UNO Collaboration Meeting
Aussois, France

VERY LARGE CAVITY EXCAVATION

Pedro Varona
ITASCA

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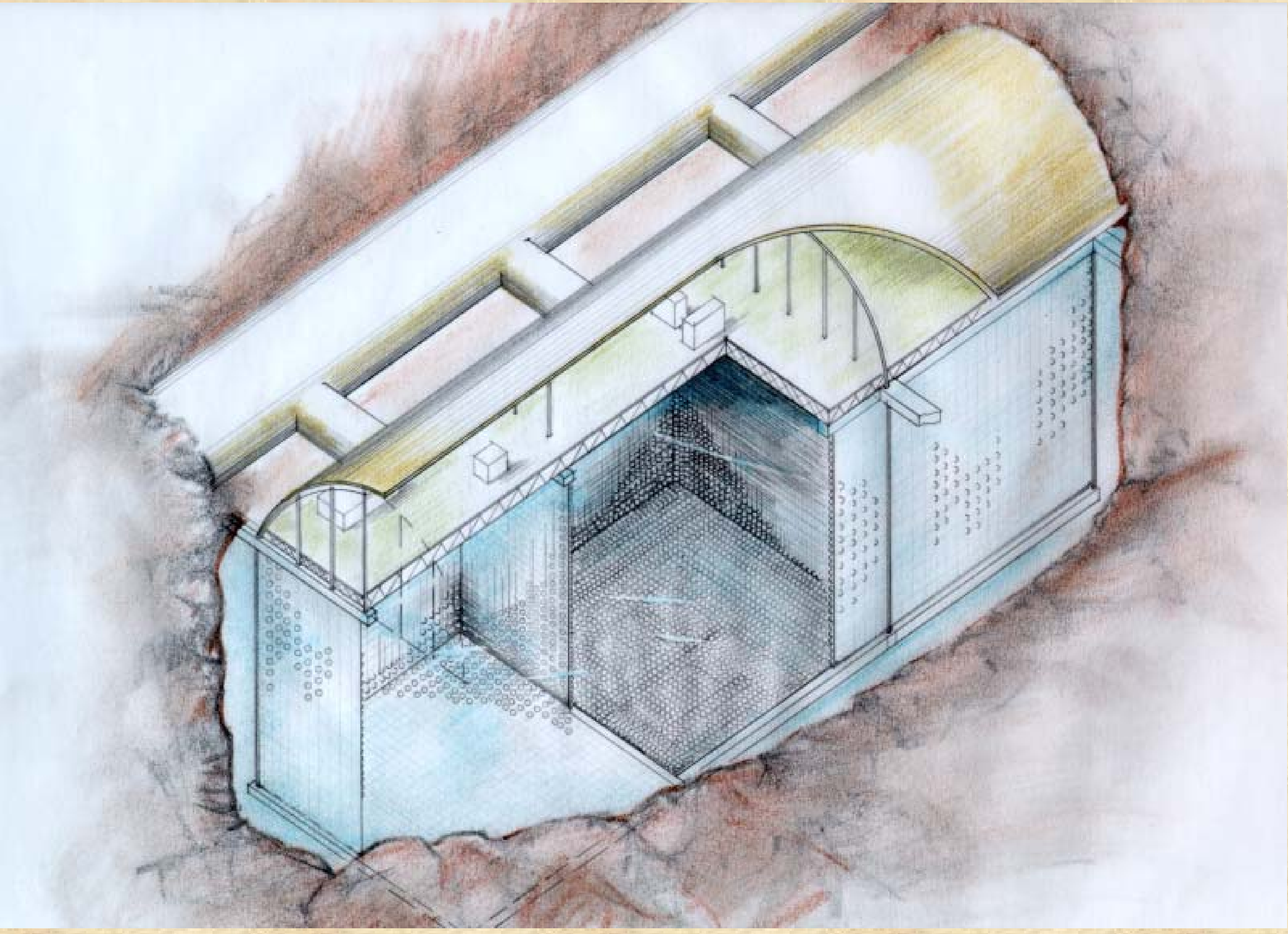
PROPOSED UNO CAVERN

- Dimensions: 60 x 60 x 180 (m^3)
- Depth: >4000 mwe (>1500 m)



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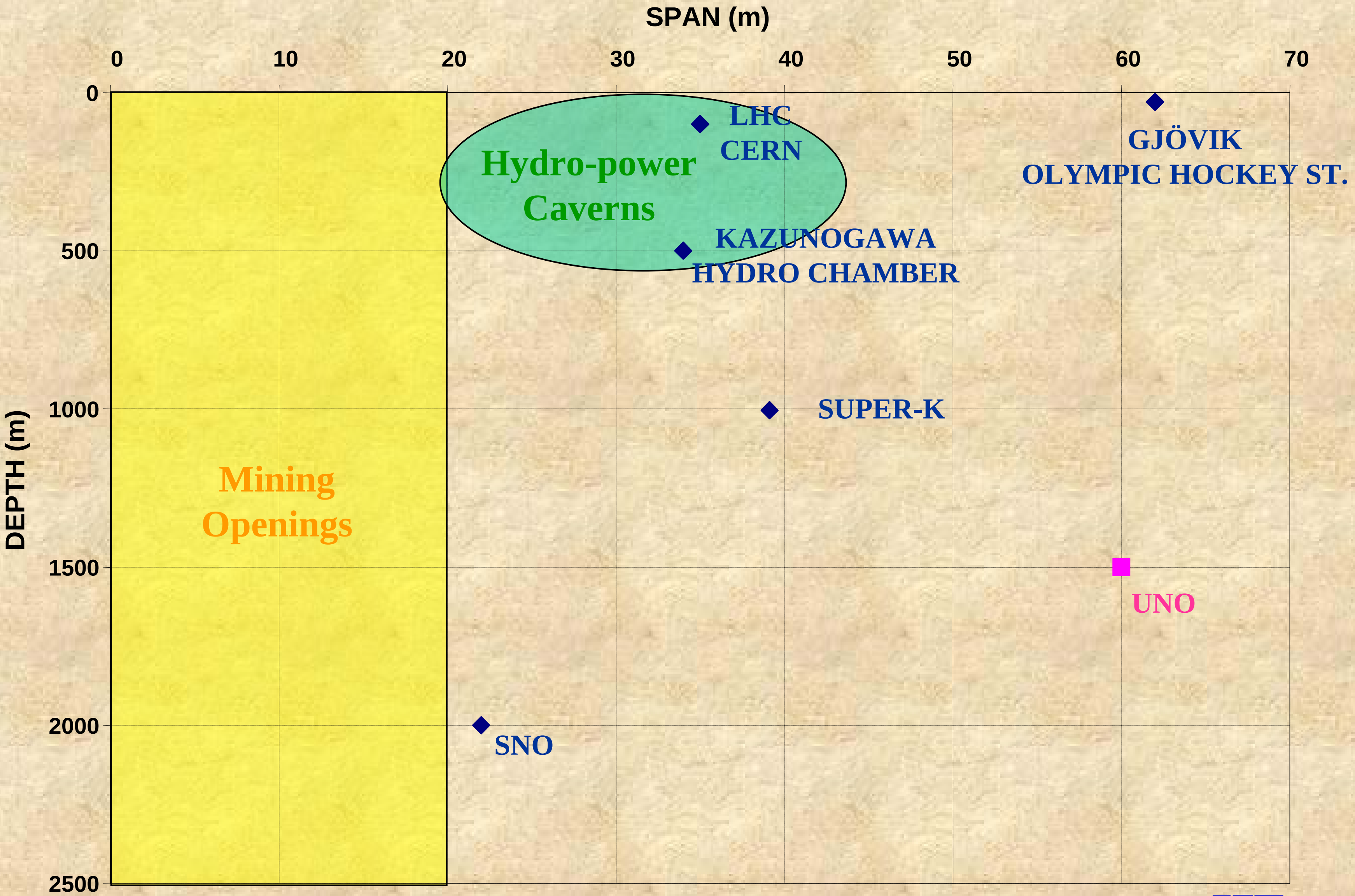
BENCH MARKING



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BENCH MARKING

	WIDTH	HEIGTH	LENGTH	DEPTH
LHC CERN	35	42	82	100
GJÖVIK	62	25	91	30
KAZUNOGAWA	34	54	210	500
SNO	22	30	22	2000
SUPER-K	39	41	39	1000
UNO	60	60	180	1500

The combination of span and depth makes the UNO excavation unique

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CONTROLLING FACTORS

- ROCK MASS STRENGTH
- "IN SITU" STRESSES
- STRUCTURAL FEATURES: JOINTS,FAULTS, ETC.

