Underground Projects in Brazil

Brasilia (2.0 million inhabitants), the capital of Brazil, is a planned city. Today, the city is surrounded by fifteen satellite cities, some of them planned and others developed along the years according to the needs. In the last decade, the population has been growing at a much higher rate than predicted and therefore, the city started presenting some traffic problems. Before it gets worse, a mass transit system was proposed, including several underground facilities in urban areas. These early solutions had the advantage of being much cheaper to be implemented, although there have been criticisms about their real usefulness.

The Brasilia metro system links the south wing of the city with the five satellite cities, covering two thirds of the total population. It has a total length of 42 km (11 km underground) and 34 stations (12 underground). An emphasis is given to the tunnel (6.8 km long, 9.6 m in diameter and 14.3 m deep) and 9 stations built in the south wing of Brasilia. Stations were excavated by cut-and-cover methods.

The tunnel was excavated by the New Austrian Tunnelling Method (NATM), following four main stages: excavation (four sequence schemes), installation of lattice girders (spaced from 0.6 to 1.0 m), shotcreting the primary lining layer (21 cm thick) and finally, placement of the secondary lining layer (20 cm thick and two layers of steel mesh). A complete instrumentation program was implemented to measure settlements, tunnel convergence and water levels.

Ground control criteria, settlement trough and interference with existing public utilities and buildings are the main concerns in underground works. For the Brasilia subway, some data are presented to demonstrate how settlement prediction and ground control are important issues in tunnelling engineering. In Brasilia, tunnelling-induced settlements were not expected to cause any problems because the tunnel was driven under extensive grass areas and only few nearby structures existed and most of them were founded on deep foundations. However, the presence of a thick layer of Brasilia porous clay caused an unexpected behaviour due to structural collapse of this soil, increasing displacements from the tunnel crown to the ground surface. These findings were very useful for a better understanding of this behaviour, improving the ground control criteria for future underground constructions in this type of soil.

Settlements induced by tunnelling in soft ground have been commonly predicted by empirical methods, based on the assumptions that the settlement trough is described by a Gaussian curve and deformations occurred with no

volume change. This latter assumption implies that a typical tunnelling-induced settlement profile presents a decreasing of the settlement values from the tunnel crown to the ground surface. The maximum surface settlements Smax, obtained from the Gaussian curves from 35 instrumented sections in Brasilia, ranged from 37 to 364 mm. These values compared with those respectively measured by the central surface marks were discrepant by only 4% in average. Similarly, the settlement trough width parameters ranged from 5.4 to 10.2 m. These results also showed that curve fitting using the Gaussian equation described very well the measured settlement troughs in the Brasilia porous clay. These curves were then used to calculate the settlement trough volume Vs. Comparing Vs and the tunnel displacement volume Vp (loss of ground), which ranged from 0.46 to 4.16 m^3/m, it can be concluded that settlement trough volumes were much greater than losses of ground (Vs > Vp), up to 180% but in average by 50%. In fact, it was a strong indication of soil contraction due to structural collapse caused by tunnel excavation.

Another common approach for predicting the settlement trough volume Vs is to take it as a percentage of the excavated tunnel volume Vt. Values from 0.5 to 3% are commonly suggested for cohesive soils. In Brasilia, the percentages (Vs/Vt) ranged from 0.9 to 12.9% and more than 50% of the sections presented values greater than 3%. These values are well above those recommended and are another indication of soil structural collapse.

Soil structural collapse constitutes another source of displacements, which would occur between the tunnel and the ground surface, changing the normal pattern of the settlement profile along the tunnel symmetry axis. These settlement profiles were obtained using measurements from the central surface mark, two extensometers and crown convergence pin. The tunnel crown settlements (17 to 165 mm) were considerably lesser than the maximum surface settlements (37 to 364 mm).

