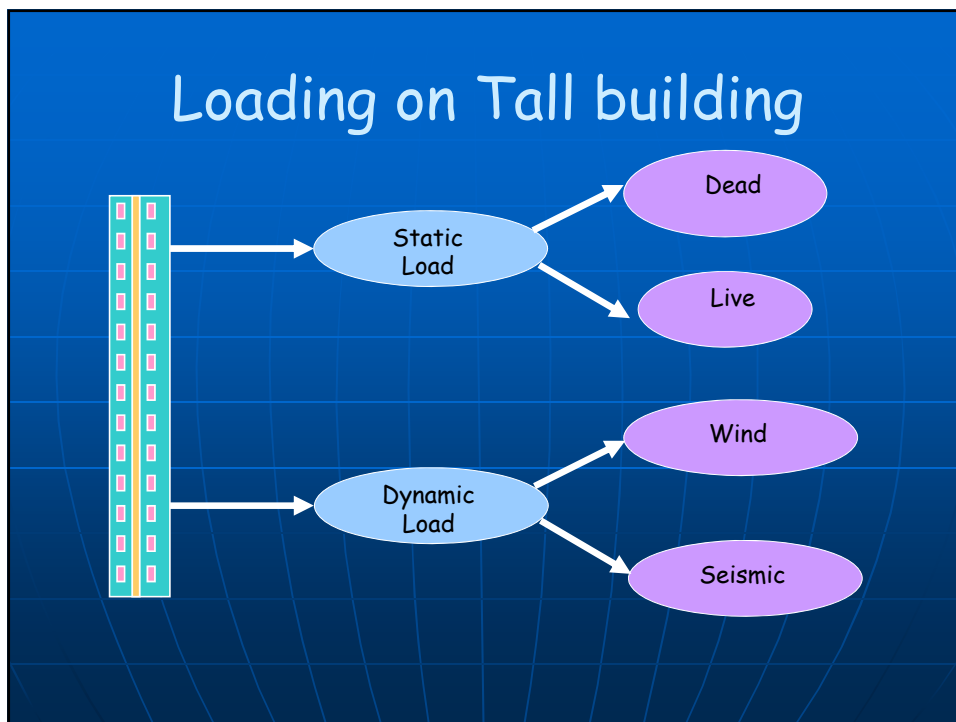
## Outline of the Presentation

- **Background**
- The structure and Actual Deployment
- **Experiment and Analysis**
- Comparing Sensor Performance
- Conclusions and Discussion