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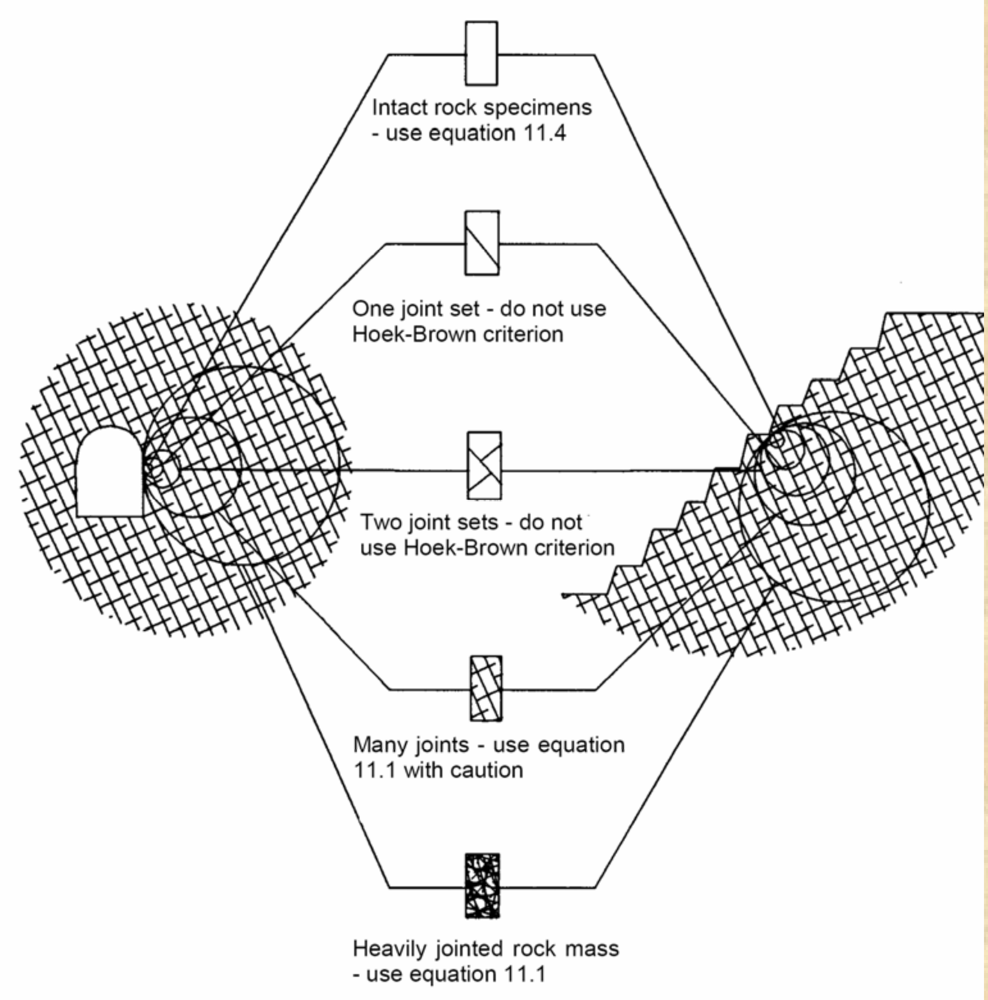
ROCK MASS STRENGTH

Rock mass strength is controlled by the intact rock and the presence of joints, infilling, water, etc.

Several classifications are used to evaluate the quality of a rock mass

- RMR
- Q
- GSI



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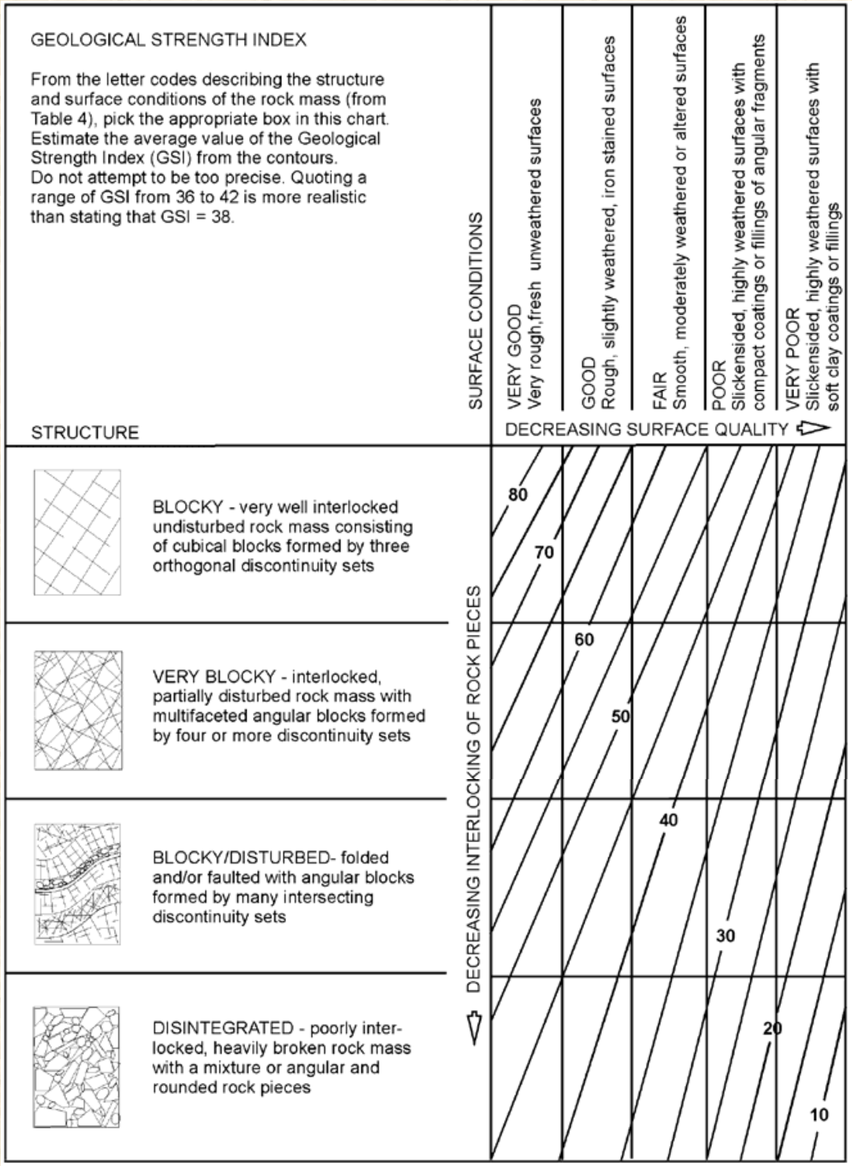
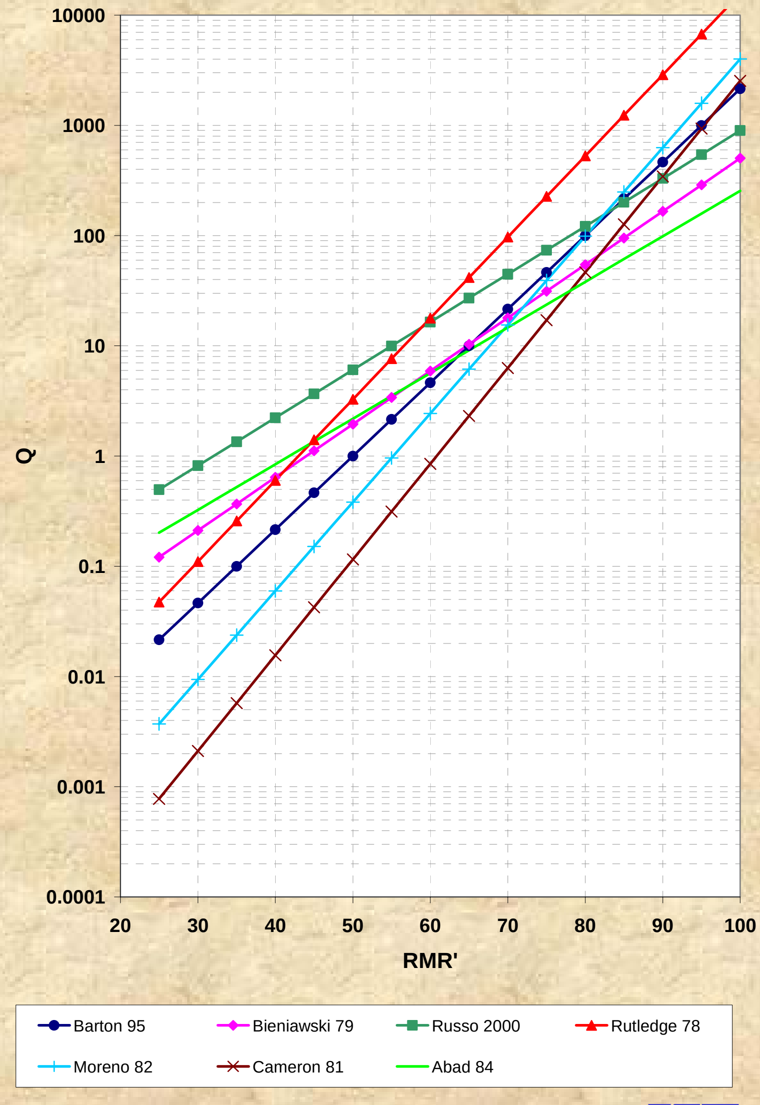
ROCK MASS STRENGTH





