



Abstract of PhD Theses

Ph.D. Theses Supervised by Prof. Bhawani Singh, Department of Civil Engineering, IIT Roorkee (formerly University of Roorkee) from 1975 to 1998 - A Brief Overview by Dr. V. M. Sharma, former Director, CSMRS and Founder (LM-1), ISRMTT

The research in Rock Mechanics at the University of Roorkee has mainly been carried out under the guidance of Prof. Bhawani Singh. A close look at the topics of the papers and dissertation would show that whereas Prof. Bhawani Singh has given due importance to theoretical analysis and computer techniques, he has never ignored the actual behaviour of rock structures. That is why most of the theses under his guidance are based on actual field measurements. These measurements have given an insight into the behaviour of rock masses when subjected to loading / unloading particularly in highly stressed conditions. Most of his students were actually working in the field and it is reflected in the maturity and level of their work. A brief description follows:

Abstract 1:

Title of Thesis: Geo-mechanical evaluation of tunnel stability under failed rock conditions
Name of PhD Candidate: A. K. Dube
Supervisor: Prof. Bhawani Singh
Year of Award: 1981
University/Institute: IIT Roorkee, Roorkee

Abstract

Dr. A. K. Dube collected instrumentation data notably the relaxation of rock with borehole extensometers and closures with tape extensometers and rock loads with pressure cells. He evolved a graphical method of finding out the radius of a broken zone. He found that the constant K was not really a constant throughout the broken zone and also it varied with time. The value in fact is reduced with an increase in radial distance. He modified the elastoplastic theory for non-hydrostatic conditions to obtain the ground reaction curves.

Dr. Dube did pioneering work by installing and collecting instrumentation data from the Giri Bata Project. It was Prof. Bhawani Singh's brilliant ideas with the help of which he was able to make a sensible interpretation, since the instrumentation was done for measuring deformations and pressures for a squeezing tunnel and it was not planned for a Ph.D. programme. This was one of the first PhDs produced in India which was based on field measurements.

Abstract 2:

Title of Thesis: Evaluation of rock pressures in tunnels through squeezing ground in lower Himalayas
Name of PhD Candidate: J. L. Jethwa
Supervisor: Prof. Bhawani Singh
Year of Award: 1981
University/Institute: IIT Roorkee, Roorkee

Abstract

Dr. Jethwa was a colleague of Dr. Dube when he started working on the instrumentation data of five Hydroelectric schemes and a road of a deep coal mine. Analysis of the data showed that the radial displacement within the broken zone decreased linearly with the logarithm of the radial distance. The failed rock mass got compacted adjacent to the supports.

Dr. Jethwa proposed a semi-empirical theory for determining ultimate creep pressure assuming that the compacting zone undergoes visco-elastic creep relaxation. He developed a methodology for the design of tunnels in squeezing ground conditions and recommended a factor of safety 3 for designing permanent tunnel lining.

Abstract 3:

Title of Thesis: Development and application of infinite elements for analysis of openings in rock mass
Name of PhD Candidate: Prabhat Kumar
Supervisor: Prof. Bhawani Singh
Year of Award: 1988
University/Institute: IIT Roorkee, Roorkee

Abstract

Prof. Bhawani Singh possesses a rare combination of combining highly theoretical/analytical work with the observations of actual Underground excavations. Some of his students chose to work on analytical aspects of the behaviour of underground excavations. One such work was carried out by Dr. Prabhat Kumar of the CBRI in which he formulated infinite elements with stretching a finite element. He developed a new finite element program in which he implemented the above-mentioned infinite elements. He used the above software for the analysis of several problems, including analysis of surface loaded isotropic homogeneous masses, multilayered rock masses with rough interfaces, non-homogenous semi-infinite rock masses, cross-anisotropic semi-infinite rock masses, deep openings in rock masses, shallow opening in rock masses, parallel and adjacent openings, lined tunnels, thermal stresses in underground openings. On the basis of these analyses, he formulated a procedure for the analysis and design of power tunnels.

Abstract 4:

Title of Thesis: Study on long -term behaviour of underground powerhouse cavities in soft rocks
Name of PhD Candidate: Subhash Mitra
Supervisor: Prof. Bhawani Singh
Year of Award: 1991
University/Institute: IIT Roorkee, Roorkee

Abstract

Subhash Mitra, a young scientist from U.P. Irrigation Research Institute, Roorkee looked at the instrumentation data of Chhibro Underground powerhouse, which was one of the first large Underground powerhouses in the Himalayan region. The powerhouse is located in poor quality dolomitic limestones which includes shear zones and several other discontinuities.

A major shear zone approximately 25 m thick is lying within 10 m of the lowest draft tube in the powerhouse area. The excavation was aligned normal to the strike of the rock formations. He studied the long-term behaviour of the powerhouse cavity which was observed with the help of strain meters, rock bolt load cells etc. installed in the steel supports and cable anchors. He found that the influence of earthquakes on the wall support pressures appeared to be significant in the neighborhood of the underlying thick shear zone. He suggested a new empirical method for assessing support pressure in the seismic region as in the lesser Himalayas.

The work done by Dr Mitra is important in the sense that it showed that the roof support pressure increased significantly after charging the water conductor system and during heavy rainfall. Also, he observed that the stresses in the steel rib supports varied with the quantity of water drawn for power generation. This was due to the hydro-geological conditions of the power house complex, leading to seepage in the roof of the cavern. Based on these findings, he recommended the use of drainage systems wherever such conditions existed.

Abstract 5:

Title of Thesis: Estimation of engineering properties of rock mass
Name of PhD Candidate: V. K. Mehrotra
Supervisor: Prof. Bhawani Singh
Year of Award: 1992
University/Institute: IIT Roorkee, Roorkee

Abstract

Another experienced engineer, who has been working in the U.P. Irrigation Department, Dr. V. K. Mehrotra has lots of experience of working on Water Resources Development Projects of the U.P. Irrigation Department.