This behaviour, where settlements increase towards the ground surface, is not common in tunnelling. It indicates another source of displacements between the tunnel and the ground surface. This source of displacements is related to the structural collapse of some porous soils, which may be caused by saturation, excessive stress or deformation changes, failing the weak cementation links of the soil structure. Numerical simulation of this tunnel demonstrated that structural collapse of the soil must be taken into account to predict correctly the settlement trough and profile, especially the high values at the surface. The magnitude of the settlements due to structural collapse is strongly dependent on the soil stiffness reduction after collapse and the extent of the collapsible zone.

Source: Tribune, ITA News Magazine

Massive Capacity Addition Planned for Hydro Sector in India

The power demand projections made in the 16th Electric Power Survey conducted by Central Electricity Authority (CEA) would require a need based capacity addition of over 100,000 MW during X and XI Plans. The hydropower development would need further boost in order to bridge the gap between demand and supply. CEA has prepared a vision paper on development of hydroelectric potential in India by 2025-26. The vision paper envisions harnessing of entire balance hydropower potential of India by 2025-26. During the forthcoming X and XI Plans, the vision paper envisages a hydro capacity addition of over 30,000 MW. The likely requirement of funds for this capacity addition over decade would be of the order of 1300 billion rupees. In terms of hydropower potential, India ranks fifth in the world at 600 billion kilowatt hours of energy annually, equivalent to a name-plate capacity of 1,50,000 MW approximately, out of which only 17 percent has so far been developed.

Hydropower is a renewable, economic, non-polluting and environmentally benign source of energy. It only can save the countries like India from depleting fossil fuel stocks and harmful effect of global warming in addition to reducing local atmospherical pollution. Hydropower stations have inherent ability for instantaneous starting, stopping, load variation, etc., and help in improving reliability of power system. In the Indian context, unsatisfactory system conditions prevail especially in the Eastern and Western regions having predominance of thermal power. The off peak surplus power and inability of thermal stations to back down are reflected in the form of impermissible high frequencies and injurious low frequencies.

To correct such a situation, the ideal hydrothermal mix should be in the ratio of 40:60. At present hydro share is below 25 per cent, which would become approximately 27 per cent of 31,700 MW of hydropower are added by2012. The greater emphasis on hydropower development for grid stability and system reliability is therefore an inevitable fall out and the Government is determined to ensure maximization of hydro development and extend full support towards this end.

The total installed capacity of power is 1,03,134 MW, out of which 25,574 MW is that of hydropower. A look at the hydropower development in various regions of country indicates that maximum hydropower potential harnessed is in the Southern Region but that also stands at a level of 53.86 per cent only. The most underdeveloped regions are Northern and North Eastern where only 15.22 per cent and 1.22 per cent of hydro potential have so far been developed. The state of Arunachal Pardesh has a hydropower potential of 50,300 MW out of which only 10.50 MW are in operation, 405 MW under construction, leaving a sizable chunk still to be developed. The other States with large

untapped hydro potential are Uttaranchal (11,145 MW), Himachal Pardesh (13,071 MW) and J&K (12,282 MW).

The 'Policy on Hydropower Development' envisages a benefit to investors by appropriately adjusting the normative levels for incentives, simplification of procedures and further reassurances of return on investments. The Ministry of Power has substantially increased its budgetary allocation for the hydropower sector in the last few years. Priority has been given to the completion of languishing state hydropower projects.

The CEA has completed a preliminary ranking study for 400 remaining potential hydropower sites having an installed capacity of over 1,07,000 MW. The ranking study has been done basin-wise for the six major river basin systems in India and the projects have been classified into categories A, B and C to enable prioritized development of potentially sound projects. The use of satellite imageries has been made for one of the basins through a national remote sensing agency. A 3-stage clearance procedure has been introduced for Central Sector hydroelectric projects to reduce the time and cost overruns in the implementation of the projects. Necessary infrastructure is being developed along with survey and investigation to ensure that project development can take off in right earnest immediately after investment approval.

The Ministry and the CEA have also initiated a dialogue with all States where hydroelectric power projects are located so as to accelerate the process of allocation of hydro potential sites for development. The financial institutions and the private developers have shown a great confidence in hydropower projects in the past year.