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“IN-SITU” STRESSES

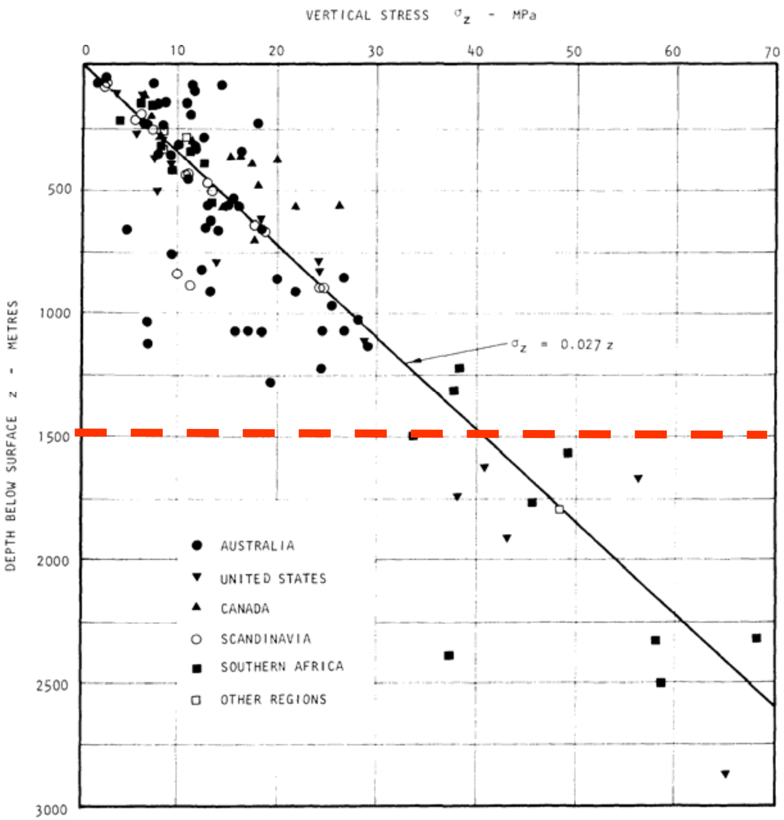

Figure 40 : Plot of vertical stresses against depth below surface.

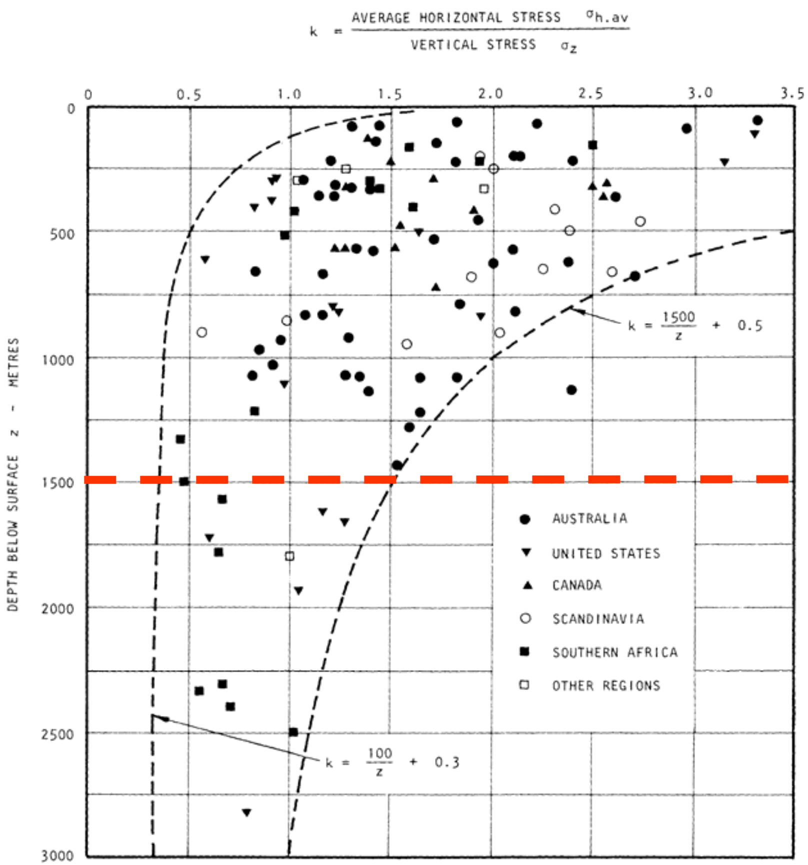

Figure 41 : Variation of ratio of average horizontal stress to vertical stress with depth below surface.

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“IN-SITU” STRESSES

“In-situ” stresses can be measured with several methods:

•Hydraulic Methods: pressure is applied along a section of a borehole isolated by packers until existing fractures are open or new fractures are created.

•Relief Methods: A rock sample is isolated from the stress field and its deformation is monitored.

