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to the challenges of modern world"

Application, specifics and technical implementation of the 3D terrestrial laser scanning for measurement and analysis of the spatial geometry of a steel construction

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FIG WORKING WEEK
17–21 MAY SOFIA BULGARIA 2015

Organised by: FIG, CHAMBER OF GRADUATED SURVEYORS

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1. INTRODUCTION

3D terrestrial laser scanning

- one contemporary way for fast and accurate gathering of spatial information

the usage of the technology depends on various factors like:

- size of the object
- quality requirements
- weather, etc.

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1. INTRODUCTION

some reasons, which may superimpose the application of **Terrestrial Laser Scanning** (TLS)

- in case there is **no documentation** available;

-existence of **dangerous** and practically **impossible to access** parts of the object;

- the classical surveying instruments – cannot deliver the required spatial data with the necessary ***amount and completeness***;

- it is required ***fast and accurate*** determination of the spatial geometry of the object.

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2. The tasks for this paper

the aims:

a) to study the technical requirements, which ***should be followed*** in the process of the scan of object with specific geometry - steel construction;

b) to use and analyse the **various sources of data**, derived from the point cloud;

c) to create the **appropriate deliverables** – as final product for usage by other professionals.

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3. Technology requirements. Advantages of the usage of terrestrial laser scanning for this project

known requirements of the TLS

- of ***significant importance*** for this project

c) measurements should not be conducted in *dust, snow or rain.*

Remark: *accuracy*, *quality* and *reliability* were **essential** in our case

b) it should be chosen an appropriate time period for conducting the measurements

- in order to be produced ***reliable and quality results;***

a) scanning *against direct sunlight* should be avoided;

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3. Technology requirements. Advantages of the usage of terrestrial laser scanning for this project

major advantages

of the application of the TLS for this project:

a) the technology ***facilitated*** the analysis of the geometry of the steel construction

There was a possibility to obtain ***thorough spatial*** data for the object ***in a short time period*** at the field;

b) the object was "*sealed*" at the moment of the measurements

The need for additional survey – ***eliminated*** if more information was required;

c) contactless technology was applied –

significant part of the steel construction, was at a ***high, dangerous and very difficult for human access*** place.

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4. Performed geodetic activities before conducting the scan

Preparation for the scan of the steel construction

Note - the steel construction consisted of total 20 columns

a) the ***necessary (short) distances*** between the various parts of the object and the scanner were controlled;

b) the required ***visibility between the scanner and the artificial*** targets was assured;

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4. Performed geodetic activities before conducting the scan

Preparation for the scan of the steel construction

It was checked and assured:

c) ***the visibility*** of the spheres between each two stations;

d) the ***max distance*** between the scanner and the spheres (in this case were used both two types of spheres);

e) the ***spatial geometry*** between the spheres.

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4. Performed geodetic activities before conducting the scan

The chosen positions of the scanner ensured

the direct visibility to:

- the ***bottom*** and ***upper*** parts of each column;
- the ***under-crane beams.***

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5. Technical particularities of the 3D terrestrial laser scanning of the steel construction

Particularities of 3D TLS of the steel construction in our **specific case**

a) the balance between the **accuracy and quality** of the scanning, also in the **productivity** of the field work was assured;

b) the raw data was input in Trimble Realworks and the necessary processing was done, applying "**spatial sampling**";

c) the used method produced one **homogeneous point cloud.**

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6. Application and usage of the point cloud for virtual interpretation and spatial study of the steel construction

some of the possible **applications** and **advantages** of the point cloud **especially** for this study

a) excellent **3D visualization** was provided;

b) simplified creation of **dimension lines** for the respective objects;

c) easy extraction and export of the necessary **3D coordinates**;

d) 3D data – available for **other software** products.

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6. Application and usage of the point cloud for virtual interpretation and spatial study of the steel construction

data, required for ***the specific analysis of the spatial geometry*** of the steel construction:

a) **the deviation** between the lower and upper part of each column;

b) **the coordinates** of certain points from the point cloud of the steel construction;

c) **the distances** between the columns;

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6. Application and usage of the point cloud for virtual interpretation and spatial study of the steel construction

data, required for ***the specific analysis of the spatial geometry*** of the steel construction:

d) **the deviations** from the *theoretical axis* of the under-crane beams;

e) **the distance** between each *north and south column;*

f) **the deviation** from the *theoretical axes* of the columns;

g) determination of **the heights** of the inner edges of the under-crane beams.

