SANIRE
SOUTH AFRICAN NATIONAL INSTITUTE OF ROCK ENGINEERING

ROCK talk

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PRESIDENT'S CORNER

Dear SANIRE member,

I trust this newsletter finds you in good health and well-versed in the recent developments within the South African mining industry and Sanire. The past three months have brought about noteworthy events, and we are eager to share these with you.

WHAT'S INSIDE

PRESIDENT'S CORNER

Minesafe Conference:

We are pleased to report the success of the Minesafe Conference, an event dedicated to celebrating the safety achievements of all mines across South Africa. However, it is with a heavy heart that we acknowledge the unfortunate incident just prior to the conference involving Impala Platinum. A catastrophic accident resulted in the loss of 12 lives when the cage fell down the vertical shaft. Our deepest condolences go out to all those affected by this tragedy, including the injured and their families. As we navigate through the challenges and triumphs within the mining industry, let us continue to work together to promote safety, excellence, and innovation. Your dedication is invaluable to the success and sustainability of the industry.

ECSA Code of Practice:

In early 2024, representatives from Sanire will meet with ECSA representatives to discuss the way forward regarding the ECSA Code of Practice. This collaboration is crucial for fostering industry standards and best practices.

Draft COP Guidelines:

The Draft COP Guidelines to combat rockfalls, rockbursts and slope instabilities in mines, have been submitted to the Chief Inspector of Mines for approval. We anticipate receiving approval early next year, marking a significant step forward in ensuring the highest standards of safety and excellence in the mining industry.

SAIMM President:

We are delighted to announce that Mr. William Joughin (see photograph below) has been elected as the President of the South African Institute of Mining and Metallurgy (SAIMM). William, a former President of SANIRE and Vice President of ISRM representing Africa, brings a wealth of experience to his new role. We extend our best wishes to William in his presidency, and we take pride in having a former SANIRE member at the helm of SAIMM.

Mr. William Joughin, SAIMM President

SANCOT Leadership Announcement:

Congratulations to Jeanne Walls on being elected as the Chairperson of SANCOT. Her dual roles on the Sanire Council and the SAIMM Council speak volumes about her dedication and expertise. We wish Jeanne all the very best in her new position and trust that her leadership will contribute significantly to the success and growth of SANCOT. May her tenure be marked by achievements and positive outcomes.

ISRM Congress 2023:

SANIRE made a strong presence at the ISRM Congress 2023 in Salzburg, Austria. Here are some noteworthy highlights:

1. Dr. Michael du Plessis, past SANIRE President and recipient of the ISRM Rocha Medal, concluded a successful 4-year tenure as the ISRM Vice President for Africa. We express our gratitude for his dedicated service to SANIRE and wish him the best in his future endeavors.
2. Mr. Jannie Maritz, past SANIRE President, was elected as the new ISRM Vice President for Africa, serving from 2023 to 2027.
3. Prof. Francois Malan, past SANIRE President and ISRM Vice President for Africa, was nominated as an ISRM Fellow, joining a prestigious group that includes Prof. Nielen van der Merwe and Prof. R. Stacey. Prof. Malan is also a past recipient of the ISRM Rocha Medal
4. SANIRE proudly stands as the second-largest group in the ISRM in terms of membership, following China. We take pride in being distinctly South African on the global stage.

Celebrating Achievements:

The achievements celebrated above (SAIMM, SANCOT, ISRM) reflect the dedication, expertise, and excellence of our members. As we move forward, let us continue to work together to elevate the mining industry and uphold the standards that define Sanire. We express our gratitude for your unwavering commitment and contributions to Sanire. Your dedication is the driving force behind the progress we continue to make in the mining industry.

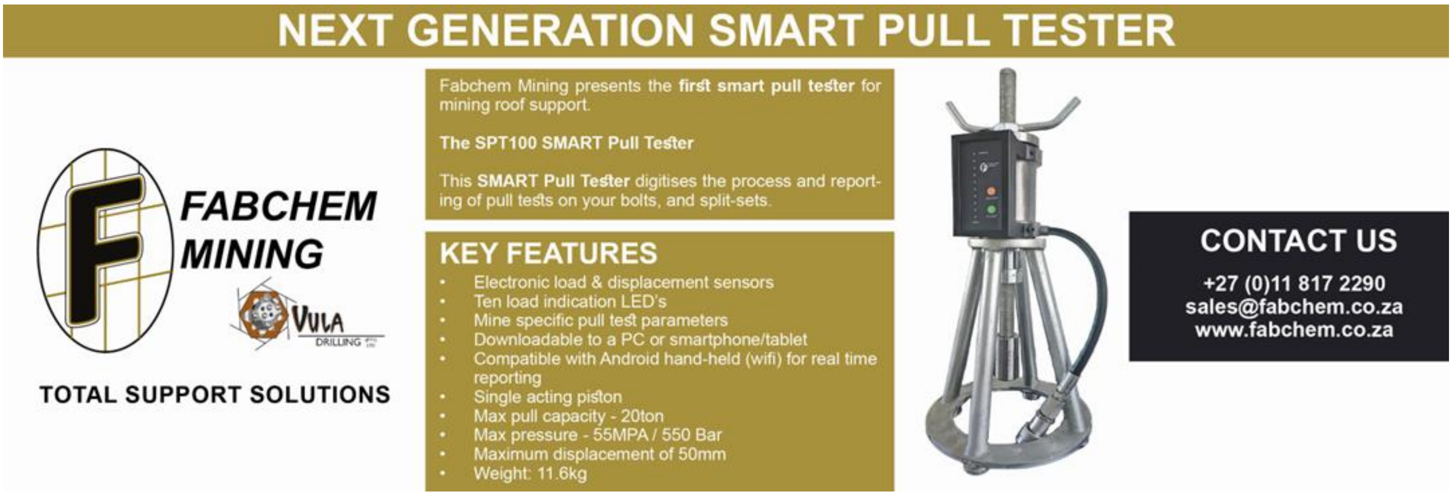
South Africa represented at ISRM Congress 2023

As we approach the festive season and bid farewell to 2023, we want to take a moment to extend our warmest wishes to all our members and their families. May this Christmas bring joy, warmth, and precious moments shared with loved ones, and may the coming year be filled with prosperity, growth, and new achievements for you and your loved ones. We are confident that, with the involvement of all our members, our community will thrive, and the mining industry will reach new heights. Once again, Merry Christmas and a Happy New Year! Thank you for being an integral part of the SANIRE family.

Take care and stay safe!

Kevin Le Bron
SANIRE President (2023 – 2025)

Mr. Jannie Maritz (incoming VP), Mr. Kevin Le Bron and Dr. Michael du Plessis (outgoing VP)



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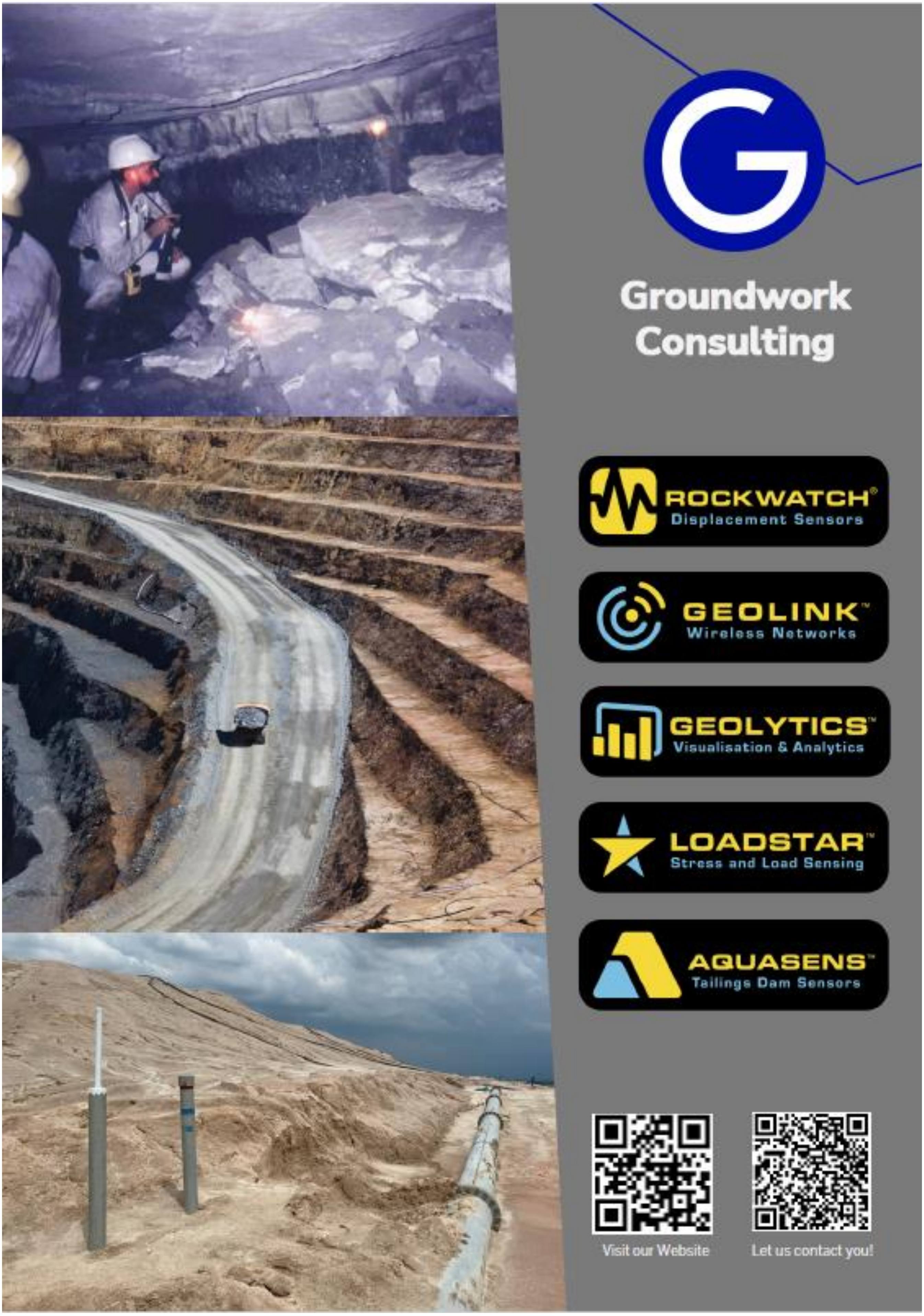
SANIRE VISION, MISSION, & VALUES

Vision

To actively promote the South African rock engineering profession.

