April 2020
Volume 16, No. 1

INDIAN SOCIETY OF ENGINEERING GEOLOGY
(IAEG India National Group)
A Biannual Newsletter

ISEG NEWS

www.isegindia.org
www.joegindia.com

Bridging Communication Gap.....Dissipating Information

MESSAGE FROM THE PRESIDENT

Dear Members,

It has been a great honour and privilege for me to serve ISEG which has completed 54 glorious years since its inception. The society has always been a platform of collaborative learning and application of intuitive wisdom of geology for the development and growth of infrastructure in the country especially, hydropower projects. Over the years, ISEG has effectively served as a formidable bridge between geologists and engineers, thus providing a vibrant technical forum for discussing and resolving complex geotechnical issues in hydropower and infrastructure industry.

As I take up this esteemed post of the President of the society, I assure its members of all possible help in taking the society to new heights. ISEG in its lap has associated best of engineering geology, engineering geophysics, geotechnical and civil engineering professionals available in the country. They all have great expertise in their respective fields and are valuable asset for the society. It would be a great endeavour for us to standardize the geological, geotechnical and geophysical investigations taken up for hydropower projects in the country.

Another important goal that the society needs to take up is publication of a compendium on the experiences and lessons learnt from various hydro power and water resources projects. This would act as guideline in resolving geological/ geotechnical issues in various on going and upcoming projects in the country.

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MESSAGE FROM THE SECRETARY

Dear colleagues,

As the new ISEG Council takes over for the term 2020-21, it gives me immense pleasure to compliment the previous council members for the accomplishment and laurels brought to the society.

The present council is very fortunate to have Shri A.K. Singh, Chairman and Managing Director, NHPC as ISEG President. I can assure all the members that under his efficacious, benevolent and worthy leadership, the society will progress and flourish manifolds.

The new council took charge on 11th January 2020. Before it could streamline its activities, the Covid-19 pandemic engulfed the world and nationwide lockdown was imposed. However, with the support of all members and executive council, the society very successfully conducted its first council meeting on 18th April 2020 online via zoom app. I feel very delighted to inform that about 24 executive council members and invited veterans participated in this highly productive meeting despite complete lockdown. My heartfelt gratitude to all of them for making it a great success.

We have come up with the calendar of ISEG activities during 2020 & 2021. Beside the GoP, society is looking ahead for organising EGCON-2020 during December 2020. This three day International Conference on "Geological Risks and Mitigation through Innovative Investigation Technique for Hydropower and Infrastructure Projects" will be organised in New Delhi. It is also proposed to organise a two day workshop on "Advance Geotechnical, Geophysical and Seismological Studies for Hydropower Projects" during December 2021. The detailed program regarding the above two proposed events shall follow soon.

Enhancing the membership base of the society is very important for its development and visibility. It shall be our

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"There's nothing to be feared. Only to be understood."
-Marie Curie

ISEG COUNCIL 2020-21

ISEG DELHI-NCR CHAPTER

SHRI A. K. SINGH, PRESIDENT, ISEG TOOK OVER THE CHARGE OF CMD NHPC

Shri Abhay Kumar Singh has taken over as Chairman and Managing Director of NHPC Limited, India's premier hydropower utility and a Schedule 'A' Enterprise of Government of India on 24th February 2020. Prior to his appointment as CMD, he held the position of Executive Director, NHPC. Limited.

Shri Singh is a strong team leader who believes in team work through ownership, responsibility, competency, knowledge, and one company mind-set. He is passionate about development of hydropower projects, and at the same time is open to advancements and diversification in the power sector, including the other Renewables. He advocates for inculcating new technologies in scheduling, construction and monitoring and deployment of state-of-the-art construction machinery for faster development of renewable energy projects in the country.

All ISEG members compliments him for this prestigious appointment!

SECRETARY ISEG WELCOMED PRESIDENT, ISEG AFTER ASSUMING CHARGE OF CMD, NHPC

After Shri A.K. Singh assumed the charge of Chairman and Managing Director of NHPC Ltd. on 24th February 2020, Shri S.L. Kapil, Secretary, ISEG welcomed him along with officers of Engineering Geology & Geotech. Division, NHPC. On behalf of ISEG Executive Council and all members of the society, he congratulated Shri Singh for this distinguished achievement.

MESSAGE FROM THE PRESIDENT

(Continued from page 1)

Now is the time when ISEG has to play a lead role in taking up challenge posed by several hydropower projects which are languishing for years due to lack of proper engineering solutions. The most glaring example are the Punatsangchhu-I HE Project in Bhutan and Parbati-II HE project in H.P., India. The engineers, geologists and geophysics professionals should strive to evolve feasible solutions to the problems associated with these projects and save valuable capital and honour of the nation. I request the senior members of the society who have vast experience in this regard, to take a lead to resolve such issues.

The society should contribute whole heartedly in working out new technologies and advanced techniques of geotechnical investigations which could minimize the geological uncertainties associated with hydropower and other infrastructure projects. In order to fulfil this endeavour, ISEG shall be organising Geoscience Meets on advanced investigation techniques and hydropower development. Eminent professionals from the field of engineering geology, geotechnical, geophysical and engineering fields would share latest information through lectures.

The world is passing through a tough phase, with Covid –19 pandemic effecting almost every country, it is the human spirit that will win over. The present ISEG council is not an exception to this great spirit. The first council meeting was held through VC mode and the enthusiasm shown by all the members reflects the true spirit of the society. I'm sure in the times to come, ISEG will flourish with the strength of all its members and shall contribute in the process of nation building.

Warm regards

(A.K. Singh)
President, ISEG

MESSAGE FROM THE SECRETARY

(Continued from page 1)

endeavour to increase the life membership of the society. I sincerely request the senior members of the society to persuade colleagues and peers in their respective organisations to take ISEG life membership. Besides, all the members are requested to join the IAEG, preferably with bulletin and strengthen our association with IAEG. Let's make efforts to reach the subscription of IAEG around 200, which seems to be an achievable target looking into the large membership base of ISEG. The membership for 2020 needs to be submitted before 15th Sept., 2020, so that we can send the consolidated list to IAEG by 30th September, 2020.

Now, the ISEG flagship publication "The Journal of Engineering Geology" is available online on our website www.joegindia.com. The vol. 43 of the journal, has been uploaded in April 2020. This volume contains peer reviewed papers from EGCON-2018. The papers which could not be published in this volume shall appear in forthcoming vol. 44 scheduled for release during July 2020. I request all members to submit their papers at the earliest for publication in the journal.

It gives me great pleasure in brining out the April 2020 issue of the society's newsletter "ISEG NEWS" following the tradition and maintaining the high quality of its content within the stipulated deadline. I compliment the Editor and his team for the efforts. In this time of Covid –19, ISEG under the guidance of our worthy President is striving incessantly to serve its members and engineering geology fraternity through its publications. I wish a safe, healthy and productive year ahead to all its members.

Best Wishes and Regards!

(S.L. Kapil)
Secretary, ISEG

EDITORIAL

Dear Members,

"No man ever steps in the same river twice, for it's not the same river and he's not the same man".

-Heraclitus

Life is constantly changing, to be more specific evolving. As I got this opportunity to serve this glorious society for the third term as an Editor, I join my hands as token of sincere gratitude to all seniors members and dear colleagues for trusting my abilities. ISEG NEWS is entering its 16th year of publication since its inception in 2004 under the editorship of Sh. Y. Deva. Since then, the newsletter has been constantly ameliorated to suite the publication standards of the present times without compromising the standard and quality perceived by the patrons. During my tenure, I had tried to put my best efforts so as to make the newsletter more and more captivating and engaging to all members under the able guidance of respective Presidents and Secretaries. In the process, I too have learnt a lot.

With taking over by the new council for the term 2020-21, by the blessings and guidance of our worthy President, Sh. A.K. Singh and Sh. S.L. Kapil, Secretary, ISEG, the society was able to publish online, two back volumes of the "Journal of Engineering Geology". Vol.43 was published during January 2020 and Vol. 44 during April 2020. There has been a significant delay in publishing due to transformation from manual printing to online publishing mode. However, since the editorial team as well as the website developer has now become well versed with online procedures, the forthcoming issue is being processed and shall be published very soon.

The present issue of ISEG NEWS carries short CV's of all esteemed council members for the term 2020-21 as a customary practice. The introduction is brief and all-out effort has been made to maintain uniformity.

In underground structures, especially large caverns, in-situ stresses always poses a great challenge for engineers. This issue has a very well written and interesting article on measurement of insitu stresses in hydroelectric projects by Sh. S.L. Kapil and Sh. Vipul Nagar. This issue also carries the concluding part of the article highlighting in-situ geotechnical investigations carried out by NIRM authored by Dr. D.S. Subrahmanyam. Likewise previous issues, we are continuing the biography series by publishing an article on "Geology by Non-Geologists" authored by Sh. M. Raju, Ex-DG, GSI. This very interesting article shall be published as a two part series. Beside the regular features, this issue also carries an article on online Open houses being conducted by our Veteran ISEG members of DDAG. In the time of Covid-19, the online platform has become a very essential tool for knowledge dissemination and imparting training. I am deeply indebted to all the authors for their valuable contributions.

"Only dead fish go with the flow" says an old proverb. Likewise, the editorial team also believes in innovation and improvisation. We are constantly striving to evolve our publications to meet the challenges of the transforming professional lives. I along with my editorial team is extremely indebted to Sh. A.K. Singh, President, ISEG for support and encouragement. Timely release of this issue was impossible without the support and guidance of Sh. S.L. Kapil, Secretary ISEG. Lastly, I'm extremely grateful to my joint editor for cooperation.

Regards

Rahul Khanna
Editor, ISEG

SUBMISSION OF TECHNICAL PAPERS AND ARTICLES

Interested authors can submit technical papers/articles/bio-sketches/ memoirs/ short articles/ news-clippings w.r.t. engineering geological projects/ invitations to workshops/conferences related to Engineering geology & Geotechniques etc. for publication in ISEG Journal and Newsletter to the Editor, ISEG on E-mails: isegpapers.gmail.com or to the Secretary, ISEG on india.seg@gmail.com.

ISEG MEMBERSHIP

- Admission fee (one time)
  New Members : Rs. 1000/-
- Institutional/Associate Membership
  (Annual) : Rs. 20000/- per annum
- Individual Membership

(i) Annual Membership : Rs. 1500/-

(ii) Life Membership
For age < 35 years : Rs. 5000/-
For age 35-50 years : Rs. 4000/-
For age > 50 years : Rs. 3000/-

One time admission fee is payable for all types of membership.

Membership forms available at ISEG website: www.isegindia.org

Dully filled-in application form, along with payment, may be sent to:

S.L. Kapil, Secretary
Indian Society of Engineering Geology
C/o Executive Director & HoD,
Engineering Geology & Geotec Division,
NHPC Ltd., Sector-33 Faridabad,
Haryana-121003
E-mail: india.seg@gmail.com;
shyamkapil@gmail.com

IAEG MEMBERSHIP

Indian Society of Engineering Geology (ISEG) is affiliated to International Association of Engineering Geology and the Environment (IAEG). Membership for IAEG is annual. Any ISEG Member, who wishes to join IAEG with bulletin, may pay the required fee 19 Euros (INR 1900/-) and without bulletin 7 Euros (INR 700/-) including GST.

In order to become IAEG Member, ISEG Members may pay the membership fee in ISEG Bank Account through online transfer and fill the Registration form available on ISEG website www.isegindia.org indicating payment details and mail to Secretary. Bank details are given below:

Name of the Bank: UCO Bank, GSI Branch, Aliganj, Lucknow
Name of account: 'INDIAN.SOC.OF.ENG.'
Account Number: 90330200000045
IFSC Code No. : UCBA0002024

All ISEG members are requested to join the IAEG, **preferably membership with bulletin** and strengthen our association with IAEG.

