CLASSIFICATION OF ROCKS AND SITE CHARACTERISATION

Tunnel engineers generally classify rocks on the basis of resistance to deformation (strength), amount of weathering, and general resistance to weathering (durability). These last two are not the same, although they may seem so at first glance, A rock may be very resistance to weathering, but may have also have been subjected to a very long period of time, which may result in significant weathering. In general, the strength and resistance to weathering of a rock is derived from the class of rock. Igneous and metamorphic rocks, in general, are more resistance to deformation and weathering than sedimentary

Although the classification in these two tables (2&3) are quite simple, the descriptions of rock masses can be extremely complex, and are much more so than for soils. The reason for this is that, although rocks have a greater innate strength than a soil, their mechanical characteristics are dominated by the effect of anisotropy (the state of a characteristic of the rock being different in different directions) and the discontinuities contained within. These discontinuities may range from foliation in the rock, such as the layering in schist or the feasibility of shale. The discontinuities may also take the form of fractures, ranging from the miniscule cracks to major faulting as concluded by Parker, 1996.

Unexpected Factors

A number of general uncertainties and unknowns are encountered when dealing with the underground. These variables can range from minor inconveniences to major challenges to the designers of the tunnel. Some of these difficulties may be summarized as follows:

a) The overriding uncertainty when dealing with any underground project.

b) The geology of the area will determine the feasibility and the cost of the undertaking.

c) Engineering properties of rock may change, sometimes drastically, with a wide range of conditions, notably time, season, rate and direction of loading.

d) Groundwater is the most difficult parameter to predict and the most troublesome during construction.

e) Drilling core, the most common method of determining underground conditions, only recovers less than 0.0005% of the excavated volume of the tunnel on a typical project in the most exhaustive survey, which leaves a great deal of room for uncertainty.

Characterization of Site

Once the designers of the tunnel get down to the actual design phase, the first activity usually performed is a characterization of the site of the excavation. This involves characterizing the rock mass into which the tunnel is to be driven. This characterization will include the following properties:

a) Topography of the area, the climate and the accessibility of the area.

b) Location of the excavation with respect to the ground surface and rock formation boundaries.

Class	Description	Unconfined Stress Range (psi)	Unconfined stress Range (mpa)
RO	Extremely soft	20-100	0.2-0.7
RI	Very low strength	100-1000	0.7-7
R2	Low strength	1000-4000	7-28
R3	Moderate strength	4000-8000	28-55
R4	Medium high strength	8000-16,000	55-110
R5	High strength	16,000-32,000	110-220
R6	Very high strength	>32,000	>220

Table 2: Generalized rock strength classification

Class	Descriptor	Definition
W1	Fresh rock	No visible signs of weathering. Any breaks are across sound rock
W2	Slightly weathered	Slight discoloration and minor weakening of the rock material
W3	Moderately weathered	Fresh rock is still present, but up to 50% of the rock material has been decomposed into soil
W4	Highly weathered	Fresh rock is still present, but more than 50% of the rock material has been decomposed into soil
W5	Completely weathered	All of the rock material has been decomposed into soil, but the original rock mass structure has been preserved
W6	Residual soil	All of the rock material has been decomposed into soil, and there has been transport, and all original structure has been destroyed.

Table 3: Generalized rock weathering classification

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c) Structural stability of the rock body, which is a function of seismisity, faults, and stress concentrations.

d) Hydrologic regime and its perturbation, which is a function of the ground and the ground water flow rates

e) Potential for subsidence and other surface effects.

f) Rock types in the rock mass, their genesis and their homogeneity.

g) Degree of weathering and weathering ability of the rock.