Values

- Honesty
- Integrity
- Professionalism
- Accountability
- Transparency



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ISRM 72nd GEOMECHANICS COLLOQUIUM

The 15th international ISRM congress 72nd geomechanics colloquium was held in Salzburg, Austria from the 9th to the 14th of October 2023. The prestigious event saw the coming together of the some of the pioneers of the Rock Mechanics fraternity and also promoted lifelong learning through the exchange and sharing of information and problem-solving strategies from operations all over the world. For the first time in a long time, the event also saw the coming together of a couple of SANIRE past presidents, Dr Michael du Plessis, Paul Couto, Jannie Maritz, Prof Francois Malan and the current president, Kevin Le Bron

Our very own **Professor Francois Malan** was admitted as a fellow to the ISRM. What a prestigious and standing ovation worthy achievement. The Prof has always been up there with the best and as the younger generation of this country, we find ourselves very fortunate to still be able to learn and grow under the tutelage of someone of his caliber. **Congratulations Prof…you made us all very proud, as usual!**

SANIRE's Dr Richard Masethe also shone bright and once again put us on the world stage. He presented two papers, titled, "Source Mechanisms of Mining-Induced Seismicity at Kloof Gold Mine, South Africa – Moment Tensor Analysis of ML>1.5 events" and "Crush Pillar Behavior at Intermediate Depths on Merensky Reef."

The event also saw the election of Jannie Maritz as the new vice president for ISRM Africa. His term will run until 2027.

The event was also coupled with the annual rock bowl competition where the 2022 champions and SANIRE's very own went to defend their title. The rock bowl competition was won by the Australian team. We remain proud of the South African team who represented us well and made their mark at a world stage.

SANIRE BRANCH MEETINGS

Northern Cape Branch – a note from the Chairperson.

In February 2023 the SANIRE Council had their first tour and visited the Northern Cape branch. The new branch committee for the year 2023/24 was elected during the visit. The involvement of the committee within the branch increased the participation of members during branch meetings and other events. The branch hosted technical visits, branch meetings and year end function which were successfully attended. These events were followed by networking and knowledge sharing.

SANIRE NC has a significant role to playing in ensuring that support is given to member within the field of rock engineering. This was evident through the hosting 2 SCO and RMC Practical exams and quarterly meetings hosted by the branch. The branch is very excited about the upcoming year and wishes to grow within the region. The branch is excited about the upcoming year's challenges, successes, development, and growth within the region. Last but not least, we are grateful for all our service providers that help us to improve health and safety in our operations and the sponsorship we received for the year 2023.

They yearend function was hosted On the 1st of December at Kalahari Country Club and Katexas Restaurant in Kathu. The function was a success as it was attended by delegates from across the province. There were no presentations for this meeting, but fun was had. The day was kick started with bowling and board games at Kalahari Country Club followed by lunch at Katexas Restaurant.

The branch would like to appreciate and show their gratitude to the event sponsors; GroundProbe, Kalahari Project Consultants, Videx, Rocbolt Technologies, Lecia Geosystems, RSC Ekusasa Mining, and Geobrugg SA. The NC branch is looking forward to the next branch meeting in the first quarter.

Photos from the SANIRE Northern Cape Branch Year End Function

Gauteng Branch – a note from the outgoing Chairperson.

Dear SANIRE Gauteng Branch Members and SANIRE as a whole,

As my tenure as the Chairman of the SANIRE Gauteng branch comes to a close after two rewarding years, I am filled with immense joy and gratitude for the incredible journey we've shared. It has been a privilege to lead such a dedicated and passionate team.

Our last quarterly meeting was held on the 29th of November 2023, at Goldfields South Deep Mine. A few of the attendees braved the heat and depth for an interesting and informative underground technical visit and as mining would have it, lots of ‘hurry up and wait’. It was followed but a succinct surface meeting attended by ±40 persons, which included two presentations from the South Deep team and voting in of the new Gauteng Branch Committee.

New Committee

Chairman – Ohveshlan Pillay
Vice Chairperson – Phumza Banjwa
Branch Secretary – Dr. Richard Masethe
Treasurer – Rabele Mokone
Education – Yolanda Chambati
Supplier Representative – Katinka Cartes
Events Coordinator – Fungai Kwangwari
Outgoing Chairman/Supporting Role – Ross van Heerden

Our collective efforts have not only elevated the visibility of our branch but have also resulted in a significant increase in attendance at our quarterly meetings. Together, we navigated through challenges and celebrated numerous successes. While mistakes were inevitable, they served as valuable lessons that fueled our growth.

I want to extend my heartfelt thanks to each member of the team. Your commitment and hard work have been the driving force behind our accomplishments. It's inspiring to witness the enthusiasm and dedication that each of you brings to our shared mission.

As I pass the baton to the incoming chairman Ohveshlan Pillay and the new committee, I am confident that the SANIRE Gauteng branch is in capable hands. Let us continue to build on the foundation of success we've created, knowing that our collaborative spirit will propel us to even greater heights.

Thank you for an unforgettable journey. I look forward to witnessing the continued success of our branch.

Outgoing Chairman – Ross van Heerden

New 2024-2026 Gauteng Branch committee, not in photograph is Katinka Cartes

Western Bushveld Branch – a note from the Chairperson.

Greetings Rockies,

I hope this letter finds you well as we prepare for the Christmas break. I hope it offers everyone rest and rejuvenated energy for the forthcoming year. It has been an exciting yet challenging year for the Mining Industry countrywide.

As the outgoing Chairperson of SANIRE Western Bushveld Branch, I would like to express my gratitude to SANIRE National Council, Western Bushveld Branch Committee, and the Members for the opportunity to serve. Over the past two years, I have learned a great deal about the Rock Engineering Profession and its organizational structures. I have had the privilege of being in the company of some of the finest practitioners in our amazing profession. It has been an honor that I will forever cherish, along with the valuable lessons I have learned and the wonderful people I have met during my tenure as chairperson.

To my Western Bushveld Branch Committee, I want to extend my thanks for the support you have provided throughout this journey. Together, we have achieved many great things. When we first started, our goal was to improve membership and foster greater engagement from the members we serve. I am pleased to say that we have successfully achieved this through various platforms such as social media, quarterly meetings, technical visits, and more. The events we organized have been successful in sharing knowledge and reducing the expertise gap among Rock Engineering practitioners in the Mining Industry and related sectors. A special thank you to all the Rock Engineers who volunteered their assistance in hosting the SCO practical exams.

To the members of SANIRE, thank you very much for the opportunity to serve, support, and contribute. In early January 2024, we will be electing the new committee for the 2024/2025 term. I encourage you all to participate in the election of our representatives who will carry the baton forward.

Yours sincerely,

Hlomani Mthombeni
SANIRE WBB Chairperson


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TECHNICAL CONTRIBUTION

A Proposed Method for Optimizing Coal Pillar Design using Coalfield Specific Uniaxial Compressive Strength

F J N Bruwer1,2, T R Stacey2

1. Anglo American - Platinum; 2. University of the Witwatersrand

Abstract

The research described considers whether the variability in coal material strength, as expressed through a series of uniaxial compressive strength (UCS) tests, could be used to indicate the variability in coal pillar strength. The aim of the research is to be able to use a distribution of UCS tests as an input into the coal pillar strength calculation. This will allow the pillar design to be expressed in terms of a probability of failure rather than as the commonly used safety factor. To achieve this, the bulk strength factor associated with commonly used pillar strength formulae was replaced with a distribution of UCS results divided by a factor. The factor was determined so as to ensure that the resulting bulk strength does not deviate from the statistically determined bulk strength published in the original formulae. This approach allowed for pillar strength distributions to be obtained using industry accepted strength formulae, subsequently allowing for a probability of failure to be calculated for a specific pillar design. Using a regional coal material strength curve as a baseline, coalfields which are comparatively stronger than the regional mean allows for optimisation. This is based on the stronger coalfield achieving lower probabilities of failure at similar safety factors. The research has considered actual UCS data from multiple mines in the Mpumalanga coalfields of South Africa and has proved that the variability in material strength between coalfields could allow for some optimisation using the proposed approach. Based on the data used in the study, an increase in extraction of 2.78% could be achieved. However, further research will be required to validate the results of the study in an underground environment.

Keywords: Pillar; Design; Probability of Failure; Uniaxial Compressive Strength

Introduction

Very few methods exist that allow for a pillar design to be based on the material strength of a specific coalfield. One example is the work by Salamon and Canbulat (2006). The advantage of such methods being that they allow for pillars in stronger coalfields to be optimised relative to weaker coalfields. There have been multiple attempts to extrapolate coal pillar strength from UCS test results, however none of these studies was able to accurately correlate pillar strength with the strength of the intact rock mass.

Unlike these studies, the research discussed in this report did not attempt to extrapolate pillar strength from UCS results, but rather investigated whether the variability in coal material strength, as observed in UCS data, could be used to estimate the variability in the strength of pillars. In so doing, the strength of a coal pillar can be expressed as a probability density function rather than a single strength value. This allows for the design to be expressed in terms of its probability of failure rather than the more commonly used safety factor. As a result, coalfields with notably stronger material strengths could be optimised in terms of the pillar size required to ensure stability.

The principles on which the research is based

A probability of failure can be determined by expressing multiple safety factors in the form of a probability density function (Hoek, 2007). Safety factor provides the ratio between the capacity of a design and the demand or load induced on that design. A safety factor above ‘1’ would therefore indicate that the capacity is greater than the demand and the design will be stable. A safety factor below ‘1’ would indicate instability. The concept is mathematically expressed in Equation [1].

$$Safety\ Factor = \frac{Capacity}{Demand} \qquad [1]$$

By introducing a data distribution into either the capacity or the demand (or both), the resulting safety factor can be expressed as a probability density function. Empirical pillar strength equations make use of a statistically determined bulk strength value, k, to express the strength of a unit cube of coal. In the current pillar strength formulae, this bulk strength is multiplied with an adjusted width to height ratio to estimate the strength of a pillar. The common power law formula on which many of these pillar strength equations are based, is given in Equation [2].

$$S = kh^{\alpha}w^{\beta} \qquad [2]$$

Where S is the pillar strength, k is a statistically derived number related to the strength of coal, h is the pillar height, w is the pillar width and α and β are dimensionless constants.

The assumptions applied to the analysis

The study made use of the following assumptions:

- Pillar loading is accurately expressed by the application of the Tributary Area Theory (TAT), where every similar sized pillar carries an equal overburden load; and
- The set of UCS results used in the study, obtained from various South African collieries within the Mpumalanga province, provides a realistic indication of the strength of, and variability in, the coal material in Mpumalanga coalfields.

History of coal pillar strength estimations

Several authors (Bieniawski, 1968; Wagner, 1974; Van Heerden, 1975) attempted to extrapolate coal pillar strength by studying the strength of small coal samples. None of the tests however, provided definitive results in estimating coal pillar strength. Salamon and Munro (1967), opted for an empirical solution, compiling a database consisting of 125 pillar "cases". From the 125 data entries, 98 represented stable cases (therefore "unfailed") with the remaining 27 representing areas where pillars failed. Using the two datasets, Salamon and Munro (1967) considered a probabilistic approach to describe the data known as the maximum likelihood approach. The final pillar strength formula proposed by Salamon and Munro (1967) is shown in Equation [3].

$$Strength = 7.17\left(\frac{w^{0.46}}{h^{0.66}}\right) \qquad [3]$$

Madden et al. (1995) conducted a re-analysis of an updated pillar failure database which contained 17 additional failures compared with the Salamon and Munro (1967) database. The results correlated well with those obtained by Salamon and Munro (1967), and although a different strength formula was obtained, the difference was not sufficient to warrant the replacement of the original Salamon and Munro (1967) formula. The failure database was again updated by Van der Merwe (2003) with an additional 28 failures, while the "unfailed" dataset consisted of the same 98 cases described in Salamon and Munro's (1967) study.