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7. Graphical representation of the data, required for the spatial study of the columns

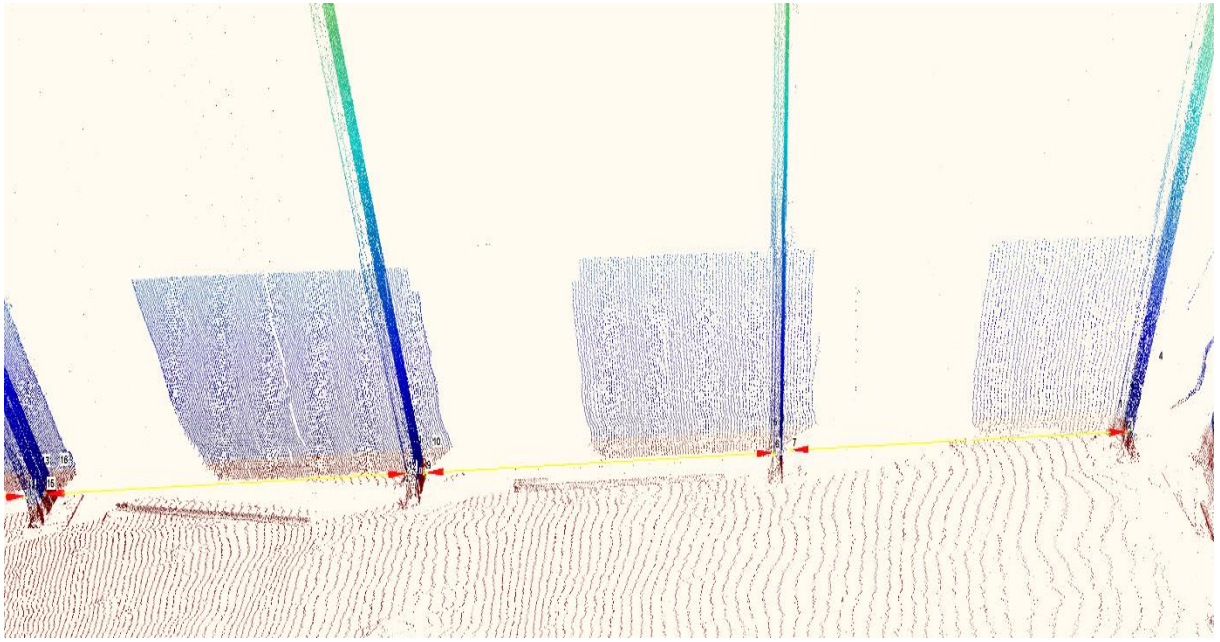

Fig. 1 Created dimension lines in the 3D space between each one of the columns

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7. Graphical representation of the data, required for the spatial study of the columns