- Ms. Jayawantiben Mehta
Minister of State for Power, Govt. of India
Source: Times of India, January 14, 2002

Ice Sheets and Volcanic Eruptions Below

When volcanoes erupt beneath sheets of ice, the resulting flash flood sometimes devastate communities, roads, and farms. But there is a new evidence that the effects of these eruptions are mostly local, with little overall effect on the ice sheets themselves.

Scientists have a special reason for worrying about subglacial volcanoes. Since 1993, it has been known that volcanoes have been erupting under the ice sheet covering West Antarctica.

If geothermal heat associated with volcanic activity should create a wide layer of water beneath this ice, it has been speculated, the water might moisten the volcanic ash on which much of the ice rests, creating a lubricant on which the ice might slide.

If the west Antarctic Ice Sheet were to slide into the ocean, the sea level would rise by 65 feet worldwide, flooding low-lying nations like Bangladesh and the Netherlands and causing a global catastrophe.

A new study of volcanic activity beneath Iceland's Vatnajokull ice cap suggests that some subglacial eruptions have little long-term effect on the stability of ice sheets. This reassuring conclusion was reported by Dr. Helgi Bjornsson and his colleagues at the University of Iceland, in Reykjavik.

The object of their investigation was a 13-day eruption that occurred a year ago, when a subglacial volcano blasted its way through a fissure named Gjalp (after a mythological giantess) and up through ice nearly a half-mile thick. The eruption sent plumes of steam and ash some 33,000 feet into the air and melted one-half cubic mile of ice.

For five weeks, water melted by the eruption, flowed into a subglacial lake, which finally overflowed, unleashing a flood that destroyed bridges, cut roads, and felled power lines. But because Icelandic experts had given ample warning of the flood, the region had been evacuated and there were no casualties.

Such floods occur every 5 to 10 years, Bjornsson said, because the ice cap covers a geological hot spot that continuously melts ice. The periodic overflow of the subglacial lake, he said, has created a channel some 30 miles long under the ice, leading to the edge of the glacier. The subglacial channel serves as a duct for the floodwater.

Bjornsson and his colleagues concluded on the basis of Arial surveys and ground measurements that the ice cap was not significantly changed by the 1996 eruption and that it remains firmly anchored to underlying bedrock.

Dr. Donald D. Blankenship of the University of Texas at Austin, a leading expert on the West Antarctic Ice Sheet, said observations made of the Icelandic eruption did not necessarily apply to Antarctica.

"There are big differences between Iceland and Antarctica," he said. "For one thing, the ice sheet in Antarctica is up to 9,000 feet thick, while its Icelandic counter-part is only 2,500 feet thick".

Blankenship said that relatively little was known about the geology underlying the West Antarctic Ice Sheet but that a system of Antarctic channels, similar to those in Iceland, might exist – channels that could carry melt waters away from regions of volcanic activity.

Source: AGID Newsletter, 1998

Rubber Dam

Bangladesh have too little rainfall in winter. So, the requirement of water for winter irrigation must be met from the groundwater source and by conserving a part of the monsoon water in suitable storages. Local Government Engineering Department (LGED), Bangladesh have introduced rubber dams, a cost-effective technology for retention and conservation of surface water in the river channels, reservoirs and lakes. For the first time in Bangladesh, two pilot rubber dams were constructed in the Bakkhali River and Idagaon khal in the Cox's Bazar District for the purpose of supplying irrigation water to 8000 ha of winter rice. Cultivation through rubber dams can be used for all purposes, where water retention is involved. These are ideally suitable for conservation of water in channel storage of the rivers and khals, as dams can be inflated to retain river flows and deflated fully to allow passage of flood flows without any obstruction. The rubber dams have been jointly designed and constructed by LGED and experts of the Institute of water Resources and Hydropower Research (IWHR) of China

Source: Institution of Engineers Newsletter Nov. 2001

New Water Purification Technique on the Anvil

A team of geoscientists has developed a new, low-tech water purification mechanism, which requires no more sophisticated equipment than a few rocks and a bucket. The technique has been developed in response to the problem of contaminated water being faced by inhabitants of Zimapan, a mining district 200 km north of Mexico city. The Zimapan inhabitants survive on a water supply contaminated with arsenic, as they cannot afford commercially available domestic purifying systems.