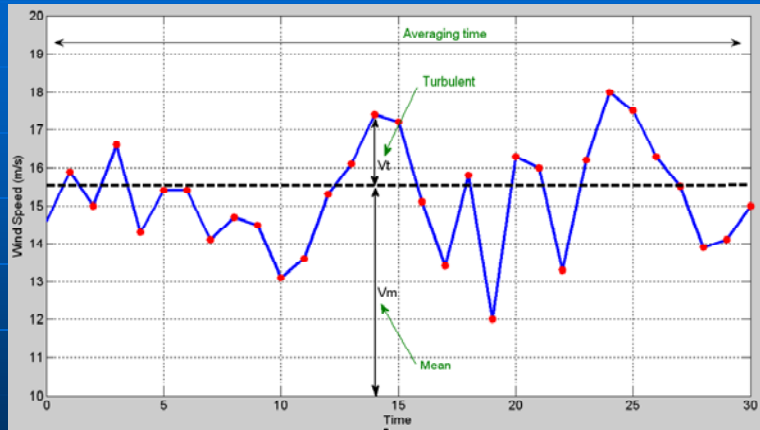
# Modal & System parameters



# Loading on Tall building

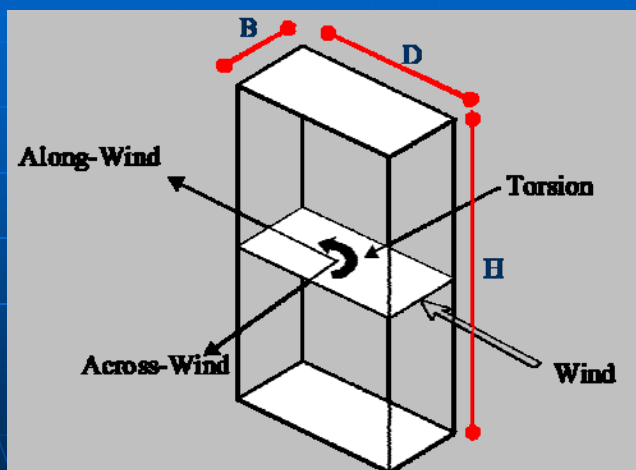


## Turbulent Characteristic of Wind

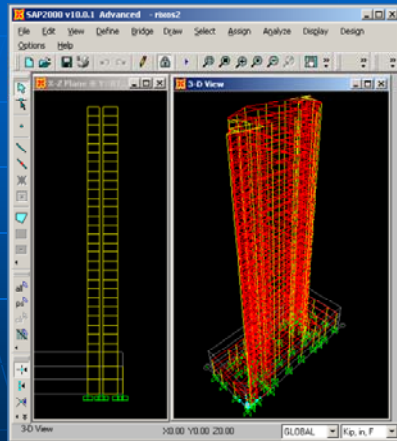


Typical trace of variation of wind speed with time

## Definition of load and wind direction



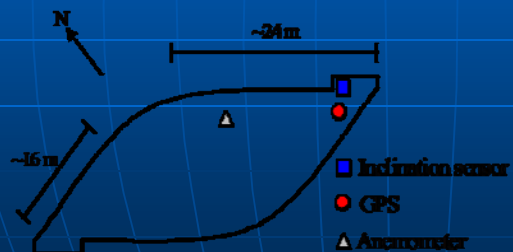
## The Predicted Natural Frequency



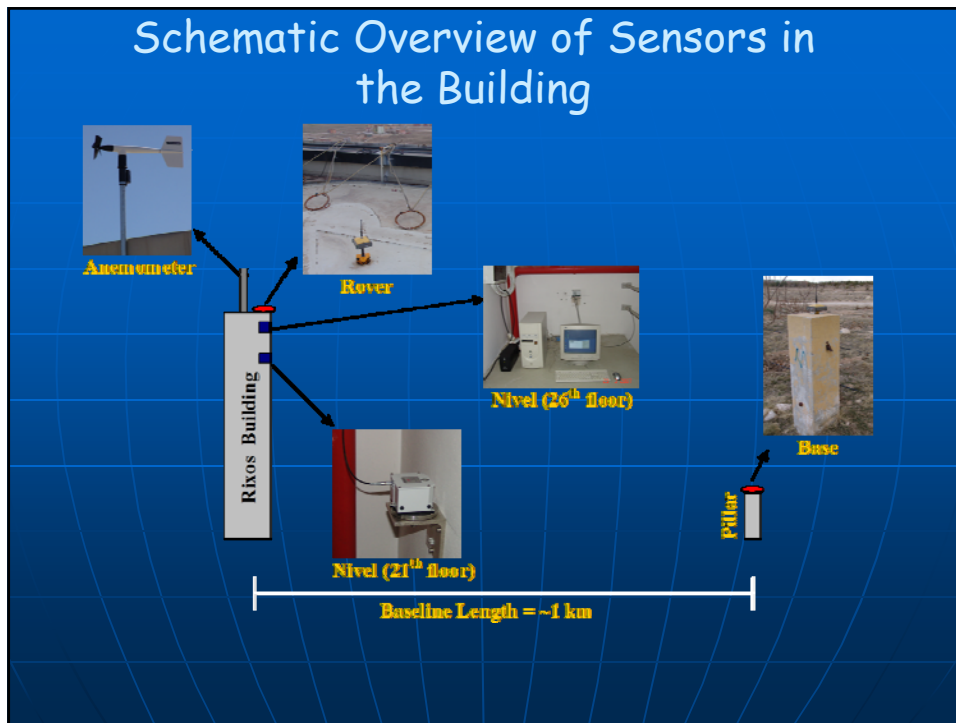
| Mode number | Frequency | Period |
|-------------|-----------|--------|
| 1           | 0.38 Hz   | 2.6 sn |
| 2           | 0.55 Hz   | 1.8 sn |
| 3           | 0.62 Hz   | 1.6 sn |
| 4           | 1.25 Hz   | 0.8 sn |
| 5           | 1.61 Hz   | 0.6 sn |
| 6           | 2.13 Hz   | 0.5 sn |

