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Measurement of Setting Force in the Points Drives

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1. Introduction

In the article some methods of direct measurements of setting force in the points drive are presented.

The setting force is the most often regulated parameter by the service staff and it is the most often measured. Electric drives transfer the rotational moment on the slide block by the regulating coupling [1].

The value of the setting force depends directly on the type of using motor and on the coupling regulation.

In case of exceeding the setting force value by the resistances of turnout rearrangement, the slide on the coupling should appear.

But the coupling regulation for the unacceptable setting force value can have an effect on the passengers' security and the points drive condition .

2. Slotted pin method

Nowadays the PKP uses for the setting force measurement the slotted pin methods, based on the measurement slotted pin located on the connection between the adjust slide – adjust rod.

Measurement slotted pin is made in a lot of variants: as the mechanic system with the data readout on the clockface sensor which measures the dislocation of slotted pin part under the influence of applying force or as a system with the built- in extensometer with the readout made on the electric display.

However the slotted pin measurements have some measuring errors. In the figure the appearance of the exemplary slotted pin instrument is presented.

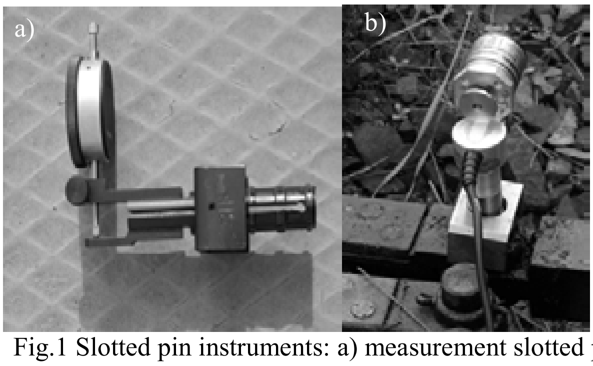

Fig.1 Slotted pin instruments: a) measurement slotted pin EZK; b) measurement slotted pin μMOZ-a

The measurement method of setting force by the measurement slotted pins is the oldest and the only one in practice.

Slotted pin instruments have been evaluating together with the technique development- however the measurement rule hasn't been changed.

In the first versions these instruments were equipped with the clockface indicator for direct measuring the deformation of the measurement element under the influence of the applying force (fig. 1a).

More modern versions are equipped in the measurement extensometers and they possess the digital readout of the measurement force (fig. 1b).

However the slotted pin methods possess a lot of mechanical and ergonomic disadvantages. Among the mechanical disadvantages it is exposure to the plastic deformation caused by the crossing the maximal acceptable force for the instrument.

Moreover in the Polish conditions a lot of instruments with clockface indicators is still used, but they are inaccurate.

The next important disadvantage is lack of the opportunity to check the correct clamping of the instrument in the measurement system.

Time of measurement high- grade work is a very important parameter. So far during using of some slotted pin methods, the measurement time is about 10 – 15 minutes. Taking into consideration that these measurements should be done every 2 months [2], this process is very time- consuming.

For example on the area of former infrastructure management in Katowice there were about 6000 points drives and it gives in the result 6*10*6000=360000 minutes for making measurements (about 250 days) [3].

For the instrument EZK the resistance analysis was pursued with the help of finite element method (FEM). The MSC. Visual NASTRAN for Windows program was used.

