USING THE VERTICAL WHEEL OF A THEODOLITE AS A SPIRIT LEVEL AND DEVICES FOR DEFINING SLOPE TESTING

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SUMMARY

New measuring devices which appear in geodetic equipment that are used to measure small inclination angle i.e. Nivel 200 from Leica or box and pipe levels which help to set auxiliary geodetic devices and electronic devices (prototype) for defining inclination are subject to periodical control. They are run on a level examiner which mainly defines level ascendancy, error of middle position of the level's bubble, influence of ecological changes and measurement range. The solutions to examinations of levels very often are of a prototype character (secured by a patent). Manufactured ones are quite expensive and have a character of laboratory devices.

A need for defining at least the ascendance of a level appears very often in geological practice. The authors suggest that a simple tests device which tests common levels can be made by building a theodolite adaptor and using its vertical wheel as a measurement system.

The paper presents building and principles of operation of the adapter for testing levels. Also initial measurement works which were run to define functionality of the adapter and expected precision of measurements have been presented. Test researches allowed formulating of appropriate measurement procedures. Electronic Level Nivel 200 and pipe levels were used during testing.

1. INTRODUCTION

In a process of geodetic servicing of investment many kinds of devices are used (laser (Pachuta, 1995), mechanical, electronically (Płatek, 1995)), liquid ones which are equipped in a level and at present also more and more often electronic levels. They allow valuation of the level, perpendicularity, direction which appear from the data included in the description of the object. They have a very important function of control which allows testing spatial relations on the objects which were defined by geodetic indirect measurements. Very often the above mentioned levels do not have the ascendancy or sensitivity values given by the producer. Legal regulations which are obligatory in Poland about geodetic performance require from contractors of geodetic work to use

devices which possess a test certificate. In the case of geodetic equipment which have various kinds of levels not all producers give their parameters.
New measuring devices which appear in geodetic equipment that are used to measure small inclination angle i.e. Nivel 200 from Leica or box and pipe levels which help to set auxiliary geodetic devices and electronic devices (prototype) for defining inclination are subject to periodical control. They are run on a level examiner which mainly defines level ascendancy, error of middle position of the level's bubble, influence of ecological changes and measurement range. The solutions examinations of levels very often are of a prototype character (secured by a patent). Manufactured ones are quite expensive and have a character of laboratory devices.

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2. PROJECT OF AN ADAPTER TO TEST LEVELS

A comfortable method of defining the value of ascendancy of any levels can be by their compression with the lunette of the geodetic instrument which is equipped in a reading system of a vertical angle. Then there is a possibility of measurements of small slope angles, axis of the main surface of the tested level. Available instruments are not equipped with adapters which allow the above mentioned compression. Using a compression adapter with stable setting of an instrument allows good results of monitoring, which can be compared with results used on an examiner. Modern electronic instruments which have systems of high precision of angle measurements and a possibility to registering also allow for automatization of the process of defining the ascendancy of any levels using built in servomotors.
That is why the authors performed a project of an adaptor compressed with theodolite whose build and functional connections are shown on figure 1.

