

## JOHN C SHARP - Consultant in Rock Engineering

---



### EDUCATION

- BSc(Eng)(Hons) Civil Engineering, ACGI, Imperial College, London, 1966
- PhD, DIC, Rock Mechanics, Imperial College, London, 1970

### AFFILIATIONS, AWARDS

- Chartered Engineer, MICE, MIMM, (UK), 1973
- Registered Professional Engineer, (Canada)
- Keynote Lecturer at International Conferences
- Unwin Medal, City & Guilds College, London, 1966

### EXPERIENCE

**1980 - 2010      GEO-ENGINEERING - GEO-DESIGN  
CONSULTANT IN ROCK ENGINEERING**

#### Principal Current Areas of Specialisation - Underground Projects

- Design and construction evaluation of large underground caverns and tunnels, particularly for weak rock and low cover conditions.
- Detailed design of integrated rock reinforcement - lining systems for caverns and tunnels in difficult rock conditions.
- Planning, investigation assessment, design and construction evaluation of tunnels for water, transportation and power.
- Specialist assessment and rationalisation of TBM related excavation - support methods particularly for long tunnels through variable / difficult ground conditions.

#### Major Underground Projects in Civil Engineering

- Brisbane Airport Link, Australia. Design Review for constructor of all major highway cavern sections and wide span ramp tunnels in weak sedimentary rock. Independent design analyses and assessment of excavation - support systems.
- West Island Line, MTR, Hong Kong. Detailed Design of two major station caverns in weathered rock including major intersection design. Evaluation of active / passive lining alternatives.



- Gerrards Cross Tunnel Collapse, UK. Leader of Technical Team investigating the collapse of a large span (20m), precast segmental arch - fill structure some 300m in length over a live railway. Detailed assessment of lining - ground interactive behaviour. (Currently a Confidential Assignment.) Review of remedial design proposals
- Gautrain High Speed Rail Link, South Africa. Review of Station and other Cavern Designs under low cover. Analytical simulations and evaluations. Rock support design using composite rock reinforcement - shotcrete approach.
- Braamhoek and Steelpoort Pumped Storage Schemes, South Africa. Project review and evaluation. Specialist advice to main consultants and owner. One project in weak sedimentary rock with large proposed spans.
- DTSS Project, Singapore. Evaluation of major collapse of TBM erection cavern in weathered granite. Comprehensive modelling of multi-phase material at depth below water table. Expert reports.
- Shatin - Central Link, Hong Kong. Cavern evaluation and stability assessments. Preliminary design studies and option evaluations.
- Malmö Citytunnel Project, Sweden. Geotechnical evaluation and rock mass characterisation studies for project. Comprehensive, fundamental assessment of cavern design options. Development and production of reference design of for Triangeln station under city centre in weak, bedded limestone at shallow depth.
- Casecnan Hydro and Transfer Project, Philippines. Specialist consultant for the assessment of tunnel excavation and lining requirements for long TBM driven tunnels through complex volcanic rocks.
- Dublin Port Tunnel, Ireland. Design assessment for tunnels in limestone. Detailed design of tunnel lay-by - crossover complex. Ongoing review and specialist inputs.
- LPG Cavern, Zhuhai, China. Ground conditions assessment. Tender design and cavern layout options.
- Channel Tunnel Rail Link, UK. Specialist review and design input to Rail Link Engineering for North Downs Tunnel (twin track large cross section tunnel in chalk strata). Analysis of potential discontinuous behaviour and excavation - support - lining systems.
- Halifax Sewer Tunnel, UK. Specialist advice on geological and tunnelling conditions as encountered to rationalise stability issues.
- Bakun Hydro Project, Philippines. Specialist consultant for review of pressure tunnel lining design. Detailed assessment and analysis of as-built conditions to derive adequacy of unlined pressure tunnel section.
- Sydney Eastern Distributor, Australia. Design review for major underground road tunnel system (up to 5 lanes wide on two levels) in horizontally bedded sandstone strata. Independent design assessment.
- Brighton - Hove Stormwater Project, UK. Expert advice on tunnelling conditions and design criteria.
- Watchet Sewerage Scheme, UK. Specialist independent review of site investigation scope, ground conditions and inferred tunnelling conditions, preparation of expert reports.
- Westrail Project, Hong Kong. Specialist consultant for major rail tunnel development at preliminary design and construction stages. Rock engineering of variable span large cross section tunnels for crossover systems. Ongoing advice during construction.
- BG Technology, UK. Concept engineering for high pressure diurnal gas storage in deep unlined caverns. Rock engineering assessments and containment studies.



