Due February 6, 2019

A circular tunnel with a diameter (span) of 8 m (24 ft) for a hydroelectric project is to be constructed in a moderately weathered basalt to a maximum depth of 125 m. The tunnel will be constructed from East to West. Two sets of discontinuities have been identified in the rock mass, with the following characteristics:

	Joint Set #1	Joint Set #2
Spacing of discontinuities	120 mm	300 mm
Roughness of discontinuities	slightly rough, undulating	smooth, planar
Infilling	none	sandy particles
Aperture	< 0.1 mm	1 - 5 mm
Persistence	8 m	3 m
Dip Direction (Azimuth)	190°	348°
Plunge (Dip)	53°	33°

The intact rock unconfined compressive strength is 132 MPa, and the rock mass has an average RQD value of 65%. The tunnel is mostly under the water table, but flow through the rock mass is expected to be moderate. In the section under analysis, there are no weakness zones and no random joints. The principal *in situ* stresses have been measured by hydraulic fracturing giving $\sigma_1 = 6$ MPa and $\sigma_3 = 4.2$ MPa.

Using the RMR and Q ratings, what excavation method and support system would you recommend for the tunnel? Also, estimate the rock mass deformability and strength properties using the RMR and Q values and the empirical equations presented in class.