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Statistical analysis of coal mine accidents in China from 2005-2013

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ABSTRACT

The present study files and categorizes coal mine accidents in within China from 2005-2013 using mathematical statistics Aspects such as accident types, occurrence time, geographical distribution, and death rate per million tons are focused on. The characteristics of the coal mine accidents are analyzed, and the coal mine accident potential regularity is summarized. From this analysis, technical prevention means and safety management measures to prevent and reduce coal mine accidents scientifically and effectively are proposed. According to the accident categories, it is found that the number deaths caused by roof accidents are the highest, while the average mortality of fire related accidents are the highest. The curve of accidents is in line with the curve of death toll and both show fluctuation according to month. February has the lowest accident rate and death toll. This effect is closely related to the low temperatures. According to the 27 provincial units, the death toll of Guizhou, Sichuan, Hunan, Shanxi, and Chongqing coal mine accidents is relatively high. To combat this, China should strengthen the supervision of these places.

KEYWORDS: Statistical analysis; Coal mine accidents; Prevention countermeasure; Safety management

1. INTRODUCTION

Safety production level is an important symbol of the progress of a social civilization. Safety production is closely related to economic and social development level, industrial structure, regulatory system, the rule of law, education, science and technology, culture and other factors (Wu, 2007; China Academy of Safety Science and Technology, 2005; Wang, 2008). China's safety production level has increased stably with the rapid development of a national economy, the striking improvement of safety management, and technical measures. However, the coal mining field remains an industry where supervision needs to be strengthened, as there is a high accident rate (State Administration of Work Safety, 2008; Shi et al., 2014; Wei et al., 2014).

On July 22, 2001, a gas explosion tore through a coal mine in Xuzhou city, Jiangsu province, killing 92 people. On February 14, 2005, a gas explosion ripped through a coal mine in Fuxin mining group co., LTD, Liaoning province, leaving 214 people dead. On March 29, 2013, a gas explosion tore through a coal mine in Tonghua mining group, Jilin province, killing 36 people. These coal mine accidents, which have caused huge property losses and casualties, have drawn wide attention.

This paper completes data analysis based on China's Coal Mine Accident statistics during 2005-2013 provided by State Administration of Work Safety (State Administration of Work Safety, 2015). The characteristics of the accident are analyzed on the basis of objective data. These statistics provide related industry practitioners and regulators with countermeasures and suggestions based on facts, in order to prevent and control coal mine accidents, avoid loss of life, and reduce accident loss.

2. ACCIDENT ANALYSES

2.1 Accident overall condition

Coal mine accidents and the death toll from 2005-2013 were submitted to statistical analysis. The corresponding curve is shown in Figure 1. According to analysis, a total of 16,229 coal mine accidents occurred in China from 2005-2013,

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causing a total of 27,173 casualties. The equivalent of an average of 1,803 coal mine accidents occurred annually with an average death toll of 1-2 people per accident. Figure 2 shows the raw coal production (one hundred million tons) and death rate per million ton. It can be seen from the figure that China's raw coal production is increasing each year, Conversely, the death rate per million tons is dropping year by year.

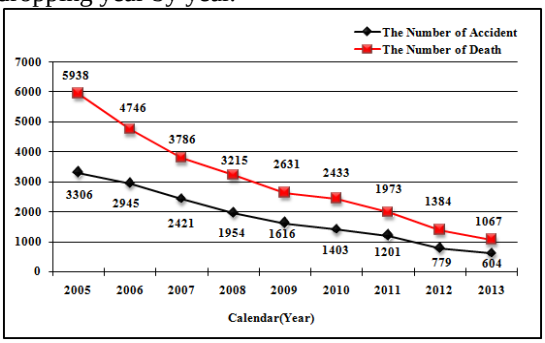

Figure 1: The number of coal mine accidents and deaths from 2005-2013.

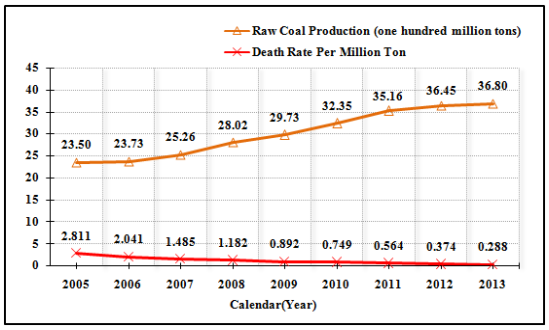

Figure 2: Raw coal production and death rate per million ton from 2005-2013.

