DISCONTINUOUS DEFORMATIONS AS A RESULT OF HORIZONTAL DEFORMATIONS

NESPOJITÉ DEFORMACE JAKO VÝSLEDEK HORIZONTÁLNÍCH DEFORMACÍ

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Abstract

Underground mining extraction causes a lot of adverse changes to the rock mass and land surface. Among others, one of important issues is the influence of horizontal deformations (strain) on the arising of linear discontinuous deformations. In this work, linear discontinuous deformations were characterized, and the case of formation of bump was analyzed. Bump formation caused the destruction of the structure of newly built construction. As it results from the considerations included in the work, bumps are associated with horizontal compressive deformation, and the distribution of the maximum horizontal deformations end had the greatest impact on the direction of their course, in the analyzed case.

Abstrakt

V této práci byly charakterizovány lineární nespojité deformace a byl analyzován stav formování horského otřesu. Vznik otřesu zapříčinil destrukci struktury nově postavené budovy. Jak vyplývá z úvah obsažených v práci, otřesy jsou spojeny s horizontální tlakovou deformací, přičemž ukončení maximálních horizontálních deformací mělo největší účinek na směr jejich šíření, což platí pro analyzovaný případ.

Keywords

deformation of mining area

Klíčová slova

deformace dobývacího prostoru

1 Introduction

Forms of mining's influence on environment are generally known from series of publications (Chudek 2002, 2010, Knothke, 1984, Strzałkowski 2010) and individual experiences of occupants of Upper Silesia and other polish regions, where raw materials are extracted. Continuous deformations, in subsidence basin's form or other related forms, appear always as a result of mining work. On Upper Silesia there are some regions, where low-depth exploitation was provided, which threaten in formation of surface-type discontinuous deformations, especially it's most common form- subsidence hollows (Chudek et al., 1988). Degree of safety of this form of deformations is constantly decreasing because of reactivation of shallow caverns is as result of repeated exploitation of deeper layers. Non-continuous, linear deformations currently make high risk. Among those forms of deformations we can mention: cracks, fissures, ground steps, humps and ditches. Those deformations where presented after work (Chudek et al., 1988) on fig. 1.

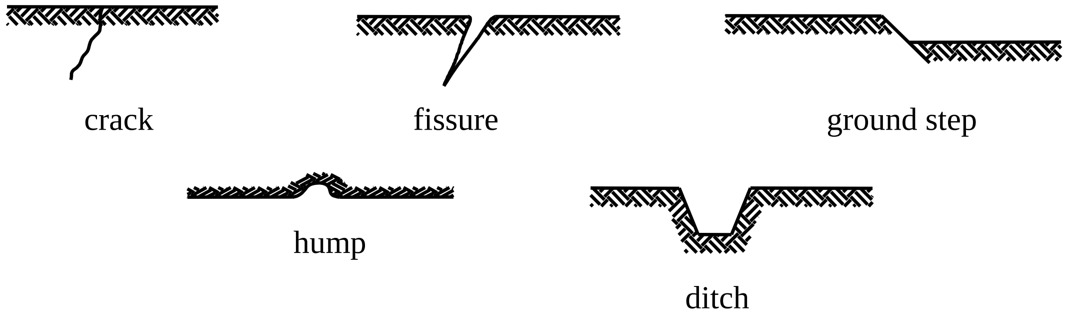

Fig.1 Forms of occurrences of discontinuous linear deformations according to Chudek, et al.1988

Particularly often there can be found faults (Fig.2), caused by mining, especially with cave-in of roof to common borderline in several seams (Strzałkowski, Scigala, 2003). Bumps occur relatively rarely, but are equally dangerous to buildings placed on surface, as rock steps. Examples of that kind of deformations, its reasons and its occurrence's impact on surface, were presented in next part of this work.

Fig.2 Example of fault occurrence, crosswise the roadway (Strzałkowski, Scigala, 2003)

2 Analysis of case of formation of discontinuous deformation

2.1 Lithology and stratigraphy

In examined area, rock mass is built of overburden layer and Carboniferous layer**.** Overburden is made of Quaternary stratum, build of embankment layers and sand. Thickness of those layers is equal about 1m. Below, there is Triassic layer made of limestone. In that layer's roof there are often found weathered rock under the form of compact and dusty clay, and dusts with limestone slivers. Thickness of Triassic layer is equal about 155 m. Below, there is a carbon layer in the form of łaziskie layers, which were formed in sandstone series together with seams of coal from group 200.