Van der Merwe (2003) approached the data analysis with what has become known as the overlap reduction method. This method presented both the failed and unfailed datasets as probability distributions, arguing that the ideal formula would result in a complete separation between the two curves. The concept is illustrated in Figure 1.

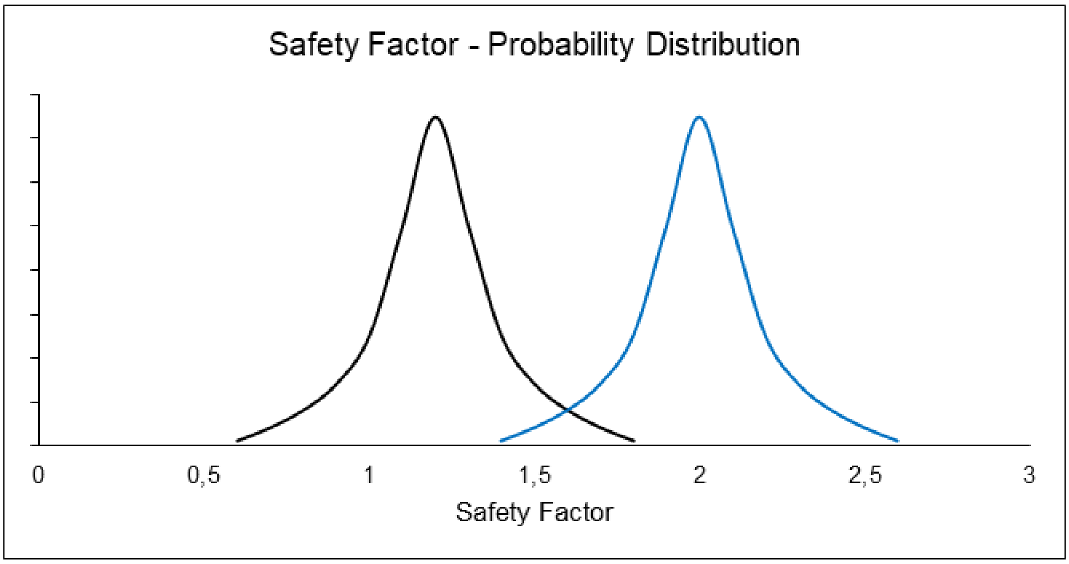

Figure 1.Illustration of the "overlap" between the stable and failed distributions as investigated by the overlap reduction method (Van der Merwe, 2003)

The analysis resulted in the pillar strength formula in Equation [4].

$$Strength = 3.5\left(\frac{w}{h}\right) \quad [4]$$

where h is the pillar height and w is the pillar width.

In 2013 another update was made to the pillar failure database, this time by Van der Merwe and Mathey (2013a). The updated database consisted of a total of 86 failed cases and 337 unfailed cases and the analysis made use of both the overlap reduction and maximum likelihood methods. As a result, two formulae were produced. The maximum likelihood method provided Equation [5] while the overlap reduction approach resulted in Equation [6].

$$Strength = 6.61\left(\frac{w^{0.5}}{h^{0.7}}\right) \quad [5]$$

$$Strength = 5.47\left(\frac{w^{0.8}}{h}\right) \quad [6]$$

With specific focus on the variability in the strength of coal between various seams, Madden and Hardman (1992) conducted a comparison between their pillar strength formula and that of Salamon and Munro (1967) using data from different seams. Interestingly, it was found that the differences between individual seams were statistically so little, and they concluded that an average strength value could be used to effectively represent the different seams. Bertuzzi (2016) found in a comparison of coal strengths between Australia, South Africa, USA, India and the UK, that the coal strengths between the different reserves, although not exactly equal, are very similar.
Contrary to this, Van der Merwe (2016) states that there is sufficient evidence indicating the strength of coal to be highly variable. A study by Salamon, Canbulat and Ryder (2006), aimed at determining seam-specific strengths by means of back analysis, also concluded that significant variations exist between coalfields. Van der Merwe and Mathey (2013a, 2013b) have also highlighted the fact that the strength of coal varies between different coalfields and coal seams.

The use of uniaxial compressive strength results in defining pillar strength

There have been many attempts to use the uniaxial compressive strength of coal to estimate pillar strength, none of which returned usable results. York and Canbulat (1998) provide a detailed summary of these attempts, all of which led to the conclusion that the extrapolation of pillar strength from a laboratory sample is significantly affected by the 'scaling' effect. The 'scaling' effect refers to the estimated reduction in sample strength obtained when increasing the size of the sample.

A study of particular relevance to this report, is that of Mark and Barton (1996) who investigated whether a stronger seam makes for a stronger pillar when extrapolating strength according to volume from laboratory coal samples. This was achieved by using UCS results from various seams to estimate the specific pillar strength associated with each seam. The pillar strengths were extrapolated using Gaddy's (1956) relationship and factors of safety were calculated using the Analysis of Retreat Mining Pillar Stability (ARMPS) formula Mark et al. (1995). Safety factors were calculated for the approximately 100 case histories used in the development of the ARMPS formula, with the case histories providing an almost even split between failed and unfailed pillars. The assumption with the study was that the weaker coal material would make for weaker pillars and therefore show failure at a higher safety factor. The study however showed that the use of a uniform bulk pillar strength, provides a significantly better fit to the back analysis of case histories, compared to the results based on the individual coal seam strengths. From this, Mark and Barton (1996) concluded that the use of seam specific strength becomes meaningless when designing coal pillars, and that the use of a uniform bulk strength value of 6.2 MPa is preferred (specific to the United States coal fields). Mark and Barton (1996) argued that one of the key reasons laboratory results are not suited to the estimation of pillar strength, is because a pillar is significantly influenced by geological features not represented in the sample. As a result, the laboratory sample will not only be significantly stronger, but the failure mechanism between sample and pillar will differ. This being the case, full scale pillar testing is currently not feasible, and even if it were, multiple pillar tests would be required to provide sufficient understanding of the variability in pillar strength within a specific coalfield. Additionally, to conduct a fair comparison between the strength of various coalfields, a common testing approach is required. Currently one of the most common and relatively inexpensive indications of rock strength remains the UCS test. Considering all its shortfalls in describing pillar strength, it still provides an indication of the strength of the material. The use of a single bulk strength value in the design of pillars, also limits the ability for any optimisation between reserves.

Research methodology

From a literature study it is clear that historic attempts to extrapolate pillar strength from UCS results by means of scaling did not provide reliable results unless samples of a cubic size larger than 1.5 m are used (Bieniawski, 1968). To the interested reader, Van Heerden (1975) provides a summary of large scale testing programmes conducted on coal samples. The approach adopted for this study, was therefore to keep to the bulk strength values determined for each of the formulae by the original authors, introducing UCS results only as a means of expressing variability.

Coal strength data

Coal, being naturally inhomogeneous and anisotropic, differs in strength from one position in a coalfield to the next. It is this variability which requires design engineers to make use of a safety factor when defining a pillar design. To effectively understand the variability in a coal seam, sufficient data points (UCS test results) are therefore required.

Van der Merwe (2003) and Van der Merwe and Mathey (2013) opted to exclude the Klipriver and Vaal basin pillar data during the development of the linear, maximum likelihood and overlap reduction strength formulae. Taking this into account, applying these formulae to data sourced from the Vaal Basin is outside of the intended scope of the formulae and could provide unrealistic results. Based on this, the data used in this study were only sourced from mines located within the Mpumalanga coalfields. The total dataset consisted of 83 coal UCS results and covered multiple mining operations. As part of the agreement to use the data, the mining operations are not mentioned by name in the study. Most operations had limited UCS data available. However, three mines, referred to as Mine A, B and C, provided sufficient data to allow for the variability in coal strength at each operation to be defined to a satisfactory confidence level. The data used in the study was compiled from various sources, collected over a number of years. As such, not all laboratory reports were available to confirm the tests adhered to ISRM standard. In the absence of this information, the test results were accepted as representative and accurate. Table 1 provides a summary of the UCS data used in the study.

Table 1. Summary of the UCS dataset used in the study (All data provided in MPa).

Source	Number of datapoints	Mean	Min	Max	Std. Dev
Mine A	9	22.4	12.3	40.5	8.9
Mine B	21	21.9	9.3	40.5	7.9
Mine C	20	29.4	22.0	38.5	5.3
Multiple sources	33	24.1	7.6	48.8	9.7
Total Dataset	**83**	**24.6**	**7.6**	**48.8**	**8.7**

In order to calculate a probability of failure from the UCS data, the data were expressed as probability density functions. To assist with analysis, the function curves were produced using the software program @Risk. The program allows the user to select the statistical function which best fits the distribution of data in a specific dataset by indicating a "fit ranking" of the available functions. The function selected for the study was Lognormal as this function provided the best representation of the actual distribution of data in each of the datasets. A comparison between the original data and the Lognormal functions is shown in Table 2. The resulting distributions are illustrated in Figure 2 to Figure 5.

Table 2. Comparison of original and best-fit datasets.

Dataset	Mean		Standard Deviation	
	Original	Lognormal curve	Original	Lognormal curve
Mine A	22.4	22.8	8.9	12.3
Mine B	21.9	21.9	7.9	8.0
Mine C	29.4	29.5	5.3	5.8
Total Dataset	24.6	24.7	8.7	8.8

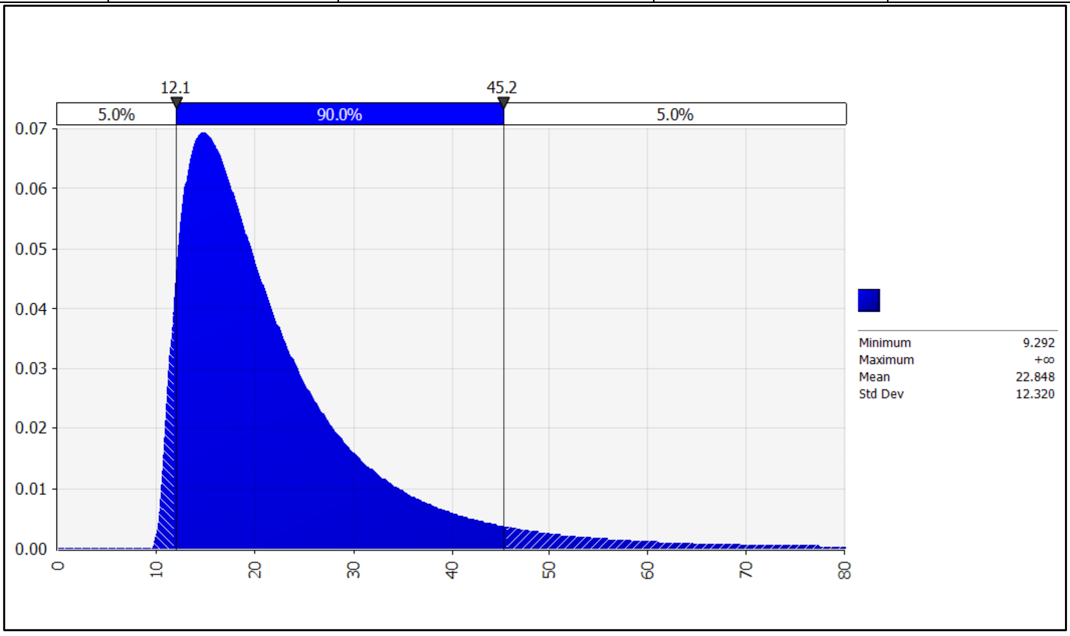

Figure 1. UCS distribution for data obtained from Mine A.

