APPENDIX 13

OFFICE OF SURFACE MINING
REPORT ON
UNDERGROUND MINE PILLAR STABILITY

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OFFICE OF SURFACE MINING (OSM)
REPORT ON
UNDERGROUND MINE PILLAR STABILITY

PREPARED IN RESPONSE TO THE OCTOBER 11, 2000,
IMPOUNDMENT BREAKTHROUGH
AT
MARTIN COUNTY COAL CORPORATION (MCCC)
BIG BRANCH SLURRY IMPOUNDMENT

This report was prepared by OSM as a part of its review of the MCCC 2000 breakthrough. This report addresses the stability of the underground mine pillars at, and adjacent to, the 2000 breakthrough.

The design of mine pillars involves the determination of proper sizes of pillars compatible with the expected load and the in situ strength of the coal strata. Thus, in deciding the most suitable dimensions for mine pillars, one needs to consider such factors as the pillar load (the stress on pillars), the pillar strength, and the factors of safety.

All pillar design methods used in the United States are empirical. The earliest, proposed by Bunting (1911), was based on case histories supplemented by laboratory testing. Later formulae followed the same basic pattern and were derived from laboratory tests (Holland, Holland - Gaddy, and Obert - Duvall formulae), large-scale in situ tests (Bieniawski formula), or case histories (the Salamon - Munro formula). OSM adopted the Holland, Holland - Gaddy, Obert - Duvall, and Bieniawski formulae in its Subsidence Development Prediction System (SDPS) program. The program is used to determine pillar stability and predict subsidence. For many years, these empirical formulae performed reasonably well for room-and-pillar mining under relatively shallow cover. Their key advantages are that they are closely linked to reality and are easy to use.

Each of these empirical pillar design formulae:

1. Estimate the pillar load using tributary theory;
2. Estimate the pillar strength using a pillar design formula; and
3. Calculate the pillar safety factor.

The SDPS program was used to evaluate the pillars at MCCC. The following parameters were used in the SDPS analysis:

In-situ coal strength.

- The analysis used both a conservative and an average strength. The conservative strength of 600 pounds per square inch (psi) was used to reflect the potential for weaker coal, due to weathering, near the outcrop. The average coal strength of 900 psi is generally used for unweathered coal.

Pillar dimensions.

- The analysis used pillars 20 feet wide and 25 feet long. This is generally the smallest pillar size in the study area.

Mining height and entry width.

- The analysis used a mining height of 10 feet. This is generally the highest mining height in the study area. The analysis also used an entry width of 20 feet. This is the typical width for the study area.

Overburden depth and density.

- An overburden depth of 70 feet and density of 160 pounds per cubic feet (pcf) was used for the pillars adjacent to the 2000 breakthrough. This depth and density is equivalent to the combined weight of the overburden, seepage barrier, and slurry at the breakthrough point, i.e., 30 feet of natural overburden; 40 feet of seepage barrier material; and 20 feet of slurry.

- Analyses were also conducted for overburden depths of 100 feet and 200 feet and density of 160 pcf. These analyses were conducted in order to determine the overall stability of the pillars in the mine works adjacent to the 2000 breakthrough. The pillars with 100 feet of overburden are located about 140 feet from the breakthrough. These pillars are currently located under the Stockton coal seam bench. The pillars with 200 feet of overburden are located about 300 feet from the breakthrough. These pillars are located beyond the highwall at the Stockton coal seam bench.

Pillar Stability Safety Factors

1. Pillars near the 2000 breakthrough; overburden depth of 70 feet.

This analysis used conservative coal strength of 600 psi because the coal adjacent to the outcrop is considered weak due to weathering. Using the stability formulae, the calculated safety factors ranges from 1.7 to 3.0. This analysis indicates that these pillars are stable. This was confirmed by the Triad drilling that was conducted near the breakthrough. The drilling did not find indications of pillar failure.

