MKAJ 1073 ENGINEERING ROCK MECHANICS

INHOMOGENEITY IN ROCK

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Unlike other construction materials (e.g. concrete & steel, rocks are not designed/formed to perfection. Being naturally occurring materials & being influenced by variable geological conditions, rocks are complex materials to deal with.

Rock are inhomogeneous, anisotropic heterogeneous. In situ, they are discontinuous (not intact) and often weathered.

Rock are inhomogeneous, anisotropic heterogeneous. In situ, they are discontinuous (not intact) and often weathered. Large-scale structural (geological) discontinuities are always present in rocks; Fault, bedding planes & joints.

Small-scale discontinuities (mineral arrangement) like lamination & foliation cannot be avoided in small samples used in lab tests.

Large-scale discontinuities in rock mass

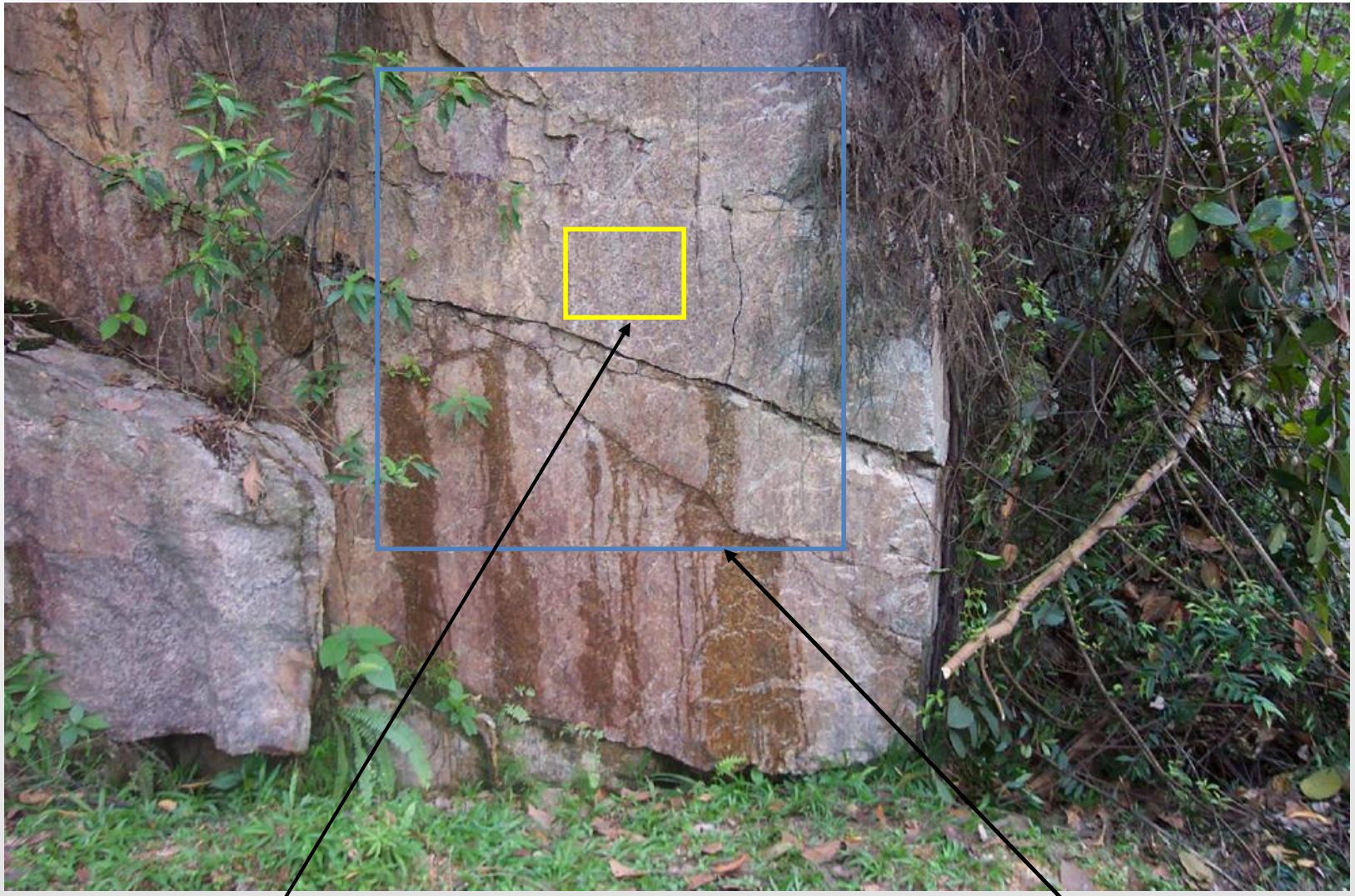
Small-scale discontinuities in rock sample

