

# # Top 100 Most Confusing Concepts in Rock Mechanics

Prepared By

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Rock mechanics is filled with complex, overlapping, and often counterintuitive concepts.

## ## Stress and Strength Concepts

1. **Effective stress vs. total stress** - The role of pore pressure in reducing effective stress
2. **Principal stress rotation** - How principal stress directions change during loading
3. **Deviatoric stress vs. mean stress** - Decomposition of stress tensors
4. **Stress path dependency** - Different loading paths yielding different results
5. **In-situ stress measurement ambiguity** - Multiple methods giving different results
6. **Tensile strength of rock** - Why rocks are much weaker in tension than compression
7. **Unconfined vs. confined strength** - The dramatic effect of confinement
8. **Residual strength vs. peak strength** - Post-failure behavior

9. **Brittle-ductile transition** - When and why rocks change behavior

10. **Mohr-Coulomb vs. Hoek-Brown failure criteria** - When to use which

## ## Time-Dependent Behavior

11. **Creep vs. relaxation** - Constant stress vs. constant strain scenarios

12. **Primary, secondary, tertiary creep** - Different creep stages

13. **Time-to-failure prediction** - Why rocks fail suddenly after sustained loading

14. **Subcritical crack growth** - Slow crack propagation below failure stress

15. **Strain rate effects** - Why loading speed matters

16. **Stress corrosion** - Chemical-mechanical coupling in time-dependent failure

## ## Scale Effects

17. **Representative Elementary Volume (REV)** - When does rock behave as a continuum?

18. **Scale-dependent strength** - Why larger samples are weaker

19. **Laboratory vs. field scale properties** - The upscaling problem

20. **Fracture spacing vs. sample size** - Statistical considerations

## **## Discontinuities and Anisotropy**

21. **Joint roughness coefficient (JRC)** - Quantifying surface irregularity

22. **Joint compressive strength (JCS)** - Wall strength vs. intact strength

23. **Barton-Bandis model** - Non-linear joint behavior

24. **Anisotropy vs. inhomogeneity** - Directional vs. spatial variations

25. **Fabric and foliation effects** - Microstructural influences on strength

26. **Persistent vs. non-persistent joints** - Connectivity effects

27. **Joint dilation angle** - Volume change during shear

28. **Asperity degradation** - Progressive wear of joint surfaces

# ## Rock Mass Classification

29. **RQD (Rock Quality Designation)** - What does it really measure?

30. **RMR vs. Q-system** - Different classification approaches

31. **GSI (Geological Strength Index)** - Subjective assessment challenges

32. **Disturbance factor (D)** - Quantifying blast damage

33. **Structure vs. surface condition** - Separating these in GSI

34. **Hoek-Brown  $m_i$  parameter** - Rock type constant ambiguities

# ## Hydraulic-Mechanical Coupling

35. **Permeability vs. transmissivity** - Different measures of flow

36. **Hydraulic aperture vs. mechanical aperture** - Fracture opening differences

37. **Cubic law limitations** - When does it break down?

38. **Stress-dependent permeability** - Non-linear coupling

39. **Biot coefficient** - Effective stress parameter for poroelasticity

40. **Undrained vs. drained conditions** - Time-dependent response

41. **Consolidation vs. compaction** - Volume change mechanisms

42. **Hydraulic fracturing vs. hydraulic jacking** - Different failure modes

## ## Failure Mechanisms

43. **Shear failure vs. tensile failure** - Different crack propagation modes

44. **Brittle vs. ductile failure** - Stress-strain curve interpretation

45. **Localized vs. distributed deformation** - Shear band formation

46. **Progressive failure** - Sequential yielding of rock mass

47. **Strain softening vs. hardening** - Post-peak behavior

48. **Dilatancy** - Volume increase during shear

49. **Fault reactivation criteria** - When existing faults slip

50. **Mode I, II, III fracture** - Different crack opening modes

## **## Testing and Measurement**

51. **Point load vs. UCS correlation** - Index test reliability

52. **Brazilian test interpretation** - Tensile strength from compression

53. **Indirect tensile tests** - Stress concentration issues

54. **Triaxial vs. true triaxial** -  $\sigma_2 = \sigma_3$  vs. all different

55. **Strain gauge drift** - Long-term measurement issues

56. **Acoustic emission interpretation** - What are AE events telling us?

