and indicate a strong linear relationship between observed seismicity and yielding elements in the finite element model.

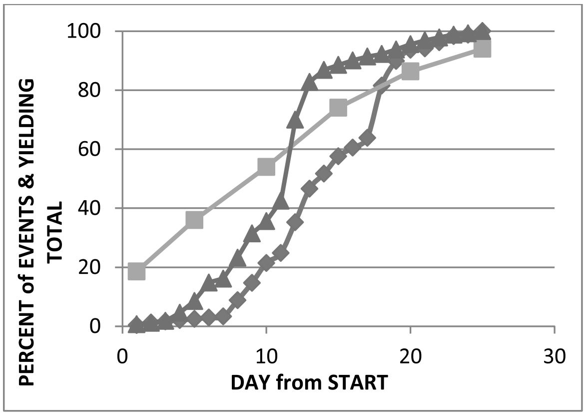

Figure 13. Seismic events and yielding elements at CCM. Green=yielding elements, Red=events July/August, 2007, Blue=events February/March, 2007.

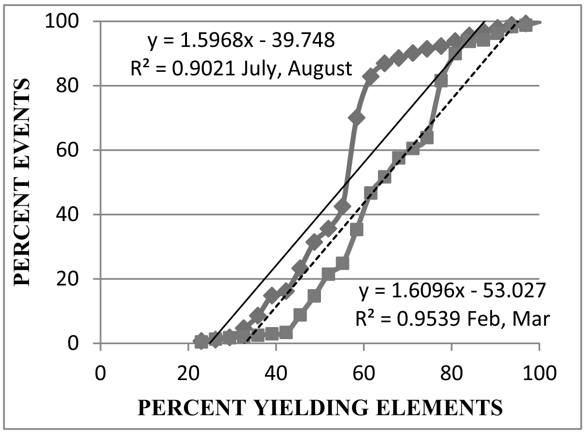

Figure 14. Regression analysis of total seismic events on total yielding elements. Red=July, August data, Blue=February, March data.

A whole mine three-dimensional finite element analysis shows that barrier pillar mining at the Crandall Canyon Mine was a questionable enterprise. These results also agree with an earlier two-dimensional finite element study (1, 2, 3). Although certainly more realistic, no feature of the three-dimensional study is at odds with the two-dimensional study. Of course, these conclusions are after the fact. In either case, modeling of the proposed mining plan before beginning operations would have reached the same conclusion that safety and stability of the proposed barrier pillar mining was in doubt.

In the present three-dimensional analysis, joint sets and properties variability were taken into account for greater realism with results that were much more pessimistic than the earlier two-dimensional results. An additional three-dimensional result is a demonstration of high correlation between mine induced seismic events and yielding elements in a finite element model. Rapid growth of yield zones and increases in seismicity are thus early warnings of potential ground control hazards.

Model improvement is always possible. Although good agreement between computed and reported maximum subsidence was obtained, trough shapes were different suggesting a better "caving" model is desirable. While a better model would lead to a better trough shape, action at seam level, which leads to subsidence, would likely remain much the same.

An important lesson is, again, the critical need to choose the right engineering tool for the job. In this case, the job is numerical modeling of strata mechanics where safe and stable roof, floor and pillars are essential to successful execution of a proposed mining plan. Computer programs that do not produce stress distributions in pillars are not the right tools. Education is key where technically sound methods such as the popular and now quite well-known finite element method have been in the undergraduate curriculum for many years. In this regard, ground control engineering requires more than familiarity with keystrokes needed to do a program run. Experience at "reading the rock" underground and interpreting complex computer output with insight and understanding would seem essential.

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