Engineering Geology has tremendous societal importance- MilindDhakate

As part of observance of "AzadiKaAmritMahaotsav" by GSI, Central Region, an online lecture was delivered by Shri. Milind V. Dhakate, Director, Policy Support Systems (PSS), Geological Survey of India (GSI), Central Region, Nagpur on the topic entitled "Role of Engineering Geologists in Nation Building". The lecture was organized under the aegis of the Gondwana Geological Society (GGS), Nagpur. Shri. Dhakate spelt out numerous contributions of Engineering Geology in nation building. Shri. Dhakate reminisced that Engineering geology provides an important support system for Civil Engineering and the subject gained its importance in the late 19th century while the first book on the subject was published by William Penning in 1880. In the Indian context, since our Independence, civil construction projectsmultiplied manifold with the view to usher in self-reliance for our country in various sectors. Engineering geologist plays vital role in sectors like Irrigation (Dams/barrages, reservoirs, canals, tunnels, large caverns), Power (hydro/nuclear, power houses, reactors, deep caverns for nuclear waste), Drinking water supply (Dams, tunnels, reservoirs, canals), Communication (Roads, railways, bridges, tunnels), Storage (underground caverns for Oil, arms, etc.),Defence (Caverns, approach tunnels, etc.), Urban Development (High rise buildings, Metro rail, flyovers etc).Engineering geologist has to carry out detailed geotechnical investigations alongwith foundation studies for all these civil superstructures to make it safe, stable and economic. While dealing with construction of superstructures, Engineering geologist faces daunting challenges from Mother Earth as no two sites of the Earth surface are similar and no two civil superstructures are similar. Moreover, the best sites for the construction of superstructures are getting exhausted.

Shri. Dhakate, emphasized over following roles & responsibilitiesof an Engineering geologist:

- To provide geological and geotechnical information, analysis and recommendations associated with planning, design and construction of engineering project /structure.

- Description of earth materials, their distribution, and general physical/chemical characteristics.
- Deduction of the Geological history of pertinent events affecting the earth materials.
- Forecasts of future events and conditions that may develop.
- Recommendation of materials for representative sampling and testing.
- Recommendation of ways to handle and treat various earth materials and processes; recommending or providing criteria for excavation design, particularly angle of cut slopes, in materials where engineering testing is inappropriate or where geologic elements control stability.
- Inspection and close interaction with engineers during construction to confirm site conditions.

While talking on safety and stability of superstructures, he enumerated various causes of superstructures failures siting examples from all over the world. He stated that, as per the worldwide available information, superstructures fail mainly due to foundation failures. The 1928 St Francis dam failure resulted in a loss of 426 lives. The foundation rocks were mainly conglomerate and mica schist. Porous rock bed, seepage and softening of the foundation led to the dam’s failure. The defective foundation design made the planners realise an engineering geologist’s important role for the first time. Other major dam failures include the Vaiontdam, Italy (1963) faileddue to landslide in reservoir area resulted inflooding in the downstream which eventually washed awaydownstream village. Shihgang dam failure in Taiwan due to an earthquake caused by faulting (1999) and the Machchhu earthen dam failure in 1979, in Morvi,Gujarat due to excess flooding of rainwater (51 cms in 16 hours) caused a loss of more than 1800-25,000 lives almost wiping out the entire town. It is the worst dam failure recorded in India so far.While sometimes natural hazards are unpredictable, in other cases geologist’s are able to foresee these in structurally unsafe areas. The structural design needs to be changed to overcome the natural hazards if these can be foreseen. Among the successful big dams constructed in India are the Bhakra Nangal dam, Hirakud dam, SardarSarovar dam, Srisailam dam, Idukki dam, Tehri dam and many more.

Dhakate was associated with the Pench Diversion project, M.P. where the GSI had been working since 1972. The Penchdam is 41m high and 6320m long composite, concrete cum earthen dam constructed at the downstream of the Pench and Kajri river confluence. The Central Spillway of the dam axis as proposed by the Central Water Commission (CWC) was relocateddue to following reasons by the GSI team led by Dhakate.

- Presence of thin layer(1-1.50 m in thickness) of massive basalt unit below the river bed level at Central spillway location.
- Presence of loose and unconsolidated riverine sediments and buried channel material (up to 21m thick) on both the abutments of the existing river channel, 2.50m-3m below the river bed level.
- Presence of fresh granite strata only at a depth of 16-18m below the ground level.
- Deep excavation to reach the foundation in the spillway section would also result in correspondingly deeper Cut off trench for the earthen dam and would also lead to enormous amount of excavation in a sizable reach involving huge cost and also causing delay in the construction schedule.
- The excavated muck cannot be utilized in construction, due to poor engineering properties and slacking tendencies.

Accordingly, several alternative sites, both on left and right flank of the Pench River were identified and geo-technically assessed.Dhakate& his team recommended location of Central Spillway between RD 1400 m and 1800 m with following advantages:

- Availability of acceptable foundation medium at shallow depth which will continue at depth to provide sufficient cushion of massive, dense basalt.
- Location of site away from the interpreted fault zones.
- The excavated rock-mass derived out of massive, dense basalt constitutes a good quality material for dam construction.

- The site provides naturally leveled ground (between +606m and +609m) where the gentle gradient of the ground profile will facilitate smooth operations for the construction work.
- Availability of a gentle gradient along spill channel alignment which reduces scouring in river channel.
- Spill channel alignment will not submerge nearby villages.

This recommended side spillway location was critically reviewed in several joint technical meetings consisting teams from Central Water Commission, Senior Project authorities Government of Madhya Pradesh and Senior GSI authorities. Dhakate has successfully defended his findings and convinced everyoneto construct spillway at the recommended site.These efforts could save Rs 130 crores as the project was built for Rs 280 crores against Rs 410 crores sanctioned estimated cost. Eventually, Dhakate and his team includingGautamSaha, R.H.Chavhanand P. T.Ilamkarwere awarded the National Geoscience Award in the year 2016 at the RashtrapatiBhavan, at the hands of Hon. President of India, Dr.Pranab Mukherjee.