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ROZPRAWA DOKTORSKA:

# *Model nieustalonych deformacji terenu górniczego wykorzystujący nową funkcję wpływów uwzględniającą jej zmienność w czasie*

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**Title:** Model of mining-induced transient ground deformations employing a time-varying influence function.

**Abstract:**

This work presents the results of research conducted on forecasting of transient mining - induced ground deformations, which refer to deformations occurring on the surface during the active mining period, when the subsidence trough changes its shape and size following the advancing mining front. This phase also includes the post-mining period known as residual effects, during which mining operations have ceased but some surface displacements decreasing asymptotically to zero are still observed.

The objective of this study was to develop a model for predicting ground deformations in mining areas in its transient phase, aiming at improving the accuracy of deformation forecasts under contemporary underground mining conditions.

To achieve this goal, it was assumed that the solution would involve modifying the influence function of W. Budryk – S. Knothe's theory in such a way that it should account its variability over time, when considering a finite elementary mining field. This means that the mining influences of a specific elementary field reach the considered point on the surface with a certain time delay, gradually increasing from 0 to a final value $w_k$.

The modification of the influence function involved introducing a component to account for its time-variant nature. The analyses conducted indicated that a specific group of probability density function (PDF) distributions could be utilized for this purpose. The final solution utilized the Rayleigh PDF function.

Based on the defined assumptions, two models were proposed in this study. The first model, referred to as the "baseline model", directly employs a suitably parameterized Rayleigh function, with time considered as the independent variable and the scale parameter $\sigma$ of the function replaced by the $r_t$ parameter, which characterizes the kinetics the deformation process on the surface. The developed model was verified using survey data from nine observing lines. For verification purposes, appropriate software was developed. The verification results shows that in 64% of the analyzed observing points, a better approximation of subsidence course over time was achieved compared to the S. Knothe model.

However, the achieved result was considered unsatisfactory, leading to the proposal of a second solution called the "extended model". This solution involved utilizing a composite function constructed from combination of two Rayleigh functions parameterized by $r_{t1}$ and $r_{t2}$

coefficients. It was assumed that the first component, with the $r_{t1}$ parameter, described the influences that rapidly manifest along with the advancing front (referred to as "immediate influences"), while the second component, with the $r_{t2}$ parameter, described the influences occurring over a longer time (referred to as "delayed influences"). Both components are tied with the $w_{12}$ parameter ranging $w_{12} \in \langle 0,1 \rangle$, representing the contribution of immediate influences to the overall transient subsidence. Verification based on the same set of observing points shows that, in all cases, better accuracy in describing subsidence course over time was achieved compared to the S. Knothe model.

Furthermore, theoretical tests simulating the stoppage of extraction field advance were conducted based on the extended model. The calculations performed using this model demonstrated its ability to describe changes in subsidence patterns over time on the surface in the presence of such breaks in extraction process. Practical applicability of the model for predicting such phenomena was also confirmed for one of the observing lines used for verification. The S. Knothe model does not offer similar capabilities.

In conclusion, the presented thesis has been proven, and all defined objectives have been achieved. The obtained solution, along with the developed software, can serve as a tool for predicting the subsidence changes over time at points on the surface of mining areas, enabling accurate forecasts under contemporary underground mining conditions.