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**WARSAW UNIVERSITY OF TECHNOLOGY POLAND**

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# UTILISATION OF GEODETIC MONITORING FOR VERIFICATION OF THE NUMERICAL MODEL OF IMPACT OF A BUILDING UNDER CONSTRUCTION ON SURROUNDING STRUCTURES

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## Specificity of Warsaw's subsoil and object location


**„Wolf Marszałkowska Building"**

located in the dense centre of Warsaw,

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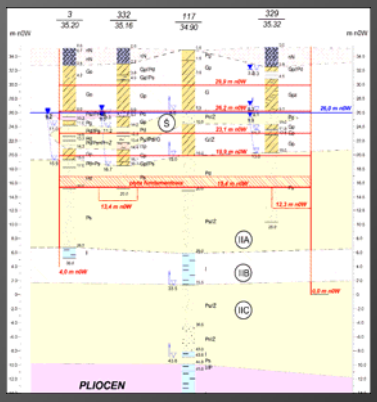


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- foundation in complex geotechnical conditions,
- not fully recognized the ground - the rubble of the destroyed post-second world war Polish capital,
- the excavation made for 5-storey underground part of the building, which implementation forced the lowering of buoyancy of the water bearing layer.

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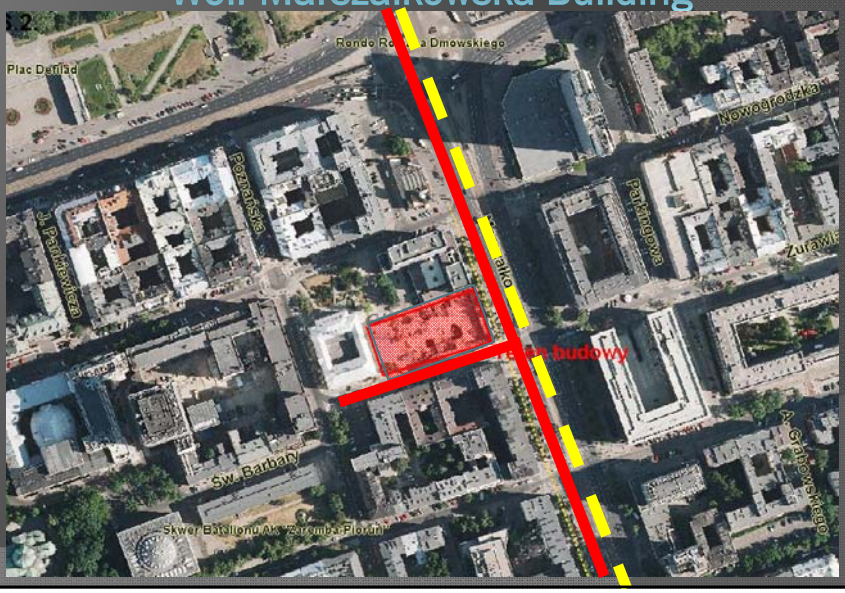


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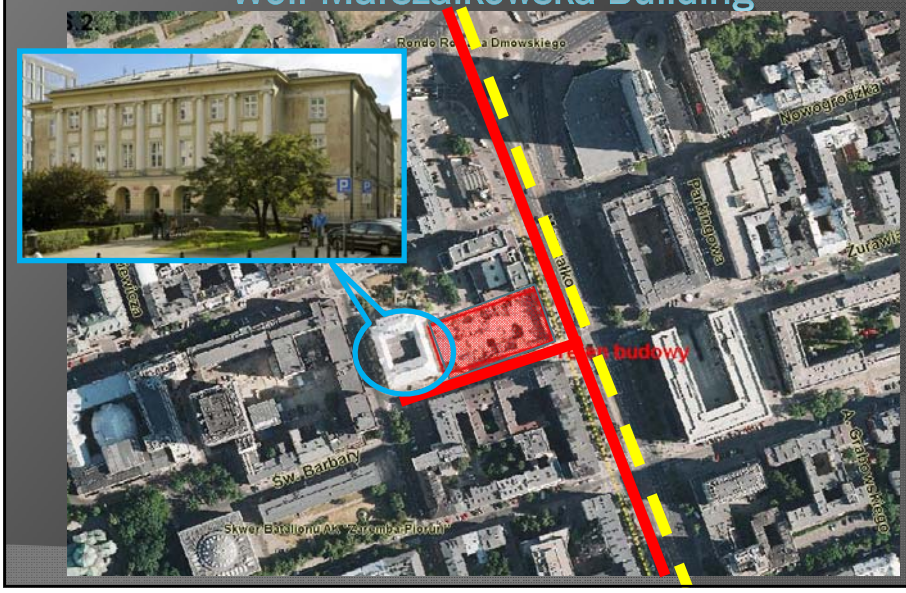

