CHAPTER IX

ROCK FOUNDATION STABILITY ANALYSIS

The problem of designing a foundation on rock is substantially the problem of predicting the load-deformation response of a given site under the possible range of applied loads. Given this information, a geotechnical solution is always possible; i.e., a structure can be designed to suit the predicted load-deformation response, or a proper ground improvement be performed, or even the unsuitable site be abandoned.

Everell et al. (1974) stated that the prediction of the load-deformation response required the range and nature of applied loads, the mechanical properties of the rock mass, and a technique for actually predicting the load-deformation response.

In the preliminary stage of the construction of the Chiew Larn dam, the range and nature of applied loads and a technique for actually predicting the load-deformation were unable to be performed, only the mechanical properties of the rock mass could be studied then The establishment of the mechanical properties of the pebbly graywackes to pebbly mudstones were performed in the laboratory testing to determine the rock substance properties, so were the field investigations to determine the tectonec stresses, groundwater and the nature of the discontinuities in the rock mass. The measurable index rock properties easily help simulating the rock mass behavior.

9.1 Geotechnical Classification

The geotechnical classification of the rock mass along the main dam area based on field observation, core logging, and simple laboratory tests, was valuable for indicating the required extent of rock types distribution and strength bearing capcity of rock mass (Figure 9.1). The pebbly graywackes to pebbly mudstones and subarkosic to arkosic sandstones are predominantly in the main dam foundation area.

9.2 Rock Quality Designation (RQD)

RQD is a core logging technique which is used to correlate the rock mass and rock substance deformation properties. The results obtained from the borehole core logs along the Chiew Larn main dam axis indicate that the rock masses are mostly fair to excellent rock (Figure 9.2).

Hobbs (1973, 1974) defined the rock mass factor, j, as the ratio of the deformability of the rock mass within any readily identifiable lithological and structural component to that of the deformability of the intact rock comprising the component. The rock mass factor is particularly useful in estimating a settlement of foundation (Farmer, 1983). Relations between RQD values, fracture frequency, velocity index and rock mass factor are given in Table 9.1.

9.3 Groundwater

The presence of the groundwater level under the main dam area was record by EGAT during the borehole drilling process in 1980 to 1982. Unfortunate, many groundwater records were misplaced in a few months after the completion of the drilling.