2.2 Accomplished exploitation

In building's area**,** extraction was provided in seams: 207 and 209. Basic information about accomplished exploitation, like time of exploitation, thickness of seam, angle of inclination, depth, distance from point established in the middle of the parcel, direction of exploitation's localization in comparison to parcel and coefficient of roof control, are presented in Tab.1. All exploitation was provided in the wall system with roof-rock caving. Schematic of location of particular fields in comparison to parcel, are presented on Fig. 3.

3 Analysis of discontinuous deformation forming results

In building's area discontinuous non-linear deformations in bump's form were pronounced. Those deformations caused damage of newly erected residential building. Currently demolition area is overgrown with weeds, so deformation is noticeable rather on neighboring property (Fig.2).

Those types of deformations are, in case of providing exploitation, outcome of high values of horizontal compressive deformations. Accordingly a resolution was made to calculate values of deformation rates, which were pronounced in examined area. For the calculations; the DEFK – Win [7] program, using W. Budryk – S. Knothe's theory (Konthe, 1984), was used.

Following values of parameters were assumed, according to coal mine's experiences:

- Coefficient of roof control for covering exploitation for seam 207 **a = 0.7;** for seam 209 **a = 0.8;**
- parameter **tgβ = 2.1;**
- proportions coefficient in Awierszyn's relationship **= 0.32.**

In calculations, seam's tilt and exploitation edge, weren't took into account. First, the ratios were calculated for the deformation approximately associated with a discontinuous deformation localized in the south of the plot (Fig.3). Subsidence of point and maximal deformations were calculated by simulating walls movement for 5-day intervals.

Tab.1. Basic information about accomplished exploitation

Seam	Wall	Beginning of extraction	End of extraction	Thickness of seam [m]	Angle of inclination [deg]	Depth [m]	Distance [km]	a
207	1	01-04-2004	30-06-2004	4.70	4	510	0.29 SW	0.7
207	10	01-01-2008	01-04-2008	4.73	4	520	0.33 SE	0.7
207	2	01-07-2004	30-07-2004	4.81	4	495	0.26 SW	0.7
207	3	01-04-2005	30-06-2005	4.14	4	525	0.34 S	0.7
207	4	01-07-2005	30-09-2005	4.21	4	500	0.05 S	0.7
207	5	01-10-2005	08-12-2005	4.05	4	475	0.00	0.7
207	6	01-10-2006	31-12-2006	4.76	4	535	0.28 SE	0.7
207	7	01-01-2007	30-03-2007	4.72	4	490	0.01 SE	0.7
207	8	01-04-2007	08-05-2007	4.64	4	460	0.06 NE	0.7
207	9	01-10-2007	31-12-2007	4.68	4	545	0.47 SE	0.7
209	11	01-07-2008	30-09-2008	3.85	4	580	0.29 SW	0.8
209	12	01-10-2008	31-12-2008	3.85	4	560	0.00	0.8
209	13	01-01-2009	12-01-2009	3.91	4	535	0.09 N	0.8
209	14	01-01-2011	30-03-2011	3.87	4	605	0.40 S	0.8
209	15	01-04-2011	30-06-2011	3.85	4	595	0.24 S	0.8
209	16	01-07-2011	30-09-2011	3.79	4	588	015 SE	0.8
209	17	01-10-2011	31-12-2011	3.68	4	580	0.09 SE	0.8
209	18	01-01-2012	30-03-2012	3.67	4	570	0.08 E	0.8
209	19	01-04-2012	30-06-2012	3.68	4	565	0.15 E	0.8
209	20	01-07-2012	01-08-2012	3.68	4	550	0.20 E	0.8