- CERN LHC Project, France / Switzerland. Design concept development and review for major large span cavern complex in marl - sandstone sequence under adverse groundwater conditions. In depth assessment of rock replacement - lining technology for major cavern abutments and invert. Detailed analysis of protected response and stabilisation system design.
- Nuclear Waste Disposal, Nirex, UK. Execution of extensive world wide precedent practice study for caverns and large span tunnels up to a significant depth below surface. Development of precedent design systems involving rock mass characterisation, depth and span.
- Western KL Distributor, Malaysia. Specialist review consultant for major highway tunnels in weathered granite.
- Lower Kihansi Hydropower Project, Tanzania. Specialist review consultant on high pressure waterway containment and power station cavern design.
- Storm Relief Holding Cavern, Jersey. Site investigation, rock mass characterisation and detailed design for 25,000m<sup>3</sup> cavern complex in central urban area for storm sewage. Contract documentation and drawings. Construction supervision and review. Review of associated tunnelling works by TBM through highly variable rock mass with sensitive water control problems.
- Lesotho Highlands Water Project, Lesotho. Specialist Consultant on Transfer and Delivery Tunnels for tunnel alignment, excavation, support and lining for some 70 km of TBM driven tunnels in basalts and sandstone. Investigation planning, evaluation of rock mass conditions, excavation support design. Contract documentation and drawings. Specialist construction review of tunnel alignment. Detailed evaluation of support and final lining requirements.
- Lesotho Highlands Water Project, South Africa. Specialist Consultant on Delivery Tunnel North (Ash and Caledon Tunnels) for tunnel alignment, excavation, support and lining for some 20km of TBM driven tunnels through weak sedimentary strata. Test tunnel performance assessment. Evaluation of feasibility of TBM excavation with concurrent one pass segmental lining. Construction evaluation and final lining designation study.
- Channel Tunnel, UK - France. Specialist Technical Consultant to Eurotunnel (Project Review) - Land and Marine Tunnels, Castle Hill, UK Crossover. Appraisal of project designs and constructed works. Review of NATM applications and observed performance. Provision of expert submissions. Comprehensive assessment of excavation - support precedent conditions in TBM driven tunnels
- Southern Conveyor Project, Cyprus. Specialist review of 14 km Dhiarizos Tunnel under high cover in chalk / marl with potential for overstressing and squeezing ground. Excavation and support requirements for TBM one pass segmental lining system. Review and remedial works design for NATM option. Final lining design study.
- Mass Transit Railway, Hong Kong - Airport Rail Link. Specialist Consultant on design studies for Lai King Station, Tunnels and Crossover complex. Evaluation of rock mass conditions in jointed granite, UDEC studies of tunnel interactions, design of rock reinforcement and tunnel linings.
- Route 3 Highway Tunnels, Hong Kong. Specialist advice on investigation, evaluation and design of twin three lane tunnel complex in weathered granitic and volcanic rocks under variable cover. Major portal excavation design. Analysis of large tunnel span behaviour in highly fractured rock.
- Muela Hydropower Project, Lesotho. Underground excavation design for power station complex in weak sandstone and major surge shaft structure in basalt. Rock mass evaluation, design analyses, support and lining systems. Use of waterproof membranes in tunnels and shafts with interface grouting.
- Island West RTS, Hong Kong. Evaluation of rock mass characteristics, outline design and specifications for a major rock cavern (28m span x 250m long) in volcanic rock mass.



