Engineering solution of an Automatic Test Equipment Pylons Inclinometer Monitoring System (ATE PIMS) during construction phase of the cable-stayed bridge over Golden Horn Bay in Vladivostok

Andrey Yachshenko
Engineering centre GFK LTD, Moscow

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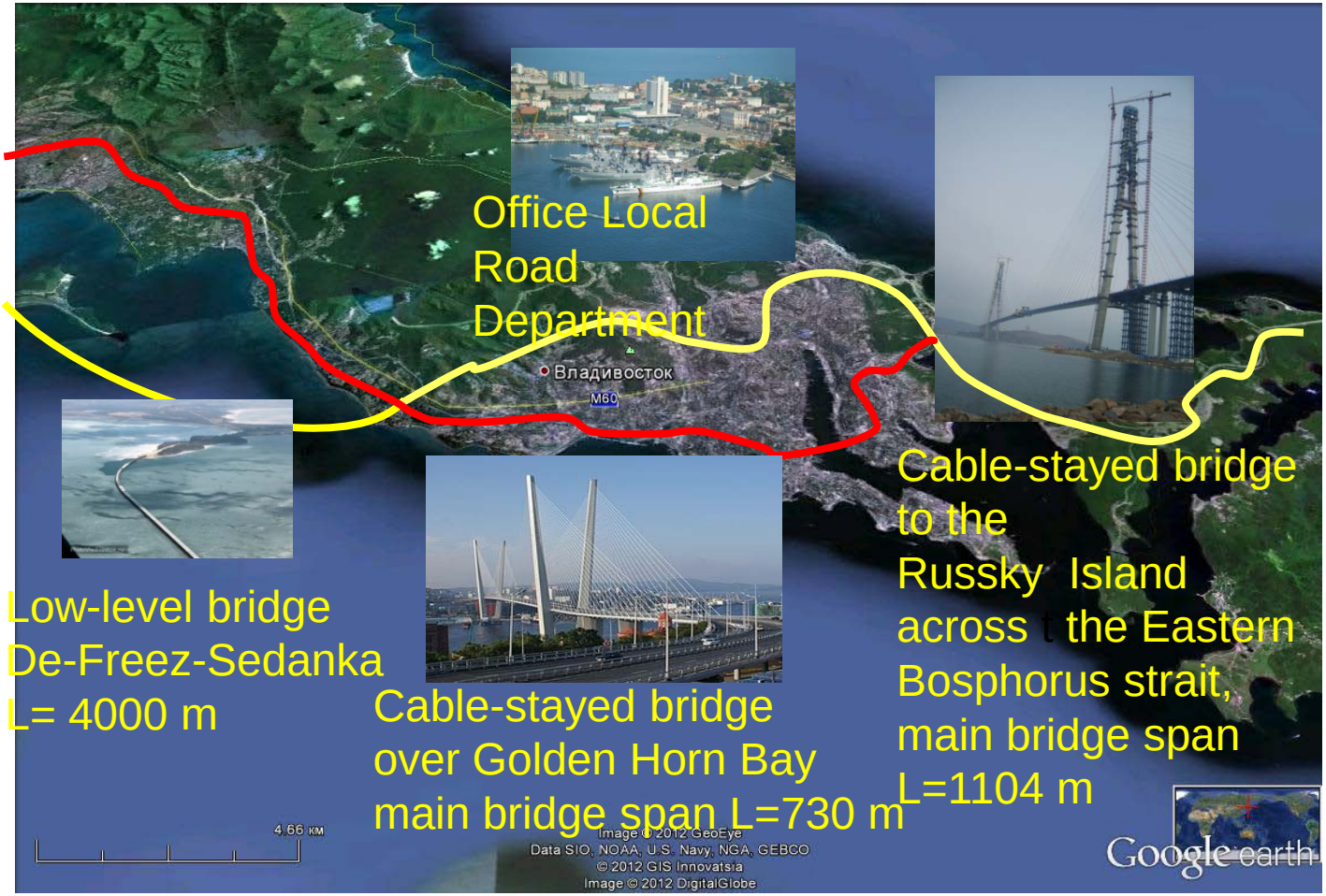
Hong Kong

Motor highways were built for Asia-Pacific Economic Cooperation Summit 2012

Andrey Yashchenko, Engineering Centre GFK LTD, Russia, AIY@Icentre-gfk.ru

The bridges of Vladivostok



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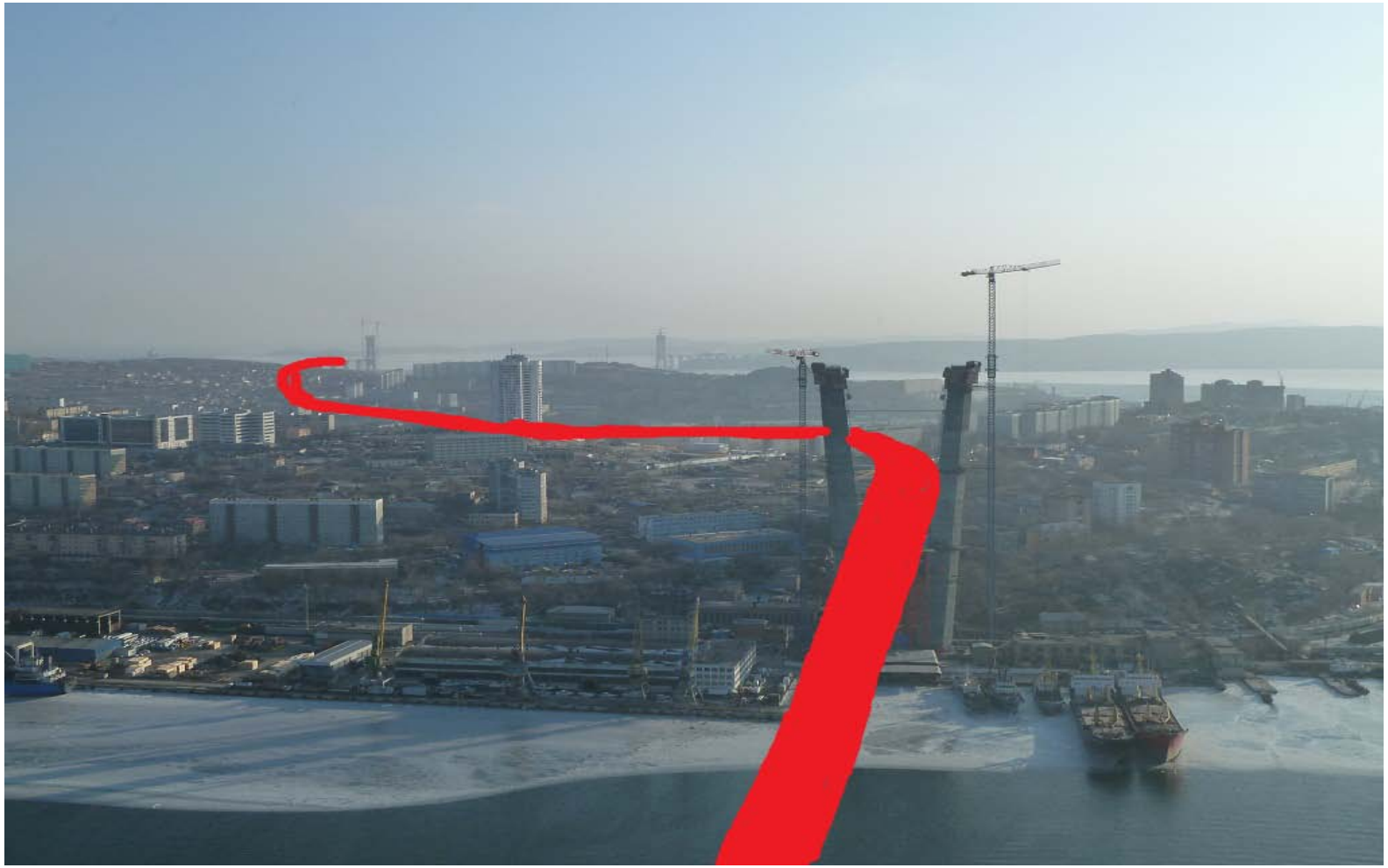
The bridges of Vladivostok



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Pedestrian crossing of the Golden Horn Bay

Municipal authority used temporally wood desk boarding instead of bridge, which were put on bay ice in winter.

