Chapter

Polish Experience in Shaft Deepening and Mining Shaft Hoist Elongation

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Abstract

Deepening of active mine shaft comprises number of specific an very difficult operations, because it calls for use of untypical devices securing hoist operation in the shaft, as well as special technology tailored to actual technology of the deepened shaft face. The Leon IV shaft at the Rydułtowy mine is one of the last mining shafts deepened in Polish coal mining from the surface, and then deepened and finally equipped with mine shaft hoist installation. This investment will allow for the construction of the exploitation level of 1150 m and the availability of further coal extraction up to a depth of 1200 m. It will guarantee the possibility of exploitation of over 65 million tons of coal and continuous operation of the mine until 2040. At the same time, for the first time in the Polish hard coal mining industry, a flexible guiding of the mining cage and skips was used, which in comparison with rigid guiding is a much cheaper solution and has many other advantages. The chapter presents most important problems and technical solution implemented during construction and deepening of the Leon IV Shaft at Rydułtowy Coal Mine in Poland.

Keywords: shaft hoist elongation, deepening mining shafts, shaft construction, adjustable guiding

1. Introduction

Hard coal mine Rydułtowy is one of the oldest Polish mines in Rybnik Coal District. Its predecessor named Charlotte started production in the year 1806 and it was one of the greatest mines at that time. The mine as the first was equipped with steam engine already in the year 1855 and it was connected with the rest of the country via railway line what facilitated coal sales. At the beginning of twentieth century, the mine in question passed through numerous crisis phases that resulted in the employment reductions, and in the year 1932 the mine was even closed for a period of 4 years. However, the mine developed during the Second World War—because Germans needed big amounts of good-quality coal. In the period 1940–1944, the employment was increased threefold up to 3582 workers. After the Second World War, the Charlotta mine was renamed as Rydułtowy mine, which belonged to various structures of Polish mining industry. In the year, the KWK Rydułtowy was joined with Anna mine forming mining plant named as KWK Rydułtowy-Anna.

In the period 1990–1998 a new shaft Leon IV was sunked with diameter 8.5 m, which rarely occured in Polish mining industry. In this period, it was decided that the shaft depth of 1076.2 m would allow development of the new level 1050 m, which would fully satisfy the mine operational needs. The large resource base of the mine at a depth of less than 1000 m and the need to avoid sub-level mining has become the basis for undertaking another investment consisting in deepening the Leon IV shaft to a depth of 1210.7 allowing development of next exploitation level 1150 m. In the year 2013, design works were started and the process of shaft pipe deepening and extension of two shaft hoists (main and auxiliary) to the depth of 1000 m have been started (https://vimeo.com/321070029).

Flexible-ropes guiding of the shaft hoist cages in the Leon IV were implemented for the first time in Polish hard coal mining industry. Shaft deepening and necessity of extension of shaft hoists to the depth of 1150 m constituted great challenge both for designers and the unit realizing building works. It should be noted that like in each active coal mine, deepening of the active shaft is related with necessity of its continuous and undisturbed operation. In case of such technological restriction, works related with shaft deepening call for special securities, among others leaving of the rock shelf called as natural bottom, or building in the shaft the so-called artificial bottom.

In such cases, transport works in deepened shaft section call for building of auxiliary hoist device with underground hoist machine of special turnstile adapter for personnel transport. Big-diameter hole used for transport, water drainage, and fresh air can greatly facilitate the works related with shaft deepening. However, in such cases, excavation on the level to which the shaft is deepened is needed. The shaft Leon IV can be a good example of application of new technical and technological solutions. Three of such solutions will be discussed in the present study:

- single-layer waterproof lining within the Section 782.0–932.0 m,
- shaft deepening technology within the Section 1076.2–1210.7 m, and
- extending of shaft hoists from the level 1000.0 (960 m) to the mining level 1050 m and auxiliary level 1200 m used for the mine water drainage.

2. Single-layer sulfate-proof lining

In original project of the shaft IV, two-layered lining with hydroinsulating shield made of PE foil was foreseen for the shaft Section 782,0–932,0 characterizing with occurrence of sulfate and magnesium waters. Such linings were commonly used by KOPEX—Shaft Building Company S.A. Sinking technology within the section in question foresees the following works [1]:

- between ordinates 784.5 and 786.0 m: building of the B15 class concrete lining (currently C12/15 concrete class),
- between ordinates 786.0 and 932.0 m: building of preliminary shaft lining (in direction from top to the bottom) in form of 0.56 m thick shaft concrete block wall,
- between ordinates 930.5 and 932.0 m: building of shaft brick made of B30 class concrete B30 (at present C25/30), and
- making of the inner layer of the final lining from concrete class B25 and B30 (at present C20/25 and C25/30) wet laid from the bottom up after laying on the walls and tight sealing of the 2 mm thick PE foil jacket.

Because at this time one of the Polish cement factories produced special Portland cement called as bridge portland cement CP 45(M) marked with symbol CP 45(M) resistant to strong sulfate and magnesium aggression, after research works executed in the AGH University of Science and Technology, modification of the construction and technology of completion of shaft lining section, has been proposed. New project of single-layered lining lied from the top to the bottom following the shaft face advance comprised making of 0.65-m-thick single-layered concrete lining lied in wet system. Due to the dependence of calculated pressure on the shaft lining, its bearing capacity was controlled due to concrete strength with use of two receipts [1] for concrete of class B25 marked as R25/1/2 and for concrete B30 marked as R30/1/4. All concretes were prepared on the basis of Bridge Portland cement CP 45(M).

Receipts developed in the AGH University of Science and Technology and verified by laboratory tests guaranteed suitable strength of the concrete and suitable bearing capacity of the lining of targeted thickness, as well as suitable water tightness of the level W8. Concrete lining was made in 4-m-long sections in direction from the top to the bottom. In such technology, waterproofness depends mainly on technological joints between upper (old) section and bottom (new) section. In the project in question, re-sealing of these joints was made first time in Polish shaft building with the use of injection hoses of the type FUKO 2 (**Figure 1**), with former opinion from Higher Mining Office concerning their security due to the presence of methane, after special tests were conducted in Experimental Mine Barbara in Poland. The injection hoses FUKO 2 were mounted to upper section of the shaft with use of metal connectors fitted with screwed joints. After the next lining, the section was concreted, the fissure was filled with a binding mixture on its whole length (see **Figures 1** and **2**) obtaining satisfactory sealing of the neuralgic element of the shaft lining.

Another issue that was solved during the construction of this shaft was the rock drainage system behind the lining. It is well known that water accumulation behind a waterproof lining is dangerous due to the possibility of high hydrostatic pressures appearing on the casing after joining various aquifers with a shaft.