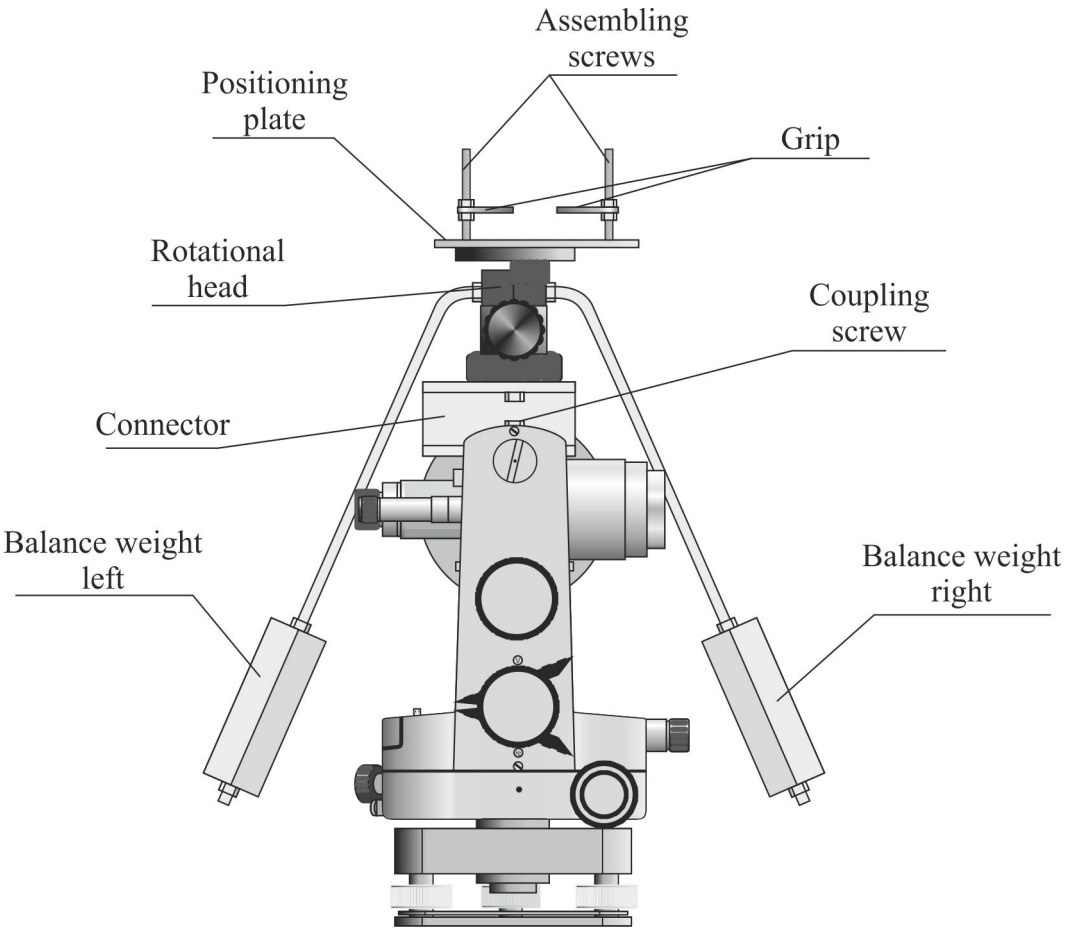

Fig. 1. Building of an adapter for testing levels.

Elaborated and performed adaptor compounds of a connector on which is a rotatable head which is equipped symmetrically on opposite sides in regulated counterweights. In the top part of the head there is a setting plate with two handles which allow fitting to tested levels. The above mentioned connector allows one to set and compress the adaptor with the tube of the lunette of the instrument.

3. METHOD OF MEASURING

Figure 2 presents carrying out the test works of a setting pipe level. After careful leveling of the angle measurement instrument on a monitoring pole and setting and fitting the level on a setting plate we need to regulate the weight center of the adapter by means of counterweights. When the bubble of the tested level transcends we need to read data of its ends on the level ampoule scale and next to do the reading from the scale of the vertical ring of the instrument. After the ends of the bubble move by the value of one dose of the scale of the ampoule, the second reading is done on the scale of the vertical ring of the instrument. The next should be done while the lunette leans in one and the other way for the following divisions of the scale of the ampulla. To increase the precision of defining the ascendancy of a level the measurements should be done in a few series. The average value of the ascendancy is defend by a formula known from literature (Szymoński, 1982, Tatarczyk, 1994, Wanic, 2007).