Pedestrian crossing of Golden Horn Bay

The temporary wood desk boarding was disposed in spring

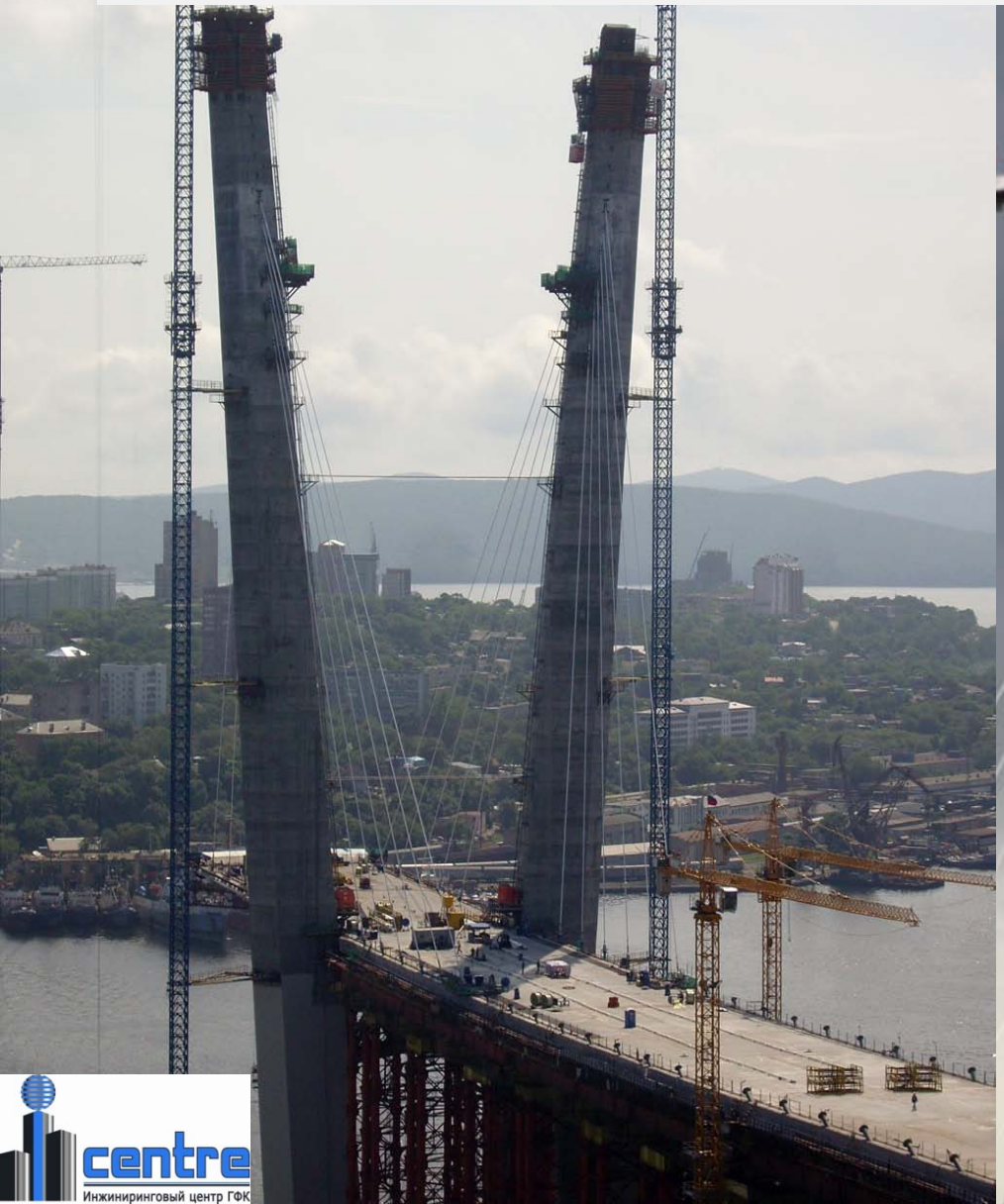
Construction phase of the cable-stayed bridge over Golden Horn Bay, Vladivostok

Bridge Description

- Overall length 1 387,09 m
- Total bridge span 2.1 km
- Width of span 30.6 м
- Width of carriageway 28.50 m
- Height of pylon 226.25 m
- Main spans 737.00 m
- Height of spans 64.00 m
- Seismic resistance 8-point
- Cables 192 pieces
- Construction budget - 670 000 000 $
- General designer - Joint Stock Company «Institute Giprostroymost» SPB
- General contractor -- Joint Stock Company Pacific bridge engineering Khabarovsk

crane hook

Complexity of the surveying of the construction process of unique and unordinary bridges



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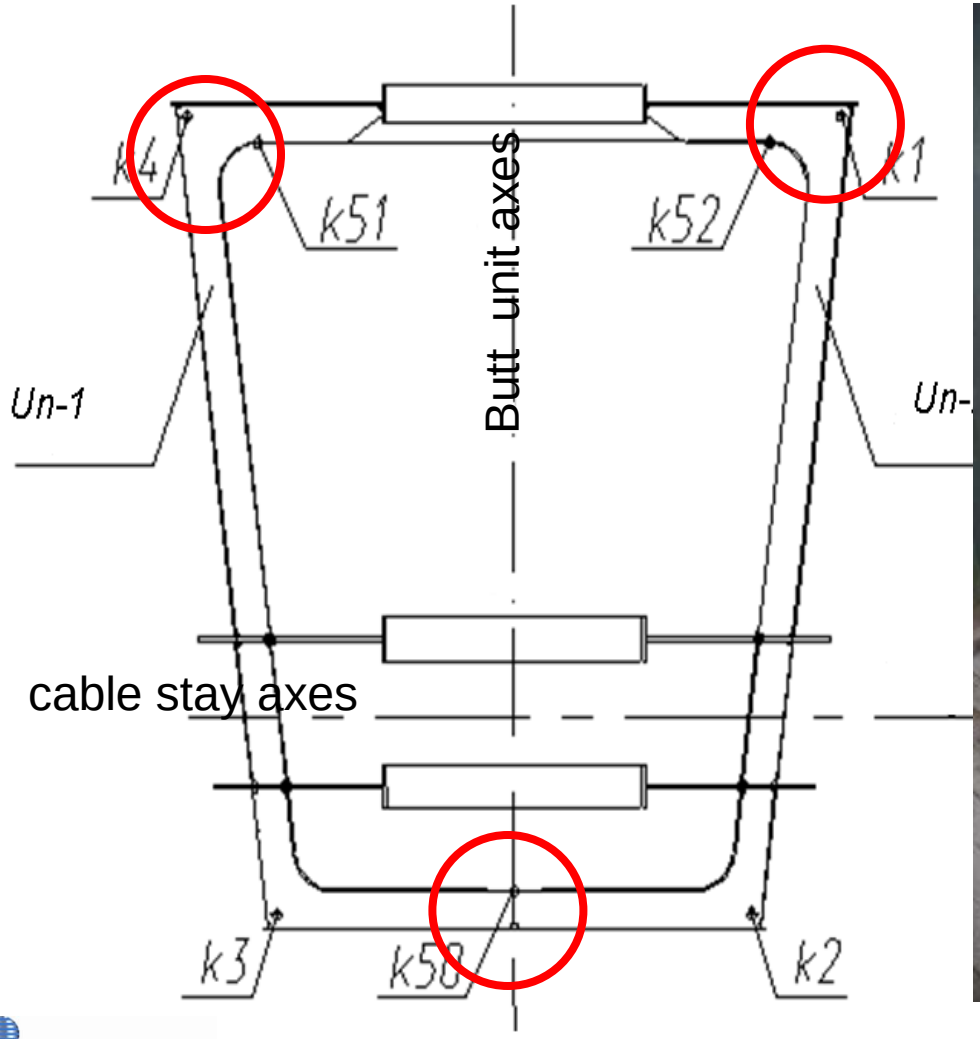
Problems of using manual of GNSS technologies

- computational complexity
- A lot of manual work
- necessity open space
- Necessity manual supervision
- Impossible measurement down mounting level
- Possibility comprehensive automation

Bridge steel core



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Working process

Traditional surveying technologies using only totalstations and GNSS periodical observations don’t provide a good measurement rate, synchronization and data adequacy to supervise pylons during the construction phase.

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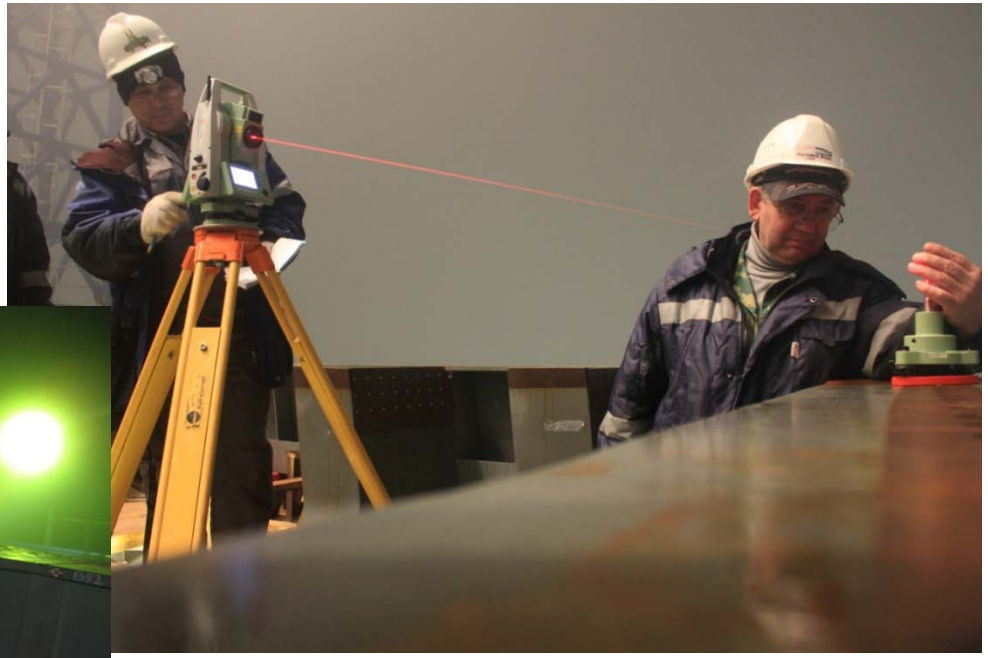
Working procedures



In addition the solar radiation significantly affects the heating of the surface of pylon; furthermore is accompanied by wind gusts

