

# Optimization Research on the In-pit Haulage System Development Under Open Pit and Underground Mining Conditions

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**Abstract:** Against the need of Large Surface Coal to carry out pit and underground mining to recovery residual coal outside the realm of end wall, analyzed the Inadequate of original layout of development and transportation system, Proposed the proposal of Pit and underground mining Share one set of end wall tunnel belt conveyor systems .Application roadway belt conveyor transport system as the main open pit coal transport system to help achieve Grade separation of coal transport system and strip transport system, layout the crusher at the bottom level, Shorten the interaction of coal truck distance and the reduce production system; Follow the open-pit end wall tunnel as underground mining of exploitation transportation roadway, Use band layout to recovery the open air outside the realm of residual coal, Can reduce the amount of shaft development projects and exploration costs, this paper use the ATB coal mine as a example, analyzed the feasibility and economic benefits of use the development plan of recycling residues outside the Boundary of 9 # coal seam.

**Keywords:** open pit and underground mining; in-pit haulage system development; end wall tunnel; belt conveyor; residual coal

## 1 Introduction

Open pit and underground mining commonly used in mining shallow coal seam, or deposit, this mode only hope as much as possible to avoid waste of resources, but also must consider the interaction between the mining system<sup>[1]</sup>. Large-collapse landslides in the Southern Dump of ANTAIBAO Surface Coal Mine of China National Coal Group Corp. as underground mining impact, severely affected the normal production of open pit mine. In view of the problems of open pit and underground mining of thick coal seams, the joint optimization of development and transportation systems were done in this paper, in order to improve the economic benefits of mine development like the premise of ensuring safety in production.

## 2 research Status

In 2004, China International Engineering Consulting Corporation on the inclined slope mining to open pit mining the impact of the analysis and research. In March 2005, the Geotechnical Engineering Institute of China University of Mining and technology (Beijing) take the Northwestern Slope of ATB Open pit Mine as research background, to complex mining conditions of circular slope mining and sequence optimization of the process by underground mining of rock slope

deformation and failure of trend forecasting, and made corresponding engineering control measures. in March 2006, Wuhan, ZHONGHAN Geotechnical Engineering Technology Development Company and Wuhan University of Technology demonstrated Well No. 2 B900 caving face mining feasibility and major hazards.

Can be seen from the above analysis, the existing research aimed at pit and underground mining conditions, open pit slope stability, while the joint optimization of production systems very little.

## 3 General Development Plan

Most of the existing open pit and underground mining are after the first open-pit mining to underground mining or underground mining after the first open-pit mining, so the open pit and shaft mining development and transportation design and more independent.

### 3.1 open Pit Mine Development

For large-scale open pit mine which expend near level coal seams, since there is no fixed non-working to help, so commonly used to help move the pit line to open up the work. Shown in Fig 1. Its main advantage is to develop the transport system does not take up pit side to help, problem caused by the transport of materials returned, so the higher cost of production. To reduce production costs, mining semi-continuous process system application is the development trend of

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open pit production process, the main form of technology in the form of single-bucket excavator - dump trucks - crushing station - belt conveyor, crusher station general arrangement in mining venue for help, or help to reduce the truck-side distance, end to help improve both transport and use of belt conveyors.

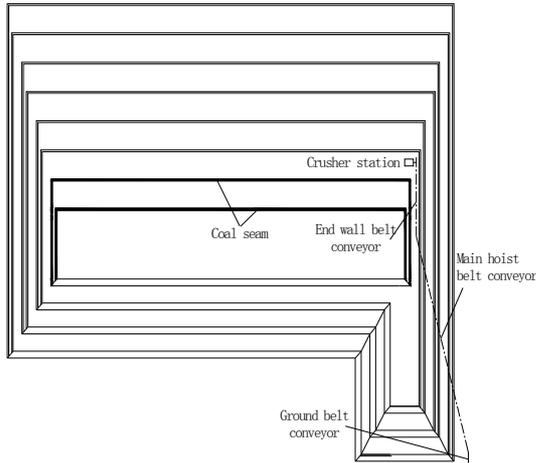


Fig 1 temporary ramp development open pit mine

### 3.2 Underground Mine Development

The following issues must be solved in underground mine explore: Shaft and layout of industrial facilities, mining the level of division of roadway and the bottom yard layout, mine depth extent in form, optimization of transport systems<sup>[11]</sup>.