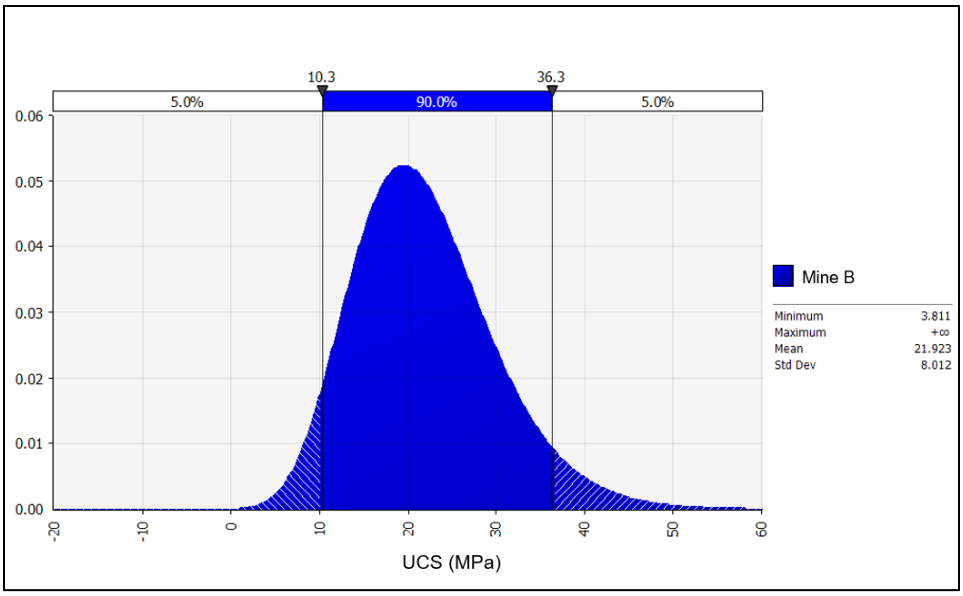

Figure 2. ***UCS distribution for data obtained from Mine B.***

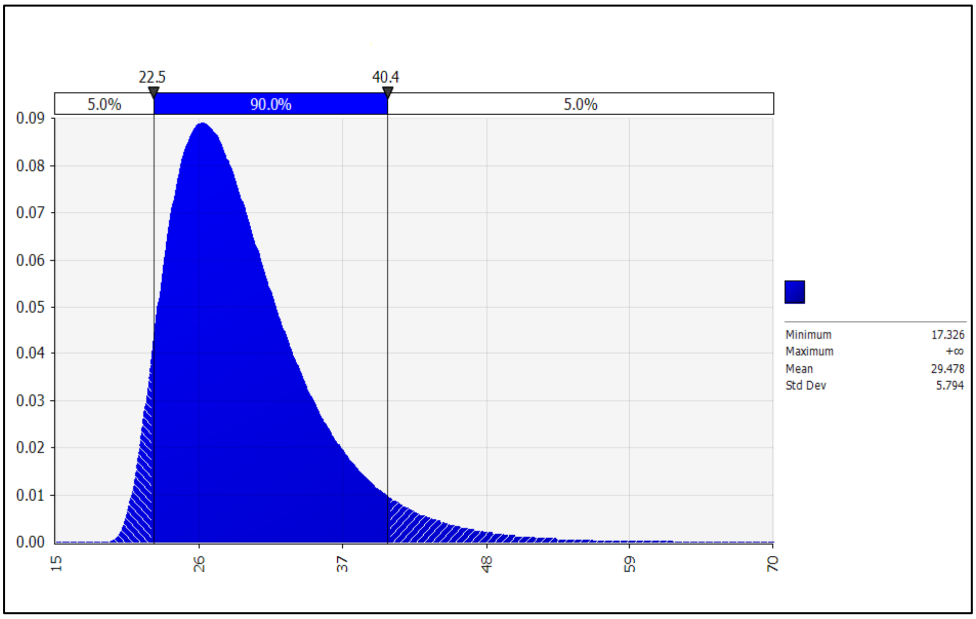

Figure 3. ***UCS distribution for data obtained from Mine C.***

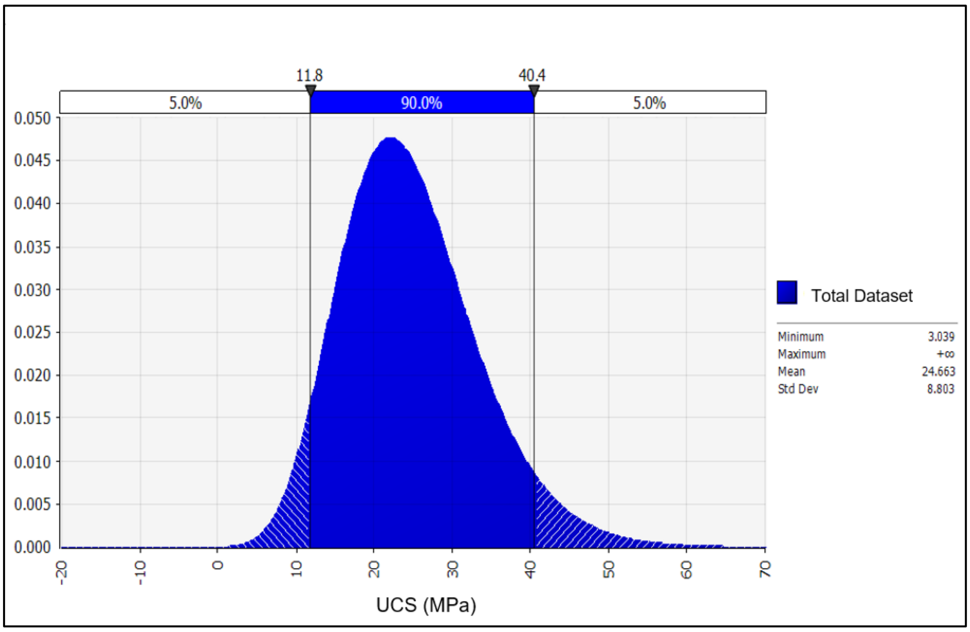

Figure 4. ***UCS distribution of the total dataset.***

Pillar database

The South African pillar failure database was ideally suited to the study as it would allow for a direct comparison between the calculation method proposed in the study, and the design methods currently used in industry. The latest iteration of the database contains a total of 424 pillar cases and covers a range of pillars at multiple depths (Van der Merwe, 2021).

Adjustments to pillar strength formulae

The current pillar strength formulae make use of a statistically determined bulk strength factor (k) to describe pillar strength. This factor however is constant regardless of the coalfield being designed for. In order to introduce the variability of the UCS data into the pillar calculation, adjustments were required to the existing pillar strength equations. It should be reiterated that the study is not aimed at extrapolating pillar strength from UCS results, but rather to describe the variability in pillar strength using the variability in UCS results. The intent was therefore to develop an approach which introduced the variability but returns a similar pillar strength as would be obtained when using the original formulae. This meant that the UCS had to be divided by a factor to ensure that the resulting bulk strength (k) used in the calculation is unchanged from the original formulae. The resulting strength parameter (k) used in the study, was therefore calculated using Equation [7].

$$Bulk\ Strength\ (k) = \frac{UCS}{Factor\ (f)} \quad [7]$$

In selecting an appropriate adjustment factor for each formula, the factors were calculated using the entire dataset of UCS results. The reasoning behind this was to ensure that the final strength factor would be appropriate for use with any of the Mpumalanga coalfields without being biased to any specific mine or seam. This was achieved by using the mean strength from the total Mpumalanga dataset (24.66 MPa). The final adjustment factor calculated for each of the formulae, was therefore based on the most likely UCS from the Mpumalanga dataset, which when divided by the factor, matches the original bulk strength value (k) from the unadjusted equations. The adjusted formulae are seen in Equation [8] to Equation [11].

Adjusted Salamon and Munro (1967) formula:

$$Strength = \left(\frac{UCS}{3.43}\right) \times \left(\frac{w^{0.46}}{h^{0.66}}\right) \quad [8]$$

Adjusted Van der Merwe (2003) formula:

$$Strength = \left(\frac{UCS}{7.05}\right) \times \left(\frac{w}{h}\right) \quad [9]$$

Adjusted Maximum Likelihood formula:

$$Strength = \left(\frac{UCS}{3.73}\right) \times \left(\frac{w^{0.5}}{h^{0.7}}\right) \quad [10]$$

Adjusted Overlap Reduction formula:

$$Strength = \left(\frac{UCS}{4.51}\right) \times \left(\frac{w^{0.8}}{h}\right) \quad [11]$$

It should be noted that the adjusted formulae are a result of the distribution of UCS values used in this study and is subsequently not intended as universal formulae to be used for any operation within the Mpumalanga coal fields. Should a different UCS dataset be used, a different set of equations will be obtained. The aim of the formulae is merely to show the application of the approach proposed in this study. Using the adjusted formulae, it is possible to calculate pillar strength using the strength of the coal material associated with a specific coalfield. Additionally, expressing the material strength as a distribution of UCS values, the adjusted pillar strength formulae allowed for the probability of failure to be calculated for different pillar scenarios.

Calculation of pillar failure probabilities and validation of adjusted pillar strength formulae

The four pillar strength formulae discussed in the previous section are all acceptable methods of calculating pillar strength and have been implemented by various mining houses in South Africa. In order to determine whether the adjustments to the formulae would alter the outcome of the results, a comparison was conducted between the result from the adjusted formulae and the result of the formulae in their original form. For a direct comparison to be made, the results were stated in terms of safety factor, as probability of failure is beyond the application of the original formulae.

