

Stress Relief Techniques in Underground Coal Mines to Improve Safety

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It is a feature of underground coal mines in Australia that the deeper the operating depth, the greater the chance of increased horizontal stresses which can create safety and operational challenges, particularly around underground roadways (excavations).

Some of the deeper mines currently in operation - 400 to 500 metres below ground - must contend with significant roadway deformation driven by high horizontal stress and relatively weak strata (rock layers).

Potential Design Weaknesses

The failure of a longwall installation roadway frequently becomes a significant event and can result in the abandonment of the entire roadway, requiring the development of a new roadway and leading to months of lost production.

This remains a challenge in high stress mining conditions, however stress relief mining techniques can significantly improve the ability to manage the stability of underground roadways, including the particularly vulnerable longwall installation roadways and conveyor belt chambers.

These roadways are critical for the continuity of mining operations and are typically wider than the standard 5.5m wide roadway, with some ranging between 6.5m and 10.5m in width.

Because of their increased spans, they require special geotechnical support designs, without which the instability and failure of widened roadways will continue to be a challenge for Australian underground coal mines.

From a geotechnical perspective, a narrower roadway is desirable as it is more stable, all things being equal. However, from a practical side, this is not always achievable.

In most instances, operational requirements dictate the roadway width with longwall installation roadways required to be wider to accommodate the dimensions of longwall equipment.

The underground geotechnical engineer on each site has the critical role of providing a robust support design to ensure the stability of these widened roadways. As part of the design process they consider potential geotechnical instability drivers, or factors that could cause the roadway to collapse or deform to an unacceptable level.

At a minimum, they would consider horizontal stress magnitude and orientation, rock strength, geological structure such as faults and joints, and the roadway's width and height.

Current Stress Relief Mining Techniques

While geotechnical engineers have little to no control over most of these factors, in terms of being able to change or manipulate them, they must understand them thoroughly to develop an effective design, including minimising the roadway dimensions as much as possible within operational requirements.

That said, operational experience has shown the geotechnical engineer can manipulate or control to some degree, the impact of horizontal stress magnitude on roadway stability.

This can be done through the implementation of stress relief mining techniques which might include modifying mining sequences and roadway orientations.

The purpose of all these techniques is to minimise (relieve) stress levels during the mining process in order to improve the stability of underground roadways.

The stress relief roadway is another technique which can be used to minimise stress levels, such as on a longwall installation roadway where the width of the pillar between the installation roadway and adjacent roadway (bleeder road) is significantly narrowed.

Additionally, the adjacent bleeder road excavation is always kept ahead of the installation roadway excavation, generally resulting in a lower stress environment for the longwall installation roadway, thereby improving its stability.

However, the stress relief roadway technique can only be effective in improving roadway stability if it has been designed correctly, allowing for the delicate balance between pillar stability and adequate stress relief.

The goal in this case, is to narrow the pillar as much as possible to maximise the stress relief benefit, without compromising the stability of the pillar.

To achieve this, a comprehensive design approach is required combining numerical, empirical, and analytical methods complemented by sound engineering judgement.

Looking Ahead

We expect the operational depth of some Australian underground coal mines will become deeper which will increase stress levels on widened roadways such as longwall installation roadways and conveyor belt chambers.

While historically this may have led to increased instability of underground roadways, there are stress relief mining techniques which can help to improve site safety by reducing the chances of underground roadway failures.

Key to these techniques is a fully informed design which prevents and reduces underground roadway failures and subsequent lost production on site. The sector has the technology and knowledge; are you making the most of it?