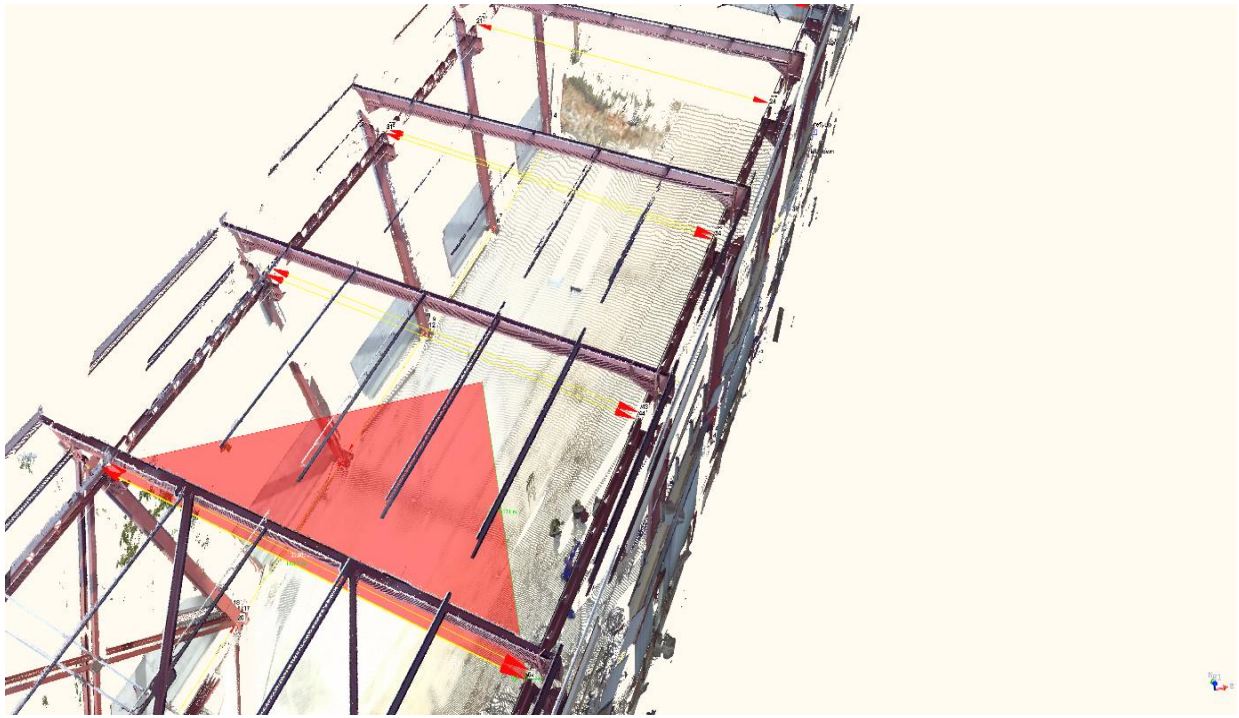

Fig. 2 Created dimension lines at the *upper part* of the construction, between the beams

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7. Graphical representation of the data – advantages of TLS

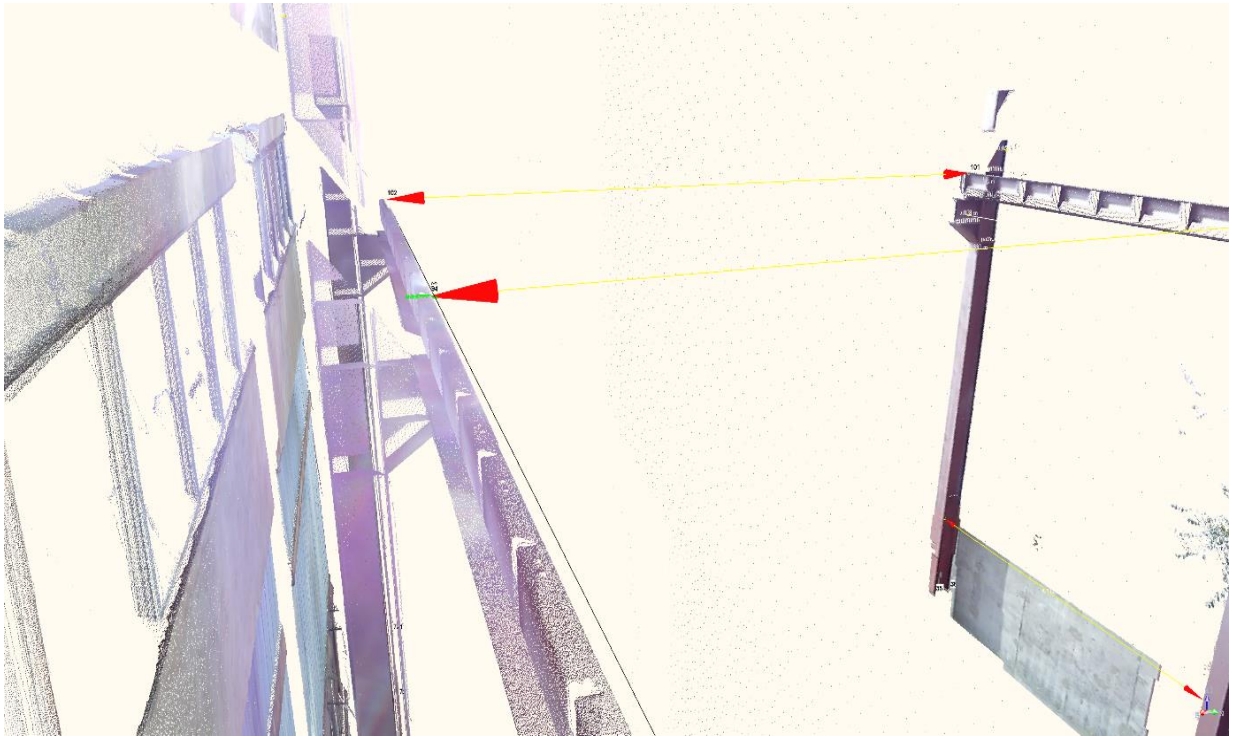

Fig. 3 One of the ***advantages*** of the point cloud – its ability to show from various points of view the *difficult or impossible for human access* parts of the object.