Keeping in mind that the adjusted formulae will produce a distribution of safety factors in order to determine a probability of failure, expressing the results from the adjusted formulae in terms of a single safety factor would require the distribution of safety factors to be reduced to a single representative value. This can easily be achieved by using the mean of the distribution as it represents the safety factor that most frequently occurs in the resulting data distribution (the peak of the distribution curve). Figure 6 illustrates a distribution of safety factors, graphically indicating the difference between the probability of failure obtained from a distribution and the mean of the distribution. In Figure 6, the probability of failure is indicated as the area below the curve for a safety factor less than one, and is expressed as a percentage of the total area below the curve as shown in Equation [12].

$$Probability\ of\ Failure = \left(\frac{Shaded\ Area}{Total\ Area}\right) \qquad [12]$$

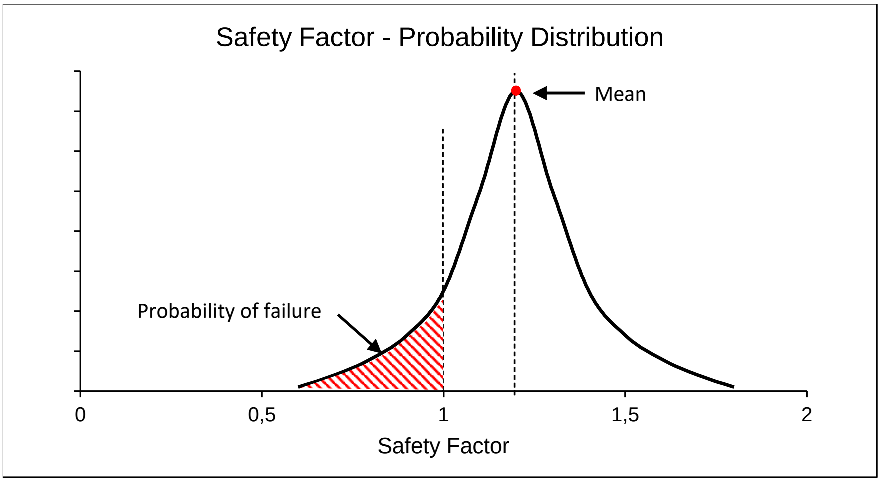

Figure 1. ***Illustration of a distribution of safety factors indicating the probability of failure and the mean safety factor for the distribution.***

In calculating the distribution of safety factors using the adjusted formulae, the total dataset of 83 UCS values was used. With the adjustments based on the total dataset, the resulting distribution of safety factors should return similar results compared to the unadjusted formulae. In order to conduct the comparison, a set of baseline pillar scenarios was selected from the South African pillar failure database. The pillar parameters obtained from the database included the pillar width, height, bord width and depth below surface. In keeping with the industry norm, an overburden density of 2500 kg/m3 was used in all calculations. Subsequently, the only parameter that changed in the comparison was the bulk strength factor (k).

The calculations of pillar safety factor using the original formulae are discussed at length in the earlier sections of the report and will not be repeated. The calculations of the safety factors using the adjusted formulae were conducted as follows:

The software program @Risk, allows the user to calculate a probability density function using a distribution of values as an input to an equation. The program then simulates results for a pre-set number of iterations. The UCS distributions discussed earlier in the report were used as the input to the UCS parameter of the adjusted formulae. All calculations made use of 1000 iterations to produce a probability density function for each pillar scenario. The resulting distributions indicate the range of pillar strengths expected for each scenario. Using the distribution of pillar strengths as the input into the “capacity” parameter in Equation [13], a distribution of safety factors is subsequently obtained in @Risk.

$$Safety\ Factor = \frac{Capacity}{Demand} \quad [13]$$

These distributions of safety factors are finally used to determine the mean safety factor for each scenario as well as the probability of failure. Probability density functions were calculated for all pillars in the South African pillar failure database (both failed and unfailed datasets). An example of one of the 424 safety factor distributions (one distribution for each scenario in the pillar database) obtained from @Risk is seen in Figure 7. The probability of failure is automatically calculated in @Risk as the area below the curve. In the example, this is 0.7 % of the total area below the curve (based on a dividing line equal to a safety factor of one).

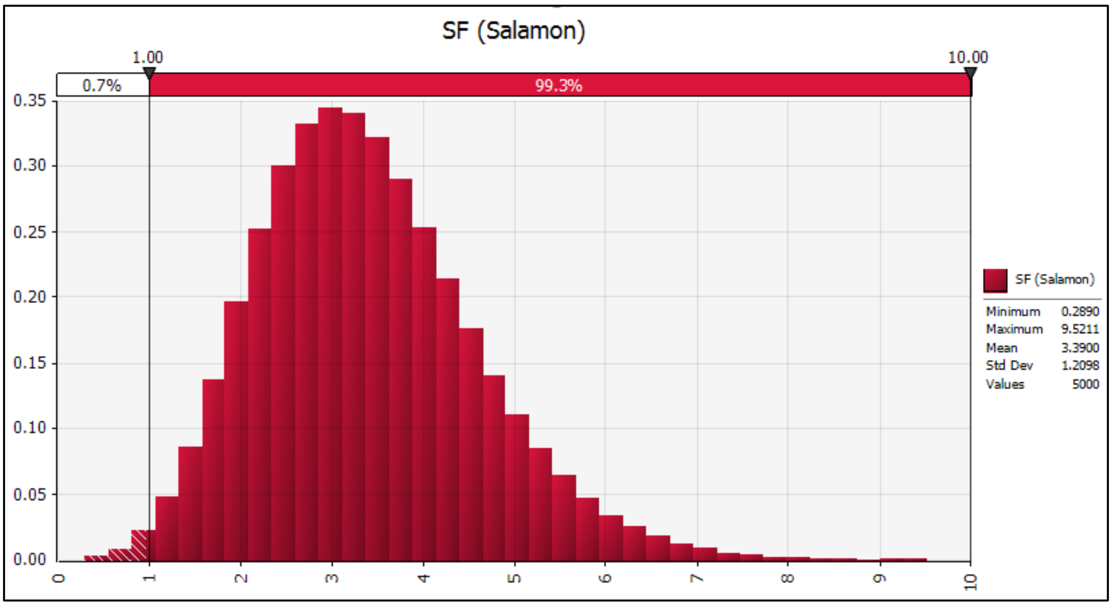

Figure 5. Example of a distribution of safety factors calculated using @Risk. The probability of failure for the distribution is 0.7% with a mean safety factor of 3.39.

Table 3 summarises the results of five randomly selected pillars from the failed dataset and five from the unfailed dataset. From these results, it can be seen that, although isolated scenarios did not provide the exact same safety factor, the difference is never more than 0.01. From the results, the adjusted pillar strength formulae were subsequently validated for use in the study.

With the adjusted formulae validated for use, the calculated probabilities of failure were considered. Figure 8 and Figure 9 provide a graphical illustration of the calculated probabilities relative to the safety factor for both the failed and unfailed pillar datasets. The graphs include the results of all four formulae, and interestingly, the relation between safety factor and probability of failure remains constant regardless which formula is used. This could however be expected as the same distributions of variables were applied to all formulae.

Table 3. Comparison of the safety factors obtained from the adjusted and original pillar strength formulae as calculated using the total UCS dataset.

Database	Pillar case number	SF - Salamon		SF - Van der Merwe		SF - Maximum Likelihood		SF - Overlap Reduction	
		Original formula	Adjusted formula	Original formula	Adjusted formula	Original formula	Adjusted formula	Original formula	Adjusted formula
Failed	5	4.85	4.84	4.45	4.45	4.58	4.59	4.75	4.75
	29	1.26	1.25	0.95	0.94	1.16	1.16	1.03	1.03
	51	0.92	0.92	0.63	0.63	0.85	0.85	0.76	0.76
	66	1.01	1.01	0.71	0.71	0.94	0.94	0.88	0.88
	83	0.77	0.77	0.63	0.63	0.72	0.72	0.67	0.67
Unfailed	71	2.48	2.47	3.82	3.82	2.47	2.47	3.85	3.84
	140	2.29	2.29	3.21	3.21	2.25	2.25	3.05	3.05
	228	2.35	2.35	3.82	3.82	2.34	2.34	3.50	3.50
	284	4.02	4.02	6.69	6.68	3.98	3.98	5.77	5.77
	328	4.01	4.01	5.18	5.17	3.92	3.92	5.10	5.10

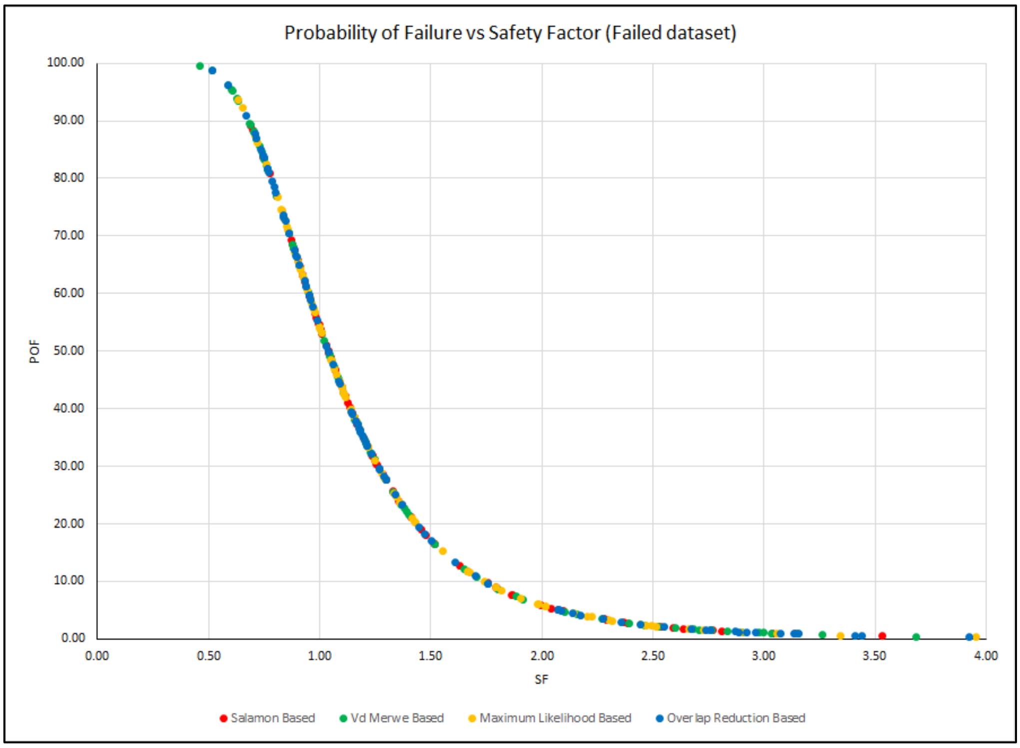

Figure 6. Probability of failure plotted against safety factor for the failed pillar dataset.

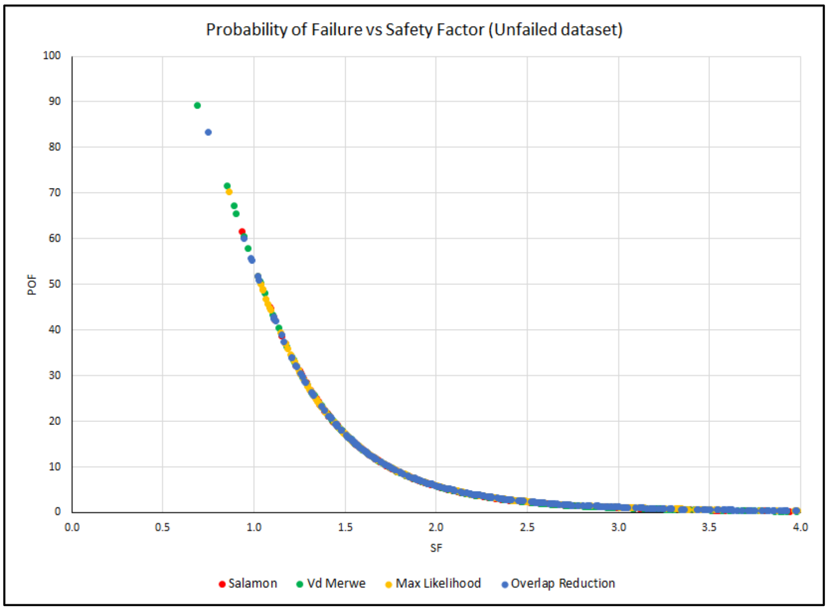

Figure 7: Probability of failure plotted against safety factor for the unfailed pillar dataset.