2. Pillars with overburden depth of 100 feet.

The calculated safety factors, using the conservative coal strength of 600 psi, range from 1.2 to 2.1. This analysis indicates that these pillars are marginally stable. Using the 900 psi coal strength, the safety factors range from 1.7 to 3.1, which indicates that the pillars are stable. It is likely that the actual safety factor lies between the values obtained using the conservative and average coal strengths.

3. Pillars with overburden depth of 200 feet.

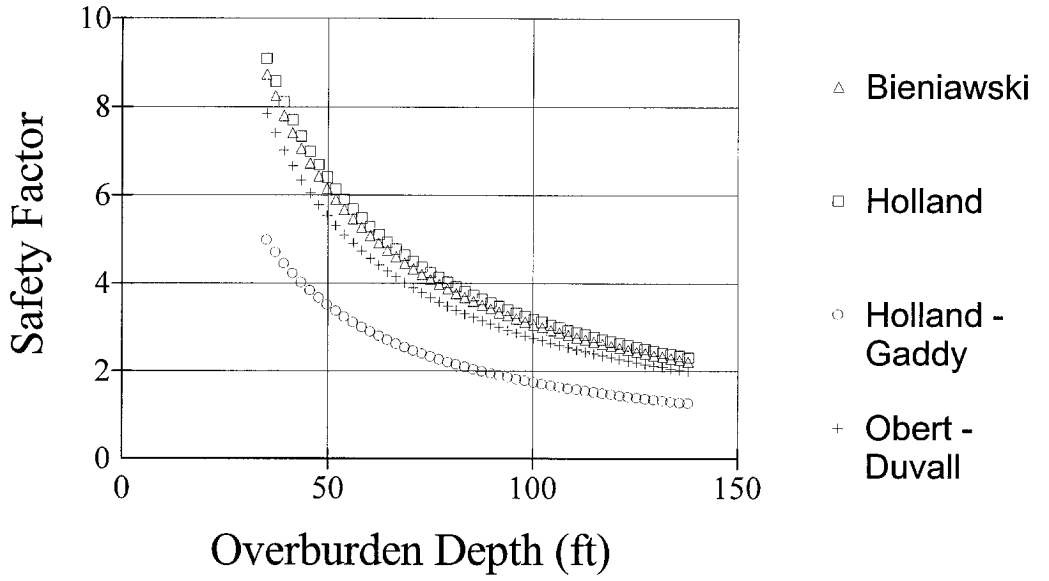
The calculated safety factors, using the conservative coal strength of 600 psi, range from 0.6 to 1.1. This analysis indicates that these pillars are not stable. Using the 900 psi coal strength, the safety factors range from 0.9 to 1.6, which indicates that the pillars are marginally stable. It is likely that the actual safety factor lies between the values obtained using conservative and average coal strengths.

All coal pillars design formulae require the use of the smallest pillar size in the area under consideration. In this case, the overburden primarily consists of a thick sandstone layer. The thick sandstone will transmit the overburden load over the weak pillars to the nearby larger pillars and keep the pillars stable.

Summary

In summary, the analysis indicates that the pillars adjacent to the 2000 breakthrough are stable. The Triad drilling, which was conducted near the breakthrough, confirmed the pillar stability. While the pillars located under thicker overburden may not be stable, there are no indications that pillar failure, if it did occur, progressed to the pillars adjacent to the breakthrough.