The district is rich in mineralised ores from which metals like lead, silver and zinc are extracted. The water supply in the area is contaminated by rainwater leaching through mine tailings, a report in the recent issue of the journal *Geochemistry – Exploration, Environment, Analysis* said.

The water, thus, has an arsenic concentration of almost 16 grams per litre. Spurred by the challenge to provide good quality water at low cost, scientists found the answer lay in the local rocks. Researchers created experimentally contaminated water (ECW) by shaking pure water with samples of mine tailings. The ECW, with a concentration of 0.6 mg arsenic per litre, was then reacted with samples of various local rocks.

Researchers found that arsenic was reduced to below detectable levels in samples of ECW mixed with rocks of the local "soyatal formation" – a

calcareous shale containing up to 15 per cent clay minerals (kaolinite and illite), the report said, adding both these minerals are known to absorb arsenic. Researchers found that water emerging though the soyatal formation were uniformly low in arsenic, the report said.

Based on their observations, the researchers concluded that one or two kilograms of crushed rock, added to about 20 litres of contaminated water, and stirred frequently over 24 hours, would effectively remove arsenic to below acceptable levels. Polluted water is a chronic problem in Mexico. About half of the water samples tested by the Mexico's national water commission have arsenic concentration above the current World Health Organisation (WHO) guidelines of 0.01 mg per litre.

The wells used for municipal water supply are heavily contaminated, and even after dilution from unpolluted water sources they have concentrations up to about 0.4 mg per litre.

Source: The Times of India

University of Roorkee - The Oldest Engineering Institution of the Sub-continent Re-incarnated as Indian Institute of Technology Roorkee

Through a presidential ordinance, the University of Roorkee has been converted into Indian Institute of Technology Roorkee, which is the 7th of its kind in the country. Founded in 1847, primarily to impart engineering education to Europeans and selected Indians for service in the Army, it is the oldest engineering Institution of the sub-continent, initially known as Civil Engineering College. The first admissions to this college were made on 1st January 1848 to train a few engineers for construction of Northern Ganga Canal. In 1854, the College was renamed as Thomason College of Civil Engineering at Roorkee in memory of James Thomson who as Lt. Governor of North West Provinces had been primarily responsible for its establishment. In 1949 the Thomason College of Civil Engineering earned the distinction of becoming the first technical university in the country in recognition of its part performance and its potential and keeping in view the needs of modern India.

Since its establishment, this Institution has played a vital role in providing the technical manpower and know-how to the country and in the pursuit of research, this Institution ranks amongst the best technological Institutions in the World and has contributed to all sectors of technological development.

At present there are about 3,200 students enrolled in this premier engineering institute studying at under-graduate and post-graduate levels. The institute has 320 teachers of science and technology in its faculty running 19 academic and 26 other research departments. At present the institute has 10 under-graduate programmes and 54 post-graduate programmes in science and technology. The

institute has recently set up an Uttaranchal Development Cell (after creation of a new Indian State), which will provide technical consultancy and will work in the areas identified jointly in consultation with the Uttaranchal Government. Already the institute is helping the Uttaranchal in tapping its huge hydropower potential. The institute's special expertise in mountain civil engineering and geo-dynamics will help in the development of safe technologies in the state.

This Institution has now entered the 155th glorious year of its existence. We all wish this Institution a magnificent and very happy future.

-- Editors

Uttaranchal- A Newly Born Indian State

The birth of new state is a time for toil and determination, for energy and dynamism, for strength and vigour. It is a time for clear thinking and selfless action, a time for construction and creation, a time for sowing but perhaps not time for reaping. In words reminiscent of President Kennedy, we could well say, "Ask not what the new-born state of Uttaranchal can do for you but what you can do for Uttaranchal". The new state of Uttaranchal, more than anything else, will need well-qualified young people who match high purpose with high ideals.