From Figure 8 and Figure 9, a probability of failure of 50 % equates to a safety factor of 1.04. This aligns well with the assumption that a safety factor of 1, taken as the divide between stable and unstable, should equate to a probability of failure of 50 %. For both graphs, a safety factor of 1.6 is achieved at a probability of failure of 13.8 %. Finding a probability of failure that aligns to a safety factor of 1.6 was necessary as a safety factor of 1.6 is commonly accepted as a design threshold for a stable pillar design. This same design threshold was required for the probability of failure obtained using the approach proposed in this study. The value of 13.8 % was therefore selected as the probability threshold for the interpretation of the results discussed in the following section.

Results obtained from the proposed method

In the previous section, the study proposed a method with which pillar probability of failure can be calculated based on the laboratory strength of a specific coal seam or mine. The calculation of the probability of failure is key to the study as this forms the basis with which pillar optimisation can be justified. This is achieved by designing a pillar to the same probability of failure as the baseline pillar obtained when using the total UCS dataset (therefore the same pillar strength as would be obtained from the original unadjusted formulae). As a result, the final pillar would have a similar probability of failure as the baseline but be designed to a lower safety factor provided the coal material is of a higher strength.

To determine whether the variability in coal strength would allow for sufficient optimisation in pillar size, the proposed method was applied to the data from mines A, B and C outlined in Table 1. Earlier in the report it was confirmed that the "failed" and "unfailed" datasets from the pillar failure database provide similar probabilities of failure across a range of safety factors. The decision was therefore made to use only the "failed" dataset for this section of the study, therefore reducing the number of calculations required while still having sufficient data from which to draw conclusions. The failed dataset consists of 87 pillar scenarios and would therefore produce 87 datapoint with which distributions could be plotted. In calculating the safety factors and probabilities of failures for each of the mines, the UCS distributions discussed earlier in the report were applied to the adjusted pillar strength formulae. Figure 10 provides a graphical comparison of the safety factor distributions obtained from each of the four datasets, being the total Mpumalanga dataset as well as the data from the three individual mines A, B and C. The distributions in Figure 10, were not graphed using @Risk, as the distributions would not be used as input into further calculations. The distributions are therefore compiled by dividing the results into bins of safety factors and plotting the number of data points per bin across the range of safety factors applicable.

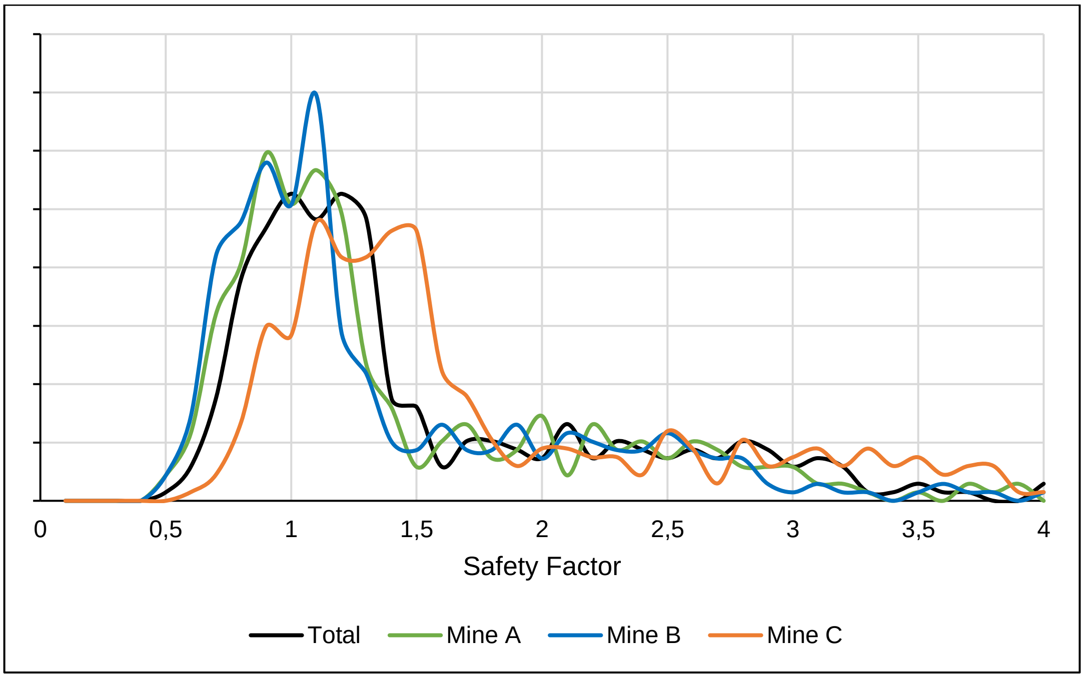

Figure 8: ***Comparison of safety factors and probabilities of failure obtained from the different datasets.***

To determine whether the different distributions would allow for any pillar optimisation, the distribution for each mine was compared to the original distribution from the total dataset (also referred to as the baseline distribution). Should the distribution move towards a higher range of safety factors compared to the baseline distribution, the adjusted formulae predicted higher pillar strengths, and pillar optimisation would be possible. This would occur when the average UCS from the mine database is higher than the Mpumalanga mean, therefore inferring a stronger pillar material. Should the distribution move towards a lower range of safety factors, the adjusted pillar formulae predicted lower pillar strengths and a larger pillar would be required to maintain the probability of failure indicated by the baseline distribution. Figure 11 to Figure 13 provide graphical comparisons of the individual distributions to the baseline. Due to the distributions returning a bi-modal curve, the harmonic mean from each distribution was used to provide a quantifiable measure for optimisation.

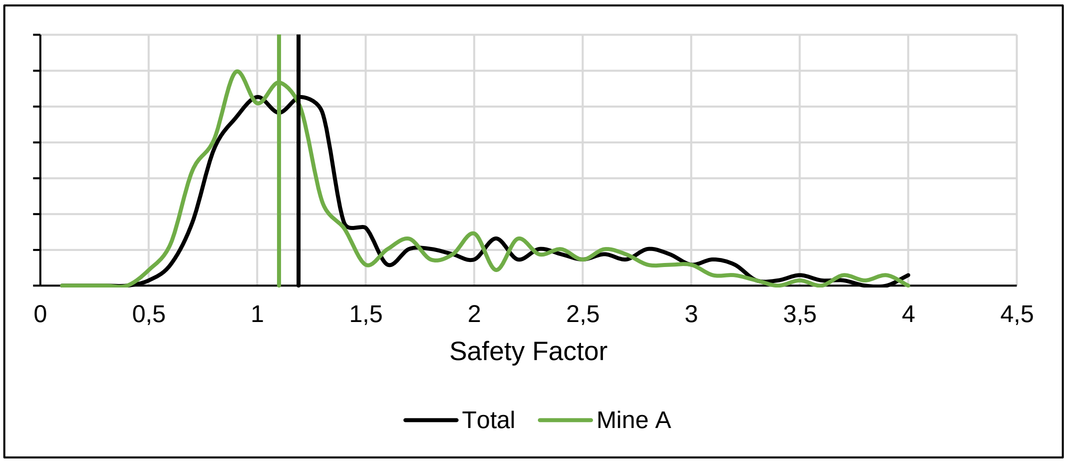

Figure 9: Comparison of the Mine A distribution to the baseline obtained from the total UCS dataset.

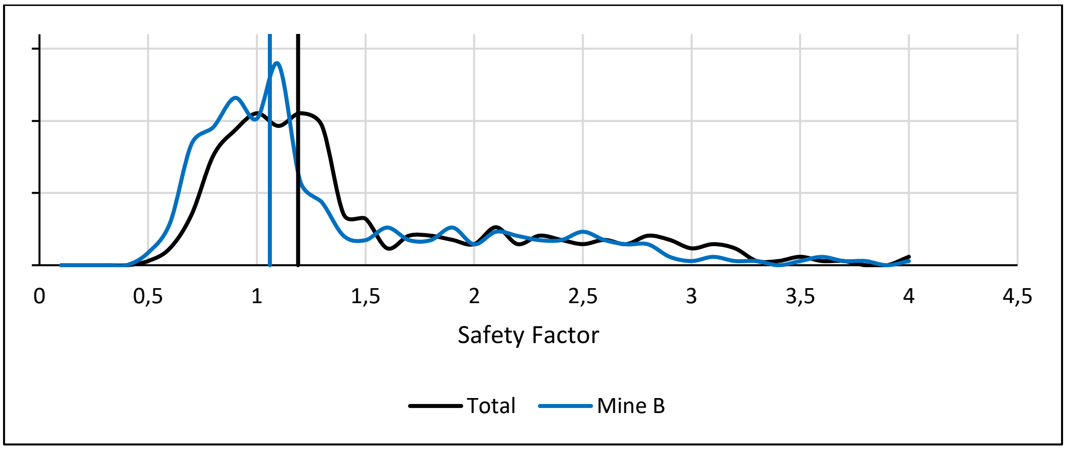

Figure 10: ***Comparison of the Mine B distribution to the baseline obtained from the total UCS dataset.***

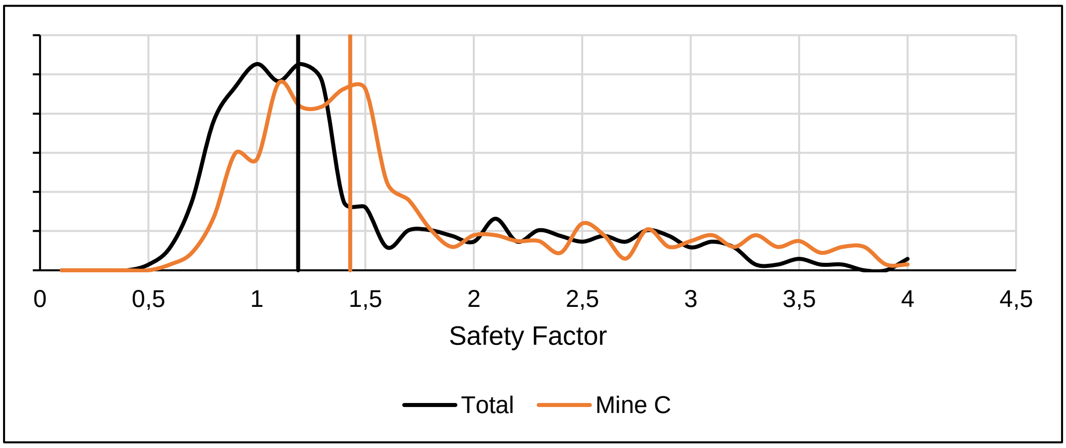

Figure 11: ***Comparison of the Mine C distribution to the baseline obtained from the total UCS dataset.***

From Figure 11 to Figure 13, it can be seen that the datasets from Mine A and B, return lower safety factors compared to the baseline. Mine C on the other hand returns higher safety factors. This is in line with expectation when considering the mean UCS from the various datasets (Table 1). Mine A and B have mean UCS values of 22.4 MPa and 21.9 MPa compared to the total dataset mean of 24.6 MPa. Mine C, however, has a mean UCS of 29.4 MPa, indicating a stronger coal material compared to the Mpumalanga average. Based on these results, the pillars from Mine C, could potentially be optimised in size without increasing the probability of failure. Figure 14 to Figure 16 graphically illustrate this effect. In plotting these graphs, the adjusted formulae are compared with the results from the original formulae relative to the probabilities of failure obtained for each dataset. To determine the actual shift in safety factor, a probability of failure of 13.8 % was used, as determined from the baseline distribution to represent a safety factor of 1.6 prior to any adjustment of the formulae.