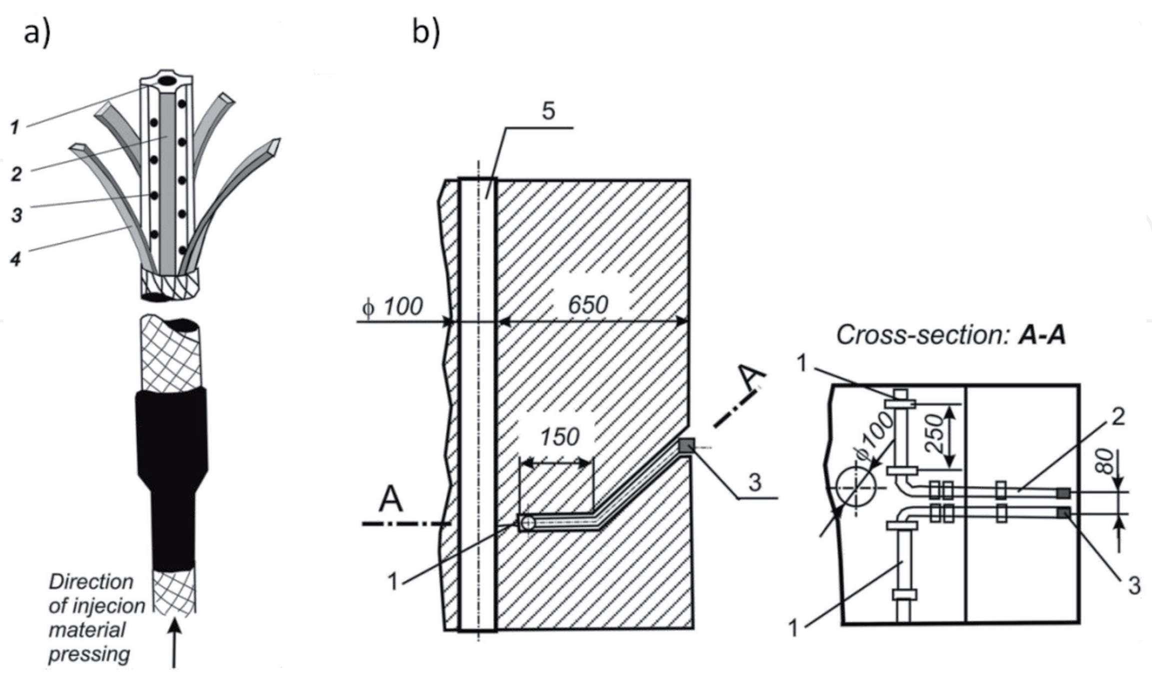

Figure 1.
Sealing system of the concrete shaft lining with use of hoses FUKO2 [1]. (a) Injection hose FUKO 2. Markings: 1—injection channel Φ = 10 mm; 2—hose core; 3—injection holes; and 4—neoprene ribbons playing role of non-return valves. (b) Housing of hoses in technological joint of sequent sections of the concrete shaft lining. Markings: 1—injection hose FUKO 2; 2—steel pipes; 3—threaded ending for pressure hoses; 4—technological joint between two concrete lining section; and 5—drainage pipeline for the rock body dewatering.

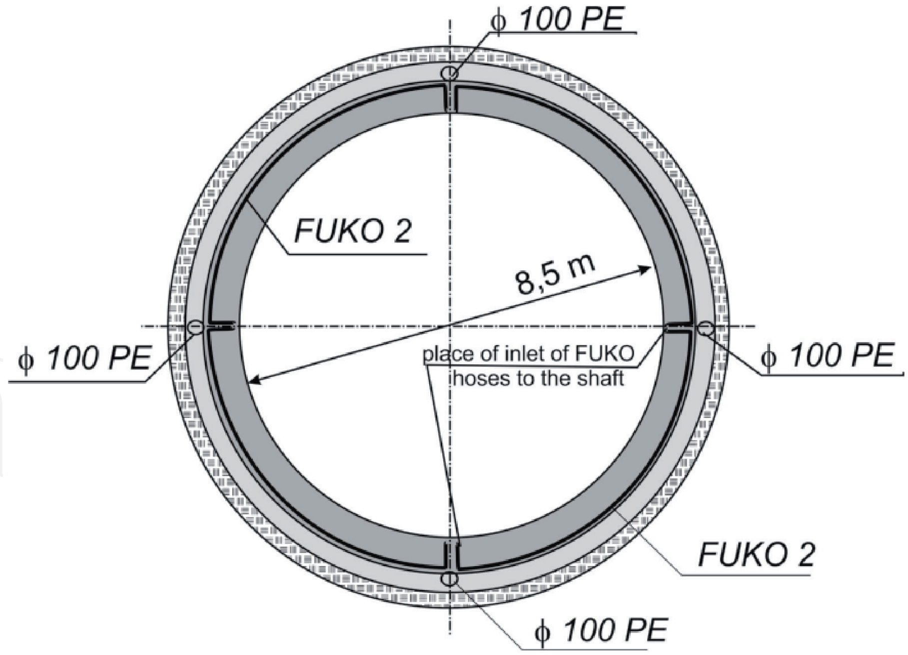

Figure 2.
Injection system via hoses FUKO 2 and rock body drainage system behind the shaft lining [1].

This problem was solved by laying vertical drainage 100 mm diameter pipelines on four azimuths along the lining arranged (**Figure 2**).

3. Chosen elements of the shaft Leon IV deepening

This, about 80-million PLN, investment in the Leon IV shaft deepening by next 140 m resulted from the necessity of the production processes' modification in the Rydułtowy mine [2]. This modification comprised first of all of shortening of the time of personnel transport to the shift face, as well as facilitation of the needed materials' delivery and considerable improvement of the ventilation of this part of the mine.

The investment task related with development of mine infrastructure in Leon IV region comprised the following activities:

- technical designs,
- physical shaft deepening and reinforcing,
- making the two-way inlet to pit bottom of exploitation level at the depth of 150 m,
- making the inlet to single-way pit bottom at the depth of 1200 m destined for needs of the mine main drainage system.
- elongation of mining hoists: main to the level of 1150 m and auxiliary to the depth of 1200 m, and
- installation of needed elements of mechanical equipment of the inlets to pit bottoms of both built levels.

Targeted depth of 1210.7 m was reached in August 2016. After completion of the reinforcing of the deepened shaft part in the year 2017, pioneering works in Polish mining industry works related with elongation of shaft hoists, including untypical and difficult elongation of guiding hoists accompanied by exchange of all leading ropes, have been executed (**Figure 3**).

3.1 Technology of the Leon IV shaft deepening

The Leon IV shaft was deepened to level 960 m, keeping full exploitation ability. Works related with shaft deepening were conducted with artificial bottom of