Secretary, ISEG

AN INTRODUCTION TO ISEG COUNCIL FOR 2020-21 TERM

A. K. Singh

President
Chairman & Managing Director, NHPC Limited, Faridabad

B. Tech in Civil Engineering, NIT - Durgapur, West Bengal

Sh. Abhay Kumar Singh completed his Civil Engineering from National Institute of Technology, Durgapur (formerly REC, Durgapur), West Bengal in 1983. Sh. Singh started his professional journey with NHPC in 1985 as a Probationary Executive at Tanakpur HE Project. His persistent learning attitude coupled with the ability to multitask, resulted in his taking up various responsibilities of the project at a very early stage. With his strategic thinking mindset, fact-based result oriented decision making, he could utilize the available resources to the fullest and also succeeded in achieving targets ahead of schedule. In his 35 years of professional life, he has played pivotal roles at many hydroelectric projects like Tanakpur (94.2 MW), Dhauliganga-I (280 MW), Teesta Low Dam Stage-IV (160 MW), Parbati Stage-II (800 MW), Parbati Stage-III (520 MW) and Kishanganga (330 MW) with responsibilities ranging from construction management of key project components to the Head of the Project (HOP) and Regional Head roles. He possesses strong capabilities in tackling complex site challenges such as managing local issues, technical & commercial issues, managing geological uncertainties, re-mobilizations, etc. Recognizing his contribution to hydropower development and water resources sector in India, REPA (Renewable Energy Promotion Association) and ENERTIA Foundation has conferred him with 'HYDRO RATNA' award. He is a firm believer of inculcating new technologies in investigation, scheduling, execution, monitoring and state-of-the-art construction equipment/ machinery for faster and development of any project. Presently, he is holding the prestigious position of CMD, NHPC.

E-mail: aksinghnhpc@gmail.com

A. K. Mishra

Vice President
Managing Director, MHPA, Bhutan

M. Tech. in Soil Mechanics & Foundation Engineering, IIT-Delhi, 1979

Sh. A. K. Mishra is a Civil Engineer, graduated in Year 1977, thereafter completed his masters degree in Soil Mechanics & Foundation Engineering from Indian Institute of Technology, Delhi. Sh. A. K. Mishra started his professional career with NHPC Ltd, a premier organization in India for the development of Hydropower Projects. While serving NHPC Ltd for more than 36 years, He contributed in Design, Engineering, Contracts Management & Construction Management of the nine Hydroelectric Projects in India and Bhutan. Presently, he is holding the prestigious position of Managing Director, MHPA, Bhutan for the Construction & Commissioning of 720MW Mangdechhu Hydroelectric Project. He started the Project from the blueprint stage and brought near to commissioning at the optimum cost and time. Mangdechhu hydro power project has been exemplified as an important milestone of Indian – Bhutanese successful cooperation. Sh Mishra shared his rich professional knowledge and experiences through publications of the Technical Articles which were published in the proceedings of various International/National Conferences& Seminars respectively. Till date, around 30 Technical papers were authored by me and same were published in the proceedings of the Conferences and Seminars. He is also associated with the various professional Institutions/Societies (15nos) around the world. The Government of India and the Private Organizations have also acknowledged his contributions and conferred the Awards to him at various occasions.

Email: md.mhpa@gmail.com

Pradeep Singh

Vice President
Director (Tech), Ministry of Mines, New Delhi

M. Sc. (Applied Geology), University of Allahabad,1991

Sh. Pradeep Singh joined GSI in 1994 and was involved with the engineering geological investigations in the States of Maharashtra, Gujrat, M.P., Chattisgarh, Punjab, Haryana, H.P., J&K etc. He was associated with geological investigations of Sorang, Kasang, Tidong, Thopan-Powari & Songtong-Karcham HE projects in H.P. During his tenure as Resident Geologist at Ranjit Sagar Dam Project, he played crucial role in tackling some complex post construction seepage problems. He was also involved with construction stage investigations, foundation mapping and treatment at Patiary, Thana, and Nara dam projects in Punjab. During his tenure at GSIFTI, Saketi he imparted training to newly inducted officers of GSI in engineering geology and Himalayan geology. Subsequently he was posted at EPE division at DGCO, New Delhi where he was engaged in geological and geotechnical appraisals of mega hydropower projects located in India, Nepal and Bhutan. His next posting was at National Mineral Exploration Trust (NME), DGCO, GSI, New Delhi where he was responsible for accelerating mineral exploration activities in the country. He has authored more than 47 unpublished geotechnical reports of GSI. Presently, Sh. Pradeep Singh is holding the prestigious position of Director (Tech) in Ministry of Mines, Govt. of India, New Delhi.

E-mail: gsitisaketi@gmail.com

Ramesh K. Chauhan

Vice President
AGM/Chief Geologist, SJVNL, Nepal

M.Sc. (Geology)

Sh. Ramesh K. Chauhan started his professional career in 1987 as geologist in HPSEB. Subsequently, he joined SJVNL in 1994 as Assistant Geologist at Nathpa Jhakri HE Project. Working in various capacities at different hydro power projects of SJVNL viz., Nathpa Jhakri, Rampur, Kholongchuu etc., Sh. Chauhan gained thirty three years of rich experience in engineering geology. He was involved in investigation and construction stage geological and geotechnical work of these projects. He has done extensive geotechnical mapping of dams, tunnels, power house complex, 3-D geological mapping of drifts, core logging of drill holes data. Interpretation of geological data and submitted reports to design office for designing the support system of tunnel, dams etc. Sh. Chauhan was involved in planning, proper installation and supervision of monitoring and data collection from geotechnical instrumentation at Rampur hydroelectric project. He was involved in preparation of DPR (Geological Chapter) and comprehensive geotechnical reports for bidding of the contracts. He also authored several technical papers presented at various national and international forums. Presently, Sh. Chauhan is heading geology department of Arun-3 HE Project (900MW)in Nepal which is under construction stage.

E-mail: chauhanrk61@gmail.com

S.L. Kapil

Vice President
Executive Director (Geo-tech & PID), NHPC Ltd., Faridabad

M. Tech (Applied Geophysics), IIT-Roorkee, 1984
M.B.A. (Finance), IMT (CDL), Ghaziabad

Shri Kapil started his career in 1985 with Punjab State Tube well Corporation. Working with NHPC since 1987, he has over 33 years of insightful experience in the areas of project investigation & management, site operations, introduction of new technologies for investigation and execution of consultancy assignments. Credited with introduction of several new technologies in NHPC like tunnel seismic prediction, resistivity imaging, vibration monitoring studies for optimum blasts design and resistivity imaging for earth mat design for power plants, he has introduced in-house data processing capabilities in seismological studies and developed Real Time Seismic Data Centre for online earthquake monitoring. Prepared PFR for geothermal energy development for Tattapani and Puga geothermal fields and ranking studies of all geothermal fields of India in association with Geothermax Inc., USA. Travelled extensively to countries like USA, France, Finland, Netherland, Thailand, Myanmar, Bhutan & Nepal for execution of projects, transfer of technology and attended seminars/conferences. Authored more than 200 technical reports for DPR and 26 technical papers on investigation & construction related activities of hydro projects. Presently, Sh. Kapil is Executive Director, NHPC holding charge of Engg. Geology & Geotechnical Division and additional charge of Project Investigation Division as HoD.

E-mail: shyamkapil@gmail.com

Nihar Ranjan Bhattacharjee

Joint Secretary
Director, Geological Survey of India, CHQ, Kolkata

M.Sc.(Geology), Banaras Hindu University

Sh. Nihar Ranjan Bhattacharjee, joined Geological Survey of India (GSI) from 2000 UPSC Batch having M.Sc Geology degree from Banaras Hindu University (BHU). His 14 years illustrious service comprised working in mega hydroelectric projects viz., Tehri, Koteshwar, Maneri Bhali Stage II, Loharinag Pala, Jamrani, Mitigation of Varunavat landslide (Uttarakhand), Pahari dam, Lahchura dam, Pahuj dam, Matatila dam (South UP), Suntaley dam, Kalejkhola dam (Sikkim), Turga pump storage project, Kalimpong water supply scheme, investigation of Tindharia landslide (West Bengal), Kharkai dam project (Jharkhand), Khudirampur project (Andaman) and Punatsangchhu HE project (Bhutan). He is presently holding the post of Director, CHQ, Kolkata entrusted to coordinate for the Disaster Management Plan of GSI; nodal officer for monitoring the construction of State of Art New Director General GSI Building and managing the entire finance of GSI to carry our multifarious activities and projects including Engineering Geology, Landslide and earthquake related studies being carried out by GSI from national perspective.

E-mail: nrbhattacharjee@gmail.com

Vachaspati Pandey

Joint Secretary
Senior Manager (Geology), NHPC Ltd., Faridabad

M. Sc. (Applied Geology), University of Allahabad, 1996
M. Tech. (Energy Sc. & Tech), Jadavpur University, 1998

Sh. Pandey is having more than 18 years of experience in engineering geology, execution of geotechnical investigations for hydropower projects, including geophysical and construction material surveys during survey & investigation, pre-construction and construction stages. He specialized in analysis of geological data for civil design, slope stabilization, tunneling & blasting techniques for different types of media, rock & soil stabilization & support analysis, dam foundation, treatment for weak rock mass, soil treatment, DPR preparation etc. Associated during investigation/ construction of Parbati Stage-II (800 MW), Parbati HEP Stage III (520 MW), Chamera HEP Stage III (231 MW), Mangdechhu HEP (720 MW), Kuri Gongri HEP (2640 MW), Chamkharchhu HEP Stage-I (770 MW) and Dibang Project (2880MW). Sh. Pandey to his credit, has presented several technical papers at various national and international conferences. He was earlier elected to ISEG council during 2018-19 term as Council Member. Since 2018, he is posted at Engg. Geology & Geotech Div., NHPC Ltd. CO, Faridabad.

E-mail: vpnhpc@yahoo.com

Dr. Mridul Srivastava

Treasurer
Suptd. Geologist, GSI, Dehradun

M.Sc, Lucknow University
Ph.D, Lucknow University

Dr. Srivastava has about twenty year experience in field of engineering geology and geotechniques. He has worked extensively for various civil engineering projects located in south eastern UP, Bundelkhand and Uttarakhand Himalayas. Having contributed to various activities of ISEG as council member in the past, he is presently holding the post of treasurer in the society. Having published technical papers in various workshops/symposiums and conference proceedings he has about eleven numbers of research papers published in various journals of national and international repute.

E-mail: aaradhy4712@gmail.com

"What you think, you become. What you feel, you attract. What you imagine, you create."

-Buddha

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AN INTRODUCTION TO ISEG COUNCIL FOR 2020-21 TERM

Rahul Khanna

Editor

Senior Manager (Geology), Parbati Stage-II HE Project, NHPC Ltd, H.P.

M. Tech (Applied Geo.), IIT-Roorkee, 1996
PGDCA, Institute of Engg. & Technology, Lucknow, 2000

Professional experience of 23 years. Started career in 1996 as Geo-logging Engineer on Marine-201 offshore oil/gas exploration rig. Subsequently, during 1997, he joined RSAC, Lucknow as Project Scientist. He started working in NHPC Ltd. at Siang Basin Projects, Arunachal Pradesh as Trainee Officer in 2001. Involved with geotechnical investigations for preparation of DPR 's of Siang & Subansiri basin Projects. Posted at Dibang Project for DPR/ Post DPR investigation works. Carried out geological mapping of 42km long reservoir area. Involved in preparation of PFR 's of 10 hydropower projects of Dibang valley under Prime Minister 's 50,000 MW initiative. Worked at Parbati HE project, stage-III during active construction phase, involved with geotechnical work of dam, cut-off wall and HRT. At CO, worked in PID and EG divisions, involved with D & E Consultancy work of Mangdechhu HE Project, Bhutan, CMS work of Shwezaye HE project, Myanmar. Involved with additional insitu rock mechanics testing at project site and preparation of updated DPR of Dibang project. Carried out in-house laboratory rock mechanics testing for number of projects. Posted since 2017 at Parbati-2 HE Project, worked at Pulga dam site for dam curtain grouting and fossil valley treatment. Presently involved with TBM works of HRT, which is in critical phase of construction, in this project of national importance. Served ISEG as Jt. Editor and then as Editor for three consecutive terms. Twice recipient of ISRMTT "Best Paper Award." Published about 20 technical papers in various conference proceedings and journals.