It should be noted that the graphs in Figure 14 to Figure 16 are only used to determine the difference in safety factor at the threshold probability of 13.8 %. The intent is therefore not to match the curve to a safety factor threshold of 1.6. The adjustment to the final pillar dimensions is conducted using the unadjusted formulae and is discussed later.

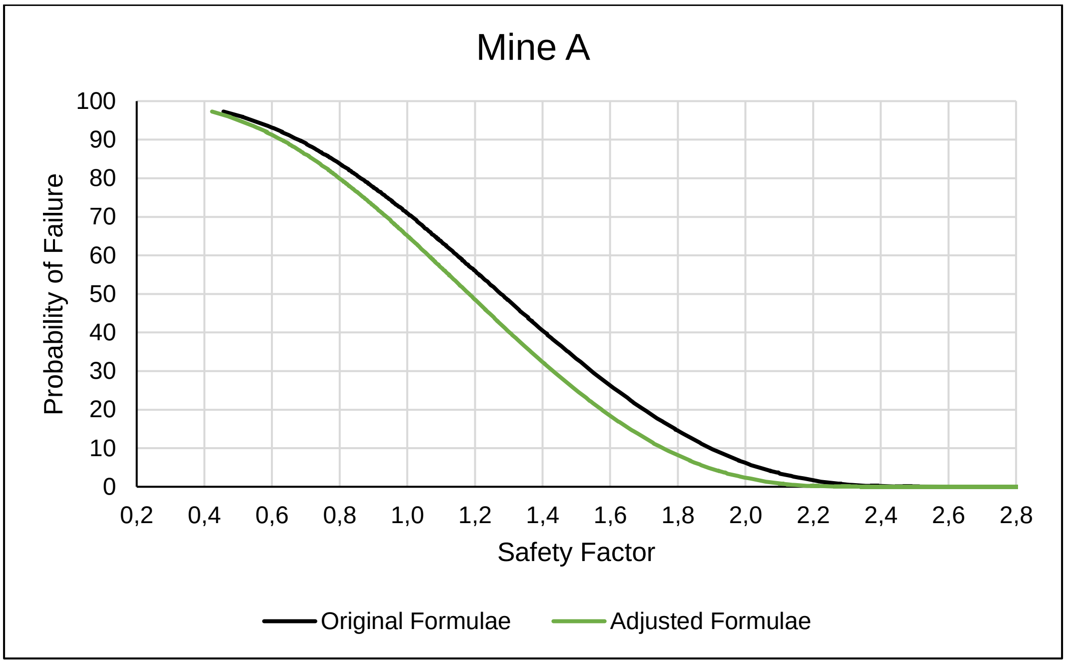

Figure 12: ***Comparison of safety factors from the original and adjusted formulae using the Mine A dataset.***

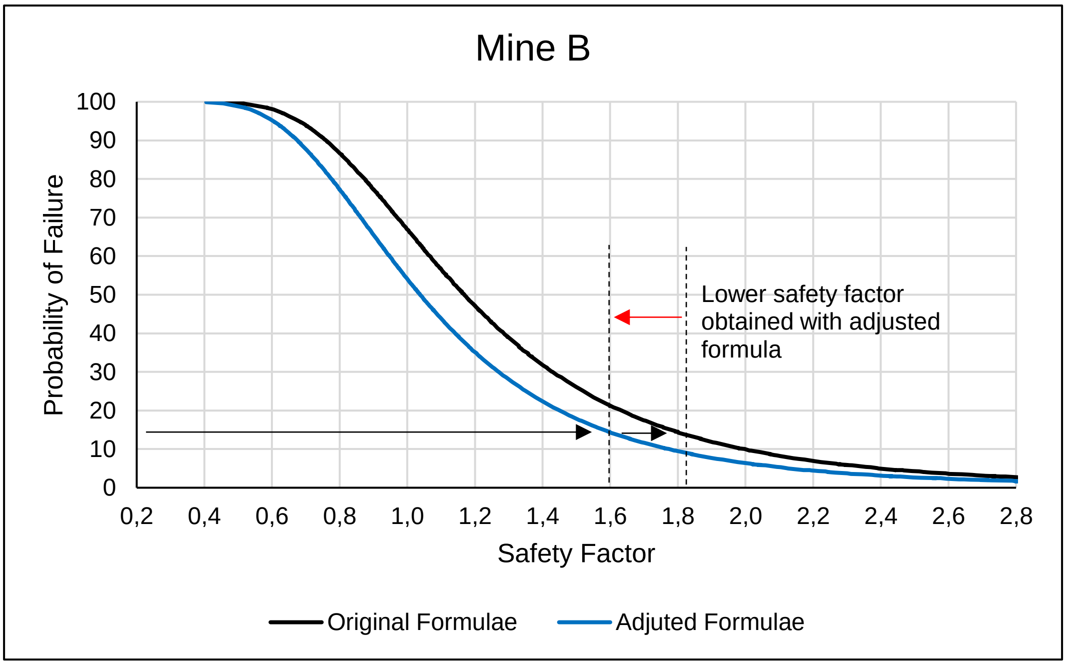

Figure 13: ***Comparison of safety factors from the original and adjusted formulae using the Mine B dataset.***

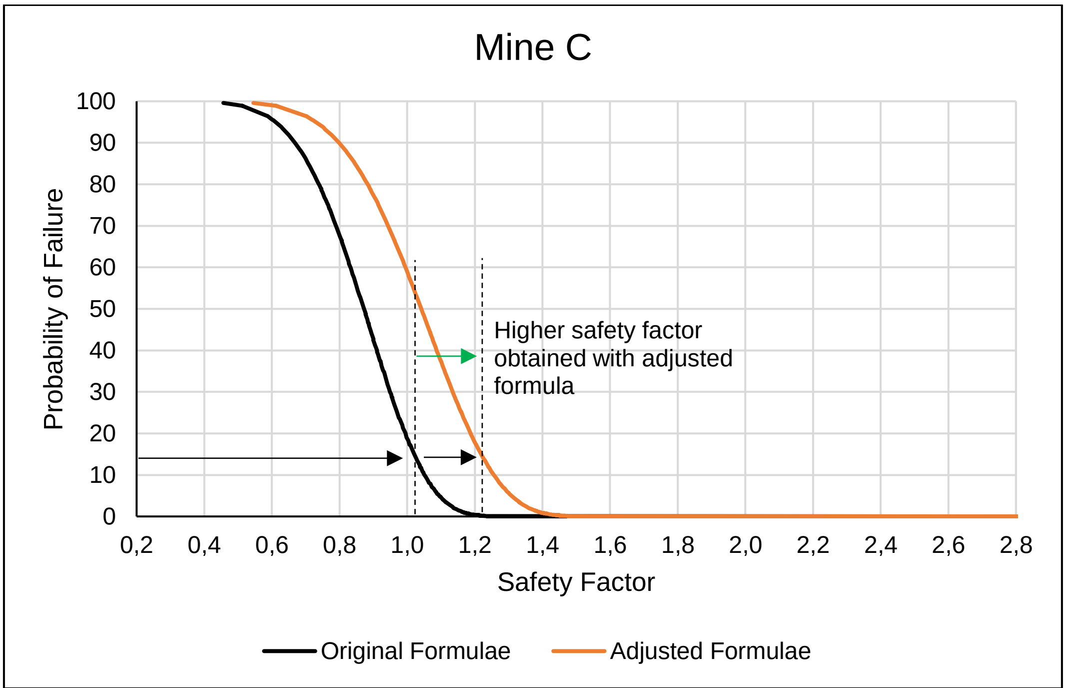

Figure 14: ***Comparison of safety factors from the original and adjusted formulae using the Mine C dataset.***

To quantify the potential optimisation using the data from the various mines, a single mining scenario was required. This would allow for the actual change in pillar dimensions to be calculated and compared. This comparison was conducted using the mining parameters from Table 4.

Table 4: ***Mining scenario used for comparison.***

Depth (m)	Pillar width (m)	Bord width (m)	Mining height (m)	Load (MPa)
100	11	6.5	3	6.33

From the parameters in Table 4, the pillar load as calculated based on TAT is 6.33 MPa. The safety factors obtained from the original pillar strength formulae for this scenario are summarised in Table 5.

Table 5: ***Safety factors obtained for the mining scenario using the original pillar strength formulae.***

Formula	**Salamon**	**Van der Merwe**	**Maximum Likelihood**	**Overlap Reduction**
Safety Factor	1.65	2.03	1.61	1.96

Using the difference in harmonic mean between the datasets as illustrated in Figure 14 to Figure 16, the allowable difference in safety factor was determined. Table 6 summarises the differences in harmonic means between the total and individual mine datasets.

Table 6: ***Difference in safety factors determined from the harmonic mean of the distributions.***

Dataset	Harmonic mean	Difference in SF
Mine A	1.10	0.09
Mine B	1.06	0.13
Mine C	1.43	-0.24
Harmonic mean of total dataset – 1.19		

The ‘optimised’ pillar design would therefore be designed to the original pillar safety factor, plus or minus the difference, depending on whether the safety factor should increase or decrease. Table 7 provides a summary of the updated pillar widths determined from the analysis. In calculating the updated pillar widths, the calculations were based on perfectly square pillars. Parameters such as depth below surface, mining height and bord width were unchanged.

Table 7: Updated pillar widths obtained from the analysis.