- Strategic Sewage Disposal Scheme, Hong Kong. Specialist Consultant on major tunnel and cavern study for interception, conveyance and treatment of waste water. Feasibility study investigation and scheme concept planning. Cavern preliminary evaluation and design. Assessment of long TBM drives through granitic rocks.
- Underground Oil Storage in Chalk. Rock engineering assessment and excavation design for major underground oil storage facility in weak, jointed chalk at shallow depth below surface. Planning and evaluation of full scale test openings (14m dia). Construction and long term monitoring assessment.
- Major Rail Tunnels in Weak Rock, Natal, RSA. Specialist advice on design and construction of twin track rail tunnels in weak bedded rock. Rock support system design, monitoring and evaluation. Independent evaluation and assessment of major tunnel failures.
- Hex River Tunnel, RSA. Independent evaluation of excavation - support requirements for 13 km long railway tunnel through metasediments including major fault zones. Provision of expert advice.
- LPG Storage Facility in Chalk. Full scale monitored pressure testing of LPG storage cavern in weak, fissured chalk. Evaluation of rock mass response including time dependency. Hydrofracture stress measurement. Guidelines for facility design and remedial works to upgrade rock surround.
- Tsing Ma Bridge Anchorages, Hong Kong. Independent design assessment for major anchorage tunnels in fractured volcanic rock. Excavation - support design and engineered reinforcement of anchorage zone.
- Pumped Storage Feasibility Studies, Ireland. Investigation, planning and preliminary design studies for two pumped storage schemes on the River Shannon. The schemes, of the order of 500 - 1000 MW in capacity are located within metamorphosed sediments. Initial scheme layouts with artificial upper reservoirs and underground power stations were evaluated.
- Carsington Aqueduct, UK. Review of tunnel excavation and lining as constructed. Planning and evaluation of full scale pressure tests. Outline design of remedial lining works.
- Mass Transit Railway, Hong Kong - Island Line. Construction and long term design assessment for major station cavern in weathered granite (28 m span x 250 m long). Assessment of excavation conditions, design of cavern lining, study and evaluation of overhead hillside excavation performance. Site assessment and design of rock excavations for major concourse development in weathered granite.
- Nirex Radioactive Waste Repository Studies, UK. Specialist advisor on excavation - support design for TBM driven access tunnels through fractured volcanic rock. Review consultant on data acquisition and evaluation of deep level RCF project. Member of Geotechnical Study Group responsible for precedent study of large cavern excavations at depth.
- Waste Isolation Studies, Washington, USA. Detailed reviews of an underground test facility in basalt. Evaluation of thermo-mechanical rock mass behaviour for use in deep level repository design. Design and evaluation of large scale in situ testing, planning of deep level test facility.
- Hydro-electric Projects, general. Evaluation of hydro-electric / pumped storage projects at Drakensberg, Elandsberg, Kariba South, Kiambere, Mvumase, Palmiet (Africa), Mount Hope (USA).
- Tunnelling Projects, general. Railway, road, mineral transportation and water tunnels in UK, Africa, America, Europe, Middle East and the Far East.
- Geothermal Energy, (UK). Project technical review of Phases 1, 2 and Phase 3 proposals for HDR project in granite.