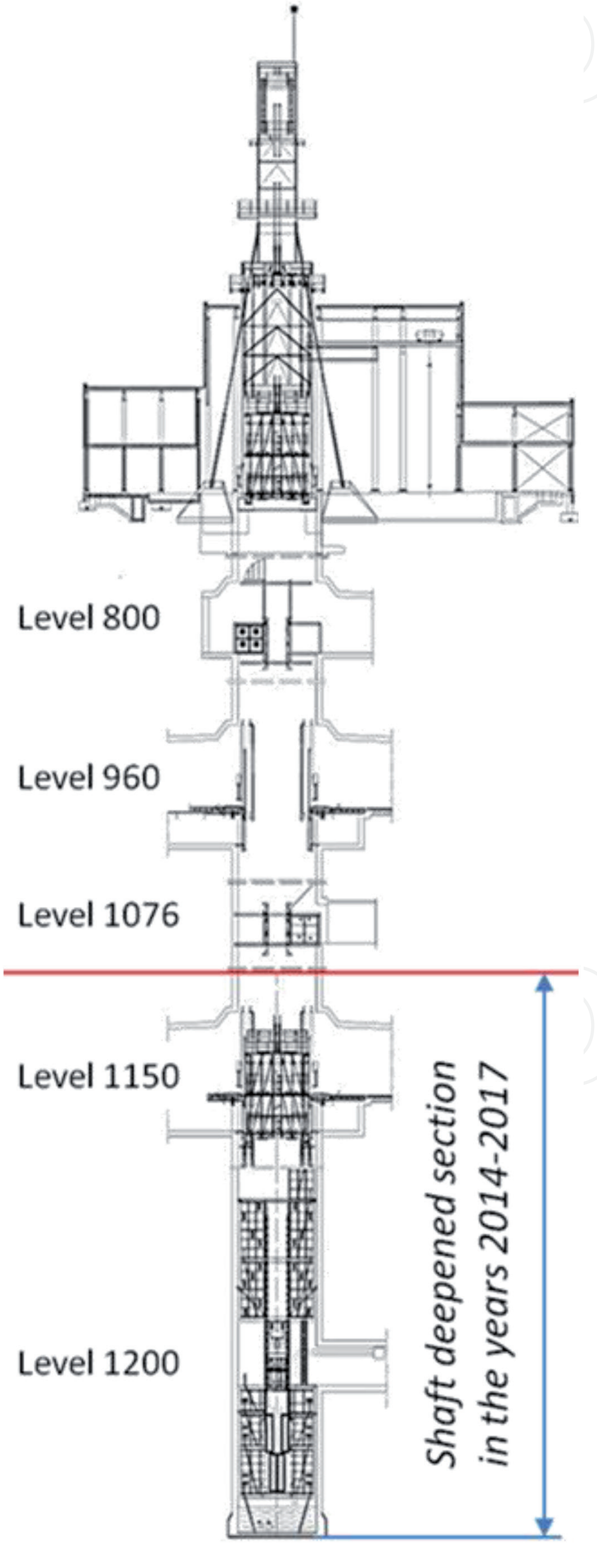

Figure 3.
Leon IV shaft profile [2].

special construction of two platforms joined with vertical partition. Mining works were conducted by standard method with use of explosives. Because haulage is the greatest problem in deepened shafts, in the case in question, at first a dike was made on level 1200 m, in order to make great diameter hole of the length of 115 m reaching the shaft bottom before deepening. The hole was located in such manner that its axis was located at a distance of 2.2 m toward east from the shaft axis, which allowed collision-free operation of the basket covering the hole inlet in the shaft face. The 1200 mm diameter hole was nevertheless endangered by the possibility of rock blockage. In order to remove the jam in the hole, a rope of 25 mm diameter with conveyor scrappers was installed in the hole. The rope vertical movements stimulated by low-speed winches KUBA-5 installed in ditches on the level 1076 and 1200 m, (see **Figure 4**) provoke fall down and the hole clearance.

Transport in the whole deepening process was handled by special devices located in ditch on level 1076 m (**Figure 4**):

- hoist machine B-1500 for bucket handling,
- two low-speed winches KUBA-10 for adjustable formwork handling,
- windlass KUBA-5 for rope handling,
- windlass KCH-9 for basket hanging protecting hole in shaft face, and
- supporting construction for assemblage of wheels during shaft deepening.

In the ditch, at the level 1200 m, low-speed windlass KUBA-5 with track wheel for the hole clearing rope (see **Figure 4**) was installed. Single–layered lining of C30/37 concrete lied in wet system with use of steel moveable formwork of the height 2.15 m, has been applied. Calculated and consulted with the Investor lining has thickness from 0.5 to 0.6 m. With respect to expected small and ephemeral water inflows into the shaft, no special waterproof precautions were designed [4].

3.2 Start-up of levels 1150 and 1200 m

Thanks to the Ruch Rydułtowy investment, it will allow the exploitation from coal seams No 713/1–2 and 712/1–2, which belong to the most promising mining assets within mining areas belonging to this part of Rybnik Mining District. Development of this part of the deposit will allow building the new level at the depth of 1150 m (https://vimeo.com/320940852). Two-way inlet is equipped with full set of the wheel transport handling, with special platform for material reloading from wheel into lifted gondola transport. The inlet performances are as follows:

- excavation founding depth: 1143.7 m,
- height: 7.3 m,
- width: W side—8.11 m and E side—7.0 m, and
- basement depth: 2.30 m.

The pit-bottom geometry with use of 3D visualization is shown in **Figure 5**. Universality is characteristic feature of the shaft pit–bottom 1150 m—main transport level (https://vimeo.com/333420960). Within this level there is a possibility of using three shaft hoists, what will considerably accelerate process of material lifting, as well as it will allow fast and fluent personnel transport. Using transport platforms forced equipping shaft pit-bottom basement with devices and machines needed for pushing mine trucks into large-size mining cages, as well as into standard cages. The deepening of the Leon IV shaft was also used to reorganize water management in this area. For this purpose, excavations needed for the main water drainage handling were localized in one-way pit-bottom at the level 1200 m, and the elongation of this level to auxiliary hoist was necessary, and it was requalified from auxiliary hoist into "small" hoist.