There are three main shaft development forms, adit, incline shaft and vertical shaft. The use of adit was limited by the terrain and the burial conditions, so its application scope is smaller. Compared to the vertical shaft explore, the inclined shaft explore with the following advantages. First, the shaft construction technology, equipment and processes is simple, and shaft driving is faster. Secondly, shaft construction unit price is lower, the ground of industrial buildings, shaft equipment, parking lots and bottom chamber are relatively simple. Thirdly, the initial investment less; shaft extending convenient construction of production less interference, less susceptible to the threat of aquifer floor. Fourthly, by belt conveyor to enhance capacity, inclined shaft explore can meet the needs of large mine hoist. Finally, the inclined shaft can be used as an emergency exit. For resources which suitable for open pit and underground mining is general shallow, so the underground mining mostly use inclined shaft explore.

Based on the advantages of belt conveyor, such as large production capacity, simple conveyor system layout, low cost, safety and reliability, as well mines by

conveyor transport device to the main roadway into the mainstream.

Underground mine development transportation system layout shown in Fig 2.

### 4 Joint Development Plan

As can be seen from the above analysis, under open pit and underground mining conditions, both of o-

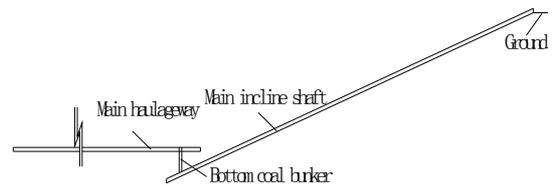


Fig 2 underground mine haulage system development

-pen pit and shaft mining use belt conveyor for the main transport and main lifting, therefore, there are conditions to use joint development transport system. In order to reduce the mine development investment, reduce the interference between open pit mining system and stripping systems, and reducing coal truck transport distance of open pit mine, we put forward the joint development plan that open pit mine and shaft mine use the same roadway – incline shaft belt conveyor as main lifting system. The joint development system layout shown in Fig 3.

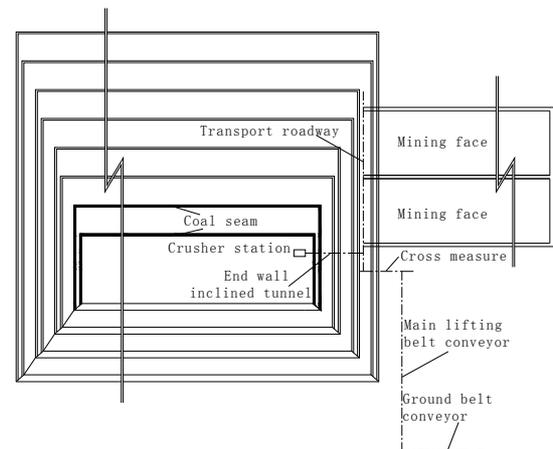


Fig 3 joint development haulage system

The inclined shafts and main transport roadway parallel to the end wall of open pit mine, so the industries squares of underground mine and open pit mine are easy to integrated arrangement. By using band extraction, we can simplification the mine production systems. Because the crushing station of open pit mine layout of the main coal seam level, the coal after broken can will carried out by end wall inclined tunnel

- the main transport roadway - the main inclined shaft system.