### Major Slope Stability Studies

- A5 - Glyn Bends, Wales. Technical evaluation of major failure of permanent rock anchors in a highway cutting (2005). Assessment of corrosion effects, protection methodology and observed overload effects.
- Los Frailes, Seville, Spain. Design and evaluation of major footwall slopes in slate including failures during early development stages. Evaluation of major ramp stabilisation system using rock reinforcement - anchorage system.
- Tuen Mun Road, Hong Kong. Specialist advisor to Highways Department on excavation and slope stabilisation designs for major new rock cuts to permit existing highway widening. Detailed studies on rockfall protection methods to protect existing operational facility.
- Ting Kau Bridge, Hong Kong. Geotechnical and rock slope engineering assessments for a major bridge project and interchange with existing highway. Bridge abutment and tower stability assessments including marine island developments. Comprehensive design review input on all geotechnical aspects.
- Jeffrey Mine, Quebec, Canada. Long term review of slope stability for 400 m high slopes in soil and rock adjacent to residential and plant areas. Extensive investigations including soil and rock slope failure evaluations since 1971. Design and performance monitoring of 300 m high anchored slope in slate. Development of specialised high resolution monitoring techniques for large slopes. Study of current 50m ton failure in weak ultrabasic rocks including large scale remedial drainage measures from underground. Prediction of long term slope performance. Estimation of long term movement limits.
- Aznalcollar, Seville, Spain. Evaluation of major slope failure in slate. Prediction of ongoing stability conditions. Long term monitoring controls. Design of new cut slopes.
- St Helier, Jersey. Evaluation of rock face stability of former quarry workings. Design and supervision of remedial works including rock anchoring, meshing and rock fall protection structures in conjunction with major housing development.
- Evretou, Cyprus. Independent assessment of Evretou Dam Intake Tunnel portal failure including remedial works design and ongoing evaluation. Appraisal of long term seismic stability.

1976 - 1980 CONSULTANT / PRINCIPAL, GOLDER ASSOCIATES

### Major project experience included the following:

- Drakensberg Pumped Storage Scheme, South Africa. A major development (1000 MW) traversing the Drakensberg escarpment N.E. of Lesotho in relatively weak sedimentary rock. The scheme has a total head in excess of 500 m and an overall alignment length of about 4 km. The underground caverns are supported by rock reinforcement and lined with shotcrete. Responsibility was taken for all major rock engineering aspects from investigation to commissioning.
- State Hydraulic Works (DSI) Turkey. Development of underground engineering capabilities within DSI as specialist consultant for the UNDP. Lecture series and review of projects under construction.
- Tara Mines, Ireland. Consultant in initial development and groundwater studies, involving long term piezometric monitoring and interpretation of adjacent river influence.
- Government Pit Slopes Project, Canada. Principal consultant/author of Groundwater chapter with associated research and development into new groundwater investigation and evaluation techniques.
- Roan Consolidated Mines, Zambia. Review consultant on all open pit developments including existing and new projects on 5 mine areas.



- Dinorwic Pumped Storage Scheme, North Wales. Specialist advice.
- Atalaya Open Pit, Spain. Rock slope stability studies.
- Kilbarchan Colliery, South Africa. Underground stability assessment.
- Nigg Bay, Scotland. Review of tunnel portal conditions.
- Rossing Uranium Open Pit, Namibia. Specialist review and planning.
- Advocate Mines, Newfoundland. Specialist review.
- Palabora Open Pit, South Africa. Groundwater studies.

#### 1970 - 1975 SENIOR ENGINEER / ASSOCIATE, GOLDER ASSOCIATES

Participated in a wide range of surface and underground projects in Canada, Australia and elsewhere.

#### RESEARCH TOPICS

Fluid Flow Through Rock Masses. Ph.D. Thesis, Imperial College, University of London 1970.

#### SELECTED PUBLICATIONS

Sharp, J.C. "Drainage Characteristics of Subsurface Galleries", Proc. 2nd Congress of Int. Soc. Rock Mech., Belgrade, 1970.

Hoek, E. and Sharp, J.C. "Improving the Stability of Rock Slopes by Drainage", Proc. Symp. on the Theoretical Background to the Planning of Open Pit Mines with Special Reference to Slope Stability, Johannesburg, 1970.

Brawner, C.O., Pentz, D.L. and Sharp, J.C. "Stability Studies in a Footwall Slope in Layered Coal Deposit", Proc. 13th Symp. on Rock Mechanics, Amer. Soc. Civ. Eng., 1972.

Sharp, J.C., Maini, Y.N.T. and Harper, T.R. "Influence of Groundwater on the Stability of Rock Masses - Hydraulics within Rock Masses", Trans. Inst. Min. and Met., 81, A13-A20, 1972.