Let us, for a moment, look at the vision that Uttaranchal has for its future. Uttaranchal is the land of mighty Himalayas, the source of sacred Ganga, the towering abode of sages and rishis (saints) in search of the ultimate Truth and realization of the Self. What should be its vision of the future? Clearly the people of Uttaranchal want development in all the multi-dimensional areas that the word has come to connote, dimensions which are material, social, and also spiritual. The challenge lies in approaching this goal without disturbing the calm of its valleys, the serenity of its hills, the depths of its forests, the clarity of its springs and running waters, the song of its birds, the bloom of its flowers, the purity of its air. In the peaceful atmosphere of the University you have, perhaps, more time to ponder over these questions and look for the right answers. What seems clear to me at the moment is that the direction we choose must be selected with infinite care so as to achieve that perfect confluence between the ancient and the modern to form a mighty development stream that carries the people towards their vision of the future without detracting from the pristine beauty of their land or striking a discordant note in the wonderful symphony of nature that is Uttaranchal.

Source: Extract from Convocation Address by Sri K.C. Pant
Dy. Chairman, Planning Commission
at University of Roorkee, Nov.26, 2000

The Himalayas

The response to the word 'Himalayas' evokes almost universal, a feeling of awe and excitement, of reverence and spirituality, of mystery and majesty and of sheer magnitude and invincibility that compels humanity yet challenges the human spirit. The Himalayan saga is man's quest for adventure and spiritualism. For centuries, the grandeur and mysteries of the stark, snowy summits have drawn explorers, pilgrims, sages and poets to their bosom. For some they are a challenge, for others a pilgrimage.

2500 km long 400 km wide and with an astonishing mean elevation of 6000 meters at their central axial range, the Himalayas are the greatest physical features of the earth. They contain the highest peak, the highest pass, the highest living animals, the highest fossils and the deepest gorges.

For sheer natural beauty, the Himalayas are unsurpassed. The silent snowbound heights guard secret valleys of unbelievable loneliness that give the seeker and the pilgrim a glimpse of paradise.

Old men and women and children with loads on their shoulders, slowly and painfully trudge over the steep rocky climbs to pay homage to the mountain gods. This strange pi1grimage is perhaps a legacy of those ancient men who crossed turbulent streams cut across hard granite walls and braved icy winds to watch nature's splendour in its totality. They saw the distant Himalayan peaks touching the heavens. Perhaps Gods resided on those lonely, frightening yet beautiful summits.

No wonder, every layer of these mighty walls of snow and rock is embedded with legends and myths. Legends of gods, goddesses, and supernatural creatures like Yeti vanquish there. Shiv, it is believed, lives atop Mount Kailash. Many summits are named after Him – Nilkanth, Gauri Shankar, Kedarnath, Trishul. His wife goddess Parvati also lent her name to peaks like Annapurna and Nanda Devi.

We engineers continue the penance initiated by the devout prince Bhagirath and pay homage to Himalayas by buildings, dams, tunnels and powerhouses to bring prosperity to the land and people.

-- Anonymous

This humble tribute paid by an engineer indeed reminds us the divine glories narrated by Lord in the Chapter X of Bhagvad Gita :

I am self seated in the heart of all beings;….
among the luminaries, I am the bright rayed Sun;
among the living beings, I am the consciousness;
among the rivers, I am the Ganges;
Of sciences, I am the science of soul (metaphysics);……
among the purifiers, I am the wind;……..
among the seasons, I am the spring;……..
among the immovables, I am the Himalayas……..

-- Subhash Mitra, Chief Editor, JRMTT

The Lessons of Success

Today represents, to many of you, a transition from the world of preparation to the real world of contribution. As you cross the threshold of your campus to enter your professional lives, you may have fixed emotions – a feeling of excitement tinged with a little anxiety about succeeding in the future as you have done in the past.

I remember going through similar feeling three decades ago when I returned from Stanford University to India. Western India Vegetable products, as Wipro was then called was a small organization located in Jalgaon District. I was suddenly propelled into a role for which I had little preparation. Initially, I found the prospect daunting. At the same time, I was excited when I realized that this enormous challenge also brought with it an enormous opportunity. Gradually, this transformed itself into a powerful vision of building a different kind of Indian organization.

