## Limitations of the RMi system

The RMi system works best in jointed rocks where block fall(s) are the main behaviour (see Figure 1). As seen, it may also cover overstressed, massive and slightly jointed, brittle rocks.

In addition, many types of weakness zones are crudely covered, especially zones of crushed rocks. Assumed effects of arching of the zone from the surrounding rock masses have been included in versions 3 and 4 of the spreadsheets for rock support estimates. The arching effect can be considerable for small weakness zones.

Geotechnical parameters, - shear strength and friction angle, - can be estimated for jointed rockmasses. This is because the constant ***s*** in the Hoek-Brown failure criterion for rock masses and the jointing parameter ***JP*** in the RMi system have the following relation: $s = JP^2$. Such estimates can be done in the version 2 spreadsheet.

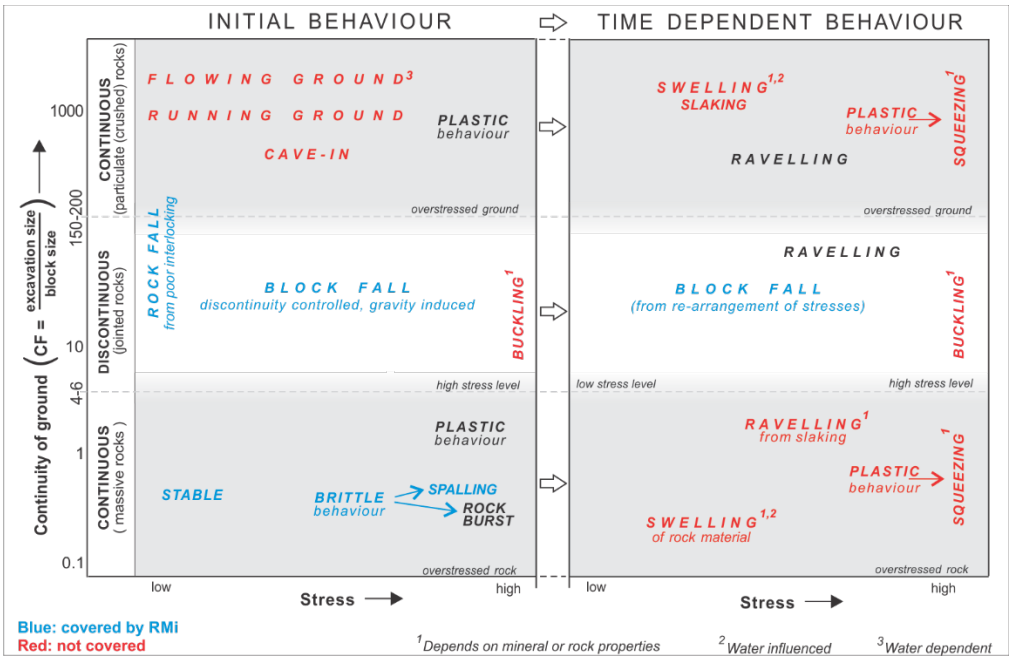


Figure 1:

Various types of failures / behaviour in underground openings and limitations of the RMi system.

Definitions of the failures are shown on next page.

Figure 2 indicates limitations of the RMi rock support method.