Sharp, J.C., Hoek, E. and Brawner, C.O. "Influence of Groundwater on the Stability of Rock Masses - Drainage Systems for Increasing the Stability of Slopes", Trans. Inst. Min. and Met., 81, A113-A120, 1972.

Sharp, J.C., and Maini, Y.N.T. "Fundamental Considerations on the Hydraulic Characteristics of Joints in Rock", Proc. Int. Soc. Rock Mech. Symp. on Percolation through Fissured Rock, Stuttgart, 1972.

Sharp, J.C., Maini, Y.N.T. and Brekke, T.L. "Evaluation of the Hydraulic Properties of Rock Masses Influenced by Major Heterogeneities", Proc. 14th Symp. on Rock Mechanics, Pennsylvania, 1972.

Bowcock, J.B., Boyd, J.M., Hoek, E. and Sharp, J.C. "Drakensberg Pumped Storage Scheme : Rock Engineering Aspects", Proc. Symp. on Exploration for Rock Engineering, Johannesburg, 1976.

Sharp, J.C. Richards, L.R. and Byrne, R.J. "Instrumentation Considerations for Large Underground Trial Openings in Civil Engineering", Proc. Int. Symp. on Field Measurements in Rock Mechanics, Zurich, 1977.



- Sharp, J.C. Ley, G.M.M. and Sage, R. "Pit Slope Manual Chapter 4 - Groundwater", Canmet, November, 1977.
- Richards, L.R., Sharp, J.C. and Pine, R.J. "Design Considerations for Large Unlined Caverns at Shallow Depths in Jointed Rock", Proc. 1st. Int. Symp. on Storage in Excavated Rock Caverns, Stockholm, 1977.
- Sharp, J.C., Pine, R.J., Moy, D. and Byrne, R.J. "The Use of a Trial Enlargement for the Underground Cavern Design of the Drakensberg Pumped Storage Scheme", Proc. 4th Congress of Int. Soc. Rock Mech., Montreux, 1979.
- Sharp, J.C. "Rock Engineering Aspects of the Drakensberg Pumped Storage Scheme", British Tunnelling Society Lecture, 1979.
- Milligan, V., Sharp, J.C. and Richards, L.R. "Trends in Underground Powerhouse Development in Weak Rocks", UN Symposium on Hydro-electric Schemes, Athens, 1979.
- Mellors, T.W. and Sharp, J.C. "Investigations for the Drakensberg Power Station Complex in Weak Sedimentary Rock", Proc. ISRM Symposium Rock Mechanics: Caverns and Pressure Shafts, Aachen, May 1982.
- Sharp, J.C. and Gonano, L.P. "Rock Engineering Aspects of the Concrete Lined Pressure Tunnels of the Drakensberg Pumped Storage Scheme Proceedings", ISRM Symp., Rock Mech.: Caverns and Pressure Shafts, Aachen, May 1982.
- Sharp, J.C. and Mellors, T.W. "Rock Engineering and Design Studies for the Drakensberg Pumped Storage Scheme", Trans SAICE Vol 24 No. 8, August 1982.
- Sharp, J.C. and Lawrence, D.L.J. "Final Shotcrete Linings for an Underground Power Station in Argillaceous Rocks", Proc. Conference on Shotcrete for Underground Support IV, Columbia, September 1982.
- Wilson, C., Sharp, J.C. and Moy, D. "Behaviour of a Shotcrete Tunnel Lining in Fine Grained Sedimentary Rock", Proc. Conference on Shotcrete for Underground Support IV, Columbia, September 1982.
- Gonano, L.P. and Sharp, J.C. "Critical Evaluation of Rock Behaviour for In Situ Stress Determination using Overcoring Methods", Proc. 5th Congress of Int. Soc. Rock Mech., Melbourne, 1983.
- Sharp, J.C. "In-situ Testing Methods in Underground Works, General Report Theme 6", Proc. Conference on In-Situ Testing, Paris, May 1983.
- Sharp, J.C., Endersbee, L.A. and Mellors, T.W. "Design and Observed Performance of Permanent Cavern Excavations in Weak Bedded Strata", Proc. ISRM Symp. Design and Performance of Underground Excavation, Cambridge UK., Sept. 1984.
- Sharp, J.C., Smith, M.C.F., Thoms, I.M. and Turner, V.D., "Tai Koo Cavern, Hong Kong - Performance of a Large Metro Excavation in a Partially Weathered Rock Mass", Proc. Int. Symp., Large Rock Caverns, Helsinki, 1986.
- Sharp, J.C., Bergeron, M. and Ethier, R. "Excavation, Reinforcement and Monitoring of a 300m high Rock Face in Slate", Proc. 6th Congress of Int. Soc. Rock Mech., Montreal, 1987.
- Sharp, J.C., Lemay, C. and Neville, B. "Observed Behaviour of Major Open Pit Slopes in Weak Ultrabasic Rocks", Proc. 6th Congress of Int. Soc. Rock Mech., Montreal, 1987.
- Speers, C.R. and Sharp, J.C. "Use of Tunnel Deformation Monitoring for Excavation Control in Weak Bedded Rock - Isangoyana Rail Tunnel", Proc. Tunnelling '88, London 1988.
- Sharp, J.C. "Performance Monitoring of Large Excavated Slopes in Complex Rock Masses", Proc. 2nd Conf. Rock Mechanics and Engineering - Natural and Excavated Slopes, Torino, 1988.



