Reduced Workers' Compensation Costs With Roof Screening

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Abstract

Each year, more than 300 underground coal miners are injured or killed by rocks falling from between or around roof supports. Researchers have reported that a reduction in rock fall injuries by implementing wire-mesh roof screens would reduce a mining company's workers' compensation (WC) premiums and would offset the annual cost of screen installation. However, the authors calculated these savings using formulas that are not used by all coal mining states, including Pennsylvania. Pennsylvania coal mines may also benefit from reduced WC premiums with roof screening.

In this paper, the potential savings in WC premiums that could be achieved due to a reduction in rock fall injuries after roof screening in Pennsylvania's underground coal mines were quantified. Hypothetical mines (representing two mine sizes: 67 and 150 employees) were constructed with realistic estimates of injuries and WC premiums. Using the Pennsylvania Coal Mine Compensation Rating Bureau's (PA CMCRB) formulas, total savings in WC premiums after a 3-year period were determined. Savings in WC premiums ranged from 5.1% to 22% when injuries were reduced by 10% to 30%. This translated to savings between $73,000 and $1.2 million, which may largely offset the annual cost of a roof screening program.

More than 300 rock fall injuries are reported to the Mine Safety and Health Administration (MSHA) each year. Nearly all of these injuries, which included six fatal injuries between 2006 and 2008, are caused by rocks falling between and around roof supports. Technology is available to prevent the vast majority of these injuries and fatalities. Surface controls like straps, headers and large roof-bolt plates can help, but by far the most effective prevention technique is roof screening. Roof screens work best because they can cover up to 94% of the roof (Robertson, et al., 2003). Roof screens also offer a first line of defense for roof-bolter operators by confining or deflecting small rocks that can come loose during drilling or bolt installation.

Several studies have now shown that roof screening is the most effective way to prevent rock fall injuries (Molinda & Klemetti, 2008; Compton, et al., 2007). At a Maryland mine studied by the National Institute for Occupational Safety and Health (NIOSH), rock fall injuries were reduced from 14 per year to 2.2 per year, 5 years after implementing roof screening. In addition, an Illinois mine showed a reduction from 8 to 0.25 injuries per year, 8 years after implementing roof screening (Robertson, et al., 2003). Despite the fact that roof screening has obvious benefits to the safety of mine workers, some mining companies have yet to implement this safety measure due to cost concerns. However, by preventing injuries to the mine workers, roof screening has a direct positive impact on a mine's WC premiums.

Background

Previous research has demonstrated that the savings in WC premiums may largely offset, or even exceed, the direct costs of a roof screening program. Moore, et al. (2010) determined savings in WC premiums associated with reducing rock fall injuries in Illinois and Kentucky. Moore selected these states' programs for evaluation because they have the highest WC premiums for underground bituminous coal, and the rating organization responsible for these states (National Council on Compensation Insurance) provides services to some 36 states. Moore's analysis illustrated a decrease in WC premiums ranging from 1.8% to 14.6% when injuries were reduced by 10% to 20%.

The state of Pennsylvania, however, is not serviced by the National Council on Compensation Insurance, but rather has its own WC rating organization for coal mining and, thus, its own unique formula to evaluate mines within its borders. In 2008, Pennsylvania's bituminous coal mines produced 63.7 million short tons of coal representing 16.3% of the total coal produced in the Appalachian Region (USEIA, 2010).

Given Pennsylvania's unique rating equations, it is important to verify that a reduction in a Pennsylvania coal mine company's WC premiums due to roof screening may partially or fully offset the cost of screen installation. Therefore, this research sought to quantify the potential savings in WC premiums that mining companies in Pennsylvania might expect after implementing roof screening as a method of reducing rock fall injuries. These savings could then be used to offset, or cover completely, the cost of implementing a roof screening program.

Overview of Workers' Compensation Rate-Setting Methods in Pennsylvania

Coal mines in Pennsylvania are rated by the Coal Mine Compensation Rating Bureau (CMCRB) of Pennsylvania. Insurance providers offering coverage for coal mines in Pennsylvania must be a member of CMCRB. Several rating plans exist, including manual rating, merit rating and experience rating. Manual rating is the simplest rating plan where rates are averages reflecting the normal conditions found in each classification and is typically used for small employers.