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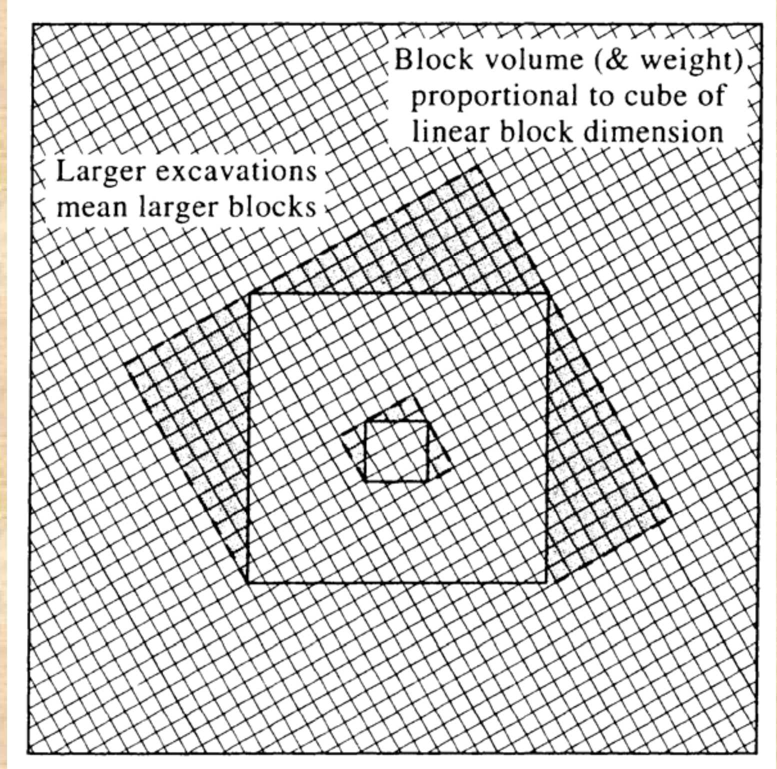
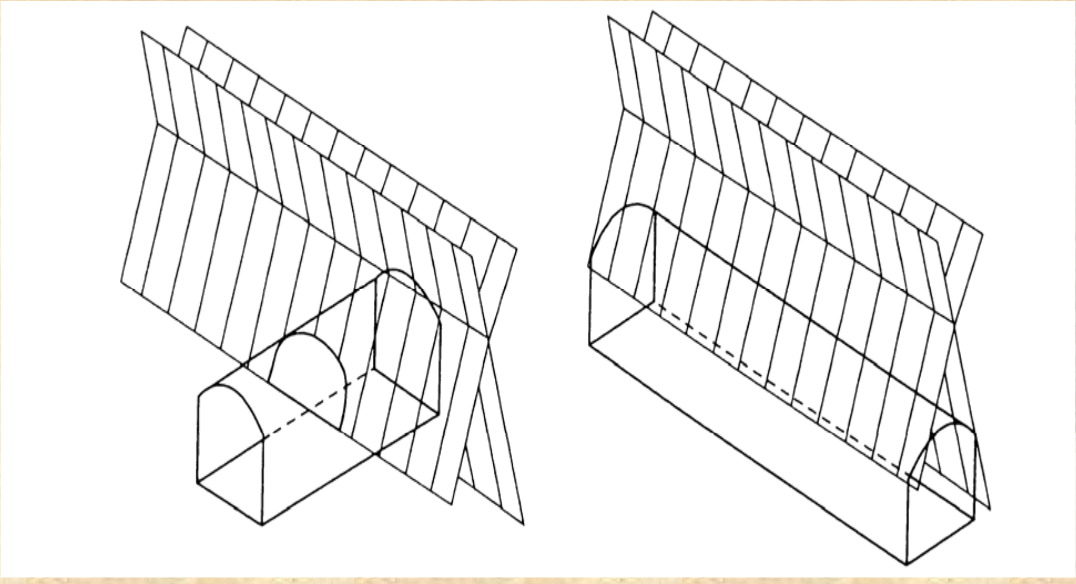
STRUCTURAL FEATURES





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DESIGN METHODS

- EMPIRICAL
- NUMERICAL

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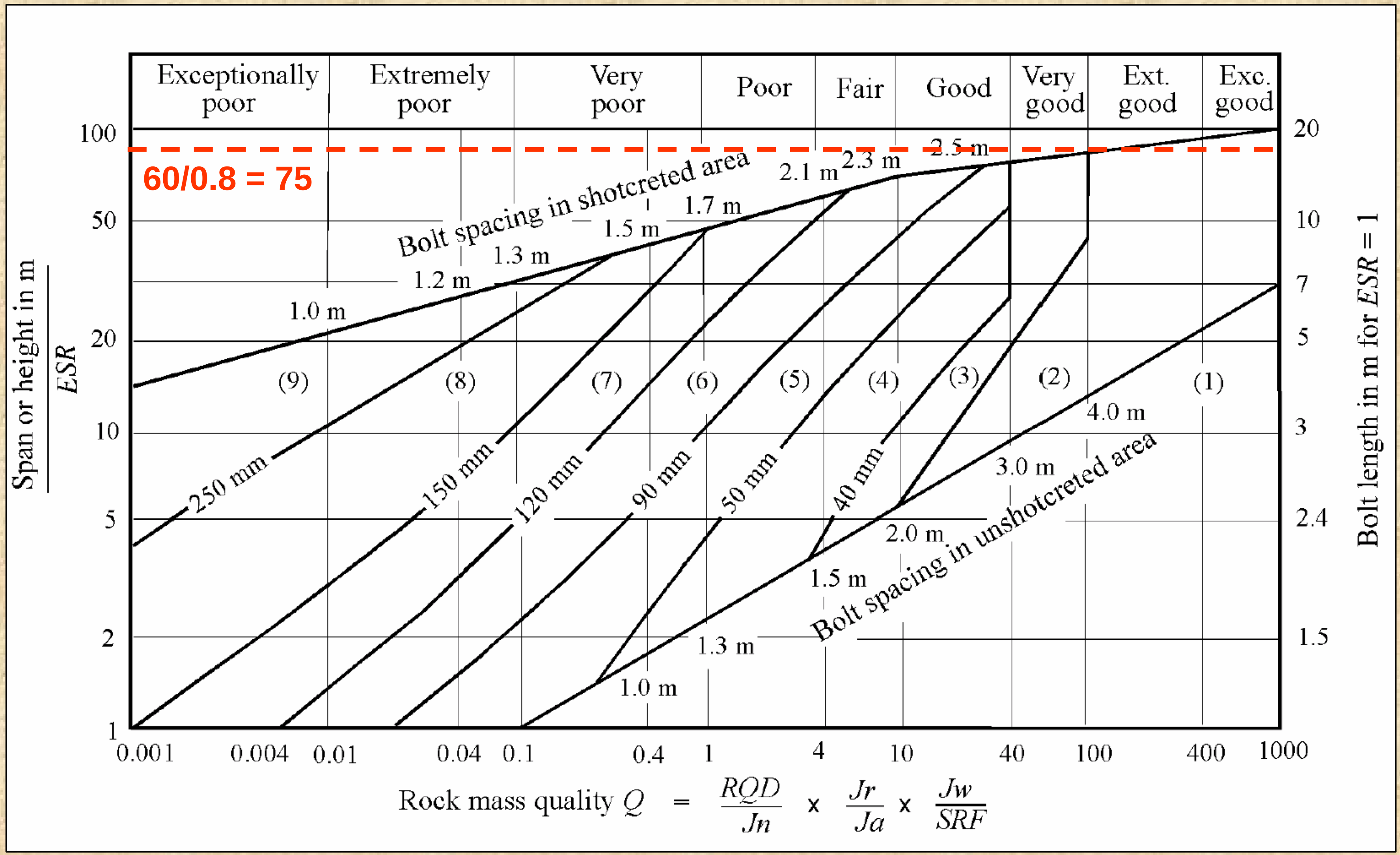
SUPPORT CATEGORIES BASED ON THE Q INDEX



Grimstad and Barton (1993) Updating the Q system for NMT. Int. Sump. on Sprayed Concrete (eds. Kompen, Opsahl and Berg), 89, A30-36