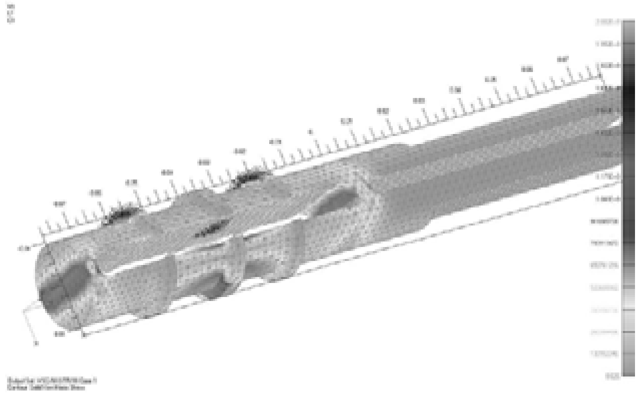

Fig.2 The map of strain measurement slotted pin EZK made in NASTRAN program

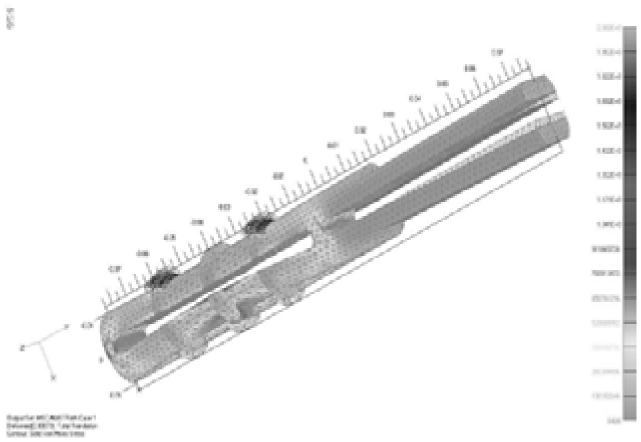

Fig.3 The map of strain with maximum dislocation of EZK measurement slotted pin elements made in NASTRAN program

This model (fig.2 and fig.3) composed from 29961 slotted pins and 15852 elements. The average value of the element is the cube with the side of 2 mms. In view of analysis the disturbing results were obtained and they testify that in case of slotted pin burdened by force about 10 kN (1000 kG) there are very big strains determined by means of Von Mises criterion. (fig. 2).

In the shown places they reach the value from 1500 MPa to even 2000 MPa. In the nearest future the analysis of plastic deformations will be done for this slotted pin. The upper limit of slotted pin load- carrying capacity was determined at 10 kN. It is also used for holding forces measurement of the points drive and here these forces reach 15 kN and more. So it is possible that a huge percentage of slotted pins posses the plastic deformations.

In the fig. 3 the total displacement of EZK slotted pin elements is presented. We can observe that the slotted pin deforms considerably during the measurement and if it crosses its declared load capacity, it will deform permanently and it won’t measure. On the strength of this analysis we can notice that the measurement slotted pins work in very uncomfortable conditions, they are susceptible to plastic deformations and they need the precise location in the meter circuit.

3. Direct method

Direct method of setting force measurement is based on this that the force value is equal of setting force in the situation when the points drive presses down the blade to the switch- point saver [3].

The measurement is possible by using the MS450 measurement instrument elaborated by the authors (fig. 4).

In the fig. 5 the 3D model was presented in the first version of the measurement head in the MS450 instrument made in AutoCAD program. The fig. 6 presents the exemplary net of the finite elements with the exemplary map of finite elements with the exemplary net of strains made in NASTRAN program [4].

In the new measurement head there is a measurement element - a beam located in the middle part of the head. This beam is subjected by stretching under the influence of applying force. The head model was also made and simulated in NASTRAN program.

Fig. 4 The measurement method with the direct method help with MS450 instrument

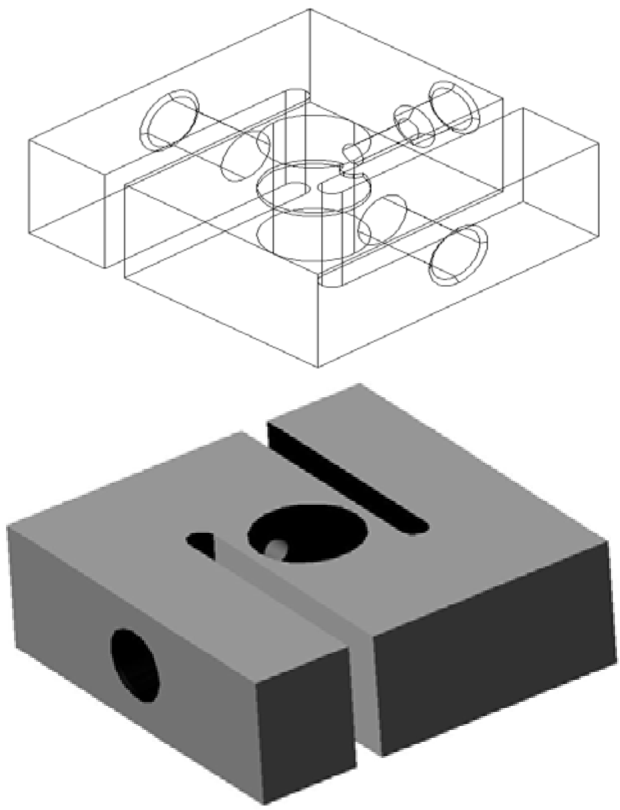

Fig. 5. 3D model of measuring head of the MS450 device made in the AutoCAD program

