PRECISE GEODETIC MEASUREMENTS ON STRUCTURS OF BLACK METALLURGY

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SUMMARY

The need for precise geodetic measurements for the determination of deformations of structures placed in facilities of black metallurgy is a great challenge for every geodetic expert. The very specific way of carrying out this type of measurements is related to the special conditions for their performance, as well as the need to ensure high accuracy in the determination of deformations on the structures.
In the concrete case, deformations are obtained by processing highly precise optical measurements on the basis of which all further alignment and on-site machining activities were planned for supporting the process of hot rolling mill stand housing windows refurbishing and its evaluation for misalignment improvements.
With this paper, the members of the Chair of Advanced Geodesy at the Faculty of Civil Engineering in Skopje want to demonstrate the universality of the geodetic deformation measurements and the concrete application in determining deformations of the mill stand which is an industrial plant with special significance for the production capacities of „Makstil" SC – Skopje.

Key words: Mill stand, precise geodetic measurements, deformations.

PRECISE GEODETIC MEASURMENTS ON MILL STAND IN SC "MAKSTIL" - SKOPJE

The mill stand is the most important plant in the industrial complex - the hot rolling mill of „Makstil" SC - Skopje, which is used for making thick tin sheets. The dimensions of the building are 10 x 5 x 6 meters.

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Due to lack of position tolerance of housing windows many product quality and equipment damage problems are possible. The mill survey summarized results and recommendations are considered in three distinct areas as follows (Jankuloski, B. et al., 2011):

1) Housing windows
2) Bottom plate
3) Top separator

Of particular importance for the production process is the bringing of the industrial construction into a position of its projected position, which implies the verticality of the carriers of the mill stand and the horizontality of the bedplates that are located on its bottom.

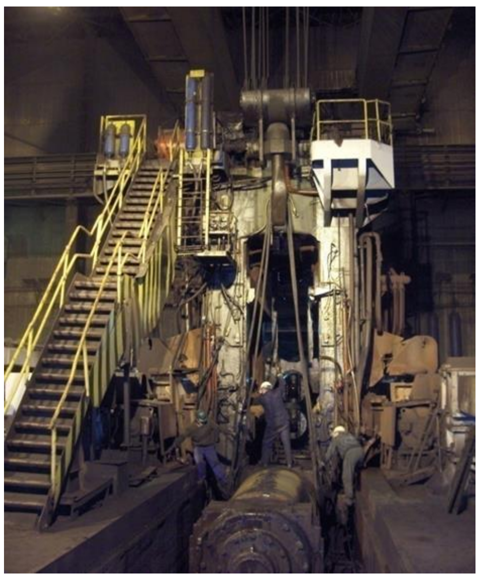

Figure 1: Mill stand construction in hot rolling mill - "Makstil" SC - Skopje

The conducted geodetic measurements in the period 4 - 8 January 2010 at an average temperature of 1˚C, covered the following activities:

- Defining the verticality of the structure through the verticality of carriers and worktops of mill stand in the direction of transport of the material;
- Defining the verticality of the construction in the direction of Roll Change Side - Drive Side;
- Defining the parallelness of the carriers of the mill stand;
- Defining the horizontality of the bedplates and rails in the mill stand;

- Defining the horizontality of the reducer located at the top of the mill stand. (Srbinoski Z., Bogdanovski Z., 2010).

Before the start of the measurements for each previously mentioned position, appropriate sampling of the construction with a certain number and layout of measuring points was carried out.
In addition is shown the layout from part of the points used for checking the verticality of the construction from the front side of the mill stand.