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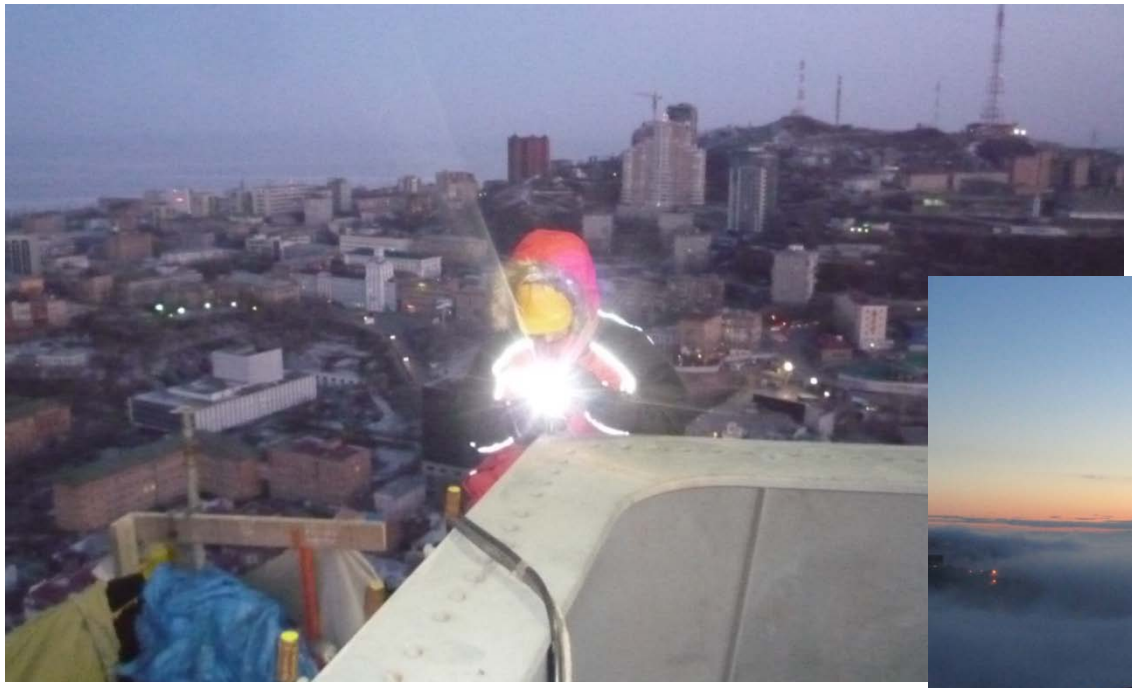
Working procedures



The crane load and works for installation also influenced on pylons tension. The pylons move in elliptic curve, which is modulating by solar, wind and construction work.

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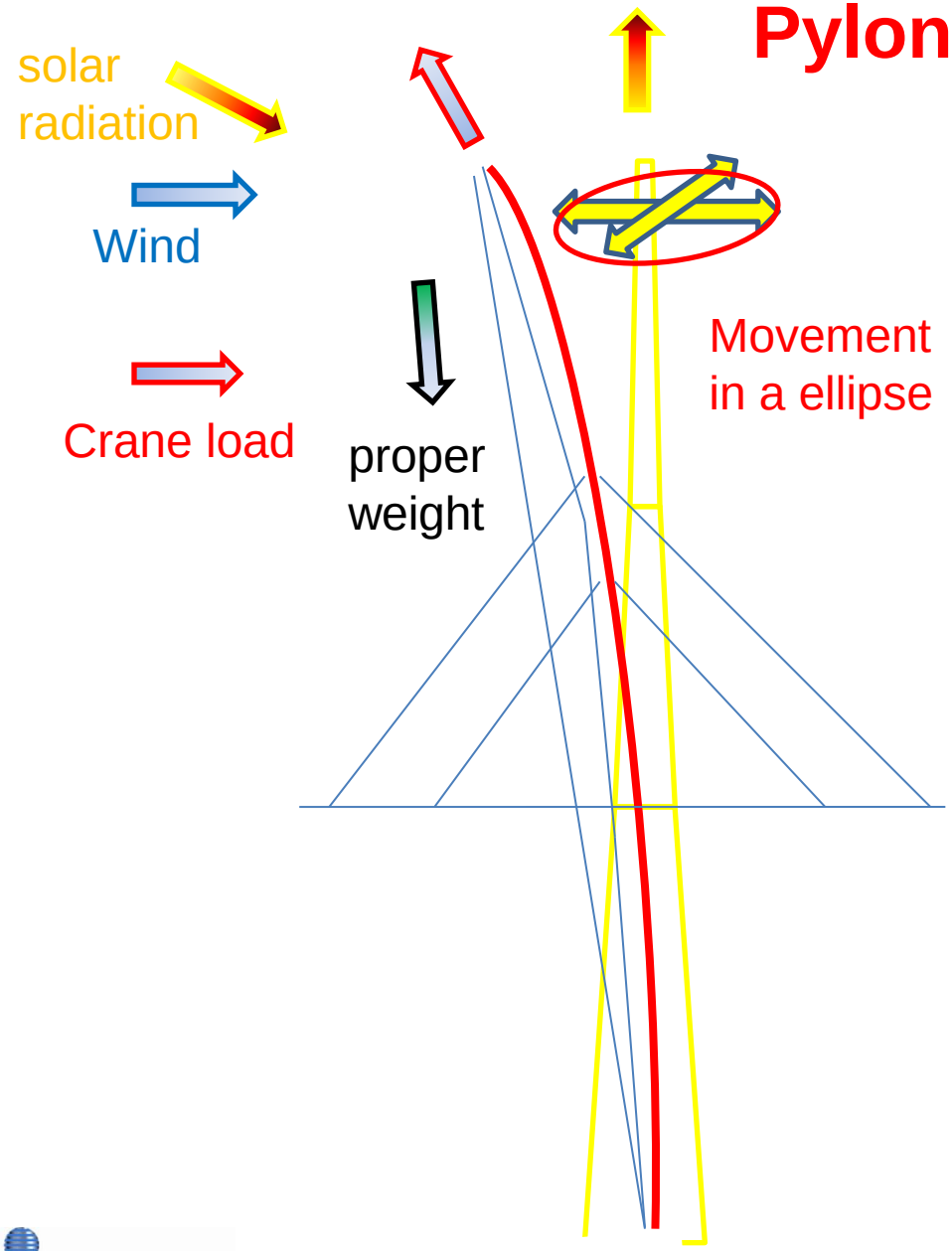
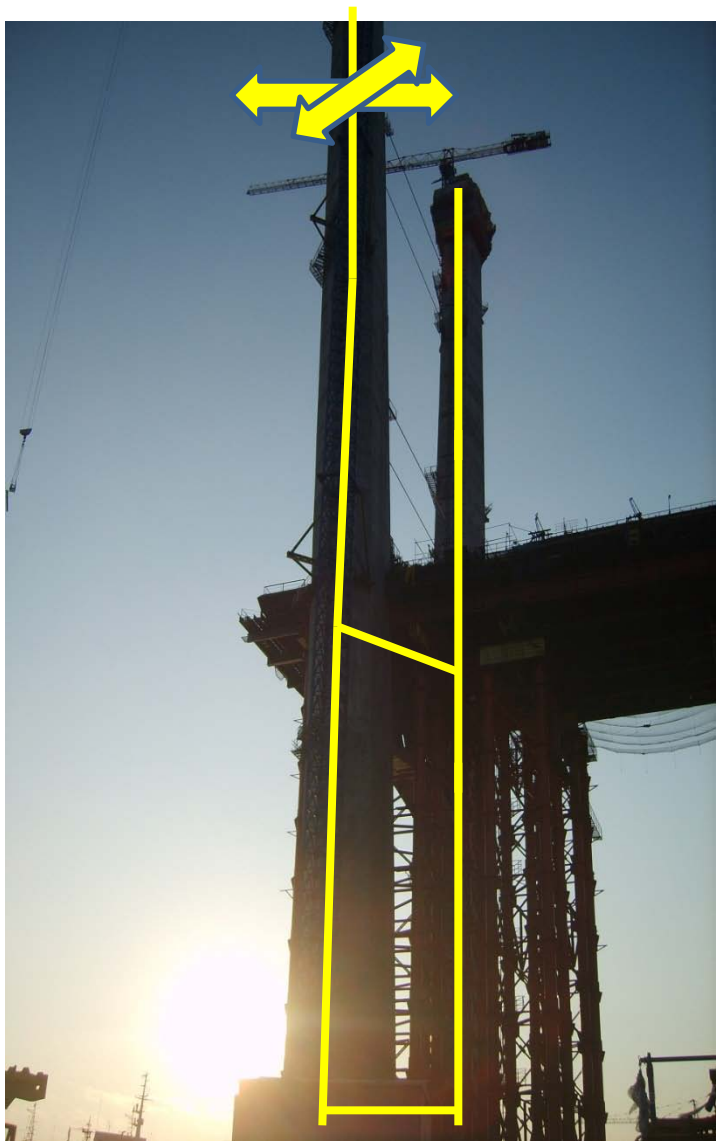
Pylon movement mechanics





Using automatic Test Equipment Pylons Inclinometer monitoring system (ATE PIMS)

Key benefits

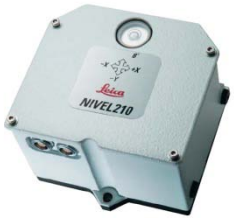
- Measurement in online mode
- Collection, communication and routing of data
- Saving and archiving a database
- Analyzing and visualization of data
- Alarm mode
- Inquiry processing
- Decision-making system

Environment and loads

- Wind loads
- Crane loads
- Construction sequence
- Solar radiation
- Vertical Movement from self-weight

Equipment options for ATE PIMS

Total stations
GNSS receivers (GNSS sensors)
Accelerometers
NZL
X-Y Inclinometers
Digital temperature sensors
Weather station



Equipment options for ATE PIMS

Weather station Viasala

Wind speed	**0 ... 60 m/s**
Direction	**0..360**
Air temperature	**-52° C..60° C**
Barometric pressure	**600 ... 1100 hPa**
Rainfall	
Relative humidity	