## Basic Properties of the Structure

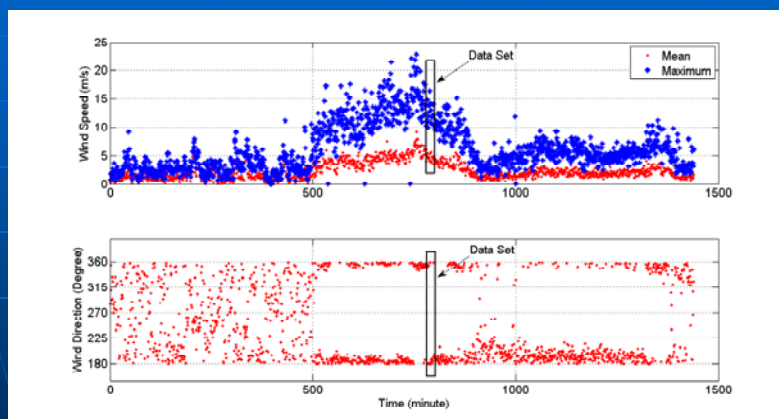
- 30-storey
- 100 m (height).
- 44 columns with different sizes and 2 shear-nucleuses (core construction).
- using as a hotel



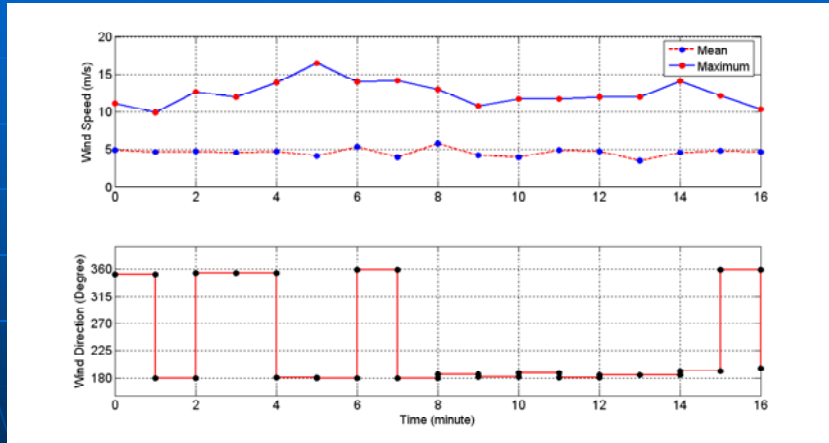
## Schematic Overview of Sensors in the Building