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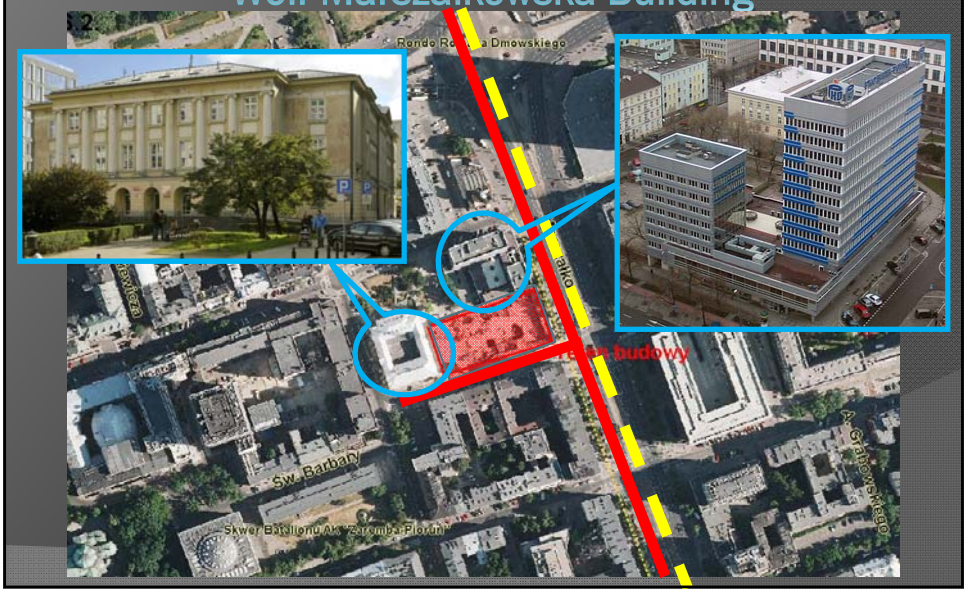


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# Characteristic stages of implementation of the Wolf Marszałkowska Building

| Stage of construction of the object | Dates | | Performed building works | Stages of dewatering works | Control measure-ments |
|---|---|---|---|---|---|
| | since | till | | | |
| 0 | | | Initial condition | | |
| 1 | 22.12.2007 | 21.03.2008 | Building diaphragm walls and barettes | | |
| 2 | 09.04.2008 | 08.05.2008 | Making the excavation, construction of the floor for the storey -1 | | |
| 3, 4, 5 | 20.05.2008 | 04.08.2008 | Making the excavation, construction of floors for storeys -2, -3, -4 | I | |
| 6, 7 | 10.08.2008 | 06.10.2008 | Making the excavation, building the foundation plate | II (phase I, II) | |
| 8, 9 | 21.11.2008 | 18.02.2009 | Building the floor of the storey 0, Transfer of loads on the foundation plate | II (phase II, III) | |
| 10 | 18.02.2009 | 10.03.2009 | Building the floor of the storey 1 | | |
| 11 | 04.03.2009 | 30.03.2009 | Building the floor of the storey 2 | | 20.03.2009 |
| 12 | 04.04.2009 | 21.04.2009 | Building the floor of the storey 3 | | 23.04.2009 |
| 13 | 23.04.2009 | 29.04.2009 | Building the floor of the storey 4 | | |
| 14 | 06.05.2009 | 22.05.2009 | Building the floor of the storey 5 | | 21.05.2009 |
| 15 | 15.05.2009 | 12.06.2009 | Building the floor of the storey 6 | | |
| 16 | | | Completion of building works | | 30.06.2009 |
| | | | Turn-key acceptance | | 02.10.2009 |
| | | | Exploitation | | 18.06.2010 |
| | | | Exploitation | | 09.10.2010 |