Using the data from several projects, Dr. Mehrotra established a correlation between the Modulus of Deformation with RMR. The relation is useful because it is essentially meant for softer and weaker Rock masses and therefore different from more established correlations of Bieniawski

(1978) and Serafim and Pereira (1993). Mehrotra studied the effect of saturation on the modulus and also the correlation between the support pressure and modulus of deformation.

Analysing extensive Data of in-situ block shear tests, Mehrotra established a correlation between RMR and shear strength parameters. Useful relationships were obtained for estimating allowable bearing pressure on poor and fair category of rock mass, both on the basis of strength and settlement.

Abstract 6:

Title of Thesis: Development of mine subsidence prediction model for Indian coal fields
Name of PhD Candidate: P.P. Bahuguna
Supervisor: Prof. Bhawani Singh
Co-Supervisors: Dr. N.C. Saxena and Dr. A.M.C. Srivastava
Year of Award: 1993
University/Institute: IIT Roorkee, Roorkee

Abstract

Subsidence is a big problem in mining areas. Lots of money is spent every year working on projects related to mining subsidence. Using two software based on a Displacement Discontinuity Method, parametric studies were carried out by Dr. Prem Prakash Bahuguna of Central Mining Research Station to obtain subsidence profiles. The effects of width-depth ratio and overburden on the parameters controlling the shape of the subsidence profiles were studied.

Field data from 125 mine workings was used for the study. Field data of 65 mine workings from long-wall and Board -and- Pillar mines were used to establish correlation between R_f and percentage of hard rock layers in the overburden and the rest 60 mine workings were used to validate the proposed semi-empirical method. The proposed methodology was used for verification from coal mines in the UK and USA. The suggested model is simple and easy to understand and is based on the theory of electricity.

Abstract 7:

Title of Thesis: Rock mass tunnel support interaction analysis
Name of PhD Candidate: Manoj Kumar Verman
Supervisor: Prof. Bhawani Singh
Co-Supervisors: Prof. M.N. Viladkar
Year of Award: 1993
University/Institute: IIT Roorkee, Roorkee

Abstract

Another Scientist Manoj Kumar Verman who was working at the Central Mining Research Station, Nagpur tried to simplify the procedure of rock support interaction analysis. He developed a simplified procedure of determining the ground reaction curve. The modulus of deformation

required for the Ground Reaction Curve was determined on the basis of a correlation between RMR and the depth of the tunnel.

Abstract 8:

Title of Thesis: Behaviour of clayey gouged Material along discontinuity surfaces in rock mass
Name of PhD Candidate: U. N. Sinha
Supervisor: Prof. Bhawani Singh
Co-Supervisors: Dr. R. K. Bhandari
Year of Award: 1993
University/Institute: IIT Roorkee, Roorkee

Abstract

Dr. Umesh Narayan Sinha of the Central Building Research Institute Roorkee, collected samples of shales from joints and shear seams of Kalia Saur Landslide area and pulverized them to simulate joints and clay gouge conditions of the field. Similar joints were produced with Kohima clay, Ball clay and China clay. Unconsolidated undrained Ko consolidated undrained triaxial tests were conducted on various joint dip angles at different speeds of shearing. The particle size distribution of gouge material was studied with laser particle size analyser to assess the extent of particle break down due to shear displacement.

Based on the test results he suggested how these parameters should be determined. He concluded that the deviatoric stress is a better criterion for the shear strength of joints and proposed modification to Barton's equation.

Abstract 9:

Title of Thesis: Influence of anisotropy and shear zones on stability of caverns
Name of PhD Candidate: N. K. Samadhiya
Supervisor: Prof. Bhawani Singh
Co-Supervisors: Prof. M. N. Viladkar and Dr. J. L. Jethwa
Year of Award: 1998
University/Institute: IIT Roorkee, Roorkee

Abstract

More recently Narendra Kumar Samadhiya developed a general-purpose software package for 3-D non-linear elastic analysis of stresses in anisotropic rock masses using finite element method with the capability to simulate in-situ stresses and geological discontinuities. The program was used to analyse the Underground powerhouse cavern of the Sardar Sarovar Project. The observed instrumentation data was used for back analysis and working out the rock mass parameters. These parameters were used for the analysis and prediction of movements for the remaining excavations. On the basis of the analysis, he established the need for additional anchors and extra thickness of shotcrete. Narendra Kumar Samadhiya found that the anisotropic model was better for modelling jointed rock masses. Since discontinuities affect the behaviour strongly, a software should be able to account for it.

Besides above 9 Ph.D. theses related to Civil Engineering, Prof. Bhawani Singh also supervised the following 3 theses pertaining to Water Resources Development Training Centre, UoR, Roorkee:

* Dr. R. L. Chauhan, 1982: A Simulation Study of Tunnel Excavation (Supervisors: Prof. Mahesh Verma & Prof. Bhawani Singh)

* Dr. A. W. Hassani, 1984: Hydraulic Fracturing with Particular Reference to Soil Cylinder (Supervisor: Prof. Bhawani Singh)

* Dr. H. S. Badrinath, 1991: Development of the Expert System for Contractual Risk Sharing in Tunnel Contracts (Supervisors: Prof. Mahesh Verma & Prof. Bhawani Singh)

Source: *An Extract from a Special Lecture on "Rock Mechanics Research in India and the Contribution of Prof. Bhawani Singh " by Dr. V. M. Sharma; National Workshop on Application of Rock Engineering in Nation's Development in Honour of Prof. Bhawani Singh, 27-28 April, 2001, University of Roorkee*