

**Revolutionizing Road Infra with Modern Equipment,  
Technologies, Sustainable Materials and Policy Guidelines**

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# **Challenges in Tunnel Construction**

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India Chapter**

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# UG STRUCTURES - ALL EMBRACING UTILITY



**RAIL**



**METRO**



**ROAD**



**HYDRO / WATER SUP/ IRRIGATION**



**MISC ASSETS**

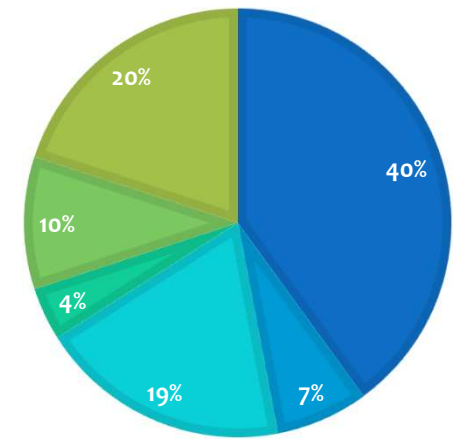
# TRENDS

- ✓ **Total number of Tunnel Projects ~ 1500 Nos**
- ✓ **Length of Tunnels ~ 3500 Km**

|                                   |     |
|-----------------------------------|-----|
| • Hydro Tunnels                   | 40% |
| • Water Supply & Sewerage Tunnels | 07% |
| • Railway Tunnels                 | 19% |
| • Highway Tunnels                 | 04% |
| • Metro Tunnels                   | 10% |
| • Irrigation Tunnels              | 20% |

## TUNNEL SECTORS

■ HYDRO   ■ WS & SWGE   ■ RAILWAY  
■ HIGHWAY   ■ METRO   ■ IIRI



**ESTIMATED MARKET SIZE - INR 4 TRILLION OVER NEXT FIVE YEARS**

# IDENTIFYING APPROACH STRATEGY

## GEOTECH ENVT

### SHALLOW

- METRO
- SUBWAYS
- RD/RAIL
- **SOIL**

### DEEP

- RD/RAIL
- HYDRO
- **ROCK**

**TWO DIFFERENT BALL GAMES !!**

## EXCAVATION MEANS

### MECHANICAL

- METRO TBMs
- RD HEADERS
- DEEP TNLS?

### DRILL & BLAST

- DEEP TUNNELS
- METROS

**MAKING THE RIGHT CHOICE !!**

# GEOTECH ENVIRONMENT

## ➤ **Shallow Tunnels in Soil**

- ✓ Easier exploration , lesser risks
- ✓ Scope for damage control
- ✓ Semi infinite, near isotropic strata



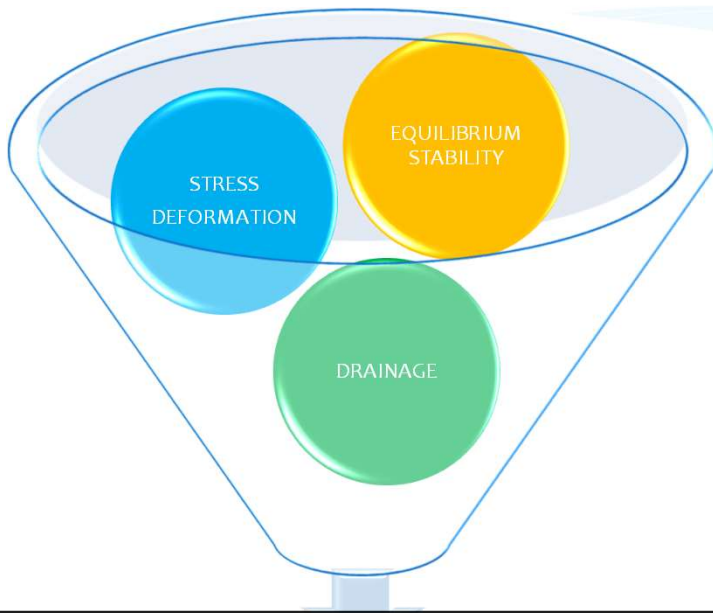
## ➤ **Deep Tunnels in Rocks**

- ✓ Complex Exploration and accessibility issues
- ✓ Larger Unknowns, Higher Risk
- ✓ Extreme Heterogeneity