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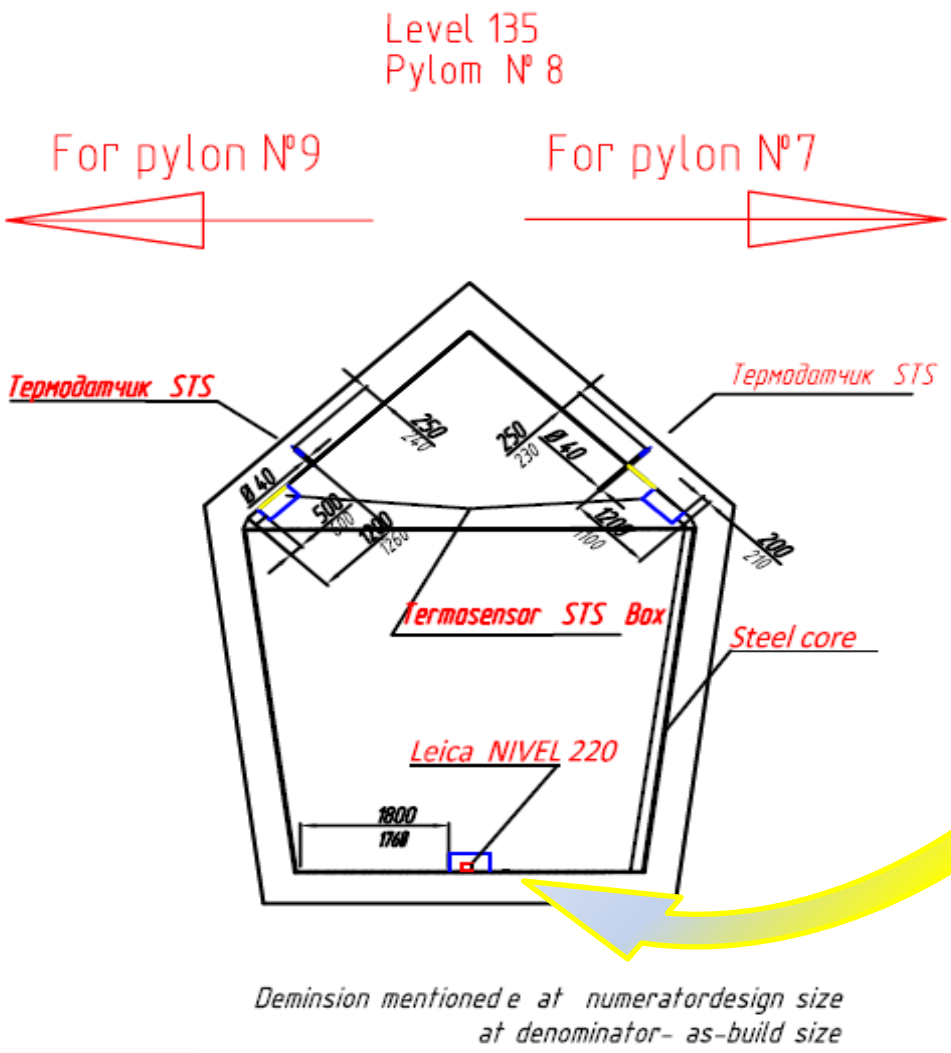
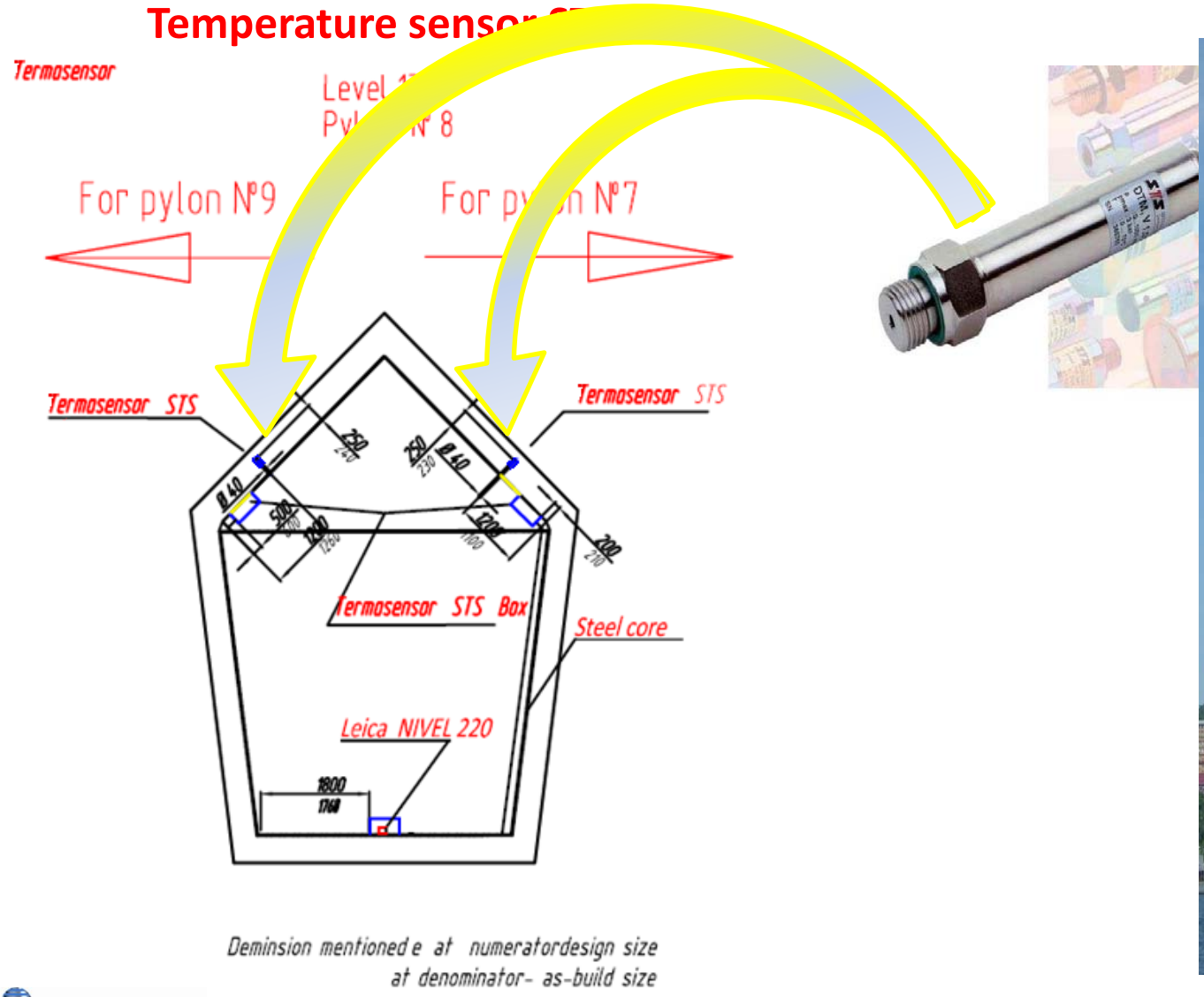
Equipment options for ATE PIMS



Precise information about inclination displacements

Equipment options for ATE PIMS

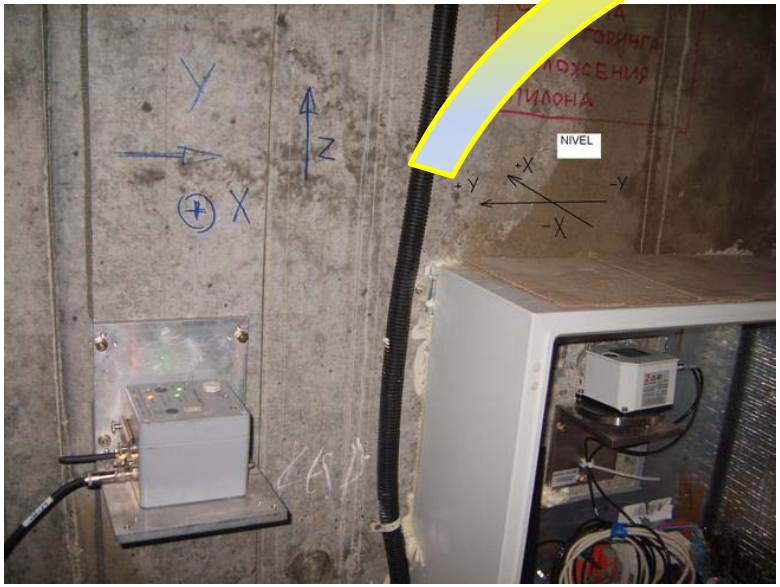
Temperature sensor



Option equipments for ATE PIMS

Digital 3 axis accelerometer

Measurement range ± 2 g
Digital data representation 16 bit
Device resolution X, Y axis 60 μg (Bandwidth = 10 Hz)
Z axis 250 μg