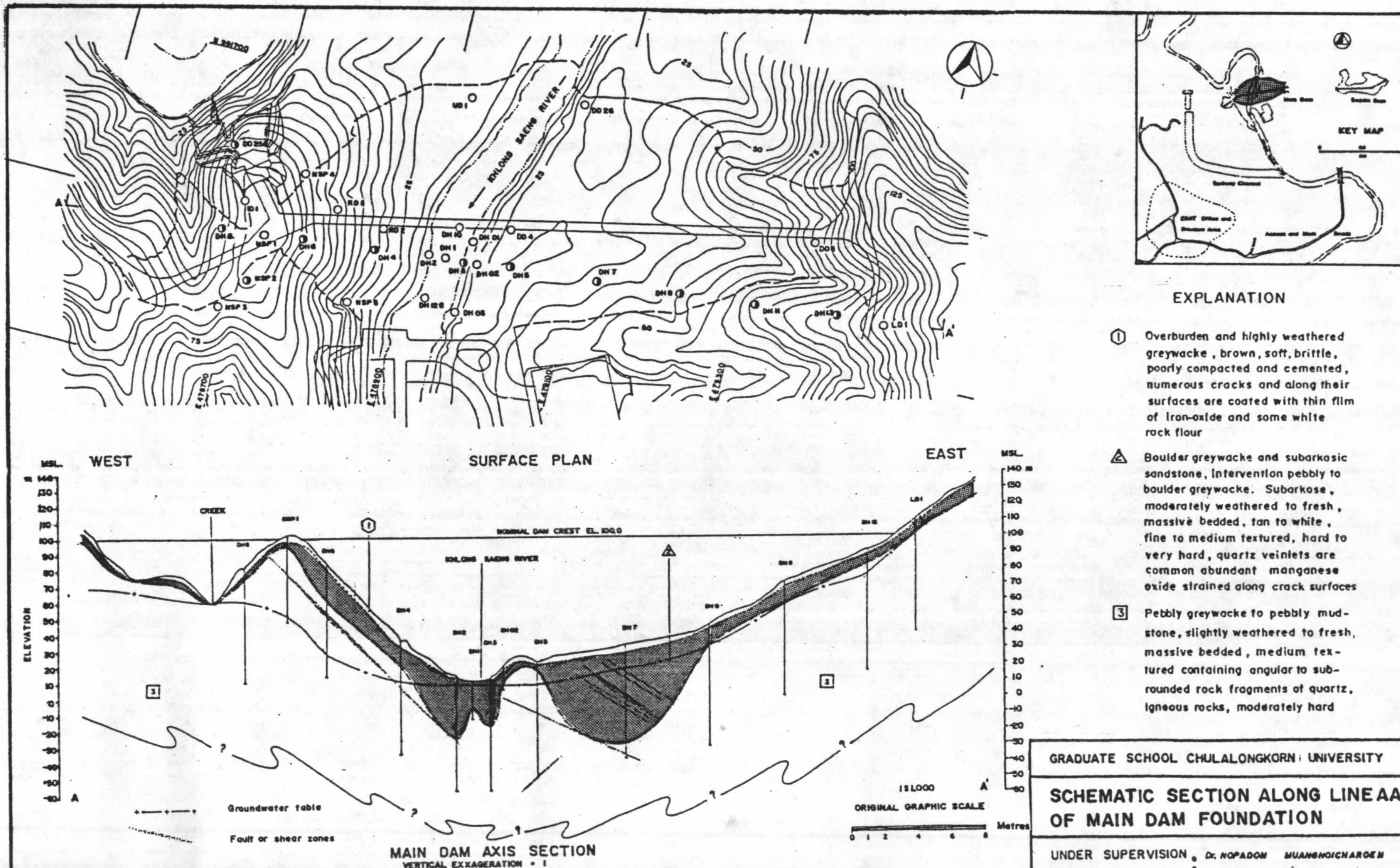

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Figure 9.1

Also important is the rock mass permeability. The value was determined in the field by using the water test or lugeon test. The results of were illustrated in Figures 9.3 and 9.4. These results indicate a low lugeon values (o to 3 lugeon) in the impermeable zones and a high lugeon unit (3-30 lugeon) in the thick shear zones.

Table 9.1 Relation between RQD and rock mass factor (after Farmer, 1983).

Quality Classification	RQD %	Fracture Frequency (per meter)	Velocity Index V_F^2/V_L^2	Rock Mass Factor
Very poor	0-25	> 15	0-0.2	0.2
Poor	25-50	15-8	0.2-0.4	0.2
Fair	50-75	8-5	0.4-0.6	0.2-0.5
Good	75-90	5-1	0.6-0.8	0.5-0.8
Excellent	90-100	1	0.8-1.0	0.8-1.0

9.4 Deformation Modulus

The output of CSIR Geomechanics Classification is an available assessment of the rock foundation in terms of modulus of rock the supplement elasticity modulus of rock materials which is obtained from the experimental works. This relationship is demonstrated in Figure 9.5.