## Experiment and Analysis

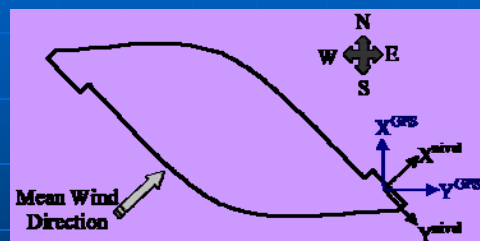


Mean & maximum wind speed (upper) and mean wind direction (bottom) for all day

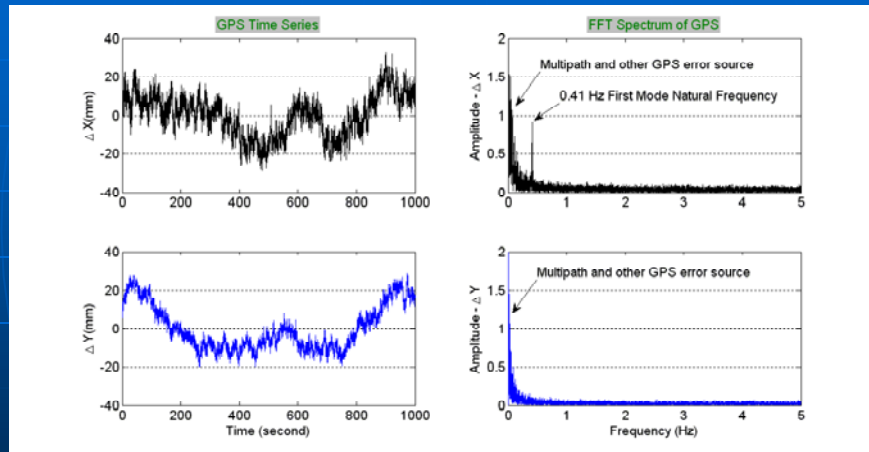


Zoom - in of the wind data during the experiment

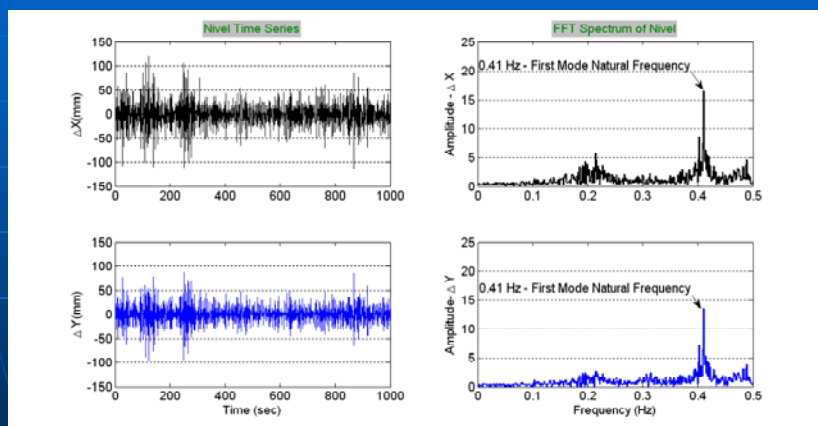
## Mean Wind Direction and GPS & Nivel Axes with respect to the Building



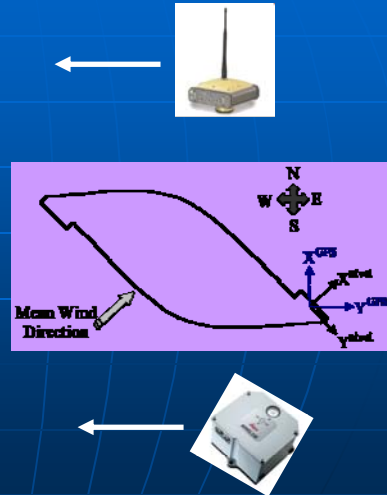
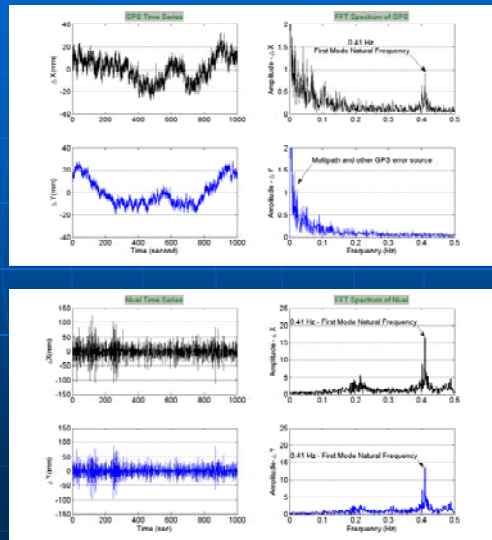
## GPS Results