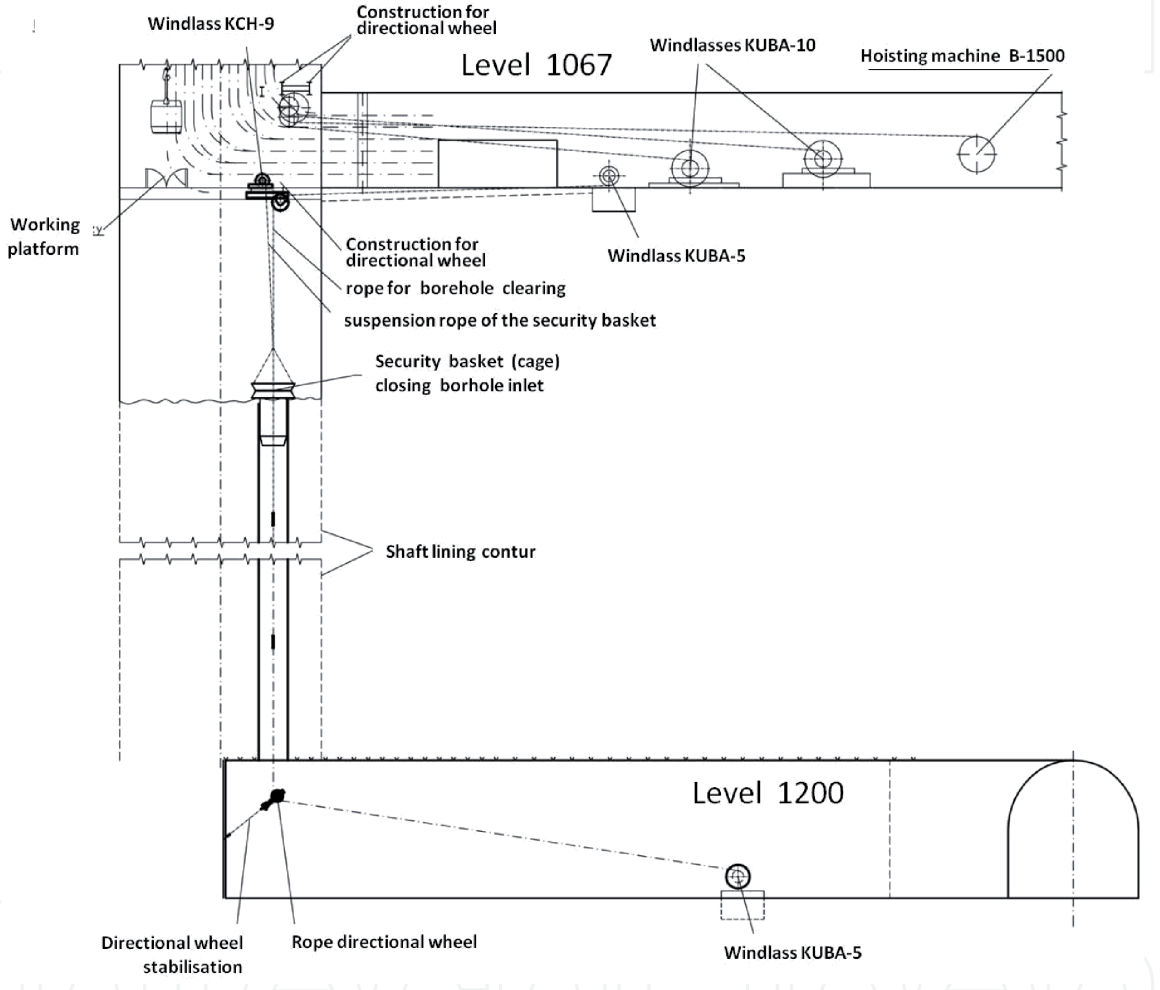

Figure 4.
Distribution of devices during Leon IV shaft deepening at levels 1076 and 1200 m [2].

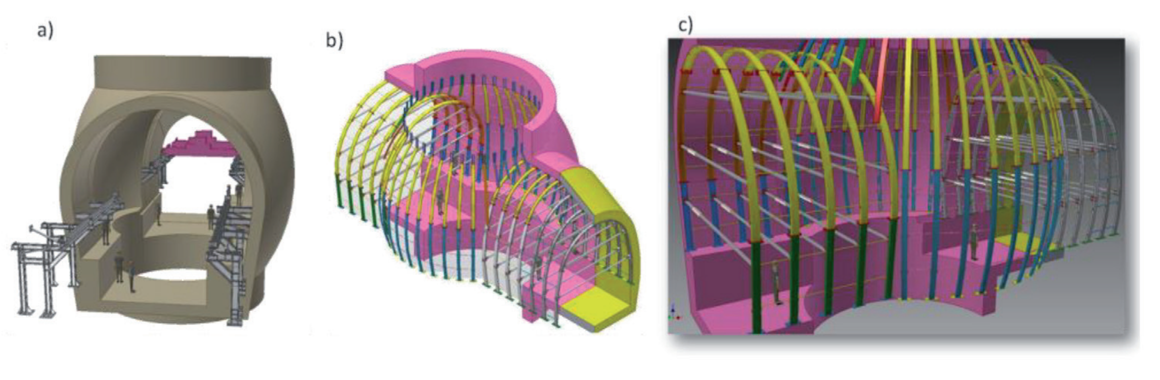

Figure 5.
3D model of the pit-bottom—level 1150 m [3]. (a) General view; and (b) and (c) 3D model of the steel-concrete pit-bottom lining.

Geometry of the shaft inlet at level 1200 m:

- depth of the excavation founding: 1195.7 m,
- height: 4.2 m, and
- width: 6.1 m.

The shaft inlet has anchor-concrete-steel lining and is equipped with level guidance construction with oscillatory platform in the inlet basement.

3.3 Furnishing of the shaft Leon IV

As the main transport shaft, the shaft Leon IV is equipped with three compartments: one for main hoist with large-size cage, second for ordinary three-deck cage, and auxiliary hoist. The shaft cages are suspended on two 48-mm-diameter rope carriers driven by drive wheel Koeppe. In order to balance masses of rope carriers, two equalizing ropes of diameter Φ = 53 mm are installed.

Shaft Leon IV is the first shaft in Polish hard coal mining industry, in which flexible guiding of shaft cages or skips has been extended. Guiding and defender ropes are suspended on wedge-shaped spreader beams located over beams of the shaft tower. The guiding and defender ropes hang down freely and are tensed by the attached weights of such mass that each 100 m of the shaft depth corresponds to tensing power of the value at least 8 kN. The guiding and defender ropes are mounted in special baskets located below lower guiding rope