Merit rating plans were formulated for smaller companies and provide a 5% premium credit to employers with no lost-time accidents over a 2-year period. Employers with two or more lost-time claims receive a 5% surcharge and those with one lost-time claim have no change in premium. This plan provides premium savings for safety-conscious small businesses. Under an experience rating plan, a company is provided an incentive (i.e., decreased costs) for implementing loss prevention programs to decrease injury costs. Any entity or company with a modified payroll of at least $300,000 during the 3-year experience period qualifies for an experience rating. Of the plans described, experience rating is the most commonly used and, therefore, is presented in this paper.

Each year, data are collected by CMCRB for each individual coal company. These companies are categorized by one of 10 possible classifications:

1) preparation plants—anthracite;
2) preparation plants—bituminous;
3) underground—anthracite;
4) underground—bituminous;
5) surface—anthracite;
6) surface—bituminous;
7) cogeneration fuel—anthracite;
8) cogeneration fuel—bituminous;
9) auger;
10) coke.

CMCRB then sets a base loss cost rate (per $100 of payroll), which must be approved by the State Insurance Commissioner's Office. The base loss cost rate consists of three components: 1) federal black lung coverage (FBLC), 2) state black lung coverage (SBLC) and 3) traumatic coverage (TC) (PA CMCRB, 2009).

Based on a mine company's 3-year injury history, a modification factor (MOD) is calculated. (For a detailed explanation of determining the MOD and the use of the Pennsylvania WC rate-setting equations, see Moore & Pollard, 2010.) The MOD is the only factor that an individual mine can influence to reduce its WC premiums. This MOD is calculated each year based on the previous 3 full-coverage years (e.g., the MOD for 2004 is based on the mine's experiences between 2000 and 2002; the MOD for 2005 would then be based on the mine's experiences between 2001 and 2003). The MOD is then used to determine whether or not the mine is credited (has a decreased premium) or debited (has an increased premium) relative to the base loss cost rate. The MOD is based on the individual company's losses. Therefore, reducing losses by implementing safety and health interventions, such as roof screen, should reduce the MOD. It should be noted that the MOD is only multiplied by the traumatic coverage portion of the base loss cost rate and not the FBLC and SBLC portions. The federal and state black lung portions are static and remain unaffected by the company's performance over the experience rating period. Additionally, each insurance provider applies its own multiplier to the base loss cost rate to cover administrative fees (e.g., taxes, overhead costs, costs associated with handling, settling and defending claims). Thus, a company's WC premium per $100 of payroll would be determined as follows:

WC premium = admin fee multiplier * (FBLC + SBLC + MOD*TC)

Methods

Data Used in This Study

The rating period used for this study was 2001, 2002 and 2003, yielding WC costs for 2005. To demonstrate the expected amount of savings in WC premiums, hypothetical mines were created that are representative of experience-rated mines in Pennsylvania. Between 2001 and 2003, there was an average of 44 active underground bituminous coal mines reporting production in PA with an average of 98 employees per mine (PA Department of Environmental Protection, 2001-03). Two sizes of mines were used in the analysis, one with 67 employees and the other with 150 employees. A mine with 67 employees was chosen because an economic analysis was previously conducted to determine the cost of screening for a mine of this size (Compton, et al., 2007). The mine with 150 employees was chosen as a larger mining company with a significantly higher payroll. To estimate the savings in WC premiums for these mines, the following parameters were necessary:

- payroll for 2001, 2002 and 2003;
- total number of injuries each of the 3 years;
- number of injuries that would have been prevented by implementing roof screening each of the 3 years;
- base loss cost rate in 2005;
- insurance provider's administrative fee;
- ultimate losses associated with each injury.

