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TEHNIČKO REŠENJE PODGRAĐIVANJA RUDARSKE PROSTORIJE U SLOŽENIM GEOTEHNIČKIM USLOVIMA

Izvod

U radu je prikazano tehničko rešenje podgrađivanja deonice rudarske prostorije „prekop k+45“, u jami „Strmosten“ Rudnika mrkog uglja „Rembas“, izrađene u nepovoljnoj sredini sa stanovišta osiguranja i podgrađivanja.

Tehničko rešenje rekonstrukcije zasnovano je na kombinovanom podgrađivanju prskanim betonom čeličnim okvirima i livenoj betonskoj oblozi.

Ključne reči: *rudnik, ugalj, rudarska prostorija, podgrađivanje*

1. UVOD

Podgrađivanje podzemnih rudarskih prostorija u radnoj sredini koja se kategoriše kao teška sa geotehničkog stanovišta je izuzetno složen zadatak. Svaka izrađena rudarska prostorija u jami treba da zadrži svoju funkcionalnost za predviđeni vek korišćenja, uz što manje troškove održavanja i rekonstrukcije.

Podgrada prostorije prima opterećenje okolnog masiva tako da kod pojačanih jamskih pritisaka nastupaju deformacije podgrade i suženja profila prostorije, koje ponekad može dovesti i do potpunog zatvarnja. Da bi se izbegle ove pojave vrše se rekonstrukcije prostorija, koje su sa tehničkog stanovišta teške i nesigurne, a sa ekonomskog stanovišta skupe, gotovo kao sama izrada.

Uzevši u obzir navedeno već kod projektovanja tehnologije rada, a kasnije kod izrade prostorija nastoji se izabrati takav sistem podgrađivanja i osiguranja kojim će se obezbediti stabilnost podgrade i funkcionalnost profila prostorije.

Poseban problem u rudarskoj praksi je izrada prostorija u glinovitim naslagama sa pojavama vode, kada usled izraženog svojstva bubrenja glina dolazi do pojačanog pritiska na podgradu. U takvim uslovima podgrada sa drvenim okvirima je krajnje nefunkcionalna a sa čeličnim okvirima takođe može biti neadekvatna za duži period korišćenja prostorije. U pojedinim slučajevima čak i kombinacija čelične podgrade i livenog betona je imala izražene deformacije, te se moraju tražiti i specifična rešenja.

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Jedno od takvih rešenja je i podgrađivanje denice prekopa k+45 u jami „Strmosten“ RMU „Rembas“-Resavica.

2. OSNOVNI PODACI O PREDMETNOJ RUDARSKOJ PROSTORIJI

Rudarska prostorija prekop +45 m izrađena u jami „Strmosten“ predstavlja kapitalnu rudarsku prostoriju, namenjenu za izvođenje glavne jamske vazdušne struje i dopremu repromaterijala po donjoj pruzi vagonetima sa lokomotivskom vučom.

Prostorija je izrađena na dubini od oko 400m ispod površine terena, pri čemu je dužina prostorije 1150 m, od čega je 750 m urađeno u krečnjačkim stenama, a 400 m kroz sivi i crveni peščar sa umetcima gline. Prostorija je izrađena klasičnom bušačko-minerskoj tehnologijom sa podgrađivanjem čeličnom lučnom podgradom od RI-profila na razmaku 1,0 m i zalaganjem sa rezanom hrastovom daskom. Nakon izrade prostorija je više puta rekonstruisana na deonicama u sivom i crvenom peščaru, pri čemu su ugrađeni čelični okviri od ojačanog zvonastog profila sa smanjenim razmakom podgrađenih okvira od 0,8 do 0,4 m.

I pored izmenjenog načina podgrađivanja nastupale su deformacije te je periodično vršena rekonstrukcija, a da bi se ovo izbeglo dato je novo tehničko rešenje podgrađivanja ugrožene deonice prostorije prekopa k+45 m.

Ovo tehničko rešenje zasniva se na rekonstrukciji prostorije u dužini od 400 m i ugradnji stalne podgrade (armirano-betonska obloga).