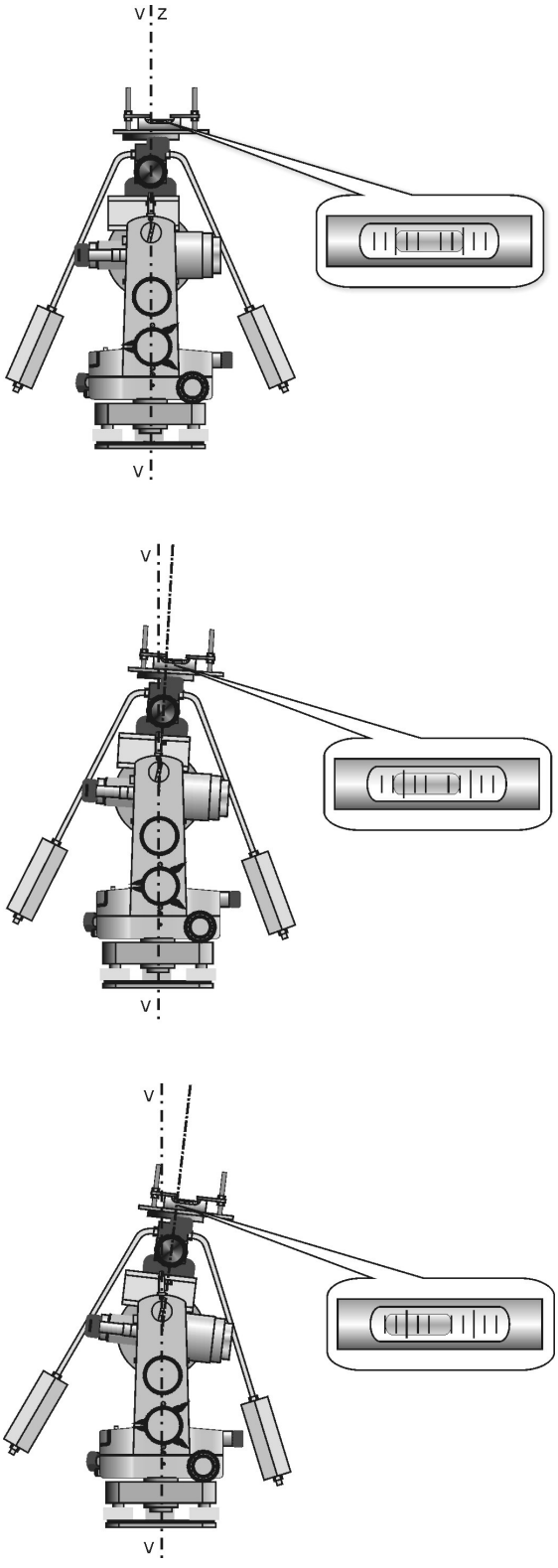

Fig. 2. Stages of experimental works on an example of a pipe level.

The following figures 3, 4, 5, 6 present pictures from experimental works for the chosen types of levels. Four types of levels were used in the researches: a setting pipe level, a setting box level, a setting machine level and a Nivel electronic level. Each of the instruments were tested by the method described above.