Software options for ATE PIMS

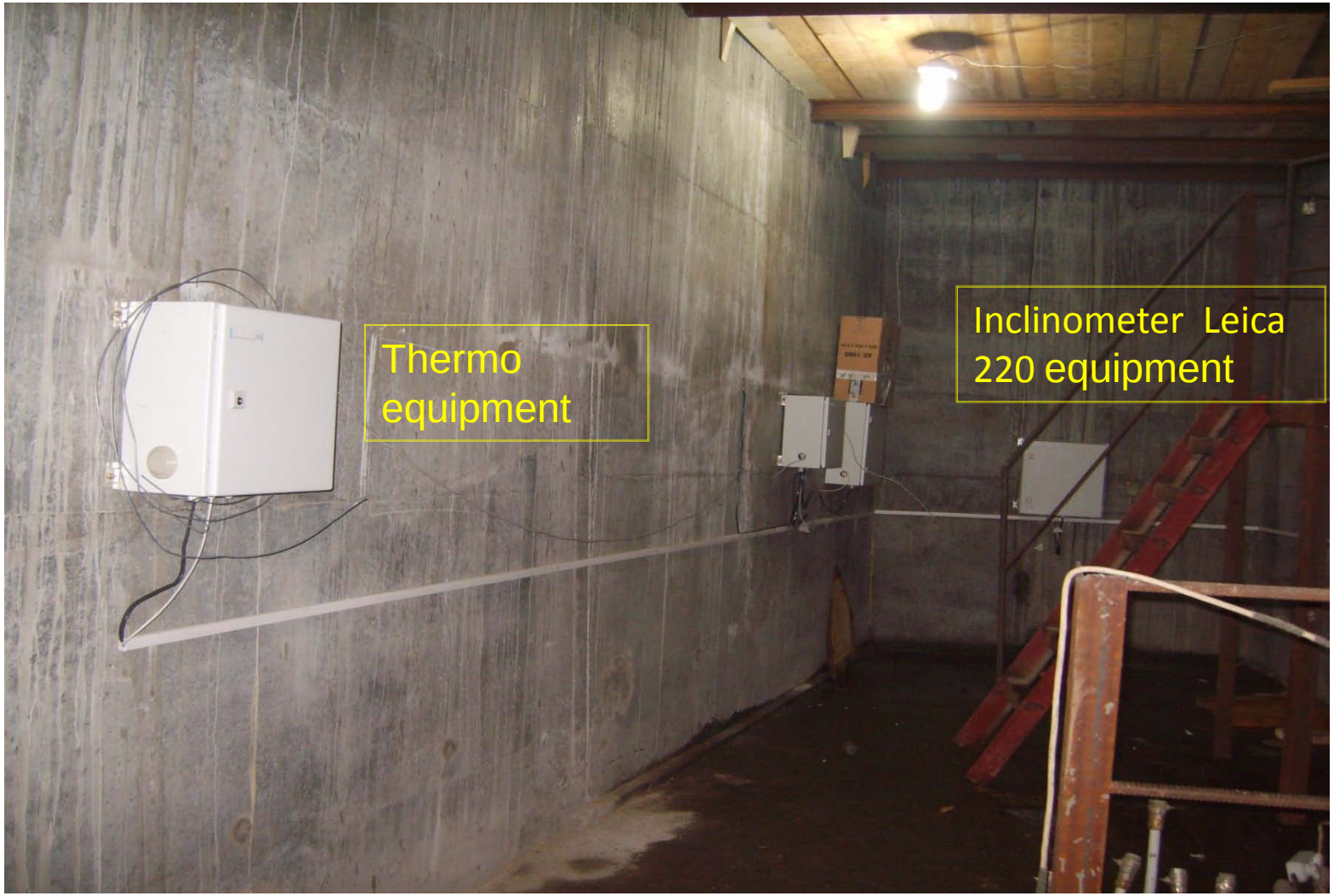
- GeoMoS Monitor
- GeoMoS Analyzer
- MeteoData- collection , processing , WEB imaging, integration to GeoMoS
- WEB GeoMoS - WEB imaging date at smartphone , IPad
- Frequency analyzer software

Monitoring site disposition

Waiting for the last (lock) section of span

Andrey Yashchenko, Engineering Centre GFK LTD, Russia, AIY@Icentre-gfk.ru

Equipment placement

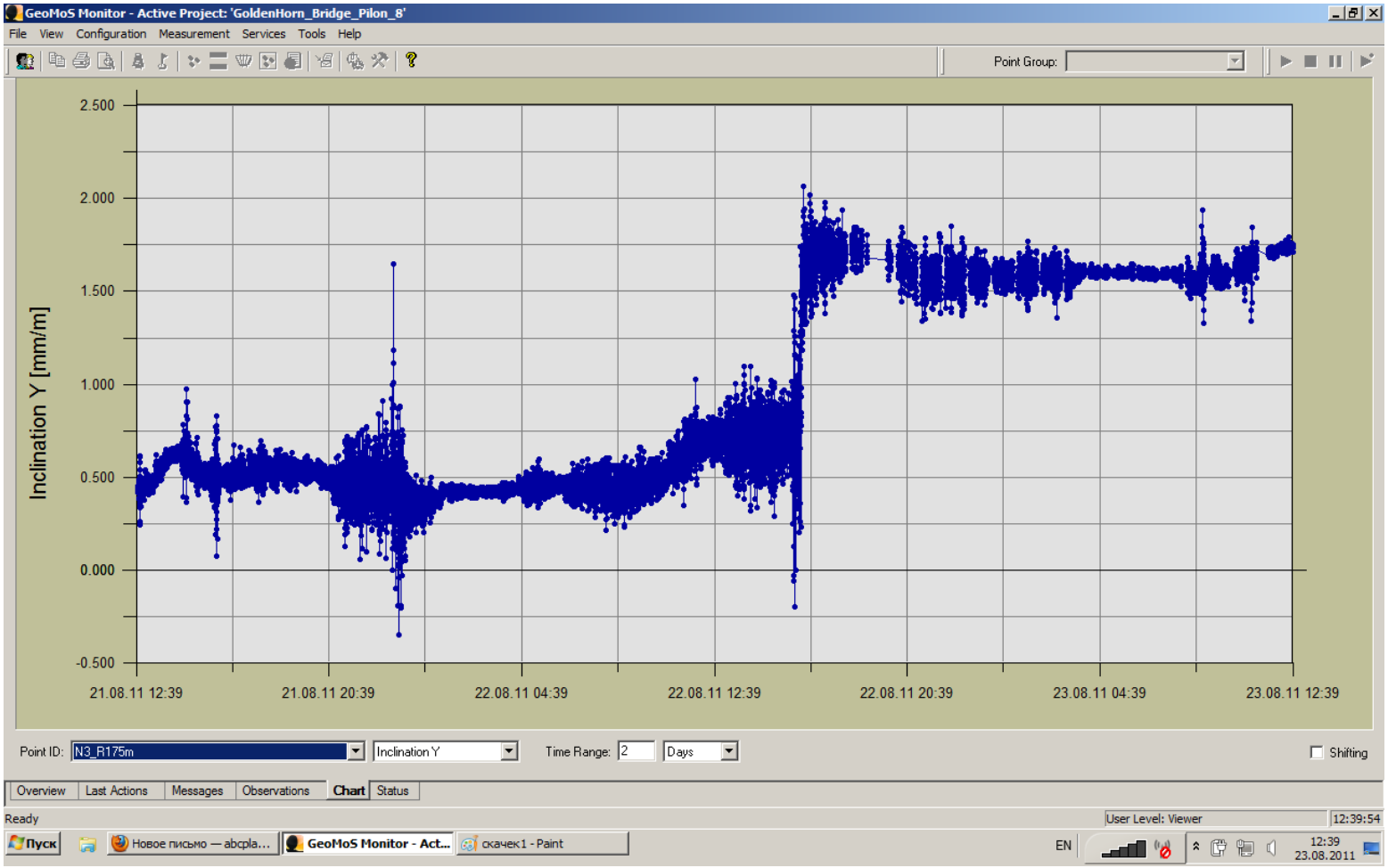


Equipment placement

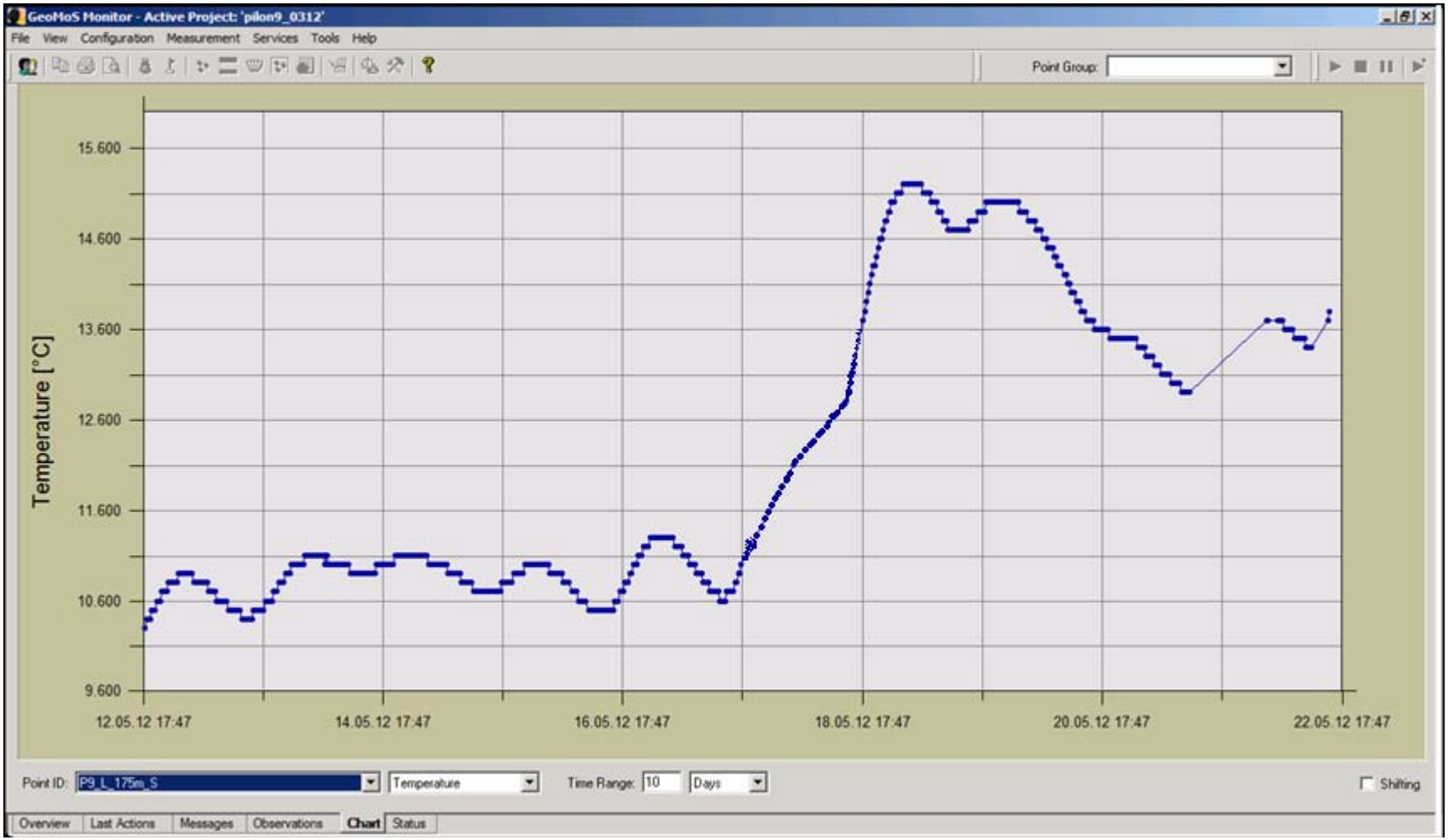
The following measuring devices were installed:

- **12 inclinometers Nivel Leica 220 - at Level 60 m, 130 m, and 175 m**
- **32 temperature sensors - at skin surface reinforced concrete pylon wall at Level 3 m, 60 m, 130 m, 175 m**
- **1 weather station - at block span crane Level 75 m**
- **Communication and uninterruptible power supply was made in anti-vandal version.**

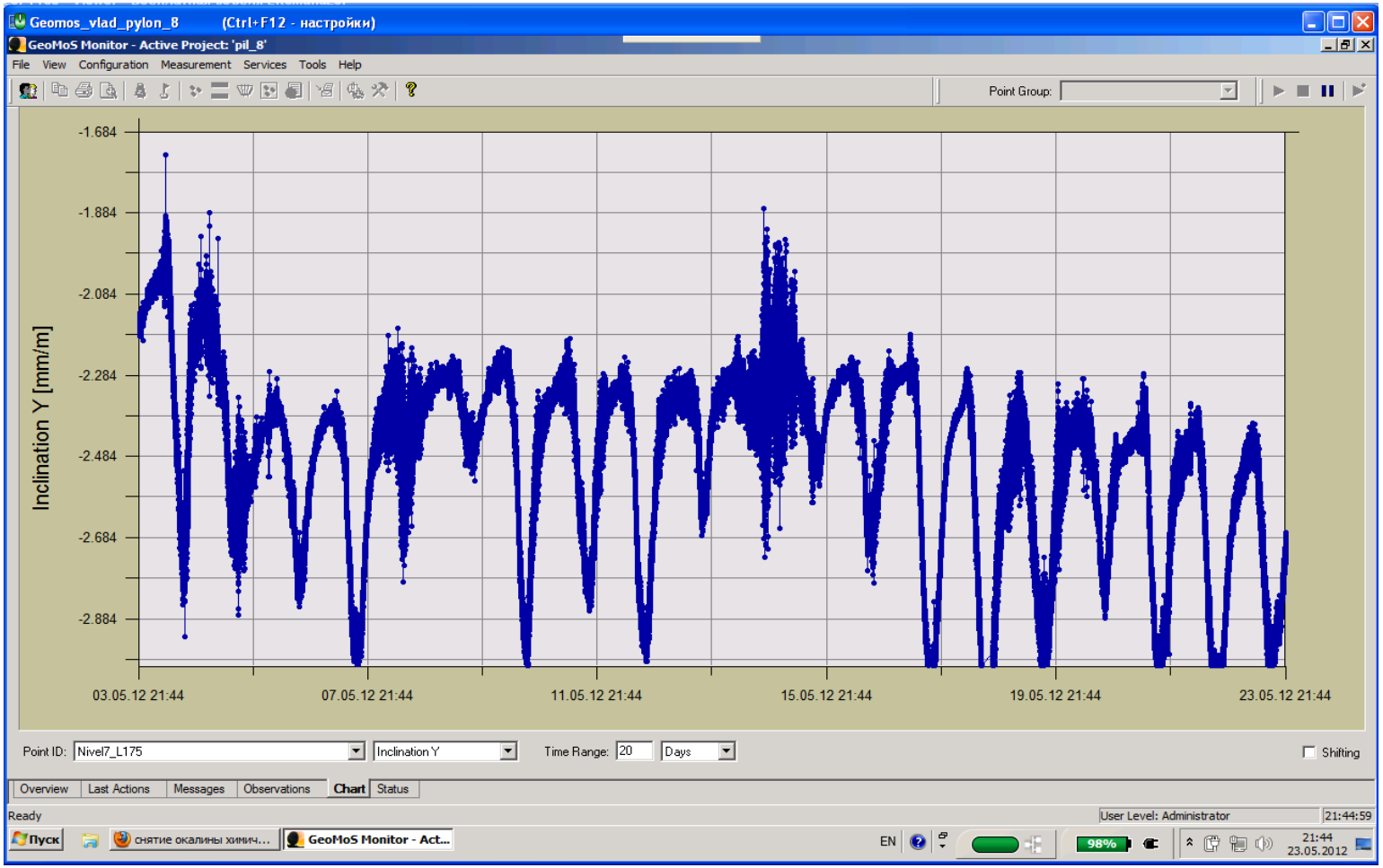