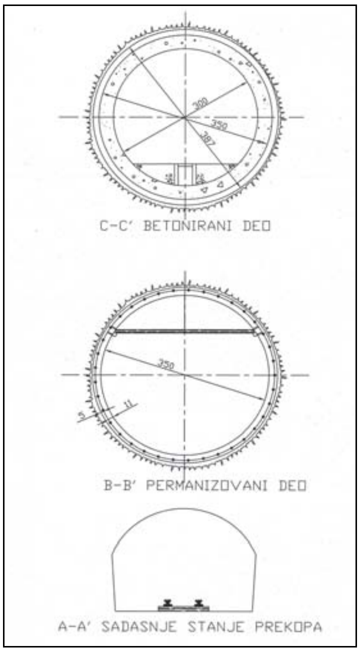
3. TEHNIČKO REŠENJE PODGRAĐIVANJA

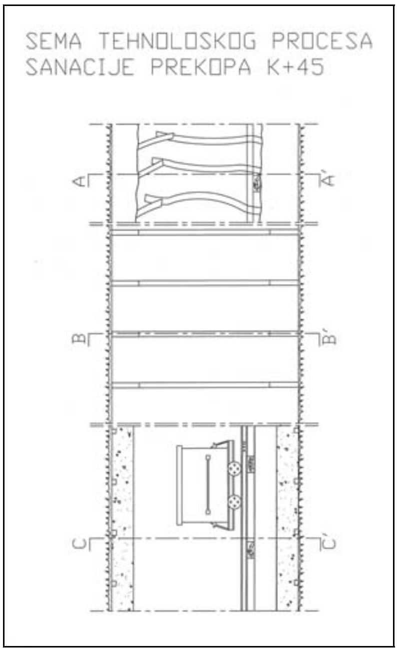
Tehničko rešenje osiguranja i podgrađivanja deonice prostorije prekop k+45m zasniva se na realiz

aciji sledećih radova:

- rekonstrukcija, i
- podgrađivanje sa definitivnom betonskom oblogom

Na slici 1. dat je izgled deformisanog profila pre rekonstrukcije (manje od 4 mm^2) i šema procesa sanacije odnosno rekonstrukcije.





Rekonstrukcija prostorije vrši se putem sledećih radnih operacija: vađenje deformisane podgrade, obrada profila do projektovane veličine, utovar iskopanog materijala, privremeno podgrađivanje i odvodnjavanje.

Izrada profila prostorije sastoji se u skidanju materijala iz stropa, pouzimanja bokova i podine sa ručnim rudarskim alatom i otkopnim čekićima, a u težim slučajevima i miniranjem. Utovar iskopa-nog materijala vrši se ručno i sa uto-varnom lopatom u jamske vagonete, koji se odvoze lokomotivom do glavne izvozne prostorije. Ove radove prati ugradnja privremenog koloseka i pomoćne preno-sne skretnice.

Nakon dovođenja profila prostorije u projektovano stanje, u cilju osiguranja iskopa i zadržavanja profila prostorije pre izrade definitivne armirano-betonske obloge, izrađuje se obloga od prskanog betona u dva sloja debljine 5 cm. Prskanje se izvodi sukcesivno sa radovima rekonstrukcije pri čemu dužina kampade koja se prska iznosi 1,0 m, a ono omogućava da se rad obavlja kontinuirano bez zastoja celom dužinom kampade.

Prskani beton ravnomerno se nanosi na obrađeni profil i na taj način obrazuje oblogu koja već nakon par sati posle nanošenja dostiže čvrstoću od 0,8 N/cm^2, što omogućava rad na podgrađivanju čeličnom podgradom. Čvrstoća prskanog betona dostiže i do 60 N/cm^2 a otpornost na zatezanje 5-15 N/cm^2.

Formiranje sloja prskanog betona vrši se stalnim udarcima zrnaca agregata iz mlaznice, te je nabijanje od sloja do sloja ravnomerno. U ovom slučaju, pošto je predviđen nabijanje dva sloja, upotrebljava se dodatak za brzo vezivanje prskanog betona. Za ugradnju prskanog betona od opreme se koristi pumpa za beton, mešalica za beton i priključci sa mlaznicom na komprimirani vazduh.

Na sveže ugrađeni prskani beton u dužini prostorije od 1,0 m postavlja se spoljna armaturna mreža Q 283, a onda montira okvir čelične podgrade prečnika 3,5 m po zadatim elementima.

S obzirom da je u prostoriji koja se rekonstruiše prisutna tekuća voda to se odvodnjavanje vrši tako što se u nekonstruisanom delu izradi privremeni vodosabirnik iz koga se voda pumpom izbacuje u vodosabirni kanal u rekonstruisanoj deonici.

Sama izrada deformisane podgrade od armirane betonske obloge vrši se sledećim radnim operacijama:

- postavljanje unutrašnje armaturne mreže Q 283,
- postavljanje i centriranje klizne oplate,
- spravljanje i ugradnja betonske mešavine u oblogu prostorije

S obzirom da je prečnik čeličnih lukova 3,5 m i da je svetli profil prostorije 3,0 m to debljina betonske obloge iznosi d=28 cm.