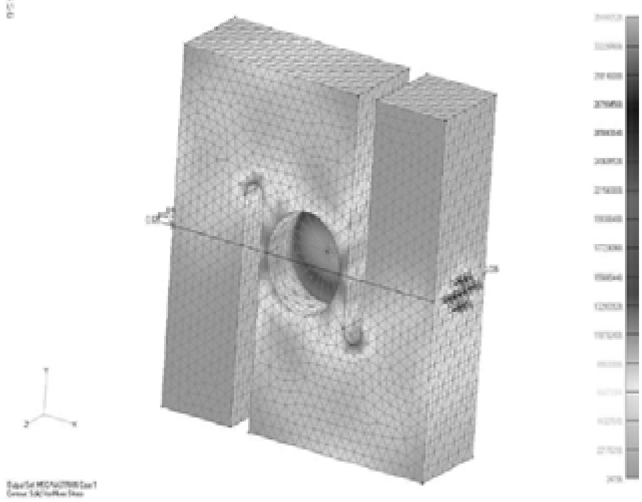

Fig. 6. FEM mesh with a sample map of strain made in the NASTRAN program

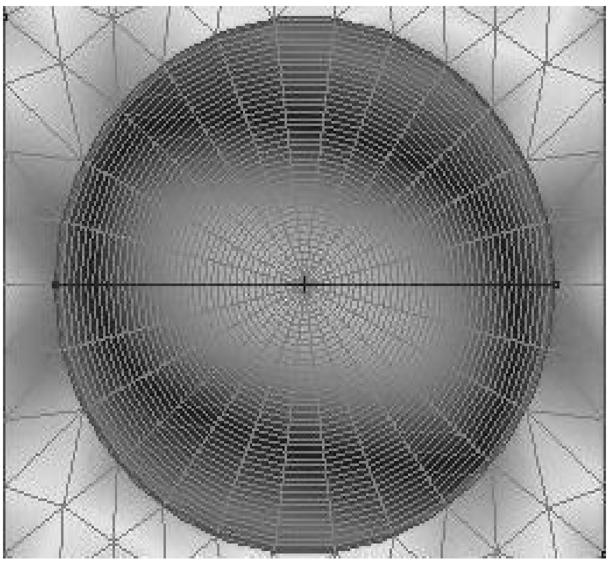

Fig. 7 The strain course in the measurement element

From this course of element strain presented in fig. 9 it can be noticed that on the measurement beam strains scan on the whole length in constant manner. Thanks to it the precisely location of measurement extensometer is possible.

4. Parameter comparison of measurement heads

Two versions of the measurement heads were accepted to the analysis. It was conducted for two variants of applying force: perpendicularly to Y axis and at an angle 5° in relation to Y axis. Force volume is 10 kN. The analysis results are presented in Table 1. As you can see a new measurement head type is characterized by less misread caused by imperpendicularly setting of measurement head in relation to Y axis.

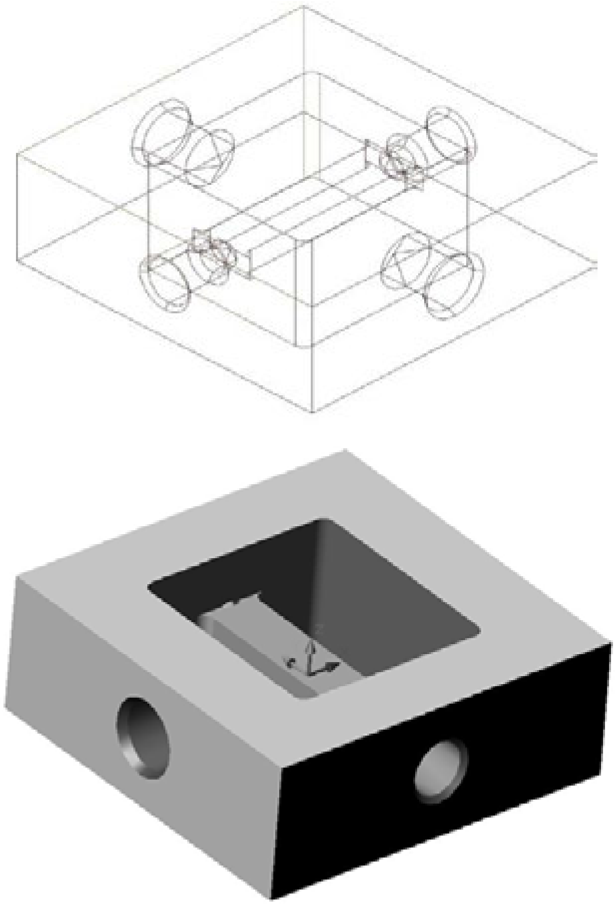

Fig. 8. 3D model of measuring head of the MS450 device made in the AutoCAD program (conception)