Output results Inclination



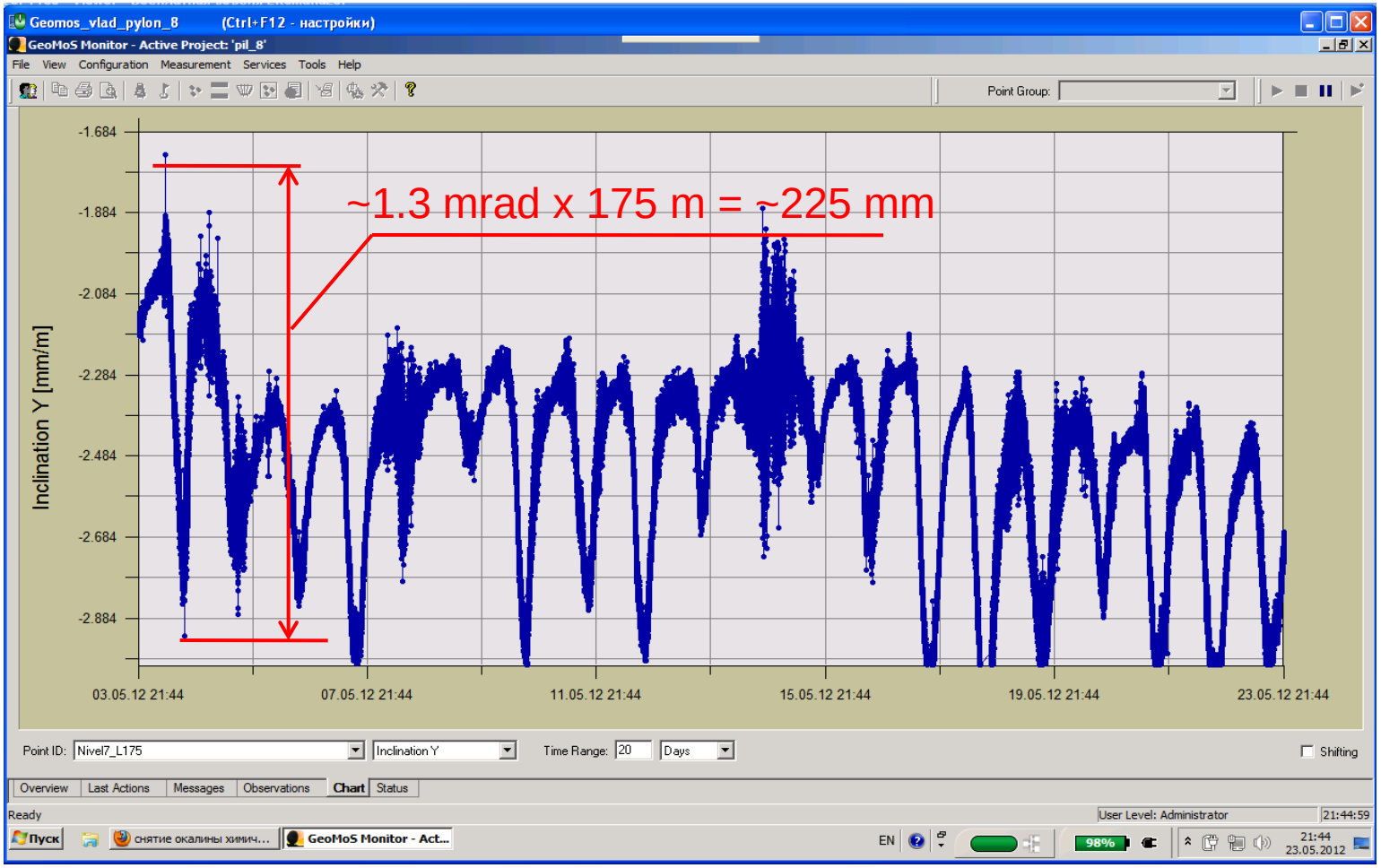
Output results temperature sensor



Output results
Inclination

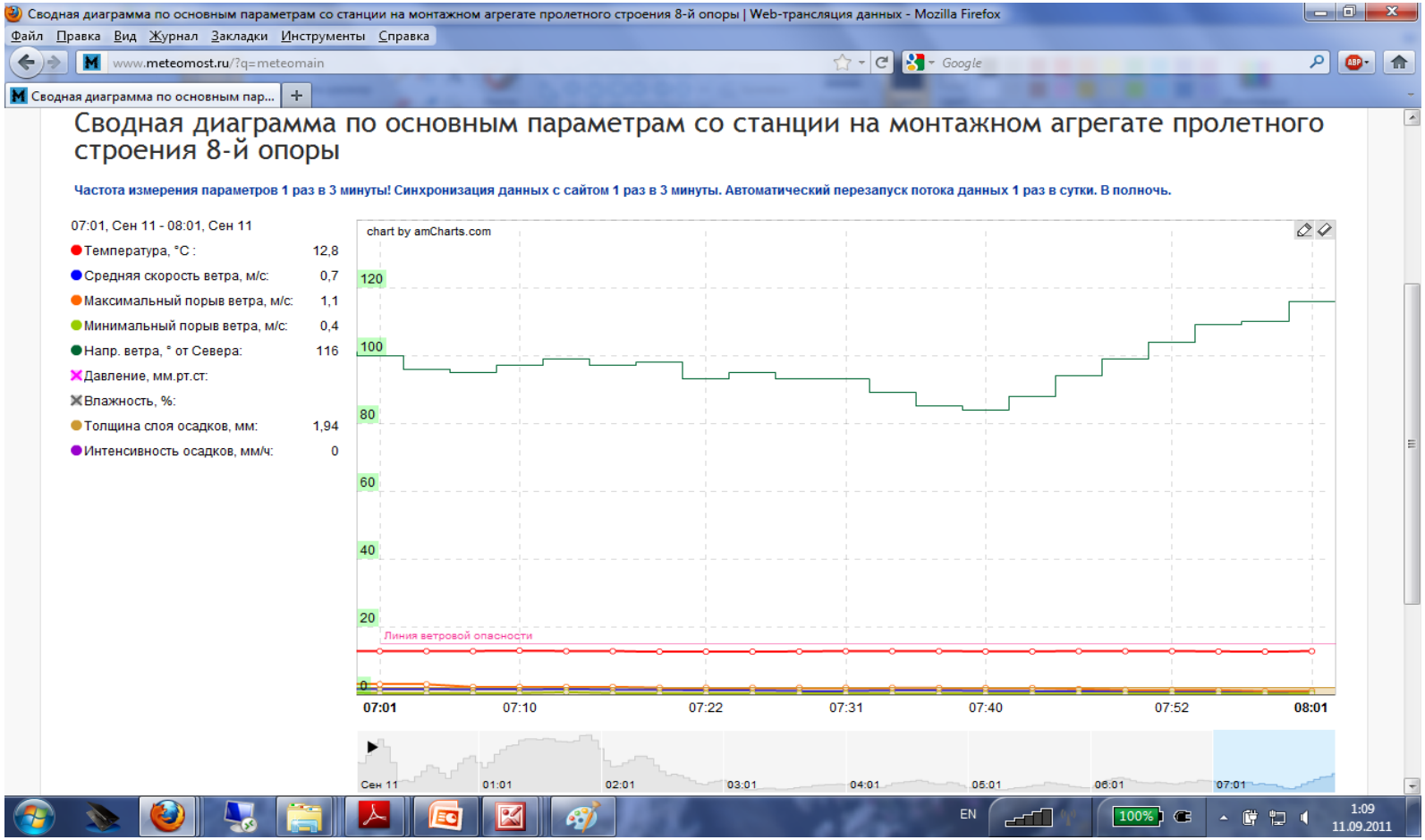


Output results
Inclination

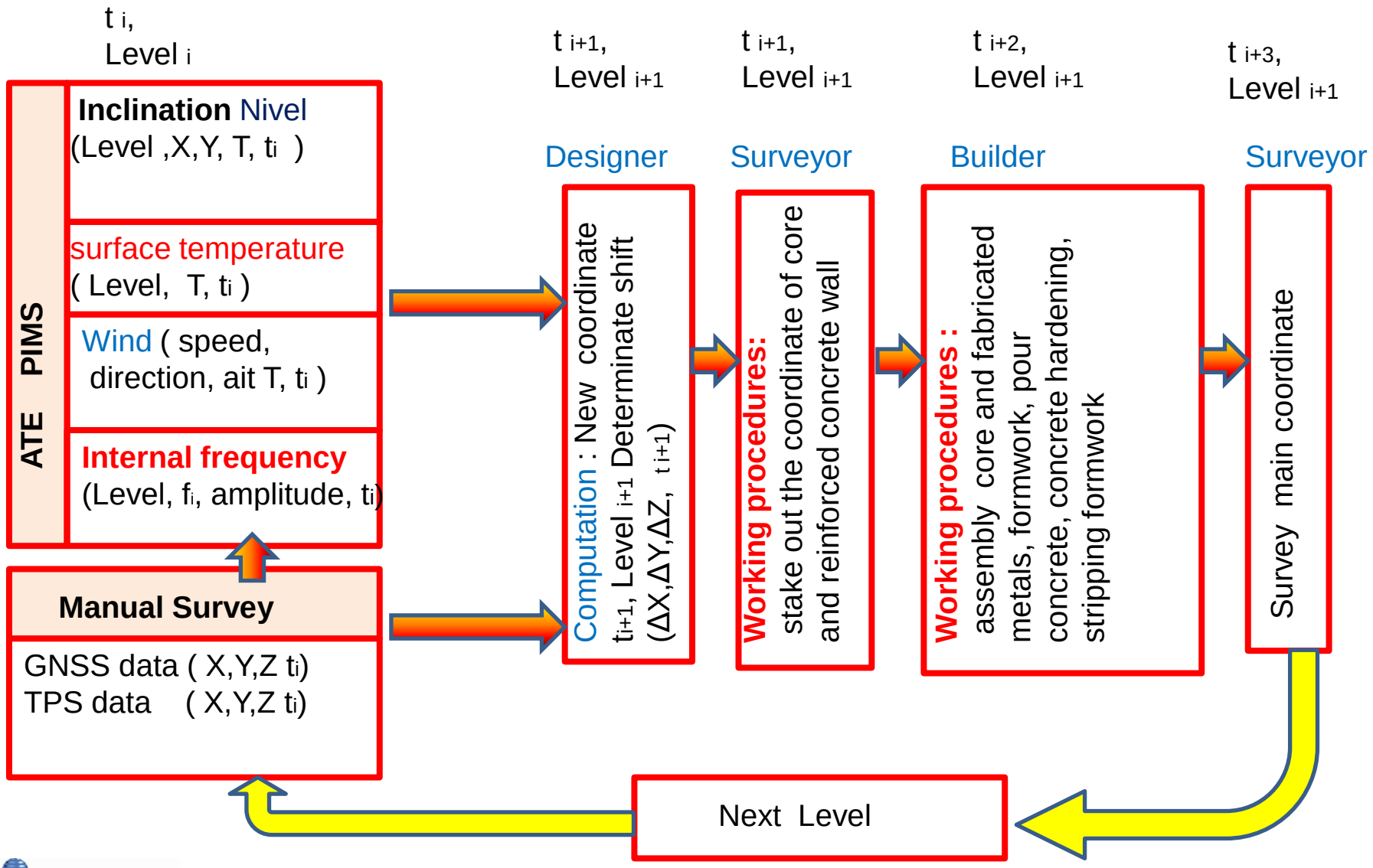


Output results
Meteodata

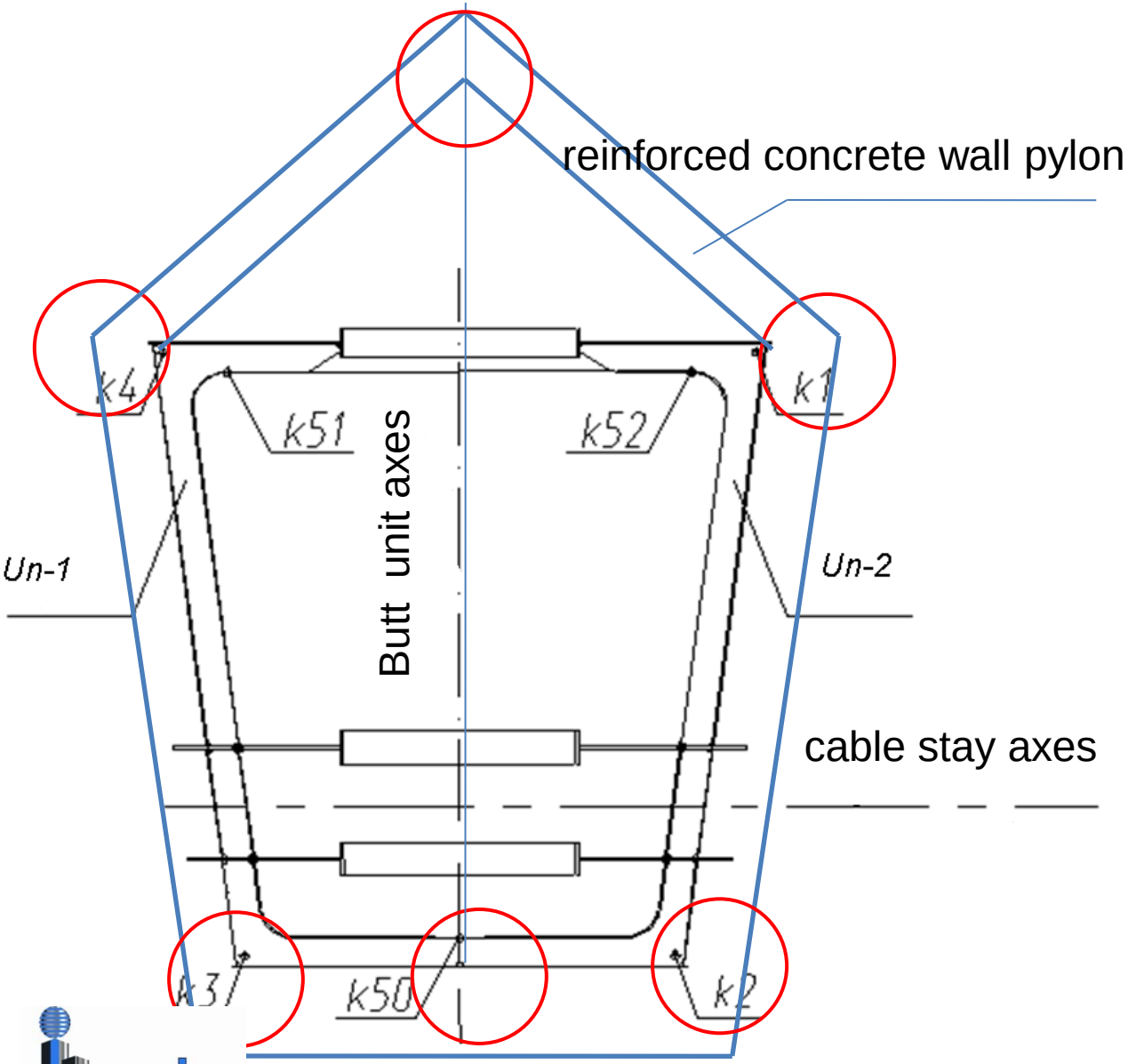
www.meteomost.ru



Output results: How do it works ?