# ROCK MASS - COMPLEX GEOTECH MELANGE

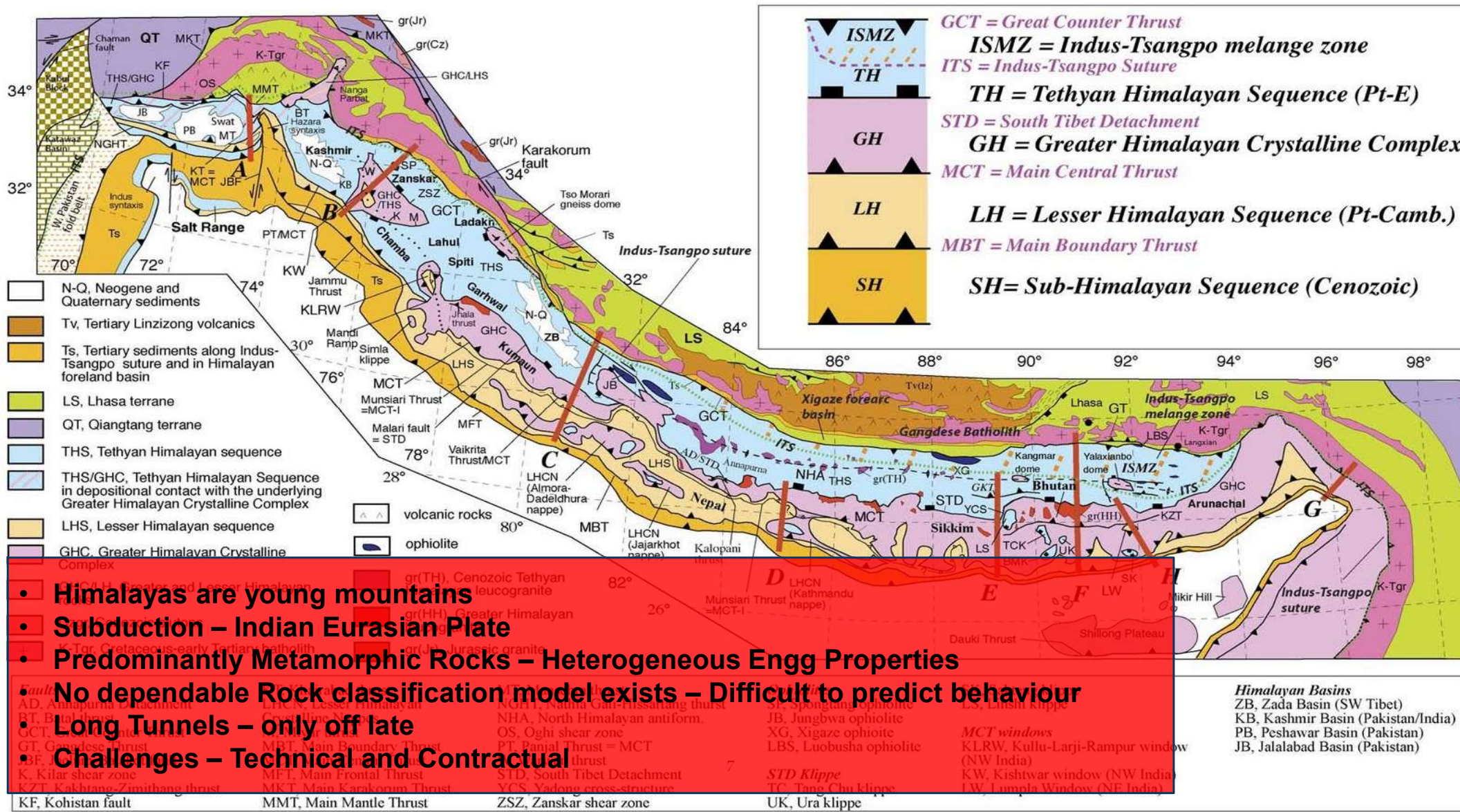


- DEFORMABILITY, STRENGTH AND FAILURE OF INTACT ROCK - INTACT ROCK CHARACTERISTICS
- 
- DEFORMABILITY, STRENGTH AND FAILURE OF ROCK MASSES - ROCK MASS CHARACTERISTICS
- 
- DISCONTINUITIES AND STEREOGRAPHIC ORIENTATION
- 
- NATURAL AND INDUCED STRESS
- PERMEABILITY OF ROCK
- ANISOTROPY
- IN-HOMOGENEITY