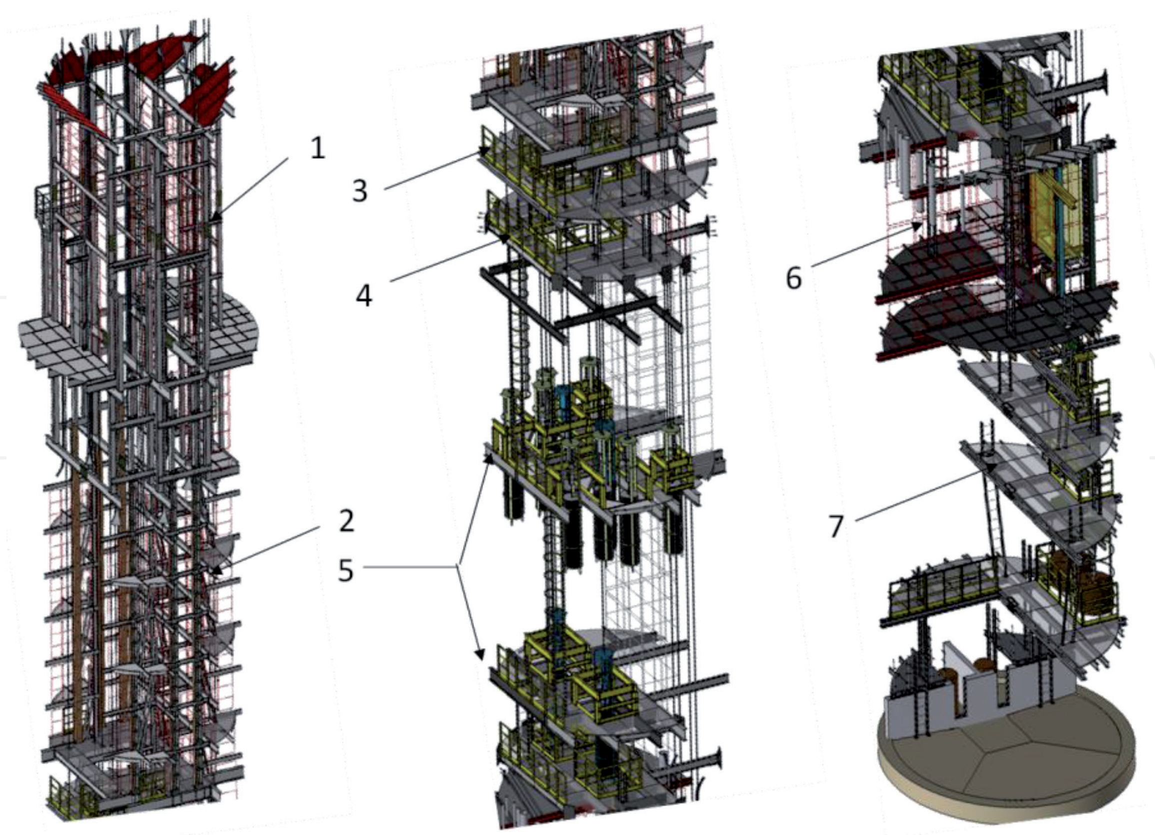

Figure 6.
Model of the Leon IV shaft furniture after deepening to the depth of 1210 m [2]. Markings: 1—level guidance at level 1150 m; 2—breaking system of the main shaft hoist; 3—return station of the equalizing ropes; 4—control platform of the equalizing ropes; 5—control platforms of guiding rope weights; 6—level guidance at level 1200 m; and 7—furniture of the Leon IV shaft sump.

frame. In case of the Leon IV shaft, the shaft furniture consists of the following elements: (**Figures 6** and 7).

Elastic guiding of the shaft cages comprises 12 guiding ropes, 4 defender ropes, and 3 rope carriers and equalizing ropes between large-size cage and three-deck cage (**Figure** 7).

Profits resulting from application of rope guiding of hoist cages or skips are great. The profits are as follows:

- low cost of used materials,
- easy handling,
- long durability,
- short assembling time in new shaft,
- guiding of the cages ore skips in the shaft is soft, without of tremors and side hits,
- possibility of fast shaft hoist operation,
- quiet run cages ore skips results in elongation of the rope carrier, and
- ventilation resistances are almost 10 times lower than in case of shafts with rigid guides.

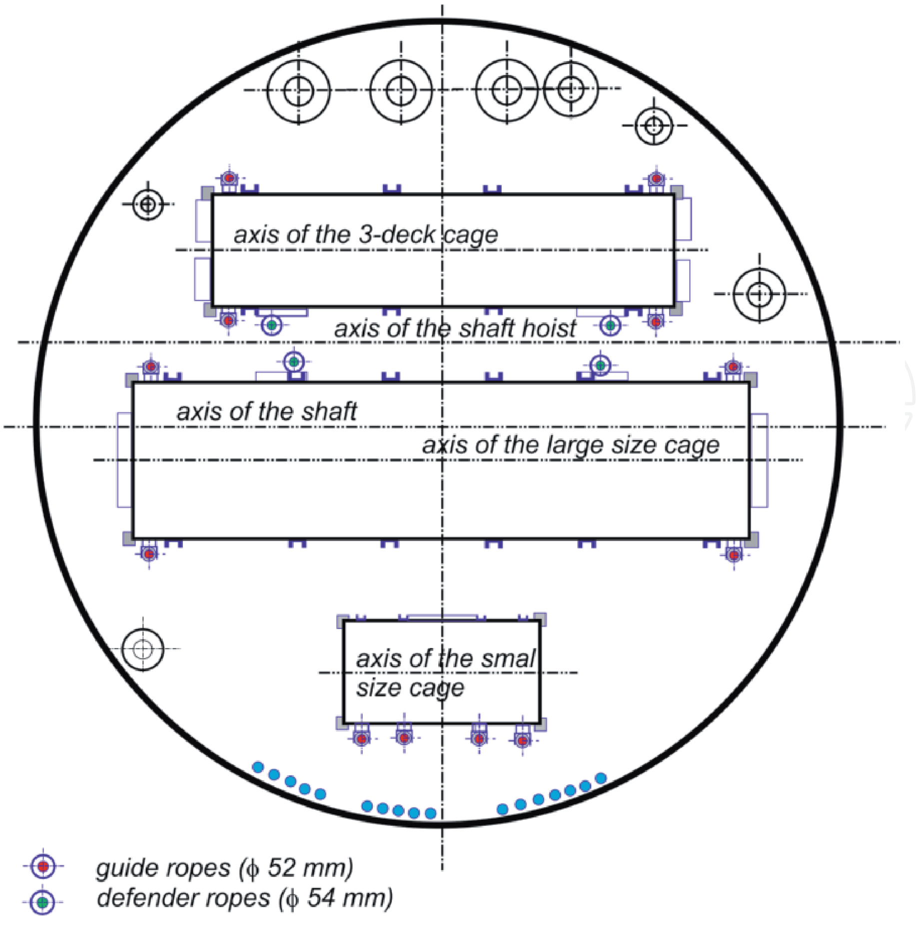

Figure 7.
Elements of the elastic guiding of shaft Leon IV.

Linear guiding of cages has also some disadvantages, like:

- possibility of transverse movements, which are vertical to the running direction, which calls for longer operation intervals than in case of rigid guides,
- serious difficulties in exploitation result—rock body movements,
- need of great size shaft diameters and difficulties related with relocation of shaft hoist devices in numerous transport sections,
- tensions of guiding ropes reaching values of 2000 kN causing additional loading of the shaft tower and application of suitable construction needed.
- rope tensioning devices require a properly managed sump,
- in case of application of two-cage hoists, the application of additional ropes called as “defender ropes” protecting against collisions of vessels moving in two different directions is needed.
- rope carrier must be made of non-rotating rope, and
- the main advantages of the application of such type of guiding result from the fact that the use of tens shaft fastening frames is not necessary.
- the main benefits of using this type of guide arise from the fact that the shaft does not require the installation of dozens of rigid guides frames.

The other element of the shaft furniture is related with main hoist cages’ braking system localized under level 1150 m and in the shaft tower. This system is composed of thickened wood guides. The other elements of the shaft furniture comprise:

- platform of the return station of equalizing rope,
- platform of equalizing ropes control system,
- positioning frame of weighs of guiding ropes and bumper ropes,
- control platforms of guiding and bumper ropes, and
- protective platform.

Necessity of equipping the flexible guidance with special corner guiding for shaft vessels is essential element of guiding on individual levels. In case of the shaft Leon IV it refers to levels 800, 1067, 1150, and 1200 m.