Large-scale discontinuities in rocks (fault, bedding planes & joints) induce some degree of weakness into even the strongest rocks.

Rock mass becomes inhomogeneous & anisotropic due to their presence. The effect is realised in the actual construction in the field (i.e. rock mass). They affect in situ deformational behaviour of the rock.

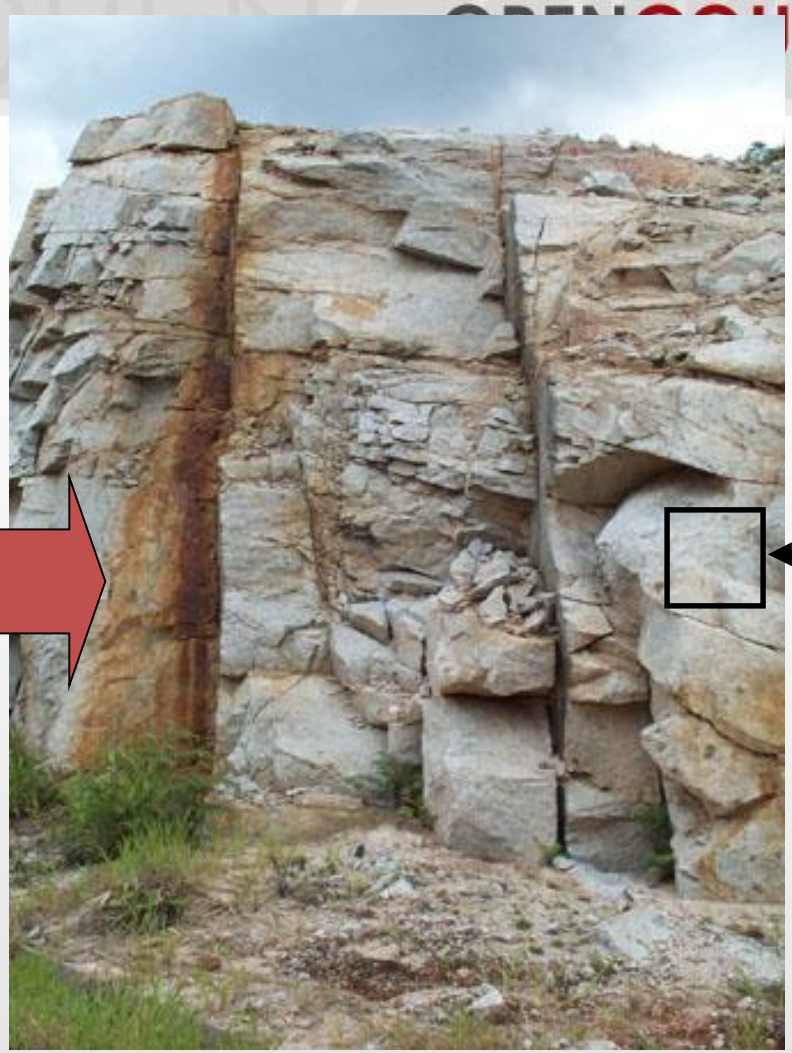
Due to their smaller size, discontinuities like lamination & foliation, affect laboratory test data on small size rock samples.

It is important to differentiate between the properties/strengths of rock mass in the field & intact small rock samples tested in the lab.



Scale effect: Rock material (intact) & rock mass (discontinuous)

Conditions of rock mass in the field – fractured & discontinuous



Conditions of rock material – small size rock samples intact & free from fractures

Bear in mind the differences! - rock mass & rock material, lab tests verify material properties

What makes rock mechanics unique is the complexity and uncertainty involved when the structure interacts with the natural geological environment and materials.

Mathematical equations are black and white but the real world is grey

Albert Einstein.