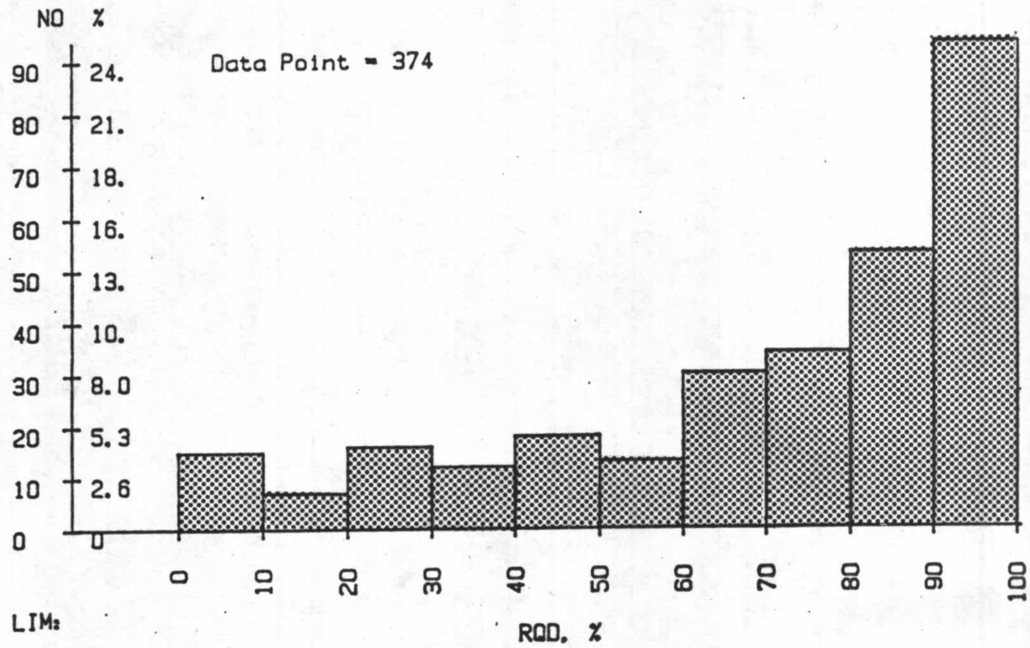

Figure 9.2 Histogram showing distribution of RQD along the diversion tunnel.

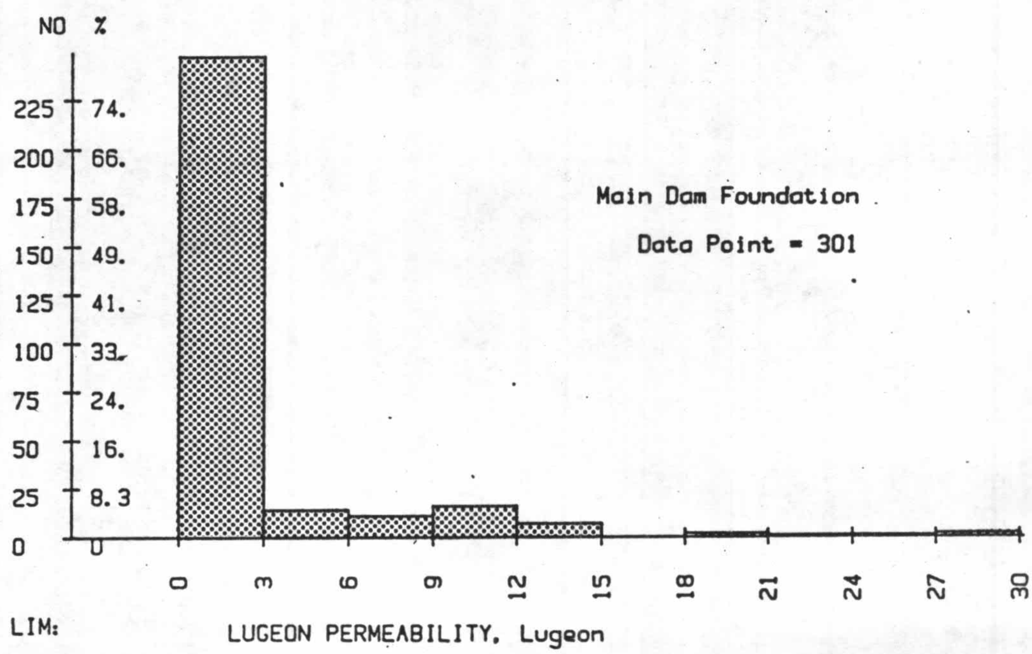

Figure 9.3 Histogram showing distribution of permeability of rock mass.