3.4 Elongation of mine shaft hoists

Shaft deepening is strictly related with necessity of mine shaft hoists. In case of the Leon IV shaft, in construction of elastic guiding of hoist cages to level 1067 m, the ropes longer than the exploited shaft were applied. Excess of ropes was stored on special drums located in pit-bottom of the level 1076 m. Thus elongation of these ropes required only suitable control of the rope destruction degree and then lowering them to the level 1150 m. Works related with elongation of the mine shaft hoist were started from auxiliary hoist and then lowering two guiding ropes of diameter Ø = 32 mm to level 1200 m. Weight of the rope of diameter 32 mm amounts for around 5.3 ton, whereas for ropes of diameter Ø = 54 mm, this weight reaches value over 25 ton. Thus, every rope maneuvers, that is, their raising or requires execution of assembling works with use of special hoist machine having high lifting capacity, as well as special guiding wheels mounted on special platform. Low-speed lifting machine EWP-35 was used for rope lifting and lowering. After making welded clamps and taking rope weight by lifting machine, disassembling was made in order to check condition of ropes by suitable expert. After acceptance of the ropes for exploitation, they were lowered to level 1200 m, where weighting baskets were mounted. Next stage of elongation of the shaft hoist comprised elongation of guiding and bumper ropes of main hoist, that is, unwrapping rope reserve accumulated at the level 1067 m. After installation of additional constructions of rope wheels on the platform on lower rope wheel of the Leon IV shaft, that is, directing technological rope of Ø = 40 mm in place of wedge-shaped spreader beam, stage of basal works related with taking and lowering ropes in targeted place have been started. When the welded clamps were installed and the weight was taken by low-speed lifting machine (40 ton), the rope was lifted to level of the foundation in order to be checked by the expert, and then the rope was lowered again to the level of weights control platform. After completion of the operations of the first rope, the guiding wheel was relocated on the platform in such a manner that operations of the next ropes would be possible. This operation was repeated eight times for guiding lines of the main hoist cages, and four times for bumper ropes located between both vessels of the same hoist. Scheme of devices needed for hoist elongation and visualization of the guiding wheels on the tower are shown in **Figure 8**.

Technology of the rope carriers and equalizing ropes in the shaft Leon IV is similar to standard technologies of ropes operated in mine shafts. In this case, at first, some preparatory works related with construction of foundation of the lift EPR-1000 and installation of sheave wheels have been executed in the shaft foundation. Carrying ropes were lowered to the shaft after placing shaft cages on special platform and taking the weight of ropes by portable lift EPR-1000.

After relocation of the great-size cage to the level 1150 m and installation of spreader beams, the equalizing ropes were elongated. In this case, the rising

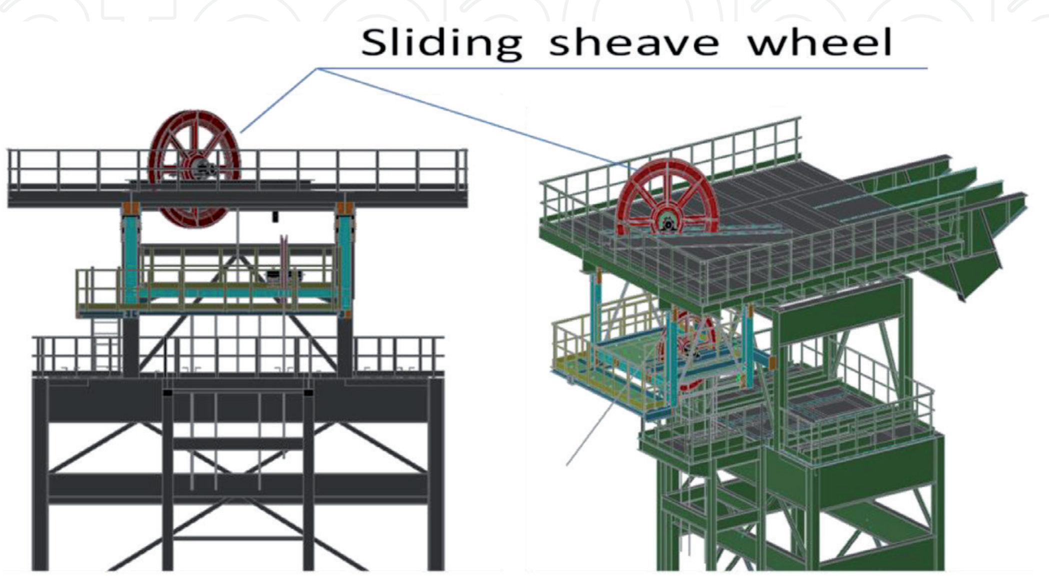

Figure 8.
Visualization of sheave wheel location on hoist tower [2].

large-size cage pulled new equalizing ropes. After relocation of three floor cages to the level 1150 m, construction of equalizing ropes under foot of three floor cage was completed.

3.5 Stabilization of the cage at the large-size Leon IV shaft hoisting system

Adjustable guiding system replaced the chairing mechanism of a rope guided cage at level 960 of "Leon IV" shaft. The mechanical part of the system is included in the project (**Figure 9**), developed to solve the issue of leading the cage through level 960. The most important factor taken into consideration was safety. With chairing, it could be ensured only at the expense of significant lengthening of the duration of a single cage ride from the ground level to level 1150 m and vice versa, since the velocity of the cage had to be reduced from 10 to 0.5 m/s, already 100 m before level 960 m. The changes between systems included replacing the angular guides with adjustable guides (including two pairs of upper and two pairs of lower guides) and the main support with four permanent frames, fixed to the shaft lining using additional girders, structurally independent from the construction of the chairing. In this arrangement, the adjustable guides can be switched between idle mode and working mode. The motion is restricted by:

- Part of a respective frame, known as roadway, serving as adjusting track for each pair of lower adjustable guides,
- Two articulated links (upper and lower), for each pair of upper adjustable guides,

Two pairs of lower adjustable guides are powered by a single hydraulic cylinder each, one end articulated to the guiding frame, the other to the guides itself. Each pair of upper guides is powered by two hydraulic cylinders, articulated with lower end to the frame, and upper end to the joint.

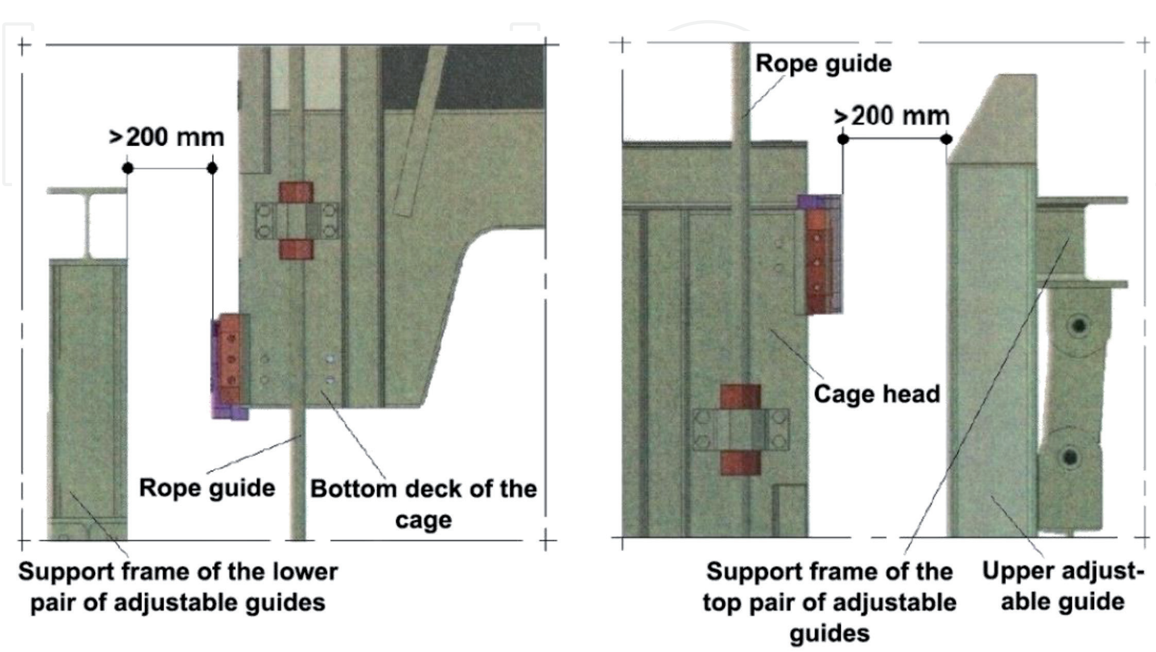

Figure 9.
System in idle mode.