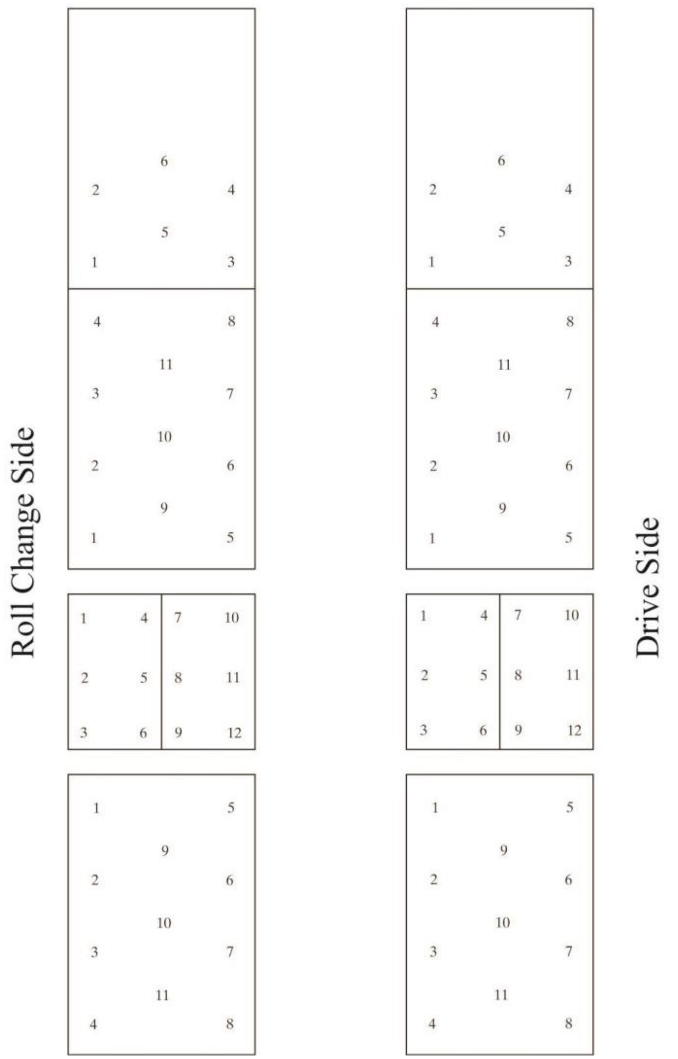

Figure 2: Location of measuring points on the entrance part from the mill stand

GEODETIC MICRONETWORK AND INSTRUMENTS FOR PERFORMING OF THE PRECISE GEODETIC MEASUREMENTS

For quality and precise determination of the deformation sizes when using the geodetic deformation measurements, the quality and accuracy of the geodetic basis, which determines these sizes, is of great importance.
Considering the specificity for carrying out geodetic measurements in industrial plants, when designing the geodetic network there are additional conditions that need to be met with regard to the design of such type of networks that serve for deformation measurements of objects and constructions in normal external conditions. First of all, this refers to the illumination of the construction and the space which contains a number of physical obstacles that disable the optical visibility within a network that is actually more than necessary (Figure 3).

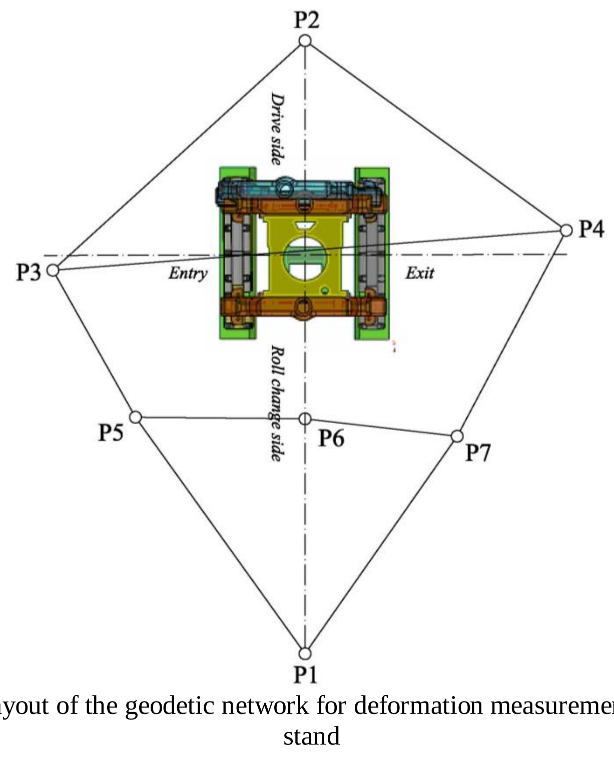

Figure 3: Layout of the geodetic network for deformation measurements in the mill stand

Based on the previously stated characteristics and possibilities that are present in closed industrial facilities, as is the case with the mill stand, the design of the network was correlated with the set tasks for examining the verticality of the construction. In the part for determining the horizontality of certain surfaces of the construction, the benchmark was used in the immediate vicinity of the mill stand which is part of the leveling network in the plant.