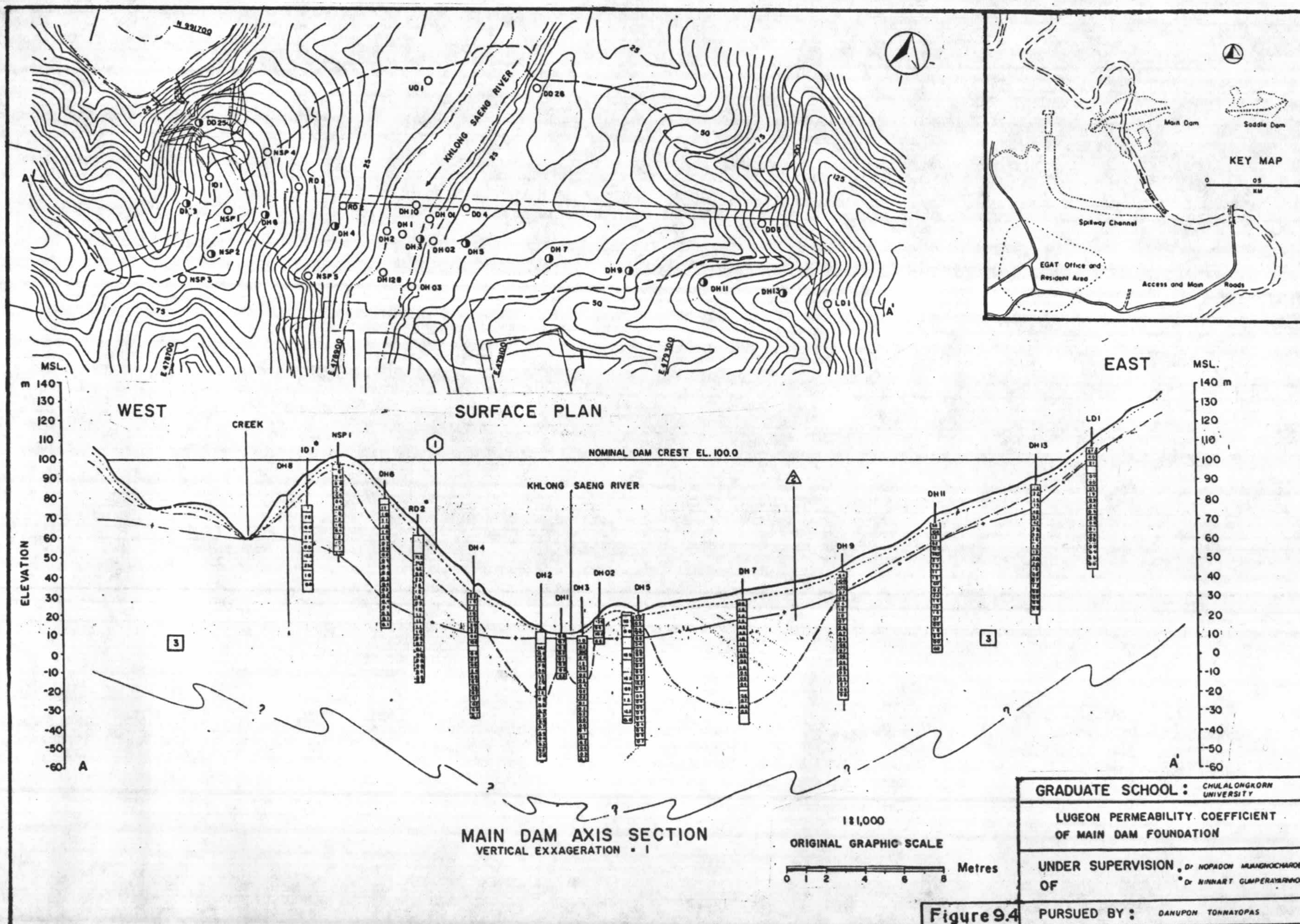
SURFACE PLAN
KHLONG SAENG RIVER
KEY MAP
Main Dam
Saddle Dam
Spillway Channel
EGAT Office and Resident Area
Access and Main Roads
MAIN DAM AXIS SECTION
VERTICAL EXXAGERATION = 1
WEST
EAST
CREEK
NOMINAL DAM CREST EL. 100.0
KHLONG SAENG RIVER
ELEVATION
MSL.
1:1,000
ORIGINAL GRAPHIC SCALE
Metres
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Figure 9.4

From the knowledge of the modulus of rock masses defromability which is of prime important and independent of strength for rock foundation design, Bieniawski (1976, 1979, 1981) developed a primary relationship between the in-situ modulus of deformation and the Geomechaics Classification of rock mass rating as exhibited in Figure 9.6. This following correlation was obtained.

$$E_M = 2(RMR) - 100 \quad \text{..................} (9.1)$$

where E_M = In-situ modulus of deformation in GPa,

and RMR = Rock mass rating from the Geomechanics Classification.

Equation 9.1 gives a 20 percent prediction accuracy which is quite acceptable for the rock engineering purposes.

The assessment results in the present study indicated that the rock masses in term of foundation are generally fair to good quality excluding those in the thick shear zones where the quality was reduced to very poor to poor as demonstrated by the histogram in Figure 9.7. When the behavior of rock masses was considered as the in-situ deformation modulus which was the prime importance for the design of rock foundation varies from 3 to 75 GPa or 33.39 $\pm$ 19.45 GPa in average (Table 9.2).