Email: isegpapers@gmail.com, rahulgeo05@gmail.com

Prof. K. S. Rao

Past President

Professor, Dept. of Civil Engineering, IIT-Delhi, New Delhi

M.Sc, Andhra University, 1978
M.Tech., IIT-Kanpur, 1980
Ph.D, IIT-Delhi, 1984

Prof. Rao 's research spanning over 36 years has been on engineering behaviour of rock mass, stability of slopes, underground structures, foundations, site characterization, numerical modelling, seismic micro zonation of megacities and impact & blast loads on tunnels. An established teacher, researcher and consultant, he is recipient of IGS – Prof. Leonards Best Ph.D thesis award and 13 other IGS best paper awards and ISRMTT best research award, he is a prolific writer having more than 350 technical papers published in national and international journals and conference proceedings. He has designed and developed a large scale Polyaxial testing facility, Impact facility and direct shear apparatus at IIT-Delhi. He has travelled extensively and collaborative research with New Castle, Glasgow and Strathclyde, Western Australian Universities. He is member of several technical committees (TC 's and ATC 's, BIS, CSIR & DST) and academic boards. Prof Rao is Fellow of Indian Geotechnical Society and as its Honorary Secretary for 10 years and President for 2011-12 term. He has also been guest Editor for "Defence Science Journal" and regular peer reviewer for several Int. journals. He has been Principal Investigator of 12 sponsored research projects and carried out 320 consultancies in the areas of soil and rock mechanics and rock engineering. He provided solutions for many projects executed by DMRC, NTPC, NHPC, GMR, GVK, L&T, Power Grid, KRCL, Mott. Mc., JP, GATI, Energy Infratech, NWDA, Reliance, Vedanta, IRCON, Northern Railway, DLF etc.

E-mail: raoks@civil.iitd.ac.in , raoks.iitd@gmail.com

M. Raju

Council Member

Director General (Retd.), GSI, Kolkata

M.Sc. (Geology), Andhra University

Shri Raju joined GSI in 1980, working in Engineering Geology for last 40 years has carried out geotechnical investigation of large number of water resources projects in the Himalayas and peninsular India. He has contributed to geotechnical studies at Srisailam left bank underground HE project, a major assignment in which massive excavation was involved for locating underground powerhouse complex and pressure tunnel system. The work was highly appreciated by consultants of the world bank and OECF, Japan the funding agencies. Given noteworthy contribution for Nagarjunasagar left canal HE project, Yeleru reservoir project, Telegu Ganga project dam foundation etc. Associated with geotechnical investigations of Vishnu Prayag HE project and other river valley projects located in Alaknanda and Dhauliganga valleys in the Himalayas. He has worked out a novel method of landslide hazard zonation by using geocoded IRS imagery. At Central Headquarters of GSI, associated with monitoring of assignments pertaining to Engineering Geology and Landslide studies. Also, associated with the Engineering Geological investigations being carried out in Bhutan and Nepal. As Head of the Department in Eastern Region, Kolkata, associated with mineral resource developmental activities in states of West Bengal, Bihar, Jharkhand and Odisha. Appointed as the Director General, GSI in June, 2016, he lead this great organisation till his superannuation on 31st August, 2017.

E-mail: geolraju@gmail.com

Akhouri Bishwapriya

Council Member

Director, GSI, Patna

M. Sc (Geology), Delhi University, 1998

Joined GSI in 2000, has more than thirteen years of experience in Mission IV activities including engineering geology, natural disaster involving landslides, mass wasting processes, extensive river bank erosion, earthquakes (Seismic Micro zonation and Microseismal survey) etc. Have worked in Himalayan terrain for several hydroelectric projects namely Tehri, Koteshwar, Maneri Bhali, Sarju valley, Tons valley projects of Uttarakhand; Lakheri, Bansagar, Pahuj, Bhaoni in Uttar Pradesh and Punasangtchu, Stg II and Damcchu- Chhukha Bypass road alignment project in Bhutan. Conducted macro seismic survey in the aftermath of Sikkim (2011), Nepal (2015)& Manipur (2016) earthquakes and Detailed Seismic Microzonation studies of Patna agglomeration. Landslide studies in parts of Pithoragarh district after the natural disaster of June, 2013 & National Landslide Susceptibility Mapping in Uttarakhand as a spin off high priority programme. Off late involved with studies in Ganga Basin and parts of North Bihar particularly for Arsenic contamination in ground water. Worked in Technical Coordination Division. Developed a geogenic model which explains the Arsenic contamination in North Bihar plains. Working in field of Geotourism and have developed as a team an audio visual documentary on the aspect of Geotourism in Gaya, Jahanabad and Rajgir area named "Signatures in Time".

E-mail: akhouri123@rediffmail.com, akhouri123@gmail.com

Vipul Nagar

Joint Editor

Senior Manager (Geophysics), EG Division, NHPC Ltd, Faridabad

M.Sc. (Tech.) in Geophysics, Banaras Hindu University, 2000

Sh. Vipul Nagar joined NGRI, Hyderabad in 2000 and involved in groundwater exploration & management studies. In 2001 he joined Indian Institute of Geomagnetism, Mumbai as Project Scientist, where he worked on Magneto telluric and co-seismic studies. Since January 2004 he has been working in NHPC Ltd. where he specializes in geophysical data acquisition, processing and analysis for various hydroelectric projects. Actively involved in preparation of more than sixty geophysical reports (Seismic Refraction, 1-D Resistivity, Resistivity Imaging, Multichannel Analysis of Surface Waves, Inclinometer monitoring studies, Blast vibration monitoring, Tunnel Seismic Prediction etc.) in NHPC. Apart from Geophysical assignments, he is also involved in seismological studies such as Micro-earthquake studies and maintenance of Real Time Seismic Data Center. He is also handling Geotechnical Remote Sensing Lab established in the Engineering Geology & Geotech. Division of NHPC Limited. He has authored more than fifteen technical papers in various national and international forums.

E-mail: vipul.nhpc@gmail.com

Dr. Saibal Ghosh

Past Secretary

Director, EPE Division, GSI, New Delhi

M.Sc. (Applied Geology), IIT, Kharagpur,1991
M.Tech. (Applied Geology), IIT, Kharagpur,1993
Ph.D., University of Twente, Netherlands, 2011

Dr. Ghosh started his professional career in GSI as Geologist in the Central Geological Services (Group A) since June '94 after qualifying the UPSC 's Geologists' Examination-1991. During his 24-year long professional career in GSI, he was associated with a number of geotechnical and landslide investigation programmes in the North Eastern and Eastern Himalayas of India & Bhutan as a consultant engineering geologist and landslide expert. He has a long experience in working for both the DPR and Construction-stage geotechnical investigations of major hydro projects in the Himalayas. In the field of landslides, he played a pivotal role in GSI for launching the national programme on landslide susceptibility mapping (NLSM) in 2014 and coordinated the entire effort of GSI by mentoring 100 young GSI geoscientists on a national mission, being the head of the *Geohazards Research & Management (GHRM) Centre*, GSI, CHQ, Kolkata between 2013 and 2017. Dr. Ghosh has also been involved in site specific investigation of at least 15 major landslides in Darjeeling-Sikkim Himalayas and suggested effective remedial measures to BRO and the State Government. He has published more than 20 research articles in various national and international peer-reviewed journals, a few book sections, special publications and also attended many national and international workshops/ symposiums as *lead key-note* speaker. He is a regular reviewer of the leading international peer-reviewed journals such as *Engineering Geology, Catena, Geomorphology, Bull. Engg. Geol. of the Environment, Jour Geol. Soc. India, Ind. Jour. Geosc., Current Science* etc. Currently, as Director, EPE Division, GSI, he is involved in technical evaluation of the geology and geotechnical aspects of major hydro projects of India, costing more than 1000 Crores as one of the appraising authorities of Central Electricity Authority (CEA). He is also working as Convener, Science Program Committee, 36th IGC 2020.

E-mail: *saibal.ghosh.gsi*@gov.in

Arindom Chakraborty

Council Member

Senior Manager (Geology), Engg. Geology Division, NHPC Ltd., Faridabad

M. Tech (App. Geology), IIT Roorkee, 2000
MBA (Spl.- Business Development), Sikkim Manipal University, 2009
Certification in Project Management, PMA, 2010

Sh. Arindom Chakraborty joined NHPC Ltd. as an Executive Trainee in 2001 at Engineering Geology and Geotechnical Division, Faridabad. Having about 19 years of experience in the field of geological & geotechnical Investigations for hydropower projects. Till date, actively associated with PFR/FR/DPR/ Construction stage geological works of more than 30 HE projects. Presently, he is posted at Engineering Geology and Geotechnical Division, NHPC Corporate Office, Faridabad and supervising geological works of Teesta-VI Project, five number hydropower projects of Sarda Valley basin Uttarakhand (2 in DPR stage, 3 in PFR stage) out of which DPR of 150 MW Goriganga-IIIA has already been submitted, consultancy projects in India and Nepal/Bhutan and as Technical Officer to HOD, providing managerial supervision of all the ministerial, intra and inter departmental technical queries, compliance reports and administrative works of the Division. He was the recipient of Exemplary Commitment Award by NHPC in 2017 due to his dedicated services during DPR preparation and submission of Goriganga-IIIA Project. His area of interests includes geological mapping, rock mass characterization, in situ and laboratory rock mechanics studies, hydrogeological studies, software applications in engineering geology. He is an active member of ISEG and previously officiated as Joint Secretary, ISEG for two consecutive terms (2016-17 & 2018-19). He made significant contributions in successfully organizing major ISEG events EGNM-2015, EGCON-2017 and EGCON-2018. He is also a member of IAEG, ISRM and ISRMTT, IGS & INHA. He is nominated committee member from NHPC for WRD-5 of BIS. He has authored and presented about 20 number technical papers in various national and international symposia/workshop/conferences.

E-mail: achakrabortynhpc@gmail.com, arindom2000@yahoo.com

Sunil J. Ganvir

Council Member

Senior Manager (Geology), Engg. Geology Division, NHPC Ltd., Faridabad

M.Sc. (Tech) in Applied Geology, Nagpur University, 1999

Joined NHPC in 2001, Sh. Sunil J. Ganvir have vast experience of 20 Years in the field of Engineering Geological investigations for hydropower projects. He had worked extensively in Uri-II, Kishanganga, Indira Sagar, Chamera-III, Baira Siul, Sewa-II and Rangit projects. Rendered geological/geotechnical consultancy on behalf of NHPC to number of hydropower projects owned by State Govt., Public and Private Sectors. Looking after the major portions of the consultancy assignments for EG Division from time to time. Provided/providing geological inputs in resolving issues being cropped up at NHPC Power Stations through periodic dam safety inspections and discussion with Design and Power Station authorities and to submit dam safety inspection reports in proper format to CWC. Presently he is life member of ISEG, ISRMTT, IAEG and ISRM-India. He is recipient of "Best Paper Award" from ISRMTT during October 2017 and also at EGCON 2018 organized by GSI & ISEG at Hyderabad during December 2018.

E-mail: kshitisun@yahoo.co.in

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AN INTRODUCTION TO ISEG COUNCIL FOR 2020-21 TERM

Dr. Neelima Satyam

Council Member
Associate Professor & Head DoCE, IIT-Indore

B. Tech, SV University, Tirupati, 2000
M. Tech, IIT Delhi, 2001,
Ph. D, IIT Delhi, 2006

She worked as Assistant professor in Earthquake Engineering Research Centre, IIIT Hyderabad before joining IIT Indore. She was visiting researcher at University of Stuttgart (2018) and at University of Tokyo (2013). She received research grants from DST, MHRD, AICTE, ITRA, DAE, NIOT, NRDMS, ISRO and MoES. She published 133+ papers in International/ National Journals and Conferences. She was actively associated with IGS Hyderabad chapter in organizing short courses/workshops and presently active with IGS Indore Chapter.