- ROCK STRUCTURE
- INSITU & INDUCED STRESS
- HYDROGEOLOGICAL CONDITIONS

# HIMALAYAN GEOLOGY !!





- **Himalayas are young mountains**
- **Subduction – Indian Eurasian Plate**
- **Predominantly Metamorphic Rocks – Heterogeneous Engg Properties**
- **No dependable Rock classification model exists – Difficult to predict behaviour**
- **Long Tunnels – only off late**
- **Challenges – Technical and Contractual**

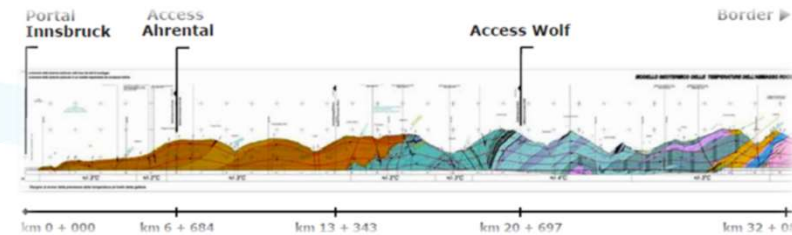
**Himalayan Basins**  
 ZB, Zada Basin (SW Tibet)  
 KB, Kashmir Basin (Pakistan/India)  
 PB, Peshawar Basin (Pakistan)  
 JB, Jalalabad Basin (Pakistan)

**MCT windows**  
 KLRW, Kullu-Larji-Rampur window (NW India)  
 KW, Kishtwar window (NW India)  
 LW, Lumpala Window (NE India)

**STD klippe**  
 TC, Tang Chu klippe  
 UK, Ura klippe

# RECOMMENDED APCH

- ✓ Geomechanical Characterisation
- ✓ Scientific Exploration – Geophysical methods & Intrusive Investigation technologies
- ✓ Robust Prelim Design – Tender with a Baseline, Flexibility
- ✓ Monitor & Optimise





# WAY AHEAD

- **Basic Rock Mechanics – Excavation & Sp Sequence – Trained Engineers.**
- **Uniformity in X-Secs & HSE Arrangements.**
- **Investigation & Exploration, Adits / Shafts – *Preparation Of DPRs – PDCs* – Decouple Plg & Exec.**
- **Characterisation - Geo-mechanical Modelling , *Behaviour & Ground Type Classification.***



# WAY AHEAD

- **Observational Methods – Robust Deformation Monitoring & Optimisation of Supports.**
- **Contract - Understanding Adv Rates, TRC & Sharing Risks (Geotech Baselines).**
- **Requirement Of Tech Expertise & Contractual Flexibility.**



# WAY AHEAD

- **Dispute Redressal Mechanisms & Expert Agencies.**
- **Geological Data Sharing – Central Repository.**
- **Right Site Organisation – Supervision Consultants to be rewarded for Timely Project Completion, All Stake holders incl client to be sufficiently Tech Competent.**



# WAY AHEAD

- **Right Contract Model - Deep Tunnels & EPC !! - FIDIC Emerald Book / Delay & Disruption Protocols for Indirect And OH Costs.**
- **Cash Flow.**
- **Provisions in Contract for Rates For Unforeseen Items.**



# WAY AHEAD

- **Pay Lines For Excavation & Shotcreting/ Concreting.**
- **Tunnel Data Book** incl Basis of Adv Rates.
- **Running Nation Wide Investigation Campaigns – Plan for the future.**



A long, empty tunnel with a grey concrete floor and white walls. The ceiling is lined with rows of bright, rectangular lights. A series of orange traffic cones are lined up in the center of the road, receding into the distance. On the left and right sides of the road, there are small white planters with flowers. A dark grey rectangular box is centered in the middle of the tunnel, containing the text 'THANK YOU' in large, orange, outlined letters with a thin orange underline.

**THANK YOU**