In 2005, the base loss cost rate was $25.30 for bituminous, underground coal mines. In Pennsylvania, typical multipliers applied by insurance providers to cover administrative fees range from 1.17 to 1.60; the average of these numbers, 1.385, was used in this study. To obtain the remaining parameters, several assumptions were made:

- **Payroll:** In 2002, the average mine worker salary in Pennsylvania was $53,700 (U.S. Census Bureau, 2002). This salary was used to estimate the salaries in 2001 and 2003 by adjusting for 1.14% inflation between 2001 and 2002 and 2.60% inflation between 2002 and 2003 (Bureau of Labor Statistics, 2001-03). The average mine worker salaries were determined for 2001 as $53,094 and for 2003 as $55,096. The total payroll for a 3-year period was used to determine the MOD. Therefore, the total payroll for each year was summed to yield a 3-year payroll.
- **Total number of injuries:** A sensitivity analysis was

	# Employees	Total Injuries	Preventable Injuries	Total Payout Per Year	Average One-Year Payroll
Mine 1	67	20	2	$303,694	$3,615,564
Mine 2	67	20	4	$303,694	$3,615,564
Mine 3	67	20	6	$303,694	$3,615,564
Mine 4	67	34	3	$506,157	$3,615,564
Mine 5	67	34	7	$506,157	$3,615,564
Mine 6	67	34	10	$506,157	$3,615,564
Mine 7	67	47	5	$708,620	$3,615,564
Mine 8	67	47	9	$708,620	$3,615,564
Mine 9	67	47	14	$708,620	$3,615,564
Mine 10	150	45	5	$679,913	$8,094,546
Mine 11	150	45	9	$679,913	$8,094,546
Mine 12	150	45	14	$679,913	$8,094,546
Mine 13	150	75	8	$1,133,188	$8,094,546
Mine 14	150	75	15	$1,133,188	$8,094,546
Mine 15	150	75	23	$1,133,188	$8,094,546
Mine 16	150	105	11	$1,586,463	$8,094,546
Mine 17	150	105	21	$1,586,463	$8,094,546
Mine 18	150	105	32	$1,586,463	$8,094,546

Table 1. Demographics of each hypothetical mine.

performed where the total number of injuries was varied to determine its effect on WC premiums. Over the 3-year period, the total numbers of injuries at both mines were defined as being 30%, 50% and 70% of the number of employees. These percentages were based upon actual injury data reported to MSHA during the same timeframe.

•**Number of preventable injuries:** A sensitivity analysis was performed where the number of preventable injuries is varied to determine the effect of reducing rock fall injuries on WC premiums. The total number of injuries that could have been prevented with roof screening was defined as being 10%, 20% and 30% of the total number of injuries. These percentages were based upon actual injury data reported to MSHA. (Injury narratives were read to determine the number of rock fall injuries and the size of the rocks associated with these injuries. The "preventable falls" were small falls and their general size was described in a variety of ways, including as the size of a golf ball, a "piece of rock" or in specific dimensions, such as 18" x 18" x 8", 4' x 3' x 1", 3' diameter x 8", 2" x 2', 2" x 9" x 2' or 6" x 6" x 2".)

•**Ultimate losses per injury.** CMCRB provided the total ultimate losses and total number of medical and indemnity claims during the 2001-03 policy years. Indemnity claims are associated with claims resulting in lost-time. Medical claims are those where costs are exclusively medical. On average, two thirds of all claims each year were medical claims with an average cost of approximately $5,000. The average cost of indemnity claims ranged from approximately $40,000 to $55,000 depending on the year.

Thus, to arrive at a representative average claim cost, it was not reasonable to divide the ultimate losses by the total number of claims. Therefore, an average claim cost was calculated for each year. The average cost of medical claims was multiplied by the number of medical claims reported, and the average cost of the indemnity claims was multiplied by the number of indemnity claims reported. This allowed the average injury costs to be weighted based on their frequency. The average of these parameters across the 3 years was then determined to be $15,109. In the current analysis, therefore, every injury was assumed to cost this amount.

Nine hypothetical mines were created, each with 67 employees, such that a mine existed representing all possible combinations for the total number of injuries (30%, 50% and 70% of the number of employees) and the total number of preventable injuries (10%, 20% and 30% of the total number of injuries). Similarly, nine hypothetical mines were created with 150 employees, yielding a total of 18 hypothetical mines in this analysis.