The main advantages of the joint development as follows. First, it can reduce a major transport - lifting system, so the investment can be reduced. Secondly, the Crushing Station layout at the main coal seam level, so the coal trucks transport distance can be shorten and the production costs can be reduced. Thirdly, the coal belt conveyor machine layout in the tunnel outside the realm of open pit, open pit stripping system to achieve a grade separation. The main disadvantages of joint development plan is open pit and shaft mines using the same belt conveyor systems, there is interference and difficult to manage.

### 5 Case Study

ANTAIBAO (ATB) open pit coal mine is the first large-scale Sino-foreign cooperation projects which Deng Xiaoping himself contributed to at the beginning of reform and opening up in China. the original design capacity of ATB is 15.33Mt/a, and the mining technology and equipment on behalf of the then international advanced mining technology. Paleozoic Carboniferous coal mine exploitation, the main coal seam for the 4#, 9# and 11# coal seam. The basic situation of coal seams shown in table 1.

**Table 1 situation of coal seams**

Coal seam	Coal seam thickness/ m	Density /t/m <sup>3</sup>	Coal quality	Floor level/ m	Overlay strata thickness/ m
4	7.6	1.4862	high ash and low sulfur	1300	70
9	13	1.4507	low ash and high sulfur	1230	120
11	4	1.4508	high ash and high sulfur	1205	140

Because of the missing of 4# coal seam and thinner of 9# coal seam in part section, some of the resources and then use the open method is not economic exploitation, and therefore determine the use of coal caving mining nine coal, design capacity 5Mt/a. Independent open pit coal mining semi-continuous system layout as: crushing station and the end wall belt conveyor arranged at the 4# coal seam floor levels, and the main lifting belt conveyor arranged at the northern end wall. In the joint development plan, the raw coal

crusher station arranged at 9# coal seam floor level of the north end wall. The coal produced by open pit mine will be transport to the main transport roadway of ANJIALING II shaft mine through end wall inclined tunnel After breaking, so the belt conveyors in the main roadway and the main inclined shaft must be responsible for the coal transportation task both of the open pit mine and shaft mine. The investment comparison of Independence explore and joint explore is shown in table 2.

Thus, the joint explore can be reduce investment 2.4Myuan. Since under the joint explore conditions the coal crusher station of open pit mine lay at the floor of 9 # coal seam, the coal truck transport distance can be shortened from 1.3km to 1.1km, although the belt conveyor transport distance will increase about 0.4km, it also can save coal freight 0.16 yuan/t (about 2.4 Myuan/a). Most importantly, the raw coal conveyor arranged to enhance the Mine Shaft in outer realm to achieve a transportation system and the stripping system interchange, with the distance to avoid the truck open pit stripping works to promote and increase.

**Table 2 investment comparison**

		Independent development	Open pit mine	Joint development	Open pit mine + shaft mine
Belt conveyor	Belt width/ m	1.2	1.4		1.6
	Belt speed/ m/s	4.5	4.5		4.5
	Belt length/ km	1.8	1.6		2.2
Investment /Myuan		10.80	11.20	22.00	17.60
Inclined tunnel/m		0	0		200
Investment /Myuan		0	0		4.00
Investment of end wall belt conveyor built/ Myuan		0	1.80		0
Total of investment/ Myuan			23.80		21.40

### 6 Conclusions

Study conclusions as following.

(1) The existing research results about open pit and underground mining are aimed at open pit slope stability, but the research of production systems joint optimization is little.

(2) Under the open pit and underground mining conditions, the general explore method of open pit mine is working slope temporary ramp – end wall

crusher station – belt conveyer, and a general explore method of shaft mine is incline shaft – belt conveyer transportation roadway.

(3) The typical joint arrangement form of development transportation system is put forward, and the main advantages and disadvantages is analyzed.

(4) The case study of ATB open pit mine shows that, using the joint development, can reduce investment 2.40 Myuan, and can save coal transportation costs 2.40 Myuan/a, and the interference between stripping systems and mining systems of open pit mine can be avoided.

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