When it comes to precise measurements such as geodetic deformation measurements, it is more than important to use the appropriate measurement technology to carry out the measurements. The term proper refers to the relationship between the declared accuracy of the instruments and their ability to be used in the special conditions present in the industrial capacities. The accuracy of the used geodetic measurement technology in determining the deformations of the mill stand corresponds with the aforementioned characteristics. A high precision total station Trimble S6 - 1” with declared angular accuracy of ± 1” was used to determine the verticality of the carriers and a measurement accuracy of ± 1mm + 1PPM. In order to determine the horizontality of certain surfaces of the construction, the Trimble DiNi digital precise leveling instrument with a precision of ± 0.1mm was used. (Srbinoski Z., Bogdanovski Z., 2010).

Figure 4: Total station - Trimble S6

Figure 5: Leveling instrument - Trimble DiNi

RESULTS OF THE PRECISE GEODETIC DEFORMATION MEASURMENTS ON MILL STAND

In the direction of the previously set goals, the performed activities, as well as the conducted calculations and analyzes, the results of the geodetic deformation measurements of the mill stand were in accordance with the expectations for the deformation of the construction relative to the projected state.

The results of the conducted geodetic deformation measurements indicated to a more comprehensive analysis due to the nature of the construction and determination of sizes that need to correct the deformed to theoretical projected state. Exactly from this point of view for this type of measurement requires control and verification of the results by independent type measurements. An example of this is the mutual confirmation of the results of the non-verticality of the carriers and the non-horizontality of the reducer at the top of the construction.

When it comes to the specific results of the frontal verticality (Roll Change Side - Drive Side), it should be emphasized that this condition is determined based on measurements of 40 measuring points placed on the worktops on the entrance (Ingoing) and exit (Outgoing) side of the mill stand. From the measurements of these points, the mean vertical planes were determined for each of the plates, and then the deviations of those planes from the axis of the construction were analyzed. With positive sign are the deformations of the points on the outer sides of the vertical plains, and with negative sign are the deformations of the points that lie between the vertical planes and the axis of the construction.

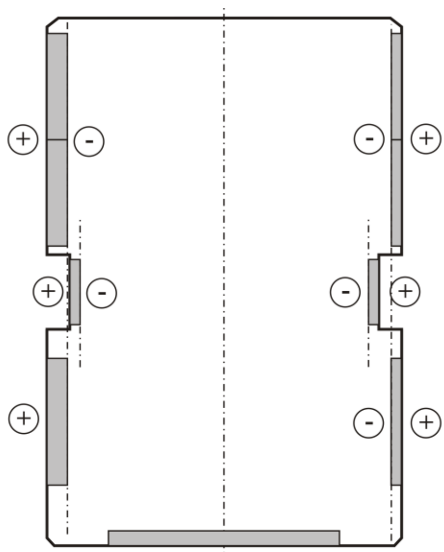

Figure 6: Sign of the deformations on the frontal verticality

The results showed that deviations from the vertical at the points located on the front (Ingoing) side of the construction moved in the range from **-1.1 mm** to **+1.0 mm**, while deviations from the vertical in items that are on the output (Outgoing) side are moving in the range of **-1.9 mm** to **+2.6 mm**.
Interesting are the results obtained from the examination of the mutual lateral side parallelness of the carriers on the construction that indicated a relatively good parallelness with a maximum deviation defined on the basis of the mean verticals of 0.5 mm.