9.5 Results and Discussion of Foundation Stability

To determine the foundation stability, the qualitative index rock properties that influence the rock mass behavior must be considered. Of all these controlling factors, as it has been emphasized

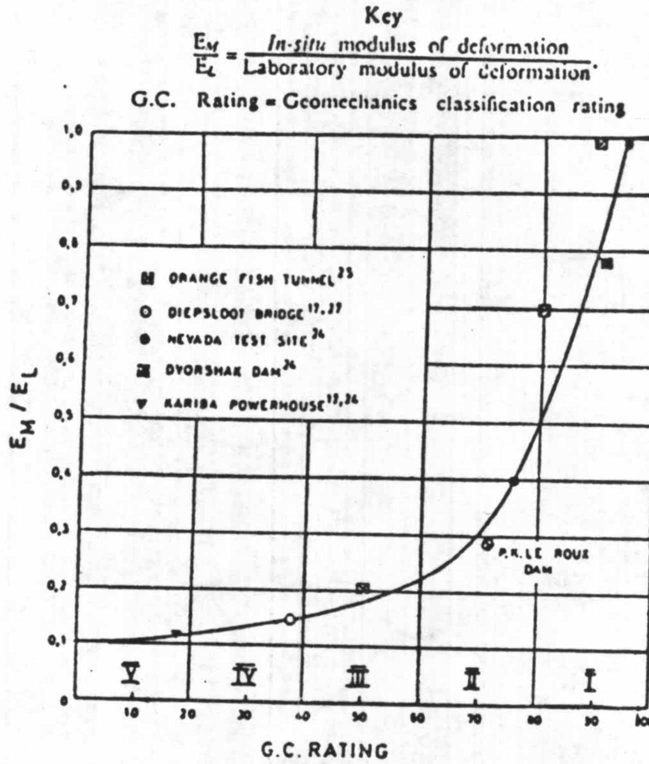

Figure 9.5 Relationship between Geomechanics Classification rating and ratio of deformation modulus of rock mass (E_M) to that of rock material (E_L) (after Bieniawski, 1976).