Mathematical equations are used to describe rock properties & behaviours (principles of mechanics), example:

$$E = \sigma/\varepsilon$$

E is rock constant (Young's modulus)

Deformation of rock under stressing is not as ideal as described by the linear equation (σ is directly proportional to ε), as rock is not linearly elastic & homogeneous & isotropic.

Assumptions & other relevant variables are included in the mathematical equations so that they can describe behaviour of rock materials more appropriately & reliably.

Various empirical approach, computer simulations/softwares & case studies help in understanding of the properties & behaviour of rocks, specifically when subjected to construction induced stresses.

Effect of large-scale discontinuities (weakness planes) on excavation in rock

Joints and bedding planes in sedimentary rock (interbedding of sandstone & shale)

Inclined bedding planes in clastic sedimentary rocks (interbedding of shale & sandstone)

Lamination and interbedding in sedimentary rock

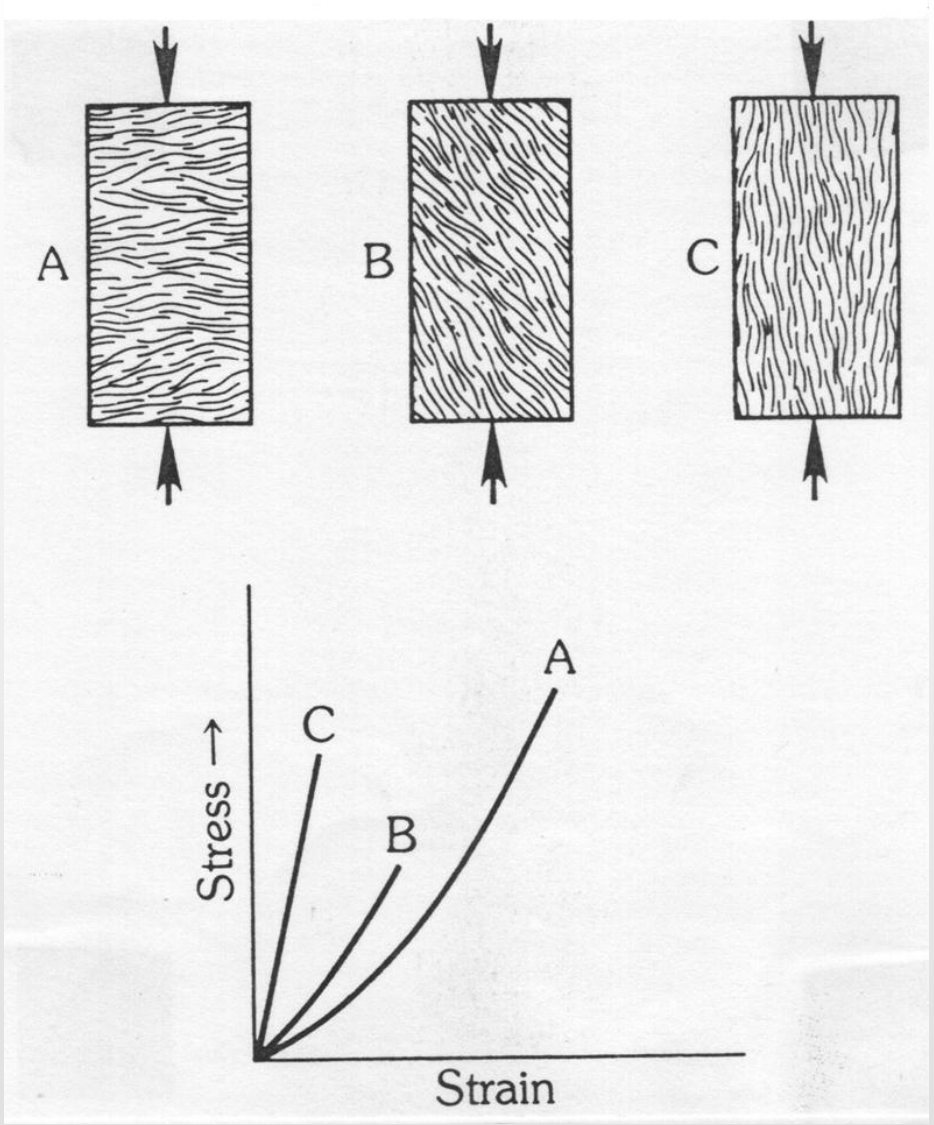
Folds - folded bedding planes in sedimentary rocks indicated that the rock has been tectonically (geologically) disturbed