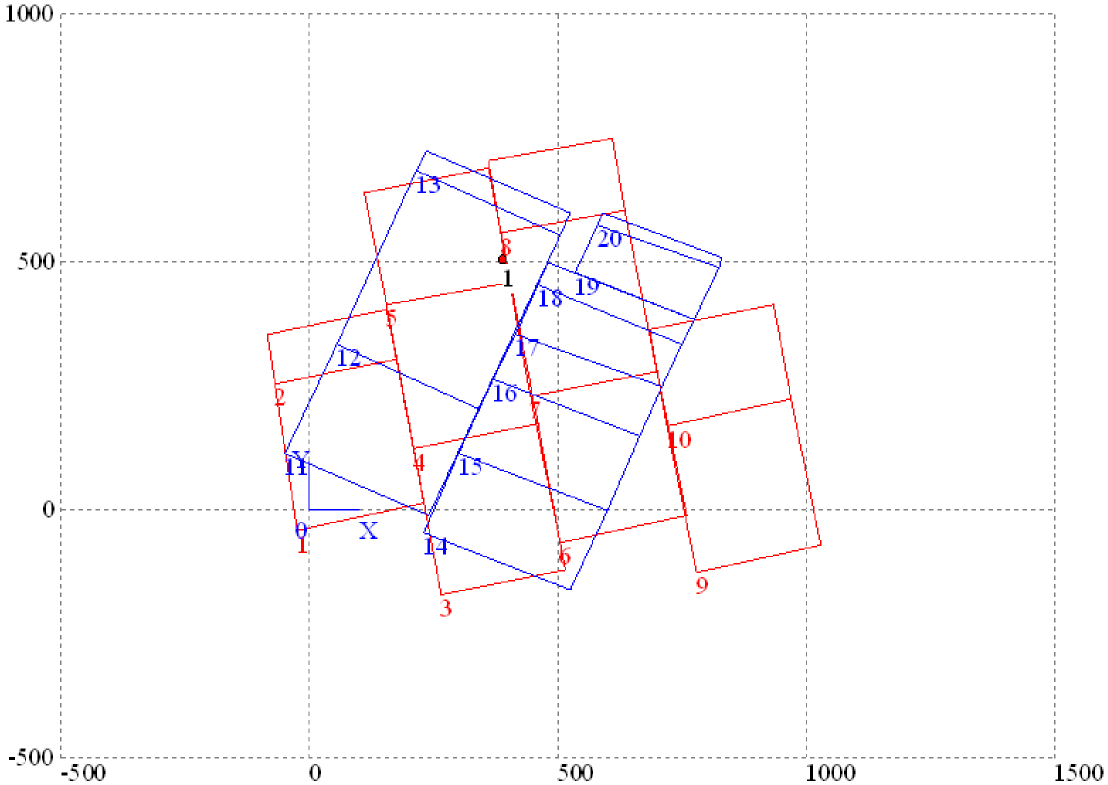

Fig.3 Schematic of particular field's localization in comparison to parcel

Fig.4 General deformation's sight

Immediate disclosure of the exploitation's impact was assumed. Subsidence graph is shown in Figure 5, and the maximum horizontal deformations are shown in Figure 6.

As can be seen from Figure 6, at the time of exploitation the area was undergoing horizontal tensile deformation (positive) and compressive (negative) alternately. In early 2009, there were horizontal compressive deformations of the greatest values $\mathbf{E_{max}}$ of approximately -8.7 mm/m. As a result of the continuation of exploitation, deformation levels declined to approximately -5.5 mm/m, however those were still compressive deformations. As mentioned above, immediate disclosure of the exploitation's impact was assumed. If so-called time factor (the coefficient describing delay in revealing the influence) were taken into account, the extreme values $\mathbf{E_{max}}$ would have occurred somewhat later – in consecutive months of 2009.