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During the hoisting operation (whether it is from the ground level to level 1150 m or in the opposite direction), each pair of the adjustable guides stays in idle mode (**Figure 9**).

This setup ensures safe movement of the cage through level 960 with velocity of 10 meters per second. Idle mode is also used when the cage moves between level 950 m and 1150 m (both directions). Setting to working mode, decided by the signalman at level 960, takes place once the cage stops at level 960. During the cycle each of the upper ends of the lower adjustable guides is inserted between pads of the emergency braking slide guide, attached to the face of the bottom deck. The upper ends of the upper adjustable guides are inserted between pads of the emergency breaking slide guide attached to the face of the cage's head. The work mode setup of the bottom and top adjustable guides is shown in **Figure 10**.

Layout of the entire system is shown in **Figure 11**. The adjustable guides consist of 180 x 260 mm box beams made of C260 C-profiles. Frames made of HEB 260 are attached to two technological beams with M24 Hex bolts, class 8.8.

Static analysis was performed for the constructions. Assumptions and results are shown in the schemes below:

Static analysis—lower frame

Known variables:

- Transportation unit load: 200 [kN]
- Continuous load:

$$q = \frac{200\ [kN]}{1.654\ [m]} = 120.92\ \left[\frac{kN}{m}\right] \tag{1}$$

The assumed load rounded to the value of 121 kN/m

- Factor of safety

$$\frac{480}{62.87} = 7.63 \tag{2}$$

- Force from the hydraulic cylinder: 139.2 [kN] (**Figure 12**)

Static analysis—upper frame

Known variables:

- Transportation unit load: 200 [kN]
- Continuous load:

$$q = \frac{200\ [kN]}{1.654\ [m]} = 120.92\ \left[\frac{kN}{m}\right] \tag{3}$$

The assumed load rounded to the value of 121 kN/m

- Factor of safety

$$\frac{480}{75.09} = 6.392 \tag{4}$$

- Force from the hydraulic cylinder: 139.2 [kN] (**Figure 13**)

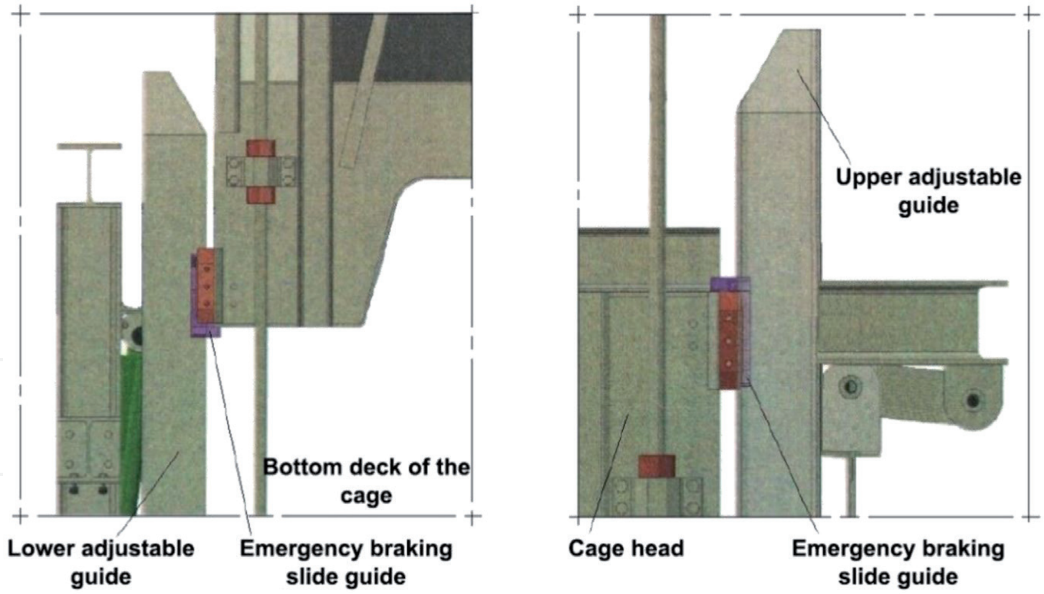

Figure 10.
System in working mode.

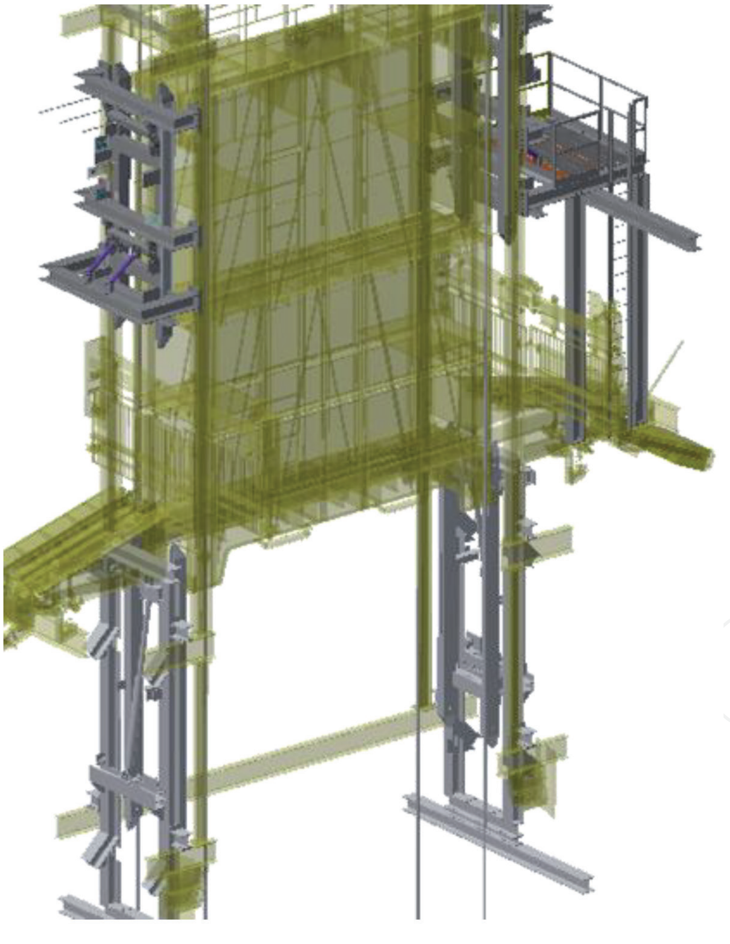

Figure 11.
Layout of the adjustable guiding (gray color).