Pillar Stability Analysis, Overburden 70 Feet and 900 PSI Compressive Strength



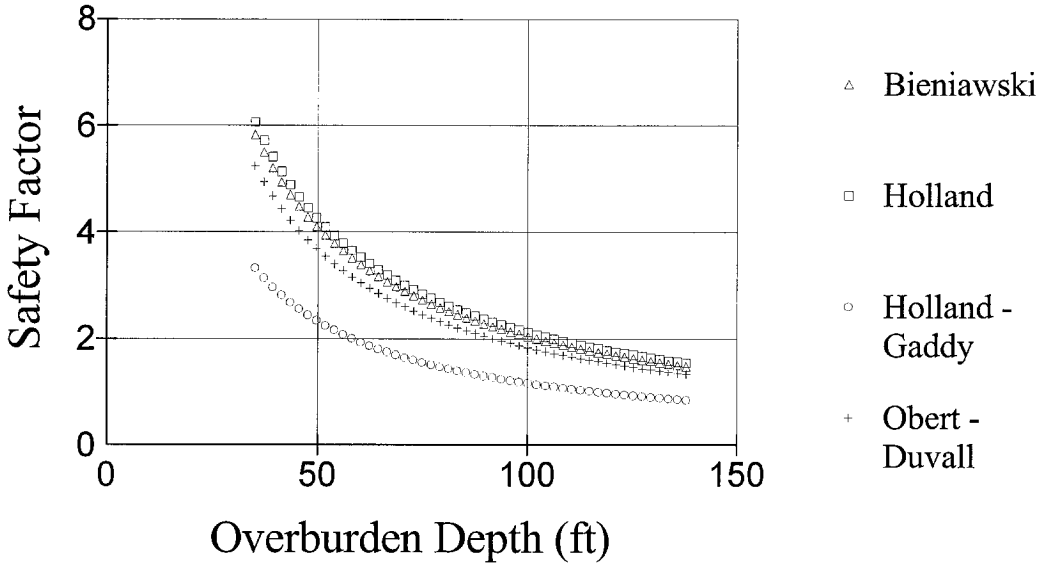
PILLAR GEOMETRY PARAMETERS
Overburden Unit Weight.....160 (pcf)
Overburden Depth.....70 (ft)
Pillar Width.....20 (ft)
Pillar Length.....25 (ft)
Pillar Height.....10 (ft)
Opening Width.....20 (ft)
Extraction Ratio.....72.22 (%)

PILLAR STRENGTH PARAMETERS
In-situ UCS of pillar.....900 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	4.4
Holland	4.5
Holland - Gaddy	2.5
Obert - Duvall	3.9

Pillar Stability Analysis, Overburden 70 Feet and Compressive Strength 600 psi



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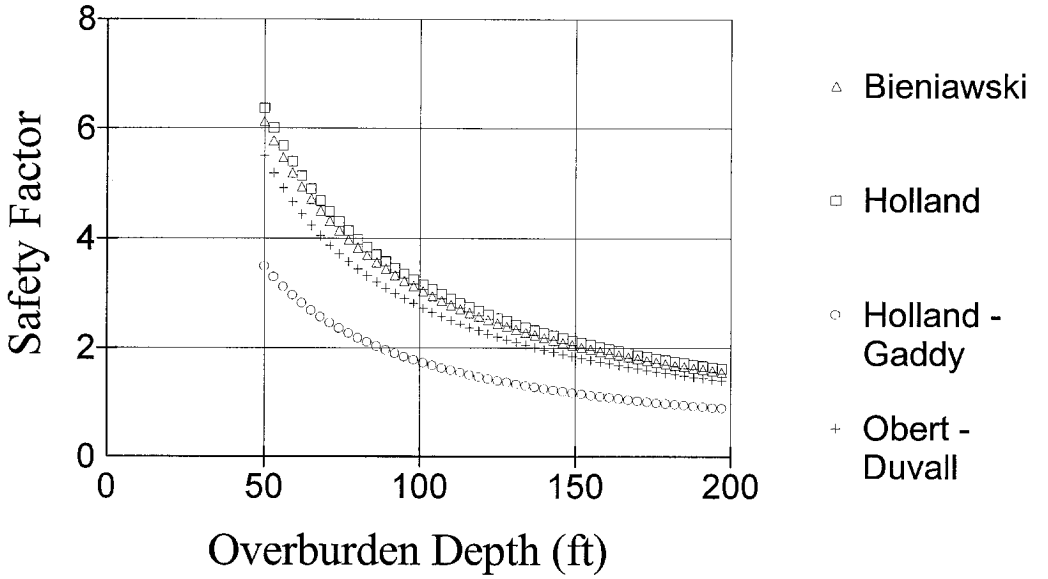
Extraction Ratio.....72.22 (%)