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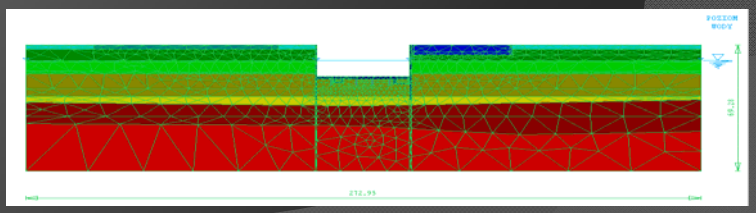
# Numerical model of deep foundation

**Designed and modified parameters of soils**

| Material no. | Symbol | Description of material | Parameters of layers assumed in accordance to geotechnical documentation (following the standard PN-81/B-03020) | | | | | Parameters considering the range of small deformations |
|---|---|---|---|---|---|---|---|---|
| | | | ν | γ | c | ϕ | $E_o$ | E |
| | | | [-] | [kN/m³] | [kPa] | [°] | [kPa] | [kPa] |
| 1 | I | Silt | 0.25 | 22 | 40 | 30 | 20 000 | 650 000 |
| 2 | Ps | Medium sand | 0.3 | 20 | 3 | 35 | 80 000 | 400 000 |
| 3 | Gπ/Π | Dusty clay close to dust | 0.25 | 20.7 | 35 | 25 | 20 000 | 450 000 |
| 4 | Ps+Pd | Medium sand with additives of fine sand | 0.3 | 18.5 | 0 | 36 | 80 000 | 300 000 |
| 5 | Gp_m | Sandy waterised clay | 0.25 | 22.5 | 35 | 23 | 47 000 | 68 000 |
| 6 | Gp_s | Dry sandy clay | 0.25 | 22.5 | 35 | 23 | 47 000 | 68 000 |
| 7 | nN | Non-building escarpment | 0.25 | 22 | 25 | 19 | 40 000 | 40 000 |



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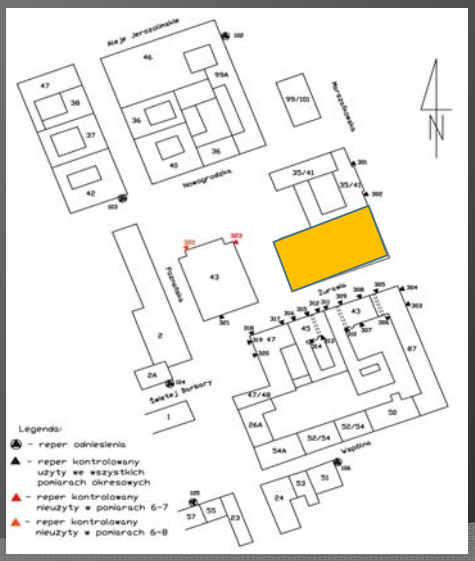
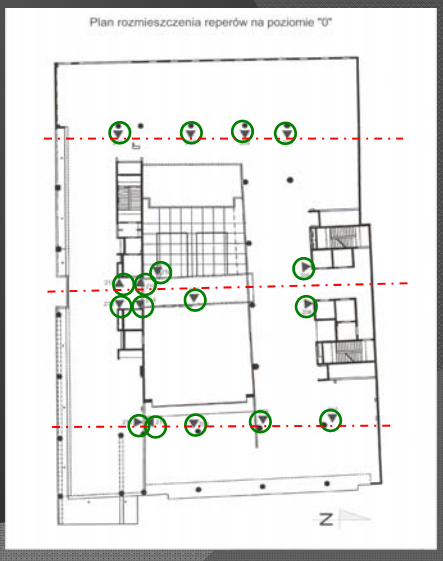
# Geodetic control network – benchmarks location