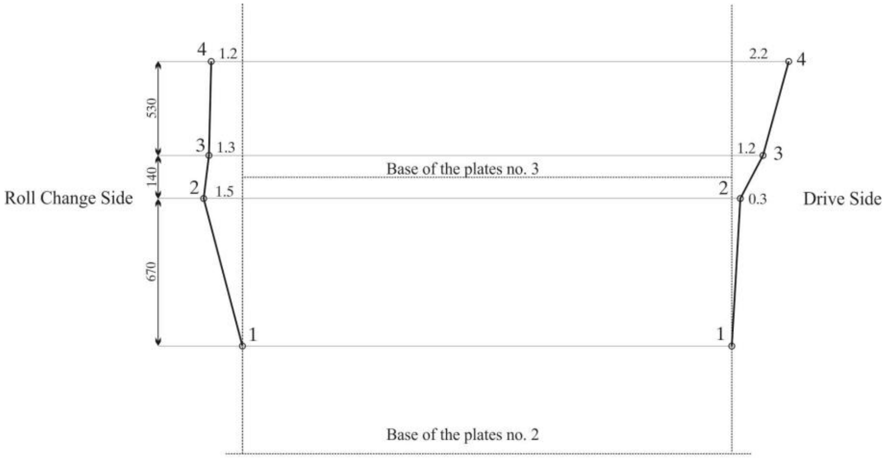

Figure 7: Lateral verticality of carriers measuring points – position Entry

The concrete results of the geodetic deformation measurements for determining the lateral verticality of the construction (Input - Output of the material) was determined on the basis of measurements at 8 points placed on the sides of the worktops Roll Change Side and Drive Side.

Figure 8: Local unevenness on the worktops

It should be emphasized that the selection of the points was based on the suggestion of the experts from Makstil, and the possible irregularities in the production of the plates (different widths and local unevenness - Fig.8), as well as the possible non-parallelism of the worktops with the construction carriers - directly influence the determination of the deviation from the vertical.

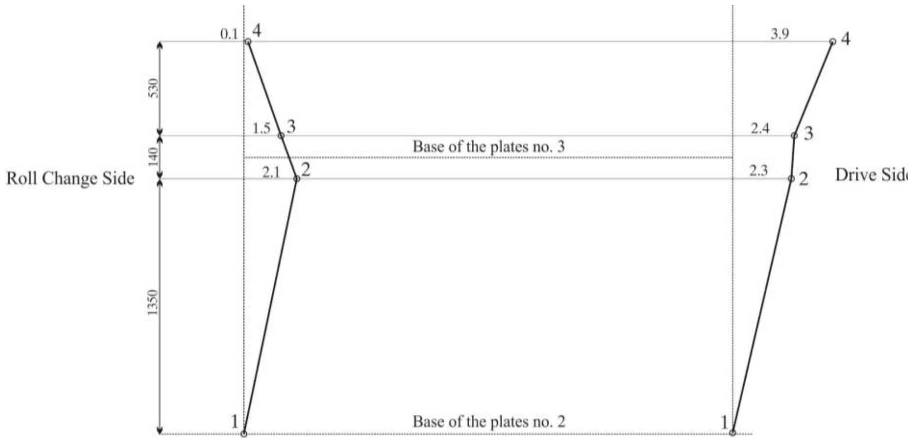

Figure 9: Lateral verticality of carriers measuring points – position Output

It is interesting to point out that the deviations from the vertical of the Drive Side points were tended towards the engine, with the mean angular deviation from the vertical of the entry and output carrier at 0º 06 '01 "corresponding to a linear deviation of **1.8 mm/m**. As regards the deviations of the Roll Change Side points, it should be noted that they were smaller and within the accuracy of manufacturing of the plates.

Further analysis of the results was related to the conducted leveling measurements to determine the horizontality of certain surfaces within the structure. At the beginning, the determination of the so-called Pass Line - the baseline in relation to which the other horizontal planes are defined. The materialization of this line was carried out on the recommendation of the investor as a tangential line of traction cylinders.

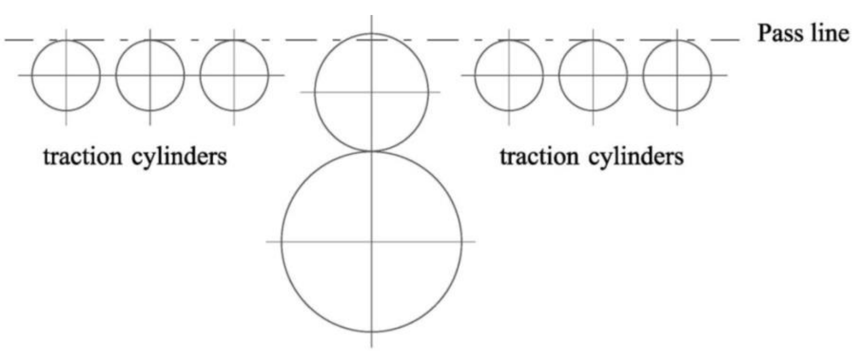

Figure 10: Defining the basic horizontal line - Pass Line

Given the fact that to a greater extent these cylinders were in un-level state, the Pass Line - the baseline was defined by the average height of the first internal traction cylinders.

Based on the defined main horizontal line are determined deviations from individual tangents of traction cylinders in relation to her.