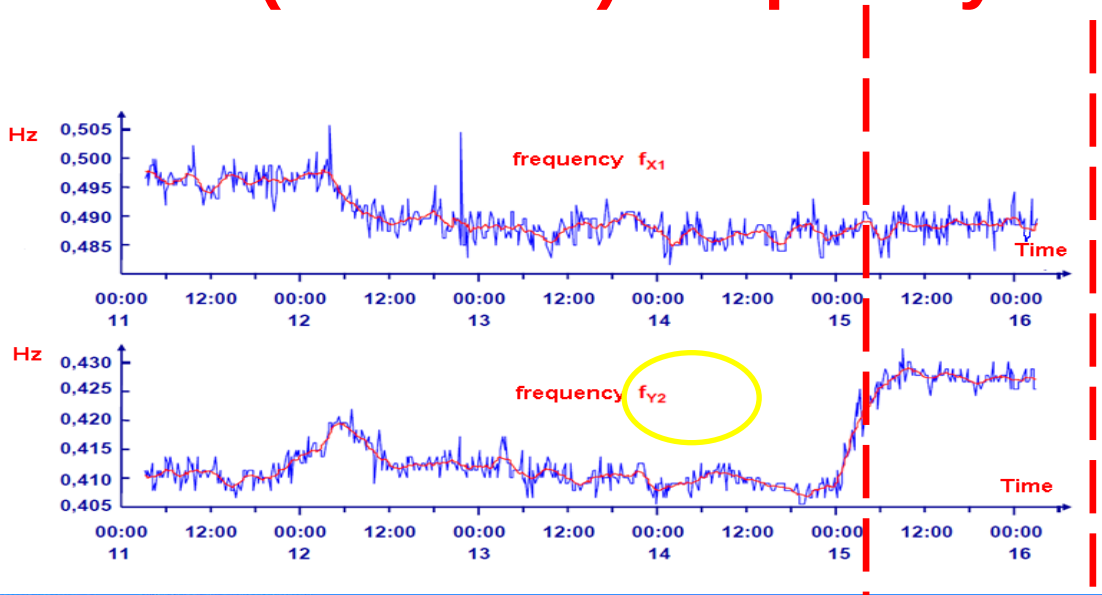


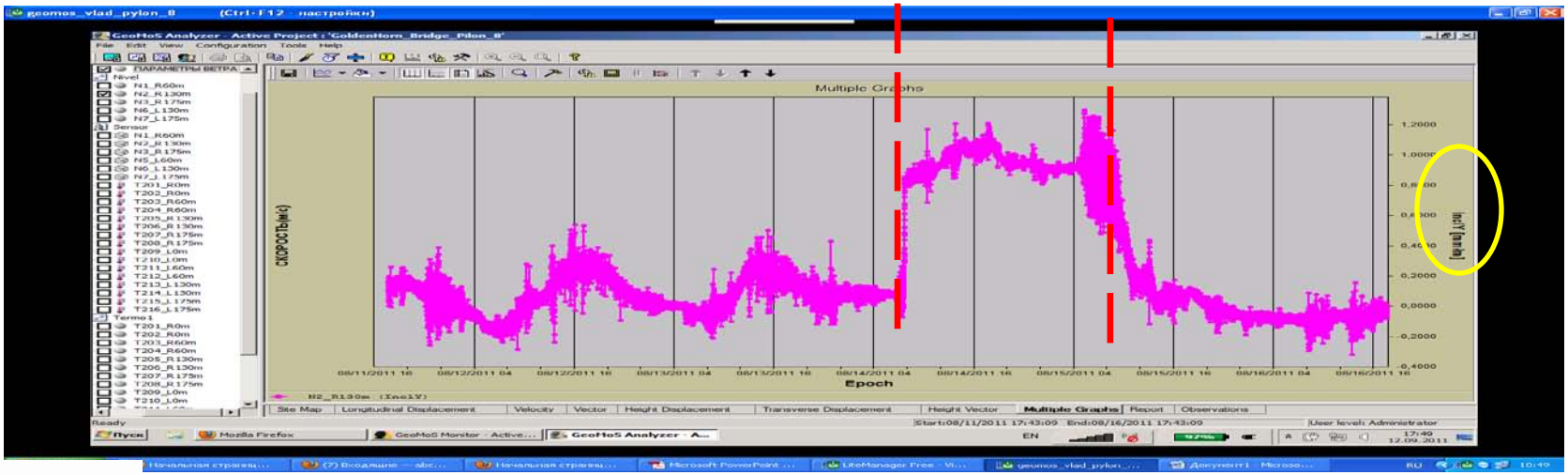
Cross-section of main pylons



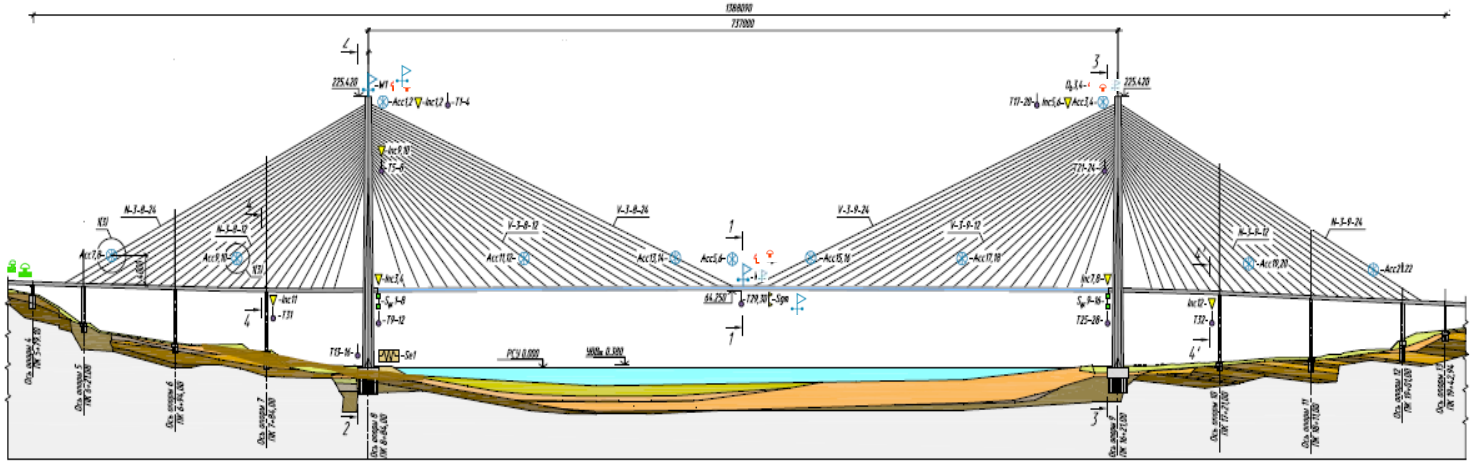
Andrey Yashchenko, Engineering Centre GFK LTD, Russia, AIY@Icentre-gfk.ru

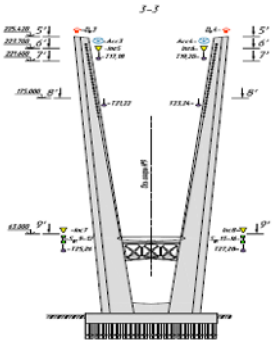
Output results
Internal (resonant) frequency displacement





Monitoring for regular maintenance second step of project





	totall	first step	second step
Reference station GNSS GR10	1 pcs.		1 pcs.
Monitoring receiver GMX902 GG	5 pcs.		5 pcs.
Weather station Vaisalla WTX 520	3 pcs.	**1 pcs.**	2 pcs.
Inclinometer Nivel 220	12 pcs.	**12 pcs.**	
Seismograph station	1 pcs.		1 pcs.
Thermo sensor STS DTM	32 pcs.	**32 pcs.**	
Concrete strain transducer	16 pcs.	**4 pcs.**	12 pcs.
Metallic strain transducer	8 pcs.	**4 pcs.**	8 pcs.
Accelerometer	22 pcs.	**4 pcs.**	18 pcs.

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Nice morning view at the bridge

Andrey Yashenko,
+7 916 961-49-59
AIY@Icentre-gfk.ru , www.icentre-gfk.ru
Manager, Engineering Centre GFK LTD, Russia

centre
Инжиниринговый центр ГФК