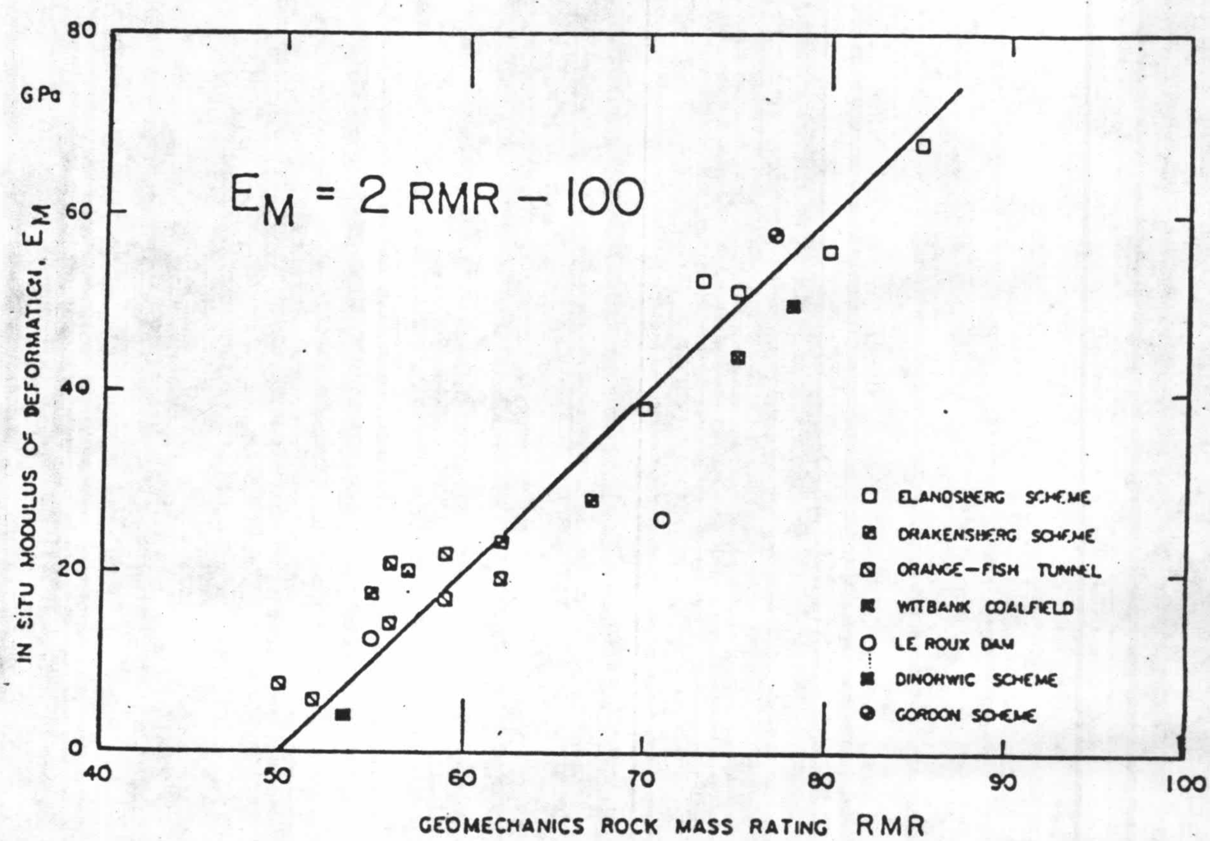

Figure 9.6 Correlation between the in-situ modulus of deformation and the Geomechanics Classification of rock mass rating (RMR) (after Bieniawski, 1979).

Table 9.2 Summary of in-situ modulus of deformation

Structural Region No.	Ranging Values	In-situ Modulus of Deformation, GPa
40	minimum	3
	average	33.39 ± 19.45
	maximum	75

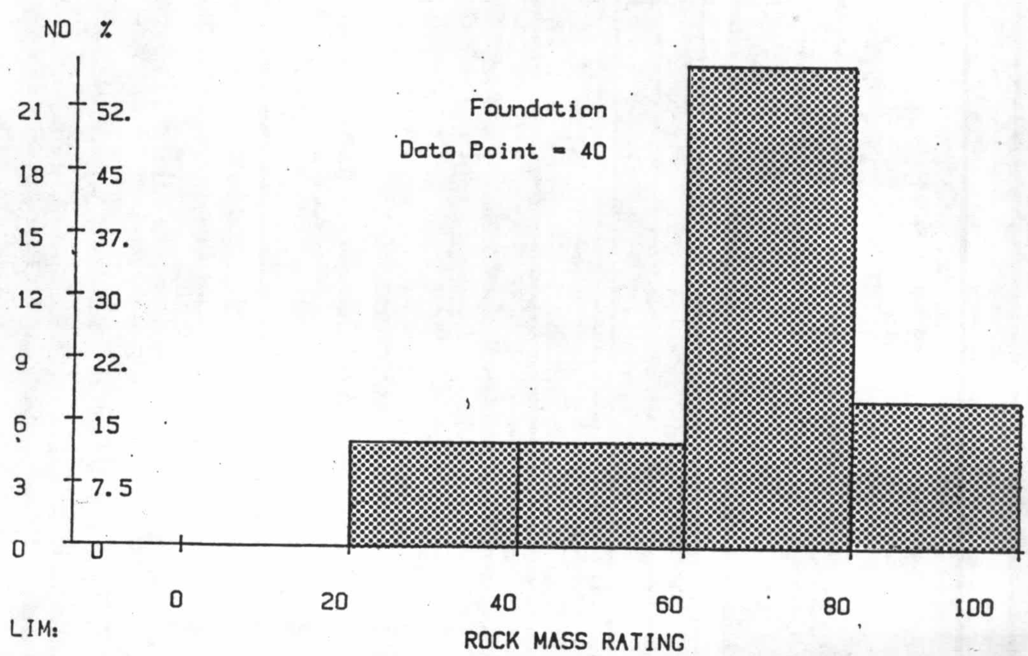

Figure 9.7 Histogram showing distribution of rock mass rating in a case of foundation.

by all investigators, the presence of the fractures in the rock mass is most important. The characteristics of the fractures which influence the deformation modulus include the stiffness of joints, fracture continuity, orientation and spacing. Other significant controlling factors are the isotropy and homogeneity of the rock mass, the presence of groundwater, the existing tectonic stresses, and the kinematic history of the rock formations.

It can be concluded from the rock mass characteristic at the main dam foundation, that the site is generally acceptable. However, there occur some small-scale shear zones with the lower quality rock mass. These zones are needed to be properly treated to improve the suitability of the damsite.