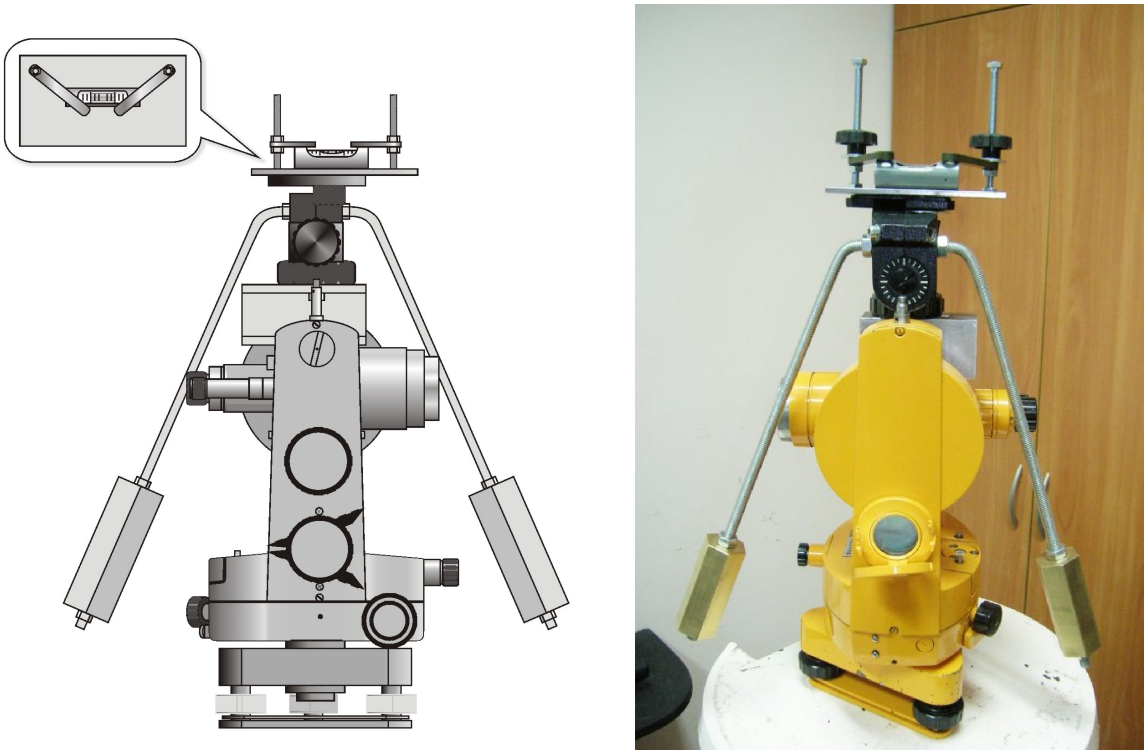

Fig. 3. A setting pipe level.

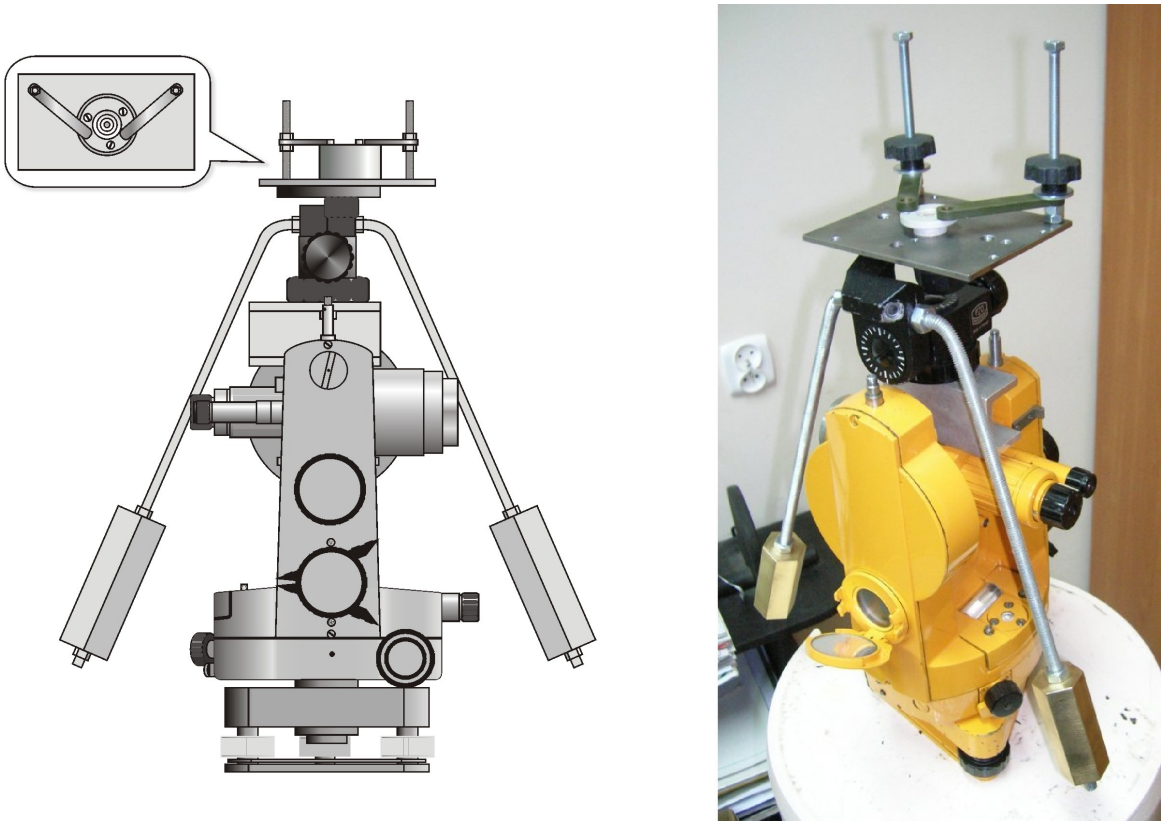

Fig. 4. A setting box level.