PILLAR STRENGTH PARAMETERS
In-situ UCS of pillar.....600 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	2.9
Holland	3.0
Holland - Gaddy	1.7
Obert - Duvall	2.6

Pillar Stability Analysis, Overburden 100 Feet and Compressive Strength 900 psi



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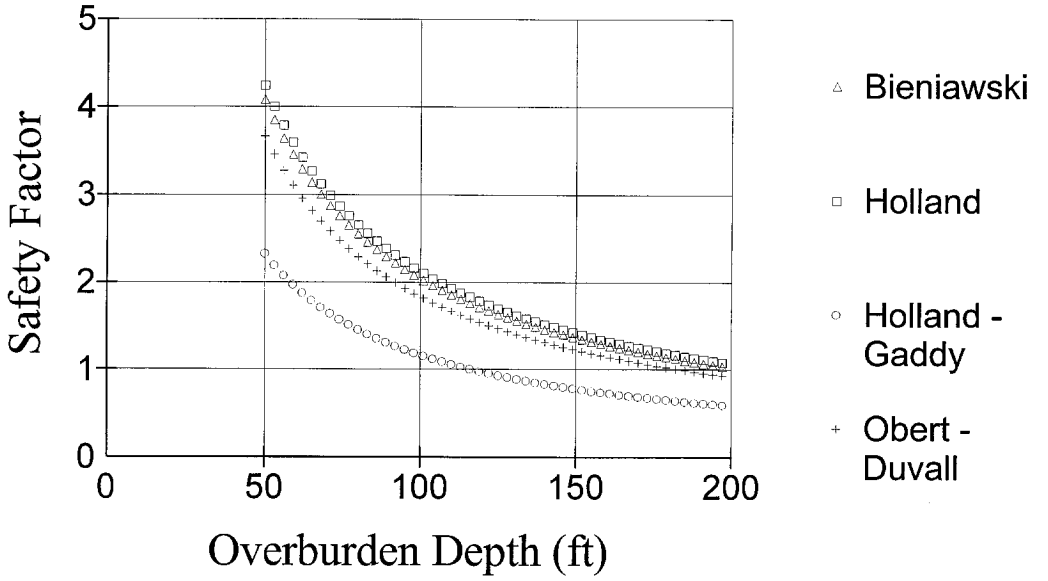
Opening Width.....20 (ft)
Extraction Ratio.....72.22 (%)

PILLAR STRENGTH PARAMETERS
In-situ UCS of pillar.....900 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	3.1
Holland	3.2
Holland - Gaddy	1.7
Obert - Duvall	2.7