Transforming the vision into reality was not going to be easy. It would need single-minded determination, unshakable self-confidence and tremendous amount of unstinting hard work. As I look back, this experience has taught me a number of useful lessons. I would like to use this opportunity to share them with you, using the story of Wipro to illustrate my learning.

The first lesson I learnt is that hard work is the most critical ingredient of success. There is no debate whether you need to work smarter or harder. One has to work both smarter and harder. Your days at IIT have taught you to work hard. If you wish to succeed in your profession, you will have to work only harder. Your peers will bring in similar credentials. The one way you can move ahead is by working harder than them. If Wipro has done better than a number of other blue chips of yesteryears, it is not because of extra-ordinary ability or resources, but by the sheer dint of hard work. Perhaps smarter men work less. But I find that if do not put in a 70-hour plus workweek, I am unable to be on top of my job. I have found no substitute for relentless hard work.

The second lesson I learnt was that hard work must be towards a purpose. One needs to identify a purpose that inspires you, challenges you and gives you tremendous satisfaction to pursue. The purpose we defined for Wipro was that it should be an organization built on values with a vision of becoming a leader in every business it was in and we took concrete steps towards achieving this. We began by defining our values in the form of six Beliefs. This was done in the seventies, long before it was fashionable to do so. These Beliefs remained our guiding beacon throughout the difficult times we went through. We have now articulated these Beliefs as four Wipro Values and these define the course of every management decision in Wipro and we monitor ourselves constantly against these to ensure that we walk our talk.

I have always been inspired by the story of two masons working on a construction. When they were asked what they were doing, one of them said that he was building a wall. The other said that he was building a cathedral. The mason who has a larger purpose in mind would have a quantitatively different approach to his work, with a far higher degree of dedication, commitment to excellence and passion. If you are clear about the higher purpose you are working towards, you will be able to see new meaning in what you do and will be propelled by a restless intensity to achieve it.

The third lesson I learnt was the pivotal role of people in any organisation. We were one of the early companies to visit premier campuses like yours for our people. Many campus recruits now occupy senior and top management positions in Wipro and have contributed enormously to its growth. We have always kept up the highest standards in our recruitment and management development to create an organization of motivated, energized people with a mission.

The fourth lesson I learnt was that one needs to continuously raise one's standards. We entered the markets with products that had features ahead of their time and assiduously built a reputation for Customer Services. But that was not enough. We resolved to become a world-class organisation. Wipro was the first company in India to adopt the Six Sigma approach to Quality. This approach helps to benchmark ourselves against the International Standards, reduce defects and cycle time of our operations. This will help us to continuously raise the bar.

The fifth lesson I learnt was that one could never afford to stop learning. It reminds me of something I read which goes; just when I knew all the answers, they changed the questions! As a company, we encourage training at all levels; I find it absolutely necessary to keep reading, attending seminars and actually teaching to keep myself up to date. I have found that teaching is a good way to learn. It puts a tremendous amount of back pressure on you to research the latest in literature available on the subject. Changes in technology and business processes are so rapid that whatever one learns becomes obsolete in no time. So, what is important is not your existing knowledge, but your ability to keep refreshing it dynamically. You have to learn to learn. And keep learning.

The sixth lesson, I learnt was that you cannot wait for opportunity to come your way. Actively search for opportunities and grab them when you see them. Long ago, I realized that future is not what happens to you, but what you make of it.

India is a very large canvas of opportunity. At the risk of repeating a well-known apocryphal story, I would like to relate it to you. Two salesmen from a shoe company went to a remote island. One came back saying that there was no market in that island since nobody wore shoes. The other returned triumphantly saying that there was tremendous market because no one else had sold shoes before in that island. It is a matter of perspective.

-- Extract from the convocation address by Mr. Azim H. Premji, Chairman & Managing Director, Wipro Ltd. at the 37th Convocation of IIT Bombay
Source: University News 37 (43), Oct.25, 1999