Sharp, J.C. "Design of Major Caverns in Granitic Rocks based on Precedent Practice in Hong Kong and elsewhere", Proc. Conf. Rock Cavern, Hong Kong, 1989.

Sharp, J.C. "Design and Application of Integrated Shotcrete Linings for Underground Openings in Weak Rock", Proc. Conference on Shotcrete for Underground Support V, Uppsala, June 1990.

Richards, J.A., Remmer, F. and Sharp, J.C., "Design and Construction of a Segmental Lining for a Machine Bored Tunnel - Delivery Tunnel North, Lesotho Highlands Water Project", Proc. Design and Construction of Tunnels, Lesotho, September 1992.

Sharp, J., Richards, J.A., Kubisch, F. and Remmer F. "Lesotho Highlands Water Project - TBM Excavated Water Tunnels in Weak Bedded Rock", Proc. Conference, Options for Tunnelling, ITA, Amsterdam, April 1993.

Sharp, J.C., Bandis, S.C., Kridiotis, C., Christodoulou, E. and Petrides, G. "Tunnelling Options in Chalk Marl - Dhiazos Diversion Tunnel, Cyprus", Proc. Conference, Options for Tunnelling, ITA, Amsterdam, April 1993.

Sharp, J.C. "Design Considerations and Parameters for the Analysis of TBM Excavation Segmental Lining Systems", Rock Characterisation for Tunnelling, Felsbau Special Publication, June 1997.

Sharp, J.C. and MacKean, R.A.N. "Rock Slope Design - A Review of Current Practice", Proc. Conference, Engineering Geology, IMM, Hong Kong, November 2000.

Kaiser, P.K., Diederichs, M.S., Martin, C.D., Sharp, J. and Steiner, W. "Underground Works in Hard Rock Tunnelling and Mining", Proc. Conference, Contributions to Geomechanics of Hard Rock 1987 - 2000, MIRARCO - Mining Innovation, Melbourne, November 2000.

Sharp, J.C. and Bandis, S.C. "Rock Engineering Design Aspects of TBM Excavated Tunnels and Segmental Lining Systems", Proc. Conference on Mechanised Tunnelling, MIR 2000, Torino, Italy, December 2000.

Sharp, J.C., Bandis S.C., and MacKean, R.A.N. "Evaluation of Design Concepts for an Urban Underground Railway Station : Engineering Assessment of Design Analysis". UDEC Symposium, Bochum 2004.