Betoniranje se vrši u kampadama dužine 4,0m po fazama, na sledeći način:

- U prvoj fazi betoniraju se stope u dužini 8-12 m. Postavljanje oplate za betoniranje stopa vrši se uz strogu geodetsku kontrolu tako da se nakon betoniranja stopa dobiju površine koje prate nagib prostorije i koje služe kao oslonac za centriranje remenata za betoniranje gornjeg i podnožnog svoda potkopa.
- U drugoj fazi doprema se oplata i centrira na izbetonirane stope i betoniraju se bokovi i kalota kroz otvore na oplati.
- U trećoj fazi betonira se podnožni svod.
- U četvrtoj fazi betonira se kanal za vodu.

Spravljanje i ugradnja betona vrši se pomoću pneumatske kontinualne mašine za spravljanje i ugradnju betona, takozvanog „Spirokreta“.

Po završetku betonskih radova na podnožnom svodu i izrade kanala preostali slobodni profil se nasipa tucanikom nakon čega se pristupa polaganju stalnog šinskog koloseka, pri čemu osovina koloseka prati podužnu osovinu prekopa.

4. ZAKLJUČAK

Po obrađenom tehničkom rešenju izvršena je rekonstrukcija i podgrađivanje deonice prostorije prekopa k+45 m u dužini od 400 m.

Praćenjem ponašanja prostorije nakon izvršenih radova nisu primećene deformacije podgrade i smanjenje profila, te se zaključuje da je dato rešenje adekvatno uslovima radne sredine.

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TECHNICAL SOLUTION OF SUPPORTING THE MINING FACILITIES IN THE COMPLEX GEOTECHNICAL CONDITIONS

Abstract

This paper describes the technical solution of supporting a part of mining facility "dig κ+45", in the pit "Strmosten" of the Brown Coal Mine "Rembas", made in unfavorable area from the standpoint of security and supporting.

Technical solution of the reconstruction is based on the combined supporting using the sprayed concrete with steel frames and cast concrete lining.

Keywords: *mine, coal, mining room, supporting*

1. INTRODUCTION

Supporting the underground mining facilities in the workplace, categorized as difficult from the geotechnical point of view, is an extremely complex task. Each constructed mining facility in the pit has to retain its functionality for intended service life with the least costs of maintenance and reconstruction.

The support of facility receives the load of surrounding massive such as, under increased pit pressures, the support deformations occur and narrowing of facility profile, which can sometimes lead to a complete closing. To avoid this problem, the reconstruction of facilities is done, which are difficult from a technical standpoint and unsafe, and costly from an economic standpoint, almost like the construction.

Taking into account the above given, in the design of operation technology, and later in making facilities, it is tried to choose a system of supporting and security that will secure the stability of support and functionality of the facility profile.

A particular problem in mining practice is making the facilities in the clay layers with the occurrences of water and due to the pronounced swelling properties of clay, the increased pressure is on a support. In such conditions, the support with wooden frames is extremely dysfunctional and with steel frames it can also be inadequate for long-term use of facility. In some cases even a combination of steel support and cast concrete supports the pronounced deformations, and the specific solutions have to be looked for.

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One of these technical solutions is supporting a part of mining facility “dig к+45“, in the pit "Strmosten" of the Brown Coal Mine "Rembas"- Resavica.

2. BASIC DATA ON THE SUBJECT OF MINING FACILITY

The mining facility “dig к+45“, made in the pit "Strmosten", is a capital mining room intended to perform the main pit airflow and delivery of raw materials on lower rail with locomotive-drawn wagons.

The room was made at depth of about 400 m below the surface, where the length of room is 1150 m, out of which 750 m was done in the limestone rocks, and 400m through gray and red sandstone with clay inserts. The room was made using the classic drilling-blasting technology with supporting of steel arched supports of the RI-profiles at distance of 1.0 m and with the carved oak plank. After construction, the room was many times reconstructed on sections in gray and red sandstone, with built steel frames of reinforced bell profiles with reduced distance of supported frames of 0.8 to 0.4 m.

Although the support was changed, the deformations occurred and the reconstruction was periodically performed, and to avoid this, a new technical solution of supporting was given for threatened section of the dig k +45 m room.