E-mail:neelima.satyam@gmail.com

Dr. Ashit K. Swain

Council Member
Supdt. Geologist, GSI, Gangtok

M.Sc (Applied Geology), University of Allahabad
Ph. D. (Geology), Ravenshaw University

Started working at ISI from 1997, Dr. Swain joined GSI in 2001. From 2006 to 2017, he worked in Antarctica and Polar studies divisions of GSI. He is having eleven years of rich experience in Polar sciences in the Polar regions including Antarctica, Arctic and the Himalayas especially in glaciology, geomorphology, quaternary sciences. He also worked in the project related to special thematic mapping in GSI, Operation: TNPK, Chennai on large scale mapping on 1:25000 scale in Sothern Granulite Belt in and around Tenkasi-Rajapalayam lying to the north of Achankovil lineament to understand the tectono-magmatic evolution of this part of the Southern granulite belt. Presently, he is engaged in Geoscientific studies in Sikkim for societal issue related projects, particularly on landslide investigation undertaken by Geological Survey of India, State Unit: Sikkim, Gangtok. He is recipient of prestigious National Geoscience Award 2017 received from Hon'ble President of India on 16th May 2018. Received 1st Prize for best paper presentation in EGCON-2018 conference at Hyderabad in December, 2018.

E-mail: swain21@gmail.com, ashit.swain@gsi.gov.in

Satish K. Goyal

Council Member
MD, Spargeo Infra Pvt. Ltd., New Delhi

Graduate from Rajasthan University, 1991

Sh. S. K. Goel has more than 30 years of experience in designing geotechnical works like shoring/slope protection, anchoring, soil nailing, grouting, diaphragm wall, sheet piling, tunneling etc. for hydro projects, metro rail projects and civil engineering works for solar projects. He is holding proven skills in effectively managing multiple tasks, often under pressure and within time constraints. He worked for eminent clients like L&T, SEW Infrastructure Ltd, SOMA Enterprise, ABIR Infrastructure Ltd., etc.

E-mail ID: skgoyal@spargrp.com

Sebabrata Das

Council Member
Senior Geologist, Geological Survey of India, Dehradun

M. Sc (Applied Geology) IIT-Mumbai

Joined GSI in 2010, Sh. Das has ten years experience in landslide monitoring, disaster management and geochemical investigations. Mostly his work area are Uttarakhand and Arunachal Pradesh. He has authored more than five technical papers in national and international journals/conferences. He has undergone extensive training on numerical modeling of landslide analysis and mitigation. Presently, he is holding the position of Senior Geologist at GSI, Jammu region.

E-mail: sebabratadas@hotmail.com

Amitabh Sharan

Council Member
CEO, EGE Consultant, Faridabad

M.Sc. (Geology), Vinoba Bhave University, Hazaribag, Jharkhand

Sh. Amitabh Sharan has 18 yrs. of experience in engineering geology, planning & execution for geotechnical investigations for hydropower projects, collection of geotechnical field data & their analysis for civil design, slope stabilization studies, tunneling & their blasting techniques for different types of media, rock & soil stabilization & support analysis, dam foundation studies, treatment for weak rock mass, soil treatment studies, geotechnical analysis etc. He is having rich experience of working in NHPC Limited, Reliance Energy, SNC Lavalin, AIMIL Ltd and APEX Geotech. Engineers (AGE). He also worked as a Consultant for Uttarakhand road projects and three small hydro projects in Myanmar. Presently he is CEO, EGE Consultants and handling preparation of Detailed Project Report activities, submergence related issues and construction activities of hydropower projects. Leading the business development and geology team at EGE Consultants.

Email: ege.consultant@gmail.com

Dharmendra Kumar

Council Member
Senior Geologist, GSI, New Delhi

M.Sc (Tech), Geology, Banaras Hindu University

Before joining GSI in 2012, Sh. Dharmendra Kumar worked as Deputy Manager (Civil/Geology) at IRCON International Ltd., PSU of Ministry of Railway in Jammu Kashmir Rail Link Project, Banihal, J&K. In GSI, he gained rich experience in geological mapping, landslide hazard and geotechnical investigations for infrastructure projects. He has published eight technical papers in various national and international forums. He is recipient of ISEG President award for Best Paper at third position in EGCON-2017 organized by ISEG at New Delhi.

E-mail: dharmendra.kumar@gsi.gov.in, dpandey025@gmail.com

ISEG DELHI NCR CHAPTER MEMBERS (TERM 2020-21)

Saikat Pal

Convener
AGM, Engineers India Ltd. (EIL), New Delhi

M.Sc. University of Calcutta , 1993
M.Tech (Applied Geology), IIT-Kharagpur, 1996

Sh. Pal has vast experiences of more than 16 years in underground investigations and excavations. A graduate from Presidency College, Kolkata, he started his professional career in 1996 with OFI Ltd. as Geo-logging Engineer in onshore/ offshore oil and gas exploration fields of India and Bangladesh. In 2002 joined NHPC and worked as Geologist and Assistant Manager (Geology) in Arunachal Pradesh, Bhutan & Corporate Office, Faridabad associated with investigation and construction of hydro power projects at Uttarakhand, H.P., Arunachal Pradesh and Bhutan. Joined EIL in 2010 for handling engineering geological aspects of underground crude oil storage caverns. Life member of ISEG, ISRMTT and Indian Geological Congress (IGC), member of IAEG. Having published more than 15 technical papers in various national Journals and international/ national conferences, also authored two chapters for the book on "Underground space technologies" published by EIL. Received Best Paper Award at EGCON-2017 & 2nd Best Paper Award at EGNM-2015 for paper published in Journal of Engineering Geology. Received prestigious "National Geoscience Award" (Team) from the honourable President of India for the year 2016, in the field of Applied Geology (Engineering Geology).

Email: saikat.pal@eil.co.in

Prashant Rai

Treasurer
Senior Manager (Geology), NHPC Ltd., Faridabad

M.Sc. (Applied Geology), University of Allahabad, 2001

He joined NHPC Limited in Jan-2004 at Parbati Project Stage-II. He had been posted during the construction of Nimoo Bazgo, Chutak, and Parbati-III Hydroelectric Project and Tamanthi Multipurpose Project Myanmar for Geological & Geotechnical Investigation works and preparation of DPR. Subsequently he was posted to EG division at NHPC Corporate Office. Later on he was posted to Sharda Valley Basin Project for geological investigation and compilation & submission of DPR. Presently he is working as Senior Manager (Geology) in Engineering Geology & Geotechnical Division, NHPC Corporate Office Faridabad. Shri. Rai has also completed MBA with specialization in Operations.

Email: prashantrainhpc@gmail.com

A. P. Singh

Co-Convener
Director, Explore Engineering Consultant Private Ltd., Delhi

B. Tech (Civil), REC-Calicut, 1992
M.E (Geotechnical Engineering) Gold Medal, IIT Roorkee, 1996
PhD, IIT Delhi

Sh. Singh is a hard-core professional serving the field of geotechnical engineering for the last 20 years as a Consultant. In 1998 he started a Geotechnical entrepreneurship 'Explore Engineering Consultants Pvt. Ltd.' in Delhi. Since then the firm has provided consultancy services for more than 2000 engineering & infrastructural projects. He has an impressive success record of solving various geotechnical problems and satisfying a wide variety of client's requirements. Before starting his own geotechnical venture, he had also worked for hydropower sector that provided him with solid foundation of this subject. His passion for learning has motivated him to complete PhD from IIT Delhi. His field of research work is rock socketed piles. His paper on numerical analysis of rock socketed piles subjected to combined vertical and horizontal load has been published in EUROCK 2017 symposium. He has been associated with various geotechnical societies as life member of IGS, ISRMTT, IRC, ISEG and member of ISRM. He has shown his leadership quality throughout his professional life.

E-mail: apsingh.grg@gmail.com

Ajay Singh

Council Member
Senior Manager (Geology), NHPC Ltd., Faridabad

M.Sc. (Applied Geology), Allahabad University, 1996
M. Tech (Petroleum Exploration), IIT (ISM), Dhanbad, 1998

Sh. Ajay Singh has more than 18 years of rich experience in the field of engineering geology. He is presently working as Sr. Manager (Geology) at Engg. Geology & Geotechnical Division, NHPC Ltd Faridabad. As an Engineering Geologist, he has worked in various projects of NHPC Ltd viz., Dhauliganga HE Project (Uttarakhand), during its construction phase while in Lakhwar- Vyasi (Uttarakhand), Kiru, Kwar, Ratle, Pakal Dul and Bursar HE Projects (J&K) during their investigation/ DPR stage. He was involved in DPR & Bid document preparation of said projects of Chenab and Marusudar basin.

Email: as1974.nhpc@gmail.com

REPORT ON ANNUAL GENERAL BODY MEETING OF ISEG HELD ON 11.01.2020

Annual General Body Meeting of the ISEG was held on 11th January 2020 at NHPC Ltd, Faridabad under the Chairmanship of Prof. K.S. Rao, president, ISEG 2018-19 and Sh. A.K. Singh, President, ISEG 2020-21.

Prof. Rao welcomed all ISEG members, past presidents, Vice Presidents, Secretary and Council members from the outgoing council and also newly elected team of ISEG Council headed by Sh. A.K. Singh, president and Sh. S.L. Kapil, Secretary, ISEG. He expressed his satisfaction on the targets achieved in the last two years of outgoing council's tenure and wished that the newly elected council shall work towards the fulfillment of the other targets. He congratulated the members for on-time publications and thanked members for devoting their valuable time for the progress of the society. Prof. Rao thanked Sh. M. Raju for his support in successful organizing of three day conference (EGCON-2018) at Hyderabad during December 2018. He expressed his sincere gratitude to Sh. R.N. Misra for his untiring efforts for arranging financial support for the conference and complimented senior members like Dr. Gopal Dhawan and Shri Y. Deva for being the guiding lights of the society.

Dr. Saibal Ghosh, Secretary ISEG presented the Secretary's Report on "Progress and Financial Status of ISEG" for the period of 2018-2019. He informed regarding the induction of 30 new life members and 77 and 100 members during 2018 and 2019 respectively for IAEG. All IAEG bulletins are accessible online and the IAEG members can collect the pass codes from Editor, ISEG. He also briefed about the publications and editorial activities. He told that as per decision of ISEG Executive Council, all journals are being published as e-journal only. In the end of his address, Secretary, ISEG placed the financial report of 2018-19 and status of income and expenditure till 31-12-2019.

Prof. K.S Rao, President, ISEG 2018-19 formally handed over the charge to Sh. A.K. Singh, President, ISEG 2020-21 by handing over ISEG Presidential Shield. Subsequently, Sh. A.K. Singh welcomed all ISEG members including past Presidents, Vice Presidents, Secretaries and other veterans and council members. He expressed his gratitude for providing him opportunity to serve this prestigious society as its President. He assured his full support and cooperation in raising endeavour of the society through new heights.

During AGM, the vacant posts in the ISEG council were filled by nominating members by Secretary, ISEG. The nominations were accepted unanimously for one each post of Jt. Secretary, Jt. Editor, Council Member respectively. Beside post bearers of ISEG Delhi-NCR chapter were also nominated.

Shri S.L. Kapil, Secretary, ISEG 2020-21 delivered a presentation on "Application of Advanced Technologies for Optimization of Geotechnical Investigations in Hydro/Infra projects". Subsequently, eminent senior members of ISEG, Dr. Gopal Dhawan, Shri R. N. Misra and Sh. Y. Deva were felicitated by Present and outgoing Presidents. All the members of outgoing Council 2018-19 were felicitated by President, ISEG 2020-21 and other senior members. The AGM ended with vote of thanks rendered by Secretary, ISEG.