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8. Results and analysis from the performed 3D terrestrial laser scanning

example for the application of *"distance measurement"*
- used for **thorough spatial analysis of the condition** of the steel construction.

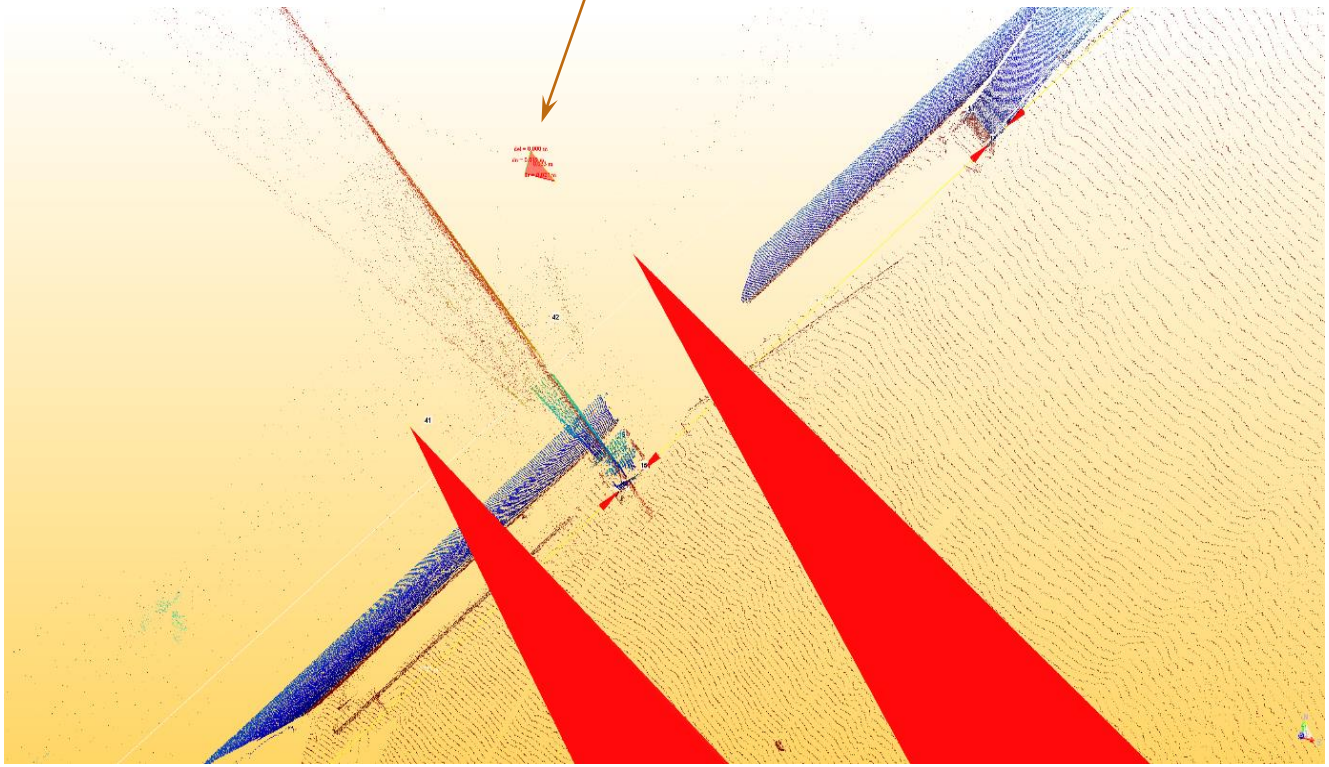

Fig. 4 The **deviation in the position** of the beam's axis, highlighted as triangle

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8. Results and analysis from the performed 3D terrestrial laser scanning