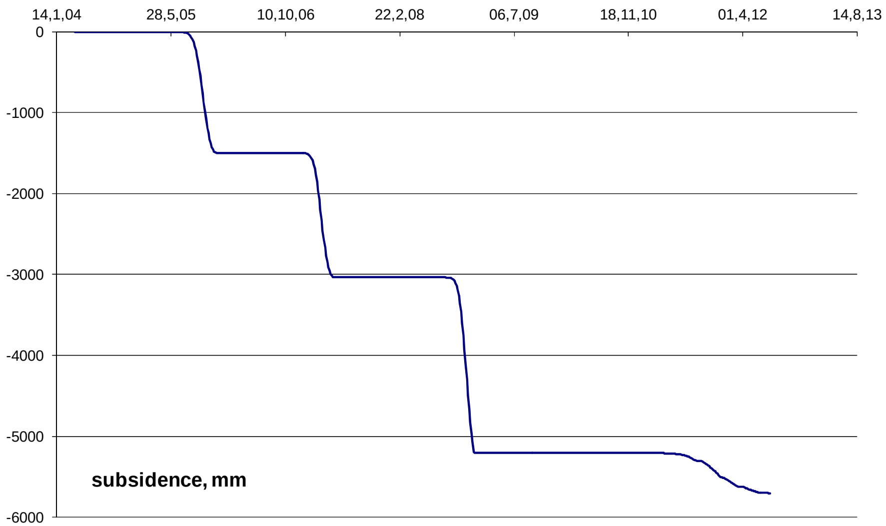

Fig.5 Calculated subsidence of point over time- graph

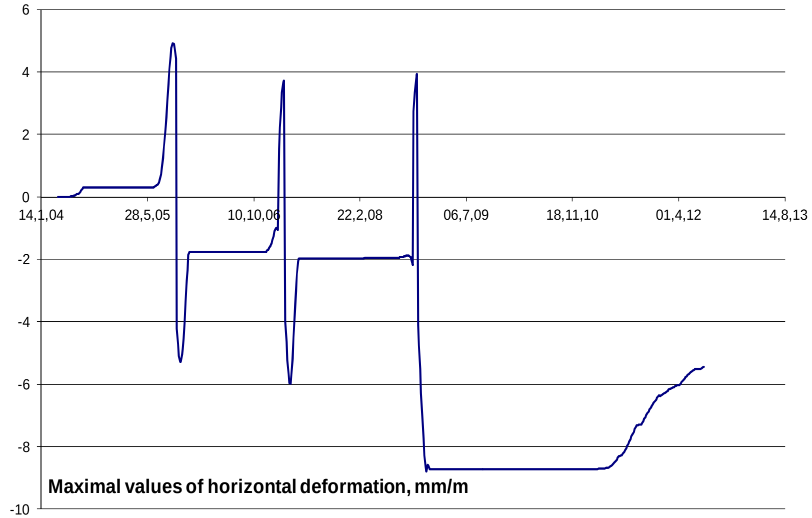

Fig.6 Maximal calculated horizontal deformation of point over time- graph

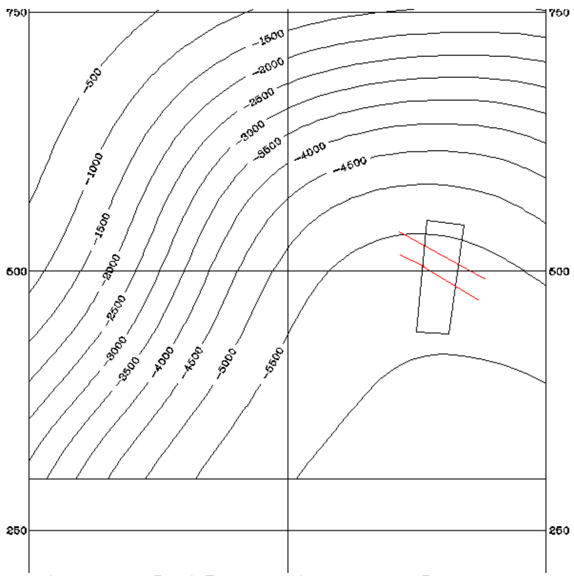

Fig.7 Subsidence in parcel's area

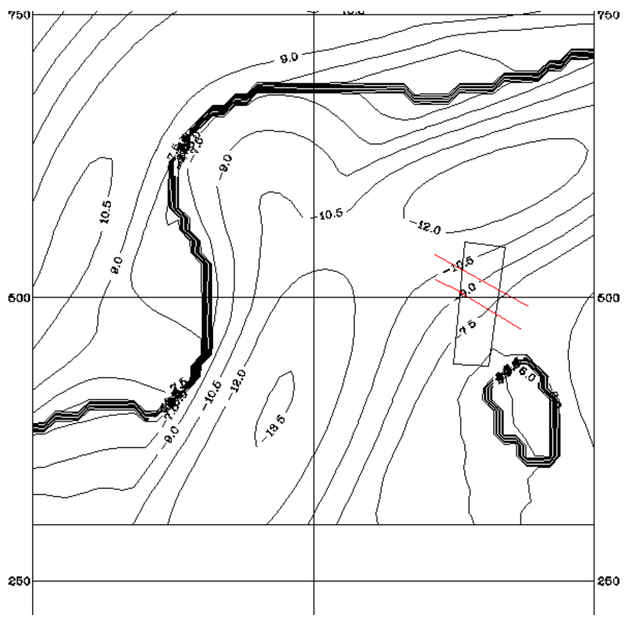

Fig.8 Temporary maximal horizontal deformation value's isolines

Subsequently, the calculations of deformation indices values, for the entire area surrounding the parcel, were performed. Figure 7 shows the subsidence isolines, and Figure 8 temporary maximum horizontal deformation, while Figure 9 shows final maximum horizontal deformation. Parcel and approximate course of the discontinuous deformation zones were also indicated.