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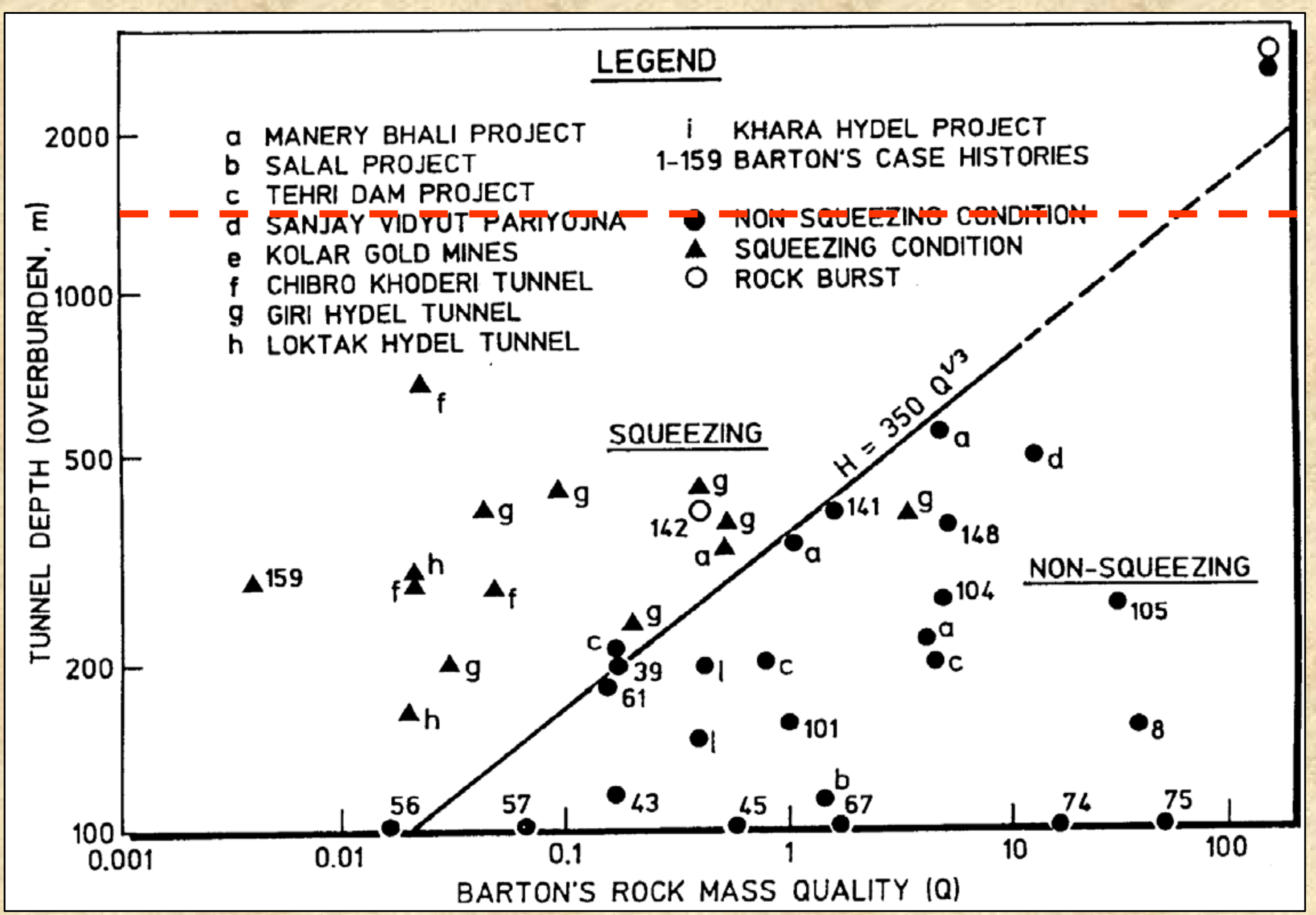
APPROACH FOR PREDICTING SQUEEZING CONDITIONS



Singh et al. (1992) Correlation between observed support pressure and rock mass quality. Tunnelling and Underground Space Technology, 7 , pp. 59-74

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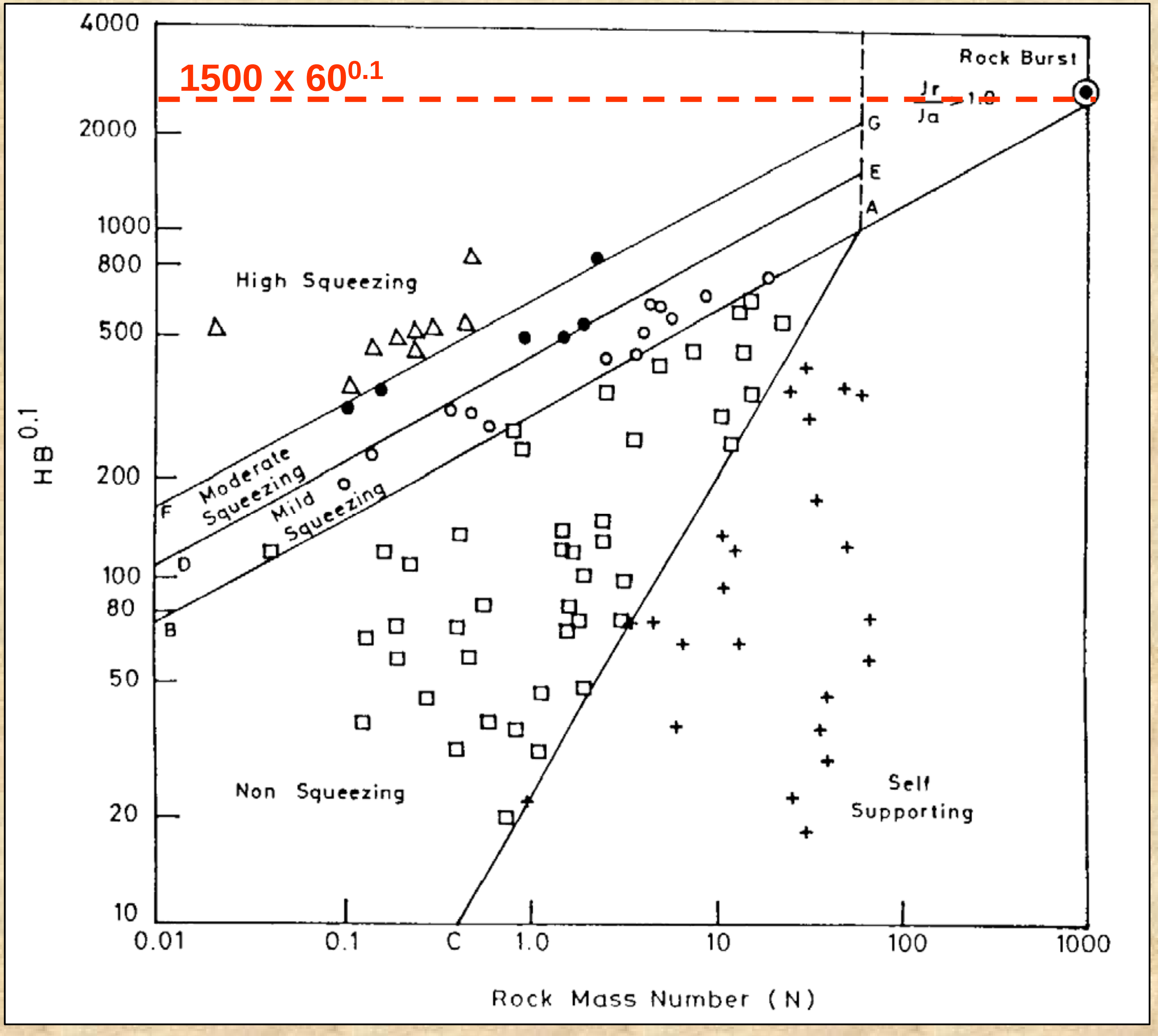
APPROACH FOR PREDICTING SQUEEZING CONDITIONS



Goel et al. (1995) Tunnelling through the young Himalayas a case history of the Maneri-Uttarkashi power tunnel. Engrg. Geol., 39, pp. 31-44

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Empirical designs would require very good rock mass (Q > 50) with the risk of rock-burst

It is necessary to make extrapolations as there is no data base for such conditions

NUMERICAL MODELING

Numerical models can directly take into account:

- Rock Mass Strength
- “In-Situ” stresses
- Structural features
- Geometry of the excavation
- Excavation sequence
- Support

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NUMERICAL MODELING

They can be used in different stages of the project

1. During the characterization phase they should be used to determine the relative importance of different parameters and thus optimize the rock mass investigation.