The detailed MoM is available on ISEG website www.isegindia.org.

IN-SITU STRESS MEASUREMENT IN HYDROELECTRIC PROJECTS AND THEIR CORRELATION WITH WORLD STRESS MAP

S. L. Kapil
Executive Director & HoD
Engg. Geology & Geotech. Division,
NHPC Limited, Sector-33, Faridabad, Haryana

Vipul Nagar
Senior Manager (Geophysics)
Engg. Geology & Geotech. Division,
NHPC Limited, Sector-33, Faridabad, Haryana.

INTRODUCTION

It is well known that the stress in rock mass is a factor of the utmost importance for the behaviour of underground structures constructed in it. The in-situ stresses directly influence any opening or structure and may cause extensive damages if not taken care of during the design stage. Bielenstein and Barron in 1971, proposed the following definitions for various types of stresses possible under the single terminology ***"in-situ stress"***.

(i) The natural stresses field can be composed of gravitational stresses (due to the mass of overburden), tectonic stresses (due to tectonic events) and residual stresses (mean stress components that remain in the structure even if external forces are removed).

(ii) Tectonic stresses may be active tectonic stresses (due to the active present day straining of the earth's crust) and remnant tectonic stresses (due to past-tectonic events which have only been partially relieved by natural processes).

Since the stresses depend on factors such as the weight of the overlying formations and forces associated with the geological history of the rock mass such as genetic, orogenic and erosive actions, they are influenced by lithological, structural and topographic patterns. Accurate assessment of the stresses is important and generally made through in-situ measurements using hydro-fracturing tests. In the present article, an attempt is made to correlate the results of in-situ tests conducted at some of the hydroelectric projects with the World Stress Map. World Stress Map is a highly valuable effort and can be used in assessment of Principal Horizontal in-situ stress directions.

IMPORTANCE OF WORLD STRESS MAP

The World Stress Map (WSM) is a collaborative project between academia and industry commenced in 1984 aims to characterize the crustal stress pattern and to understand the stress sources. It has a global compilation of information on the crustal present-day stress field maintained since 2009 at the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences.The World Stress Map project offers free access to global stress database kept in public domain (Fig.1). The database is not only helpful in academic researches but also for commercial utilization. In underground constructions, the long axis of the cavern generally kept parallel to the direction of principal horizontal stress. Hence, big caverns and tunnel scan be oriented in suitable directions as per the WSM data. Thus, in the absence of any in-situ stress measurements, the world stress map can be used as a preliminary guideline for designing underground structures.

The Himalayan region is tectonically very active. The magnitude of tectonic horizontal stress vary considerably depending upon geographical region, geological environment and distance from main tectonic features, in particular, the distance from Main Boundary Thrust (MBT) and the Main Central Thrust (MCT) (Panthi 2011).

The distribution of in-situ stresses in terms of magnitude and orientation affects the geometry, shape, dimensioning, excavation sequence and orientation of underground openings/caverns. In hydroelectric projects, in-situ stress measurements are performed for optimization of alignment of powerhouse caverns and other structures based on direction of the principal horizontal stress.

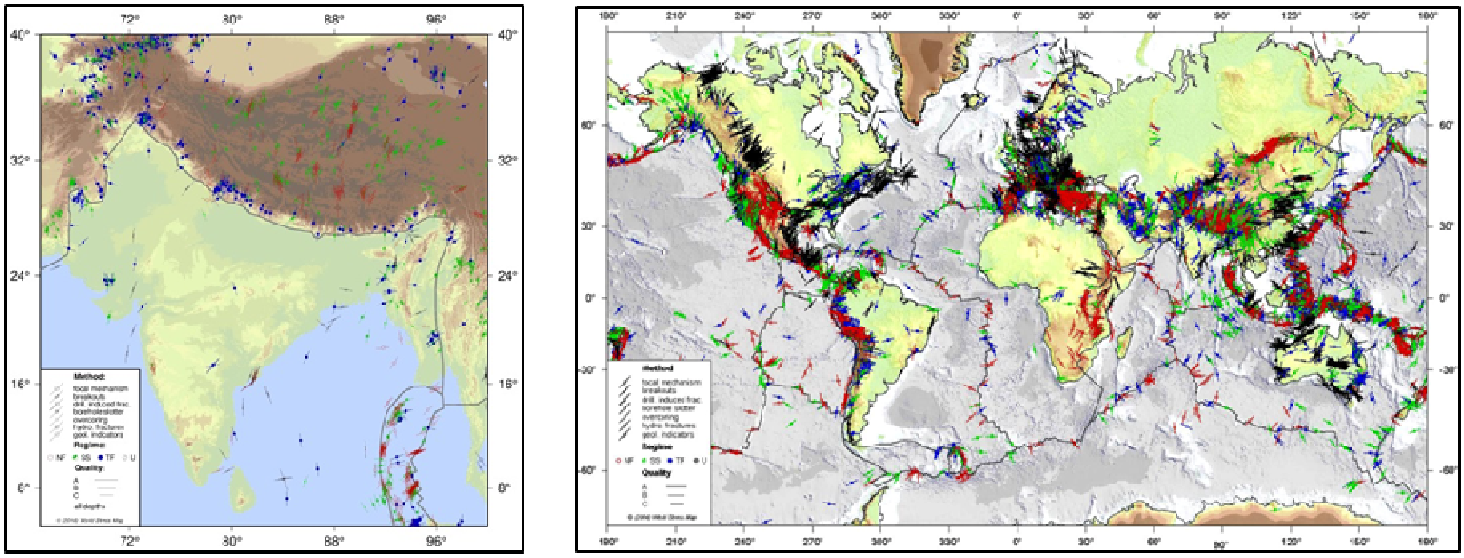

Figure 1 Stress Map of India and World Stress Map (WSM–2016, GFZ, Germany)

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Table 1
Results of in-situ measurements carried out at hydroelectric projects

Project Name	Vertical Stress (σ_V)		Major Horizontal Stress (σ_H)		Minor Horizontal Stress (σ_h) in MPa	Ratio σ_H / σ_h	Stress Ratio $K_{AV} = (\sigma_H+\sigma_h)/2\sigma_V$
	Magnitude (MPa)	Overburden Cover (m)	Magnitude (MPa)	Direction			
Kiru HEP, J&K	3.74	140	5.5	N50E	3.5	1.58	1.20
Kwar HEP, J&K	5.28	200	9.1	N60E	5.5	1.65	1.38
PakalDul HEP, J&K	6.00	225	12.0	N65E	3.5	3.43	1.29
Dulhasti HEP, J&K	7.15	270	10.4	N70E	5.4	1.92	1.10
Baglihar HEP, J&K	7.72	292	9.9	N50E	6.3	1.60	1.05
Dugar HEP, HP	5.16	200	23.4	N49E	12.8	1.82	3.52
Such Khas HEP, HP	2.04	75	10.8	N65E	5.4	2.00	3.97

In this article, an attempt has been made to correlate in-situ stress measurement results with World Stress Map database for some of the hydroelectric projects located in North-West Himalayan region. The details of in-situ measurements using hydro-fracturing method are given in Table-1.

The study area is lying between 75^0E – 77^0E Longitude and 32^0N – 34^0N Latitude. The database of World Stress Map has been prepared utilizing COSMO online support of WSM. The orientations of principal horizontal stresses evaluated using hydro-fracturing tests for projects are plotted in yellow colour and Stress vectors as per World Stress Map have been plotted in Cyan colour as shown in Fig. 2.

The direction of σ_H evaluated based on hydro-fracturing tests varies from N49E to N70E and WSM stress vectors varies from N39E to N84E range. Hence, it can be interpreted that the range of orientations of principal horizontal stress derived from hydro-fracturing tests lies within the range of WSM.

Kiru HE Project: The hydro-fracturing test was undertaken in Powerhouse drift. As per the outcome of the study, the vertical stress (σ_V) with 140m cover and unit weight of 26.6 KN/m^3 is 3.74MPa whereas major and minor horizontal stress components (σ_H & σ_h) are 5.5MPa and 3.5MPa respectively. The average stress gradient K_{AV} is 1.2 and the direction of principal horizontal stress is estimated as N50E which is well corroborated with the directions of nearby stress vector of WSM.

Kwar HE Project: At Kwar HE Project, hydro-fracturing test was undertaken at Powerhouse Drift. The observed σ_V with 200m cover and 26.4 KN/m^3 unit weight of the rock mass is 5.28MPa. The σ_H & σ_h values are evaluated as 9.1MPa and 5.5MPa respectively. The K_{AV} value is 1.38 and the direction of principal horizontal stress is estimated as N60E. The orientation of the principal horizontal stress is in concurrence with the WSM.

Pakal Dul HE Project: At Powerhouse drift, the observed σ_V with 225m cover and 26.6 KN/m^3 unit weight of the rock mass is 6.0MPa. The σ_H & σ_h values are evaluated as 12.0MPa and 3.5MPa. The stress gradient K_{AV} is 1.29 and the direction of principal horizontal stress is estimated as N65E. The results are well corroborated with the directions of nearby stress vectors of WSM.

Dulhasti HE Project: At Dulhasti HE Project, hydro-fracturing test was undertaken at Powerhouse Drift. The observed σ_V with 270m cover and 26.9 KN/m^3 unit weight of the rock mass is 7.15MPa. The σ_H & σ_h values are evaluated as 10.4MPa and 5.4MPa respectively. The stress gradient K_{AV} is 1.10 and the direction of principal horizontal stress is estimated as N70E. The orientation of the principal horizontal stress is in concurrence with the WSM.

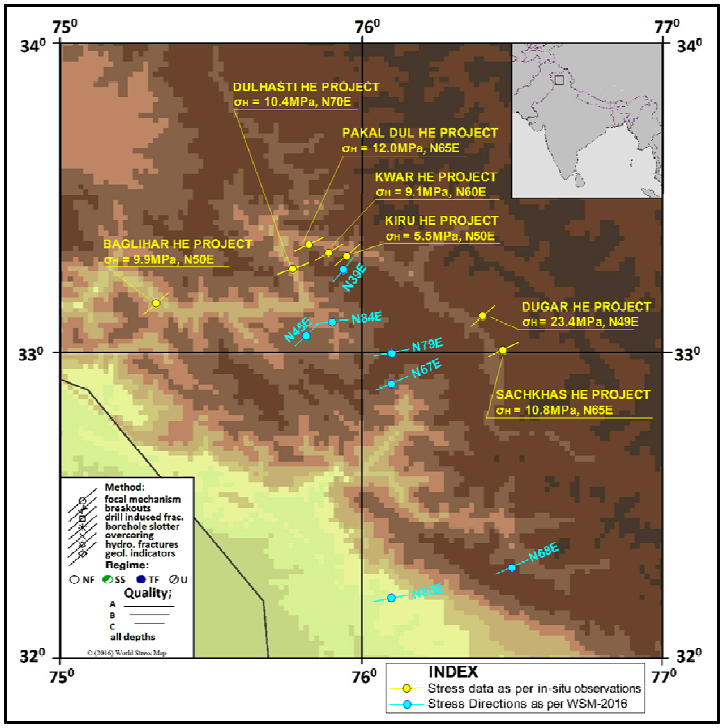

Figure 2 Direction of measured in-situ stresses of different hydroelectric projects on WSM

Baglihar HE Project: The in-situ stress test undertaken at Baglihar HE Project Powerhouse Stage-I drift. As per the outcome of the study, the σ_V with 292m overburden cover is 7.72MPa whereas σ_H & σ_h values are evaluated as 9.9MPa and 6.3MPa. The K_{AV} value is 1.05 and the direction of principal horizontal stress is estimated as N50E which is well corroborated with the directions of nearby stress vector of WSM.