Results

The demographics and injury statistics associated with each hypothetical mine are shown in Table 1. The total injuries across the 18 hypothetical mines ranged from 20 to 105 injuries, of which 2 to 32 were assumed to be preventable with roof screening. The total injury payout per year ranged from $303,694 to $1.6 million. Table 2 shows the MODs and resulting WC premiums for each of the 18 hypothetical mines with and without roof screening. Additionally, the expected savings in WC premiums, which may be achieved with roof screening, are also provided. Almost all mines had MODs greater than 1, which indicates that most mines were debited and were expected to pay above the base loss cost rate. The MODs ranged from 1.21 to 2.15 before roof screening and 0.99 to 1.99 after roof screening. This reduction in the MOD yielded savings in WC premiums of $73,000 to $1.2 million.

Figure 1 (p. 28) shows the percent savings in WC premiums for each of the hypothetical mines. Savings in WC premiums ranged from 5.1% to 22%. Additionally, Figure 2 (p. 29)

	Without Roof Screening			When Injuries Prevented Through Roof Screening			**Savings in WC Premium with Roof Screening**
	MOD	WC per $100 Payroll with Admin Fee	WC Premium	MOD	WC per $100 Payroll with Admin Fee	WC Premium	
Mine 1	1.21	$40	$1,447,836	1.14	$38	$1,374,408	$73,427
Mine 2	1.21	$40	$1,447,836	1.08	$36	$1,300,981	$146,855
Mine 3	1.21	$40	$1,447,836	1.01	$34	$1,227,553	$220,282
Mine 4	1.66	$54	$1,937,351	1.55	$50	$1,814,972	$122,379
Mine 5*	1.66	$54	$1,937,351	1.43	$47	$1,692,593	$244,758
Mine 6*	1.66	$54	$1,937,351	1.32	$44	$1,570,215	$367,137
Mine 7	2.10	$67	$2,426,867	1.95	$63	$2,255,537	$171,331
Mine 8*	2.10	$67	$2,426,867	1.79	$58	$2,084,206	$342,661
Mine 9*	2.10	$67	$2,426,867	1.63	$53	$1,912,876	$513,992
Mine 10	1.21	$40	$3,228,117	1.13	$38	$3,054,057	$174,060
Mine 11	1.21	$40	$3,228,117	1.06	$36	$2,879,998	$348,119
Mine 12*	1.21	$40	$3,228,117	0.99	$34	$2,705,938	$522,179
Mine 13*	1.68	$54	$4,388,514	1.56	$51	$4,098,415	$290,099
Mine 14*	1.68	$54	$4,388,514	1.44	$47	$3,808,315	$580,199
Mine 15*	1.68	$54	$4,388,514	1.32	$44	$3,518,216	$870,298
Mine 16	2.15	$69	$5,548,911	1.99	$64	$5,142,772	$406,139
Mine 17*	2.15	$69	$5,548,911	1.82	$59	$4,736,633	$812,278
Mine 18*	2.15	$69	$5,548,911	1.65	$54	$4,330,494	$1,218,417

Table 2. MOD and associated WC premiums with and without roof screening showing savings. ***Note: *Savings in WC premium may fully cover the cost of roof screen installation assuming roof screening costs $240,000 and $480,000 for the 67 and 150 personnel mines, respectively (Compton, et al., 2007).***

shows the savings in WC premiums associated with a decrease in ultimate losses. Although not a 1:1 ratio, savings in injury claim costs result in large savings in WC premiums.

Discussion

In this study, the methods used by the state of Pennsylvania to determine an underground bituminous coal mine's WC premiums were also used to determine the savings in WC premiums that may be realized after reducing the number of injuries with roof screening. A sensitivity analysis with 18 different hypothetical PA underground bituminous coal mines was performed. In this analysis, the number of total injuries and the number of injuries that could have been prevented with roof screening were varied to determine their effects on a mine's MOD and, therefore, WC premium.

This analysis was completed for a medium-sized mine (67 employees) and for a larger mine (150 employees). The reduction in losses associated with roof screening was shown to decrease the MOD in all cases. While reducing actual losses by a set dollar amount does not directly correspond to the expected reduction in WC premiums, a significant savings in WC premiums is passed on to the mine. These savings ranged from 5.1% to 22% when injuries were reduced by 10% to 30%. For mines with a larger number of employees, and thus a larger payroll, the percent savings in WC premiums was slightly greater than that of a smaller mine with a similar percent reduction in injuries.