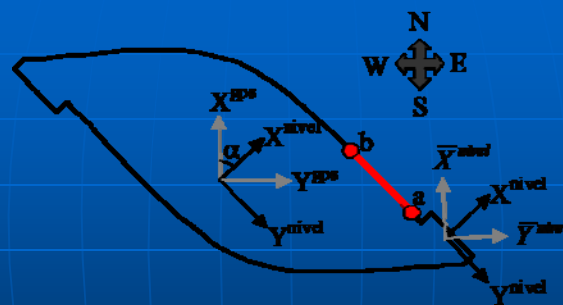
## Nivel Results



## GPS and Nivel Results



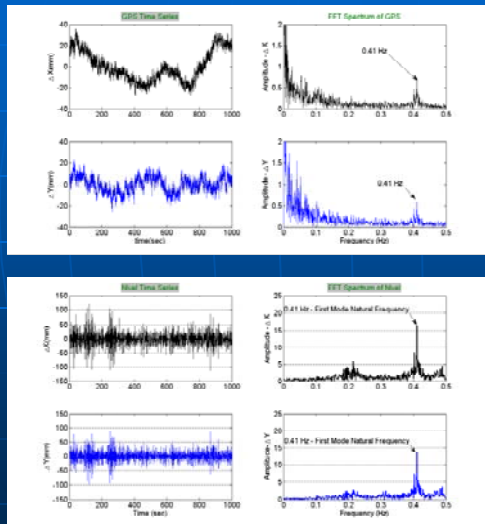
## Determination of rotation angle



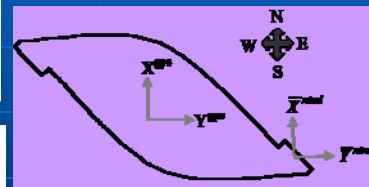
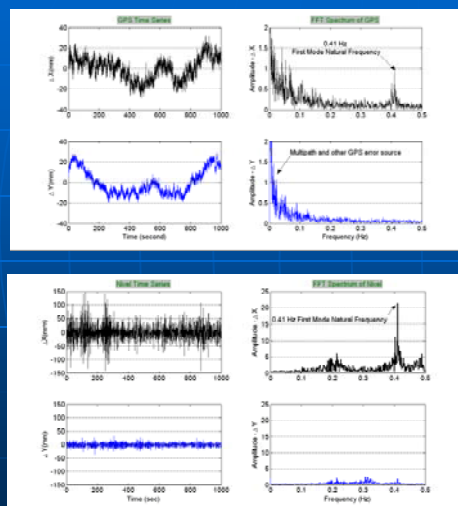
$$\begin{bmatrix} \Delta \bar{X}_i^{nivel} \\ \Delta \bar{Y}_i^{nivel} \end{bmatrix} = \begin{bmatrix} \cos \alpha & -\sin \alpha \\ \sin \alpha & \cos \alpha \end{bmatrix} \begin{bmatrix} \Delta X_i^{nivel} \\ \Delta Y_i^{nivel} \end{bmatrix}$$



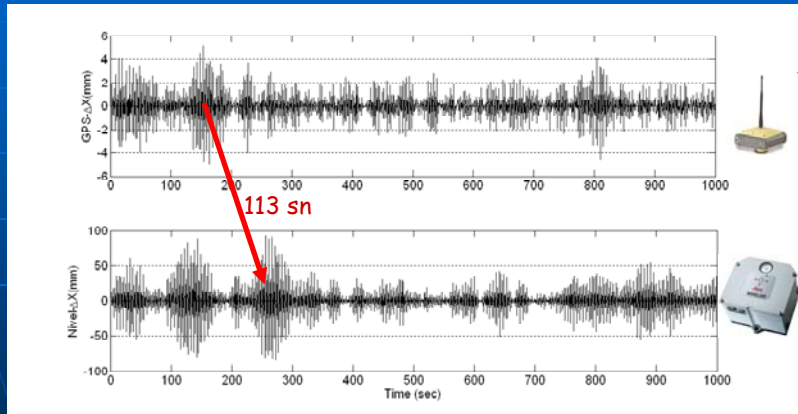
# Conversion GPS Coord. Syst. to Nivel Coord. Syst.