Effect of small-scale discontinuities on rock strength

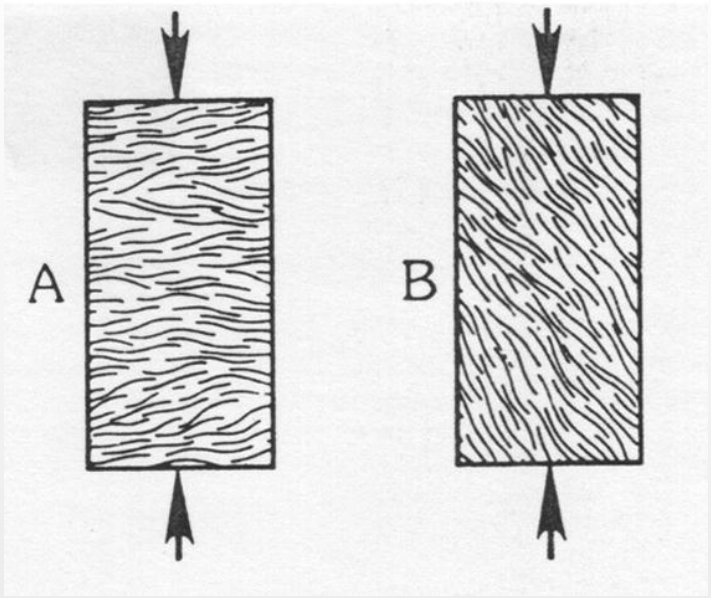
Lamination in sandstone (clastic sedimentary rock)

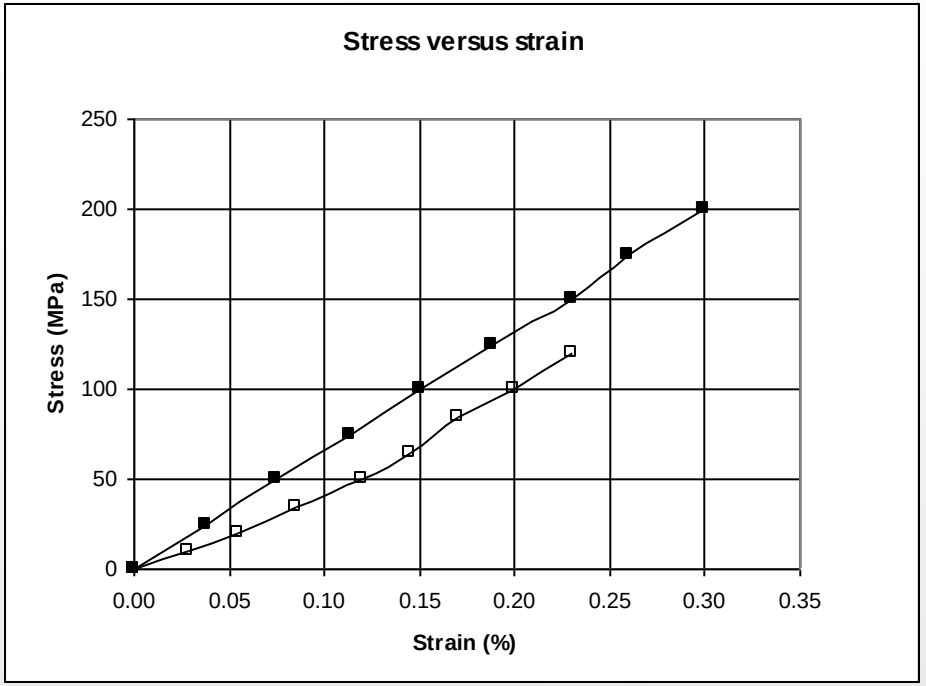
LAMINATION is minerals arrangement due to sedimentation

Lamination in shale (clastic sedimentary rock)



Effect of loading orientation on samples displaying mineral arrangements – strength (UCS) & strain at failure varies, depending on loading orientation





Different loading orientation with respect to mineral arrangement in rock sample will affect its strength - anisotropy

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