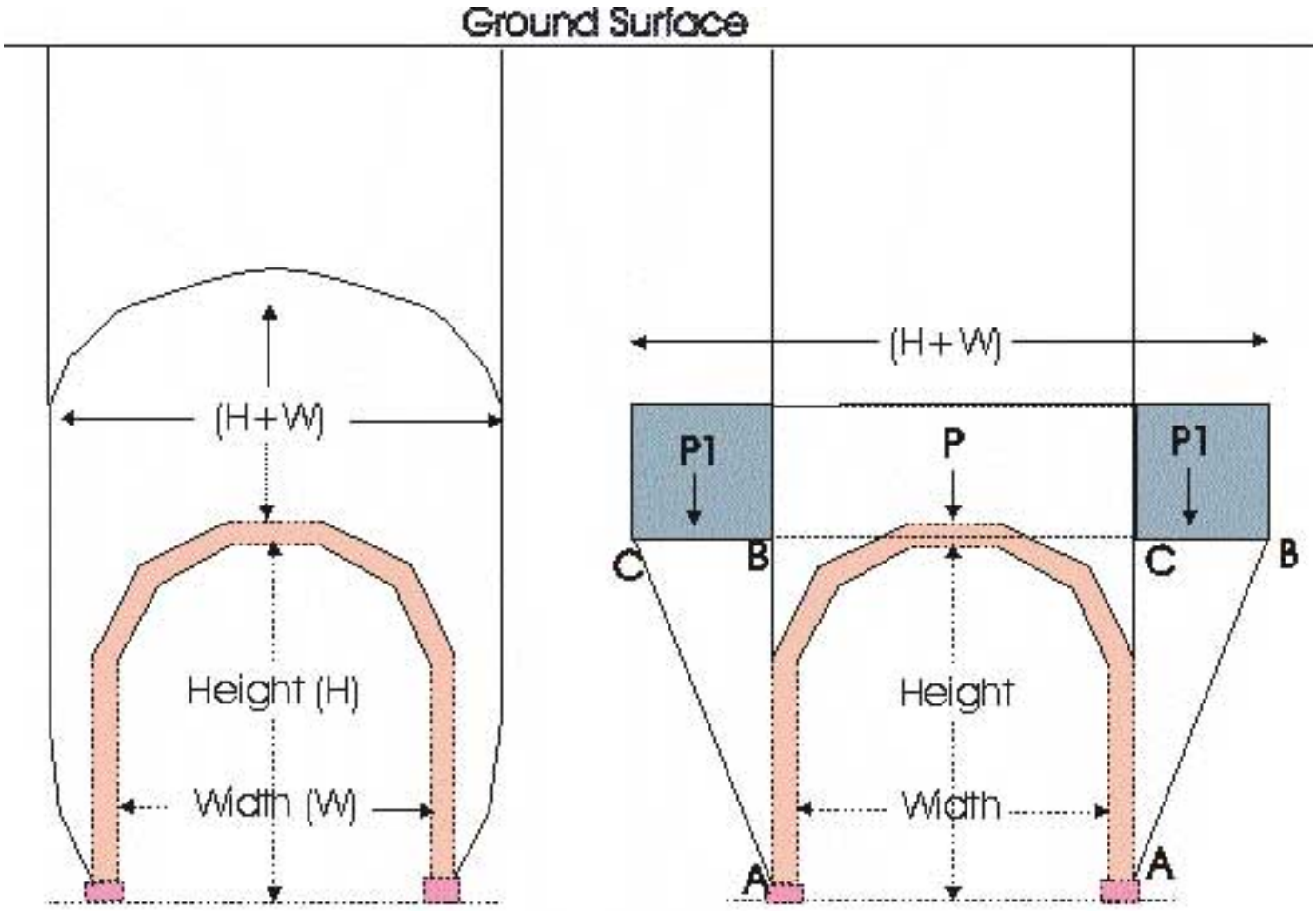
h) Geologic discontinuities and other defects.

i) Deformability characteristics under short and long-term loading.

j) Strength characteristics in reference to a rational failure criterion.

k) In-situ stress and hydraulic and/or dynamic loads.

l) Geometric and mechanical properties of systematic and extensive discontinuities.



PRESSURE ON A TUNNEL LINING