Measurements

The main purpose of measurements was to determine:

- maximum forces applied to the head and the bottom deck of the cage during experimental cycles of loading and unloading the heaviest transportation unit approved for this type of transportation, performed at level 960,

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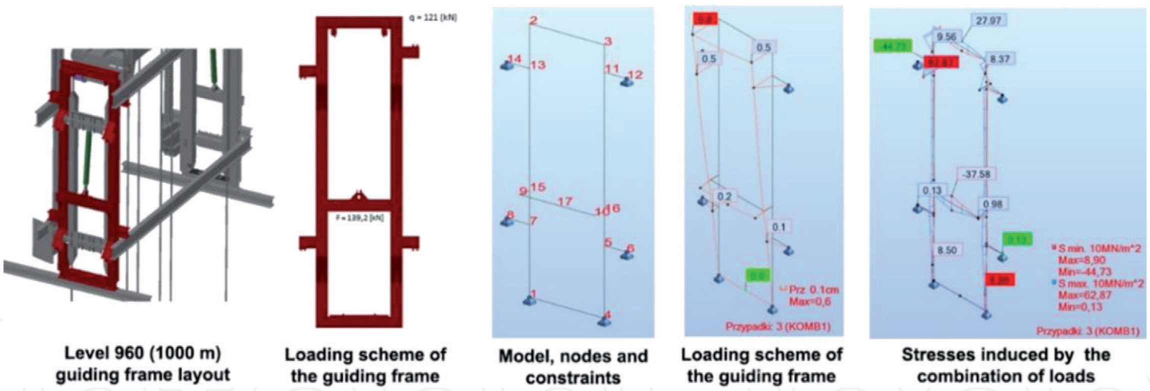

Figure 12.
Static analysis for the bottom frame.

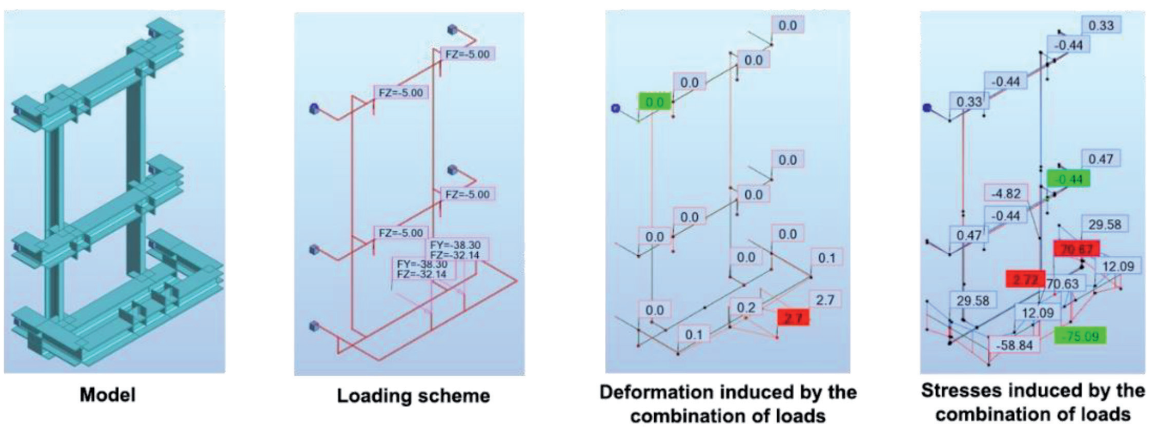

Figure 13.
Static analysis of the upper frame.

- maximum stresses induced in girders of the cage during experimental loading and unloading cycles, being the result of absorbing forces from the adjustable guides.

The force measurements were conducted accordingly to the previous ones, carried out on exactly the same cage in July 2018, also concerning the forces absorbed the cage during the experimental loading and unloading cycles, but forces from angular guides were replaced with forces from adjustable guides. Moreover, the scope did not include measuring the stresses induced in girders as a result of absorbing forces from angular guides, as these guides were also stabilizing the middle deck during the experiments.

The reason for adding stress measurement was the necessity to properly assess whether resigning from stabilization of the middle deck of the cage in this arrangement may be considered a viable assumption. Theoretical analysis based on calculation model from [5] demonstrated such possibility; however, empirical verification was deemed vital. It was implemented by equipping the main measurement unit with two external modules attached to the middle deck for the time of measurement operations. The cycles were divided in two stages:

- Stage one, covering the first six experimental loading and unloading cycles, concerned measuring the forces at the bottom deck of the cage as well as stresses induced in girders on the distance between the middle deck and the lower deck,

- Stage two, covering the following six experimental cycles, concerned measuring the forces at the top deck of the cage as well as stresses induced in girders on the distance between the middle deck and the head.

4. Conclusions

Technical problems related with the shaft Leon IV sinking and deepening presented in this chapter can be considered as an example of continuous innovation and development of the shaft building technology. Although nowadays shafts are rarely deepened, high level of modern technique and mechanization of both sinking and equipping the shafts indicate potential possibilities of further development of this building branch.

Application of new bridge cements M45 and modification of the philosophy of assuring the shaft lining tightness even during building the shaft Leon IV allowed implementation of very profitable replacement of multilayered lining with single-layer lining, which is less time-consuming and much cheaper.

Shaft deepening during its exploitation was possible only in result of application of modern construction of "artificial bottom," which tightly separated the shaft from the area of works conducted by the company named as Shaft Building Company S.A. (PBSz).

Application of elastic system in the shaft Leon IV in hard coal mining industry and use of much more longer ropes and storage of the rope surplus on the level 1078 m can be classified as the uniquely far-sighted project. This in turn allowed implementation of much more easy technologies of shaft hoists elongation.

Designed by Shaft Sinking Company, elongation of the shaft hoists, which was realized in possibly shortest stoppage of the shaft operation, was a pioneer and innovative venture. Total work comprised elongation of 20 ropes.

Modernization of the shaft Leon IV was a key element of the restructuring plan and development of the joint-venture mine ROW gathering mines: Jankowice, Chwałowice, Marcel, and Rydułtowy. Elongation of shaft hoists, development of main transport horizon at the level 1150 m, and development of the main drainage system at level 1200 m will allow considerable shortening of the time of personnel transport to exploitation excavations, which is related with considerable improvement and elongation of the personnel working time, that is, improvement of financial results of mine operation and whole mine ROW.

Conducted analysis and research confirm that the mechanical system, its attachment to the shaft lining and particular structural elements of the tested solution are correct and fulfill the conditions defined in the Decree of the Minister of Energy from November 23, 2016 concerning the detailed requirements of operating in underground mines (Journal of Laws of the Republic of Poland 2017, item 1118), as well as in the technical standard PN-G-46227: 2002—Mining shafts. Shaft equipment. Requirements.

Changes introduced at level 960 m (1000 m), made according to Annex No. 2, included removing the corner guides of the cage. The additional space obtained between the chairing elements ensures the safe passage of the cage through level 960 with the set velocity of 10 m/s, assuming the requirement of § 545 of the Decree of the Minister of Energy is met. After analyzing the results of measurements of the forces from bottom deck and the head of the cage absorbed by adjustable guides during loading and unloading cycles, it can be stated that replacing the corner guides with adjustable guides does not violate this approval.

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