2. During the design process the should be used to determine the optimal geometry, support and construction sequence.

3. During construction the should be used to analyze monitoring data and reassess support.

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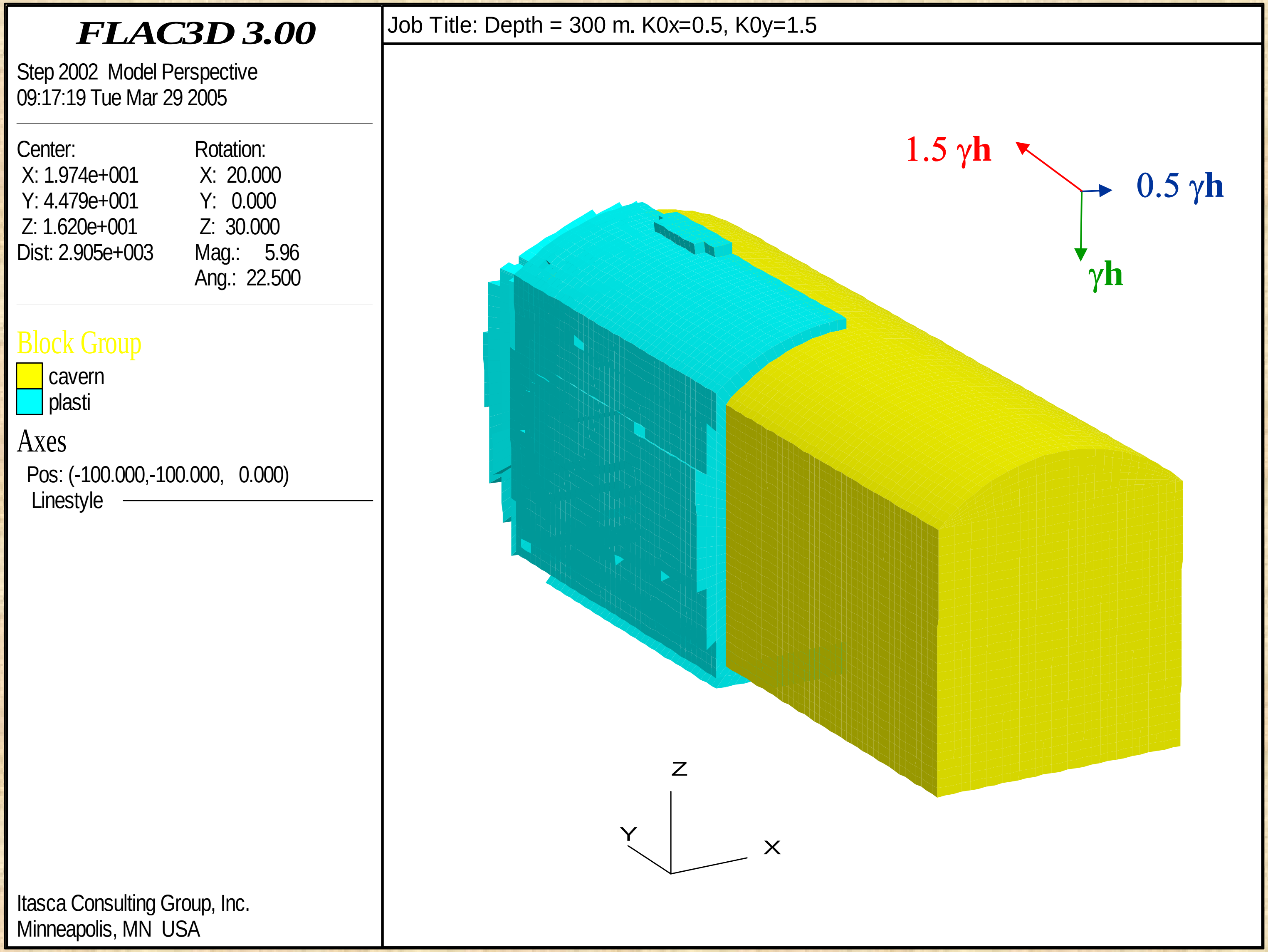
NUMERICAL MODELING



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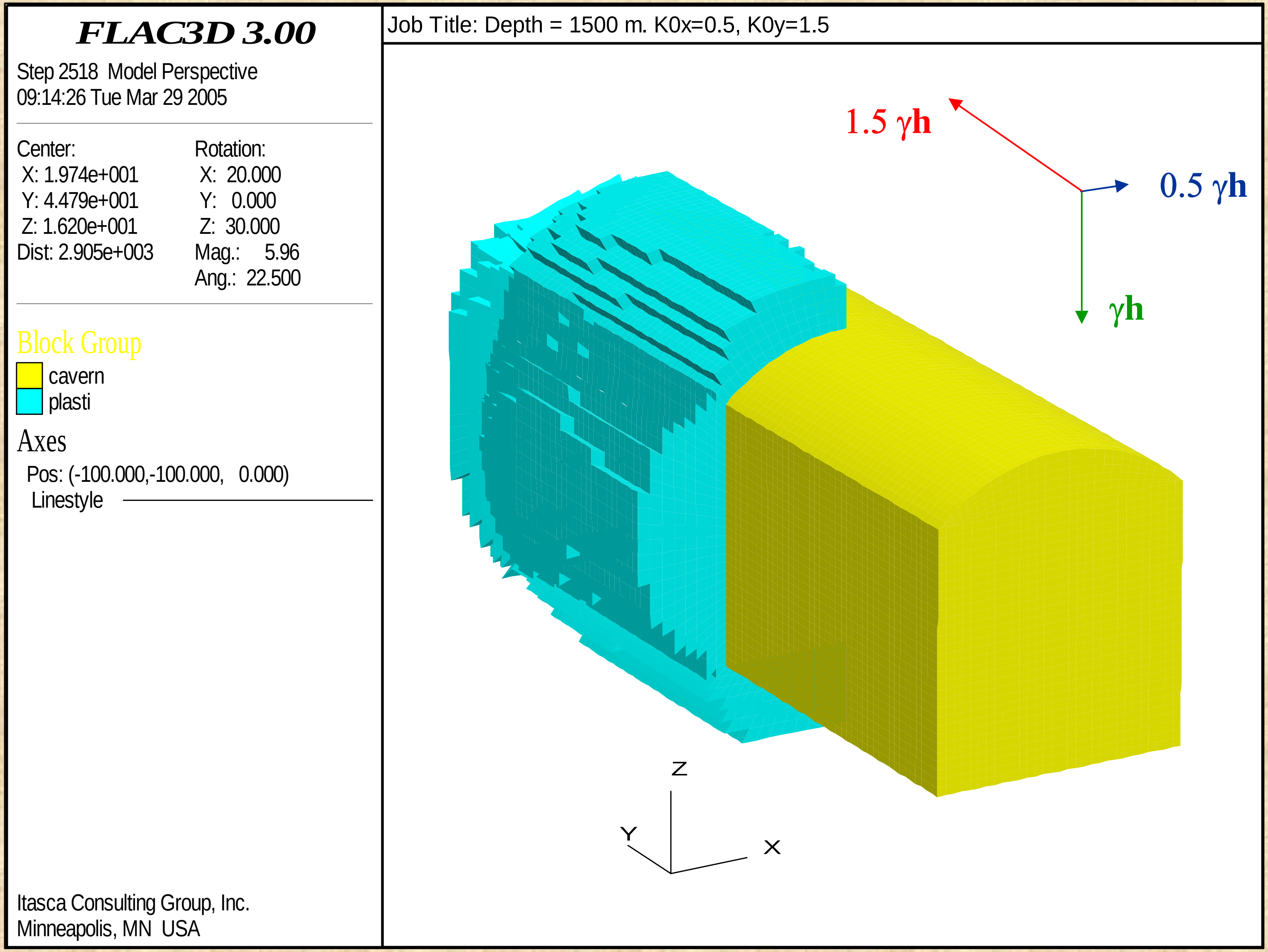
NUMERICAL MODELING