The savings after reducing injuries with roof screening may largely offset, if not cover completely, the cost of implementing a roof screening program. Compton, et al. (2007) determined the cost of roof screening for a room-and-pillar mine employing 67 people and producing 800,000 tons per year. If roof screens were installed in 50% of the drivage, the annual cost for screen installation was estimated to be $240,000. This cost varies between mines but provides a relative estimate for the expected cost of screen installation. Based on this estimate, several of the 67-employee hypothetical mines in this study would cover the cost of their roof screen program solely from savings in WC premium.

It is important to note that mines with greater rock fall injuries will see more substantial savings in their premiums. The size of the mine (determined by their payroll) determines their expected losses (injury costs expected for a mine of that size) and the premium paid to the WC insurance provider (WC premiums are relative to every $100 of payroll). However, the actual losses at the mine influence how much the mine will pay in premiums. This means that a larger mine with fewer injuries may actually have a lower WC premium than a smaller mine with more injuries.

There were several limitations to the current study. The

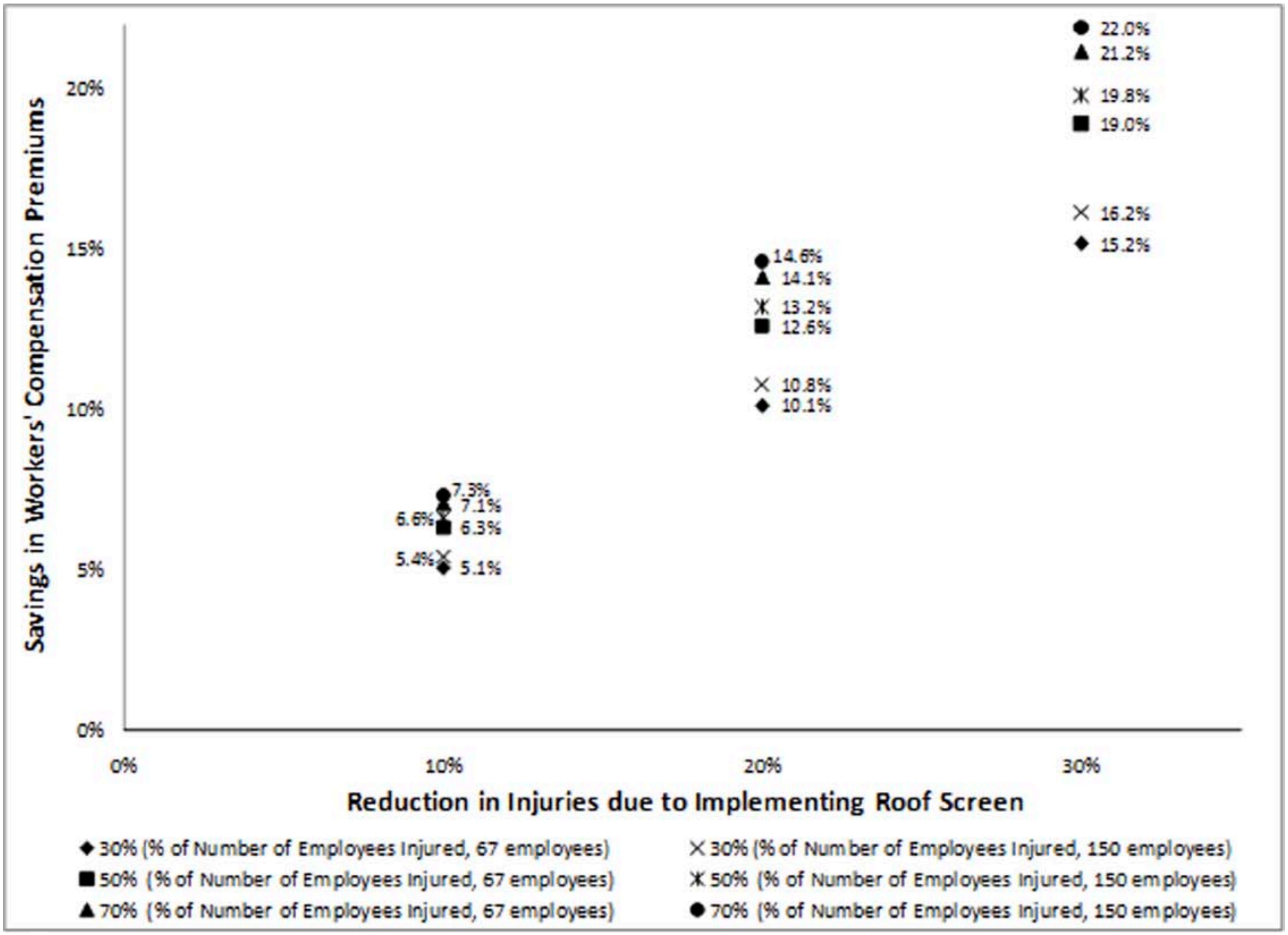

Figure 1. Percent savings in WC premiums associated with 10%, 20% and 30% reductions in injuries due to implementing roof screens for mines with total injuries equal to 30%, 50% and 70% of the number of employees. The number of employees was set to equal either 67 or 150.

mines in the study were hypothetical as opposed to using real mine demographic and injury data. The total number of injuries and the preventable injuries at each hypothetical mine were based upon injury data obtained from the MSHA injury database. As a result, mines of comparable size may have more or less savings depending on their actual injury records and roof control plans.