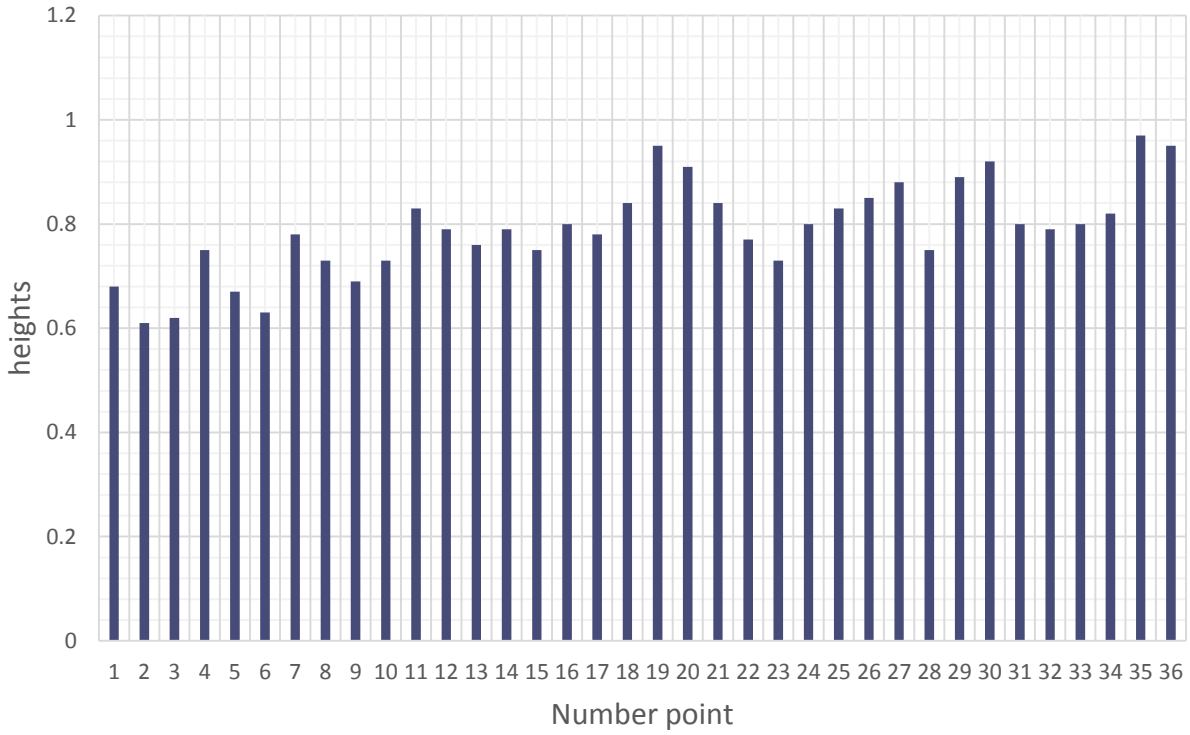

Fig.5 The **variations of the heights** of the inner edges of the under-crane beams

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8. Results and analysis from the performed 3D terrestrial laser scanning