It also can be seen from Figure 1 that the trends of the accident curve and the death toll curve are consistent. These two curves trend down, which illustrates that the number of accident and the number of deaths is proportional to the decrease. It also can be seen from Figure 2 that the trends of the raw coal production curve and the death rate per million tons curve are contrary to each other, showing that high production does not mean high accident rate.

Overall, China's raw coal production has increased steadily from 2.35 to 3.68 billion tons from 2005-2013 (National Bureau of Statistics of the People's Republic of China, 2015). The annual average growth rate was 5.45%. On the contrary, the total number of coal mine accidents, total deaths, and death rate per million tons all decreased with the average annual decline rate of 19.14%, 19.31%, and 24.78%. This shows that improvements in safety management level and technical level play a vital role in reducing coal mine accidents and mortality (Yang and Li, 2014).

2.2 The accident category analysis

Coal mine accidents from 2005-2013 were input to statistical analyses according to 8 kinds of accident categories, including roof, gas, electromechanical, transportation, blasting, flood, fire, and other accidents, as shown in Figure 3.

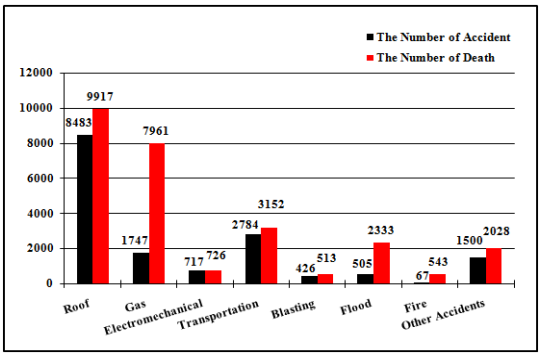

Figure 3: The number of coal mine accidents and deaths according to the accident categories from 2005-2013.

The number of accidents and the death toll in the roof category is the largest. A total of 8,483 roof-related accidents occurred, killing 9,917 people, accounting for 52% of the total number of accidents and 36.5% of all deaths. Fire-related accidents were the least common, with a total of 67 cases. Blasting deaths were the least common, killing 513 people. The average death toll of fire-related accidents was 8 deaths per accident, which is the highest average death toll of each accident type. The second most fatal are flood and gas-related accidents, with 4-5 deaths per accident. Therefore, we should focus on strengthening the management of fire, flood, and gas accidents.

2.3 Accident analysis according to the month

Coal mine accidents during 2005-2013 are input to statistical analyses according to the month, as shown in Figure 4. It can be seen from Figure 4 that in the month with the highest accident rate, April, there were 1,679 accidents; there were 2,770 casualties which is the highest of any month. In February, the number of accidents and the death toll were 664 and 664, respectively, which is the least of any month. In addition, accident rate and the death toll in January were relatively low.

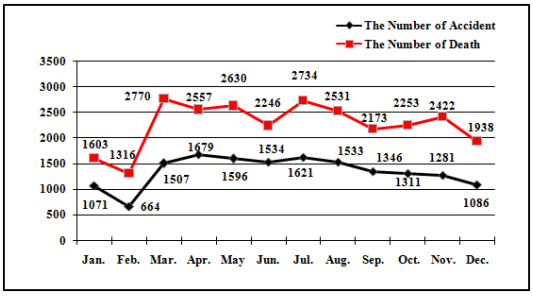

Figure 4: The number of coal mine accidents and deaths according to the months from 2005-2013.

The accident rate is lower in January and February because all the working strength is low at the beginning of the year. Moreover, low temperatures result in a decrease of fire-related accident risk (Wang and He, 2013). Therefore, there are fewer accidents in this period of the year. Conversely, there are more accidents in March and April due to the increasing workload on the employees who have not yet fully adapted to the working environment. As a result, weak safety consciousness and fluky mentality lead to more accidents. Therefore, the government should strengthen supervision in this accident-prone period.

2.4 The accident area analysis

In the 27 provincial coal-producing statistical units (with the exception of Tianjin, Shanghai, and Hainan), 5 regions including Chongqing, Shanxi, Hunan, Sichuan, and Guizhou suffered the largest number of deaths from 2005-2013, as shown in Figure 5. The corresponding death tolls were 2,185, 2,340, 2,681, 2,862, and 3,865 people, respectively, accounting for 51% of the total death toll.