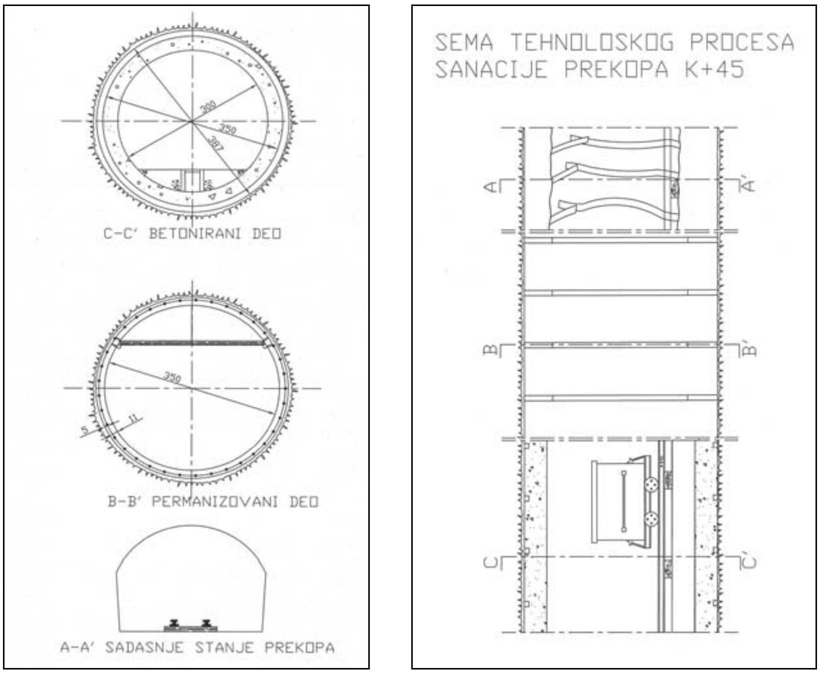
This technical solution is based on the room reconstruction with length of 400 m and installation the permanent support (reinforced concrete lining).

3. TECHNICAL SOLUTION OF SUPPORTING

Technical solution of security and supporting a part of the dig k+45 m room is based on the realization of the following works:

- reconstruction, and
- supporting and with a definite concrete lining

Figure 1 gives a view of deformed profile before reconstruction (less than 4mm^2) and scheme of the rehabilitation and reconstruction process.



Reconstruction of the room is done through the following working operations: the extraction of deformed support, processing of profile to the designed size, loading of excavated material, and temporary supporting and dewatering.

Development of the room profile consists of material removal the ceiling, taking the sides and footwall with hand mining tools and excavation hammers and, in severe cases, by blasting. Loading of excavated material is carried out manually with a loading shovel into the pit wagons, which are transported by locomotive to the main export facilities. These works are followed by the installation of temporary tracks and auxiliary transmission switch.

After bringing the room profile in designed state, to ensure the excavation and retaining the room profile before development the final reinforced concrete lining, the lining is made of sprayed concrete in two layers, thickness of 5cm. Spraying is carried out successively with reconstruction works in which the sprayed section length is 1.0 m, and it allows continuous work without interruption along the whole section length.

Sprayed concrete is applied equally to the processed profile and thus form a coating that within a few hours after application reaches strength of 0.8 N/cm^2, allowing the supporting with steel support. The strength of sprayed concrete reaches up to 60 N/cm^2 and tensile strength of 5-15 N/cm^2.

Formation of sprayed concrete layer is carried out by permanent shocks of aggregate grains from nozzle, and the compaction of the layer to layer is equal. In this case, as compaction of two layers is predicted, the addition for quick bonding of sprayed concrete is used. Concrete pump, concrete mixer and connections with nozzle on compressed air are used for sprayed concrete.

On fresh installed sprayed concrete in room length of 1.0 m, the outer armature network Q 283 is set, and then the frame of steel support, diameter 3.5 m, is installed with the specified elements.

Since the liquid water is present in the room under reconstruction, drainage is done by construction a temporary water collector in unconstructed part from which water is discharged with pump into a water collector channel in the reconstructed section.

Development the deformed support of reinforced concrete lining is carried out by the following operations:

- Installation the internal armature network Q 283,
- Installation and alignment of slide plating,
- Preparation and installation of concrete mixture into the room lining.

Since diameter of steel arches is 3.5 m and light profile of the room is 3.0 m, then the concrete lining thickness is d = 28 cm.

Concreting is done in sections, length of 4.0 m in stages, as follows:

- In the first stage, the feet are concreted in length 8-12m. Setting of formwork for feet concreting is carried out with strict geodetic control so that the surfaces are obtained that follow the slope of the room and serve as a support for centering for concreting the top and invert arch of a dig.
- In the second stage, the formwork is delivered and centered on concreted feet and the blocks and spherical sections through the openings in the formwork.
- In the third stage, the foot arch is concreted.
- In the fourth stage, the channel for water is concreted.

Preparation and installation of concrete is done using the pneumatic continuous machines for making and installation of concrete, so-called "Spirokreta".

Upon completion of concrete works at the foot arch and development of the channel, the remaining free profile is filled with gravel after which the permanent rail tracks are set, where the track axle follows the longitudinal axis of digs.

4. CONCLUSION

After processed technical solution, the reconstruction and supporting of a part the dig k+45 m room in length of 400m were done.

Observing the room behavior after carried out works did not point out support deformations and profile reduction, and it is concluded that the given solution is adequate to the conditions of working environment.

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