Dugar HE Project: At Dugar HE Project, hydro-fracturing test was undertaken at Powerhouse Drift. The observed σ_V with 200m cover and 25.8KN/m^3 unit weight of the rock mass is 5.16MPa. The σ_H & σ_h values are evaluated as 23.4MPa and 12.8MPa respectively. The stress gradient K_{AV} is 3.52 and the direction of principal horizontal stress is estimated as N49E. The orientation of

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Sachkhas HE Project: As per the in-situ stress test undertaken at Sachkhas HE Project Powerhouse drift, the σ_V with 75m overburden is 2.04 MPa whereas σ_H & σ_h values are 10.8MPa and 5.4 MPa respectively. The K_{AV} value is 3.97 and the direction of principal horizontal stress is estimated as N65E which is well corroborated with the directions of nearby stress vector of WSM.

STESS GRADIENT AND HOEK AND BROWN CRITERIA

The average stress gradient for all the projects under review has been plotted on Hoek and Brown (1980) envelop (Fig. 3). The in-situ stress gradient is found to be lie well within the Hoek and Brown (1980) criteria corresponding to all projects.

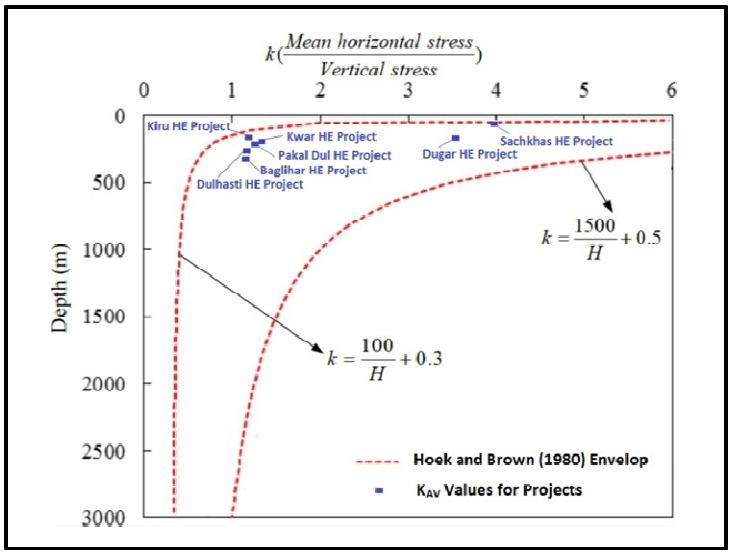

Figure 3 Plot of Average Stress Gradient on Hoek and Brown (1980) Envelop

CONCLUSIONS

The study area covers the region between 75^0E – 77^0E Longitude and 32^0N – 34^0N Latitude. In the study area, the direction of σ_H evaluated based on hydro-fracturing tests varies from N49E to N70E and as per WSM stress directions varying from N39E to N84E range. The in-situ measurement results are corroborating well with the stress directions of World Stress Map. Based on these results, it can be concluded that in the absence of any in-situ stress measurement in this region, direction of principal horizontal stress can be assessed using WSM as a guideline for fixing the orientation of underground caverns.

The in-situ stress gradients corresponding to all projects within the study area is lying well within the Hoek and Brown criteria. In most of the cases σ_H/σ_h ratio is varying from 1.58 to 2.00. Utilizing the Hoek and Brown criteria, vertical stress and horizontal stress ratio initial estimate of major and minor horizontal stress components can also be made.

The present study is confined to a limited area as per data availability. The similar study can also be extended to other areas for better understanding the horizontal stress pattern and its correlation with WSM.

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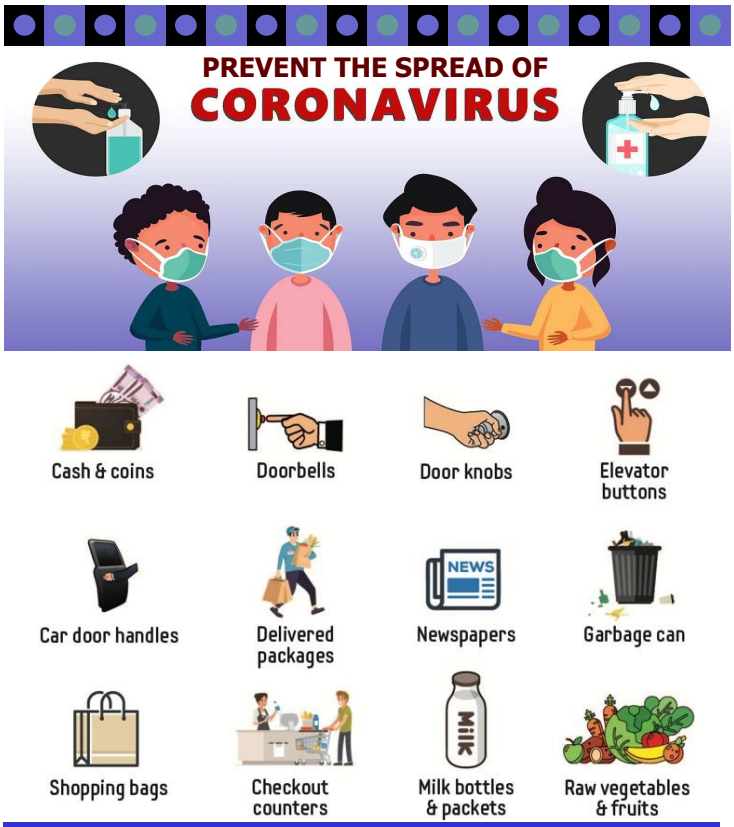


INSITU GEOTECHNICAL INVESTIGATIONS: FORTE OF NATIONAL INSTITUTE OF ROCK MECHANICS, BENGALURU (PART 2)

D.S. Subrahmanyam
Scientist & Head,
Geotechnical Engineering Division
National Institute of Rock Mechanics
E-mail:subbu3268@gmail.com

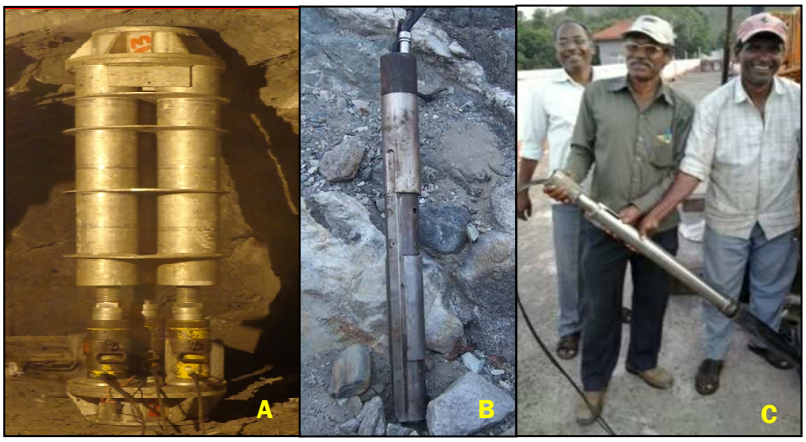


Photo 1A Plate load equipment setup for determining modulus of deformability. Photo 1B & 1C Goodman Jack and Pressure meter equipment for measuring deformability modulus inside the borehole.

In-situ Deformability Parameters

The in-situ modulus of deformability (E_m) is one of the engineering properties of rock mass. It is a basic input parameter used for the design of underground excavations viz., caverns, tunnels, shafts and foundations viz., dam, powerhouse and ventilation stack. The plate-load/plate jacking test is one of the most common methods to determine the deformability of rock mass in-situ. In this method, a load is applied to a specially prepared flat surface by means of a rigid or semi rigid finite plate and measuring the deformation at any convenient point within the rock mass. Thus, rock modulus can be calculated using the relationships developed depending on the shape of the loading plate and nature of the rock. Geotechnical Engineering Department of NIRM is having vast experience in this field to conduct these tests in-situ.

In-situ Direct Shear Parameters

The in-situ shear strength of the rock mass defined by two parameters Cohesion (c) and Internal friction angle (Φ) is an important engineering property.

Photo 2A In-situ Direct Shear test being conducted inside the tunnel
Photo 2B In-situ Direct Shear test being conducted on the surface

It is a basic input parameter used for the design of underground excavations viz., foundations and dam etc. Shear parameters of rock mass and concrete-rock interface are important parameters required for the design of the dam and in the evaluation of its stability against sliding.

Another key requirement is the shear strength of foundation joints and discontinuities. These shear strength parameters cannot be predicted based on case histories and on any classification system. Therefore, it is important to measure them *in-situ* at each site, particularly due to variation of rock mass properties at different sites. The shear strength of rock depends upon number of factors such as strength of rock, rock type, joint pattern, rate of loading, rate of shearing etc.

Geotechnical Engineering Department of NIRM is having vast experience in this field to conduct these tests in-situ.

In-situ Modulus of Subgrade Reaction of Soil (K-VALUE)

The modulus of sub-grade reaction of the soil in place usually known as K-value of sub-grade is essentially a plate bearing test for evaluation of strength of sub-grade for roads, runway pavements and raft foundations. The Modulus of sub-grade for soils of backfilled or overburden material are generally determined by plate bearing method. Geotechnical Engineering Department of NIRM is having vast experience of conducting this in-situ test.

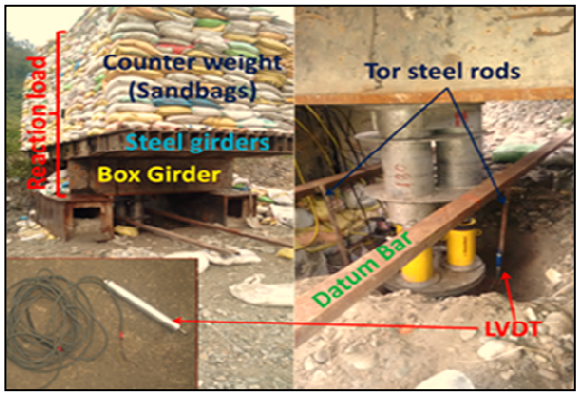


Photo 3 Modulus of Subgrade reaction of Soil tests at Teesta Low Dam project of NHPC Ltd

In-situ Safe Bearing Capacity

The bearing capacity of foundations is needed for dimensioning the foundation for any structure. The safe bearing capacity may be defined as the *"Maximum intensity of loading that the foundation will safely carry without the risk of shear failure of soil irrespective of any settlement that may occur".*

Continued on page 14

BIOGRAPHY SERIES

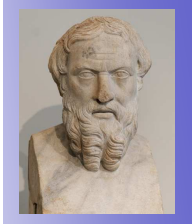
GEOLOGY BY NON GEOLOGISTS

PART 1

M. Raju
Director General (Retired)
Geological Survey of India
E-mail:geolraju@gmail.com

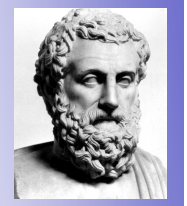
Science is universal, deal with anything and everything. In order to understand the same, one has an unbiased, logical and scientific thinking, attitude, and interest to explore beyond his spectrum of understanding. At the same time, specialization in any narrow branch of that subject is also permitted. Present way of approach in any scientific endeavor is to become a specialist in any one branch of that subject. But at the same time, one should not ignore a broad spectrum of his science, to think beyond his horizon, encroaching upon adjacent fields of science, reorient his knowledge to view the field in total with a different backdrop. Sometimes, the unbiased and unconventional approach facilitates to address some issues of the subject differently, resulting to explore new vistas of the science. It is attempted to place on record here a few such great personalities whose field of science was different, still that was not a hurdle to find/ propose new ideas in the science of Geology. As many of our present day celebrated geologists perform many other duties other than Geology, it is attempted to bring notice that there are a few non geology celebrities who excelled in their own subject besides a few landmark findings in the subject of Geology too. It is attempted here to mention a few non-geology celebrities who made specific scientific contributions in the subject of Geology. Though such personalities are rare, but the list is not exhaustive. The information is gathered and compiled from different sources.