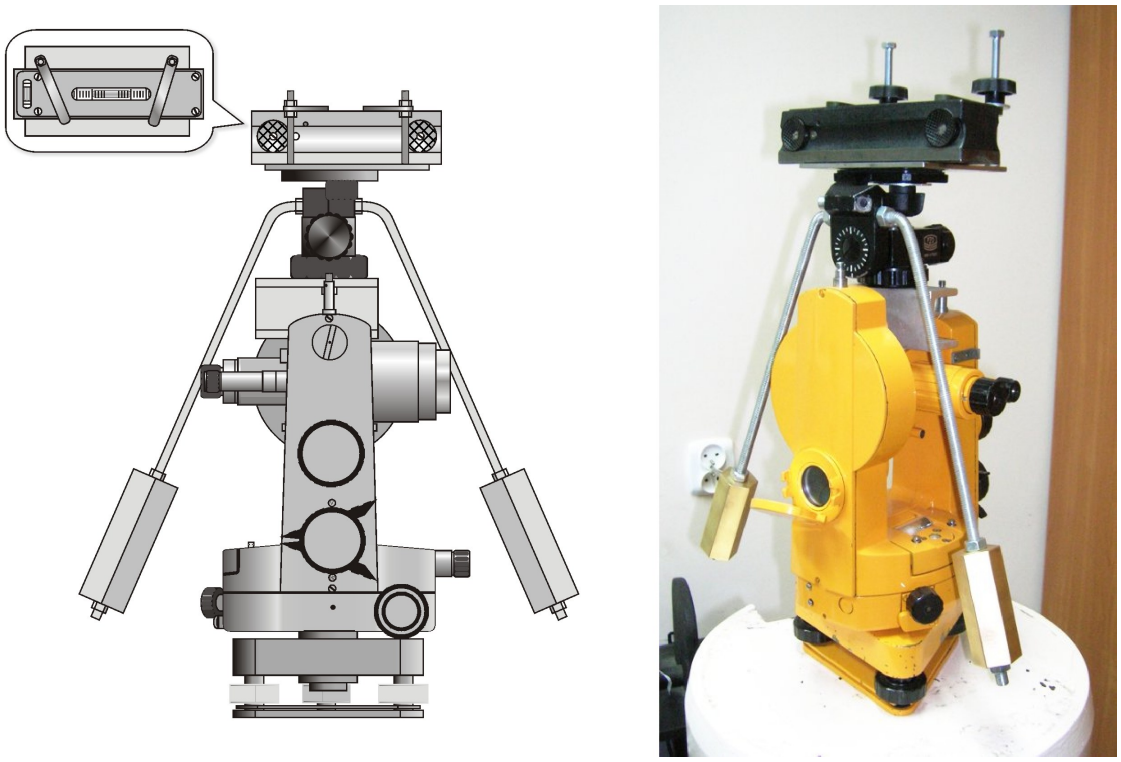

Fig. 5. A machine pipe level

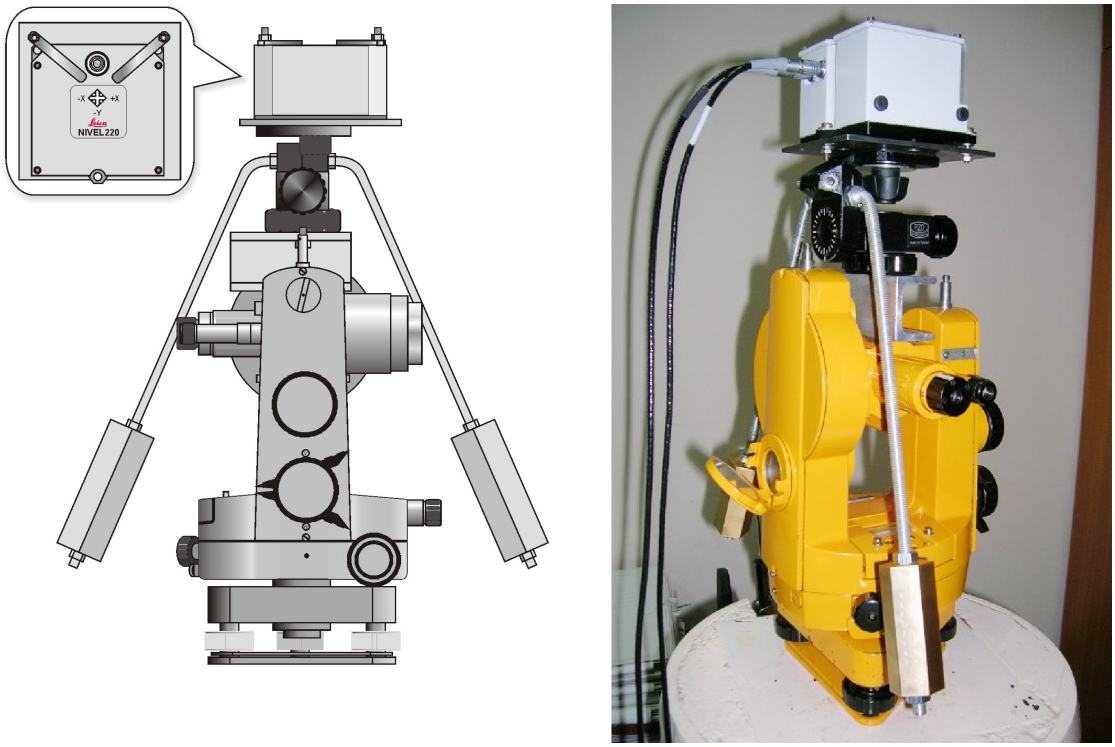

Fig. 6. A Nivel electronic level.

On a base of experimental works performed, a value of the ascendancy for each level was determined (tables 1,2,3) and for Nivel electronic level (tables 4 and 5).
Determined ascendancies were compared with the values of ascendancies given by the producer and set in pairs at the following drawings.

Table 1. Comparison of the values declared by the manufacturer and obtained in tests – pipe level

Value of the ascendancy of a setting pipe level	
given by a producer	determined by the experiment
30''	29,7''±0,3''

Table 2. Comparison of the values declared by the manufacturer and obtained in tests – box level

Value of the ascendancy of a setting box level	
given by a producer	determined by the experiment
8'	8,1'±6''

Table 3. Comparison of the values declared by the manufacturer and obtained in tests – pipe machine level

Value of the ascendancy of a pipe machine level	
given by a producer	determined by the experiment
10''	10,3''±0,3''

Table 4. Comparison of the values declared by the manufacturer and obtained in tests an electronic level

Checking the range of angle measurement by an electronic level.	
given by a producer	determined by the experiment
$\pm 1900^{cc}$	$\pm 1890^{cc}$

Table 5. Comparison of the values declared by the manufacturer and obtained in tests an electronic level in range $\pm 960^{cc}$

An average error of an angle measurement with an electronic level in measurement range of $\pm 960^{cc}$ (basing of a pair of observations)	
given by a producer	determined by the experiment
$\pm 3,0^{cc}$	$\pm 2,1^{cc}$

4. CONCLUSION

In the case of geodesic equipment which included various levels (figure 7) not all producers give their parameters. The authors propose to minimalize the above mentioned difficulty by self-testing of the used levels with the use of the project of an adapter described in the elaboration. The presented adapter was placed on a theodolite with optical reading. When using this measurement construction the only obstacle can be direct reading of the results by the observer. That is why cheaper and cheaper electronic theodolites which can be found on the market can be, after compression with the described form of an adapter, a better solution with a possibility of transmitting the measurements to the computer.

Draw. 7. Examples of geodetic equipment including levels.

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