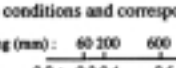
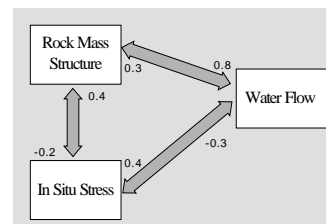


1. Proposed range for parameters /concepts

Parameter / Concept	State conditions and corresponding ranges
Discontinuity Density (or Q-system: RQD/ J_n)	Spacing (mm): 40 100 600 2000 State: 0.0 ← 0.2 0.4 0.6 0.8 → 1.0
Discontinuity Condition (or Q system: J_r/J_c)	Infilling: clay infilling ←→ hard infilling Separation: 5 mm 1-5 mm No separation Condition: slickensided smooth sl. rough rough v. rough Persistence: >30m 10-20m 3-10m 1-3m <1m State: 0.0 ← 0.2 0.4 0.6 0.8 1.0
Discontinuity Orientation	 State: 0.0 0.2 0.4 0.6 0.8 1.0
Groundwater Condition	Condition: Flowing Dripping Wet Damp Dry State: 0.0 ← 0.2 0.4 0.6 0.8 1.0
Intact Rock Strength related	σ_c (MPa): 1.5 25 50 100 250 State: 0.0 ← 0.2 0.4 0.6 0.8 → 1.0
Rock Mass Strength - Stress Ratio (σ_{vm}/σ_c)	RMR < 44 heavy modulus non-squeezing (σ_{vm}/σ_c state < 1.0) σ_{vm}/σ_c : 0.2 1 ← swelling 2 stable → State: 0.0 ← 0.2 0.4 0.6 0.8 → 1.0
Rock Behavior (or deformation rate)	Degree of ← swelling/squeezing/palling (plastic) stable → State: 0.0 ← 0.2 0.8 → 1.0
Excavation Geometry (w/h: width-to-height of opening, k horizontal-to- vertical in-situ stresses)	(w/h) / k: ← 1 width: ← opening size increases State: 0.0 ← 0.2 0.8 → 1.0
Support (& reinforcement)	Support: forepoling/grouting ← support increases no support State: 0.0 ← 0.2 0.8 → 1.0
Rock Mass (and excavated face) Homogeneity	Homogeneity: Non-homogeneous ← homogeneous State: 0.0 ← 0.2 0.8 → 1.0
Site & Project Conditions	Resources availability: problematic ← not limiting State: 0.0 ← 0.2 0.8 → 1.0
Excavability Index (percentage of maximum advance rate)	Favorability of cond. ← adverse favorable → for excavation State: 0.0 ← 0.2 0.8 → 1.0



1. Fuzzy cognitive map representation

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2) FCM 가
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RMR
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3.

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