Possibilities of Precise Determining of Deformation and Vertical Deflection of Structures Using Ground Radar Interferometry

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Moto:

- New geodetic technologies like radar interferometry and ground base radar interferometry with synthetic aperture (GB InSAR) can be used with success for deformation monitoring.
- This new technologies are mainly use for determining the deformations of:
  - deflections of bridges,
  - horizontal movements of wind power towers, chimneys, water towers, high buildings, ...
  - landslides in dangerous areas,
  - horizontal movements of dams,
  - etc.

Principles of radar interferometry

Radar interferometry

\[ \Delta \phi = \frac{\Delta R}{2R} \]

Stepped frequency wave
Instrument characteristics - IBIS-FS

- **producer:** Ingegneria Dei Sistemi S.p.A., Italy
- terrestrial coherent radar interferometer
- microwave spectrum with mean frequency of 17 GHz
- sampling frequency from 10 to 200 Hz
- maximum effective range is 1 km
- standard deviation according to manufacturer is 0.01 mm
- resolution is 0.75 m in range direction

Line of sight movement and real movement

- The displacement is measured in the direction of the line of sight of the system
- To calculate the real displacement is needed to know the acquisition geometry
Radar interferometry (IBIS-S) advantages

IBIS-S introduces a totally new method for the dynamic and static monitoring of movements, with significant advantages over traditional including:

- **Remote sensing**, without the need to access the structure;
- **Fast and easy to install**: complete monitoring of the entire structure performed quickly (e.g.: an entire bridge can be dynamically monitored in less than one hour)
- Provides a practically continuous **mapping of the dynamic displacements** of the entire structure
- Directly measures the structural displacements in **real time**, with an accuracy of between 1/100 and 1/10 of a mm
- Can follow and accurately measure both slow movements and fast movements in the frequencies range [0-50 Hz]

A method of monitoring bridges

Current monitoring of the entire bridge or a selected part
Example of the bridge in Rataje nad Sázavou

Example of the road bridge near Pelhřimov
Deflections of bridge during 10 min measurements

Detail 30 sec
Frequency Analysis

Horizontal movements of water towers
Horizontal movements of water towers during 25 min

Detail during 140 sec
Horizontal movements of wind-power plant pylons

Movements during 30 min measuring
Horizontal movements of wind-power plant pylons

Detail by switch off

Detail by switch on
Horizontal movements of wind-power plant pylons

Comparison of the radar measurements with total station measurements

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Thank you for your attention