On November 5 and 12, 2006, 7 days apart, 2 coal mine accidents occurred in Shanxi Province, 47 and 34 people were killed, respectively. These two accidents were the "11•5" gas explosion accident in Jiaojia ore coal group and the "11•12" Explosive burning accident in Nanshan coal mine, Jinzhong city. On October 20 and November 11, 2004, 22 days apart, 2 coal mine accidents occurred in Henan Province. 148 and 34 people were killed, respectively. These two accidents were gas explosion accidents in Zhengzhou coal group and Lushan County, Pingdingshan city. It can be seen from Figure 5 that coal mine accidents are relatively concentrated in the northeast, central and southwest regions, mainly in coal production areas. The coal mine production in these areas is relatively dense, leading to a high probability of coal mine accidents and an increase in the death toll.

Figure 5: Region distribution of death toll in coal mine accidents from 2005-2013.

3. ACCIDENT CAUSE ANALYSES

According to the curve trend of overall accident situation, China's coal mine accidents were decreasing yearly from 2005-2013. The improvements in safety production situation are closely related to the supervision work of all localities and departments. In 2010, the State Council issued a "notice on carrying out the safe production activities further" and a "notice on strengthening safety production work in enterprises further". These two files not only clarified general requirements and major target tasks of safety production work in enterprises, but also created comprehensive requirements for the enterprise's safety production work. At the same time , the State Council issued a "notice on strengthening backward production capacity further " and a "notice on several opinions of accelerating the coal mine enterprise merger and reorganization", to put forward the requirements of eliminating backward production capacity, optimizing the industrial structure, promoting the healthy development of the coal mine industry, and ensuring national energy security. Focusing on coal mines, metal and nonmetal mines, State Administration of Work Safety issued " the decision of modifying part of the terms about coal safety regulations", "take the leadership class to go down and mine safety supervision and inspection requirements", "take the leadership class to go down and metal and nonmetal mines safety supervision and inspection requirements". These rules are emphasized to strengthen the site safety management and discover and eliminate hidden dangers.

In 2010, China is focusing on prevention, strengthening supervision, and increasing responsibility through promulgating a series of regulatory documents, rules and regulations to advance "three actions" stably, intensify "three constructions", and concentrate on illegal special operation, rectification, comprehensive supervision and inspection of key industries (sectors) in safety production. As a result, coal mine gas accidents have dropped, coal mine gas extraction and utilization has increased, villages and towns coal mine accidents have declined dramatically, and coal mine gas control and closed work has had great achievements. At the same time, cracking down on illegal production and business operation construction behaviour has made new progress and significant results were obtained in safety production management action.

From 2011-2013, the State Council issued "the opinions of adhering to the scientific development and safe development to promote safety production situation steadily", and the "notice on deepen the "safe production" activities continually" in order to effectively prevent and curb serious accidents. The main focus was on strengthening and carrying out the safety production "three responsibilities" of enterprise main body, department supervision and territorial administration. At the same time, they continue to crack down on illegal production and business operation construction behaviour. China's series of major policy decisions over safety production work show their strict, which directly led to a decline in coal mine accidents. Thus, perfecting legal system and enhancing superintendence strength are important measures to curb production safety accidents and are strong protections to reduce safety production accidents (Cao, Q. and Li, K., 2012).

4. CONCLUSIONS

China's coal mine accidents curve trend and the death toll curve trend from 2005-2013 are consistent, and both show an overall downward trend. This shows that the development momentum of China's coal mine accidents tends to improve. Perfecting the safety law system and improving safety supervision system are key actions to control accidents.

Roof accidents are the most common, making up about half number of the total accidents. From a safety level, we should strengthen the safety management of coal mine industry, and especially focus on reducing roof accidents.

Few accidents happen at the beginning of the year. The accident-prone period falls around the month of April.. The government should increase safety investment in order to reduce the accident rate during the accident-prone period.

Coal mine accidents in the northeast, central and southwest regions are relatively concentrated, mainly in coal production areas. Regional safety production technical support ability should be balanced and safe investment for high-risk areas and accident-prone areas should be increased in order to reduce the accident rate.

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