Analysis of Coal Pillar Stability (ACPS): A New Generation of Pillar Design Software

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The NIOSH Ground Control Toolbar

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1.1.02
AHSM
ALPS
AMSS

ARBS
ARMPS
ARMPS-HWM
CMRR
Disclaimer
EXIT

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NIOSSH Pillar Design Software

ANALYSIS OF MULTIPLE SEAM STABILITY (AMSS)

Z. Agioutantis and C. Mark, PEM, Lexington, KY, Sept 14, 2018
About ARMPS

The "Analysis of Retreat Mining Pillar Stability" (ARMPS) program was originally created by Dr. Christopher Mark, Mining Engineer, of the United States Bureau of Mines, Pittsburgh Research Center, (now NIOSH), in MS Basic.

It was later updated to version 4 for the Windows environment. Version 5.x was created by Dr. Zach Agioutantis. ARMPS 2010 (ARMPS version 6) was also created by Dr. Zach Agioutantis.

The help and support of Dr. Chris Mark during all development and debugging stages is greatly appreciated.
NIOSH Pillar Design Software

• ARMPS is used for any development mining, retreat mining, and most bleeder pillar analyses.
• ALPS is used only for the tailgate corner of longwall panels.
• AMSS is for multiple seam interactions, and it incorporates ARMPS and ALPS evaluations.
Inconsistencies

• ALPS had an advanced geometry module (variable cross cut angle, variable cross cut spacing per pillar row)
• ARMPS did not have an advanced geometry module (only allowed for uniform cross cut angle)
• AMSS used the same logic when implementing these algorithms.
Empirical Criteria

The case history data bases are the heart of these methods.

Z. Agioutantis and C. Mark, PEM, Lexington, KY, Sept 14, 2018
Goals for ACPS

- Simplify pillar design process
- Consistent and uniform results
- Improved and updated methods
New Features in ACPS

- “Advanced Geometry” for complex mining layouts
- More flexibility with “Leave Pillars” for retreat mining
- New multiple seam guidelines using expanded data base
- New CMRR “Estimator”
- New Help file
ACPS Program Flow

- Choose project type
- Choose project units
- Additional options within each project type
Familiar Input Form
Variable Center-to-Center, Xcut Angle, Xcut Spacing
### Input Tailgate Pillar Development Parameters

#### Development

<table>
<thead>
<tr>
<th>Panel Widths and Abutment Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>First panel width (ft)</td>
</tr>
<tr>
<td>Abutment angle for first panel</td>
</tr>
<tr>
<td>Second panel width (ft)</td>
</tr>
<tr>
<td>Abutment angle for second panel</td>
</tr>
</tbody>
</table>

#### CMRR

<table>
<thead>
<tr>
<th>CMRR</th>
<th>Suggested Tailgate SF based on CMRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>1.44</td>
</tr>
</tbody>
</table>

Only for Development

**Diagram:**

- **First Panel**
- **Second Panel**
Panel specification:
- Entry height (ft): 5
- Depth of cover (ft): 1200
- Crosscut angle (deg): 90
- Entry width (ft): 20
- Crosscut spacing (ft): 90
- Number of entries: 6
- Advanced Geometry
- Retreat Mining
- Multiple Seam

Average extraction ratio (%): 44.4

Center-to-center entry spacing:
- P1: 70
- P2: 70
- P3: 70
- P4: 70
- P5: 70

Equal spacing option selected.
Advanced Geometry Options
Modeling Complex Geometries is Easy
ARMPS 2010 “Leave Pillar” Options
ACPS “Leave Pillar” Options During Retreat Mining
“Leave Pillar” Options for ACPS
Comparison “Leave Pillar” Options: ACPS vs ARMPS 2010
Original Multiple Seam Module (AMSS)
Updated Multiple Seam Analysis

- Statistics were updated
- The Multiple Seam option is now on the same form as the rest of the input data.
CMRR Estimator
CMRR Estimates for CENTRAL APPALACHIAN COALFIELDS

Dominant Rock Type in Primary Bolt Horizon

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>CMRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick Claystone</td>
<td>40</td>
</tr>
<tr>
<td>Thick shale</td>
<td>45</td>
</tr>
<tr>
<td>Stackrock (laminated sandstone/shale)</td>
<td>45</td>
</tr>
<tr>
<td>Siltstone</td>
<td>50</td>
</tr>
<tr>
<td>Bedded Sandstone</td>
<td>55</td>
</tr>
<tr>
<td>Massive Sandstone</td>
<td>65</td>
</tr>
</tbody>
</table>

Roof rock type must be validated with known geologic data. If data is unavailable, then a conservative CMRR = 45 should be assigned.
ACPS VERSION 1.0
USER'S GUIDE TO ANALYSIS OF COAL PILLAR STABILITY

Overview
The File Menu
The Edit Menu
The Calculation Menu
The Utilities Menu
The Help Menu
References
About ACPS

Help File Updated: Tuesday, September 11, 2016

• Context Sensitive Help
• PDF Help File
Conclusions

• Integrated approach covering all pillar design formulations
• Updated multiple seam analysis
• Familiar interface
• Free software for the international mining community
• Ability to import data directly from ARMPS, ALPS and AMSS files
• New comprehensive help file
Current Status and Outlook

• ACPS is currently in version 1.0.49 and ... its almost done
• MSHA tech support personnel have already been trained on ACPS (April 2018)
• ACPS was also shared with industry during the ground control meeting in Morgantown in July 2018
• MSHA is currently accepting roof control plans with ACPS
• ACPS is almost ready for wide distribution – a few minor bug fixes remain
Website for downloading the program

• http://www.minegroundcontrol.com/ground-control/