Characterization of Himalayan Phyllite with Reference to Foliation Planes

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Abstract : Major engineering constructions and foundations (e.g., dams, tunnels, bridges, underground caverns, etc.) in and around the Himalayan region of Uttarakhand are not only confined within hard and crystalline rocks but also stretched within weak and anisotropic rocks. While constructing within such anisotropic rocks, engineers more often encounter geotechnical complications such as structural instability, slope failure, and excessive deformation. These severities/complexities arise mainly due to inherent anisotropy such as layering/foliations, preferred mineral orientations, and geo-mechanical anisotropy present within rocks and vary when measured in different directions. Of all the inherent anisotropy present within the rocks, major geotechnical complexities mainly arise due to the inappropriate orientation of weak planes (bedding/foliation). Thus, Orientations of such weak planes highly affect the fracture patterns, failure mechanism, and strength of rocks. This has led to an improved understanding of the physico-mechanical behavior of anisotropic rocks with different orientations of weak planes. Therefore, in this study, block samples of phyllite belonging to the Chandpur Group of Lesser Himalaya were collected from the Srinagar area of Uttarakhand, India, to investigate the effect of foliation angles on physico-mechanical properties of the rock. Further, collected block samples were core drilled of diameter 50 mm at different foliation angles, β (angle between foliation plane and drilling direction), i.e., 0º, 30º, 60º, and 90º, respectively. Before the test, drilled core samples were oven-dried at 110ºC to achieve uniformity. Physical and mechanical properties such as Seismic wave velocity, density, uniaxial compressive strength (UCS), point load strength (PLS), and Brazilian tensile strength (BTS) test were carried out on prepared core specimens. The results indicate that seismic wave velocities (P-wave and S-wave) decrease with increasing β angle. As the β angle increases, the number of foliation planes that the wave needs to pass through increases and thus causes the dissipation of wave energy with increasing β. Maximum strength for UCS, PLS, and BTS was found to be at β angle of 90º. However, minimum strength for UCS and BTS was found to be at β angle of 30º, which differs from PLS, where minimum strength was found at 0º β angle. Furthermore, failure modes also correspond to the strength of the rock, showing along foliation and non-central failure as characteristics of low strength values, while multiple fractures and central failure as characteristics of high strength values. Thus, this study will provide a better understanding of the anisotropic features of phyllite for the purpose of major engineering construction and foundations within the Himalayan Region.

Keywords : anisotropic rocks, foliation angle, Physico-mechanical properties, phyllite, Himalayan region
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