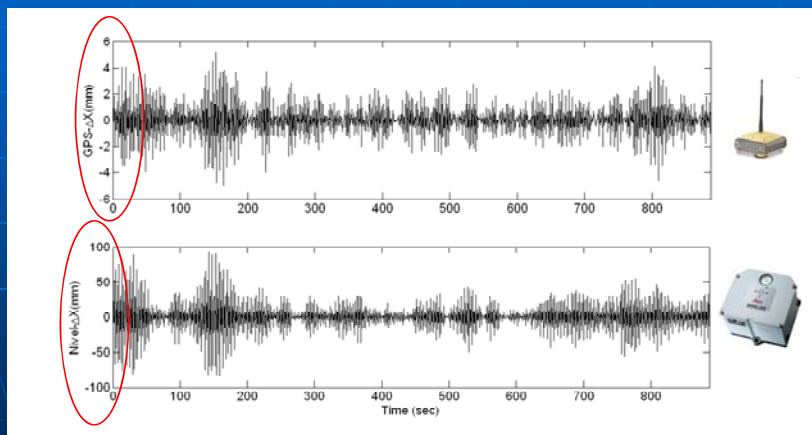
# Conversion Nivel Coord. Syst. to GPS Coord. Syst.



## Comparison in terms of Dynamic Component

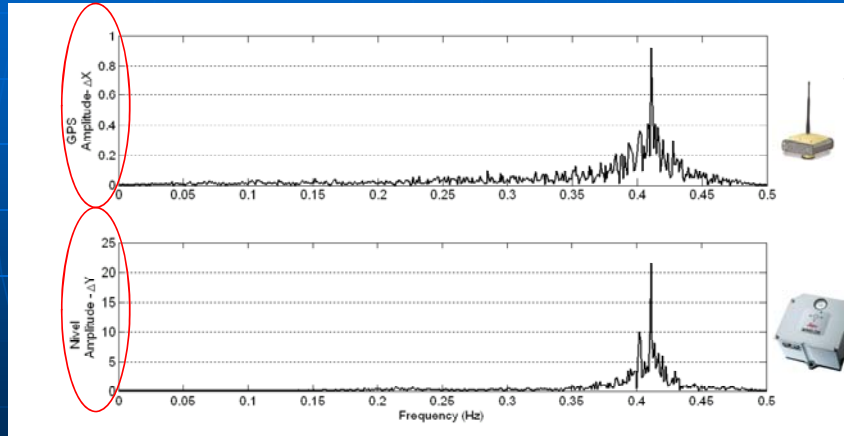


## Comparison in terms of Dynamic Component



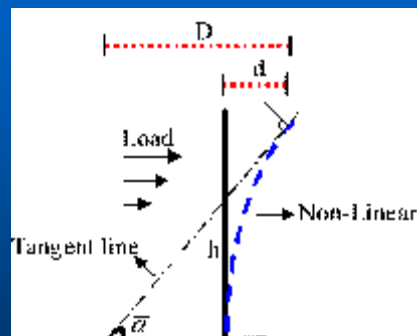
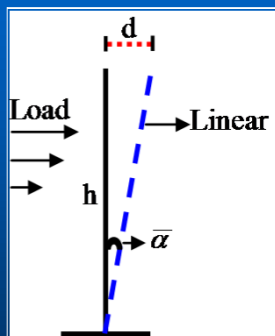
Correlation coefficient = 0.65

# FFT Spectrum



## Converting inclination into displacement

$$d(\text{mm}) = h(\text{m}) * \alpha(\text{mrad})$$



(a) linear case

(b) non-linear case

Illustration of converting inclination into displacement