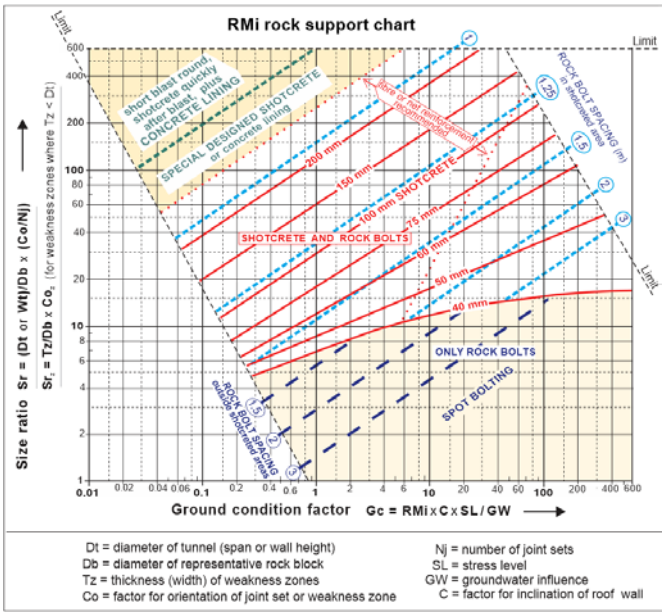


Figure 2: The RMi support chart for jointed rockmasses shows the RMi limitations.

The use of RMi requires that the user is familiar with geology and knows. The estimates depend on proper observation and description of the input parameters applied in the system.

## Some types of ground behaviour in underground openings

| | |
|---|---|
| *Block fall(s)* | a. Discontinuity controlled, gravity induced, falling and sliding of blocks (see also *slabbing*). |
| | b. Falls caused by poor interlocking / low stress level. May also take place where abundant altered joints occur in weakness zones containing angular and rounded blocks. |
| *Brittle failure* | Characterised by sudden loss of strength. |
| *Buckling* | The breaking out rock fragments under sufficiently high load with a narrowly spaced discontinuity set, frequently associated with shear failure. |
| *Cave-in* | Sudden downfalls of large volumes (> 10 $m^3$ ) of rock debris into a tunnel or cavern. |
| *Flowing ground* | The ground flows like a viscous liquid. The material consists of intensely fractured, poorly interlocked rocks or soil with high water content. |
| *Mixed ground* | Combination of several types of ground behaviour with strong local variations of stresses and deformations over longer sections, such as heterogeneous fault zones; block-in-matrix rock, and tectonic melanges. |
| *Plastic behaviour* | The (deformable) material undergoes plastic deformation when stress is gradually increased beyond the elastic limit. |
| *Popping* | Violent detachment of rock slabs with considerable force and speed. |
| *Ravelling ground* | A ground, which gradually breaks up into individual pieces, flakes, or fragments, consisting of moderately coherent and friable materials. |
| *Rock bursting* | Sudden, violent detachment of thin rock slabs from sides or roof caused by overstressing of hard, brittle rock with rapid release of accumulated strain energy. See also *popping*. |
| *Rock slabbing* | Downfalls of rock slabs, i.e., block fall(s). |
| *Running ground* | Particulate 'dry' material invades the tunnel until a stable slope is formed at the face. Stand-up time is zero or nearly zero. The material may consist of clean medium to coarse sands and gravels above ground water level. |
| *Slaking* | Breaking-up, crumble or disintegration of a rock or soil when exposed to dry[1], moist or saturated air, or when immersed in water. Slaking is often a part of the swelling process, but contrary to slaking, swelling also involves expansion. |
| *Soluble rock* | Instability due to the content of chemically unstable minerals, such as calcite and rock salt. |
| *Spalling* | Similar to "rock slabbing"; expression is often used for instabilty in overstressing, brittle conditions. |
| *Squeezing ground* | Slow inward movement into the tunnel of the surrounding rock, caused by overstressing of deformable (plastic or ductile) rock. |
| *Stable* | The ability to stand or endure with potential of few and small block or fragment falls of rock. |
| *Swelling* | The increase in volume exhibited by certain soils or rocks on absorption of water. The expansion causes pressures on the surrounding rocks and on the tunnel support. It is important to be aware of the difference between:<br>*a. Swelling rock*. The swelling ability of the former may sometimes be difficult to identify in the field<br>*b. Swelling clay in seams (filled joints).* Occurs as soft fill material, sometimes possible to identify in the tunnel. |

[1] Originally defined only to moist air. Slaking may also occur after dehydration (drying out) of certain materials (some zeolites, e.g. laumontite).