Herodotus (484-425 BC), a Persian, who was known as the 'father of history', also remembered for some of his geological observations. He recognized the importance of yearly increments of silt and clay deposited by the Nile. A statement that 'Egypt is the gift of the river' was attributed to him. He thought that earthquakes were responsible for formation of mountains than that they were the expression of the wrath of the Gods. He noted shells in the hills of Egypt and concluded from their presence there that the sea at some time must have extended over lower Egypt, anticipating to some degree the idea of changing sea levels, a matter of great geomorphic significance. The observations reportedly made by Herodotus were much advanced to his time and all of them are found to be geologic facts and processes, at much later times.



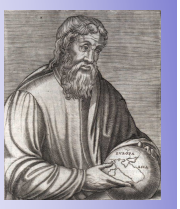
Herodotus

Aristotle (384-322 BC), a Greek philosopher, indicated in his writings, on origin of springs. He believed that waters which flowed out of springs consisted of (a) some rain water which had percolated downward; (b) water that had formed within the earth by condensation from air which had entered the earth; (c) water that had condensed within the earth from vapors of uncertain origin. All these waters were held by the mountains as if they were great sponges. The term river was then applied only to running waters fed by springs. He could not visualize that rain water could produce continuous flow of river. Later, it was proved by some other, that rainfall was sufficient to maintain flow of rivers. Aristotle also believed that the sea covered tracts that were formerly dry land and also the probability that land would reappear where now the sea exists. He recognized that streams removed material from the land and deposited it as alluvium and cited examples from the Black Sea region where river alluvium had accumulated so rapidly in matter of 60 years. Aristotle was one of the first people to record any geological observations. He stated that geological change was too slow to be observed in one person's lifetime. Aristotle noted changes such as, "lakes that had dried up" and "deserts that had become watered by rivers", upheaval of one of the aeolian islands, previous to a volcanic eruption and growth of the Nile delta since the time of Homer.



Aristotle

Strabo (54 BC-25 AD), a Greek philosopher, geographer and historian, travelled widely and observed carefully, noted examples of local sinking and rise of the land. He recognized the importance of river alluvium and thought that the delta of a river varied in size according to the nature of the region drained by the river and that the largest deltas are found where the regions drained are extensive and the surface rocks are weak. He observed some deltas are retarded in their seaward growth by the ebb and flow of the tides. His study on presence of marine shells buried in the earth at great elevations and distances from the sea, helped to proposal of sea level fluctuations. The 'Vale of Tempe' is a gorge in the northern Greece, located between Olympus to the north and Ossa to the south. The valley is 10 kilometers long and as narrow as 25 meters in places, with cliffs nearly 500 meters high, and through it flows the Pineios River. In ancient times, it was celebrated by Greek poets as a favorite haunt of Apollo. He considered that the Vale of Tempe, a result of earthquake along with volcanic activity, which was attributed to force of winds within the earth's interior. He rightly inferred from the nature that Mt. Vesuvious was of volcanic origin, although it was never active during his lifetime.



Strabo

Aryabhata (476-550 AD), was the first of the major mathematician-astronomers from the classical age of Indian mathematics and Indian astronomy. Mathematicians of ancient India often applied their mathematical knowledge to make accurate astronomical predictions. Aryabhata, in his book *Aryabhatiya,* represented the pinnacle of astronomical knowledge at the time. He correctly propounded that the Earth is round, rotates on its own axis and revolves around the Sun i.e, the heliocentric theory. He also made predictions about the solar and lunar eclipses, duration of the day as well as the distance between the Earth and the Moon.

Aryabhata

Contd. on page 13

REPORT ON FIRST COUNCIL MEETING OF ISEG (TERM 2020-21)

The first meeting of the ISEG Council 2020-21 was held on 18th April, 2020 at 11.00am online through zoom platform amidst prevailing nationwide lockdown due to Covid-19 pandemic. Overall 24 council members including invited senior patrons of the society participated in the meeting. The meeting was chaired by Sh. A.K. Singh, President, ISEG. The meeting started with all house members congratulating President, ISEG on assuming the charge of CMD, NHPC. Sh. S.L. Kapil, Secretary, ISEG welcomed all the participants and express his happiness over presence of all executive council members and the veteran members despite complete lockdown.

Sh. A.K. Singh, President, ISEG addressed the house with an assurance of providing all possible help. He proposed that the society should take up publication of a compendium on the experiences and lessons learnt from various hydropower and water resources projects. He also emphasised on taking up the standard-ization of geological explorations for hydropower projects. The proposals were well taken by the house. He further expressed that engineers, geologists and geophysicists of the country should strive to evolve feasible solutions to problems associated with Punatsangchhu-I and Parbati HE projects, which are languishing for years due to lack of proper engineering solutions. He emphasised on the use of advanced investigation techniques for minimizing geological uncertainties.

Invited senior members of the society Dr. Gopal Dhawan, Sh. R.N. Misra and Sh. Y. Deva also addressed the house and shared their valuable experiences on the above issues. Dr Dhawan endorsed the proposal of publishing case histories raised by President ISEG. He suggested that ISEG should take lead in this matter by bringing out special issues of journal of engineering geology. Sh. A.K. Mishra and Sh. Pradeep Singh, Vice Presidents, ISEG also addressed the meeting.

Secretary, ISEG presented the proposed calendar of activities of the society for 2020-2021. The issue was discussed in detail in light of prevailing Covid-19 conditions. Sh. Kapil stressed upon enhancing the membership base of the society by persuading young professionals to join the society. President proposed to give all the council members a target to get at least 5 new members within next three months. Same efforts are required for IAEG membership. Secretary, ISEG also presented the publication status of journal of engineering geology and forthcoming issue of ISEG News. The issue of permanent office space for ISEG was also discussed during the meeting. The President assured the house for looking into this issue and efforts will be made for suitable space for the society.

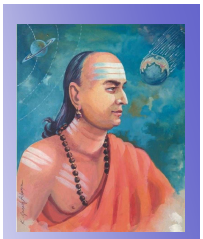
The meeting ended with vote of thanks by Secretary, ISEG. He expressed special gratitude for President, ISEG and all senior members for sparing valuable time from busy schedule and providing valuable inputs for the growth of the society. The meeting ended with thanks to the Chair.

The detailed Minutes of Meeting are available on ISEG website: www.isegindia.org.

BIOGRAPHY SERIES **GEOLOGY BY NON GEOLOGIST** **Compiled by M. Raju**

.....Contd. from Page 12

Varahamihira (505-550 AD), was a Hindu polymath who lived in Ujjain, Madhya Pradesh, India, wrote the Brihat Samhita, an influential encyclopedic text in Sanskrit. He worked on architecture, temples, planetary motions, eclip-ses, timekeeping, astrology, seasons, cloud formation, rainfall, agriculture, mathematics, gemology, perfumes and many other topics. This text exists in many Indian scripts, copied and was preserved. Varahamihira was learned scholar of the Vedas, but he was not a blind believer in the supernatural. He was a scientist. Like Aryabhata before him, he declared that the earth was spherical. In the history of science he was the first to claim that some "force" might be keeping bodies stuck to the round earth. The force is now called gravity. He proposed that the Moon and planets are lustrous not because of their own light but due to sunlight. He made some significant observations in the field of ecology, hydrology and geology too. He was the first person who predicted underground water. His claim that plants and termites serve as indicators of underground water is now receiving attention in the scientific world. Apart from these, Varahamihira also predicted the presence of water on Mars. He said that planet Mars has both water and iron present on its surface, which have now been revealed by NASA and ISRO.



Varahamihira

Abu Rayhan al-Biruni (973-1050 AD), was an Iranian scholar and polymath during the Islamic Golden Age. He was variously called as the 'founder of Indology', 'Father of Comparative Religion', 'Father of modern geodesy' and the first anthropologist. He was well versed in physics, mathematics, astronomy and natural sciences and also distinguished himself as historian, chronologist and linguist. Biruni devised a novel method of determining the earth's radius by means of the observation of the height of a mountain. He carried it out at Nandana in Pind dadan Khan (present-day Pakistan). He used trigonometry to calculate radius of the Earth using measurements of the height of a hill and measurement of the dip in the horizon from the top of that hill. His calculated radius for the Earth of 3928.77 miles was 2% higher than the actual mean radius of 3847.80 miles. His estimate was given as 12,803,337 cubits, so the accuracy of his estimate compared to the modern value depends on what conversion is used for cubits. One significant problem with this approach is that Al-Biruni was not aware of atmospheric refraction and made no allowance for it. He used a dip angle of 34 arc minutes in his calculations, but refraction can typically alter the measured dip angle by about 1/6, making his calculation only accurate to within about 20% of the true value. In his *Codex Masudicus* (1037), Al-Biruni theorized the existence of a landmass along the vast ocean between Asia and Europe, or what is today known as the America. He argued for its existence on the basis of his accurate estimations of the Earth's circumference, which he found spanned only two-fifths of the Earth's circumference, reasoning that the geological processes that gave rise to Eurasia must have given rise to lands in the vast ocean between Asia and Europe.

Al– Biruni

TO BE CONTINUED

DR V K SHARMA, FORMER VICE PRESIDENT OF ISEG CONFERRED WITH GEOLOGICAL SOCIETY OF INDIA SESQUICENTENNIAL COMMEMORATIVE AWARD 2019

Dr. V.K. Sharma, Former Dy. Director General, Geological Survey of India and the Vice President of the Indian Society of Engineering Geology (2016-2017) has been conferred prestigious *GSI Sesquicentennial Commemorative Award-2019* for outstanding contributions to geosciences in the field of engineering geology with application to slope remediation and susceptibility modeling of landslide risks, by the Geological Society of India. Dr. Sharma, studied Applied Geology at University of Roorkee (Now IIT- Roorkee), in 1977 and at Centre of Advanced Studies in Geology, University of Lucknow, he evolved a Geotechnical model for Landslide Susceptibility, which earned him Ph.D. (2011). Dr. Sharma worked in the GSI (1981-2016) for over 35 years holding different positions. He was a member of '*Project Oversight Committee* 'of Subansiri Lower Hydroelectric Project (SLHP) constituted by Ministry of Power, Govt. of India; delegate of Govt. of India to Uganda for development of hydro-power potential of River Nile in African Rift Valley System; and participated in technical sessions of Geological Society of America, USA, European Geosciences Union (EGU) at Vienna, Austria. Currently, Dr. Sharma is an Expert/ Adviser: Engineering Geologist of Department of Water Resources, Govt. of Bihar and member of review panel of various irrigation and flood control projects in the state.

LIFE IN TIMES OF COVID 19-A POETRY

The Corona pandemic has inspired people to pause and reflect on their lives during worldwide lockdown. A new reality, a new lifestyle, a new normal has emerged which has taught us not to take nature and our lives for granted. The virus has thrown many challenges before us- isolation, quarantine, sickness and loneliness. At the same time, it has opened new vistas, new openings and new frontiers. Many, however, also look at it as an opportunity to slow down and savour life, one day at a time. Bro. Richard Hendrick, an Irish priest, wrote a small poetry titled "Lockdown". It went viral and the world resonated with it. He speaks of the birds that have begun to sing again and of skies that have turned blue again.

Yes there is fear.
Yes there is isolation.
Yes there is panic buying.
Yes there is sickness.
Yes there is even death.
But,
They say that in Wuhan after so many years of noise
You can hear the birds again....
All over the world people are waking up to a new reality
To how big we really are.
To how little control we really have.
To what really matters.
To Love....

INSITU GEOTECHNICAL INVESTIGATIONS: FORTE OF NIRM BENGALURU

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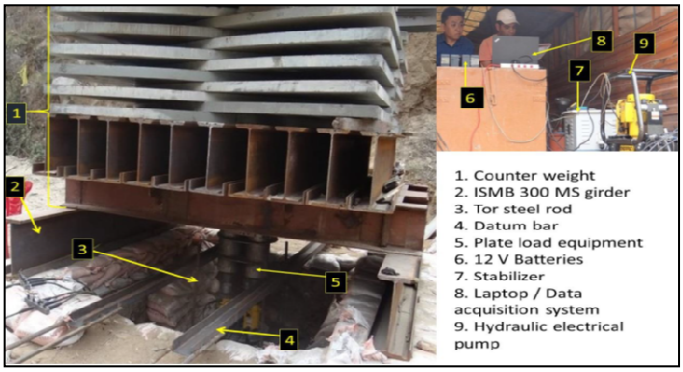


Photo 4 Determination of safe Bearing Capacity of Soil at Punatsangchhu H.E. Project, Bhutan.