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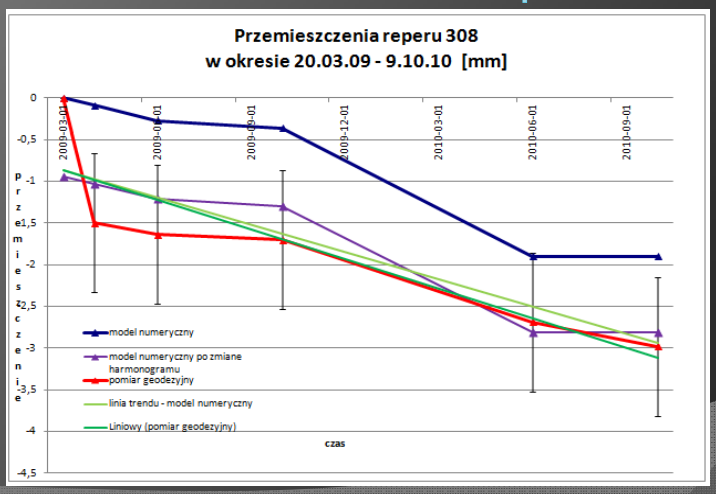
## Comparison of predicted and observed displacement

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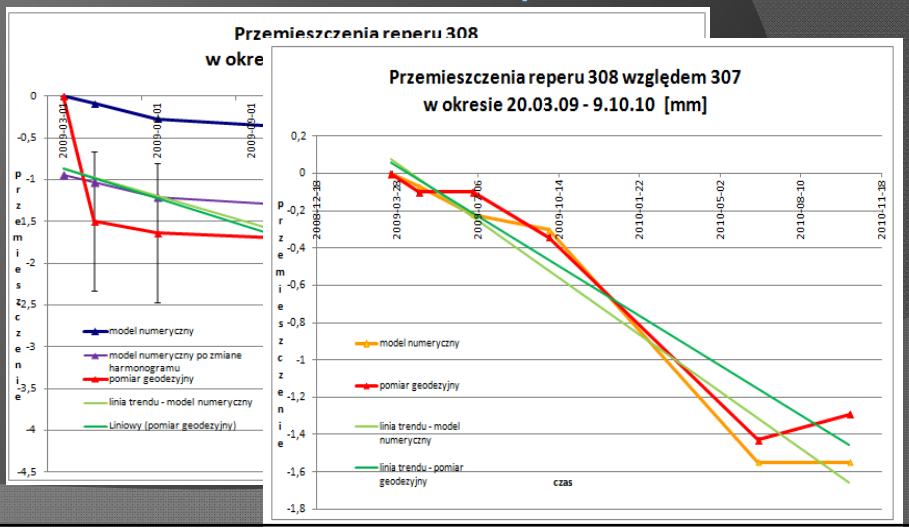

## CONCLUSIONS

- Reliability of results of numerical calculations depends of the accuracy of geological recognition and the correctness of determination of parameters of materials.
- Designing and implementation of building objects in difficult conditions (complicated composition of background, neighbourhood of existing buildings, deep excavations etc.) cannot be based on typical estimation of parameters and standard methods of static calculations.
- Performed surveying observations allow for verification of the correctness of the FEM model with respect to the reality.
- Application of relative analysis of displacements between chosen points of measurement network and similar nodes on the MES model allows for assessment of the correctness of the conducted numerical simulation, regardless of possible displacements of the reference benchmarks.

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