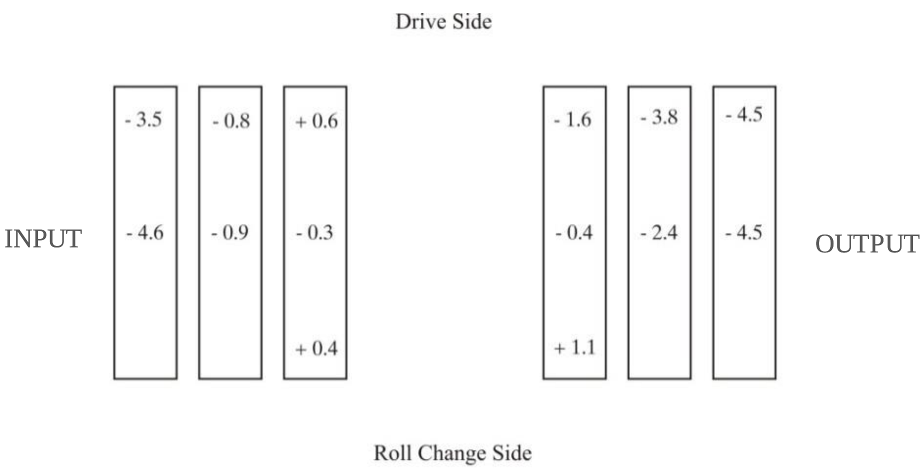

Figure 11: Deviations in relation to Pass Line registered at the measuring points of the traction cylinders

The largest deviations of the traction cylinders appeared on the most distant cylinders (relative to the axis of the object) and they were **-4.5 mm**.

The deviations of the horizontality of the bedplates were also determined. The median height difference between the Roll Change Side and Drive Side plates was 1.7 mm, which showed the un-leveled surface of Drive Side in relation to the Roll Change Side.

Last of the planned tasks was determining the horizontality of the reducer mounted on the upper mill stand in the area of Drive Side. From the obtained results of the leveling measurements, it is concluded that the maximum inclination is in the direction of Roll Change Side - Drive Side.

For a better display, the deviations are displayed relative to the endpoint seen toward the Roll Change Side page, marked with number 1.

This inclination was 3.1 mm, that if we take into account the distance between the measurement points corresponding to the relative inclination of 1.9 mm / m. This result fully corresponds with the results of the examination of the lateral verticality of the carriers of the construction of the mill stand.

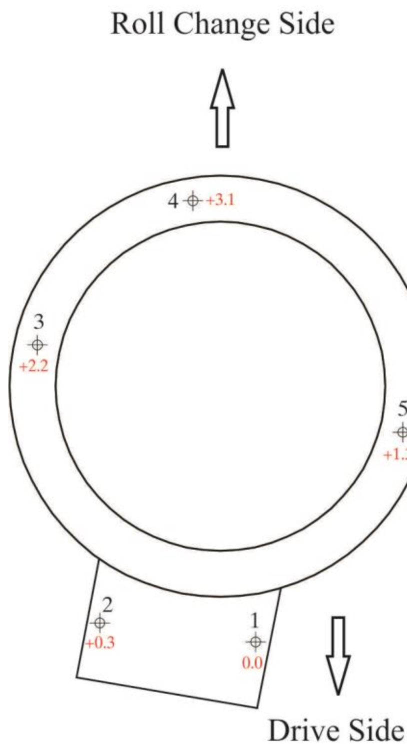

Figure 12: Deviations registered at the measuring points of the reducer relative to point 1

CONCLUSION

The significance of geodetic techniques and technologies in determining deformations on structures of black metallurgy is of great importance. It can be freely stated that geodetic deformation measurements of industrial structures have a leading role in monitoring the working life of such type of constructions, as well as in obtaining information on the state and condition of these constructions. The very importance of industrial structures leads to the need for constant control of the theoretically set constructive characteristics and determination of their eventual changes. Apart from their particularity from the aspect of the specific conditions in which the production activities are carried out and the need for continuous activity of the production process, these objects are included in the group of constructions "dependent" on geodetic deformation measurements. Therefore, the use of geodetic deformation measurements is inevitable in determining the changes in the structural elements in relation to the theoretically set conditions for the optimal functionality of the industrial plants and, consequently, the industrial capacities as a whole.

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