As shown in Figure 7, in the area of the property there was lowering of more than 5.5 m. Temporarily extreme maximum horizontal deformation was equal to about -11 mm/m - Figure 8. These values are high, which could result in discontinuous deformation field in the form of a bump. Temporary maximal deformation graph does not coincide with the direction of the course of deformation. Whilst there is some compliance in the course of deformation and isolines of the final discontinuous maximum horizontal deformations - Figure 9, at least when taking into consideration the bump located in southern part of parcel. Greater consistency between the locations of bumps would probably be noticeable in case of taking into consideration the angle of tilt of overburden and exploitation edge.

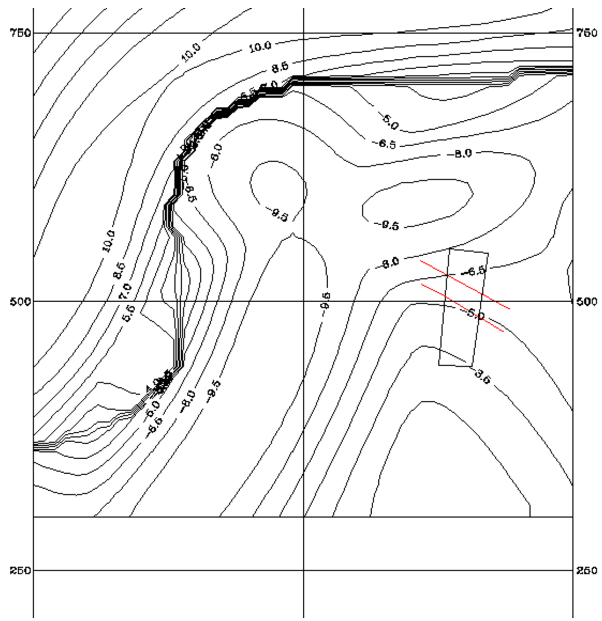

Fig.9 Final maximal horizontal deformation value's isolines

4 Summaries

Analysis of geological and mining conditions, carried out in this work, allow presenting the following conclusions:

- Discontinuous linear deformations are going to be, as it can be assumed, the dominant form of discontinuous deformation in subsequent years. The most frequently noticed types of this deformation are steps, as a result of exploitation, especially caving to a border of multiple seams.
- Less frequent, but equally dangerous for building, form of non-linear deformations, are bumps. They can appear as a result of developing high values of horizontal compressing deformations in mining area. Discontinuous deformation analyzed in this work is related with high values of horizontal compressing deformations, which amounted periodically to approximately -11 mm/m. These values are relatively high, ranging V category of mining areas. Time of forming deformation (2009) coincides with the time of maximum instantaneous horizontal deformations, which further confirms the formation of deformation relationship with the impact of mining activities. Direction of the deformation correlates with the final values of maximum horizontal deformations. It can therefore be initially concluded that the occurrence of deformation was affected either by temporary extreme horizontal deformation, as well as deciding on its course, final extreme deformation values.

References

CHUDEK M., JANUSZ W., ZYCH J. *Studium dotyczące stanu rozpoznania tworzenia się i prognozowania deformacji nieciągłych pod wpływem podziemnej eksploatacji złóż*. Zeszyty naukowe Pol. Śl. S. Górnictwo, z. 141. Gliwice 1988.

CHUDEK M. *Geomechanika z podstawami ochrony środowiska górniczego i powierzchni terenu*. Wydawnictwo Politechniki Śląskiej. Gliwice 2002.
CHUDEK M. *Mechanika górotworu z podstawami zarządzania ochroną środowiska w obszarach górniczych i pogórniczych*. Wyd. Pol. Śl. Gliwice 2010.
KNOTHE S. *Prognozowanie wpływów eksploatacji górniczej*. Wydawnictwo "Śląsk". Katowice 1984.
STRZAŁKOWSKI P. *Zarys ochrony terenów górniczych*. Wyd. Pol. Śl. Gliwice 2010.
STRZAŁKOWSKI P, ŚCIGAŁA R. *The example of linear discontinuous deformations caused by underground extraction*. Sbornik vedeckych praci Vysoke Skole Banske TU Ostrava. 2, rok 2003. Rocnik V. Transaction of VSB – Technical University of Ostrava, Civil Engineering Series.
ŚCIGAŁA R. *Komputerowe wspomaganie prognozowania deformacji górotworu i powierzchni wywołanych podziemną eksploatacją górniczą*. Wyd. Pol. Śl. Gliwice 2008.

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