Another limitation to the study was that an average injury cost was used instead of determining the true injury costs associated with known injuries at a specific mine. The estimated cost for installing roof screens presented in this study ($240,000) was associated with only one mine of 67 employees; however, this cost estimate was based on an actual mine providing them more validity than a hypothetical estimation of costs.

Finally, it should be noted that large coal companies tend to purchase nonstandard WC policies. Specifically, there would be some type of risk-sharing policy, such as a large deductible or the mining company may be self-insured and have purchased an excess WC policy. For the latter case, the cost associated with every claim eliminated through roof screening is directly saved by the company; additional savings would then be observed by the reduction in the MOD associated with the excess WC policy.

The data presented in this study demonstrate that a savings in WC premiums may be expected after roof screening for a 3-year period. This means that companies may not fully benefit from reduced injuries until 5 years after instituting their safety measures. However, some financial benefits may be seen after 3 years. While the hypothetical mines used in this sensitivity analysis were only PA mines, the results are comparable to those obtained in a similar study, which investigated the potential savings in WC premiums for states using a different, and more commonly implemented, experience rate-setting formula (Moore, et al., 2010).

While the savings in WC premiums are less than the value saved in direct injury costs, the savings are still substantial. Results of this analysis showed a linear relationship between the decrease in ultimate losses and the savings in WC premiums. Injury costs are directly proportional to WC premiums, and implementing safety measures to reduce injuries may be financed by the potential savings in WC premiums alone.