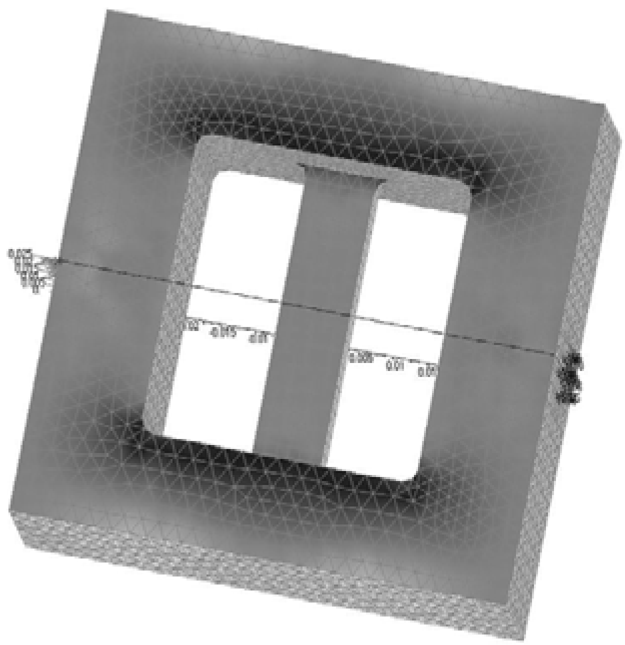

Fig. 9. FEM mesh with a sample map of strain made in the NASTRAN program

Table 1.

Displacement comparison of 10 elements on the surface of measurement part

ordinal	Head 1			Head 2		
	Applying force in axis	Applying force at an angle 5°	Difference [%]	Applying force in axis	Applying force at an angle 5°	Difference [%]
	Element displacement 10^{-4}[m]	Element displacement 10^{-4}[m]		Element displacement 10^{-3}[m]	Element displacement Element displacement 10^{-3}[m]	
1	703	335	52.35	236	233	1.27
2	699	274	60.80	236	234	0.85
3	696	417	40.09	236	235	0.42
4	691	438	36.61	235	237	-0.85
5	695	241	65.32	236	241	-2.12
6	690	208	69.86	235	254	-8.09
7	684	481	29.68	235	267	-13.62
8	677	501	26.00	236	268	-13.56
9	675	508	24.74	236	265	-12.29
10	703	310	55.90	236	202	14.41

5. Conclusions

In this article the conception of new instrument for applying force measurement in turnouts was presented. In the course of researches, after making the optimization of measurement head and definition the wrong effect of setting the head during the measurement on the results, the final measurement head and instrument shape come into being.

Improvement of measurement instrument lets run the verification of its precision and improve the measurement method details. The next step will be validation of the measuring method. In the study there is already a test stand.

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A. Sładkowski, J. Młyńczak

MEASUREMENT OF SETTING FORCE IN THE POINTS DRIVES

S u m m a r y

In this article the conception of new instrument for setting force measurement in the rail turnout is presented. The FEM analysis of the EZK slotted pin instrument, which contains the stress and dislocation analysis in this slotted pin under the influence of setting forces. The next measurement instrument is new MS450, with the help of it the direct method may be measured. The FEM analysis results of two head types were presented. Some defects of original solution and advantages of new head were shown. It was shown that a new measurement head is less susceptible to wrong instrument setting during the measurement and it is easier to stick extensometers on it.

А. Сладковский, Я. Млыньчак

ИЗМЕРЕНИЯ ПЕРЕВОДНЫХ СИЛ В ПРИВОДАХ ПЕРЕВОДНЫХ МЕХАНИЗМОВ

Р е з ю м е

В статье представлена концепция нового прибора для измерения переводных сил с железнодорожных стрелочных переводах. Представлен КЭ анализ штифтового прибора типа EZK, содержащий анализ напряжений и перемещения в указанном штифте под действием переводных сил. Вторым описанным измерительным прибором является разработанный прибор MS450, при помощи которого проводятся измерения непосредственной методикой. Представлены результаты КЭ анализа двух типов измерительной головки для данного прибора. Указаны недостатки первого технического решения, а также преимущества новой головки. Определено, что новая измерительная головка менее подвержена влиянию неправильной установки прибора во время измерений, а также приклеивание тензорезисторов для нее выполняется удобнее.

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