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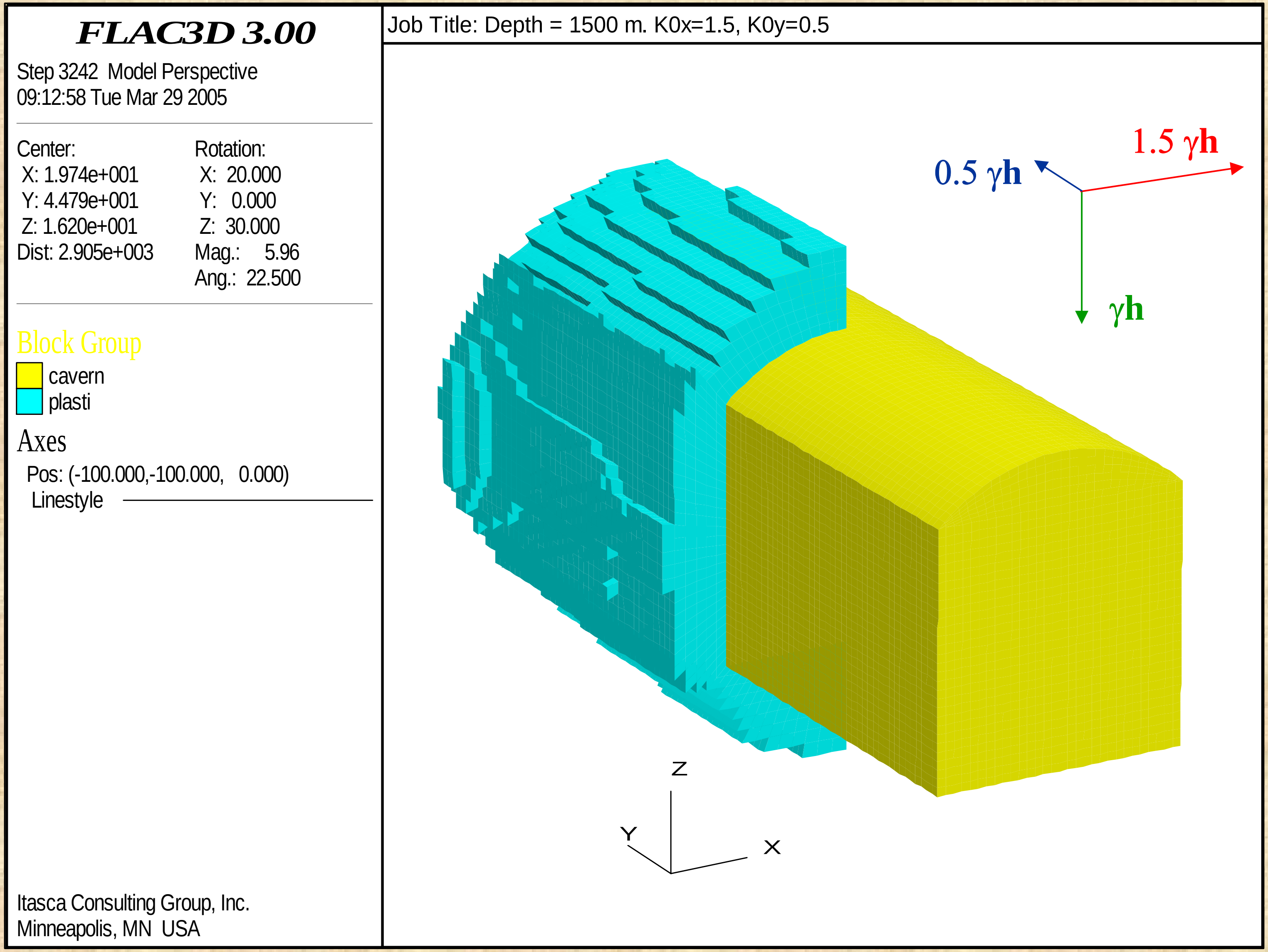
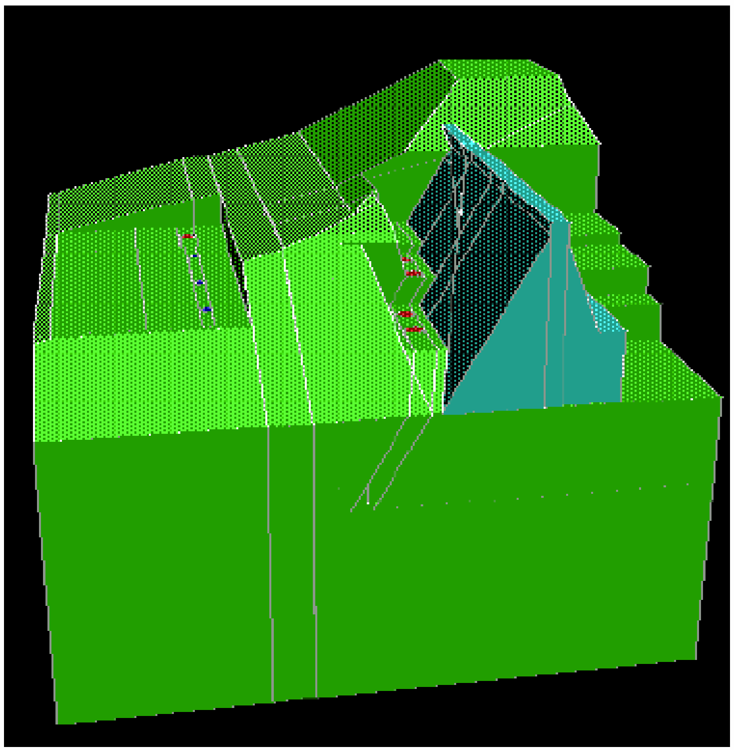
NUMERICAL MODELING