Pillar Stability Analysis, Overburden 100 Feet and Compressive Strength 600 psi



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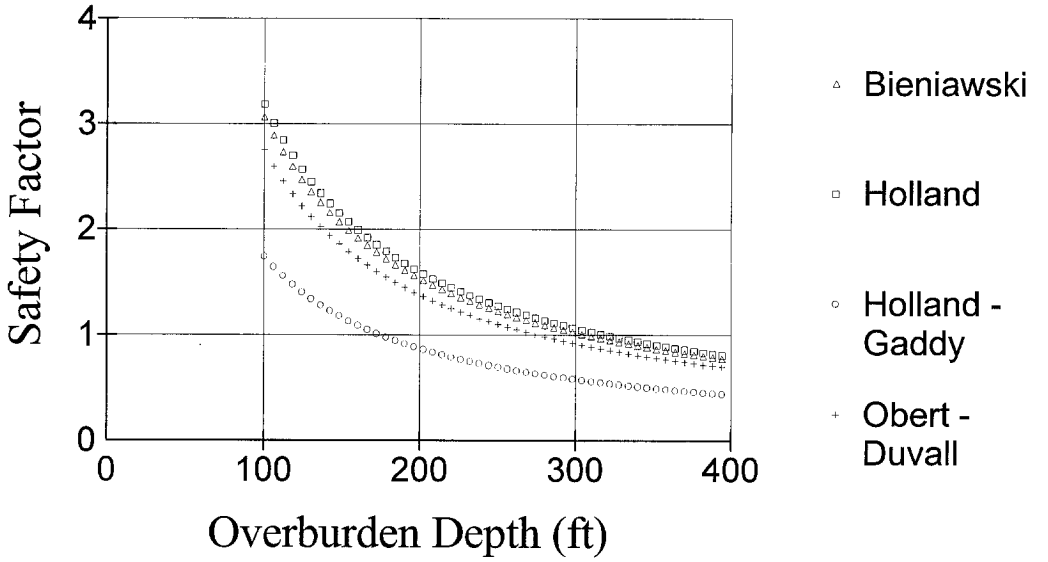
Extraction Ratio.....72.22 (%)

PILLAR STRENGTH PARAMETERS
In-situ UCS of pillar.....600 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	2.0
Holland	2.1
Holland - Gaddy	1.2
Obert - Duvall	1.8

Pillar Stability Analysis, Overburden 200 Feet and 900 psi Compressive Strength



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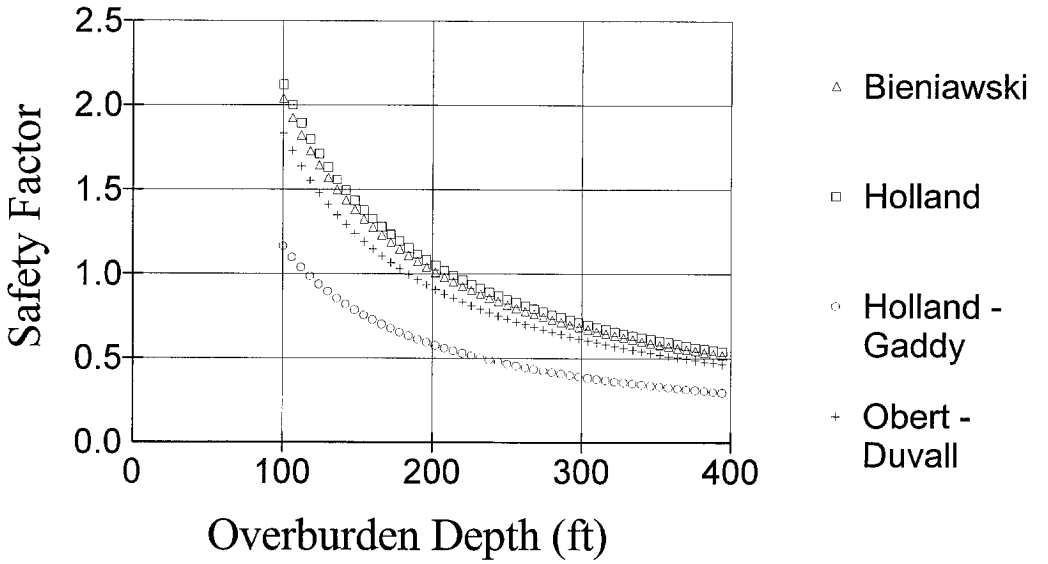
PILLAR STRENGTH PARAMETERS]
In-situ UCS of pillar.....900 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	1.5
Holland	1.6
Holland - Gaddy	0.9
Obert - Duvall	1.4

Pillar Stability Analysis, Overburden 200 Feet and Compressive Strength 600 psi



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PILLAR STRENGTH PARAMETERS
In-situ UCS of pillar.....600 (psi)

SAFETY FACTOR CALCULATIONS

Formula	**Safety Factor**
Bieniawski	1.0
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