- **distances** between the various parts of the steel construction

- **the deviations** from the relevant axes

- **the directions** of the deviations

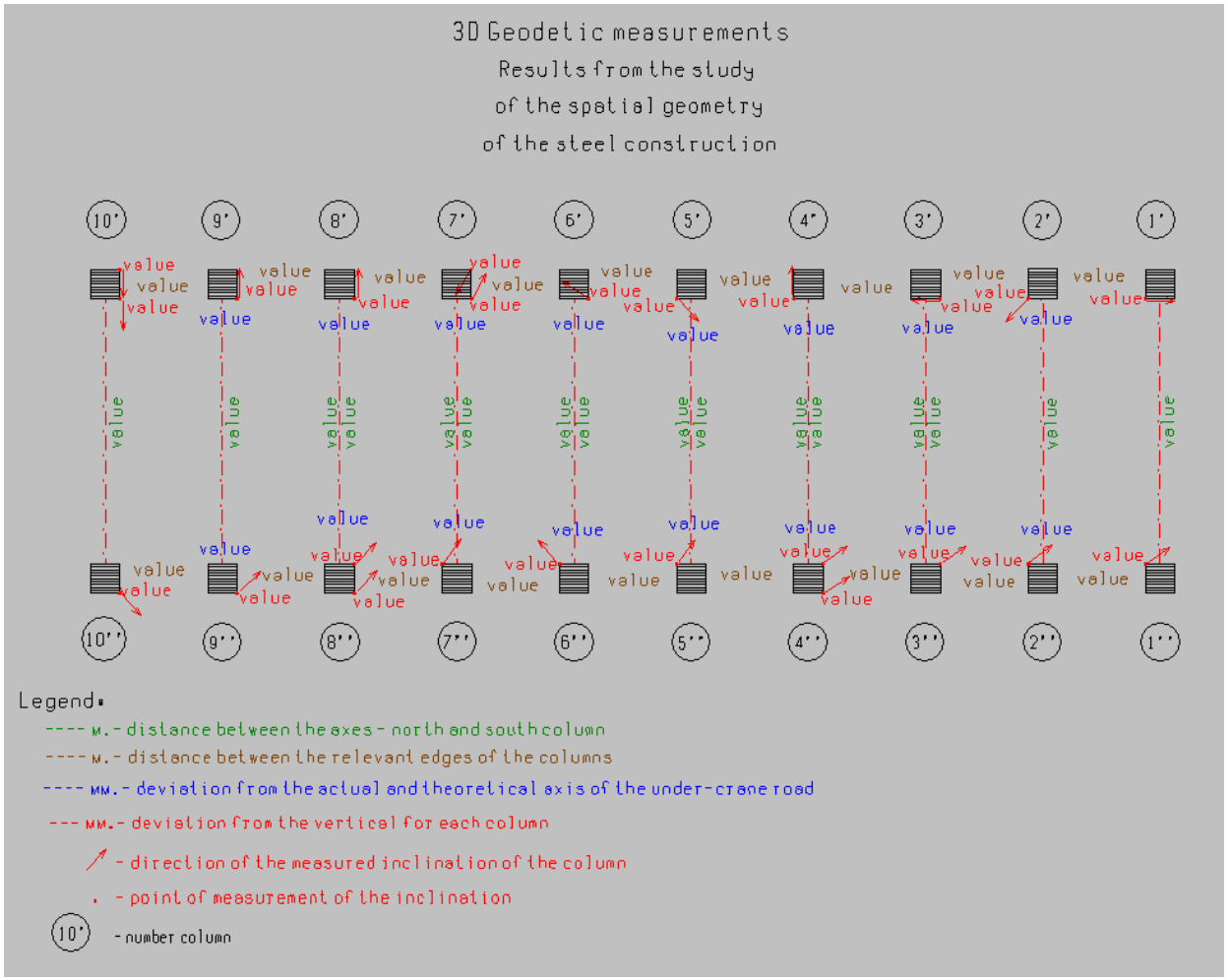

Fig.6 2D graphic with **combined information** for the current condition of the steel construction

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9. CONCLUSION. RECOMMENDATIONS. FUTURE WORK

the results, given in fig 6
- used in the **decision making;**

the values indicate:

where exactly?

how much?

in which **direction?**

to **alter the geometry** of the steel construction

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these linguistic terms,
combined with the calculated values of the variables

were essential for the required maintenance of the steel construction.

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9. CONCLUSION. RECOMMENDATIONS. FUTURE WORK

One ***contemporary, precise and productive*** way for gathering of spatial information was used for geodetic measurements and analysis.

The usage of *other* survey method was ***practically not applicable*** in our case, due to: time limitations, requirements for accuracy and productivity, also the necessity for delivery of large amount of spatial information.

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The data in this project consisted of various sources of deliverables, **including and not limited to**:
-**3D coordinates**;
-**various dimension lines**;
-**drawings (in *.dwg, *.pdf, etc.)**;
-**tables**;
-**screenshots,** etc.

The created data *was successfully* implemented in the **urgent** decision-making for the maintenance of the steel construction.

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9. CONCLUSION. RECOMMENDATIONS. FUTURE WORK

Despite all the mentioned technological requirements and limitations of the terrestrial laser scanning, its usage could be **strongly recommended**, for study and analysis of objects with complexity like steel constructions.

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Future work

this study raises the following questions:

1. Improvement of the possibilities for combined usage of Trimble RealWorks with the external software;

2. The necessity for maintenance of Trimble Realworks in order to be fully compatible with the third party software (i.e. IE);

3. Implementation of the possibility for usage of other browsers (e.g. Mozilla Firefox, Opera, etc.) for visualisation and management of the measured 3D data.

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http://www.trimble.com/globalTRLTAB.asp?nav=Collection-31049

Used Software:

1. Trimble Realworks;
2. Mkad.

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Thank you for your attention!

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