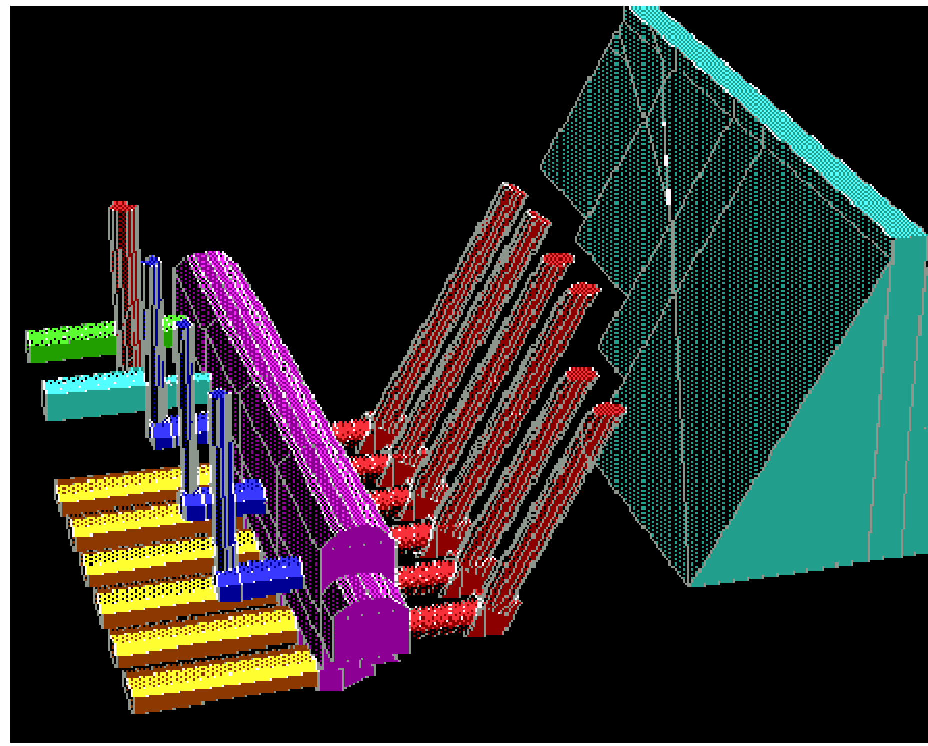
NUMERICAL MODELING

SARDAR SAROVAR PROJECT (SSP)
GUJARAT, WESTERN INDIA

Model Domain



Model of Excavations and Dam



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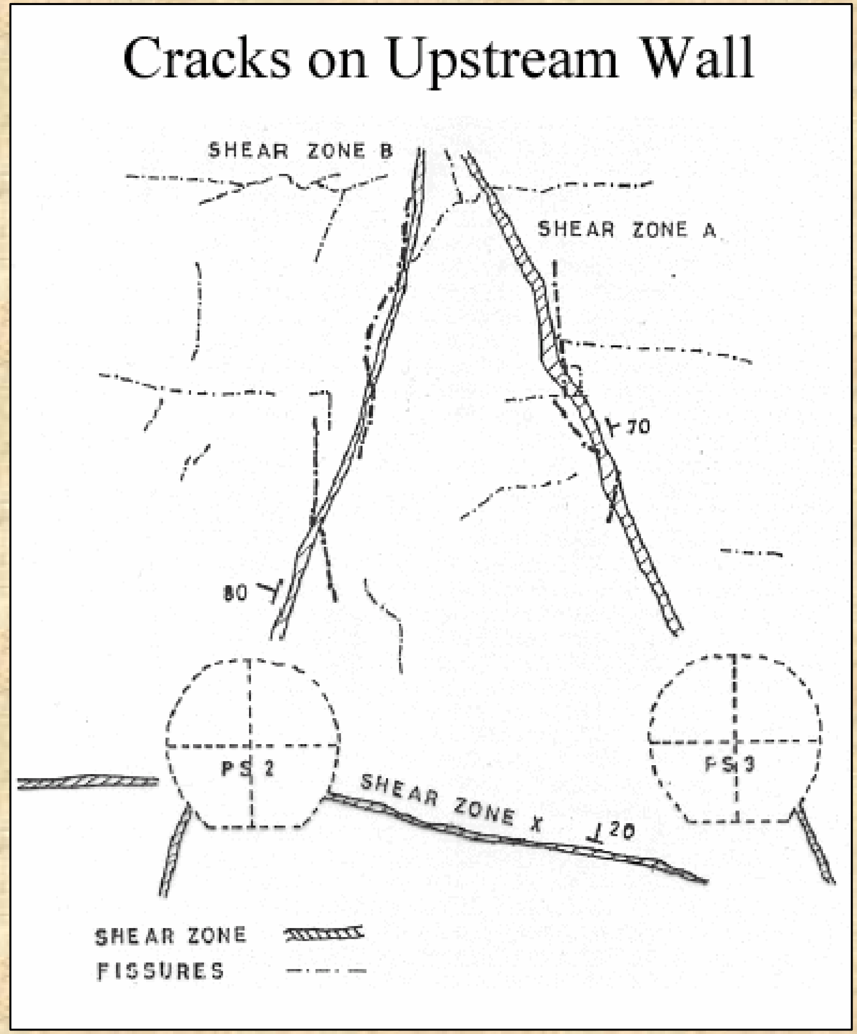
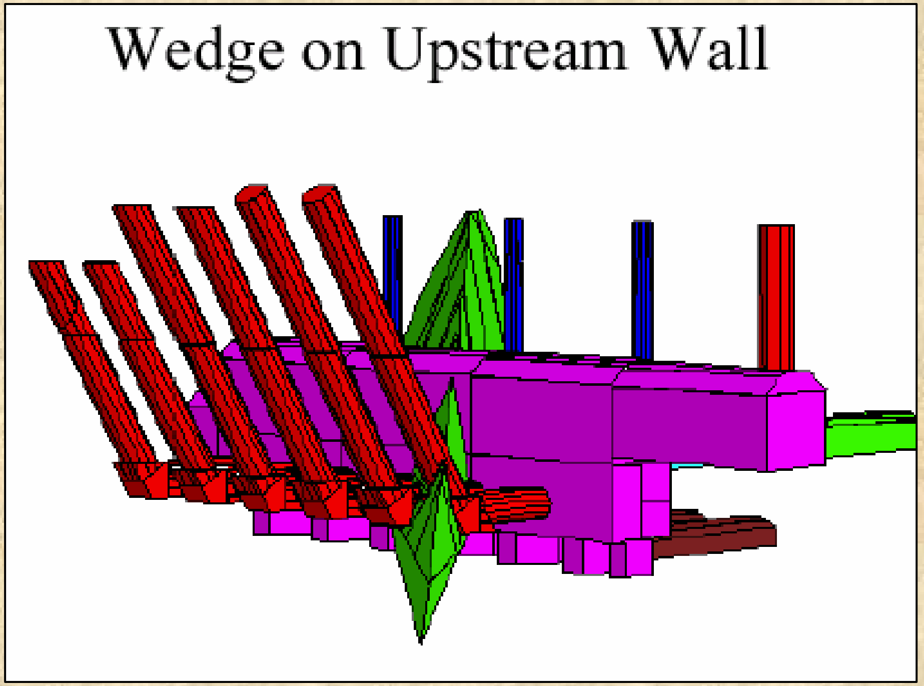
NUMERICAL MODELING

SARDAR SAROVAR PROJECT (SSP)
GUJARAT, WESTERN INDIA





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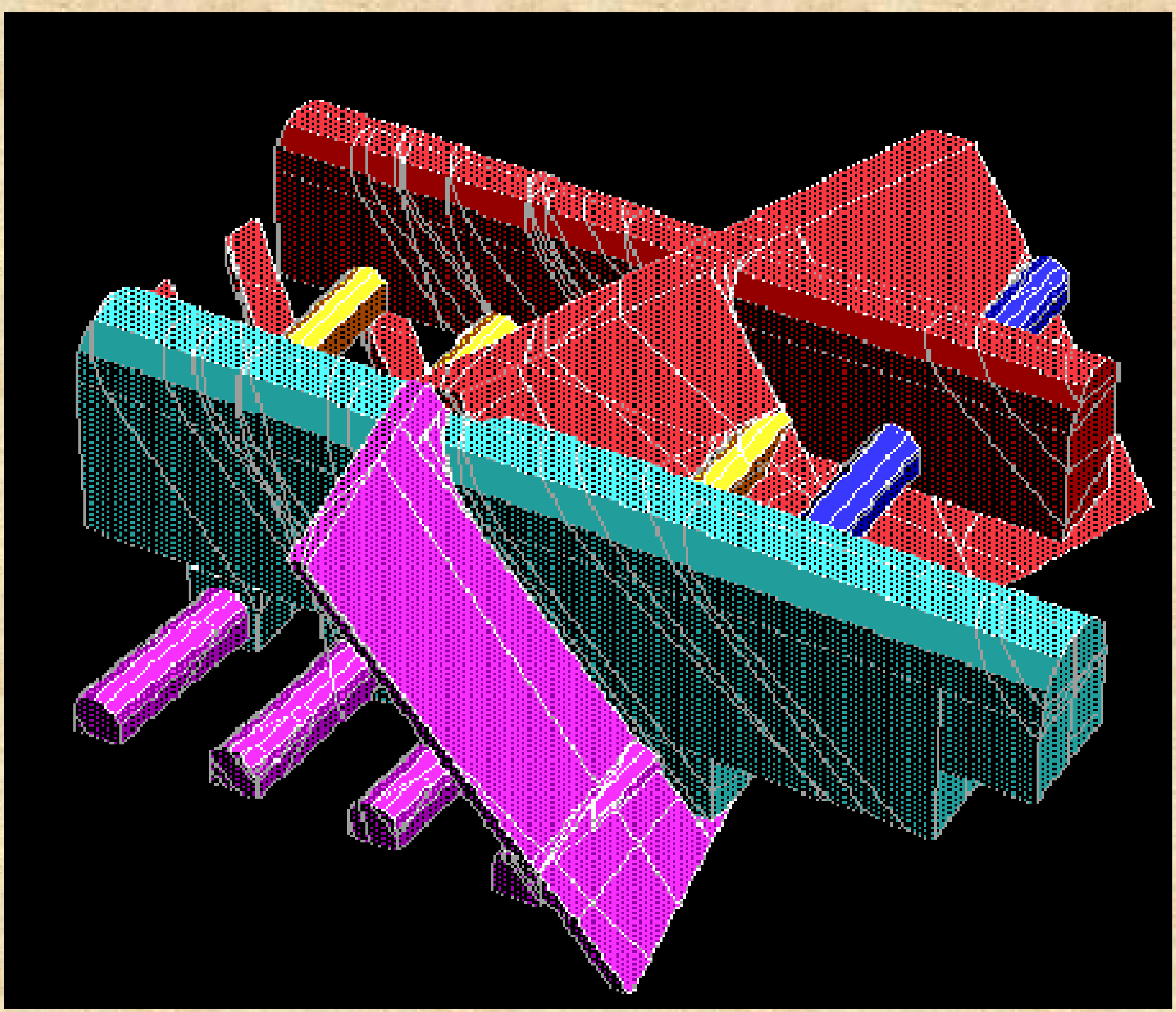
NUMERICAL MODELING

TEHRI HYDRO POWER PROJECT
U.P., NORTHERN INDIA



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CONCLUDING REMARKS

• UNO proposed excavation is unique and outside of the data base of empirical design methods.

•There is no theoretical limit to the applicability of numerical models. However, the role of numerical models in rock mechanics is not the same as in other branches of engineering since there will never be a complete characterization of the rock mass and the constitutive models available are an idealization of the behavior of the rock mass.