Photo 5 Acoustic Borehole Tele viewer tests being conducted at the depth of 600m.

The knowledge of behaviour of soil (or) any foundation material upon loading can be studied *in-situ* by carrying out **plate load test (or) foot load tests**. The ultimate bearing capacity and safe bearing capacity are essential for the design of foundations. Considering the large size of aggregates involved, foot load tests are best suitable. Steel plates are not of much use because of seating difficulties. Best results are obtained with cast in-situ concrete blocks or with precast blocks, set with fresh mortar, so that there is perfect bond between the soil and the block. Geotechnical Engineering Department of NIRM is having vast experience in this field to conduct these tests in-situ.

High resolution Acoustic Borehole Tele-viewer Logging

High resolution Acoustic Borehole Tele viewer logging is used to measure several physical properties of the geological formations intersected by boreholes. The information gained may then be employed to determine the geometry of major subsurface structural discontinuities and to estimate the mechanical properties of the formations surrounding the borehole.

"Success is not final, failure is not fatal: it is the courage to continue that counts."
– Winston S. Churchill

A BRAIN STORMING SERIES ON DIGITAL PLATFORM

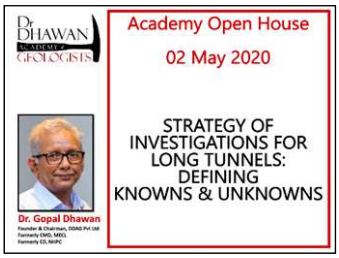
Yogendra Deva
Former Director, GSI and Ex-Secretary, ISEG
Dr. Dhawan Academy of Geologists
(DDAG Private Limited), Noida, UP.
E-mail : www.dhawanacademy.com

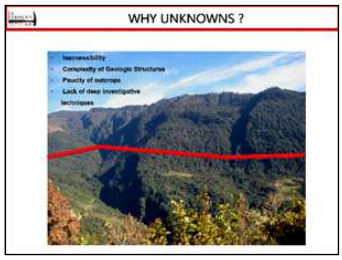
Not that the world has not been on digital platform, indeed it has been on a big scale, but, the kind of spurt that the rampant COVID-19 pandemic has generated, the growth is phenomenal. The last two months of national lockdown bear ample testimony to it. One wonders why it was necessary to keep moving out for every little need when everything continues without stepping out from your home for over two months. Office work continues – albeit more efficiently as commuting time is gone, your provisions are delivered at your door-step, more than required entertainment is available on your smart televisions, family get together and parties with friends are held more frequently, there is unlimited scope for playing top quality games like Bridge and Chess, and so on and so forth. For professionals like us, a spurt in webinars has come as a boon. Plenty to choose from. Digital platforms have made all this possible. Yes, outdoor activities are missed but that is the other side of the coin. There too, many have improvised activities like morning walks within the confines of their homes, or, devised even playing Golf – read putting - indoors!

In this post-COVID-19 changing world, organisations are emerging in new avatars and, not that they hadn't digital programs in their agenda, or, they weren't already in to it, their online activity just got a boost to a different level. Dr. Dhawan Academy of Geologists is no different. They too had contemplated online training programs but the two-month long lockdown expedited their move in this direction. The Academy has come up with a series of brainstorming sessions in the form of Open Houses. A no-fee program, it got going on Saturday the 02 May 2020 and the 2nd Edition is scheduled for Saturday the 30 May 2020. Punctuality being the Academy's USP, the one-hour Open House opens sharp at 1600 hrs and closes at 1700 hrs sharp.

The Academy Open House is a participant driven one-hour online program where the topic of discussion is chosen based on the participants' suggestions. The announcement for the first Open House attracted as many as a hundred topics half of which belonged to the discipline of Engineering Geology. While these topics alone would steer the series of Open Houses for a long time, many more topics shall keep adding to the list following the registrations for forthcoming announcements.

Typically, an Open House is conducted on Microsoft Teams platform and commences with the presentation on the selected topic by an expert following a very brief introduction by the program host. The participants are invited to raise their queries in the Chat Box while the presentation is on and these are answered by the expert immediately following his presentation. Time permitting, audience participation in discussions is encouraged making it a truly brainstorming session. Closing comments, again, don't take more than a couple of minutes.





The common interest topic for the inaugural Open House was "Strategy of Investigations for Long Tunnels: Defining Knowns & Unknowns". Dr. Gopal Dhawan, Founder and Chairman of the Academy, made the expert presentation and answered participants' queries. He advocated good design for 'Known Knowns', appropriate contractual architecture for 'Known Unknowns', construction phase investigations for 'Unknown Unknowns', and dealing with residual uncertainties as they come. Laying emphasis on systematic geological and geotechnical investigations leading to risk identification and enabling risk management, Dr. Dhawan concluded with undeniable role of engineering geological mapping in an overall integrated approach to project implementation.

The next Open House on 30 May 2020 will be on the common interest topic – "Criteria for Earthquake Resistant Design of Infrastructure" and the expert presenter would be Dr. Prabhas Pande, formerly Additional Director General, Geological Survey of India, and a renowned seismologist in the country.

The Academy invites the ISEG fraternity to make the Open Houses livelier with their esteemed presence and interaction. Besides personalized mails, Open House registrations are available on popular social media sites.

"Impossible is just a word thrown around by small men who find it easier to live in the world they've been given than to explore the power they have to change it. Impossible is not a fact. It's an opinion. Impossible is potential. Impossible is temporary. Impossible is nothing."

– Muhammad Ali

ISEG NEWS

(A Biannual Newsletter of ISEG)

S. L. Kapil, Secretary,
Indian Society of Engineering Geology
C/o Executive Director & HoP,
Engg. Geology & Geotech Division,
NHPC Office Complex, Sector-33,
Faridabad, Haryana-121003.
Mobile: +91-9911103790
E-mail: india.seg@gmail.com;
shyamkapil@gmail.com

Rahul Khanna, Editor, ISEG
C/o Senior Manager (Geology),
Engineering Geology Division,
Parbati HE Project, Stage-II
NHPC Ltd, Nagwain, Dist– Mandi, H.P.
Mobile: +91-9560600377
E-mail: isegpapers@gmail.com;
rahulgeo05@gmail.com

DR RANJIT RATH, FORMER CONVENOR ISEG DELHI-NCR CHAPTER AND CMD MECL TOOK OVER ADDITIONAL CHARGE OF DIRECTOR GENERAL GSI ON 01.05.2020

Dr. Ranjit Rath, former Convener, ISEG Delhi-NCR Chapter (Term 2018-19) and the Chairman cum Managing Director of Mineral Exploration Corporation Limited (MECL), a Mini Ratna -I CPSE under Ministry of Mines, has been entrusted with the additional charge of Director General of Geological Survey of India from 1st May 2020. Dr. Rath succeeds Sh. M. Sridhar who retired on 30th April 2020.

A practicing geoscientist, Dr. Ranjit Rath, is a recipient of the prestigious "*National Geosciences Award 2016*" from Hon'ble President of India. He is an alumnus of IIT Bombay, IIT Kharagpur, Utkal University and IIFT, New Delhi. Earlier, he was General Manager with EIL, New Delhi. He has a portfolio of multifarious roles spanning from strategy formulation, business development, upstream oil & gas assets management and application of geosciences & exploration geology in several important projects including creation of Strategic Petroleum Reserves (SPRs), a first of its kind initiative of Ministry of Petroleum & Natural Gas, Govt. of India entailing underground unlined rock caverns for strategic storage of crude oil – An intervention towards energy security. He has co-authored a very distinctive book on "*Underground Storage Technologies*" beside publishing several technical papers.

Heartiest congratulations to Dr. Rath from all ISEG members!

Indian Society of Engineering Geology

C/O Director Monitoring, GSI, CHQ, 27 JL Nehru Road, Kolkata, West Bengal-700016

INCOME & EXPENDITURE ACCOUNT

(For the year ended on 31.03.2019)

INCOME	Amount (Rs.)	Amount (Rs.)
Sponsorship Fees	11,36,421.10	
Membership fees (IAEG & ISEG)	3,42,847.00	
Interest received / accrued on FDR's	1,15,514.80	
Interest on IT refund	780.00	
Sponsorship Fee (RCM)	1,43,157.00	
Interest received on Saving account	19,955.00	17,58,674.90
Total		**17,58,674.90**

EXPENSES	Amount (Rs.)	Amount (Rs.)
Activity Expenses		
Seminar Expenses	12,05,894.00	
Printing and Stationary Expenses	51,946.00	
IAEG Expanses	91,673.00	13,49,513.00
Administrative Expenses		
Bank Charges	70.26	
Web Updation & Server Rental Charge	14,849.00	
Travelling Expenses	2,155.00	
Postage Courier & Internet Expenses	6,727.96	
Legal Expanses	46,000.00	
Interest & Penalty	32,554.00	
Fee and Taxes	3,880.00	
Audit Fees	15,000.00	
Accounting Charges	10,000.00	1,31,236.22
Depreciation		62.00
Total		**14,80,811.22**
Excess of Income over Expenditure		**2,77,863.68**

Auditor's Report
As per our separate report of even date attach
FOR RAKESH K SRIVASTAVA & CO.
Chartered Accountants
Sd/-
Stamp of firm (Parul Agarwal)
Partner
M. No– 443030

FOR INDIAN SOCIETY OF ENGG. GEOLOGY

Sd/- Sd/-
(Mridul Srivastava) **(Saibal Ghosh)**
Treasurer Secretary
Place: Lucknow
Date: 30.06.2019

Indian Society of Engineering Geology

C/O Director Monitoring, GSI, CHQ, 27 JL Nehru Road, Kolkata, West Bengal-700016

BALANCE SHEET AS ON 31.03.2019

Source of Funds	SCH	AMOUNT(Rs.)	AMOUNT(Rs.)
General Fund			
Opening Balance		49,38,892.88	
Add: Excess of Income Over Expenditure		2,77,863.68	
		52,16,756.56	
Less: Income tax written off		1,000.00	52,15,756.56
Total			**52,15,756.56**

Application of Funds	SCH	AMOUNT(Rs.)	AMOUNT (Rs.)
FIXED ASSETS			
Opening Balance		624.00	
Less: Depreciation @ 10%		62.00	562.00
INVESTMENTS	A		**36,30,058.80**
CURRENT ASSETS, LOANS & ADVANCES			
Stock of Publication		1,03,870.00	
Sponsorship Fee Receivable		2,00,000.00	
Advances recoverable in cash or kind			
T.D.S. (A.Y. :2019-20)		40,557.00	
Advance to Dr. Saibal Ghosh		20,000.00	
Other Advances		26,397.00	
Cash and Bank Balances			
Cash in Hand		138.06	
Cash at Bank:			
SBI Kolkata		2,400.28	
SBI Lucknow		2,38,014.85	
UCO Bank Lucknow		9,54,802.57	
		15,87,379.76	
Less: Current Liabilities			
GST Payable		2,244.00	15,85,135.76
Total:			**52,15,756.56**
Significant Accounting Policies & Notes on Accounts	B		

Auditor's Report
As per our separate report of even date attach
FOR RAKESH K SRIVASTAVA & CO.
Chartered Accountants
Sd/-
Stamp of firm (Parul Agarwal)
Partner
M. No.—443030

FOR INDIAN SOCIETY OF ENGG. GEOLOGY

Sd/- Sd/-
(Mridul Srivastava) **(Saibal Ghosh)**
Treasurer Secretary
Place: Lucknow
Date: 30.06.2019