57. **Seismic velocity vs. static modulus** - Dynamic vs. static properties

58. **Sample preparation effects** - End effects and friction

59. **Loading rate standardization** - Comparing different test speeds

## **## Constitutive Modeling**

60. **Elastic vs. plastic deformation** - Reversible vs. permanent

61. **Strain hardening/softening moduli** - Post-yield behavior parameters

62. **Yield surface evolution** - How failure criteria change with damage

63. **Associated vs. non-associated flow rule** - Dilation modeling

64. **Viscoplasticity** - Combined rate and plastic effects

65. **Damage mechanics** - Quantifying microcrack accumulation

66. **Cap models** - Modeling pore collapse in porous rocks

67. **Critical state concept** - Ultimate shear resistance state

## ## Geomechanical Applications

68. **Stress concentration around openings** - Analytical vs. numerical solutions

69. **Pillar strength formulas** - Which one to use?

70. **Arching effect** - Load transfer mechanisms

71. **Squeezing vs. rockbursting** - Different tunnel instability modes

72. **Stand-up time** - Unsupported excavation stability duration

73. **Support reaction curve** - Ground-support interaction

74. **Equivalent continuum models** - Representing fractured rock as continuum

75. **Hoek-Diederichs criterion for brittle failure** - Spalling around tunnels

## **## Seismicity and Dynamic Loading**

76. **Static vs. dynamic triggering** - Earthquake initiation mechanisms

77. **Seismic moment vs. magnitude** - Different energy measures

78. **b-value in seismicity** - Frequency-magnitude relationship

79. **Stress drop** - Energy release during failure

80. **P-waves vs. S-waves** - Different wave types and velocities

81. **Rayleigh and Love waves** - Surface wave propagation

82. **Damping in rock** - Energy dissipation mechanisms

83. **Liquefaction in fractured rock** - Can it happen?

## **## Special Topics**

84. **Coefficient of earth pressure at rest ( $K_0$ )** - In-situ horizontal stress

85. **Locked-in stresses** - Tectonic vs. gravitational stress

86. **Thermal stress** - Temperature-induced stress changes

87. **Residual stress** - Stress without external loads

88. **Kaiser effect** - Acoustic emission memory

89. **Fellenius effect** - Stress redistribution in slopes

90. **Wedge stability** - 3D block analysis complexity

## **## Advanced Numerical Concepts**

91. **Explicit vs. implicit time integration** - Numerical stability

92. **Mesh dependency** - Results varying with element size

93. **Regularization techniques** - Avoiding mesh sensitivity

94. **Interface elements** - Modeling discontinuities

95. **Discrete Element Method (DEM) calibration** - Micro vs. macro properties

## **## Material Property Ambiguities**

96. **Poisson's ratio for jointed rock** - Effective vs. intact values

97. **Young's modulus from different tests** - Why they differ

98. **Cohesion vs. tensile strength relationship** - Theoretical vs. measured

99. **Friction angle vs. dilation angle** - Often confused but different

100. **Weathering grade effects** - Quantifying degradation impacts

## **## Why These Are Confusing**

These concepts are particularly challenging because they involve:

- **Multi-scale phenomena** (micro to field scale)

- **Coupled processes** (mechanical, hydraulic, thermal, chemical)

- **Time-dependent behavior** (rate effects, creep)

- **Discontinuous materials** (joints, faults, bedding)

- **Non-linear behavior** (most rock behavior is non-linear)

- **Measurement uncertainties** (scale effects, sample disturbance)

- **Empirical relationships** (correlations without physical basis)

- **Terminology overlap** (same words meaning different things in different contexts)

Understanding these concepts requires solid foundations in continuum mechanics, fracture mechanics, soil mechanics, and geology—plus extensive practical experience with how rocks actually behave!

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