Roof screening allows mines to provide up to 94% roof cov-

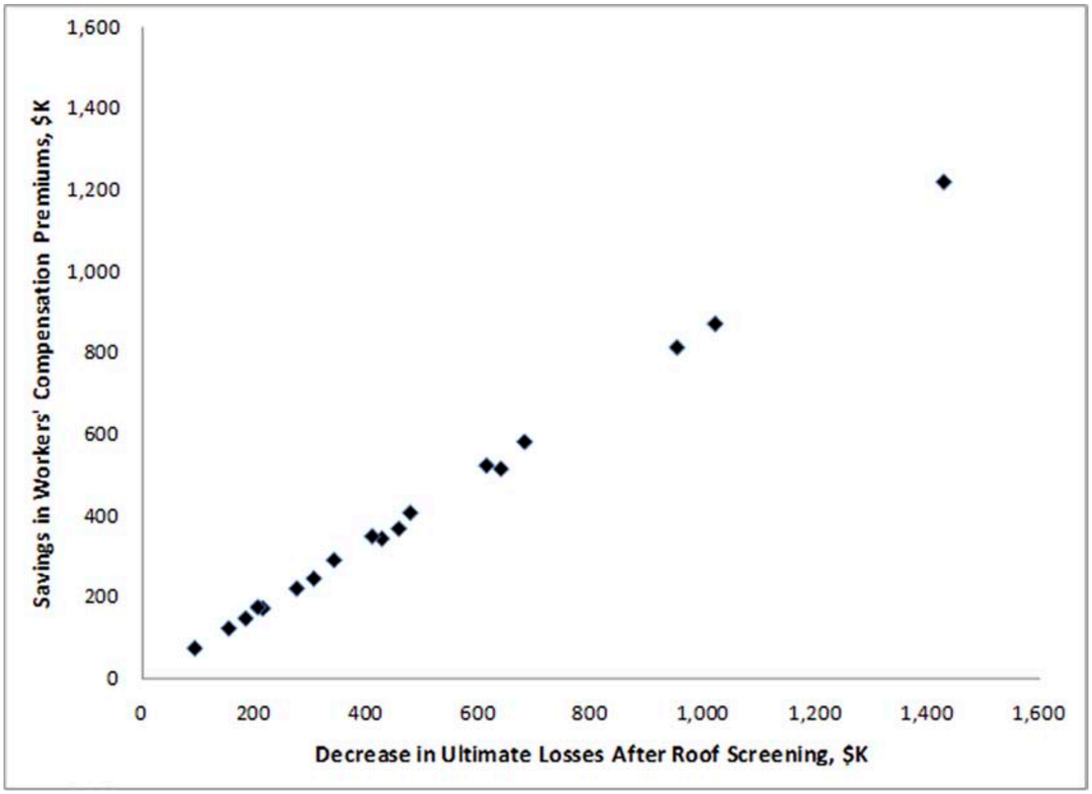

Figure 2. Savings (in thousands of dollars) in WC premiums associated with decreased ultimate losses (in thousands of dollars) after roof screening.

erage and, therefore, reduce the potential falls of smaller rocks, which cause about 99% of all rock fall injuries (Robertson, et al., 2003; Molinda, et al., 2002). Considering the obvious safety benefit of using roof screen, some mines still do not implement a roof screening program. Barriers for screen installation include material costs, time for installation and possible ergonomic risks to the operators (Robertson & Hinshaw, 2002). NIOSH studies, including this analysis, have examined all of these barriers and recommendations are provided for alleviating these concerns. Moore, et al. (2010) found significant savings in WC premiums after roof screening in Illinois and Kentucky underground bituminous coal mines. The results of their analysis were in agreement with this study in that many mines may fully cover the cost of roof screen installation with savings in WC premiums.

In a case study of four underground coal mines, the additional material costs and time associated with roof screening were examined (Robertson & Hinshaw, 2002). Authors found that the material costs for roof screening resulted in an extra $0.58/ft when used instead of steel straps and significantly increased roof coverage by 61%. A significant variation in the additional cycle time required for roof screening was seen between the four mines, and the authors noted that some of this time may be reduced with time and practice. In general, the use of a bolting machine with a built-in materials handling system was shown to decrease the necessary cycle time. The authors also noted the concern with sprains and strains associated with manually handling roof screens and stated that "any innovations in bolting machines, supplies or processes that could eliminate or reduce material handling are worthy of consideration for the safety of the workforce."

In a later analysis, Compton, et al. (2007) conducted ergonomic analyses of roof screen handling techniques. Subjects manually handled roof screen while instrumented with devices to measure the muscle activity of the arms and torso and trunk position, velocity and acceleration. Results showed reduced demands and decreased cycle time when roof screens are slid along rails mounted on top of the roof bolter. The authors also suggested storing screens on the mine rib or stacked/stored on the rails mounted on the roof bolter to reduce the risk for back injuries.

Roof screening has been proven to be a successful means of reducing the hazards of working under a coal mine roof. NIOSH researchers have examined the roof screening process in hopes of alleviating the concerns with increased material costs, cycle times and risks for materials handling injuries. Researchers have found the effects of roof screening to result in financial savings that may recoup some (if not all) of the costs of installation.

WC premiums are just one of the financial savings that may be realized with roof screening. The actual cost savings to the mine are expected to be greater than that which has been estimated using the method described in this paper. Other savings include reduction in costs associated with replacing injured workers, reduced requirements for extra spot bolts to support loose roof and reduced costs associated with long-term cleanup and resupport (Compton, et al., 2007). Moreover, production rates are often impacted by nontangibles, such as increased employee morale, positive safety culture, maintenance of a consistent, knowledgeable workforce, etc., which exist when safety is made a priority, hazards are removed and injuries are reduced or eliminated. ✪

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