Dataset	Formula	Original width (m)	Updated width (m)	Difference (m)
Mine A	Salamon	11	11.5	+ 0.5
	VdM	11	11.3	+ 0.3
	ML	11	11.5	+ 0.5
	OR	11	11.3	+ 0.3
Mine B	Salamon	11	11.7	+ 0.7
	VdM	11	11.4	+ 0.4
	ML	11	11.8	+ 0.8
	OR	11	11.5	+ 0.5
Mine C	Salamon	11	9.7	- 1.3
	VdM	11	10.2	- 0.8
	ML	11	9.7	- 1.3
	OR	11	10.1	- 0.9

Based on the results from Table 7, the potential gain involves a reduction in pillar width that ranges between 0.8 m and 1.3 m. Due to practical mining considerations, a pillar width will not be adjusted by a value of 0.8 m or 1.3 m. The change would rather be made in factors of 0.5 m. This would mean that the pillar design values using the Salamon and Munro and Maximum Likelihood formulae would reduce by 1 m, and the Van der Merwe and Overlap Reduction formulae by 0.5 m. To link this to the expected change in a production profile, Table 8 provides a summary of the additional tonnes that could be mined per pillar based on these adjustments.

Table 8: Gain in production tonnes per pillar based on the optimised pillar sizes.

Formula	Salamon	VdM	ML	OR
Pillar width original (m)	11.0	11.0	11.0	11.0
Pillar width new (m)	10.0	10.5	10.0	10.5
Difference in width (m)	- 1.0	- 0.5	- 1.0	- 0.5
Gain in tonnes per pillar	157.50	80.63	157.50	80.63

The reduction in pillar sizes stipulated in Table 8 increases the extraction percentage as indicated in Table 0.9, providing an additional 2.78 % for the Salamon and Maximum Likelihood formulae, and 1.36 % for the Van der Merwe and Overlap Reduction formulae. Although the increase appears marginal, it would allow for better resource utilisation and could aid in extending the life of a mining operation.

Table 9: Increase in extraction percentage for each of the strength formulae compared to the base case used in the study.

Formula	Salamon	VdM	ML	OR
Original extraction %	60.49 %	60.49 %	60.49 %	60.49 %
Updated extraction %	63.27 %	61.85 %	63.27 %	61.85 %
Gain in extraction %	+ 2.78 %	+ 1.36 %	+ 2.78 %	+ 1.36 %

Discussion

From the results, it seems plausible that the method proposed by the study would allow for optimisation in pillar design where the coal material is comparatively stronger than the regional average. There have been multiple studies which concluded that pillar strength cannot be extrapolated from UCS results, the most notable being the study by Mark and Barton (1996). This being the case, the method proposed by this study does not attempt to extrapolate pillar strength from smaller samples by means of scaling, but rather matches the bulk pillar strength of the original formulae using the regional average UCS. The strength of a pillar is subsequently adjusted based on the UCS of the coal material specific to a coal seam or mine. A similar approach has been adopted in the hard-rock pillar design fraternity, with both Potvin et al. (1989) and Lunder and Pakalnis (1997) defining the pillar bulk strength by means of the UCS divided by a factor. Another approach commonly used in South African hard rock mines, which supports the link between UCS and pillar strength, is to estimate the pillar bulk strength as a third of the UCS (Ozbay et al, 1995). It is therefore not uncommon to use the UCS of a rock type to describe the expected pillar strength. In a study conducted by Van der Merwe (2003), he was also able to differentiate and rank the strength of various coal mines from weakest to strongest using a range of "small sample" tests. What is different in the approach proposed by the current research, is the introduction of a distribution of UCS values in describing not only pillar strength, but variability in pillar strength. This allows for a pillar design to be expressed in terms of a probability of failure, which forms the basis on which optimisation can be conducted. It should be noted that the use of probability rather than safety factor as a basis for design is also not a first in coal pillar design. Van der Merwe and Matthey (2013) and Van der Merwe (2016) previously adopted a probability approach. One which is currently in use on some mines.

A question that remains unanswered however, is whether the behaviour of a pillar can effectively be estimated using only the UCS of a material without considering the effect that jointing has on the stability of the pillar? The study by Mark and Barton (1996) indicates this as unlikely based on the inability of a laboratory UCS test to account for natural discontinuities and imperfections in the larger mass. Esterhuizen (2000) studied the effect of jointing on pillar stability using field data from South African coal mines. He concluded that the weakening effect of jointing in a pillar reduces with increasing width to height and is largely dependent on the joint orientation. This presents a challenge as the orientation of jointing in a reserve is generally not well defined prior to start of mining and based on the above-mentioned studies, should be accounted for in the pillar design prior to start of mining.

Another consideration that should be taken into account however, is that the pillar strength formulae discussed in this report have been implemented in industry for many years without pillars failing abnormally as a result of jointing. This could be attributed to the fact that the pillars recorded in the South African pillar failure database provide an indication of actual pillar behaviour, including the effects of material imperfections, cleating and discontinuities. Taking this into consideration, it begs the question whether further adjustment to the pillar strength formulae to include the effect of discontinuities are in fact required?

Regardless of whether the effect of discontinuities is sufficiently accounted for in the current pillar strength formulae, the use of UCS test data in expressing pillar strength seems prudent. Additionally, it provides a logical and viable means with which to express pillar probability of failure, based not on the statistical back analysis of pillar failure data, but on the variability of the coal material as determined by existing laboratory testing methods. These failure probabilities subsequently provide a means with which to potentially optimise the pillar design on a mine. The method proposed by the research does however require further validation, ideally by means of underground trials in a controlled environment, to ensure that underground stability is maintained for as long as underground stability and surface protection is required.

Conclusion

The research described in this paper was conducted on UCS data from actual mines, and proved the capacity for optimisation between reserves by considering the difference in material strength as obtained from UCS tests. Based on the datasets considered, a potential increase in extraction of up to 2.78 % could be obtained without any change to the calculated probability of failure. The results however assume that the variability in pillar strength can be effectively described by the variability in UCS strengths of a specific reserve. The probability of failure is determined from a distribution of safety factors, which in turn is calculated from a distribution of UCS results used in pillar strength formulae adopted from existing methods.

The results of the research confirm on a theoretical basis the applicability of the proposed optimisation method. The additional extraction resulting from the optimisation would aid in resource utilisation as well as extending the life of mine. The results however, do not confirm the proposed method as one that can be implemented without due consideration. The assumption that the variability in small scale test samples is representative of the variability in coal pillars, remains an assumption that must still be confirmed. To ensure this approach does not compromise long-term pillar stability, further research is required. It is recommended that the optimised pillar sizes obtained from this approach, be trialled in a controlled environment where abnormal pillar behaviour will not affect the rest of the mine. Once trial mining confirms stable behaviour is maintained, the optimised design can systematically be introduced across the remainder of the mine.

Acknowledgments

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THE NEXT ROCK Star

ROCK STAR OF THE QUARTER

Full Name: Rethabile Seabela

Company/Organization: Dwarsrivier Chrome Mine

Designation: Strata Control Officer r

Date and Place of Birth: 21 October, Polokwane

Education: BSc Geology, University of Pretoria

First Job: Graduate Geologist, Kgalagadi Manganese Mine

Philosophy of Life: Peace of mind is priceless.

Favourite Food/Drink: Any chicken dish

Favourite Sport: None

Q. What motivates you to get out of bed in the morning?

My son. He's the light of my life.

Q. What is your favourite quote (why)?

"Set peace of mind as your highest goal and organize your life around it" by Brian Tracy. In this day and age where there exists so many external factors that wreak havoc to our wellbeing, we need to be extra cautious about the things we let affect our peace of mind. It is not cowardly but self-preservation to distance ourselves from the people or situations that interfere with our mental, physical and emotional health.

Q. What is your personal song (why)?

I don't have a specific one, I listen to a variety of music depending on the occasion.

Q. What is your favourite movie?

August rush. It is a movie about a young musically gifted orphan boy overcoming adversity in the search for his birth parents. It's a story of faith and resilience.

Q. If the story of your life were to become a biopic, what would the title be?

Silently impactful

Q. What is the best vacation you've been to or plan on going to?

I would love to go to Santorini Greece.

Q. Do you have a favourite newspaper, blog?

I don't have one. I prefer TED talks.

Q. What is your greatest fear?

Dying while my son is still too young.

Q. What is your hidden talent?

People who do not know me outside of work don't know that I'm actually quite good at creating art and crafts. I mostly enjoy creating DIY decorations for different occasions. I'm also that aunt that the nephews and nieces call when there's a school project involving a creation of some sort.

Q. What's your most memorable facepalm moment?

I drove around for almost two weeks with an expired car disk without realizing it until my mother asked me about it. Turns out that when I cut out the new disc I didn't put it in the sleeve but returned the old one. Luckily I'm a bit or a paper hoarder and I never throw any document away so I was able to find the new disk all was well.

Q. If you could interview one person (dead or alive) who would that be (why)?

Not a person but a deity. I have sooo many questions about life and death!

Q. If you were an animal what would you be (why)?

A cat, they always land on their feet.

Q. If you were on death row, what would your last meal be?

Grilled chicken with ice cream for dessert.

Q. If you were stuck on an island what three things would you bring?

Why three? I only need one thing- my phone so I can call for help and get out if there!

Q. If you were a rockstar, what would your stage name be?

Could never be me *laughs*

Q. Growing up, what was your dream career?

I wanted to be a mechanical engineer.

Q. Why did you choose Rock Engineering as a career?

When I started my career as a graduate geologist, I spent some time within other MRM sub departments to learn what they do and their contributions towards the operation. I was immediately intrigued when I got to the Rock Engineering Department. Here were these superstars whose job was to keep the ground from falling! I had always imagined one needed to be loud and imposing in order to deal with mining personnel when it comes to stopping unsafe working places and issuing instructions. I met an excellent SCO in that department who reminded me much of my calm and quiet self and encouraged me to give it a shot.

Q. What do you find the most challenging of Rock Engineering?

Constantly being viewed as 'the one who stops production and denies us our monthly bonus". I always say as long as you are adhering to the recommendations, you can call me by whatever name you like 😊. In the end we are all working towards the common goal of producing blood free minerals.

Q. What do you like most about Rock Engineering?

I like that it is a well-researched discipline. Whatever condition you come across; someone has encountered something similar. The answers are out there just waiting for you to discover.

Q. What are some areas that you believe will become of increasing importance in the near future of the rock engineering discipline?

Falls of ground are currently the biggest killer in the mining sector. I think remote monitoring instruments that will give trigger warnings on surface and the development thereof will become increasingly important as we strive towards reducing that number. If we are able to detect warning signs before disaster strikes, we can take measures to prevent or minimize the impact of those disasters.

Q. What advice would you give to someone who want to choose Rock Engineering as career?

Don't be afraid to move around. That's how you build your knowledge base and your network.

Q. What is the best advice you have ever been given?

Consult and ask a lot of questions. You may find that the next person knows an easier way to achieve your objective.


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EDITORS CORNER

A Christmas Message to All

As we near the end of the year, let us take the time to look back and reflect on the year that was. This Christmas may our blessings be many, our worries few and days spent with those who mean the most to us.
Enjoy the presents under the tree, the people who put them there and the extra spark of gratitude the season brings. May the richness of gratitude be yours…and cheers!!

SANIRE would like to hear from you. If you have any information or content you would like us to include in the next newsletter, please submit them via email to info@sanire.co.za & fezekilem@Dwarsrivier.co.za

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